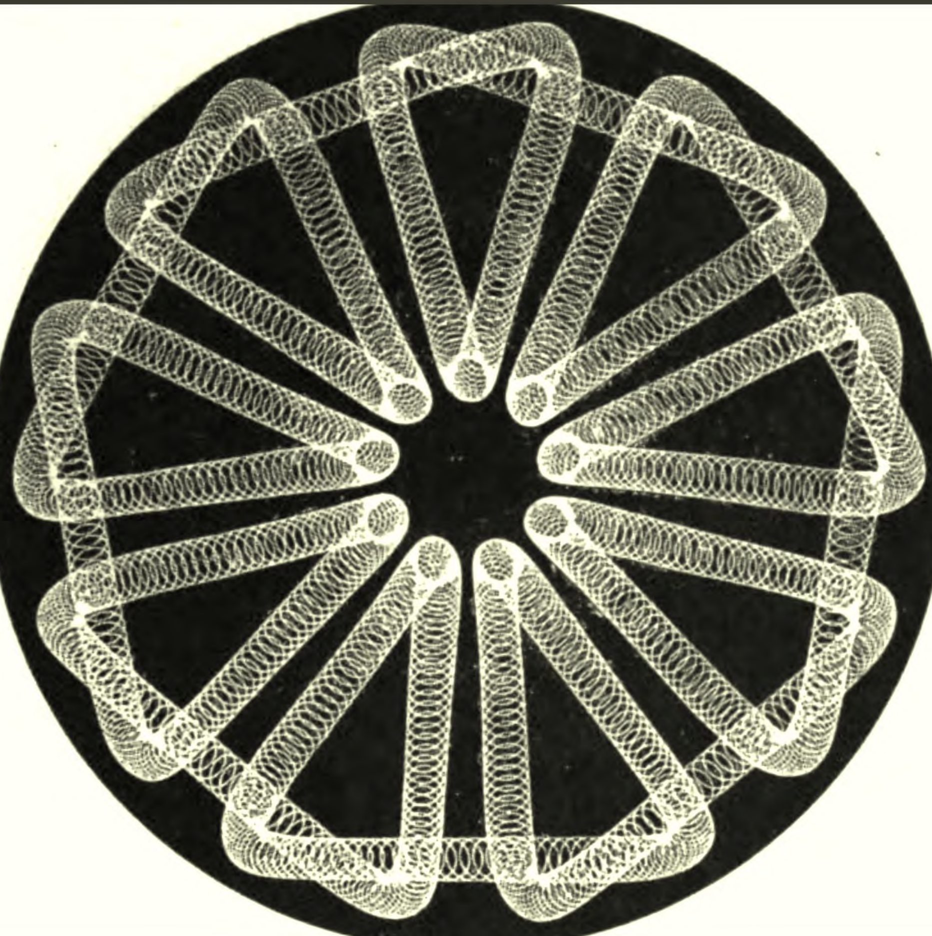
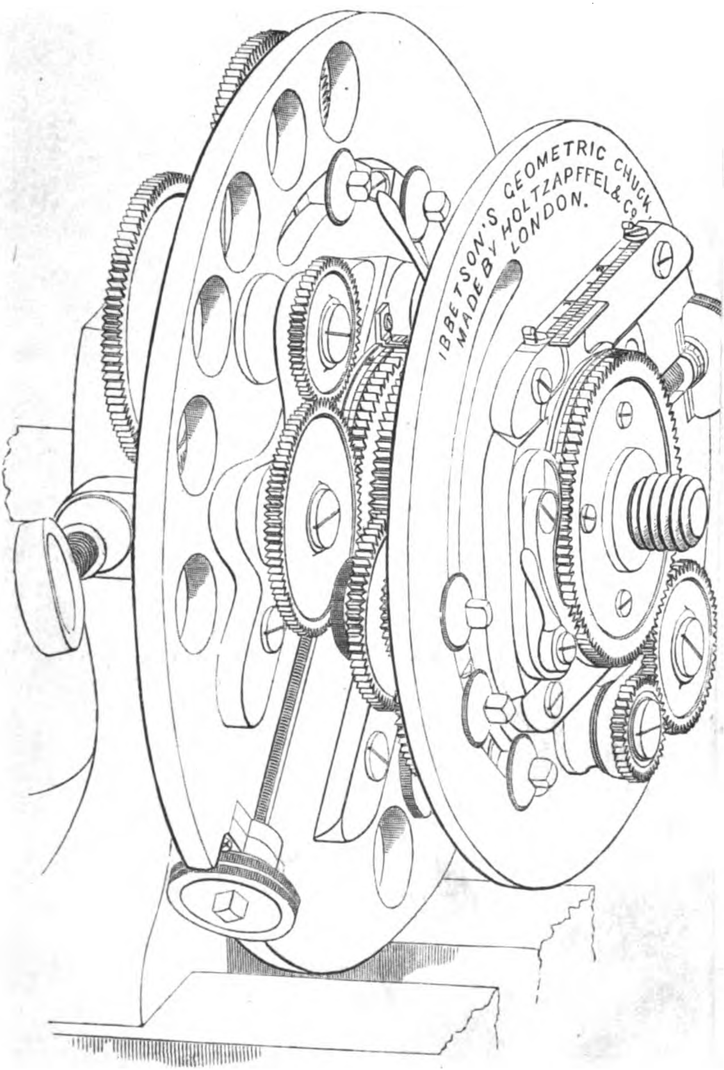


Index to the Geometric Chuck

Thomas Sebastian Bazley


IBBETSON'S GEOMETRIC CHUCK.
MADE BY HOLTZAPFFEL & Co.
LONDON.

The Geometric Chuck.

INDEX TO THE

GEOMETRIC CHUCK:

A TREATISE UPON

THE DESCRIPTION, IN THE LATHE,

OF

SIMPLE AND COMPOUND EPITROCHOIDAL OR "GEOMETRIC" CURVES.

BY

THOMAS SEBASTIAN BAZLEY, M.A.,

AUTHOR OF

"NOTES ON THE EPICYCLOIDAL CUTTING FRAME."

LONDON:
LITHOGRAPHED, PRINTED, AND PUBLISHED FOR THE AUTHOR, BY
WATERLOW AND SONS, GREAT WINCHESTER STREET, E.C.;
AND SOLD BY
HOLTZAPFFEL & CO., 64, CHARING CROSS.

1875.

PREFACE.

In the preface to the Notes on the Epicycloidal Cutting Frame,* a list was given of the publications which had up to that time appeared on curve tracing as applied to ornamental turning; and their number has since been increased by Mr. Savory's work,† which contains a rich and extensive series of designs.

The Chuck by which those engravings were produced, and for the manipulation of which very ample directions are given, is that known as Plant's—but which would be called Hartley's with more propriety—and a drawing of it as mounted in the lathe appears in Mr. Savory's book. Its solidity and compactness are considerable, and on some accounts it possesses many advantages over other forms; but its rather limited character of change wheels, both in number and position, and the circumstance that the multiplying value, reckoned backwards, of its permanent wheels is *three*, seem to render this construction less desirable for general use, especially where low

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* Trübner & Co.

† "Geometric Turning," by the Rev. H. S. Savory, Longmans.

numbers are employed, than that known as Ibbetson's, as now manufactured, with improvements from various sources, by Messrs. Holtzapffel and Co.

The combinations of which the Geometric Chuck is susceptible are so varied and numerous, that without some knowledge of the results to be expected from changes in each of the several adjustments, much time may be lost in vague trials, and some desired effect be still unattained. The object, therefore, of the present volume is to furnish the Amateur with a manual of reference upon the Chuck, and a sort of Index to its performances, not with a desire to exhibit an interesting series of pretty patterns, but rather to show how pretty patterns may be made.

Enough has been said,—and drawn,—to indicate, though not to illustrate completely, the inexhaustible resources of any apparatus for compound epicycloidal* turning. The methods of compensation recommended in these pages may be found useful, and the perhaps too copious collection of diagrams may save time and trouble in examining some special conditions of adjustment. And the considerable increase to the resources of the Chuck obtained by adding the Epicycloidal Cutting Frame, as a constituent part of the whole apparatus, as described in the last two chapters, will not be without interest. But if nothing else has been established, it will be admitted that fractional values, for one or more of the

* "Epitrochoidal," more correctly.

"Parts" employed, have proved vastly superior to the more usual combinations where the train-values are solely integral.

Some may prefer the delicate engraving on wood or metal, or even glass, which is the more commonly practised; others may choose to enrich a comparatively simple figure by deep cutting with an ornamental drill. Both forms of decorations have their special charms, and it is hoped that this treatise may render their pursuit more easy and agreeable.

The impression of this work consists of 150 copies only, probably about equivalent to the number of persons who take an interest in this peculiar branch of amateur mechanism; and as the lithographic stones were obliterated as the successive transfers were completed, the book cannot be reprinted.

THOS. SEBASTIAN BAZLEY,

HATHEROP CASTLE,
FAIRFORD,
February, 1875.

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GLOSSARY

OF

TERMS AND ABBREVIATIONS.

G.C. The Geometric Chuck, in one or more "parts."

Part. A single geometric chuck, or similar apparatus, with separate train of wheels and eccentric slide.

Ex., Ex_1, &c.—Amount of eccentricity expressed in hundredths of an inch given to the eccentric slide.

S.R. Distance on the slide rest, expressed in hundredths of an inch, from the axis of the mandrel, measured towards the observer.

V, V_1, &c. The train-value or diminishing effect of the wheels in use on any particular "part."

n The velocity ratio resulting from the value given to V. [Page 5.]

"in." The number of arbors engaged in the train referred to is odd.

"out." That number is even.

$F.M_1$, $F.M_2$. The first motion wheel in the first and second "parts" respectively.

Initial position. The mutual position of two or more portions of the apparatus necessary to the correct description of the curve.

Companion figures. Obtained by change of one "initial position" for another, without alteration of any of the numerical values, or directions of motion, concerned.

Sp. Train-value of the Spiral Apparatus, including that of the subsidiary train.

E.C.F. The Epicycloidal Cutting Frame;

Fr. and Fl. Its frame and flange;

T.S. The tangent screw of its adjusting wheel at the hinder end of its principal axis.

CHAPTER I.

The Simple, or First Part, Chuck.

THE simple, or first part, Geometric Chuck bears considerable resemblance in its main features to the well-known Eccentric Chuck, and in fact may be used as such. Each has, in front of the foundation plate, an eccentric slide, actuated by a screw of 10 threads to the inch, and carrying a large front wheel, usually of 96 teeth, which can be secured at any point of its circumference by a strong detent clamp, and whose axis terminates with a screw corresponding to that of the lathe mandrel for carrying any of the lighter fixing chucks. But in the Eccentric Chuck the large front wheel carried by the eccentric slide remains absolutely fixed, as regards the neighbouring parts, during the rotation of the chuck in the lathe; whereas, in the Geometric chuck, the similar large front wheel receives under such circumstances an independent motion of rotation. And this motion, effected by a train of wheels, can be made to bear almost any desired ratio to that of the chuck itself, *i.e.*, of the mandrel. It may also be in the same direction as that of the chuck, or the contrary.

This train of wheels is arranged in the following manner. Upon the central boss, at the back of the foundation plate, in which is pierced the internal screw for attaching the chuck to the mandrel, is placed a wheel of the same diameter (96 teeth) as that in front of the eccentric slide. This wheel, which may be called the "first motion wheel," rotates easily upon the boss, and is maintained there by a screwed steel ring. Another wheel of 96 teeth, but of less width and lighter make, is placed in contact with the first motion wheel, being mounted eccentrically on a removable arbor, keyed, with a wide range of position, into a long curvilinear mortise cut through the foundation plate for about half its circumference and near the edge. Whatever be the position in the mortise in which this last-named wheel may be secured, it will be always in gear with the first motion wheel, though its eccentric arbor provides for adjustment of the two wheels as to depth of contact, and also for their complete separation when necessary. The arbor is long enough to receive the 96 wheel which it always carries, and two other wheels besides, of the same thickness: and the first motion wheel is also sufficiently wide to receive the 96 wheel, whichever of the three positions it may occupy on the arbor. Three other removable arbors, of similar size and shape, but without the eccentric fitting, can also be fixed, together or separately, in the curvilinear mortise of the foundation plate; they are each of such a length as to carry three wheels, either one, or two, only, being in operation, and the remaining spaces or space being filled by two blanks, or one; the blank being a small toothless ring of the least diameter practicable, and of uniform thickness with the wheels. All these arbors possess an independent axial rotation, and are provided with a projecting key for the security of the wheels they carry.

Just beyond the termination of the curvilinear mortise, is a socket in the foundation plate, through which passes a permanent arbor, carrying at the hinder end a wheel of 96 teeth, and at the front end, on the face of the chuck, a wheel of (48) half that number of teeth. This last communicates with the front (96) wheel by a single intervening wheel of convenient size, which is supported by the extremities of two arms of a simple link motion, whose other ends are attached centrally behind the 48 wheel last mentioned, and the front wheel, respectively. And the object of this connection by link is to provide that no alteration in the eccentricity of the chuck slide shall throw the front wheel which is carried by the slide, "out of gear" with the 48 wheel on the front end of the arbor passing through the foundation plate.* The hinder end of this arbor is adapted (like the four removable arbors) to receive in any one of three planes the 96 wheel which it carries: and the various change wheels which may be required are interposed, on one or more arbors, between the 96 wheel last-mentioned and the 96 which is always in contact with the first motion wheel. For convenience of distinction, the five arbors which have been described are engraved with the letters from A to E respectively, beginning with that which transfers the motion from behind the chuck to the front. And supposing that no change wheels whatever are introduced, but that 96 on the sliding arbor E is brought up along the mortise into gear with the 96 on the fixed arbor A, being at the same time in gear with the (96) first motion wheel, this arbor A would make one rotation for one of the first motion wheel. Then, as there is a diminishing effect of one-half produced by the wheels in front of the chuck, it follows that, when no change wheels are in use, the front 96 makes one rotation for every two of the first motion wheel. This statement is altogether irrespective of the motion of the chuck in the lathe (for then the properties of an epicyclic train would have their effect), and refers only to the relative speed of the two wheels in question, supposing one of them to be turned by hand on its axis. The normal value, therefore, of Ibbetson's geometric chuck, or the diminishing effect of its permanent wheels, is *two,* instead of *three* as in the construction referred to in the preface.

A large assortment of change wheels, from 24 to 96, with duplicates of several, is furnished with the chuck, and minute details of the settings are supplied by the makers, specifying the wheels required for such numbers of consecutive loops as are within the compass of the instrument,—the order of their

* This contrivance, frequently used in mechanism to maintain a constant distance between the centres of two or more adjacent wheels, is understood to have been applied to the geometric chuck by Henry Perigal, Esq., F.R.A.S.; who has studied the subject of compound circular motion more deeply than any other Amateur. (See Northcott, "Lathes and Turning," pa. 275, and the article "Trochoidal Curves" in the Penny Cyclopædia.)

arrangement (which is frequently of importance),—and the plane, as regards its position on the arbor, which each wheel is to occupy. In the composition of trains for high numbers there is frequently occasion for some management and care in adapting the selection of wheels to their mutual size and position; it is also sometimes impossible to arrange them satisfactorily without including an "idle wheel," or "carrier," in the train, and in such instances it will be necessary to include another "carrier" if the direction of motion, when the train has been composed, be not that which is intended.

The reader, if unacquainted with the Geometric Chuck, will be inquiring by this time how the train, when duly completed, is to be set in motion; for it is obvious that, as hitherto described, there is no reason why any rotation of the wheels should occur, during their revolution with the chuck upon the mandrel, unless they should become affected by centrifugal force, to prevent which the front wheel is secured by its detent when its fixity is essential. The mechanism is converted into an epicyclic train by the following additional apparatus. A brass plate is secured to the face of the lathe head by a large finger screw at each end, in the same way that the ring of the Elliptic (or so-called "Oval") chuck is fastened in the same place; and, like that ring, this brass plate has a range of transverse endways, by the action of its finger screws, for a purpose which will appear subsequently. A three-toothed spring detent, similar to that which applies to the front wheel of the chuck, is attached to the plate in such a position that it can clamp the "first motion wheel" at any point of its circumference, or, on being released, will allow it to move freely on its axis in its central position at the back of the chuck.

The symbol V will be used, in the following pages, to denote the diminishing effect of the whole train of wheels; *i.e.*, the number of times which the first motion wheel if turned by hand would rotate during one rotation of the front 96 wheel, and this is synonymous with the number of loops which the chuck is arranged to produce. The value assigned to V may be either integral or fractional, and we have seen that when no change wheels are in use the rate of motion is affected only by the 48 wheels in front of the chuck, and then V=2. Now when the first motion wheel is held fast by its detent clamp on the brass plate, and the lathe is set in motion, the succeeding wheels begin to rotate on their respective arbors, and the front 96 wheel, being free from its own detent, will make fewer rotations than the mandrel in proportion to the value, V, of the train. But it does not make V times fewer. On the contrary, it will, if rotating in the same direction as the mandrel of the lathe, make (V+1) rotations for each one of the chuck; while, if rotating in the opposite direction, it will make (V–1) rotations for each one of the chuck. The test of experiment will readily satisfy the amateur that this is the fact;—for example, when the permanent wheels only of the chuck are engaged, and V=2, the front 96 wheel will make one rotation for one of the chuck, and the directions of motion of chuck and front wheel are opposed; and, if an arbor carrying a single wheel be interposed between the two 96's on the arbors A and E, the directions of motion of chuck and front wheel become identical, and the latter makes three rotations for one of the former. It may here be observed, once for all, that (unless V be less than unity, a condition of things which is entirely exceptional) the directions of motion are opposed, and the loops turn outwards when the number of arbors from A to E inclusive is *even;* and that when the number of those arbors is *odd*, the directions of motion are the same, and the loops turn inwards. Strictly speaking, it should have been said that, in the former case, the rotations of the front wheel are (1–V) in number, V being the negative; but the employment of the minus sign would entail some awkwardness in tabulating the adjustments, and it is not proposed to encumber these pages with mathematical explanations. An attempt at elucidating the theory of the subject was made in the "Notes on the Epicycloidal Cutting Frame," mentioned in the preface, and further information may be obtained from the article in the Penny Cyclopædia there quoted.

Suffice it to say, that if the number of rotations of the chuck for those of its front wheel in a given time be as n : 1 ; then, when the eccentricity of the chuck slide (Ex.), and the radius of the tool or describing point in the slide rest (S.R.) *i.e.*, its distance from the axis of the mandrel, reckoned from right to left, are likewise in the proportion of n : 1,—*i.e.*, when $\frac{\text{Ex.}}{\text{S.R.}} = n$,—the curve produced is cusped (fig. 6), and when these distances are in the proportion of $n^2 : 1$,—*i.e.*, when $\frac{\text{Ex.}}{\text{S.R.}} = n^2$,—the figure is, at one or more points, nearly right-lined in character (fig. 25). Also, when $\frac{\text{Ex.}}{\text{S.R.}}$ is less than n^2, but greater than n, the cusps are rounded and immature (fig. 60) ; and when $\frac{\text{Ex.}}{\text{S.R.}}$ is less than n, the cusps develop into loops (fig. 7). Further, as Ex. becomes less and S.R. greater than the values they respectively possessed at the appearance of the loops, the loops enlarge, intersect, and approach the centre of the figure, passing through that centre when Ex. = S.R. And lastly, as S.R., now greater than Ex., continues to increase, and Ex. still further to diminish, the loops become less distinguishable, and the lines more crowded, the effect generally produced being that known as the "Turk's cap" in eccentric turning (fig. 32) ; till, when Ex. has vanished altogether, we have a circle only, whose radius = S.R., and similarly, if S.R. has no value, the resulting circle is of the radius = Ex. From what precedes it is evident that when the chuck is arranged to produce internal loops, $n = V + 1$, and when it is arranged to produce external loops, $n = V - 1$. Therefore, since V is always known,—being the resulting fraction, in its lowest terms, obtained by the general rule for ascertaining the effect of any train of wheelwork, viz., multiplying all the drivers together for the numerator, and all the driven together for the denominator,—it is a matter of simple calculation to find what values, for any given arrangement of wheels, should be taken for Ex. and for S.R., in order that the curve may be looped, cusped, waved or right-lined in character.

The readiest way of reducing the final velocity of the front terminal 96 wheel, thereby increasing the value of V, is to place a small wheel on the arbor E, by which, instead of by the 96 on that arbor, the motion shall be transmitted to the 96 on the arbor A. For instance, if that small wheel have 32 teeth, the velocity will be diminished one-third, and V will =6. Suppose now another removable arbor, B, to be added, carrying the pair of wheels 24 and 60, of which the 24 is intended to gear with the 96 on A, and the 60 with the 32 on E. Then, arranging the whole train as fractions in the usual manner, beginning with the front 96 wheel, placing the drivers as numerators and the driven as denominators, they would stand thus :—

$$\frac{96 \text{ front}}{48 \text{ link}} \times \frac{96 \text{ on A}}{24 \text{ on B}} \times \frac{60 \text{ on B}}{32 \text{ on E}} \times \frac{96 \text{ on E}}{96 \text{ fixed}} = 15\,;$$

and V therefore would = 15 for the case supposed. But on proceeding to arrange the wheels and arbors in the manner here indicated, it would be found that the 60 on B could not be brought into contact with the 32 on E, owing to the large diameter of the 96 on the latter. This inconvenience may be remedied in either of two ways; either by interposing a single wheel of suitable size between the 32 on E and the 60 on B, or by selecting another pair of wheels for the latter arbor in the same proportion as the 24 and 60, but of higher numbers: and the pair 32 and 80, or at any rate the pair 36 and 90, which pairs are both in the same proportion as the 24 and 60, would afford sufficient space for the accommodation of the neighbouring wheels. And, proceeding in the same manner, if one pair of change wheels will not effect the desired ratio between the velocities of the chuck and its front wheel, we may add one, or even two additional pairs on the arbors C, D, beside placing a second wheel on the arbor E smaller than the 96, upon that arbor which is always in gear with the first motion wheel. It is not necessary to remind any one who may read these pages, and who will, therefore, presumably have some previous acquaintance with mechanism generally, that a single wheel or "carrier," introduced at any part of a train, alters the direction of rotation of all the succeeding wheels, but makes no difference in their speed. The addition of a single wheel in this manner on a removable arbor will consequently alter the relative directions of motion of the chuck and its front wheel, and will be found to change the loops, from "in" to "out," or *vice versâ*. And it is often requisite, as suggested in the case just given, to add a single wheel to the train, in order to bring those into gear, which would otherwise be prevented from meeting by some wheel of larger diameter employed on one of two adjoining arbors. Moreover, on some occasions *two* single wheels may be necessary; one to render the train complete, the other to obtain the ultimate direction of motion which may be desired.

In calculating the value V of any arrangement of wheels, it is more convenient to begin from the front 96 wheel, instead of from the first motion wheel at the back; as by so doing, the result expresses at once the number of loops produced: and it is doubtless for this reason that the fixed arbor is designated A, and the last sliding arbor E. The 96 permanently attached to this arbor E, and the 96 fixed or first motion wheel, which, in all cases make up the concluding fraction of the series, may clearly be omitted from the calculation: and instead of writing down the front terminal 96, and the 48 which follows it by the intervention of the link motion, the figure 2 may be prefixed to the remaining fractions. Hence the value of V for any given train, will be obtained by substituting the numbers of teeth in the respective wheels for the letters in the following expression:—

$$V = 2 \times \frac{a \times b' \times c' \times d'}{b \times c \times d \times e}$$

where a represents the 96 on A, a and b′ the pair on B, and so on; of which b is in gear with a, and b′ with c, c′ with d, and d′ with e; e being either the smaller wheel on E, when that arbor carries two, *or* the 96 itself when that is the only wheel in use upon that arbor, and in that case, a and e being each equal to 96, may both be struck out. Of course, such of the pairs bb′, cc′, dd′, as are not required will also be omitted from the calculation.

The converse process of ascertaining what wheels should be used to give a specific value to the train will be effected by putting that value for V in the expression stated above, and then selecting such numbers, corresponding with wheels at our disposal, for the factors b b′, &c., to e, as will satisfy the simple equation thus formed. But it often requires some discrimination to hit upon the most eligible numbers; for fractions, though perfectly correct, cannot always be translated into wheels of the same numbers; and others in like proportion have to be substituted, as was explained in the example just given for V = 15.

Since $V = 2\frac{a}{b.}\frac{b' \; c' \; d'}{c \; d \cdot e}$, let $\frac{a}{e}$ stand for the fraction or series of fractions by which the desired change wheels may be represented. Then $\frac{a}{e} = \frac{V}{2}$, and in order to discover what wheels should in each case be adopted, we have only (when V is a whole number) to take the required value of V for the numerator of a fraction, and 2 for its denominator; and then to expand that fraction until, without interfering with its value in its lowest terms, it has become expressed in numbers representing wheels which are available. Thus, if an eight-looped figure is wanted, and V is therefore to be equal to 8, we have $\frac{V}{2} = \frac{8}{2} = \frac{96}{24}$, for which the simplest arrangement will be to add a 24 wheel in front of the 96 on the E arbor, and to bring that 24 into gear with the 96 on A. Similarly if V is to be 12, we have $\frac{V}{2} = \frac{12}{2} = \frac{2}{1} \times \frac{6}{2} = \frac{96}{48} \times \frac{96}{32}$; and here the pair of wheels 96 and 48 on the removable arbor B will be brought into requisition together with a 32 on E. So, again, if V is to be 25, $\frac{V}{2} = \frac{25}{2} = \frac{5 \times 5 \times 2}{2 \times 2 \times 1} = \frac{60}{24} \times \frac{70}{28} \times \frac{96}{48}$, but as wheels of these numbers are not suitable to one another, others of larger size and equivalent proportion must be found, and the following would be found to answer,—$\frac{80}{32} \times \frac{90}{36} \times \frac{96}{48}$. It will be remembered that each of the arbors A to E will receive wheels upon any of three planes; and this offers a convenient method for recording any particular arrangement. For instance, the train now composed for V = 25 would be described thus:—

A.	B.	C.	D.	E.
96	—	32	—	—
—	—	—	90	48
—	—	80	36	96

And the valuable tables furnished by Messrs. Holtzapffel & Co., with their Geometric chucks, are constructed on this principle. But the amateur will find it advantageous to be independent of memoranda, and to be able to calculate at once without reference to tables any train that may be required. A few further examples, therefore, may be useful.

With a 24 wheel on E, transmitting the motion from that arbor, we have V=8, without any other change wheels. And for values of V, whether integral or fractional, up to about 30, a single pair of change wheels on the arbor B, interposed between the 24 on E and the 96 on A, or, as is more frequently necessary, between the 96 on A and another 96 mounted simply in gear with the 24 on E, will probably suffice. Let these two wheels on B be designated by $\frac{b}{b'}$, then with the 24 on E, as now suggested, $\frac{b}{b'} = \frac{V}{8}$. Suppose V = 14, then $\frac{b}{b} = \frac{14}{8} = \frac{56}{32}$, or $\frac{70}{40}$, or $\frac{84}{48}$: and if V = 22, $\frac{b}{b'} = \frac{22}{8} = \frac{66}{24}$, or $\frac{88}{32}$; and for V = 30, $\frac{b}{b'} = \frac{30}{8} = \frac{90}{24}$.

For higher values of V than this, a third pair of change wheels will be generally requisite, and it is convenient to adopt the pair $\frac{96}{32}$, placing it between the arbor E and the single "carrier" wheel 96. With this arrangement, the value of the train becomes $2 \times \frac{b}{b'} \times \frac{96}{32} \times \frac{96}{24}$, and therefore $\frac{b}{b'} = \frac{V}{24}$;

and by using a 24 wheel to represent b′, it has the advantage that the only change wheel in the train corresponds to the number of loops required. Thus, if V=54, we have $\frac{b}{b'}=\frac{54}{24}$, and the following description shows how the wheels would be placed :—

A.	B.	C.	D.	E.
96	24	—	—	—
—	—	—	96	32
—	**54**	96	24	96

Any other wheel, not exceeding the limit of 96, having the same number of teeth as some other intended integral value for V, can be readily substituted for the 54 on B, and the figure will have as many loops as there are teeth in this particular wheel.

Higher values still for V can be obtained so long as the train is not too complicated, and the wheels too numerous to be received by the curvilinear mortise in the foundation plate.

A similar method of treatment is applicable when a fractional value is assigned to V. The denominator of the given fraction is to be multiplied by 2, or its numerator divided by 2 if that be practicable, and the fraction itself then expanded in the manner explained above. For example, if $V=\frac{8}{5}$, $\frac{b}{b'}=\frac{V}{2}=\frac{4}{5}=\frac{48}{60}$; and a pair of wheels of these or equivalent numbers would be placed on B between the two 96's on A and E. Again, if $V=\frac{17}{3}$, $\frac{b}{b'}=\frac{17}{6}=\frac{68}{24}$, and that pair would be used in the same manner. And in dealing with simple fractions of this kind, arising from either integral or fractional values of V, it is well to observe that the wheel *first put on* the removable arbor is that which corresponds to the numerator of the fraction : but when fractions require more than one pair of change wheels for their expression, this rule does not always hold good, the order of the wheels being sometimes inverted for their mutual convenience.

As a concluding example, take the fraction $\frac{81}{40}$ for the value of V. Here $\frac{b}{b'} = \frac{81}{80} = \frac{9 \times 9}{10 \times 8} = \frac{54}{60} \times \frac{72}{64}$: and these two pairs could be placed, on the removable arbors B and C, between the 96 on A and the 96 on E, thus:—

A.	B.	C.	E.	
96	54	—	—	(i.)
—	60	72	—	
—	—	64	96	

But if a numerator of one of the fractions can be made equal to 96, one of the arbors may be dispensed with; a wheel corresponding to the denominator of one of the fractions being placed in front of the 96 on E, thus:—

A.	B.	E.	
96	64	—	(ii.)
—	54	80	
—	—	96	

And this train is clearly equal to the former in value (though not in direction) since $\frac{81}{80} = \frac{3 \times 27}{2 \times 40} = \frac{96}{64} \times \frac{54}{80}$.

Besides the removable arbors receiving any two wheels in any of three planes, there is provided a single 48 wheel on so short an axis that it can be placed behind larger wheels occupying the second or third planes on either of the adjoining arbors, in order to connect wheels on the first planes of those arbors. It could be used, for instance, behind the 96 on D, between the 24 on that arbor and the 96 on C, in the train described above for producing 54 loops or any other similar number, in order to change the ultimate direction of motion from "in" to "out;" the number of arbors engaged being odd in the former case, and even in the latter. And in such a case as (ii.) above, the 80 and 96 might change places on the arbor E, the 54 on B be removed from the second plane of that arbor to the first; and then the single 48 wheel could be used if needful to connect the 80 and the 54.

There is also a double wheel 48-24, which is employed to connect a wheel on the first plane of one arbor with a wheel on the second plane of another arbor, reducing the velocity by one-half at the same time; and the axis of this double wheel is short enough to permit it to pass behind a larger wheel on the third plane of the former arbor. Before leaving the subject of change wheels and their arrangements, it should be pointed out that a series of three or four fractions, whose numbers do not readily accommodate themselves to the dimensions of the corresponding wheels, may often become manageable by changing the position of the numerators, or of the denominators, among themselves, so that wheels of suitable sizes may follow one another. Though this proceeding would affect the value of the fractions individually, it would not alter the product of the whole, nor the final operation of the train.

The value of S.R. is determined as usual by the slide rest screw in hundredths of an inch; the bed of the rest should be graduated in inches and tenths, and care be taken to counteract any "loss of time" in the screw. The value of Ex. is given in a similar manner by the screw of the chuck's eccentric slide, but the error of loss of time may, in this case, fortunately be neglected, as the reading of the eccentricity of the slide is obtained by a vernier on its edge; though the slide screw is also furnished with a micrometer head, for use when preferred, and for occasional comparison with the indications of the vernier. Decimals of a division, *i.e.*, thousandths of an inch, may be estimated on both slides, more or less successfully. The edges of the first motion wheel, and of the front terminal wheel, are marked off into 12 equal parts, with subdivisions for the guidance of their respective detents.

The following figures (1—214), which are offered in illustration of the elementary performances of the geometric chuck, consist, with a few exceptions which will be specially noticed as they occur, in each case of a single line; and they will, it is thought, be better adapted to explain the operations of the chuck, and to show the results to be expected from various adjustments in combination, than more complicated and more elegant designs. Each class of figures is of the same size, and the plan adopted has been to vary the quantities Ex. and S.R. from zero to a maximum of 60 divisions (0·6 in.), one increasing while the other diminishes. Diagrams are given of those phases of the curve which possess sufficient distinctive interest, although the series in the tables is commonly given more fully; and for the sake of expedition, the figures were drawn on lithographic paper by a pen mounted at a suitable angle in the slide rest. They are often imperfect, and in no instance pretend to any beauty of execution, but they will answer their intended purpose as well as engravings from the more costly and tedious processes required for the use of boxwood blocks or copper plates.

No Geometric chuck can be complete without a paper chuck and a spring pencil-holder for preliminary trials. The former, in its most convenient form, consists of an ordinary brass "face-plate" 5 or 6 inches in diameter, to which is hinged in front and retained by a spring fastening, a flat ring of equal exterior diameter, and having a central circular aperture of 3 or 4 inches in diameter; with this contrivance. the paper is securely held, and can be changed instantly. The spring holder may receive an ordinary lead pencil in cedar, or an "ever-pointed" pencil stem carrying a patent "lead" of the smallest size. Metallic paper and pencil may also be employed with much advantage. And the figures can readily be drawn by pen and ink if preferred: for the ordinary use of a pen by hand entails frequent alternation of motion, and a good steel pen, held at an angle of about 35° with the plane of the paper, will make fine strokes in all directions with almost equal facility. There ought, therefore, to be no difficulty in adapting a pen held by the slide rest to the vertical position of the paper, and to its varying rate and direction of movement, and the following simple arrangement will be found fairly satisfactory.

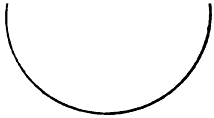
A piece of brass wire about 7 inches long and of convenient thickness (about $\frac{3}{16}$ of an inch) for receiving at one end the metal barrel of a small sized penholder, is to be filed at the other end, with a semi-cylindrical termination, and fitted tightly into the steel holder which receives the little tools of the drilling instrument in the process of sharpening, and which can be secured like an ordinary fixed tool in the slide rest. The wire thus prepared should be bent into a swan-necked shape, leaving the ends straight, and making with each other an angle of about 55°. The length of the wire in front can be reduced as may be required till the point of the pen, in its holder, falls conveniently within the range of the elevating screw of the slide rest for adjustment to height of lathe centre. The pen is placed with the concave side upwards, and usually distributes in proper quantity the ink with which it may be charged. Being inclined at about 55° to the horizon, the pen will make an angle of about 35° with the paper, which is held vertically; a position which is found to be the most favourable for the avoidance of spluttering. This liability, however, cannot be avoided entirely; occasions will arise when the course of the paper carried by the chuck is such as to render the pen peculiarly prone to catch at the slightest inequality; and also when, during a retrograde movement, the ink, especially lithographic ink, which is not so tractable as ordinary writing ink, tends to quit the pen too freely. Under such circumstances, an exceedingly slow movement of the chuck, an occasional withdrawal of the pen, and the exercise of considerable patience, are the only remedies.

The arrangement for the pen described above is, it will be observed, independent of a spring holder; for the pen does not, like the pencil, require pressing against the paper. On the contrary, when charged with ink it attracts the paper, and the latter, though tightly stretched, clings to the pen, and the continuity of the inked line is seldom broken. The lithographic ink, paper and pens used for this work were obtained from Messrs. Waterlow & Sons, by whom also the diagrams were transferred to stone and printed. The mark left by this ink upon the prepared paper, though sufficient for the printer's use, is often barely perceptible. But when the pen passes over the same ground more than once, and intersects lines already damp with a previous deposit of ink, there is a tendency to tear off specks of the composition with which the paper is coated. These require removal from the point from time to time, and the pen should be kept scrupulously clean ; a good one will last a long time, and the greater part of the diagrams in this book were drawn by the same pen without renewal. In some of the more complicated figures the marks are only partial, and these points of failure of ink contact, though detracting from the effect, may help to show more clearly the course of the describing point, and the construction of the figure.

It may be useful to remark here that while *the sum* of Ex. and S.R. remains the same, the size of the figure (or, to speak more correctly, the diameter of the circle circumscribing the figure) also remains the same, and that while *the difference* of Ex. and S.R. is similarly constant, the diameter of the circle which may be inscribed in the figure remains unchanged. Whenever, therefore, it is desired to describe a curve which shall approach within a definite distance (*a*) of the centre of the surface, and which shall extend for a specified distance (*b*) beyond that centre, the corresponding values for Ex. and S.R. will be found by taking (*a*) for the difference and (*b*) for the sum of the two quantities. And their sums and differences being thus given, the quantities themselves are known also. For example, if a=40, b=20. (Fig. 32.)

Ex.+S.R.=60 or	2 Ex. =100	and Ex. =50
Ex.-S.R.=40	2 S.R.= 20	S.R.=10

But so far as the outer and inner boundaries of the curve are concerned, it is immaterial whether the higher value of the two which are obtained in this manner be given to Ex. or to S.R. ; and in the instance now referred to it happens that Ex. was 10 and S.R. 50. Therefore when a succession of curves is required to pass through a point in their course nearest to the centre, Ex. and S.R. must increase or diminish



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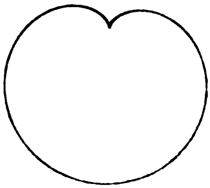

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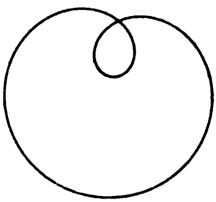

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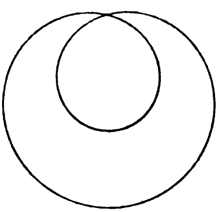

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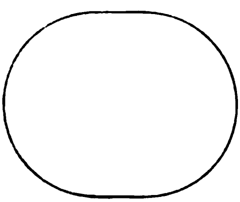

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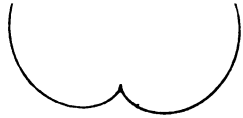

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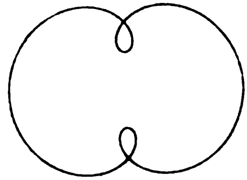

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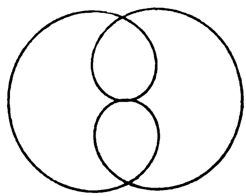

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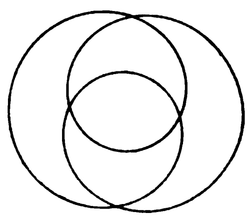

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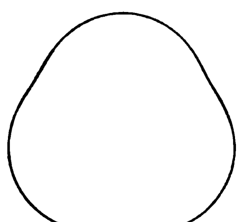
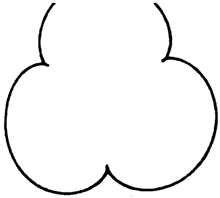


10.

together equally, and when a similar succession of curves is to pass through a point furthest from the centre, any increase in either Ex. or S.R. must be accompanied by a corresponding decrease in S.R. or Ex. When Ex. = S. R. all curves pass through the centre of the work, *i.e.*, the axis of the mandrel.

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
1	2	odd	1 in	48	12	1	$\frac{Ex.}{S.R.} = n^2$ (See page 6 for meaning of n.)
				40	20	2	,, = n
				35	25	3	
				30	30	4	
				20	40	...	The loop increases, and ultimately touches the opposite side of the curve, the two forming one circle.
				10	50	...	
1	0	even	none	...	...	...	The surface carried by the terminal wheel has no *rotation*, but moves round in a circle with a motion of translation only. The result is a circle whose radius = S.R., and whose centre is in the circumference of the circle whose radius = Ex.
2	3	odd	2 in	54	6	5	$\frac{Ex.}{S.R.} = n^2$
				45	15	6	,, = n
				40	20	7	
				30	30	8	
				20	40	9	
				10	50	..	
2	1	even	out	...	...	...	An ellipse is described, whose semi-major axis = Ex. + S.R., and semi-minor axis = Ex. − S.R. The conditions of $\frac{Ex.}{S.R.} = n^2$, $\frac{Ex.}{S.R.} = n$, and Ex. = S.R., are identical, and yield a straight line.
3	4	odd	3 in	56·2	3.8	10	$\frac{Ex.}{S.R.} = n^2$

V	n	arbrs	loops	Ex.	S.R.	Fig.	
3	4	odd	3 in	48	12	11	$\frac{Ex.}{S.R.} = n$
				40	20	12	
				30	30	13	
				10	50	14	
3	2	even	3 out	48	12	15	,, $= n^2$
				40	20	16	,, $= n$
				35	25	17	
				30	30	18	
				10	50	19	
4	5	odd	4 in	57.8	2·2	20	,, $= n^2$
				50	10	21	,, $= n$
				40	20	22	
				30	30	23	
				20	40	...	
				10	50	24	
4	3	even	4 out	54	6	25	,, $= n^2$
				45	15	26	,, $= n$
				40	20	27	
				30	30	28	
				20	40	...	} Similar in development to
				10	50	...	} those preceding.
8	9	odd	8	59·3	0·7	...	$\frac{Ex.}{S.R.} = n^2$ [S.R. too small to exhibit the right-lined form satisfactorily.]
				54	6	29	,, $= n$
				45	15	30	
				30	30	31	
				10	50	32	
8	7	even	8 out	58·8	1.2	33	,, $= n^2$
				52·5	7·5	34	,, $= n$
				45	15	35	
				30	30	36	
				10	50	37	



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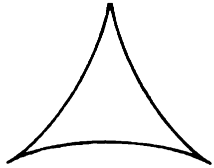

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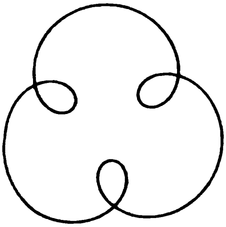

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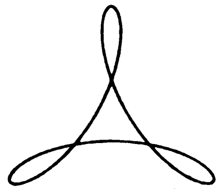

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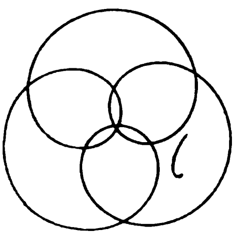

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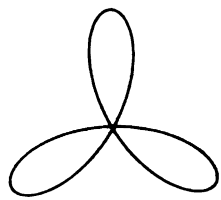

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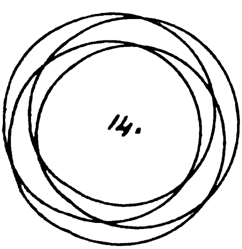

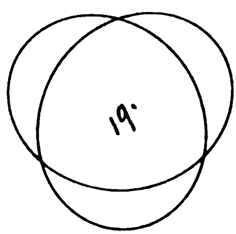

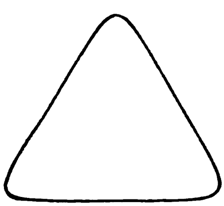

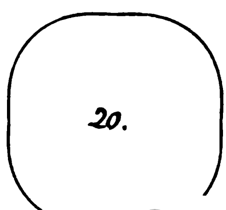

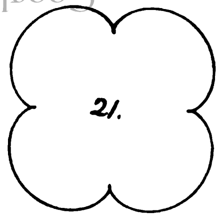
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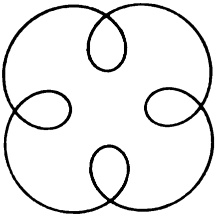
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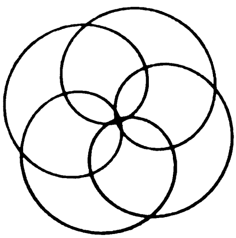
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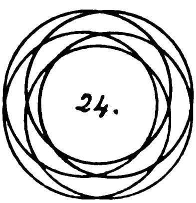
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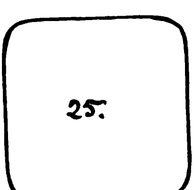
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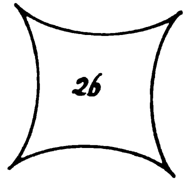
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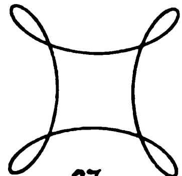
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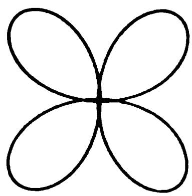
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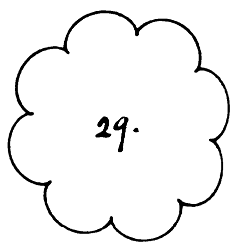
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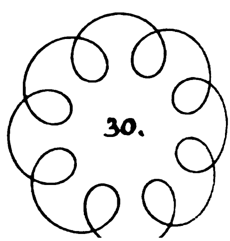
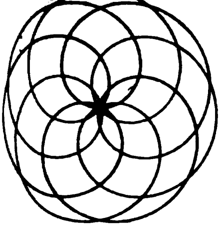

30.

The characteristic features of "consecutive" loops which always result from integral values of V, both internal and external, will be evident from these examples. The number of consecutive loops arranged in the circumference of a circle, which the geometric chuck can produce, is only limited by the size of the apparatus and the assortment of change wheels; the highest number attainable by the chuck now described being 256. But, speaking generally, the curves with loops formed consecutively are far inferior in interest and variety to those called "circulating," where the loops occur alternately, or at wider intervals. Curves of this latter kind are obtained when V is fractional instead of integral, and it is to be preferred that the fractional value should be greater than unity. In every such case it will appear that the numerator of the fraction expresses the number of loops produced, and its denominator expresses the number of times which the describing point will pass round the figure before the curve returns into its original path; while the mixed number to which the fraction may be reduced shows the class of consecutive loops of whose character the circulating curve partakes by repetition. Suppose $V = \frac{15}{2}$, for example, $= 7\frac{1}{2}$; then 15 loops are produced, and they are formed at some distance from the centre; for the curve will be observed, while being traced, to resemble in its course a figure with 7 or 8 consecutive loops. But, if $V = \frac{15}{7} = 2\frac{1}{7}$, the curve, though still possessing 15 loops, bears a strong family likeness, during its description, to the ellipse, or to the two-looped figure, as the case may be.

It is important to observe that the fractional value assigned to V must always be in its lowest terms; and that if not so expressed, when the calculation for the wheels is made, the chuck of its own accord will reduce the fraction to that condition. It is not possible, for instance, to obtain a curve with 16 loops requiring 4 rotations of the chuck for its completion, nor one with 16 loops, to be completed in 6 rotations; for in the former case we should have simply a 4-looped figure, and in the latter a curve with 8 loops described at thrice, notwithstanding the wheels had been correctly arranged in accordance with the values assumed. The conditions existing between n, as representing the velocity of the chuck compared with that of the front terminal wheel,—and V as representing the value of the train of wheels,—continue in force for fractional values of V; and the curve, although circulating, becomes cusped when $\frac{\text{Ex.}}{\text{S.R.}} = n$, and rectilinear to some extent when $\frac{\text{Ex.}}{\text{S.R.}} = n^2$: the symbol n, as formerly, being V+1 or V−1, according to the directions of motion. The interest and variety of the phases of curves described with different directions of motion, *i.e.*, having the loops external, are decidedly superior to those attaching to curves with loops turning inwards.

The following short series of circulating 7-looped curves will be a suitable introduction to the employment of fractional values for V.

V	n	arbrs.	loops	Ex.	S. R.	Fig.	
$\frac{7}{2}$ in	$\frac{9}{2}$	odd	7 in	57	3	38	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ nearly. [Change wheels $\frac{84}{48}$ on B, between A and E.]
				49	11	39	,, = n, nearly.
				40	20	40	
				30	30	41	
				20	40	42	
				10	50	43	
$\frac{7}{2}$ out	$\frac{5}{2}$	even	7 out	51·8	8·2	44	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$
				43	17	45	,, = n
				38	22	46	
				30	30	47	
				20	40	48	
				10	50	49	
$\frac{7}{3}$ in	$\frac{10}{3}$	odd	7 in	55·1	4·9	50	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels, $\frac{84}{72}$ on B, between A and E.]
				46·2	13·8	51	,, = n
				40	20	52	
				30	30	...	Similar to Figs. 41 to 43.
				20	40	...	
				10	50	...	



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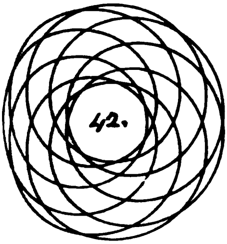

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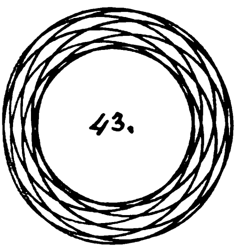

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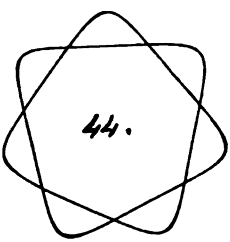

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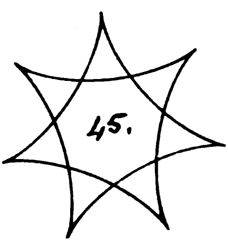

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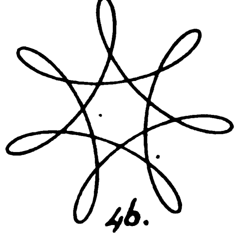

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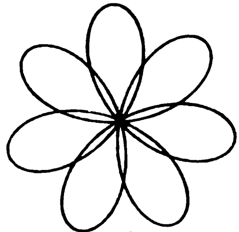

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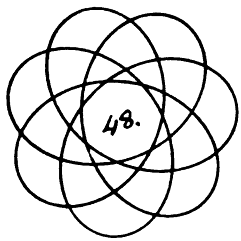

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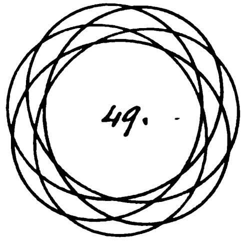

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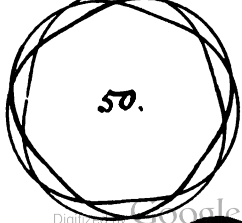

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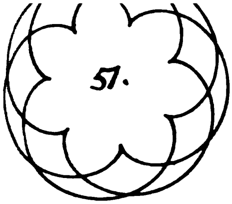

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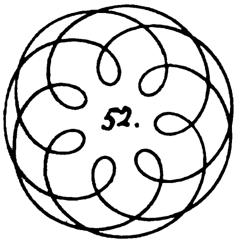

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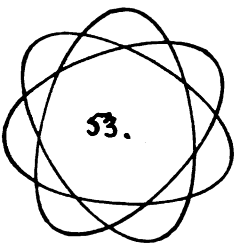

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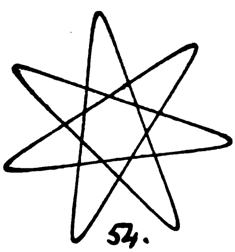

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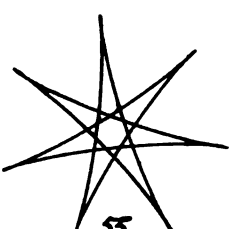

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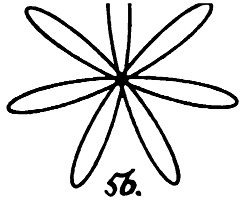

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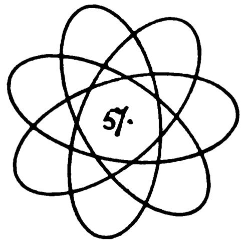

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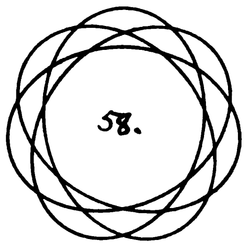

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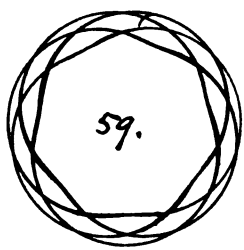

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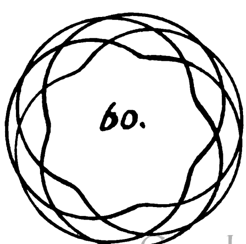

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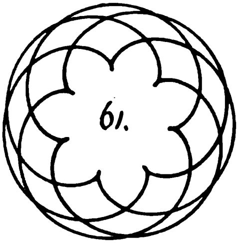
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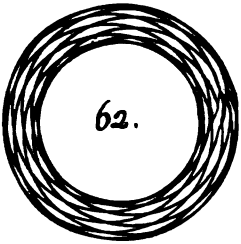
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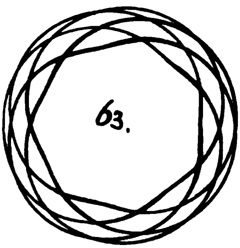
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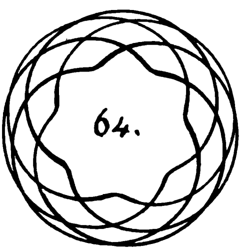
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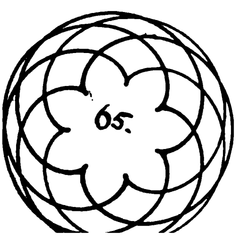
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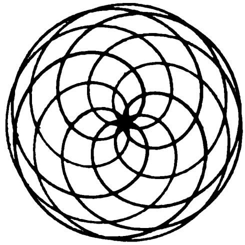
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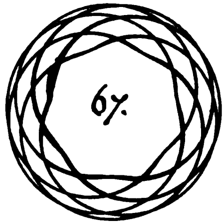
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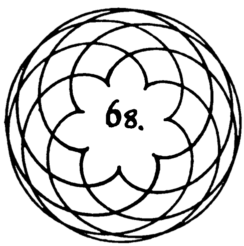
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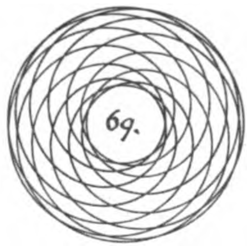
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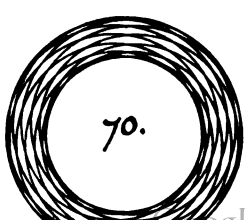

70.

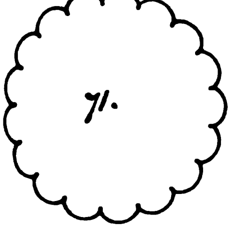
V	n	arbrs.	loops	Ex.	S. R.	Fig.	
$\frac{7}{3}$ out	$\frac{4}{3}$	even	7 out	50	10	53	
				38·4	21·6	54	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$
				34·3	25·7	55	" = n
				30	30	56	
				20	40	57	
				10	50	58	
$\frac{7}{4}$ in	$\frac{11}{4}$	odd	7 in	53	7	59	" = n^2 [Change wheels, $\frac{84}{96}$ on B, between A. and E.]
				50	10	60	The waved form occurs with a low value for V and internal loops, Ex. being considerably greater than S.R.
				44	16	61	$\frac{\text{Ex.}}{\text{S.R.}} = n$
				40	20	...	Similar to figs. 40 to 42.
				30	30	...	
				20	40	...	
				10	50	62	
$\frac{7}{4}$ out	$\frac{3}{4}$	even	7 out	...	...	...	The same development of curves now arises as when n = $\frac{4}{3}$ and V = $\frac{7}{3}$, Figs. 53 to 58, provided the values there given for Ex. and S.R. are exchanged, the one for the other.
$\frac{7}{5}$ in	$\frac{12}{5}$	odd	7 in	51·2	8·8	63	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels $\frac{56}{80}$ on B. between A and E.]
				47·5	12·5	64	
				42·4	17·6	65	$\frac{\text{Ex.}}{\text{S.R.}} = n$
				30	30	66	
				20	40	...	Similar to Figs 42, 43.
				10	50	...	
$\frac{7}{5}$ out	$\frac{2}{5}$	even	7 out	...	...	...	Same development of curves, Ex. & S.R. being interchanged, as when n = $\frac{5}{2}$, V = $\frac{7}{2}$, Figs. 38 to 43.
$\frac{7}{6}$ in	$\frac{13}{6}$	odd	7 in	49·5	10·5	67	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels $\frac{56}{96}$ on B, between A. and E.]

V	n	arbrs.	loops	Ex.	S. R.	Fig.	
$\frac{7}{8}$ in	$\frac{13}{8}$	odd	7 in	41	19	68	$\frac{\text{Ex.}}{\text{S.R.}} = n$
				30	30	...	Similar to Fig. 66.
				20	40	69	
				10	50	70	
$\frac{7}{8}$ out	$\frac{1}{8}$	even	7 out	...	...	...	Same development of curves, Ex. and S.R. being interchanged, as would be obtained when n = 6, V = 7, the figure containing 7 consecutive external loops.

It will be noticed here that two very different values for V, give, on three occasions, the same figure, when the eccentricities of the slide rest, and the chuck slide are exchanged. This identity of result occurs, without exception, whenever the numerical value of n in one case is equivalent to that of $\frac{1}{n}$ in the other. There are, therefore, always two ways of describing the same simple curve with *external* loops, whether consecutive or circulating.

A more extended series of fractional values for V will now be given, taking the number 17 for the numerators in succession, and varying the denominator from 1 upwards.

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{17}{1}$	18	odd	17 in	56·9	3·1	71	$\frac{\text{Ex.}}{\text{S.R.}} = n$ [Change wheels $\frac{68}{24}$ on B, 32 on E.]
				50	10	72	
				40	20	73	The centre of the figure would be much crowded if both eccentricities were alike.
				32	28	74	
				20	40	75	
				10	50	76	
$\frac{17}{1}$	16	even	17 out	56·5	3·5	77	,, = n
				50	10	78	
				40	20	79	
				32	28	80	
				20	40	81	



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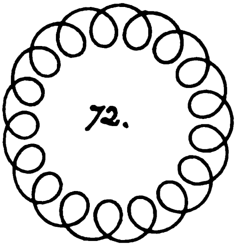

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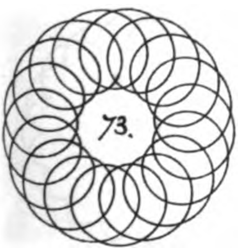

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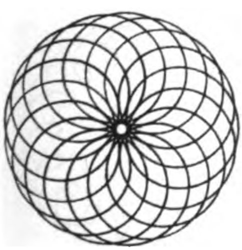

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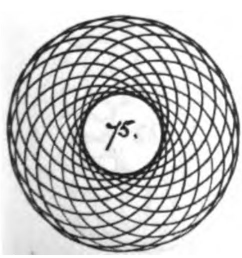

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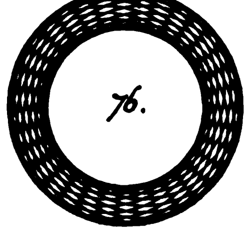

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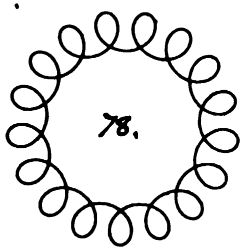

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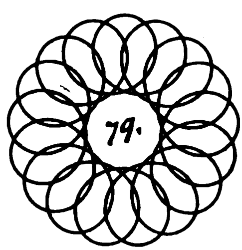

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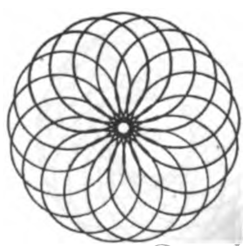

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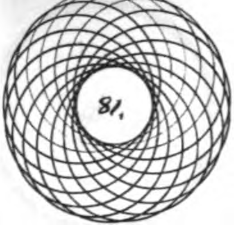
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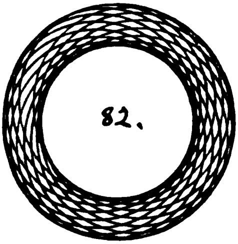
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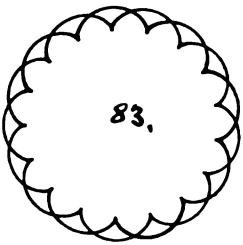
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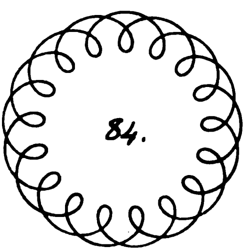
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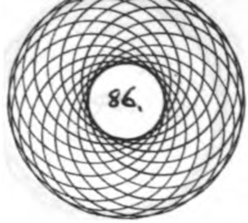
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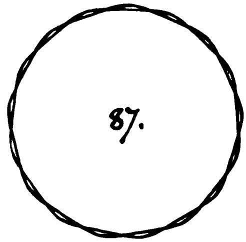
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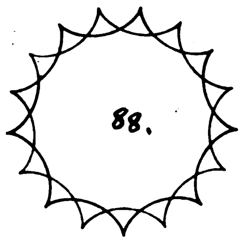
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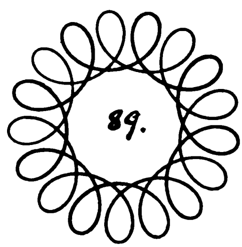
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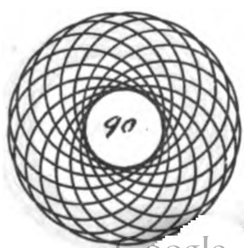
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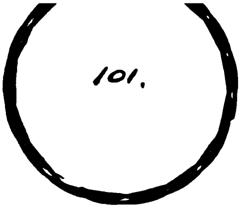
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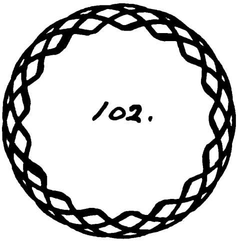
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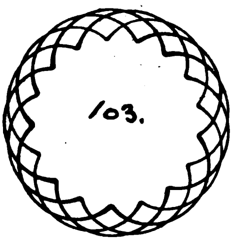
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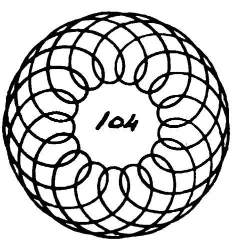
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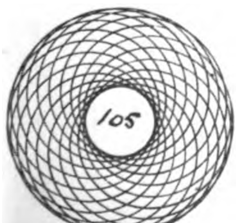
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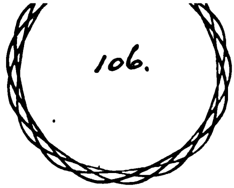
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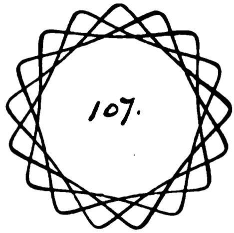
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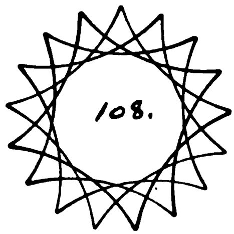
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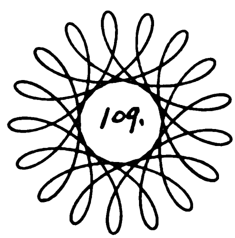
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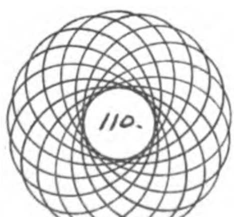
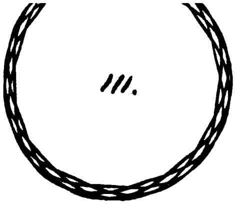

110.

V	n	arbrs.	loops	Ex.	S.R.	Fig.		
$\frac{17}{1}$	16	even	17 out	10	50	82		
$\frac{17}{2}$	$\frac{19}{2}$	odd	17 in	54·3	5·7	83	$\frac{Ex.}{S.R.} = n$	[Change wheels $\frac{68}{48}$ on B, 32 on E.]
				50	10	84		
				40	20	85		
				30	30	...		
				20	40	86		
				10	50	...		
$\frac{17}{2}$	$\frac{15}{2}$	even	17 out	59	1	87	,, $= n^2$	
				53	7	88	,, $= n$	
				45	15	89		
				30	30	...		
				20	40	90		
				10	50	...		
$\frac{17}{3}$	$\frac{20}{3}$	odd	17 in	58·2	1·8	91	,, $= n^2$	[Change wheel $\frac{68}{48}$ on B, 48 on E.]
				52	8	92	,, $= n$	
				40	20	93		
				32	28	94		
				20	40	...		
				10	50	95		
$\frac{17}{3}$	$\frac{14}{3}$	even	17 out	57·4	2·6	96	,, $= n^2$	
				49·4	10·6	97	,, $= n$	
				40	20	98		
				32	28	99		
				20	40	...		
				10	50	100		
$\frac{17}{4}$	$\frac{21}{4}$	odd	17 in	57·9	2·1	101	,, $= n^2$	[Change wheels $\frac{68}{32}$ on B, between A and E.]
				54	6	102		
				50·4	9·6	103	,, $= n$	
				40	20	104		
				20	40	105		

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{17}{4}$	$\frac{13}{4}$	even	17 out	54·8	5·2	106	$\frac{Ex.}{S.R.} = n^2$
				50	10	107	
				46	14	108	„ $= n$
				40	20	109	
				20	40	110	
$\frac{17}{5}$	$\frac{22}{5}$	odd	17 in	57·1	2·9	111	„ $= n^2$ [Change wheels $\frac{68}{40}$.]
				53	7	112	
				49	11	113	„ $= n$
				44	16	114	
				20	40	...	
$\frac{17}{5}$	$\frac{12}{5}$	even	17 out	56	4	115	
				51·1	8·9	116	„ $= n^2$
				47	13	117	
				42·4	17·6	118	„ $= n$
				35	25	119	
				20	40	120	
$\frac{17}{6}$	$\frac{23}{6}$	odd	17 in	56 2	3·8	121	„ $= n^2$ [Change wheels $\frac{68}{48}$.]
				52	8	122	
				47·6	12·4	123	„ $= n$
				43	17	124	
				20	40	...	
$\frac{17}{6}$	$\frac{11}{6}$	even	17 out	52	8	125	
				46·3	13·7	126	„ $= n^2$
				42·5	17·5	127	
				38·8	21·2	128	„ $= n$
				33	27	129	
				20	40	130	
$\frac{17}{7}$	$\frac{24}{7}$	odd	17 in	55·3	4·7	131	„ $= n^2$ [Change wheels $\frac{68}{56}$.]
				51	9	132	
				46·5	13·5	133	„ $= n$



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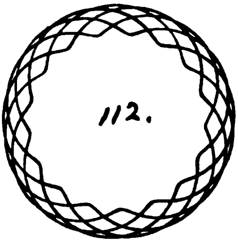

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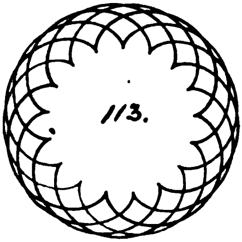

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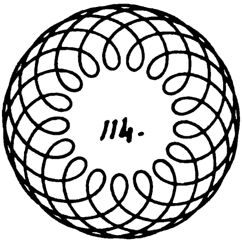

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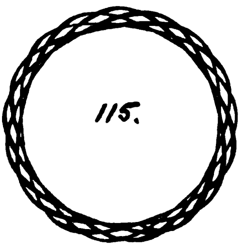

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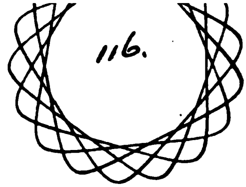

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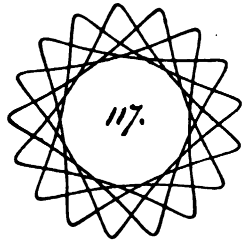

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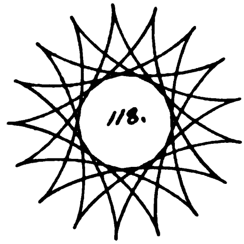

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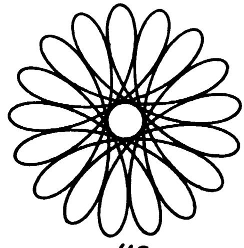

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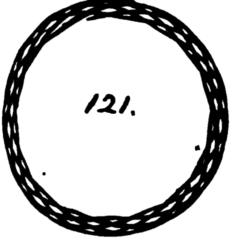

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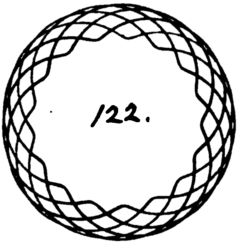

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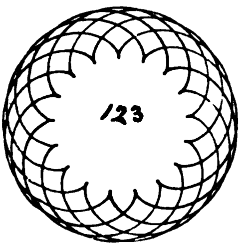

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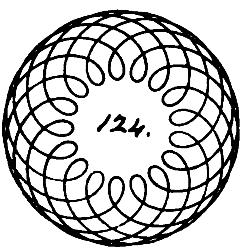

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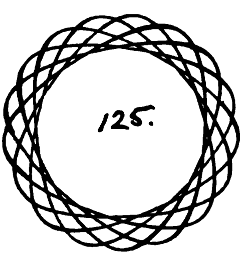

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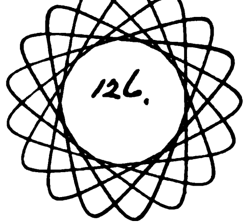

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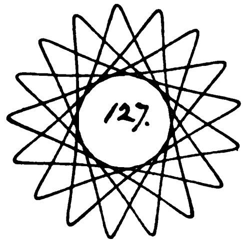

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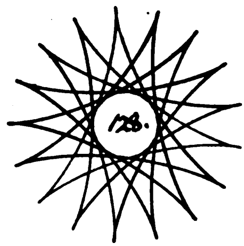

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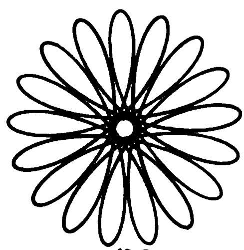

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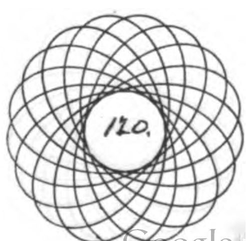

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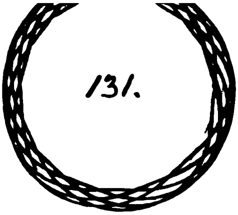

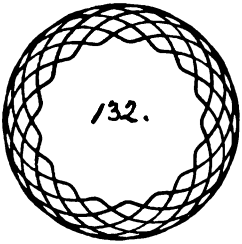

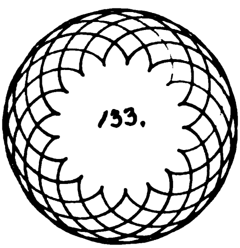

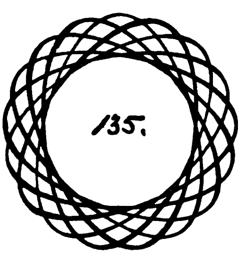

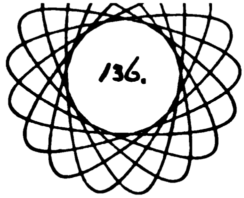

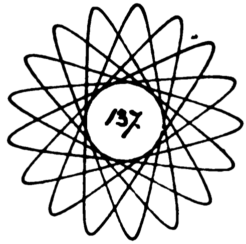

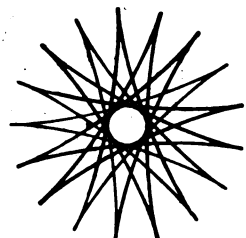

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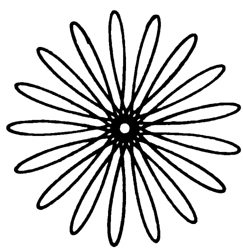

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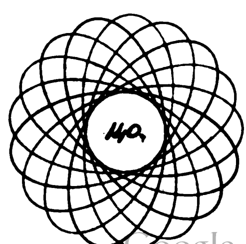
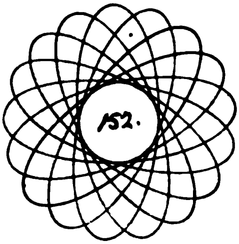


V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{17}{7}$	$\frac{24}{7}$	odd	17 in	42	18	134	
				20	40	...	
$\frac{17}{7}$	$\frac{10}{7}$	even	17 out	50	10	135	
				45	15	136	
				40·3	19·7	137	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$
				35·3	24·7	138	,, $= n$
				32	28	139	
				20	40	140	
$\frac{17}{8}$	$\frac{25}{8}$	odd	17 in	54·5	5·5	141	,, $= n^2$ [Change wheels $\frac{68}{64}$.]
				50	10	142	
				45·5	14·5	143	,, $= n$
				41	19	144	
				20	40	...	
$\frac{17}{8}$	$\frac{9}{8}$	even	17 out	50	10	145	
				42	18	146	
				33·6	26·4	147	,, $= n^2$
				31·7	28·3	148	,, $= n$
				31	29	149	
				29	31	150	
				25	35	151	
				20	40	152	
$\frac{17}{9}$	$\frac{26}{9}$	odd	17 in	53·6	6·4	153	,, $= n^2$ [Change wheels $\frac{68}{72}$.]
				49	11	154	
				44·6	15·4	155	,, $= n$
				40	20	156	
				20	40	...	
$\frac{17}{9}$	$\frac{8}{9}$	even	17 out	...	...	...	Same development of curves, Ex. and S.R. being interchanged, as when $n = \frac{9}{8}$, $V = \frac{17}{8}$, Figs. 145 to 152.
$\frac{17}{10}$	$\frac{27}{10}$	odd	17 in	52·8	7·2	157	,, $= n^2$ [Change wheels, $\frac{68}{80}$.]
				48	12	158	

When n is slightly in excess of unity, the loops being external, the phases of the curve are numerous and distinct, especially when Ex. and S.R. are nearly equal.

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{17}{10}$	$\frac{27}{10}$	odd	17 in	43·3	16·7	159	$\frac{\text{Ex.}}{\text{S.R.}} = n$
				20	40	...	
$\frac{17}{10}$	$\frac{7}{10}$	even	17 out	...	...	...	Same development of curves, Ex. and S.R. being interchanged, as when n = $\frac{10}{7}$, V = $\frac{17}{7}$, Figs. 135 to 140.
$\frac{17}{11}$	$\frac{28}{11}$	odd	17 in	...	...	...	[Change wheels, $\frac{34}{44}$.] There is now much similarity between the remaining curves of the series with internal loops, and alternate examples only are given.
$\frac{17}{11}$	$\frac{6}{11}$	even	17 out	...	...	...	See Figs 125 to 130, where n = $\frac{11}{6}$, V = $\frac{17}{6}$.
$\frac{17}{12}$	$\frac{29}{12}$	odd	17 in	51·3	8·7	160	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels, $\frac{34}{48}$.]
				47	13	161	
				42·4	17·6	162	,, = n
$\frac{17}{12}$	$\frac{5}{12}$	even	17 out	...	...	...	See Figs 115 to 120, where n = $\frac{12}{5}$, V = $\frac{17}{5}$.
$\frac{17}{13}$	$\frac{30}{13}$	odd	17 in	...	...	...	Similar to Figs. 160 to 162.
$\frac{17}{13}$	$\frac{4}{13}$	even	17 out	...	...	...	See Figs. 106 to 110, where n = $\frac{13}{4}$, V = $\frac{17}{4}$.
$\frac{17}{14}$	$\frac{31}{14}$	odd	17 in	49·9	10·1	163	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels, $\frac{34}{56}$.]
				46	14	164	
				41·4	8·6	165	,, = n
				20	40	...	
$\frac{17}{14}$	$\frac{3}{14}$	even	17 out	...	...	...	See Figs. 96 to 100, where n = $\frac{14}{3}$, V = $\frac{17}{3}$.
$\frac{17}{15}$	$\frac{32}{15}$	odd	17 in	...	...	...	Similar to Figs. 163 to 165.
$\frac{17}{15}$	$\frac{2}{15}$	even	17 out	...	...	...	See Figs. 87 to 90, where n = $\frac{15}{2}$, V = $\frac{17}{2}$.
$\frac{17}{16}$	$\frac{33}{16}$	odd	17 in	48·6	11·4	166	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels, $\frac{34}{64}$.]
				45·	15·	167	As the concluding example of the series, this is figured more fully; but the curve resembles those which precede it with internal loops.

151.



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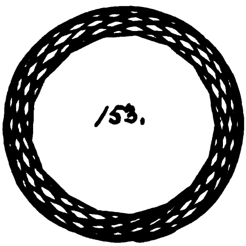

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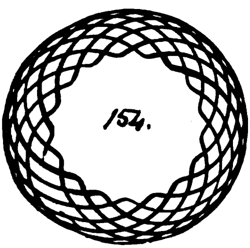

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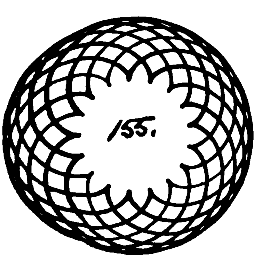

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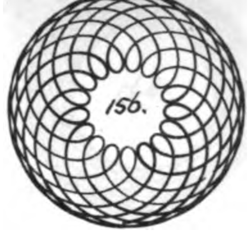

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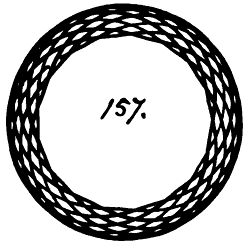

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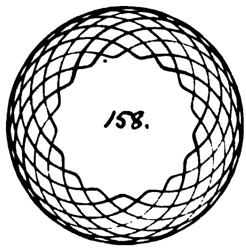

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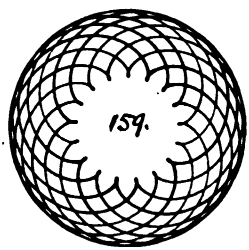

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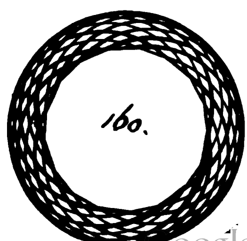


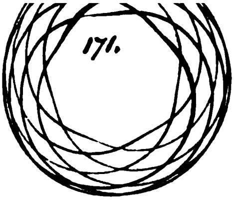
160.

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{17}{16}$	$\frac{33}{16}$	odd	17 in	40·4	19·6	168	$\frac{\text{Ex.}}{\text{S.R.}} = n$
				37·5	22·5	169	
				20	40	170	
				10	50	...	
$\frac{17}{16}$	$\frac{1}{16}$	even	17 out	...	..	...	See Figs. 77 to 82. where n = 16, V = 17.
$\frac{17}{17}$	2	odd	1 in	...	...	...	The one-looped figure, Figs. 1 to 4
$\frac{17}{17}$	0	even	none	...	...	...	Result, a circle (see page 17.)

The series is now completely examined from 17 to 1, proceeding by fractional intervals; and the phases of that division of the figures which is distinguished by external loops have manifestly been exhausted : since it proves to be impracticable to reduce the value of V below 2 for external loops, and still to obtain fresh results. But with internal loops we may reasonably expect some further variety by continuing the series of fractional values for V downwards below unity : and, in conducting this examination, it will be convenient to resume the consideration of the 7-looped circulating figure (Figs. 38 to 70), as requiring a less lengthy analysis than the corresponding curve with 17 loops which has just received illustration up to a certain point.

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{7}{8}$	$\frac{15}{8}$	odd	7 in	46·7	13·3	171	$\frac{\text{Ex.}}{\text{S.R.}} = n^2$ [Change wheels, $\frac{35}{80}$.]
				43·	17	172	
				39·2	20·8	173	,, = n
				34·	26	174	
				20	40	...	
$\frac{7}{8}$	$\frac{1}{8}$	even	7 in	...	...	...	Though the arbors are even in number, the loops now turn inwards, and the curve is the same as that when n = 8, V = 7, Ex. and S.R. being interchanged.

V	n	arbrs.	loops	Ex.	S. R.	Fig.	
$\frac{7}{9}$	$\frac{16}{9}$	odd	7 in	45·6	14·4	175	$\frac{Ex.}{S.R} = n^2$ [Change wheels, $\frac{35}{90}$.]
				42	18	176	
				38·4	21·6	177	,, = n
				34	26	178	
				40	20	...	
$\frac{7}{9}$	$\frac{2}{9}$	even	7 in	...	...	...	Same development of curves, Ex. and S.R. being interchanged, as when $n = \frac{9}{2}$, $V = \frac{7}{2}$. Figs. 38 to 43.
$\frac{7}{10}$	$\frac{17}{10}$	odd	7 in	44·6	15·4	179	$\frac{Ex.}{S R} = n^2$ [Change wheels, $\frac{35}{50}$·$\frac{48}{96}$.]
				41·5	18·5	180	
				37·8	22·2	181	,, = n
				33·5	26·5	182	
$\frac{7}{10}$	$\frac{3}{10}$	even	7 in	...	...	...	Same development of curves, Ex. and S.R. being interchanged, as when $n = \frac{10}{3}$, $V = \frac{7}{3}$. Figs. 50 to 52.
$\frac{7}{11}$	$\frac{18}{11}$	odd	7 in	43·7	16·3	183	$\frac{Ex.}{S.R.} = n^2$ [Change wheels, $\frac{35}{55}$·$\frac{48}{96}$.]
				40·5	19·5	184	
				37·3	22·7	185	,, = n
				33	27	186	
$\frac{7}{11}$	$\frac{4}{11}$	even	7 in	...	...	...	See Figs. 59 to 62, where $n = \frac{11}{4}$, $V = \frac{7}{4}$.
$\frac{7}{12}$	$\frac{19}{12}$	odd	7 in	43	17	187	,, = n^2. Change wheels, $\frac{35}{60}$·$\frac{48}{96}$.]
				40	20	188	
				36·8	23·2	189	,, = n
				33	27	190	
$\frac{7}{12}$	$\frac{5}{12}$	even	7 in	...	...	...	See Figs. 63 to 66, where $n = \frac{12}{5}$, V $\frac{7}{5}$.
$\frac{7}{13}$	$\frac{20}{13}$	odd	7 in	42·2	17·8	191	,, = n^2 [Change wheels, $\frac{35}{65}$·$\frac{48}{96}$.]
				39·5	20·5	192	
				36·4	23·6	193	,, = n
				33	27	194	
$\frac{7}{13}$	$\frac{6}{13}$	even	7 in	...	...	...	See Figs. 67 to 70, where $n = \frac{13}{6}$, $V = \frac{7}{6}$.



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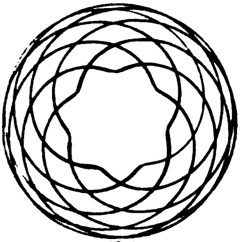

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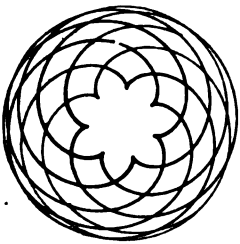

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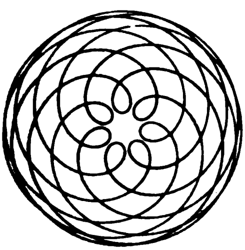

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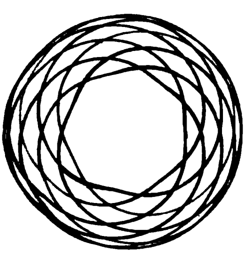

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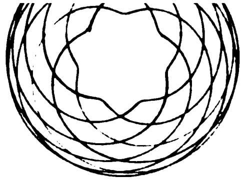

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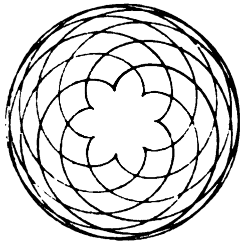

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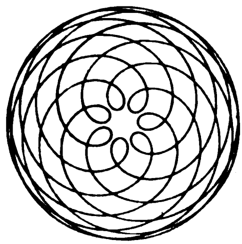

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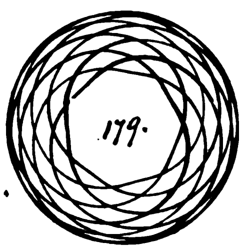

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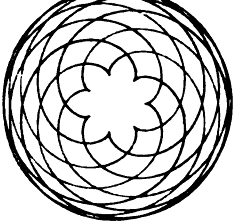
180.



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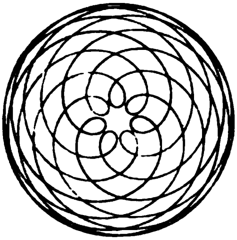

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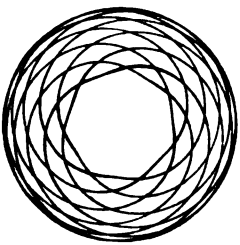

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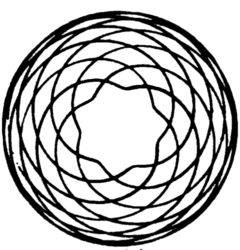

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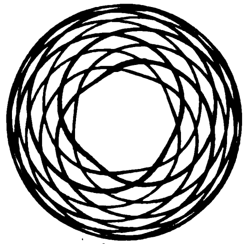

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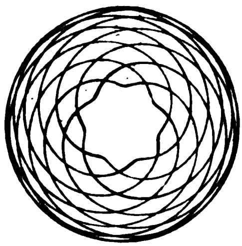

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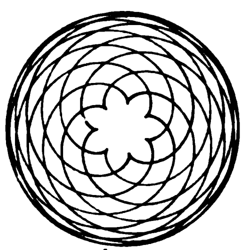

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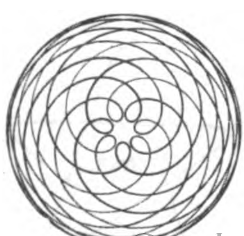

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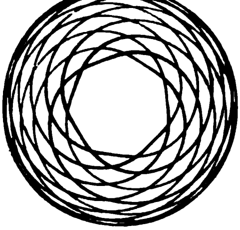

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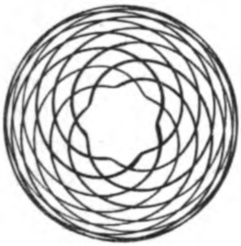

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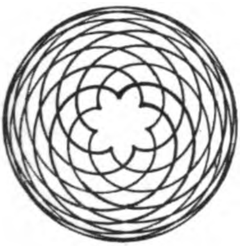

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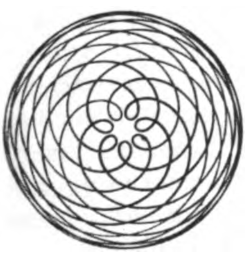

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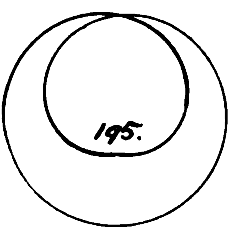

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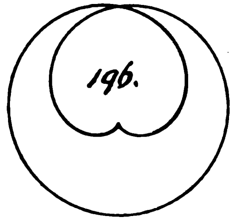

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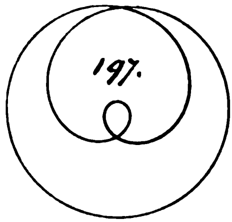

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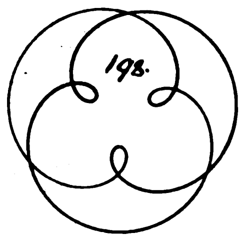

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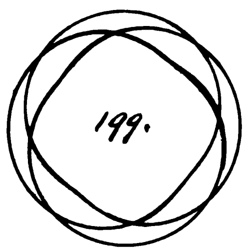

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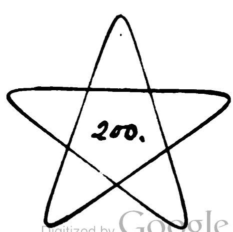


200.

V	n	arbrs.	loops	Ex.	S.R.	Fig.	
$\frac{7}{11}$	$\frac{3}{2}$	odd	1 in	41·6	18·4	195	$\frac{Ex.}{S.R.} = n^2$ [Change wheels, $\frac{35}{70} \cdot \frac{48}{96}$.]
				36	24	196	n
				30	30	197	
$\frac{7}{14}$	$\frac{1}{2}$	even	1 in	...	...	...	See Figs. 1 to 4, where n = 2, V = 1.

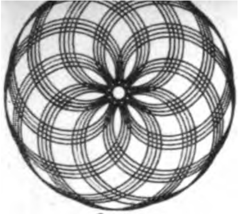
When the denominator of the fractional value of V has reached 14, that value has become equal to $\frac{1}{2}$, and the result (the number of arbors being odd) is a one-looped figure described at twice, *i.e.*, requiring two rotations of the surface for its completion (figs. 195 to 197); and if the series were further extended till the denominator became 21, we should have V = $\frac{1}{3}$, and the curve would again have one loop, but described at thrice; the intervening values yielding similar results to those shown by figs. 191 to 194. Such a continuance, however, of diminishing values for V would afford no new feature, and would be contrary to the principle and intention of the Geometric Chuck, whose mechanism contemplates a reduction, not an acceleration, of the velocity of its terminal wheel. At the same time, it would certainly be practicable in order to obtain figures of this class to apply the driving power to the front wheel of the chuck by an elastic band instead of the mandrel pulley.

On comparing the tabulated adjustments for the two sets of seven-looped figures (38 to 70 and 171 to 197), we again see that different values for V have produced the same curve; for there are six cases in the latter set, which when the loops are *internal*, although the arbors are *even* in number, correspond perfectly, by interchange of Ex. and S.R., with six cases in the former. And this identity arises as before from the circumstance that the numerical value of n in one instance happens to coincide with that of $\frac{1}{n}$ in another. On the former occasion we found (page 22) that the *external* looped curve,—for example, that figured 38 to 43—was equally obtained whether V was $\frac{7}{5}$ or $\frac{7}{2}$, n being $\frac{2}{5}$ in one case, and $\frac{5}{2}$ in the other, (n of the one $= \frac{1}{n}$ of the other): and it now appears that the *internal* looped curve of the same class (figs. 63 to 66) is equally obtained whether V was $\frac{7}{5}$ or $\frac{7}{12}$, n being $\frac{12}{5}$ in one case, and $\frac{5}{12}$ in the other, (n of the one $= \frac{1}{n}$ of the other). It may now, therefore, be stated more fully than on page 22, that there are always two ways of describing the same simple curve, whether its loops be consecutive or circulating, and whether they be internal or external. It does not follow, however, that both ways will be equally eligible. The mechanism of the chuck works more pleasantly when its speed is greater than that of its front terminal wheel, and the curve is traced more easily and with less change in the position of the describing point with reference to its path on the moving surface when the eccentricity of the slide rest is less than that of the chuck slide. But occasions may present themselves when it may be advantageous to have the choice of the two methods, and the following simple formulæ will provide for the calculation of each pair of values for V.

Let $V = \frac{p}{q}$ which will embrace all values, for if V is integral, $q = 1$.

Then, the loops being *internal*, V may be made equal to $\frac{p}{p+q}$ or to $\frac{p}{q}$ indiscriminately, provided Ex. and S.R. are exchanged, the one for the other; also, the loops being *external*, V may be made equal to $\frac{p}{p-q}$ or to $\frac{p}{q}$ indiscriminately, provided Ex. and S.R. are exchanged the one for the other. It will have been observed, and this is the exception referred to in page 5, that when V is less than unity, a change in the number of arbors makes no alteration in the direction of the loops, which under this condition are always internal.

Many of the lower or fractional numbers are of pleasing form, and specimens of three are given in the following figures:—



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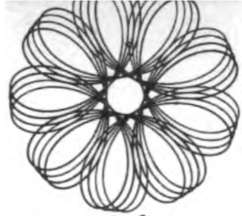

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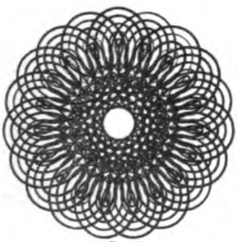

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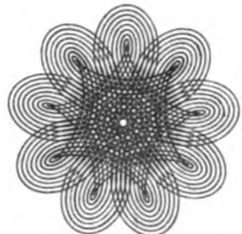

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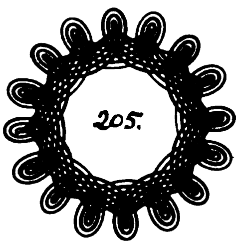

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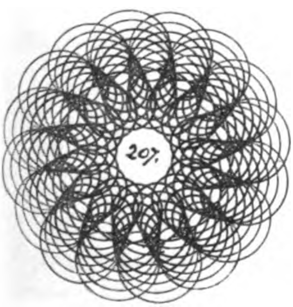

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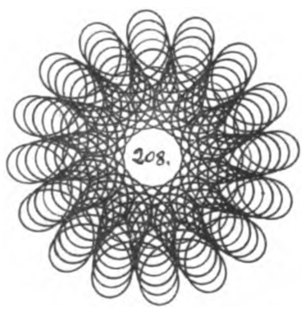

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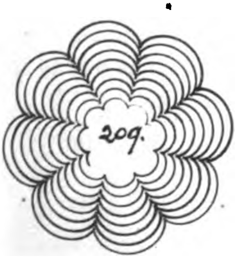

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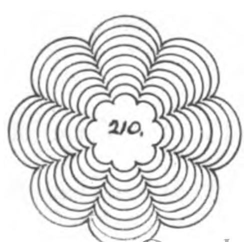


210.

V	n	arbrs.	loops	Ex.	S.R.	Figs.	
$\frac{3}{2}$	$\frac{5}{2}$	odd	3 in	38	29	198	
$\frac{4}{3}$	$\frac{7}{3}$	odd	4 in	50·7	9·3	199	$\frac{Ex.}{S.R.} = n^2$
$\frac{5}{2}$	$\frac{3}{2}$	even	5 out	41·5	18·5	200	„ $= n^2$

All the examples hitherto given consist in each case of one continuous line; but to produce ornamental effects in simple geometric turning it is often necessary to employ several curves in the same designs, and to change the adjustments singly or in combination, in the following manner:

(i.) By varying the position of the detent in the fixed first motion wheel behind the chuck.

(ii.) By varying the distance (S.R.) of the describing point in the slide rest from the axis of the mandrel.

(iii.) By varying the distance (Ex.) of the centre of the front terminal wheel from the axis of the mandrel.

(iv.) By varying the diminishing effect (V) of the train of change wheels.

Adjustment (i.) produces the same phase of the same curve as before, but in another angular position, with reference to a line drawn through the common centre of the figure. For example:

V	Ex.	S.R.	Fig.
$\frac{9}{2}$ in	32	28	201
$\frac{9}{2}$ out	35	25	202

In each of these figures there are four curves, the repetition being obtained by releasing the detent of the first motion wheel, and re-clamping it six teeth in advance, or the twenty-fourth part of its circumference, before tracing the next curve.

Adjustment (ii.) produces another phase of the same curve, but in the same angular position as before.

V	Ex.	S.R.	Fig.	
$\frac{19}{3}$ out	34	10 to 26	203	(S.R. increased by 4.)
$\frac{9}{2}$ out	31	13 to 29	204	(S.R. increased by 2.)

If this variation be adopted on both sides of the axis of the mandrel, moving the describing point in the slide rest as much to the right of the central position as it was at first to the left, the same curves are described in corresponding positions; but the undulations of each pair are opposed, loops occurring in the second curve where spaces existed in the first.

V	Ex.	S.R.		Fig.
8 out,	45,	3 to 15,	(repeated on each side the centre)	205
5 in,	42,	6 to 18,	" " "	206

Here the effect is the same as if the curves had been repeated, with the same positions of the describing point, but with alterations in the position of the detent in the first motion wheel.

Adjustment (iii.) produces also another phase of the same curve, but, in Ibbetson's chuck, with rectilinear slide and link motion, *not* in the same angular position as before. For the action of the eccentric slide induces some rotation in the train, and thus changes the relative positions of its first and last wheels; thereby causing the front terminal wheel and the surface which it carries to take up a new angular position, and thus producing the effect of an arbitrary alteration of the detent of the first motion wheel. This is confessedly a disadvantage to the simple, or "Part I." Geometric chuck of this construction, when used alone; amply counterbalanced, however, by the superior facilities for adjustment when Parts I. and II. are combined, and by the freedom from the constant clamping and unclamping required at every change of the eccentric slides, when the "link motion" is not provided, and a portion of the train is carried on a separate radius plate.

The inequality of angular position in two curves, having different values for Ex., is practically remedied by moving the detent of the first motion wheel past a certain number of teeth (and parts of a tooth, if necessary), until the position of the new curve is found by trial to assimilate with that of the old one. When a whole number of teeth will not effect this accurately, a distance equal to any desired fraction of a tooth is accomplished by altering the end finger screws of the detent plate under the guidance of its vernier. The distortion produced by a change of eccentricity among the consecutive curves of the following figure is corrected in fig. 210.

V	Ex.	S.R.	Fig.
8 in	18 to 54	2 to 6	209

(Ex. increasing by 4·5. S.R. increasing by 0·5.)

The correction, however, was not obtained here by trial, but automatically, by the following expedient. The contrivance consists of a separation of the 96 wheel upon the A arbor, into two concentric portions, of which either may rotate without the other, though the two can be clamped firmly together by a thin steel ring and binding screws. In that condition the divided wheel forms a rigid whole, but when the screws are released, the rotation which would otherwise occur in the train by the action of the eccentric slide is prevented, since the inner disc of the wheel on A is free to move on its axis without its toothed periphery. Consequently it is practicable for the extreme wheels of the train to be clamped by their respective detents, while the eccentric slide receives any desired alteration, and the movement which that alteration causes, in the link motion and subsequent wheels, expends itself harmlessly in the partial rotation of the inner disc of the divided wheel. And the fixity of mutual position which has thus been preserved between the first motion wheel and the front terminal wheel, secures the same angular position for each succeeding curve. The *modus operandi* is briefly this: (1) Clamp the mandrel pulley by its tangent screw at a moment when the teeth of the detent of the front terminal wheel are exactly opposite to any corresponding spaces in the latter. (2) Clamp the front terminal wheel. (3) Release the binding screws of the divided wheel on A. (4) Alter the eccentric slide as may be desired. (5) Tighten the binding screws of the divided wheel on A. (6) Release clamp of front terminal wheel. (7) Unclamp mandrel pulley. It is important to guard against "loss of time" in this operation; and with this view, when the eccentricity of the slide is to be *increased* the motion of the chuck should be *reversed* for a few turns before clamping; when the eccentricity is to be diminished this precaution is unnecessary.

The following figures exemplify the disturbance caused by a larger eccentricity, and its correction:—

	V	Ex.	S.R.	
Fig. 211 } ,, 212 }	32 out.	90 to 98.	5 to 13.	Ex. increased by 2 S.R. ,, 2

When this expedient of the divided wheel is not employed, recourse must be had to an alteration of the detent of the first motion wheel, either by trial or by calculation. The extent of alteration that will be necessary depends, not only upon the amount of eccentricity which has caused the disturbance, but also upon the value of the train. And it is unfortunate that when the proper compensation, with a given train of wheels, has been determined for a given increase of eccentricity, at one part of the slide provided with "link-motion," it will not answer for the same increase of eccentricity at another part. For the slide has a continually increasing, and not an uniform, effect upon the wheels in which its movement induces a small amount of rotation. And the greater the eccentricity happens to be, prior to receiving a definite addition, the greater is the consequent disturbance.

But it is possible to calculate beforehand the precise quantity of correction, at the first motion wheel, which will be necessary, whatever may be the value of V, and whatever may be the position of the slide at which an alteration of eccentricity is to take place. To do this it is first requisite to establish with considerable accuracy the correction which corresponds, when V=1, to a movement from one graduation to the next, *i.e.*, for every tenth of an inch, over the whole scale of the eccentric slide. This could no doubt be arrived at theoretically, the exact distances of the wheels comprising the link motion from their respective centres and from the centre of the front wheel being carefully measured. But it will answer every purpose to obtain the desired information experimentally; such a method has the advantage of being tested by the amateur at any time, and it may readily be accomplished in the following manner.

Let change wheels be attached to the chuck affording any convenient integral value, 6 or 8 for example. Clamp the front wheel, leaving the first motion wheel at liberty; clamp also the mandrel pulley. Then the whole disturbing effect upon the train, caused by an alteration of the eccentric slide will be concentrated upon the first motion wheel, which will receive successive impulses of rotation, gradually increasing in amount, corresponding to the successive intervals of advance of the slide by a tenth of an inch at a time, from zero to its limit of about two inches. The intervals thus passed over by the first motion wheel can be observed with much exactness, and estimated to the tenth part of a graduation, by fixing a slip of stout writing paper behind the detent clamp on the brass plate for use as a fiducial edge parallel to the graduations. The spaces thus passed over by the first motion wheel are to be written down as they arise, and the experiment should be repeated in various forms with values for V ranging from about 4 to 10; not going lower than 4, because the effect is not then so apparent, nor higher than 10, because the strain upon the wheels with so considerable a multiplying power as their inverted action would then produce might tend to destroy their uniformity of movement.

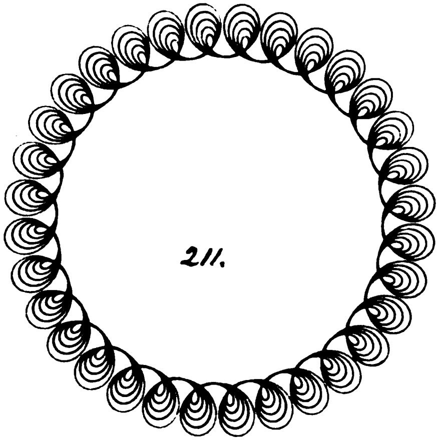
Each series of observations, divided by its special value for V, should give the same series of numbers, or as nearly so as the inevitable errors of the process will permit. Then, taking a mean of all the results, a set of numbers will be obtained, such as the following, which will represent the correction to be made at the first motion wheel, when V=1, for an alteration of one-tenth of an inch, from any one graduation to the next, in the eccentricity of the slide. And it is obvious that for any other value of V, whether integral or fractional, the proper correction at any part of the slide will be found by multiplying together that value and the corresponding number in the table; while if any alteration in the eccentric slide of less amount be made, the suitable correction can be obtained by interpolation.

Ex. slide moved from	Correction when V = 1.	Ex. slide moved from	Correction when V = 1.
0 to 10	0·258	100 to 110	0·620
10 — 20	0·292	110 — 120	0·657
20 — 30	0·326	120 — 130	0·694
30 — 40	0·360	130 — 140	0·732
40 — 50	0·405	140 — 150	0·771
50 — 60	0·440	150 — 160	0·810
60 — 70	0·475	160 — 170	0·850
70 — 80	0·511	170 — 180	0·891
80 — 90	0·547	180 — 190	0·933
90 — 100	0·583	190 — 200	0·976

The correction is here expressed in decimals of a tooth of the first motion wheel, and it can be translated to the nicety of one-tenth of a tooth by the vernier which regulates the adjustment of the brass plate carrying the detent clamp; or by a tangent screw with decimal graduations, if that arrangement could be applied to the first motion wheel.

It is essential that "loss of time" be annihilated before the observations are commenced. This can be done by carrying the eccentric slide backwards beyond its zero or central point, as far as it will go, and pressing the train together by hand, bringing the wheels well into contact, in the direction in which they will commence to turn when the slide is moved forwards. And the same precaution can be observed when the slide is moved backwards and the readings are reversed. The correction will of course be the same for the same value of V, whether the loops be "in" or "out," but its direction will be different in the two cases. When the loops are "in," or the arbors from A to E inclusive are uneven in number, an increase in the eccentricity will require the correction at the first motion wheel to take place in the order of its graduations; but when the loops are "out," an increase of eccentricity requires for correction a decrease at the first motion wheel.

As an example of the use of this table suppose V = 16, and



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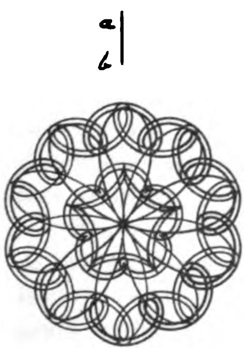

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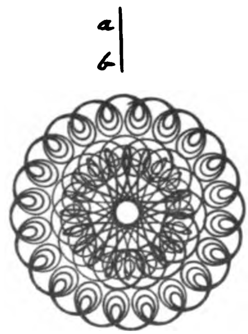

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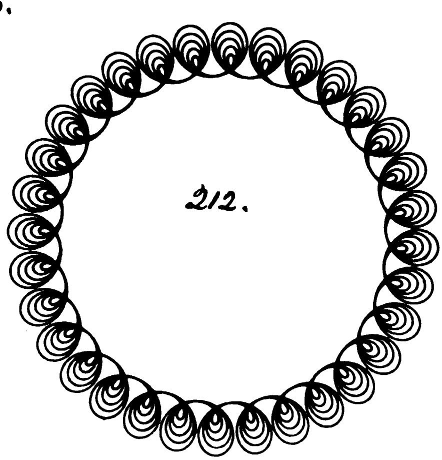


212.

that a curve having been described with Ex.=65, it is required to add another with Ex.=106 and similarly situated; the value of S.R. being here immaterial, since it has no influence upon the associated curves. The correction from 60 to 70 is tabulated as ·475, therefore from 65 to 70 will be ·24. Again, from 100 to 110 the correction is ·62, therefore from 100 to 106 will be ·372. To these two interpolated numbers we must add the three intervening terms from 70 to 100, and the addition of the whole five amounts to 2·253. It now remains to multiply this total by the value supposed for V, viz., 16, giving 36·1 teeth nearly as the required extent of correction.

But there is another method of correcting definitely, and without either calculation or special apparatus, the disturbance in the angular position of the front terminal wheel, whether caused by an alteration in the eccentric slide, or by a rearrangement of the train. And that is to provide, before commencing the work, a short line of reference as near the circumference of the surface as it can be placed. In marking this preliminary line, by the describing point in the slide rest, the mandrel pulley should be previously fixed by its index or tangent screw; and after any disturbance of the chuck it is only requisite to reclamp the mandrel pulley at the same point as before, and then by means of the adjustment at the first motion wheel, to bring the line of reference again to coincide with the describing point. The plan succeeds perfectly, but like that last mentioned requires care in avoiding "loss of time" among the wheels; and, to this end, the line of reference should be brought *up* to the describing point, or be brought *down*, in whichever direction the surface is about to travel. The constant traverse of the slide rest screw from the line of reference to the spot where the curve is to be traced, and back again, is objectionable, for the sake of the screw; but, on the whole, this method is as satisfactory and convenient as any. Figs. 213 and 214 illustrate its application; each consists of several distinct curves requiring frequent changes both of the eccentric slide and the train of wheels. Above each figure may be noticed a short line marked a b:

and this reference line was always made horizontal, the mandrel pulley being secured at the same point on each occasion, after each change in eccentricity or in the train of wheels.

Adjustment (iv), the last of those stated on page 31, necessarily involves a complete disturbance of the chuck, and it is not easy after an alteration in the train of wheels to bring the new curve exactly into a symmetrical position with its predecessors. The use of the divided wheel, or of the short reference line as just explained, may sometimes succeed, but it is not often to be expected that a train of wheels can be composed, and brought properly into gear, while its two extremes are clamped to prevent rotation.

The good effect of a simple geometric figure naturally depends upon the taste and skill with which its component curves are arranged. Where there is so much room for invention the amateur will generally prefer to design his own patterns; but some valuable hints on this branch of the art will be found in the earlier illustrations of Mr. Savory's work referred to in the preface; Nos. 44, 46, and 48, for instance, of the first series of those figures seem especially elegant and original. It may be well, however, to bear in mind that consecutive loops are less susceptible of varied results than circulating, and internal loops less satisfactory than external. But the interesting character of curves produced by the compound Geometric Chuck is so much greater, and the frequency of its adjustments necessary for the completion of a design so much fewer, that the amateur who has such an apparatus at his disposal will not often wish to reduce its capabilities to the simple form.

CHAPTER II.

The Compound Geometric Chuck.

THE simple Geometric Chuck is converted into a compound or "two-part" form by the addition of a second somewhat smaller chuck (in all respects resembling that which has been already described), screwed at pleasure upon the nose of the first; and the distinct, though combined, portions are spoken of as Part I. and Part II. The epicyclic train of the second part is also of similar arrangement to that of the first, with removable arbors fitting, as before, into a curvilinear mortise, but receiving no wheel of larger size than 66 teeth, owing to the more limited space afforded by the less diameter of the second foundation plate. And when the two distinct "parts" are thus united, and converted into a double chuck, the arrangement and effect of their several independent centres of motion stand thus:—

(1.) The foundation plate of Part I.: making as many rotations as the lathe mandrel upon which it is screwed, and in the same direction.

(2.) The first motion wheel of Part I.: which is clamped as formerly to the face of the headstock, and does not rotate at all, except as a matter of adjustment.

(3.) The front terminal wheel of Part I.: whose rotations and their direction, as compared with those of the mandrel, depend upon the value of the train of change wheels behind it; while its centre of rotation is determined by the eccentric slide upon which it is mounted.

(4.) The foundation plate of Part II.: which is screwed on to the front terminal wheel of Part I., and, therefore, partakes of its motion in every particular.

(5.) The first motion wheel of Part II.: which is clamped to the eccentric slide of Part I. by the detent which properly belongs to the front terminal wheel of Part I., and which is brought forward for this purpose by a temporary brass packing. This first motion wheel of Part II., therefore, makes as many rotations as that of the foundation plate of Part I., *i.e.*, as the mandrel; and its centre of rotation is coincident with that of the front terminal wheel of Part I.

(6.) The front terminal wheel of Part II.: whose centre of rotation depends upon the eccentric slide of Part II. which carries it, and whose actual rotations are influenced, as to number and direction, by the combined effect of the epicyclic trains of both Part I. and Part II. A detent applies to this last terminal wheel for preventing all rotation of the train, when the detent of the first motion wheel of Part I. is released and the chuck is used, strictly in a central condition, as a holding chuck only, for the preparation of the surface which is to receive the curves.

The method and progress of this combined motion, resulting from the two epicyclic trains and two separate eccentricities, are singularly curious, and the results are often unexpected to a surprising degree. Very many examples of compound geometric turning are now to be met with, both in private hands and in the books to which reference has already been made, and it is hoped that the explanations about to be given will render the construction of such figures more intelligible and more interesting.

In all that follows, the notation will correspond to that already employed.

S.R., sometimes spoken of as the "radius," denotes the distance measured on the slide rest from right to left, or towards the observer, of the describing point from the axis of the mandrel; the slide rest being placed transversely upon the lathe bearers, parallel to the chuck, and the describing point being correctly adjusted for height of centre.

Ex_1 and Ex_2 denote the eccentricities given to the eccentric slides of Part I. and Part II., respectively; these quantities, as well as S.R., being always expressed in hundredths of an inch.

V_1 denotes the value or diminishing effect of the train of wheels of Part I.; and V_2 has the same signification for Part II. The addition of " in " or " out " to these two symbols is essential to their proper interpretation, and indicates that for " in " the number of arbors employed is *odd*, and for " out " the number of arbors is *even*. Under ordinary circumstances, and regarding each part separately, the simple loops with the arrangement thus specified would turn inwards or outwards, according to this designation. But as regards the resulting compound curve, the direction of the individual loops generally varies according as Ex_1 is made greater or less than Ex_2, although no alteration has been made in the number of arbors of the train of either part. This is shown very clearly in figs. 1,084 and 1,085, compared with figs. 1,092 and 1,093, where the difference in direction of loops, as will be seen by referring to the tabulated adjustments, is caused solely by an inversion of the values assigned to Ex_1 and Ex_2.

The reducing effect of the train of wheels in Part II., upon the front terminal wheel, is obtained just as in Part I.; and the observations already made upon this head, and the rules already given for calculating the value V of any arrangement of wheels, and for ascertaining what wheels should be used to produce any desired value of V_1, will apply to Part II. as well as to Part I. But owing to the more limited dimensions of train accommodation in Part II., and to the fact that both parts have to be supplied from one collection of change wheels, it is not always easy to arrange satisfactory trains for both. And it not unfrequently happens that a wheel, of which no duplicate may be at hand, which would be very suitable for Part I., is absolutely essential for Part II., and consequently the train intended for Part I. must undergo some modification.

It may be useful, therefore, to enlarge a little upon the composition of trains for Part II.

For low values of V_2, whether integral or fractional, it is generally sufficient to introduce a single pair of wheels, on a removable arbor, between the 64 on E (which receives its motion from the 96 first motion wheel of Part II.) and the 64 on A, which transfers the motion to the front of the chuck. And, as was explained when treating of Part I., this pair of wheels will be represented by a fraction equivalent to V_2 divided by 2: for in Part II., as well as in Part I., 2 is the diminishing effect of the permanent wheels of the train. Thus, if $V_2=5$, the pair of wheels required will be equal to $\frac{V_2}{2} = \frac{5}{2} = \frac{60}{24}$. And if $V_2 = \frac{8}{3}$, the fraction indicating the proportion which must exist between the corresponding pair of wheels will be $\frac{4}{3}$, and the wheels themselves may be 48 and 36, or 56 and 42, or any others in the same proportion. Fractions, which can only be represented by two pairs of wheels, are to be developed as already shown on p. 12; and the rule continues in force that the wheel first placed upon the removable arbor represents the numerator of the fraction, and the second wheel its denominator.

The higher values of V_2, which are less easy to provide than similar values of V_1, are obtained by placing a 24 wheel on the first plane of the E arbor,—the 64 being on the third,—and using for the next pair the attached $\frac{48}{24}$ (noticed in connection with Part I., page 13), whose arbor is short enough to pass behind the 64 on E. The arbors are now being again distinguished by letters of reference from A to E, as previously, and the former plan of writing down the wheels and spaces in their correct positions, in three lines underneath these letters of reference, as adopted in the tabulated adjustments for integral values of V, which are furnished by Messrs. Holtzapffel and Co. with their chucks,—cannot be improved upon. Adopting that method of description, and assuming for the present that one other pair of change wheels upon the arbor B will afford a sufficient reduction of velocity in Part II., the train would be indicated as follows:—

A.	B.	C.	D.	E.
64	b	—	—	64
—	b′	24	—	—
—	—	48	—	24

Now, to ascertain the complete effect of the train, we must begin, as in Part I., with the 96 front terminal wheel of Part II., and include the wheels of the link motion in front, as well as the 96 first motion wheel of Part II. And, as a whole, they stand thus:—

$$\frac{96}{32} \cdot \frac{64}{b} \cdot \frac{b'}{24} \cdot \frac{48}{24} \cdot \frac{64}{96}$$

The first and last of these fractions represent the permanent wheels of the train, and are equal to 2, and the product of the entire series of fractions is equal to the value of V_2. Therefore we have—

$$2 \times \frac{b'}{b} \times \frac{64}{24} \times \frac{48}{24} = V_2$$

Or, $$\frac{b'}{b} = \frac{3\,V_2}{32}.$$

And those Amateurs who do not object to solve so simple an algebraic equation as this will find that method of much assistance in completing a train of which certain wheels are specified. For, instance, in the above expression the fraction $\frac{b'}{b}$ denotes the pair of wheels required to produce a certain value of V_2, when the wheels on the arbors C and E are those stated above. Suppose V_2 is to be 20, then $\frac{b'}{b} = \frac{3 \times 20}{32} = \frac{60}{32}$; and that pair of wheels will give the desired reduction in velocity. Or, let $V_2 = 24$; then $\frac{b'}{b} = \frac{3 \times 24}{4 \times 8} = \frac{18}{8} = \frac{54}{24}$, and this will be found to be the highest integral value obtainable for V_2 with this arrangement of four arbors. Fractional values of V_2 are not readily produced in high numbers with the wheels on E and D, as specified, and one other pair on B, unless the denominator of the required fractional value be some multiple of 3. Thus, if $V_2 = \frac{80}{3}$, $\frac{b'}{b} = \frac{3}{32} \times \frac{80}{3} = \frac{60}{24}$, which are wheels at our command; but, if $V_2 = \frac{45}{2}$ $\frac{b'}{b} = \frac{3}{32} \times \frac{45}{2}$; and no single pair of wheels admissible by the apparatus will give effect to that expression.

But it is easy to consider $\frac{b'}{b}$ as representing two pairs of wheels, instead of one, the second pair being placed on the arbor D, which has not yet been introduced, and thus to obtain higher integral values of V_2, as well as such fractional values as cannot be represented by $\frac{b'}{b}$ taken singly. For example, the above value of $\frac{45}{2}$ for V_2, for which one pair of wheels would not suffice, is readily expressed by two pairs in the following manner:—

$$\frac{b'\,d}{b\,d'} = \frac{3}{32} \times \frac{45}{2} = \frac{45}{32} \cdot \frac{48}{32};$$

and if, as is probable, the 45 wheel proves to be too small to gear correctly with the rest, we can break up the fractions differently, as $\frac{15}{8} \times \frac{9}{8}$, which would give the wheels $\frac{60}{32} \cdot \frac{54}{48}$. Similarly, let $V_2 = 40$, then to find the corresponding wheels we have—

$$\frac{b'\,d}{b\,d'} = \frac{3}{32} \times 40 = \frac{3}{2} \times \frac{5}{2} = \frac{48}{32} \cdot \frac{60}{24}.$$

Some amount of dexterity in manipulating simple vulgar fractions is of much assistance in arranging these trains of change wheels. For in Part I., where one wheel may have four times as many teeth as another on the same axis, there are often many ways in which suitable wheels can be selected; while in Part II., where the ratio of the highest and lowest wheels which can be placed on the same axis is $2\frac{3}{4}$ to 1, instead of 4 to 1, the choice is much more restricted. And it is convenient to bear in mind the equivalents of the fractions representing some of the more frequent combinations, thus:—

$$\frac{11}{4} = \frac{66}{24}, \quad \frac{8}{3} = \frac{64}{24}, \quad \frac{5}{2} = \frac{60}{24}, \quad \frac{9}{4} = \frac{54}{24},$$

$$\frac{13}{6} = \frac{52}{24}, \quad \frac{7}{3} = \frac{56}{24}, \quad \frac{12}{5} = \frac{60}{25}, \quad \frac{7}{4} = \frac{56}{32}.$$

Suppose $V = 56$, then $\frac{b'd}{bd'} = \frac{3}{32} \times 56 = \frac{3}{1} \times \frac{7}{4}$; and though $\frac{7}{4}$ is readily translated into $\frac{56}{32}$, we cannot, in Part

II., use wheels representing the fraction $\frac{3}{1}$. The best way to overcome this difficulty will be to multiply both numerator and denominator of the $\frac{3}{1}$ by 3. The two fractions then become $\frac{9}{3} \times \frac{7}{4}$, or $\frac{9}{4} \times \frac{7}{3}$, which are within the prescribed limits, and the wheels will be $\frac{54}{24} \times \frac{56}{24}$. In like manner, if $V_2 = 52$, $\frac{b'd}{bd'} = \frac{3}{32} \times 52 = \frac{3}{1} \times \frac{13}{8} = \frac{18}{6} \times \frac{13}{8} = \frac{9}{4} \times \frac{13}{6} = \frac{54}{24} \; \frac{52}{24}$.

Fractional values of considerable magnitude can also be provided for V_2, such as the following, many of which were required for some of the later examples:—

$$V_2 = \frac{160}{3},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{160}{3} = 5 = \frac{5}{2} \times \frac{2}{1} = \frac{60}{24} \cdot \frac{48}{24}$$

$$V_2 = \frac{176}{3},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{176}{3} = \frac{11}{2} = \frac{11}{4} \times \frac{2}{1} = \frac{66}{24} \cdot \frac{48}{24}$$

$$V_2 = \frac{140}{3},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{140}{3} = \frac{35}{8} = \frac{7 \times 5}{4 \times 2} = \frac{56}{32} \cdot \frac{60}{24}$$

$$V_2 = \frac{220}{3},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{220}{3} = \frac{55}{8} = \frac{11 \times 5}{4 \times 2} = \frac{66}{24} \cdot \frac{60}{24}$$

$$V_2 = \frac{99}{2},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{99}{2} = \frac{3 \times 9 \times 11}{4 \times 8 \times 2} = \frac{11}{4} \times \frac{27}{16} = \frac{66}{24} \cdot \frac{54}{32}$$

$$V_2 = \frac{77}{2},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{77}{2} = \frac{3 \times 7 \times 11}{2 \times 8 \times 4} = \frac{11}{4} \times \frac{21}{16} = \frac{66}{24} \cdot \frac{42}{32}$$

$$V_2 = \frac{87}{2},\ \frac{b'd}{bd'} = \frac{3}{32} \times \frac{87}{2} = \frac{3 \times 29 \times 3}{2 \times 8 \times 4} = \frac{9}{4} \times \frac{29}{16} = \frac{54}{24} \cdot \frac{58}{32}$$

In the last example but one, the wheels $\frac{42}{32}$ would probably be inappropriate, the 42 being too small to gear with the 24 of the attached $\frac{48}{24}$ which should be the adjoining arbor. The set of change wheels is not likely to include a 63, therefore the fraction $\frac{21}{16}$ cannot be converted from $\frac{42}{32}$ into $\frac{63}{48}$: but we can restate the fractions as $\frac{66}{32} \cdot \frac{42}{24}$, and then substitute, for the $\frac{42}{24}$, its equivalent $\frac{56}{32}$.

High numbers of this kind are frequently useful on Part II., and to improve the more limited facilities in this respect which Part II. possesses as compared with Part I., it is desirable to have duplicates of many of the wheels; and it is also convenient to regard the 64 on the permanent arbor A as a change wheel, and to have double key-ways made in the set of change wheels from 48 to 66 (which will not in the least interfere with their reception by the removable arbors with one key only) in order that they may suit the double-keyed arbor A. But even without this expedient, the two arbors B and D generally give scope enough: and the following arrangement, which will be found effective for high numbers in Part II., possesses the advantage of producing the value which may be desired for V_2, in terms of the number of teeth of one of the wheels of the train; and that wheel one which is easily removable.

A.	B.	C.	D.	E.
60	25	—	64	24
—	**54**	24	—	60
—	—	48	24	—

The train as here described gives $V_2 = 54$; and any other value not less than 48, nor greater than 60, can be obtained by exchanging the 54 on B for a wheel of as many teeth as there may be loops required. For a value of V_2 between 60 and 66, a wheel corresponding to the required number would be placed on E instead of the 60, and the 60 be transferred to B in place of the 54. Another scheme is this:—

A.	B.	C.	D.	E.
64	24	—	64	24
—	54	24	—	64
—	—	48	24	—

where, as now given, the resulting value of V_2 is 64; and any other value may be had by changing the 64 on A for a wheel, with double key way, the number of whose teeth is equal to that other value of V_2. For numbers below 48 these methods do not apply: in such cases, and for all fractional values, the wheels to be used on the arbors B and D will be readily found from the expression first given, $\frac{b'd}{bd'} = \frac{3V_2}{32}$. When the value required is one, such as 55, for which there is no corresponding wheel, it can be broken up into factors, unless a prime number: thus $\frac{b'd}{bd'} = \frac{3}{32} \times 55 = \frac{3 \times 11 \times 5}{2 \times 4 \times 4} = \frac{15}{8} \times \frac{11}{4} = \frac{60}{32} \cdot \frac{66}{24}$. And sometimes it is even possible to introduce another arbor, generally with wheels $\frac{48}{24}$, besides those specified. For example, the wheels $\frac{66}{24} \cdot \frac{54}{32}$ on B and D, with the usual $\frac{64}{24}$ on E, and 64 on A give $V_2 = \frac{99}{2}$: and to find room in the train for another arbor it will be necessary to change the $\frac{64}{32}$, [of which 64 is on A, and 32 on B or D] for $\frac{48}{24}$ and to move the 54 from B to A. Then we have $V_2 = 99$, arranged in this way.

A.	B.	C′.	C.	D.	E.
—	48	24	—	66	24
—	—	48	24	—	64
54	24	—	48	24	—

The most obvious performance of the two-part Geometric Chuck is to describe a series of numerous consecutive loops, closely interlaced, so numerous as to be almost circular, along the course of any figure which may be produced by the single geometric chuck alone. The value of V which belongs to the outline figure is represented by Part II., *i.e.*, by V_2; and V_1 is made equal to the number of loops which it is desired to place in each compartmment of the figure. Speaking generally, not accurately, Part I. describes V_1 loops for, and upon, every loop of V_2, also, V_2 defines the general aspect or characteristic feature of the compound curve, as square or four-looped if $V_2=4$, six-looped or hexagonal if $V_2=6$, &c., while V determines the frequency of the intersecting loops, whether few or many, inscribed on the course of the simple curve defined by V_2. Figure 215, for example, is an amplification of fig. 30, which is a simple eight-looped figure, where V was equal to 8, Ex. $=45$, and S.R. $=15$; and these values were transferred to the two-part chuck as follows:—V_2 was made equal to 8, $Ex_2=45$, and $Ex_1=15$. Then, the number of loops, in this case 32, which it was proposed that each compartment of the figure should contain, was taken for V_1; and the size or radius of the closely-intersecting loops was determined by giving the value of 5 to S.R.

Any other curve, right-lined, cusped, or looped, consecutive or circulating, which can be produced by the simple Geometric Chuck, may be decorated in this manner; transferring the adjustments V, Ex., and S.R., by which that simple curve would be described, to V_2, Ex_2, and Ex_1, respectively, of the two-part chuck, leaving the dimensions and frequency of the loops which will be placed in the path of the simple curve, to be determined by V_1 and S.R.

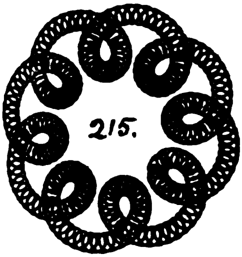
To embellish, for example, the rectilinear variety of the four-looped figure (fig. 25) with a considerable number of loops, say 40, in each side of the square, it will be necessary to arrange Part I. for 40 loops,—whether "in" or "out" is not very material,—and Part II. for 4 loops "out." Then to give expression to the ratio $\frac{1}{.n^2}$ or 1 : 9 in this instance, which must subsist between the radii of the two imaginary circles* on which the foundation of the curve depends, the eccentricities of Parts I. and II. must be in that proportion: in other words, the eccentricity of the slide of Part II. must be nine times the eccentricity of the slide of Part I. As another illustration, fig. 216 is founded upon fig. 54, and its adjustments were these

$V_1=32$ "in," $V_2=\frac{7}{3}$ "out," $Ex=21{\cdot}6$, $Ex_2=38{\cdot}4$, $S.R.=6_1$,

where it will be observed that the values of V_2, Ex^1, and Ex_2, are identical with those for V., S.R., and Ex., respectively, which were employed for the simple, or foundation, figure, fig. 54, and this is the rule to be adopted in effecting all adjustments of the two-part Geometric Chuck for a like purpose.

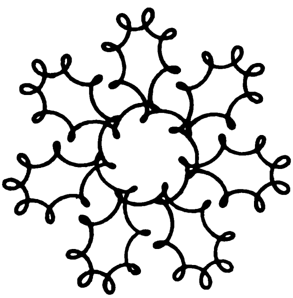
It will be remarked that the distribution of a large assem-

* See Penny Cyclopædia, Art. "Trochoidal curves."

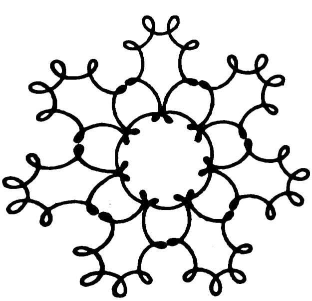


215.

216.



217.



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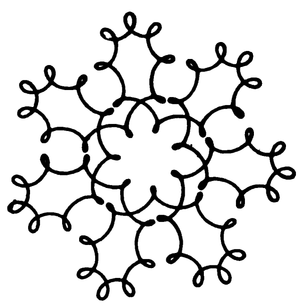

219.

blage of loops in the periphery of a simple geometric curve is unequal; at some points more compressed, at others more extended. Thus, the intersections are more frequent at the extremities of the loops in figs. 215 and 216 than at the intermediate portions of the compound curve. For this there is no remedy; but as the inequality occurs with regularity, being uniformly repeated at all similar points of the curve, there is the less objection to its existence. In the case of the ellipse, however, a mode of correction was applied by the late Mr. Ibbetson, which consisted in placing a short train of wheels, separately mounted, between the two parts of the chuck, with an eccentric adjustment similar to that of the "Compensating Index," applied to the mandrel pulley, for the equal division of the ellipse by the drill or eccentric cutter. The effect of this apparatus is to create another inequality of motion, equal in amount and opposite in direction to that which already exists; and, in consequence, the loops produced by Part I. are disposed uniformly in the periphery of the ellipse described by Part II. Such a compensatory method could probably be extended to other simple figures besides the ellipse, but its advantage is not considerable even in that case, compared with the additional complication of the attendant mechanism. This intermediate apparatus is sometimes spoken of as "Part III.," but is not on that account to be confounded with a third distinct chuck, or "*Part*," with its independent epicyclic train, which is sometimes superadded to the geometric chuck.

So long as the value of V_1 greatly exceeds that of V_2, the point at which the first motion wheel of Part I. is clamped by its detent makes no very perceptible difference in the disposition of the various members of the compound curve, with reference to any straight line supposed to be drawn through the centre; though even here the points of approach or intersection will be more exact and satisfactory when the precaution about to be mentioned has been respected. But when V_1 is not much greater than V_2, and still more when the two are equal, or when V_1 is less than V_2, it is very probable that on proceeding to trace the curve, with the first motion wheel of

Part I. clamped at random, it will assume an unsymmetrical and discordant outline,—such, for instance, as that exhibited by fig. 217. Careful tentative alterations of the clamp of this first motion wheel will improve the aspect of the curve, until, by the nicest adjustment of the end finger-screws of the detent plate, a point of clamp contact is found at which the described curve becomes symmetrical in every sense. This having been accomplished, it will then be discovered that [so long as V_1 is integral] by moving the first motion wheel half-way round precisely, another position is attained in which another curve can be described, equally symmetrical, but differing (sometimes slightly, though frequently in a striking degree, figs. 508 and 509 for example) from its companion curve previously traced. But for all points intermediate to these two, at which the first motion wheel may be clamped, the result is a curve,—sometimes of pleasing contour, and forming interesting designs when repeated at small intervals, or varied by slight changes of S.R.,—but which cannot strictly be called symmetrical.

Figs. 217, 218, and 219, where $V_1 = 8$ "out," $V_2 = 7$ "out," exemplify the remarks which have now been made. The first figure shows the distorted result which may usually be expected if the curve be traced without first attending to the relative position of the two eccentric slides, as determined by the adjustment of the first motion wheel of Part I.; while figs. 218 and 219 are the two symmetrical "companion figures" of the curve in question for the values of Ex_1, Ex_2, and S.R., which happened to be adopted.

In changing the point of this clamp contact, the first motion wheel is moved, to a greater or less degree, upon its axis, and that alters the angle at which the two eccentric slides in parallel planes are inclined to one another. And it is rather a tedious operation to find by trial either of the two points of the first motion wheel of Part I., which correspond to the two symmetrical phases of the curve. But fortunately there is a simple expedient by which one of the desired positions may be selected at once; and that consists in making the longer edges of both eccentric slides *horizontal together*. To accomplish this it is convenient to clamp the mandrel pulley by its tangent screw,—or adjusting index finger in the absence of the latter,—at such a point that the edge of the eccentric slide of Part I. is apparently horizontal; and then to make it so precisely, by the aid of a spirit level temporarily placed upon the square edge of one of the two steel bars between which that slide traverses. The mandrel pulley still remaining clamped, the first motion wheel of Part I. should be released, and (the first motion wheel of Part II. being clamped) the eccentric slide of Part II. can also be brought approximately into the horizontal position, and finally corrected under the guidance of the spirit level, by the end adjusting screws of the first motion wheel of Part I. The mandrel pulley may now be placed at liberty, and the compound chuck will describe one of the two symmetrical companion curves which would result from the other conditions of eccentricity and relative velocity previously determined. If the result be not, at once, quite satisfactory, the reason will probably be that the describing point has not been adjusted exactly to the height of lathe centre; or that the eccentric slide of Part II. has not been brought up to the horizontal position in such a direction that all the wheels of both trains were prepared to commence their movement without "loss of time," when the chuck was set in motion.

When this "initial position" has been once secured, the eccentricity of the slide of Part II., and its train of wheels also, may be varied *ad libitum* without deranging the symmetrical condition of any one of the curves which may thus be successively produced. If, however, any alteration be made, whether for value or direction, in the train of Part I., or in the eccentricity of its slide, the initial position will be disturbed, and must be refound in the manner described above, or by trial.

It may be remarked here that the two eccentric slides are not horizontal together as often as the same edges come uppermost. Their different rates of rotation will evidently prevent this; and it is, therefore, possible that they may be in proper relative adjustment although, at the time of inspection, one slide may be horizontal while the other is inclined. The same edges will only coincide after a certain number of rotations of the chuck, and the coincidence may recur for the first time on completion of the curve, or there may be two or more coincidences at equal intervals before the whole curve be traced. But the safest way of proceeding is always to make both slides horizontal at starting. And, in recommending the use of the spirit level, it is, of course, presumed that the lathe bearers and the bed of the slide rest would stand the same scrutiny.

But these two symmetrical positions are not found invariably at opposite points of the first motion wheel. There is an exception to that rule when the value of V_1 is fractional; for under these circumstances the rule only applies when the denominator of the fraction—always in its lowest terms—is an *odd* number. When that denominator is *even*, the second position of symmetry is obtained by moving the first motion wheel a quarter round, instead of half-way. And in these cases the curves produced at the two positions, 90^0 apart, on the first motion wheel, are not equally symmetrical: but that it is right to treat them both as "companion figures," is proved by the fact that the point of clamp contact at which the inferior or quasi-symmetrical figure occurs, is that at which the better result appears when the direction of V_1 has been changed from "in" to "out," or the reverse. As regards V_2, a fractional value of any kind makes no difference; the adjustment for a truly-disposed curve, equally balanced on each side of an imaginary axis, depends solely upon the first motion wheel of Part I.

The point at which the first motion wheel of Part II. may be clamped has no influence upon the character of the curve or its symmetrical condition individually. The only effect of changing the position of this first motion wheel with respect to its detent is to produce the same curve, with the same centre, but with its recesses and projections placed behind, or in advance of, the points at which they had previously occurred.

The symmetrical condition of a compound geometric curve, as regards itself individually, is one thing; its symmetrical position, as regards its association with different curves in the same design, is another. The former condition is secured by the adjustment of the first motion wheel of Part I.; the alteration of whose detent affects the position, *inter se*, of the component parts of the curve. And this can be attained with any required degree of nicety, since the vernier and end screws of the detent plate give the means of adjustment to the tenth part of a tooth. The latter condition depends upon the due alteration of the first motion wheel of Part II., which has the effect of changing the angular position of the curve as a whole with reference to any imaginary datum line through the common centre. And this, with the present construction of the chuck, can only be arrived at within certain limits, there being no provision for moving the detent of the first motion wheel of Part II. through a less space than one tooth.

The nicest adjustment of the two eccentric slides for initial position, by the spirit level, is not always easy; and when it has once been satisfactorily settled for a given value of V_1, the correction for any change in Ex_1, while V_1, V_2, and Ex_2, remain the same, may be sometimes found with less trouble by calculation from the tabulated numbers corresponding to the correction required when $V=1$, for intervals of ten divisions on the eccentric slide, as given on page 36. There is also no reason whatever why the same method should not be applied to Part II., as will appear subsequently. For the present, the effect of an alteration of the detent of the first motion wheel of Part II. need not be considered, since it is only needed for the correct association of differing curves; and before noticing the peculiarities of curves in combination, it will be well to ascertain, as fully as possible, the share which belongs to each adjustment of the chuck in any one compound curve.

After some experiments with figures of the more usual stamp, such as figs. 215 and 216, it will be recollected that the loops of Part I. need not be so much more numerous than those of Part II.; that they might be identical in number, or that those of Part II. might even exceed those of Part I.; and that, in fact, V_1 and V_2 may each be of any magnitude whatever for which trains of wheels can be arranged; also, that these values may be either integral or fractional; and, again, that the directions of motion in each Part may be either "out" or "in." Then, too, the eccentricities of Parts I. and II., and of the slide rest, may each be of any convenient value. Practically that of S.R. proves to be limited for useful effect to amounts ranging from 0 to about 25 hundredths of an inch; and for figures of moderate size, a maximum value of about 60 appears to be sufficient for both Ex_1 and Ex_2.

With so many variable elements in combination it is almost necessary, in order to discover their several and united effects, to select a series of values which shall be assigned in turn to V_1 and V_2, and to trace curves for each, both for the "in" and "out" condition, with alternating values for Ex_1 and Ex_2, and with such values for S.R. as may prove in each case to show the nature of the curve most successfully. With this view the following investigation was undertaken, and the figures—drawn with lithographic ink as described on a former page—have been preserved for the future reference of those who may be interested in the subject of Trochoidal Curves. By far the greater number of the figures are too lacking in distinctness and individuality to be worth recording, were it not that their retention may be useful to point out those combinations which are the least promising, and to show the amateur that he need not waste time in experiments in that direction. The diagrams are not offered as "patterns for turning," though some few of them may be eligible in that capacity, and nearly all the simpler figures could be used as foundation figures for a three-part Geometric Chuck, and equally so for deep cutting on a plane surface with an ornamental drill.

The series adopted was the following:—comprising all numbers of loops from 1 to 10 inclusive, some of them being fractional values.

$$1,\ 2,\ 3,\ 4,\ \frac{5}{2},\ 6,\ \frac{7}{2},\ \frac{8}{5},\ 9,\ \frac{10}{3}.$$

The selection is purely arbitrary, and a different series, especially with different denominators for the fractional numbers, would have afforded other information. Since, however, the more striking effects are obtained by the employment of low values for either V_1 singly, or for both V_1 and V_2 together, the greater part of this series must, in any case, have been included; and the resulting diagrams will, at any rate, serve to clear the ground for further observation. As regards the integral values 1 to 4, 6, and 9, it will not be difficult to infer, from the examples given, what difference may be expected from the substitution of other similar whole numbers 5, 7, 8, 10, 11, 12, &c. But, as regards the fractional values, though they all follow to some extent the course which would result from the employment of their nearest integer instead of the given fraction, a slight change in the numerical value makes frequently a great alteration in the compound curve produced; and therefore, though some hints may be gleaned from the series about to be developed, actual experiment will be desirable in almost every pair of fractional values that may be suggested.

Beginning with $V_1 = 1$ "out," it was found that, when V_2 had the same value, the result was a circle only, whose radius $= Ex_2 + S.R.$, and whose centre is at a distance $= Ex_1$ from the axis of the mandrel.

Continuing $V_1 = 1$ out, it appeared that, with $V_2 = 1$ in, the cardioid was produced in variety; with $V_2 = 2$ out, ellipses were described, whose centres were always in the axis of the mandrel; with $V_2 = 2$ in, the two-looped figure occurred; and similarly it was found that, whatever may be the value of V_2 while $V_1 = 1$ out, the resulting curve does not differ from that which would be described by the simple Geometric Chuck. It is therefore evident that the condition $V_1 = 1$ out may be omitted from the series.

Again, when $V_2 = 1$ out, it proved that, with $V_1 = 1$ in, ellipses were obtained, whose semi-axes were $Ex_2 \pm S.R.$ respectively, and centres $= Ex_1$ from the axis of the mandrel; —with $V_1 = 1$ out the result has just been stated.

Continuing $V_2 = 1$ "out,"—it appeared that, with $V_1 = 2$ "in," a simple curve with three external loops was produced; and with $V_1 = 2$ out, the cardioid or one-looped figure. Similarly, with $V_1 = 3$ in, the curve had four loops "out"; and, with $V_1 = 3$ out, the curve had two loops "in." Fractional values for V_1 followed the same law, viz.,—that, when $V_2 = 1$ out, the result is a simple curve with $V_1 + 1$ external loops when V_1 is "in," and with $V_1 - 1$ internal loops, when V_1 is "out." Consequently, the value of 1 "out" is of no more effect in obtaining a compound geometric curve when assigned to V_2 than it was when given to V_1. Hence, this value may be omitted altogether, and the illustrations of the series will commence with 1 "in," which *does* produce a compound effect whether ascribed to V_1 or to V_2.

As a matter of convenience it was found preferable to keep V_1 constant, while V_2 was changed for the successive numbers of the adopted series,—instead of keeping V_2 constant and changing V_1—because the correction at the first motion wheel for the specified alterations of Ex_1 will continue the same as long as V_1 remains undisturbed. The diagrams are not fully extended, but are still very numerous; and, to abbreviate the collection, the later portions of the series have been illustrated more sparingly, one of the two companion figures which are afforded by each set of adjustments being generally omitted, although to show the effect of each, the successive diagrams, where one only of each kind is given, are taken at alternate positions of the chuck. Extreme nicety of correction for symmetry was not attempted; no fractional part of a tooth being used in the adjustment of the first motion wheel of Part I., but the values of Ex_1, Ex_2 and S.R., were carefully transferred to their respective slides.

The range of experiments would be incomplete without giving to both Ex_1 and Ex_2, in turn, a zero value. When this is done, the resulting curve is always one which could be produced by the simple Geometric Chuck only, but with different adjustments to those of either Part I. or Part II. in the case supposed.

And for the earlier portions of the following series of examples, the kind of curve obtained, when Ex. of one part is o, and of the other 60, is tabulated, though not illustrated, with the rest. Many of the results are curious, and at first sight hardly reconcileable. For instance—

V_1	V_2	Ex_1	Ex_2	Simple curve produced.
3 in	4 out	60	o	4 consecutive loops, "in."
4 out	$\frac{10}{8}$ out	o	60	10 ,, ,, "out."
,,	,,	60	o	40 circulating ,, ,, ($V=\frac{40}{7}$)*
$\frac{5}{2}$ out	6 out	o	60	9 consecutive ,, "in."
$\frac{5}{2}$ in	$\frac{7}{2}$ out	60	o	7 circulating ,, "in" ($V=\frac{7}{2}$)

But when the observations had been sufficiently extended, and especially when those depending on fractional values for V_1 and V_2 had been considered, it became obvious that they followed a definite law in each of the eight possible cases which occur, according as the zero value is assigned to Ex_1 or to Ex_2; and according as either or both of the two trains of wheels (whose effect is denoted by V_1 and V_2 respectively) have their ultimate directions of motion identical or opposed, and inwards or outwards. And it is believed that the following expressions accurately indicate, for all values of V_1 and V_2 whatever, the nature of those curves which, though producible by one part only, arise from this special condition in the adjustments of the two parts in combination.

* NOTE.—It was explained on pages 19 and 29 that when a simple curve is defined by representing V as equivalent to a specified fraction, the numerator of that fraction denotes the number of loops in the curve, and the denominator the number of rotations of the surface on which the curve is being traced required to complete the curve.

Formulæ for expressing the number of loops in the curve produced when either Ex_1 or $Ex_2 = 0$:—

Ex_1	Ex_2	V_1	V_2	Number and direction of loops.		
none	any	out	out	$(V_1 - 1) V_2$	loops	"in."
"	"	"	in	"	"	"out."
"	"	in	out	$(V_1 + 1) V_2$	"	"out."
"	"	"	in	"	"	"in."
any	none	out	out	$\frac{V_1 \times V_2}{V_2 - 1}$	"	"out."
"	"	in	"	"	"	"in."
"	"	out	in	$\frac{V_1 \times V_2}{V_2 + 1}$	"	"out."
"	"	in	"	"	"	"in."

These formulæ were obtained inductively by comparison of the observations, and by assuming such theories for each of the eight cases as seemed probable, until one was found that proved to answer for all successive and for all other values of V_1 and V_2 of which experiment was made. The formulæ have been freely tested, and seem to hold good for all cases. But at the best the matter is one of curiosity only, since it would be needless to use the compound chuck in order to describe a simple curve.

CHAPTER III.

Detailed Adjustments relating to the lithographed figures of the Series.

THE numerical values assigned successively and in turn to V_1 and V_2 are stated at the foot of page 54, and the Table which appears in two halves over the next leaf exhibits at a glance the distinctive numbers which are attached to the figures,—every figure consisting of a single continuous curve,—which illustrate each combination. The values taken for V_1 are to be found in the vertical column on the left hand; those belonging to V_2 being in the top horizontal line; and the numbers which occur at the points of intersection are those by which the corresponding diagrams are distinguished. For instance, to observe the characteristic effects produced when $V_1 = 2$ out and $V_2 = 9$ in, the figs. 518 to 528 inclusive may be consulted; and when those values are exchanged for $V_1 = 9$ in and $V_2 = 2$ out, the figures numbered 2240 to 2249 will show the various phases of which that curve is susceptible. In the pages which follow this table a complete reference is given for the adjustments of each individual figure.

The "companion figures" are bracketed, that is to say, the numbers thus connected refer to two figures produced with the same values for V_1, V_2, Ex_1, and Ex_2, but with a change at the first motion wheel of Part I., from one symmetrical position to the other; and, sometimes, with different values for S.R.

Though the investigation may be thought needlessly minute, it is by no means exhaustive; and an extension of the amounts of eccentricity, especially Ex_2, to at least 100, would frequently give striking results of intermediate character to those in the present series.

It may be here repeated that all measurements are expressed in hundredths of an inch.

V_2

V_1

	1 in	2 out	2 in	3 out	3 in	4 out	[illegible] in	[illegible] out	[illegible] in	[illegible]
1 in	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 out	—	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 517
2 in	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 710
3 out	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 941	942 957
3 in	1074 1083	1084 1093	1094 [illegible]	1104 1113	1114 1123	1124 1133	1134 1143	1144 1153	1154 1163	1164 1173
4 out	1258 1267	1268 1277	1278 1287	1288 1297	1298 1307	1308 1317	1318 1327	1328 1337	1338 1347	1348 1357
4 in	1450 1459	1460 1469	1470 1479	1480 1489	1490 1499	1500 1509	1510 1519	1520 1529	1530 1539	1540 1549
6 out	1640 1649	1650 1659	1660 1669	1670 1679	1680 1689	1690 1699	1700 1709	1710 1719	1720 1729	1730 1739
6 in	1830 1839	1840 1849	1850 1859	1860 1869	1870 1879	1880 1889	1890 1899	1900 1909	1910 1919	1920 1929
9 out	2020 2029	2030 2039	2040 2049	2050 2059	2060 2071	2072 2083	2084 2095	2096 2105	2106 2117	2118 2127
9 in	2230 2239	2240 2249	2250 2259	2260 2269	2270 2281	2282 2293	2294 2305	2306 2315	2316 2325	2326 2337
$\frac{5}{2}$ out	2438 2447	2448 2457	2458 2467	2468 2479	2480 2489	2490 2499	2500 2509	2510 2517	2518 2525	2526 2535
$\frac{5}{2}$ in	2610 2617	2618 2627	2628 2635	2636 2645	2646 2653	2654 2663	2664 2671	2672 2681	2682 2691	2692 2701
$\frac{7}{2}$ out	2778 2783	2784 2789	2790 2795	2796 2803	2804 2811	2812 2819	2820 2829	2830 2837	2838 2845	2846 2849
$\frac{7}{2}$ in	2912 2914	2915 2918	2919 2923	2924 2927	2428 2931	2932 2937	2938 2941	2942 2947	2948 2953	2954 2957
[illegible] out	3004 3007	3008 3017	3018 3021	3022 3031	3032 3035	3036 3041	3042 3047	3048 3053	3054 3059	3060 3069
[illegible] in	3118 3121	3122 3127	3128 3133	3134 3137	3138 3141	3142 3145	3146 3149	3150 3153	3154 3157	3158 3161
[illegible] out	3198 3201	3202 3207	3208 3213	3214 3217	3218 3223	3224 3231	3232 3239	3240 3247	3248 3253	3254 3261
[illegible] in	3312 3313	3314 3317	3318 3321	3322 3327	3328 3333	3334 3339	3340 3345	3346 3351	3352 3357	3358 3361

V$_2$

V$_1$	9 in	$\frac{5}{2}$ out	$\frac{5}{2}$ in	$\frac{7}{2}$ out	$\frac{7}{2}$ in	$\frac{8}{5}$ out	$\frac{8}{5}$ in	$\frac{10}{3}$ out	$\frac{10}{3}$ in
1 in	342 349	350 360	361 369	370 377	378 385	386 402	403 407	408 419	420 427
2 out	518 528	529 545	546 555	556 569	570 581	582 593	594 598	599 614	615 625
2 in	717 720	721 731	732 739	740 749	750 759	760 775	776 785	786 795	796 805
3 out	958 975	976 991	992 1003	1004 1019	1020 1031	1032 1041	1042 1053	1054 1063	1064 1073
3 in	1174 1179	1180 1189	1190 1199	1200 1209	1210 1219	1220 1229	1230 1237	1238 1247	1248 1257
4 out	1358 1367	1368 1377	1378 1387	1388 1397	1398 1407	1408 1417	1418 1429	1430 1439	1440 1449
4 in	1550 1559	1560 1569	1570 1579	1580 1589	1590 1599	1600 1609	1610 1619	1620 1629	1630 1639
6 out	1740 1749	1750 1759	1760 1769	1770 1779	1780 1789	1790 1799	1800 1809	1810 1819	1820 1829
6 in	1930 1939	1940 1949	1950 1959	1960 1969	1970 1979	1980 1989	1990 1999	2000 2009	2010 2019
9 out	2128 2139	2140 2151	2152 2163	2164 2176	2174 2185	2186 2195	2196 2207	2208 2217	2218 2229
9 in	2338 2349	2350 2361	2362 2373	2374 2383	2384 2395	2396 2403	2404 2415	2416 2425	2426 2437
$\frac{5}{2}$ out	2536 2545	2546 2555	2556 2563	2564 2571	2572 2577	2578 2587	2588 2593	2594 2603	2604 2609
$\frac{5}{2}$ in	2702 2709	2710 2719	2720 2727	2729 2737	2738 2743	2744 2751	2752 2761	2762 2769	2770 2777
$\frac{7}{2}$ out	2850 2857	2858 2863	2864 2871	2872 2879	2880 2887	2888 2893	2894 2901	2902 2905	2906 2911
$\frac{7}{2}$ in	2958 2961	2962 2967	2968 2971	2972 2977	2978 2983	2984 2989	2990 2995	2996 2999	3000 3003
$\frac{8}{5}$ out	3070 3073	3074 3081	3082 3087	3088 3091	3092 3093	3094 3097	3098 3099	3100 3107	3108 3117
$\frac{8}{5}$ in	3162 3165	3166 3171	3172 3175	3176 3179	3180 3181	3182 3185	3186 3187	3188 3193	3194 3197
$\frac{10}{3}$ out	3262 3269	3270 3275	3276 3283	3284 3289	3290 3295	3296 3299	3300 3303	3304 3307	3308 3311
$\frac{10}{3}$ in	3362 3365	3366 3369	3370 3373	3374 3377	3378 3379	3380 3383	3384 3385	3386 3389	3390 3391

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	1 in	0	60	—	(*a*)
		10	50	25	220, 221
		20	40	14	222, 223
		30	30	17	224
		40	20	21	225
		60	0	—	(*b*)
1 in	2 out	0	60	—	(*c*)
		10	50	6	226, 227
		,,	,,	14	228, 229
		,,	,,	20	230, 231
		20	40	3	232, 233
		,,	,,	7	234, 235
		,,	,,	20	236, 237
		24	36	14	238, 239
		30	30	8	240, 241
		34	26	20	242, 243
		40	20	6	244, 245
		40	20	20	246, 247

(*a*) 2 consec. loops in.
(*b*) 1 circ. loop in, $V=\frac{1}{2}$.
(*c*) 4 consec. loops out.

V	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	2 out	50	10	7	248, 249
		,,	,,	20	250, 251
		60	0	—	(*d*)
1 in	2 in	0	60	—	(*e*)
		10	50	16	252, 253
		20	40	6, 9	254, 255
		,,	,,	20	256, 257
		30	30	20	258, 259
		40	20	19	260, 261
		50	10	20	262, 263
		60	0	—	(*f*)
1 in	3 out	0	60	—	(*g*)
		10	50	15	264, 265
		20	40	5	266, 267
		,,	,,	15	268, 269
		30	30	5	270, 271
		,,	,,	15	272, 273
		40	20	5	274, 275

(*d*) 2 consec. loops in.
(*e*) 4 consec. loops in.
(*f*) 2 circ. loops in, $V=\frac{2}{3}$.
(*g*) 6 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	3 out	40	20	15	276, 277
		50	10	14	278, 279
		60	0	—	(*h*)
1 in	3 in	0	60	—	(*i*)
		10	50	11	280, 281
		15	45	6	282, 283
		20	40	16	284, 285
		30	30	18	286, 287
		40	20	18	288, 289
		60	0	—	(*k*)
1 in	4 out	0	60	—	(*l*)
		10	50	6	290, 291
		"	"	12	292, 293
		20	40	4	294, 295
		"	"	12	296, 297
		30	30	16	298, 299
		40	20	13	300, 301

(*h*) 3 circ. loops, in, $V = \frac{3}{2}$.
(*i*) 6 consec. loops, in.
(*k*) 3 circ. loops, in, $V = \frac{3}{4}$.
(*l*) 8 consec. loops, out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	4 out	50	10	18	302, 303
		60	0	—	(*a*)
1 in	4 in	0	60	—	(*b*)
		10	50	4	304, 305
		"	"	11	306, 307
		20	40	13	308, 309
		30	30	19	310, 311
		40	20	13	312, 313
		50	10	16	314, 315
		60	0	—	(*c*)
1 in	6 out	0	60	—	(*d*)
		10	50	10	316, 317
		20	40	10	318, 319
		30	30	14	320, 321
		40	20	16	322, 323
		60	0	—	(*e*)
1 in	6 in	0	60	—	(*f*)
		10	50	10	324, 325

(*a*) 4 circ. loops in, $V = \frac{4}{3}$.
(*b*) 8 consec. loops, in.
(*c*) 4 circ. loops, in, $V = \frac{4}{5}$.
(*d*) 12 consec. loops, out.
(*e*) 6 circ. loops, in, $V = \frac{6}{5}$.
(*f*) 12 consec. loops, in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	6 in	20	40	13	326, 327
		30	30	15	328, 329
		40	20	14	330, 331
		60	0	—	(*g*)
1 in	9 out	0	60	—	(*h*)
		5	55	5	332, 333
		10	50	8	334, 335
		20	40	10	336, 337
		30	30	15	338, 339
		40	20	10, 22	340, 341
		60	0	—	(*i*)
1 in	9 in	0	60	—	(*k*)
		5	55	5	342, 343
		10	50	10	344, 345
		20	40	14, 17	346, 347
		30	30	20	348, 349
		60	0	—	(*l*)

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	$\frac{5}{2}$ out	0	60	—	(*m*)
		10	50	2	350, 351
		,,	,,	10	352, 353
		20	40	9	354, 355
		30	30	15	356, 357
		40	20	15	358, 359
		50	10	20	360
		60	0	—	(*n*)
1 in	$\frac{5}{2}$ in	0	60	—	(*o*)
		10	50	5, 8	361, 362
		20	40	13, 17	363, 364
1 in	$\frac{5}{2}$ in	30	30	18, 22	365, 366
		40	20	25	367
		50	10	20	368, 369
		60	0	—	(*a*)
1 in	$\frac{7}{2}$ out	0	60	—	(*b*)
		10	50	17, 6	370, 371
		20	40	13	372, 373

(*g*) 6 circ. loops, in, $V = \frac{6}{7}$.
(*h*) 18 consec. loops, out.
(*i*) 9 circ. loops, in, $V = \frac{9}{8}$.
(*k*) 18 consec. loops, in.
(*l*) 9 circ. loops, in, $V = \frac{9}{10}$.

(*m*) 5 consec. loops, out.
(*n*) 5 circ. loops, in, $V = \frac{5}{3}$.
(*o*) 5 consec. loops, in.
(*a*) 5 circ. loops in, $V = \frac{5}{7}$.
(*b*) 7 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	$\frac{7}{2}$ out	30	30	4, 13	374, 375
		40	20	7, 17	376, 377
		60	0	—	(*c*)
1 in	$\frac{7}{2}$ in	0	60	—	(*d*)
		10	50	6, 11	378, 379
		”	”	18	380
		20	40	16	381, 382
		30	30	20	383, 384
		40	20	23	385
		60	0	—	(*e*)
1 in	$\frac{8}{5}$ out	0	60	—	(*f*)
		10	50	8, 10	386, 387
		”	”	20, 22	388, 389
		20	40	10	390, 391
		”	”	23	392, 393
		30	30	10	394
		”	”	18	395, 396
		40	20	10	397, 398
		”	”	20	399

(*c*) 7 circ. loops in $V = \frac{7}{5}$.
(*d*) 7 consec. loops in.
(*e*) 7 circ. loops in $V = \frac{7}{9}$.
(*f*) 16 circ. loops out, $V = \frac{16}{5}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	$\frac{8}{5}$ out	50	10	1	400
		”	”	10, 15	401, 402
		60	0	—	(*g*)
1 in	$\frac{8}{5}$ in	0	60	—	(*h*)
		10	50	17, 23	403, 404
		20	40	8	405
		30	30	25, 15	406, 407
		60	0	—	(*i*)
1 in	$\frac{10}{3}$ out	0	60	—	(*k*)
		10	50	5, 10	408, 409
		20	40	3, 6	410, 411
		”	”	15	412, 413
		30	30	13	414, 415
		40	20	6, 16	416, 417
		50	10	20	418, 419
		60	0	—	(*l*)
1 in	$\frac{10}{3}$ in	0	60	—	(*m*)
		10	50	6	420, 421

(*g*) 8 circ. loops in, $V = \frac{8}{3}$.
(*h*) 16 circ. loops in, $V = \frac{16}{5}$.
(*i*) 8 circ. loops in, $V = \frac{8}{13}$.
(*k*) 20 circ. loops out, $V = \frac{20}{3}$.
(*l*) 10 circ. loops in, $V = \frac{10}{7}$.
(*m*) 20 circ. loops in, $V = \frac{20}{3}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
1 in	$\frac{10}{3}$ in	10	50	13	422, 423
		20	40	15	424, 425
		30	30	20	426, 427
		60	0	—	(*n*)
2 out	1 in	0	60	—	(*a*)
		60	0	—	(*b*)
2 out	2 out	0	60	—	(*c*)
		60	0	—	(*d*)
2 out	2 in	0	60	—	(*e*)
		30	30	20	428, 429
		40	20	20	430, 431
		50	10	20	432, 433
		60	0	—	(*f*)
2 out	3 out	0	60	—	(*g*)
		10	50	10	434

(*n*) 10 circ. loops in, $V = \frac{10}{13}$.
(*a*) Circle.
(*b*) Circle. When neither Ex_1 nor $Ex_2 = 0$, phases of the one-looped figure occur.
(*c*) 2 consec. loops in.
(*d*) 4 consec loops out. The adjustments intermediate to (*c*) and (*d*) correspond, inversely, to those of $V_1 = 1$ in, $V_2 = 2$ out.
(*e*) Ellipse, axes $= V_2 + S.R.$
(*f*) 4 circ. loops out, $V = \frac{4}{3}$.
(*g*) 3 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 out	3 out	10	50	17	435, 436
		20	40	16	437, 438
		30	30	7	439, 440
		"	"	15	441, 442
		40	20	8	443, 444
		"	"	15	445, 446
		50	10	20	447, 448
		60	0	—	(*h*)
2 out	3 in	0	60	—	(*i*)
		10	50	17, 25	449, 450
		20	40	16	451, 452
		30	30	7	453
		"	"	15	454, 455
		40	20	20	456, 457
		50	10	20	458, 459
		60	0	—	(*k*)
2 out	4 out	0	60	—	(*l*)
		10	50	15	460, 461

(*h*) 3 consec. loops out.
(*i*) 3 consec. loops out.
(*k*) 3 circ. loops out, $V = \frac{3}{2}$.
(*l*) 4 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 out	4 out	20	40	7	462, 463
		,,	,,	15	464, 465
		30	30	11	466, 467
		40	20	15	468, 469
		50	10	12	470, 471
		60	0	—	(*m*)
2 out	4 in	0	60	—	(*n*)
		10	50	17	472
		20	40	8	473, 474
		30	30	17	475, 476
		40	20	10	477, 478
		50	10	15	479, 480
		60	0	—	(*o*)
out	6 out	0	60	—	(*a*)
		10	50	10, 15	481, 482
		20	40	15	483, 484
		30	30	15	485, 486
		,,	,,	25	487, 488

(*m*) 8 circ. loops out, $V = \frac{8}{3}$.
(*n*) 4 consec. loops out.
(*o*) 8 circ. loops out, $V = \frac{8}{5}$.
(*a*) 6 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 out	6 out	40	20	19	489, 490
		50	10	17	491, 492
		60	0	—	(*b*)
2 out	6 in	0	60	—	(*c*)
		10	50	20	493, 494
		20	40	15	495, 496
		30	30	20	497, 498
		40	20	15	499, 500
		50	10	10	501, 502
		60	0	—	(*d*)
2 out	9 out	0	60	—	(*e*)
		10	50	5	503
		,,	,,	12	504, 505
		20	40	5	506, 507
		,,	,,	12	508, 509
		,,	,,	17	510, 511
		30	30	11, 18	512, 513
		40	20	15	514, 515

(*b*) 12 circ. loops out, $V = \frac{12}{5}$.
(*c*) 6 consec. loops out.
(*d*) 12 circ. loops out, $V = \frac{12}{7}$.
(*e*) 9 consec. loops in.

V_1	V	Ex_1	Ex_2	S.R.	Fig.
2 out	9 out	50	10	15	516 517
		60	0	—	(*f*)
2 out	9 in	0	60	—	(*g*)
		10	50	6	518
		,,	,,	15	519 520
		20	40	7 20	521 522
		30	30	20	523 524
		40	20	20	525 526
		50	10	15	527 528
		60	0	—	(*h*)
2 out	$\frac{5}{2}$ out	0	60	—	(*i*)
		10	50	10 20	529 530
		20	40	15	531 532
		30	30	5	533 534
		,,	,,	10	535 536
		,,	,,	15	537 538
		40	20	10	539 540
		,,	,,	15	541 542

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 out	$\frac{5}{2}$ out	40	25	9	543
		50	10	15	544 545
		60	0	—	(*k*)
2 out	$\frac{5}{2}$ in	0	60	—	(*l*)
		10	50	20 25	546 547
		20	40	10	548 549
		30	30	20	550 551
		40	20	10	552 553
		50	10	10	554 555
		60	0	—	(*m*)
2 out	$\frac{7}{2}$ out	0	60	—	(*a*)
		10	50	10 20	556 557
		20	40	5	558 559
		,,	,,	10	560 561
		30	30	6	562 563
		,,	,,	15	564 565
		40	20	10	566 567
		50	10	12	568 569

(*f*) 9 circ. loops out, $V = \frac{9}{4}$.
(*g*) 9 consec. loops out.
(*h*) 9 circ. loops out, $V = \frac{9}{5}$.
(*i*) 5 circ. loops in, $V = \frac{5}{2}$.

(*k*) 10 circ. loops out, $V = \frac{10}{3}$.
(*l*) 5 circ. loops out, $V = \frac{5}{2}$.
(*m*) 10 circ. loops out, $V = \frac{10}{7}$.
(*a*) 7 circ. loops in, $V = \frac{7}{2}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 out	$\frac{7}{2}$ out	60	0	—	(*b*)
2 out	$\frac{7}{2}$ in	0	60	—	(*c*)
		10	50	20	570, 571
		,,	,,	35	572, 573
		20	40	15, 20	574, 575
		30	30	25	576, 577
		40	20	20, 38	578, 579
		50	10	38, 40	580, 581
		60	0	—	(*d*)
2 out	$\frac{8}{5}$ out	0	60	—	(*e*)
		20	40	10, 20	582, 583
		30	30	20	584, 585
		40	20	1, 6	586, 587
		,,	,,	19, 21	588, 589
		50	10	5	590, 591
		,,	,,	20	592, 593
		60	0	—	(*f*)
2 out	$\frac{8}{5}$ in	0	60	—	(*g*)
		30	30	30	594
		40	20	22	595, 596
		50	10	20	597, 598
		60	0	—	(*h*)
2 out	$\frac{10}{3}$ out	0	60	—	(*i*)
		10	50	7, 20	599, 600
		20	40	5	601, 602
		,,	,,	10, 15	603, 604
		30	30	9	605, 606
		,,	,,	21	607, 608
		40	20	10	609, 610
		,,	,,	22, 25	611, 612
		50	10	22	613, 614
		60	0	—	(*k*)
2 out	$\frac{10}{3}$ in	0	60	—	(*l*)
		10	50	25	615, 616
		,,	,,	35	617, 618

(*b*) 14 circ. loops out, $V = \frac{14}{5}$.
(*c*) 7 circ. loops out, $V = \frac{7}{2}$.
(*d*) 14 circ. loops out, $V = \frac{14}{9}$.
(*e*) 8 circ. loops in, $V = \frac{8}{5}$.
(*f*) 16 circ. loops out, $V = \frac{16}{3}$.
(*g*) 8 circ. loops out, $V = \frac{8}{5}$.
(*h*) 16 circ. loops out, $V = \frac{16}{13}$.
(*i*) 10 circ. loops in, $V = \frac{10}{3}$.
(*k*) 20 circ. loops out, $V = \frac{20}{7}$.
(*l*) 10 circ. loops out, $V = \frac{10}{3}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 out	$\frac{10}{3}$ in	20	40	10	619
		30	30	25	{ 620 621
		40	20	20	{ 622 623
		50	10	15	{ 624 625
		60	0	—	(*m*)
2 in	1 in	0	60	—	(*a*)
		60	0	—	(*b*)
2 in	2 out	0	60	—	(*c*)
		10	50	15	{ 626 627
		20	40	15	{ 628 629
		30	30	13	{ 630 631
		40	20	15	{ 632 633
		50	10	15	{ 634 635
		60	0	—	(*d*)
2 in	2 in	0	60	—	(*e*)
		10	50	15	{ 636 637

(*m*) 20 circ. loops out, $V = \frac{20}{13}$.
(*a*) 3 consec. loops out.
(*b*) 1 loop in. For adjustments between (*a*) and (*b*), the curve resembles figs. 252—263, one side of the figure being without loops.
(*c*) 6 consec. loops out.
(*d*) 4 consec. loops in.
(*e*) 6 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	2 in.	20	40	16	{ 638 639
		30	30	16	{ 640 641
		40	20	22	{ 642 643
		50	10	22	{ 644 645
		60	0	—	(*f*)
2 in	3 out	0	60	—	(*g*)
		10	50	10	{ 646 647
		20	40	12	{ 648 649
		30	30	10	{ 650 651
		40	20	10	{ 652 653
		50	10	20	{ 654 655
		60	0	—	(*h*)
2 in	3 in	0	60	—	(*i*)
		10	50	10	{ 656 657
		20	40	20	{ 658 659
		30	30	20	{ 660 661
		40	20	20	{ 662 663
		50	10	20	{ 664 665

(*f*) 4 circ. loops in, $V = \frac{4}{3}$.
(*g*) 9 consec. loops out.
(*h*) 3 consec. loops in.
(*i*) 9 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	3 in	60	0	—	(*k*)
2 in	4 out	0	60	—	(*l*)
		10	50	9	666, 667
		20	40	9	668, 669
		30	30	8	670, 671
		"	"	15	672, 673
		40	20	15	674, 675
		50	10	15	676, 677
		60	0	—	(*m*)
2 in	4 in	0	60	—	(*n*)
		10	50	10, 12	678, 679
		20	40	12	680, 681
		30	30	12, 10	682, 683
		40	20	15	684, 685
		50	10	13	686, 687
		60	0	—	(*o*)
2 in	6 out	0	60	—	(*a*)
		10	50	13	688, 689

(*k*) 3 circ. loops in, $V = \frac{3}{2}$.
(*l*) 12 consec. loops out.
(*m*) 8 circ. loops in, $V = \frac{8}{3}$.
(*n*) 12 consec. loops in.
(*o*) 8 circ. loops in, $V = \frac{8}{5}$.
(*a*) 18 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	6 out	20	40	13	690, 691
		30	30	10	692, 693
		40	20	8, 10	694, 695
		50	10	12	696, 697
		60	0	—	(*b*)
2 in	6 in	0	60	—	(*c*)
		10	50	10	698, 699
		20	40	15	700, 701
		30	30	14, 16	702, 703
		40	20	10	704, 705
		50	10	15	706, 707
		60	0	—	(*d*)
2 in	9 out	0	60	—	(*e*)
		10	50	8	708, 709
		20	40	15	710, 711
		30	30	11	712, 713
		40	20	11	714
		50	10	15, 14	715, 716

(*b*) 12 circ. loops in, $V = \frac{12}{5}$.
(*c*) 18 consec. loops in.
(*d*) 12 circ. loops in, $V = \frac{12}{7}$.
(*e*) 27 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	9 out	60	0	—	(*f*)
2 in	9 in	0	60	—	(*g*)
		10	50	10	717, 718
		20	40	12	719, 720
		60	0	—	(*h*)
2 in	$\frac{5}{2}$ out	0	60	—	(*i*)
		10	50	7	721
		"	"	10	722, 723
		20	40	9, 15	724, 725
		30	30	16	726, 727
		40	20	15	728, 729
		50	10	15	730, 731
		60	0	—	(*k*)
2 in	$\frac{5}{2}$ in	0	60	—	(*l*)
		10	50	13	732, 733
		20	40	17	734, 735
		30	30	15	736, 737
		50	10	17	738, 739

(*f*) 9 circ. loops in, $V = \frac{9}{4}$.
(*g*) 27 consec. loops in.
(*h*) 9 circ. loops in, $V = \frac{9}{5}$.
(*i*) 15 circ. loops out, $V = \frac{15}{2}$.
(*k*) 10 circ. loops in, $V = \frac{10}{3}$.
(*l*) 15 circ. loops in, $V = \frac{15}{2}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	$\frac{5}{2}$ in	60	0	—	(*m*)
2 in	$\frac{7}{2}$ out	0	60	—	(*n*)
		10	50	12	740, 741
		20	40	8, 10	742, 743
		30	30	10	744, 745
		40	20	10	746, 747
		50	10	16	748, 749
		60	0	—	(*o*)
2 in	$\frac{7}{2}$ in	0	60	—	(*a*)
		10	50	10	750, 751
		20	40	12	752, 753
		30	30	14	754, 755
		40	20	17	756, 757
		50	10	20	758, 759
		60	0	—	(*b*)
2 in	$\frac{8}{5}$ out	0	60	—	(*c*)
		10	50	4	760, 761

(*m*) 10 circ. loops in, $V = \frac{10}{7}$.
(*n*) 21 circ. loops out, $V = \frac{21}{2}$.
(*o*) 14 circ. loops in, $V = \frac{14}{5}$.
(*a*) 21 circ. loops in, $V = \frac{21}{2}$.
(*b*) 14 circ. loops in, $V = \frac{14}{9}$.
(*c*) 24 circ. loops out, $V = \frac{24}{5}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	$\frac{8}{5}$ out	10	50	9	762, 763
		20	40	3	764, 765
		"	"	11	766, 767
		30	30	4	768, 769
		"	"	10	770, 771
		40	20	15	772, 773
		50	10	10	774, 775
		60	0	—	(*d*)
2 in	$\frac{8}{5}$ in	0	60	—	(*e*)
		10	50	10	776, 777
		20	40	10, 15	778, 779
		30	30	10	780, 781
		40	20	15, 18	782, 783
		50	10	18	784, 785
		60	0	—	(*f*
2 in	$\frac{10}{3}$ out	0	60	—	(*g*)
		10	50	11	786, 787
		20	40	9, 11	788, 789

(*d*) 16 circ. loops in, $V = \frac{16}{3}$.
(*e*) 24 circ. loops in, $V = \frac{24}{5}$.
(*f*) 16 circ. loops in, $V = \frac{16}{13}$.
(*g*) 10 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
2 in	$\frac{10}{3}$ out	30	30	7	790, 791
		40	20	10	792, 793
		50	10	14, 12	794, 795
		60	0	—	(*h*)
2 in	$\frac{10}{3}$ in	0	60	—	(*i*)
		10	50	8	796, 797
		20	40	13	798, 799
		30	30	13	800, 801
		40	20	13	802, 803
		50	10	18	804, 805
		60	0	—	(*k*)
3 out	1 in	0	60	—	(*l*)
		10	50	12, 15	806, 807
		"	"	25	808, 809
		20	40	20	810, 811
		25	35	15	812, 813
		30	30	15	814, 815
		40	20	15	816, 817

(*h*) 20 circ. loops in, $V = \frac{20}{7}$.
(*i*) 10 consec. loops in.
(*k*) 20 circ. loops in, $V = \frac{20}{13}$.
(*l*) Ellipse.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	1 in	50	10	10	818, 819
		60	0	—	(*m*)
3 out	2 out	0	60	—	(*a*)
		10	50	13	820, 821
		20	40	10	822, 823
		24	36	12	824
		30	30	10	825, 826
		40	20	10	827, 828
		50	10	3	829, 830
		,,	,,	12	831, 832
		60	0	—	(*b*)
3 out	2 in	0	60	—	(*c*)
		10	50	18	833, 834
		20	40	15	835, 836
		,,	,,	25	837, 838
		30	30	10	839, 840
		,,	,,	20	841, 842
		,,	,,	30	843, 844

(*m*) 3 consec. loops out.
(*a*) 4 consec. loops in.
(*b*) 6 consec. loops out.
(*c*) 4 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	2 in	40	20	10	845, 846
		,,	,,	20	847, 848
		50	10	15	849, 850
		60	0	—	(*d*)
3 out	3 out	0	60	—	(*e*)
		10	50	13	851, 852
		20	40	12	853, 854
		30	30	10	855, 856
		40	20	10	857, 858
		50	10	10	859, 860
		60	0	0	(*f*)
3 out	3 in	0	60	—	(*g*)
		10	50	13	861, 862
		20	40	8, 10	863, 864
		,,	,,	14	865
		30	30	10	866, 867
		,,	,,	18	868, 869
		40	20	10	870, 871

(*d*) Ellipse.
(*e*) 6 consec. loops in.
(*f*) 9 circ. loops out, $V = \frac{9}{2}$.
(*g*) 6 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	3 in	50	10	10	872, 873
		60	0	—	(*h*)
3 out	4 out	0	60	—	(*i*)
		10	50	7	874, 875
		”	”	15	876, 877
		20	40	10	878, 879
		30	30	8	880, 881
		”	”	15	882, 883
		40	20	8	884, 885
		”	”	17	886, 887
		50	10	8	888, 889
		”	”	15	890, 891
		60	0	—	(*k*)
3 out	4 in	0	60	—	(*l*)
		10	50	5	892, 893
		”	”	11	894, 895
		20	40	8	896, 897
		”	”	18, 13	898, 899

(*h*) 9 circ. loops out, $V = \frac{9}{4}$.
(*i*) 8 consec. loops in.
(*k*) 4 consec. loops out.
(*l*) 8 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	4 in	30	30	8	900, 901
		”	”	15	902, 903
		40	20	10, 13	904, 905
		”	”	18, 23	906, 907
		50	10	10	908, 909
		60	0	—	(*a*)
3 out	6 out	0	60	—	(*b*)
		10	50	12	910, 911
		20	40	9	912, 913
		30	30	9	914, 915
		”	”	14	916, 917
		40	20	5	918, 919
		”	”	13	920, 921
		50	10	10	922, 923
		60	0	—	(*c*)
3 out	6 in	0	60	—	(*d*)
		10	50	4, 5	924, 925
		”	”	8, 12	926, 927

(*a*) 12 circ. loops out, $V = \frac{12}{5}$.
(*b*) 12 consec. loops in.
(*c*) 18 circ. loops out, $V = \frac{18}{5}$.
(*d*) 12 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	6 in	20	40	8	928, 929
		"	"	14	930, 931
		30	30	7	932, 933
		"	"	14	934, 935
		40	20	8	936, 937
		"	"	17	938, 939
		50	10	17	940, 941
		60	0	—	(*e*)
3 out	9 out	0	60	—	(*f*)
		10	50	10	942, 943
		20	40	5	944, 945
		"	"	15	946, 947
		30	30	6	948, 949
		"	"	12	950, 951
		"	"	18	952, 953
		40	20	10	954, 955
		50	10	15	956, 957
		60	0	—	(*g*)
3 out	9 in	0	60	—	(*h*)
		10	50	2	958, 959
		"	"	8	960, 961
		"	"	15	962, 963
		20	40	7	964, 965
		"	"	12, 20	966, 967
		30	30	10	968, 969
		"	"	19	970, 971
		40	20	19, 21	972, 973
		50	10	20	974, 975
		60	0	—	(*i*)
3 out	$\frac{5}{2}$ out	0	60	—	(*k*)
		10	50	10	976, 977
		20	40	12	978, 979
		30	30	10	980, 981
		"	"	16	982, 983
		40	20	8	984, 985
		"	"	18	986, 987

(*e*) 18 circ. loops out, $V = \frac{18}{7}$.
(*f*) 18 consec. loops in.
(*g*) 27 circ. loops out, $V = \frac{27}{8}$.
(*h*) 18 consec. loops out.
(*i*) 27 circ. loops out, $V = \frac{27}{10}$.
(*k*) 5 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	$\frac{5}{2}$ out	50	10	8	988, 989
		”	”	18	990, 991
		60	0	—	(*a*)
3 out	$\frac{5}{2}$ in	0	60	—	(*b*)
		10	50	10	992, 993
		”	”	17	994
		20	40	10	995
		”	”	20	996, 997
		30	30	18	998, 999
		40	20	18	1000, 1001
		50	10	15	1002, 1003
		60	0	—	(*c*)
3 out	$\frac{7}{2}$ out	0	60	—	(*d*)
		10	50	13	1004, 1005
		20	40	15	1006, 1007
		30	30	5, 7	1008, 1009
		”	”	17	1010, 1011
		40	20	7	1012, 1013

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	$\frac{7}{2}$ out	40	20	15, 20	1014, 1015
		50	10	7	1016, 1017
		”	”	15	1018, 1019
		60	0	—	(*e*)
3 out	$\frac{7}{2}$ in	0	60	—	(*f*)
		10	50	10	1020, 1021
		20	40	8, 12	1022, 1023
		”	”	15, 20	1024, 1025
		30	30	16	1026, 1027
		40	20	19	1028, 1029
		50	10	19	1030, 1031
		60	0	—	(*g*)
3 out	$\frac{8}{5}$ out	0	60	—	(*h*)
		10	50	12	1032, 1033
		20	40	22	1034, 1035
		30	30	15	1036, 1037
		40	20	9, 15	1038, 1039

(*a*) 5 consec. loops out.
(*b*) 5 consec. loops out.
(*c*) 15 circ. loops out, $V = \frac{15}{7}$.
(*d*) 7 consec. loops in.

(*e*) 21 circ. loops out, $V = \frac{21}{5}$.
(*f*) 7 consec. loops out.
(*g*) 7 circ. loops out, $V = \frac{7}{5}$.
(*h*) 16 circ. loops in, $V = \frac{16}{5}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	$\frac{8}{5}$ out	50	10	13	1040, 1041
		60	0	—	(*i*)
3 out	$\frac{8}{5}$ in	0	60	—	(*k*)
		10	50	15	1042
		,,	,,	20, 25	1043, 1044
		20	40	15, 20	1045, 1046
		,,	,,	35	1047
		30	30	21	1048, 1049
		40	20	21	1050, 1051
		50	10	19	1052, 1053
		60	0	—	(*l*)
3 out	$\frac{10}{3}$ out	0	60	—	(*m*)
		10	50	16	1054, 1055
		20	40	16	1056, 1057
		30	30	14	1058, 1059
		40	20	17	1060, 1061
		50	10	20	1062, 1063
		60	0	—	(*n*)

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 out	$\frac{10}{3}$ in	0	60	—	(*a*)
		10	50	13	1064, 1065
		20	40	9, 10	1066, 1067
		30	30	16	1068, 1069
		40	20	22	1070, 1071
		50	10	20	1072, 1073
		60	0	—	(*b*)
3 in	1 in	0	60	—	(*c*)
		10	50	20	1074, 1075
		20	40	20	1076, 1077
		30	30	20	1078, 1079
		40	20	20	1080, 1081
		50	10	20	1082, 1083
		60	0	—	(*d*)
3 in	2 out	0	60	—	(*e*)
		10	50	10	1084, 1085
		20	40	10	1086, 1087

(*i*) 8 consec. loops out.
(*k*) 16 circ. loops out, $V = \frac{16}{5}$.
(*l*) 24 circ. loops out, $V = \frac{24}{13}$.
(*m*) 20 circ. loops in, $V = \frac{20}{3}$.
(*n*) 30 circ. loops out, $V = \frac{30}{7}$.

(*a*) 20 circ. loops out, $V = \frac{20}{3}$.
(*b*) 30 circ. loops out, $V = \frac{30}{13}$.
(*c*) 4 consec. loops in.
(*d*) 3 circ. loops in, $V = \frac{3}{2}$.
(*e*) 8 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 in	2 out	30	30	10	1088, 1089
		40	20	10	1090, 1091
		50	10	10	1092, 1093
		60	0	—	(*f*)
3 in	2 in	0	60	—	(*g*)
		10	50	15	1094, 1095
		20	40	15	1096, 1097
		30	30	18	1098, 1099
		40	20	20	1100, 1101
		50	10	20	1102, 1103
		60	0	—	(*h*)
3 in	3 out	0	60	—	(*i*)
		10	50	12	1104, 1105
		20	40	15	1106, 1107
		30	30	15	1108, 1109
		40	20	15	1110, 1111
		50	10	15	1112, 1113
3 in	3 out	60	0	—	(*k*)
3 in	3 in	0	60	—	(*l*)
		10	50	10	1114, 1115
		20	40	13	1116, 1117
		30	30	15	1118, 1119
		40	20	15	1120, 1121
		50	10	18	1122, 1123
		60	0	—	(*m*)
3 in	4 out	0	60	—	(*n*)
		10	50	9	1124, 1125
		20	40	14	1126, 1127
		30	30	13	1128, 1129
		40	20	13	1130, 1131
		50	10	15	1132, 1133
		60	0	—	(*o*)
3 in	4 in	0	60	—	(*a*)
		10	50	10	1134, 1135
		20	40	12	1136, 1137

(*f*) 6 consec. loops in.
(*g*) 8 consec. loops in.
(*h*) 2 consec. loops in.
(*i*) 12 consec. loops out.

(*k*) 9 circ. loops in, $V = \frac{9}{2}$.
(*l*) 12 consec. loops in.
(*m*) 9 circ. loops in, $V = \frac{9}{4}$.
(*n*) 16 consec. loops out.
(*o*) 4 consec. loops in.
(*a*) 16 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 in	4 in	30	30	15	1138, 1139
		40	20	15	1140, 1141
		50	10	20	1142, 1143
		60	0	—	(*b*)
3 in	6 out	0	60	—	(*c*)
		10	50	10	1144, 1145
		20	40	15	1146, 1147
		30	30	15	1148, 1149
		40	20	15	1150, 1151
		50	10	15	1152, 1153
		60	0	—	(*d*)
3 in	6 in	0	60	—	(*e*)
		10	50	10	1154, 1155
		20	40	10	1156, 1157
		30	30	10	1158, 1159
		40	20	15	1160, 1161
		50	10	15	1162, 1163

(*b*) 12 circ. loops in, $V = \frac{12}{5}$.
(*c*) 24 consec. loops out.
(*d*) 18 circ. loops in, $V = \frac{18}{5}$.
(*e*) 24 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 in	6 in	60	0	—	(*f*)
3 in	9 out	0	60	—	(*g*)
		10	50	13	1164, 1165
		20	40	12	1166, 1167
		30	30	12	1168, 1169
		40	20	14	1170, 1171
		50	10	16	1172, 1173
		60	0	—	(*h*)
3 in	9 in	0	60	—	(*i*)
		10	50	10	1174, 1175
		20	40	10	1176, 1177
		50	10	15	1178, 1179
		60	0	—	(*k*)
3 in	$\frac{5}{2}$ out	0	60	—	(*l*)
		10	50	10	1180, 1181
		20	40	10	1182, 1183
		30	30	15	1184, 1185
		40	20	12	1186, 1187

(*f*) 18 circ. loops in, $V = \frac{18}{7}$.
(*g*) 36 consec. loops out.
(*h*) 27 circ. loops in, $V = \frac{27}{8}$.
(*i*) 36 consec. loops in.
(*k*) 27 circ. loops in, $V = \frac{27}{10}$.
(*l*) 10 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 in	$\frac{5}{2}$ out	50	10	12	1188, 1189
		60	0	—	(*m*)
3 in	$\frac{5}{2}$ in	0	60	—	(*n*)
		10	50	10	1190, 1191
		20	40	15	1192, 1193
		30	30	15	1194, 1195
		40	20	18	1196, 1197
		50	10	19	1198, 1199
		60	0	—	(*o*)
3 in	$\frac{7}{2}$ out	0	60	—	(*a*)
		10	50	10	1200, 1201
		20	40	12	1202, 1203
		30	30	12	1204, 1205
		40	20	12	1206, 1207
		50	10	15	1208, 1209
		60	0	—	(*b*)
3 in	$\frac{7}{2}$ in	0	60	—	(*c*)

(*m*) 5 consec. loops in.
(*n*) 10 consec. loops in.
(*o*) 15 circ. loops in, $V = \frac{15}{7}$.
(*a*) 14 consec. loops out.
(*b*) 21 circ. loops in $V = \frac{21}{5}$.
(*c*) 14 consec. loops in.

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V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 in	$\frac{7}{2}$ in	10	50	12	1210, 1211
		20	40	14	1212, 1213
		30	30	15	1214, 1215
		40	20	15	1216, 1217
		50	10	15	1218, 1219
		60	0	—	(*d*)
3 in	$\frac{8}{5}$ out	0	60	—	(*e*)
		10	50	15	1220, 1221
		20	40	15	1222, 1223
		30	30	10, 15	1224, 1225
		40	20	11, 14	1226, 1227
		50	10	14	1228, 1229
		60	0	—	(*f*)
3 in	$\frac{8}{5}$ in	0	60	—	(*g*)
		10	50	17	1230, 1231
		20	40	15	1232, 1233
		30	30	15	1234, 1235

(*d*) 7 circ. loops in, $V = \frac{7}{8}$.
(*e*) 32 circ. loops out, $V = \frac{32}{5}$.
(*f*) 8 consec. loops in.
(*g*) 32 circ. loops in, $V = \frac{32}{5}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3 in	$\frac{8}{5}$ in	50	10	20	1236, 1237
		60	0	—	(*h*)
3 in	$\frac{10}{3}$ out	0	60	—	(*i*)
		10	50	15	1238, 1239
		20	40	15	1240, 1241
		30	30	15	1242, 1243
		40	20	15	1244, 1245
		50	10	15	1246, 1247
		60	0	—	(*k*)
3 in	$\frac{10}{3}$ in	0	60	—	(*l*)
		10	50	12	1248, 1249
		20	40	12	1250, 1251
		30	30	16	1252, 1253
		40	20	15	1254, 1255
		50	10	15	1256, 1257
		60	0	—	(*m*)
4 out	1 in	0	60	—	(*n*)
		10	50	15	1258, 1259

(*h*) 24 circ. loops in, $V = \frac{24}{13}$.
(*i*) 40 circ. loops out, $V = \frac{40}{3}$.
(*k*) 30 circ. loops in, $V = \frac{30}{7}$.
(*l*) 40 circ. loops in, $V = \frac{40}{3}$.
(*m*) 30 circ. loops in, $V = \frac{30}{13}$.
(*n*) 3 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	1 in	20	40	15	1260, 1261
		30	30	20	1262, 1263
		40	20	10	1264, 1265
		50	10	15	1266, 1267
		60	0	—	(*o*)
4 out	2 out	0	60	—	(*a*)
		10	50	10	1268, 1269
		20	40	10	1270, 1271
		30	30	10	1272, 1273
		40	20	10	1274, 1275
		50	10	10	1276, 1277
		60	0	—	(*b*)
4 out	2 in	0	60	—	(*c*)
		10	50	10	1278, 1279
		20	40	14	1280, 1281
		30	30	10	1282, 1283
		40	20	15	1284, 1285

(*o*) Ellipse.
(*a*) 6 consec. loops in.
(*b*) 8 consec. loops out.
(*c*) 6 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	2 in	50	10	18	1286, 1287
		60	0	—	(*d*)
4 out	3 out	0	60	--	(*e*)
		10	50	13	1288, 1289
		20	40	14	1290, 1291
		30	30	14	1292, 1293
		40	20	14	1294, 1295
		50	10	10	1296, 1297
		60	0	—	(*f*)
4 out	3 in	0	60	—	(*g*)
		10	50	11	1298, 1299
		20	40	10	1300, 1301
		30	30	18	1302, 1303
		40	20	17	1304, 1305
		50	10	25	1306, 1307
		60	0	—	(*h*)
4 out	4 out	0	60	—	(*i*)

(*d*) 8 circ. loops out, $V = \frac{8}{3}$.
(*e*) 9 consec. loops in.
(*f*) 6 consec. loops out.
(*g*) 9 consec. loops out.
(*h*) 3 consec. loops out.
(*i*) 12 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	4 out	10	50	15	1308, 1309
		20	40	16	1310, 1311
		30	30	16	1312, 1313
		40	20	14	1314, 1315
		50	10	14	1316, 1317
		60	0	—	(*k*)
4 out	4 in	0	60	—	(*l*)
		10	50	10	1318, 1319
		20	40	5	1320, 1321
		30	30	11	1322, 1323
		40	20	17	1324, 1325
		50	10	20	1326, 1327
		60	0	—	(*m*)
4 out	6 out	0	60	—	(*n*)
		10	50	15	1328, 1329
		20	40	12	1330, 1331
		30	30	12	1332, 1333

(*k*) 16 circ. loops out, $V = \frac{16}{3}$.
(*l*) 12 consec. loops out.
(*m*) 16 circ. loops out, $V = \frac{16}{5}$.
(*n*) 18 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	6 out	40	20	10	1334, 1335
		50	10	10	1336, 1337
		60	0	—	(o)
4 out	6 in	0	60	—	(a)
		10	50	15	1338, 1339
		20	40	15	1340, 1341
		30	30	15	1342, 1343
		40	20	15	1344, 1345
		50	10	15	1346, 1347
		60	0	—	(b)
4 out	9 out	0	60	—	(c)
		10	50	12	1348, 1349
		20	40	11	1350, 1351
		30	30	15	1352, 1353
		40	20	10	1354, 1355
		50	10	10	1356, 1357
		60	0	—	(d)

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	9 in	0	60	—	(e)
		10	50	10	1358, 1359
		20	40	10	1360, 1361
		30	30	11	1362, 1363
		40	20	11	1364, 1365
		50	10	18	1366, 1367
		60	0	—	(f)
4 out	$\frac{5}{2}$ out	0	60	—	(g)
		10	50	10	1368, 1369
		20	40	10	1370, 1371
		30	30	12, 10	1372, 1373
		40	20	10	1374, 1375
		50	10	5	1376, 1377
		60	0	—	(h)
4 out	$\frac{5}{2}$ in	0	60	—	(i)
		10	50	13	1378, 1379
		20	40	12	1380, 1381

(o) 24 circ. loops out, $V = \frac{24}{5}$.
(a) 18 consec. loops out.
(b) 24 circ. loops out, $V = \frac{24}{7}$.
(c) 27 consec. loops in.
(d) 9 circ. loops out, $V = \frac{9}{2}$.
(e) 27 consec. loops out.
(f) 18 circ. loops out, $V = \frac{18}{5}$.
(g) 15 circ. loops in, $V = \frac{15}{2}$.
(h) 20 circ. loops out, $V = \frac{20}{3}$.
(i) 15 circ. loops out, $V = \frac{15}{2}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	$\frac{5}{2}$ in	30	30	15	1382, 1383
		40	20	13	1384, 1385
		50	10	16	1386, 1387
		60	0	—	(*k*)
4 out	$\frac{7}{2}$ out	0	60	—	(*l*)
		10	50	12	1388, 1389
		20	40	12	1390, 1391
		30	30	13	1392, 1393
		40	20	12	1394, 1395
		50	10	10	1396, 1397
		60	0	—	(*m*)
4 out	$\frac{7}{2}$ in	0	60	—	(*n*)
		10	50	15	1398, 1399
		20	40	15	1400, 1401
		30	30	17	1402, 1403
		40	20	15	1404, 1405
		50	10	20	1406, 1407

(*k*) 20 circ. loops out, $V = \frac{20}{7}$.
(*l*) 21 circ. loops in, $V = \frac{21}{2}$.
(*m*) 28 circ. loops out, $V = \frac{28}{5}$.
(*n*) 21 circ. loops out, $V = \frac{21}{2}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	$\frac{7}{2}$ in	60	0	—	(*o*)
4 out	$\frac{8}{5}$ out	0	60	—	(*a*)
		10	50	10	1408, 1409
		20	40	11	1410, 1411
		30	30	8	1412, 1413
		40	20	13	1414, 1415
		50	10	12	1416, 1417
		60	0	—	(*b*)
4 out	$\frac{8}{3}$ in	0	60	—	(*c*)
		10	50	10	1418, 1419
		20	40	9	1420, 1421
		,,	,,	20	1422, 1423
		30	30	18	1424, 1425
		40	20	19	1426, 1427
		50	10	20	1428, 1429
		60	0	—	(*d*)
4 out	$\frac{10}{3}$ out	0	60	—	(*e*)
		10	50	10	1430, 1431

(*o*) 28 circ. loops out, $V = \frac{28}{5}$.
(*a*) 24 circ. loops in, $V = \frac{24}{5}$.
(*b*) 32 circ. loops out, $V = \frac{32}{3}$.
(*c*) 24 circ. loops out, $V = \frac{24}{5}$.
(*d*) 32 circ. loops out, $V = \frac{32}{13}$.
(*e*) 10 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 out	$\frac{10}{3}$ out	20	40	12	1432, 1433
		30	30	11	1434, 1435
		40	20	15	1436, 1437
		50	10	15	1438, 1439
		60	0	—	(*f*)
4 out	$\frac{10}{3}$ in	0	60	—	(*g*)
		10	50	12, 15	1440, 1441
		20	40	13	1442, 1443
		30	30	17	1444, 1445
		40	20	16	1446, 1447
		50	10	16	1448, 1449
		60	0	—	(*h*)
4 in	1 in	10	50	12	1450, 1451
		20	40	15	1452, 1453
		30	30	12	1454, 1455
		40	20	15	1456, 1457
		50	10	16	1458, 1459

(*f*) 40 circ. loops out, $V = \frac{40}{7}$.
(*g*) 10 consec. loops out.
(*h*) 40 circ. loops out, $V = \frac{40}{13}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 in	2 out	10	50	10	1460, 1461
		20	40	10	1462, 1463
		30	30	10	1464, 1465
		40	20	10	1466, 1467
		50	10	10	1468, 1469
4 in	2 in	10	50	12	1470, 1471
		20	40	13	1472, 1473
		30	30	15	1474, 1475
		40	20	15	1476, 1477
		50	10	15	1478, 1479
4 in	3 out	10	50	10	1480, 1481
		20	40	12	1482, 1483
		30	30	14	1484, 1485
		40	20	12	1486, 1487
		50	10	12	1488, 1489
4 in	3 in	10	50	10	1490, 1491
		20	40	10	1492, 1493
		30	30	12	1494, [illegible]

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 in	3 in	40	20	12	1496 1497	4 in	6 in	20	40	11	1532 1533
		50	10	16	1498 1499			30	30	12	1534 1535
4 in	4 out	10	50	10	1500 1501			40	20	14	1536 1537
		20	40	11	1502 1503			50	10	16	1538 1539
		30	30	10	1504 1505	4 in	9 out	10	50	11	1540 1541
		40	20	12	1506 1507			20	40	10	1542 1543
		50	10	14	1508 1509			30	30	11	1544 1545
4 in	4 in	10	50	10	1510 1511			40	20	12	1546 1547
		20	40	12	1512 1513			50	10	17	1548 1549
		30	30	13	1514 1515	4 in	9 in	10	50	11	1550 1551
		40	20	13	1516 1517			20	40	10	1552 1553
		50	10	16	1518 1519			30	30	12	1554 1555
4 in	6 out	10	50	10	1520 1521			40	20	13	1556 1557
		20	40	9	1522 1523			50	10	17	1558 1559
		30	30	11	1524 1525	4 in	$\frac{5}{2}$ out	10	50	9	1560 1561
		40	20	12	1526 1527			20	40	10	1562 1563
		50	10	15	1528 1529			30	30	12	1564 1565
4 in	6 in	10	50	11	1530 1531			40	20	10	1566 1567

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
4 in	$\frac{5}{2}$ out	50	10	11	1568 1569	4 in	$\frac{8}{5}$ out	30	30	10	1604 1605
4 in	$\frac{5}{2}$ in	10	50	10	1570 1571			40	20	11	1606 1607
		20	40	9	1572 1573			50	10	12	1608 1609
		30	30	12	1574 1575	4 in	$\frac{8}{5}$ in	10	50	9	1610 1611
		40	20	12	1576 1577			20	40	9	1612 1613
		50	10	15	1578 1579			30	30	11	1614 1615
4 in	$\frac{7}{2}$ out	10	50	7	1580 1581			40	20	12	1616 1617
		20	40	9	1582 1583			50	10	13	1618 1619
		30	30	9	1584 1585	4 in	$\frac{10}{3}$ out	10	50	11	1620 1621
		40	20	12	1586 1587			20	40	11	1622 1623
		50	10	13	1588 1589			30	30	12	1624 1625
4 in	$\frac{7}{2}$ in	10	50	7	1590 1591			40	20	11	1626 1627
		20	40	11	1592 1593			50	10	13	1628 1629
		30	30	13	1594 1595	4 in	$\frac{10}{3}$ in	10	50	8	1630 1631
		40	20	14	1596 1597			20	40	13	1632 1633
		50	10	15	1598 1599			30	30	13	1634 1635
4 in	$\frac{8}{5}$ out	10	50	13	1600 1601			40	20	17	1636 1637
		20	40	11	1602 1603			50	10	18	1638 1639

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 out	1 in	10	50	10	1640 1641
		20	40	15	1642 1643
		30	30	15	1644 1645
		40	20	13	1646 1647
		50	10	15	1648 1649
6 out	2 out	10	50	10	1650 1651
		20	40	6 10	1652 1653
		30	30	5 12	1654 1655
		40	20	6 10	1656 1657
		50	10	10	1658 1659
6 out	2 in	10	50	9	1660 1661
		20	40	9 14	1662 1663
		30	30	14	1664 1665
		40	20	15	1666 1667
		50	10	16	1668 1669
6 out	3 out	10	50	10	1670 1671
		20	40	11	1672 1673
		30	30	6 12	1674 1675
6 out	3 out	40	20	7	1676 1677
		50	10	5 12	1678 1679
6 out	3 in	10	50	5 11	1680 1681
		20	40	8 12	1682 1683
		30	30	10	1684 1685
		40	20	5	1686 1687
		50	10	5 20	1688 1689
6 out	4 out	10	50	11	1690 1691
		20	40	15	1692 1693
		30	30	11	1694 1695
		40	20	5	1696 1697
		50	10	5	1698 1699
6 out	4 in	10	50	5 11	1700 1701
		20	40	5 11	1702 1703
		30	30	5 12	1704 1705
		40	20	5 15	1706 1707
		50	10	10 20	1708 1709
6 out	6 out	10	50	11	1710 1711

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 out	6 out	20	40	8, 11	1712, 1713
		30	30	3, 9	1714, 1715
		40	20	3, 15	1716, 1717
		50	10	8, 12	1718, 1719
6 out	6 in	10	50	12	1720, 1721
		20	40	9, 12	1722, 1723
		30	30	5, 11	1724, 1725
		40	20	6, 15	1726, 1727
		50	10	10, 16	1728, 1729
6 out	9 out	10	50	7, 11	1730, 1731
		20	40	8	1732, 1733
		30	30	4, 5	1734, 1735
		40	20	2, 6	1736, 1737
		50	10	7, 11	1738, 1739
6 out	9 in	10	50	10	1740, 1741
		20	40	8	1742, 1743
		30	30	5, 15	1744, 1745
		40	20	8	1746, 1747

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 out	9 in	50	10	7, 11	1748, 1749
6 out	$\frac{5}{2}$ out	10	50	10	1750, 1751
		20	40	6, 15	1752, 1753
		30	30	14	1754, 1755
		40	20	7, 12	1756, 1757
		50	10	13	1758, 1759
6 out	$\frac{5}{2}$ in	10	50	6, 10	1760, 1761
		20	40	5, 11	1762, 1763
		30	30	9	1764, 1765
		40	20	10	1766, 1767
		50	10	10, 15	1768, 1769
6 out	$\frac{7}{2}$ out	10	50	9	1770, 1771
		20	40	9, 13	1772, 1773
		30	30	5, 12	1774, 1775
		40	20	5, 14	1776, 1777
		50	10	10	1778, 1779
6 out	$\frac{7}{2}$ in	10	50	9	1780, 1781
		20	40	4, 11	1782, 1783

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 out	$\frac{7}{2}$ in	30	30	3, 15	1784, 1785	6 out	$\frac{10}{3}$ in	10	50	8	1820, 1821
		40	20	10, 20	1786, 1787			20	40	7	1822, 1823
		50	10	10, 17	1788, 1789			30	30	5, 12	1824, 1825
6 out	$\frac{8}{5}$ out	10	50	5, 14	1790, 1791			40	20	9, 12	1826, 1827
		20	40	4, 10	1792, 1793			50	10	13, 23	1828, 1829
		30	30	12	1794, 1795	6 in	1 in	10	50	9	1830, 1831
		40	20	10	1796, 1797			20	40	10	1832, 1833
		50	10	8, 13	1798, 1799			30	30	10	1834, 1835
6 out	$\frac{8}{5}$ in	10	50	11	1800, 1801			40	20	13	1836, 1837
		20	40	13, 9	1802, 1803			50	10	15	1838, 1839
		30	30	4, 13	1804, 1805	6 in	2 out	10	50	10	1840, 1841
		40	20	5, 17	1806, 1807			20	40	10	1842, 1843
		50	10	18, 25	1808, 1809			30	30	10	1844, 1845
6 out	$\frac{10}{3}$ out	10	50	8, 12	1810, 1811			40	20	10	1846, 1847
		20	40	8, 12	1812, 1813			50	10	10	1848, 1849
		30	30	4, 13	1814, 1815	6 in	2 in	10	50	9	1850, 1851
		40	20	8	1816, 1817			20	40	10, 13	1852, 1853
		50	10	5, 10	1818, 1819			30	30	10	1854, 1855

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 in	2 in	40	20	9	1856 1857	6 in	4 in	20	40	11	1892 1893
		50	10	10	1858 1859			30	30	4 12	1894 1895
6 in	3 out	10	50	8	1860 1861			40	20	6	1896 1897
		20	40	5 12	1862 1863			50	10	8	1898 1899
		30	30	10	1864 1865	6 in	6 out	10	50	10	1900 1901
		40	20	5 10	1866 1867			20	40	8	1902 1903
		50	10	5 10	1868 1869			30	30	12	1904 1905
6 in	3 in	10	50	6 12	1870 1871			40	20	4	1906 1907
		20	40	7 14	1872 1873			50	10	5 15	1908 1909
		30	30	10	1874 1875	6 in	6 in	10	50	6 12	1910 1911
		40	20	5 11	1876 1877			20	40	6 12	1912 1913
		50	10	8	1878 1879			30	30	5 10	1914 1915
6 in	4 out	10	50	3 10	1880 1881			40	20	6 11	1916 1917
		20	40	12	1882 1883			50	10	8 16	1918 1919
		30	30	9	1884 1885	6 in	9 out	10	50	9 13	1920 1921
		40	20	4 9	1886 1887			20	40	7	1922 1923
		50	10	5 15	1888 1889			30	30	12	1924 1925
6in	4 in	10	50	10	1890 1891			40	20	4	1926 1927

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 in	9 out	50	10	5 9	1928 1929	6in	$\frac{7}{2}$ out	30	30	9	1964 1965
6 in	9 in	10	50	9	1930 1931			40	20	4 9	1966 1967
		20	40	4 9	1932 1933			50	10	5	1968 1969
		30	30	5	1934 1935	6 in	$\frac{7}{2}$ in	10	50	4 9	1970 1971
		40	20	10	1936 1937			20	40	7	1972 1973
		50	10	6 12	1938 1939			30	30	5	1974 1975
6 in	$\frac{5}{2}$ out	10	50	9	1940 1941			40	20	5 12	1976 1977
		20	40	15	1942 1943			50	10	7 14	1978 1979
		30	30	14	1944 1945	6 in	$\frac{8}{5}$ out	10	50	10	1980 1981
		40	20	11	1946 1947			20	40	4 10	1982 1983
		50	10	4	1948 1949			30	30	8	1984 1985
6 in	$\frac{5}{2}$ in	10	50	9	1950 1951			40	20	9	1986 1987
		20	40	10	1952 1953			50	10	7	1988 1989
		30	30	8	1954 1955	6 in	$\frac{8}{5}$ in	10	50	10	1990 1991
		40	20	6 14	1956 1957			20	40	7	1992 1993
		50	10	8	1958 1959			30	30	10	1994 1995
6 in	$\frac{7}{2}$ out	10	50	9	1960 1961			40	20	10	1996 1997
		20	40	10 15	1962 1963			50	10	9 15	1998 1999

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
6 in	$\frac{10}{3}$ out	10	50	11	2000, 2001
		20	40	8	2002, 2003
		30	30	9	2004, 2005
		40	20	3	2006, 2007
		50	10	12, 14	2008, 2009
6 in	$\frac{10}{3}$ in	10	50	6	2010, 2011
		20	40	9	2012, 2013
		30	30	10	2014, 2015
		40	20	6	2016, 2017
		50	10	12	2018, 2019
9 out	1 in	12 (*a*)	48	10	2020, 2021
		20 (*b*)	40	5, 11	2022, 2023
		30	30	10	2024, 2025
		40	20	9	2026, 2027
		50	10	5, 7	2028, 2029
9 out	2 out	10	50	5, 10	2030, 2031
9 out	2 out	20	40	5, 10	2032, 2033
		30 (*a*)	30 (*b*)	5, 10	2034, 2035
		40	20	5, 10	2036, 2037
		50	10	5, 10	2038, 2039
9 out	2 in	(*a*) 6	54	5	2040
		15 (*b*)	45	10	2041
		20	40	7, 12	2042, 2043
		30	30	4, 14	2044, 2045
		40	20	5, 15	2046, 2047
		50	10	9	2048, 2049
9 out	3 out	12 (*a*)	48	3, 7	2050, 2051
		20 (*b*)	40	10	2052, 2053
		30	30	9	2054, 2055
		40	20	5, 10	2056, 2057
		50	10	4, 12	2058, 2059
9 out	3 in	3·5 (*a*)	56·5	5, 20	2060, 2061

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 out	3 in	12 (*b*)	48	6, 12	2062, 2063
		20	40	6, 12	2064, 2065
		30	30	2, 4	2066, 2067
		40	20	6	2068, 2069
		50	10	4	2070, 2071
9 out	4 out	6 (*a*)	54	8, 20	2072, 2073
		15 (*b*)	45	6, 10	2074, 2075
		20	40	9, 12	2076, 2077
		30	30	10	2078, 2079
		40	20	6, 12	2080, 2081
		50	10	11	2082, 2083
9 out	4 in	2·3 (*a*)	57·7	7, 20	2084, 2085
		10 (*b*)	50	5, 10	2086, 2087
		20	40	7, 12	2088, 2089
		30	30	12	2090, 2091
		40	20	5	2092, 2093

V_1	V_2	Ex_1	Ex	S.R.	Fig.
9 out	4 in	50	10	7, 15	2094, 2095
9 out	6 out	2·3 (*a*)	57·7	16	2096
		10 (*b*)	50	6	2097
		20	40	10	2098, 2099
		30	30	2, 10	2100, 2101
		40	20	3, 10	2102, 2103
		50	10	4	2104, 2105
9 out	6 in	7·5 (*b*)	52·5	5	2106
		13	47	5	2107
		20	40	6, 9	2108, 2109
		30	30	3, 13	2110, 2111
		40	20	3, 13	2112, 2113
		50	10	5, 13	2114, 2115
9 out	9 out	1 (*a*)	64	3, 20	2116, 2117
		6·6 (*b*)	53·4	5	2118
		13	47	5	2119
		20	40	2, 7	2120, 2121
		30	30	3, 12	2122, 2123

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 out	9 out	40	20	4, 12	2124, 2125	9 out	$\frac{5}{2}$ in	30	30	4, 6	2158, 2159
		50	10	13	2126, 2127			40	20	7, 15	2160, 2161
9 out	9 in	5·4 (*b*)	54·6	3, 13	2128, 2129			50	10	8, 18	2162, 2163
		12	48	6, 7	2130, 2131	9 out	$\frac{7}{2}$ out	8·3 (*a*)	51·7	3, 13	2164, 2165
		20	40	2, 10	2132, 2133			17·1 (*b*)	42·9	5, 10	2166, 2167
		30	30	3, 12	2134, 2135			30	30	6, 9	2168, 2169
		40	20	4, 12	2136, 2137			40	20	2, 8	2170, 2171
		50	10	9, 13	2138, 2139			50	10	5, 15	2172, 2173
9 out	$\frac{5}{2}$ out	10	50	2, 8	2140, 2141	9 out	$\frac{7}{2}$ in	2·8 (*a*)	57·2	2, 12	2174, 2175
		18·4 (*a*)	41·6	2, 12	2142, 2143			10·9 (*b*)	49·1	8	2176, 2177
		24 (*b*)	36	4, 7	2144, 2145			20	40	5	2178, 2179
		30	30	7, 10	2146, 2147			30	30	3	2180, 2181
		40	20	2, 8	2148, 2149			40	20	4, 8	2182, 2183
		50	10	3, 10	2150, 2151			50	10	7, 17	2184, 2185
9 out	$\frac{5}{2}$ in	4·5 (*a*)	55·5	4, 14	2152, 2153	9 out	$\frac{8}{5}$ out	10	50	3, 10	2186, 2187
		13·3 (*b*)	46·7	4	2154, 2155			21·4 (*a*)	38·6	3, 10	2188, 2189
		25	35	2, 4	2156, 2157			30	30	7	2190

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 out	$\frac{8}{5}$ out	37·5 (*b*)	22.5	7	2191
		40	20	8, 14	2192, 2193
		50	10	7, 14	2194, 2195
9 out	$\frac{8}{5}$ in	7·7 (*a*)	52·3	7	2196, 2197
		16·6 (*b*)	43·4	8	2198, 2199
		20	40	6	2200, 2201
		30	30	4	2202, 2203
		40	20	5	2204, 2205
		50	10	11, 18	2206, 2207
9 out	$\frac{10}{3}$ out	9·3 (*a*)	50·7	5, 15	2208, 2209
		18 (*b*)	42	6, 9	2210, 2211
		30	30	9	2212, 2213
		40	20	3, 9	2214, 2215
		50	10	4, 10	2216, 2217
9 out	$\frac{10}{3}$ in	3 (*a*)	57	5, 10	2218, 2219
		11·2 (*b*)	48·8	10	2220, 2221
		20	40	6, 8	2222, 2223
9 out	$\frac{10}{3}$ in	30	30	5, 10	2224, 2225
		40	20	3, 6	2226, 2227
		50	10	6, 16	2228, 2229
9 in	1 in	12 (*a*)	48	10	2230, 2231
		20 (*b*)	40	5, 11	2232, 2233
		30	30	5, 10	2234, 2235
		40	20	5, 9	2236, 2237
		50	10	5, 7	2238, 2239
9 in	2 out	10	50	5, 10	2240, 2241
		20	40	5, 10	2242, 2243
		30 (*a*)	30 (*b*)	5, 10	2244, 2245
		40	20	5, 10	2246, 2247
		50	10	5, 10	2248, 2249
9 in	2 in	6 (*a*)	54	5	2250
		15 (*b*)	45	10	2251
		20	40	7, 12	2252, 2253
		30	30	4, 14	2254, 2255

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 in	2 in	40	20	5 15	2256 2257
		50	10	9	2258 2259
9 in	3 out	12 (*a*)	48	3 7	2260 2261
		20 (*b*)	40	5 10	2262 2263
		30	30	4 9	2264 2265
		40	20	5 10	2266 2267
		50	10	4 12	2268 2269
9 in	3 in	3·5 (*a*)	56·5	5 10	2270 2271
		12 (*b*)	48	6 12	2272 2273
		20	40	6 10	2274 2275
		30	30	2 4	2276 2277
		40	20	6	2278 2279
		50	10	4	2280 2281
9 in	4 out	6 (*a*)	54	8 20	2282 2283
		15 (*b*)	45	6 10	2284 2285
		20	40	9 12	2286 2287
9 in	4 out	30	30	10	2288 2289
		40	20	6 10	2290 2291
		50	10	3 11	2292 2293
9 in	4 in	2·3 (*a*)	57·7	7 20	2294 2295
		10 (*b*)	50	5 10	2296 2297
		20	40	8 12	2298 2299
		30	30	4 12	2300 2301
		40	20	3 5	2302 2303
		50	10	7 12	2304 2305
9 in	6 out	2·3 (*a*)	57·7	16	2306
		10 (*b*)	50	6	2307
		20	40	3 10	2308 2309
		30	30	2 10	2310 2311
		40	20	3 10	2312 2313
		50	10	4 10	2314 2315
9 in	6 in	7·5 (*b*)	52·5	5	2316

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 in	6 in	13	47	5	2317
		20	40	6	2318
				9	2319
		30	30	3	2320
				13	2321
		40	20	3	2322
				12	2323
		50	10	5	2324
				13	2325
9 in	9 out	1 (*a*)	64	3	2326
				20	2327
		6·6 (*b*)	53·4	5	2328
		13	47	5	2329
		20	40	2	2330
				7	2331
		30	30	3	2332
				12	2333
		40	20	4	2334
				12	2335
		50	10	7	2336
				13	2337
9 in	9 in	5·4 (*a*)	54·6	3	2338
				13	2339
		12	48	6	2340
				7	2341
		20	40	2	2342
				12	2343
		30	30	3	2344
				12	2345
		40	20	4	2346
				12	2347

V_1	V_2	Ex_1	Ex	S.R.	Fig.
9 in	9 in	50	10	7	2348
				13	2349
9 in	$\frac{5}{2}$ out	10	50	2	2350
				8	2351
		18·4 (*a*)	41·6	2	2352
				12	2353
		24 (*b*)	36	4	2354
				7	2355
		30	30	7	2356
				10	2357
		40	20	2	2358
				8	2359
		50	10	3	2360
				10	2361
in	$\frac{5}{2}$ in	4·5 (*a*)	55·5	4	2362
				14	2363
		13·3 (*b*)	46.7	4	2364
					2365
		25	35	2	2366
				4	2367
		30	30	4	2368
				6	2369
		40	20	7	2370
				15	2371
		50	10	8	2372
				13	2373
9 in	$\frac{7}{2}$ out	8·3 (*a*)	51·7	3	2374
				13	2375
		17·1 (*b*)	42·9	5	2376
				10	2377
		30	30	6	2378
				9	2379

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. **(*b*)** $Ex_1 : Ex_2 :: 1 : n$.
where $n = V_2 \pm 1$, **according as** V_2 **is "in" or "out."**

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 in	$\frac{7}{2}$ out	40	20	2, 8	2380, 2381
		50	10	5, 15	2382, 2383
9 in	$\frac{7}{2}$ in	2·8 (*a*)	57·2	2, 12	2384, 2385
		10.9 (*b*)	49·1	7, 8	2386, 2387
		20	40	4, 5	2388, 2389
		30	30	3	2390, 2391
		40	20	4, 8	2392, 2393
		50	10	7, 17	2394, 2395
9 in	$\frac{8}{5}$ out	10	50	3, 10	2396, 2397
		21.4 (*a*)	38·6	3, 10	2398, 2399
		30	30	7	2400
		37.5 (*b*)	22·5	7	2401
		50	10	7, 14	2402, 2403
9 in	$\frac{8}{5}$ in	7·7 (*a*)	52·3	3, 7	2404, 2405
		16.6 (*b*)	43·4	8	2406, 2407
		20	40	6	2408, 2409
		30	30	4	2410, 2411

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
9 in	$\frac{8}{5}$ in	40	20	5	2412, 2413
		50	10	8, 11	2414, 2415
9 in	$\frac{10}{3}$ out	9·3 (*a*)	50·7	5, 15	2416, 2417
		18 (*b*)	42	6, 9	2418, 2419
		30	30	3, 9	2420, 2421
		40	20	3, 9	2422, 2423
		50	10	11, 18	2424, 2425
9 in	$\frac{10}{3}$ in	3 (*a*)	57	5, 10	2426, 2427
		11·2 (*b*)	48·8	10	2428, 2429
		20	40	2, 7	2430, 2431
		30	30	3, 10	2432, 2433
		40	20	3, 6	2434, 2435
		50	10	6, 16	2436, 2437
$\frac{5}{2}$ out	1 in	0	60	—	(*c*)
		10	50	60	2438, 2439
		20	40	10	2440, 2441
		30	30	20	2442, 2443

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."
(*c*) 3 circ. loops "out," $V = \frac{8}{3}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	1 in	40	20	15	2444, 2445
		50	10	15	2446, 2447
		60	0	—	(*b*)
$\frac{5}{2}$ out	2 out	0	60	—	(*c*)
		10	50	14	2448, 2449
		20	40	14	2450, 2451
		30	30	12	2452, 2453
		40	20	12	2454, 2455
		50	10	16	2456, 2457
		60	0	—	(*d*)
$\frac{5}{2}$ out	2 in	0	60	—	(*e*)
		10	50	15	2458, 2459
		20	40	12	2460, 2461
		30	30	9	2462, 2463
		40	20	10	2464, 2465
		50	10	15	2466, 2467
		60	0	—	(*f*)

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	3 out	0	60	—	(*g*)
		10	50	10	2468, 2469
		20	40	10, 17	2470, 2471
		30	30	4	2472, 2473
		"	"	8	2474, 2475
		40	20	9, 16	2476, 2477
		50	10	16	2478, 2479
		60	0	—	(*h*)
$\frac{5}{2}$ out	3 in	0	60	—	(*i*)
		10	50	16	2480, 2481
		20	40	7	2482, 2483
		"	"	17	2484, 2485
		30	30	15	2486, 2487
		40	20	20	2488
		50	10	0	2489
		60	0	—	(*k*)
$\frac{5}{2}$ out	4 out	0	60	—	(*l*)
		10	50	10	2490, 2491

(*b*) 5 consec. loops out.
(*c*) 3 consec. loops in.
(*d*) 5 consec. loops out.
(*e*) 3 consec. loops out.
(*f*) 5 circ. loops out, $V = \frac{5}{3}$.

(*g*) 9 circ. loops in, $V = \frac{9}{2}$.
(*h*) 15 circ. loops out, $V = \frac{15}{4}$.
(*i*) 9 circ. loops out, $V = \frac{9}{2}$.
(*k*) 15 circ. loops out, $V = \frac{15}{8}$.
(*l*) 6 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	4 out	20	40	10	2492, 2493
		30	30	16	2494, 2495
		40	20	17	2496, 2497
		50	10	20	2498, 2499
		60	0	—	(*m*)
$\frac{5}{2}$ out	4 in	0	60	—	(*a*)
		10	50	9	2500, 2501
		”	”	19	2502, 2503
		20	40	12, 15	2504, 2505
		30	30	15	2506, 2507
		40	20	15	2508
		50	10	20	2509
		60	0	—	(*b*)
$\frac{5}{2}$ out	6 out	0	60	—	(*c*)
		10	50	8, 10	2510, 2511
		20	40	12	2512, 2513
		30	30	10	2514, 2515
		40	20	12	2516
		50	10	14	2517

(*m*) 10 circ. loops out, $V = \frac{10}{3}$.
(*a*) 6 consec. loops out.
(*b*) Ellipse.
(*c*) 9 consec. loops in

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	6 out	60	0	—	(*d*)
$\frac{5}{2}$ out	6 in	0	60	—	(*e*)
		10	50	10	2518, 2519
		20	40	15	2520, 2521
		30	30	13	2522, 2523
		40	20	17	2524
		50	10	24	2525
		60	0	—	(*f*)
$\frac{5}{2}$ out	9 out	0	60	—	(*g*)
		10	50	16	2526, 2527
		20	40	16	2528, 2529
		30	30	14	2530, 2531
		40	20	17	2532, 2533
		50	10	20	2534, 2535
		60	0	—	(*h*)
$\frac{5}{2}$ out	9 in	0	60	—	(*i*)
		10	50	10	2536, 2537
		20	40	9	2538, 2539

(*d*) 3 consec. loops out.
(*e*) 9 consec. loops out.
(*f*) 15 circ. loops out, $V = \frac{15}{7}$.
(*g*) 27 circ. loops in, $V = \frac{27}{2}$.
(*h*) 45 circ. loops out, $V = \frac{45}{16}$.
(*i*) 27 circ. loops out, $V = \frac{27}{2}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	9 in	30	30	15	2540, 2541
		40	20	20	2542, 2543
		50	10	24	2544, 2545
		60	0	—	(*k*)
$\frac{5}{2}$ out	$\frac{5}{2}$ out	0	60	—	(*l*)
		10	50	13	2546, 2547
		20	40	13	2548, 2549
		30	30	15	2550, 2551
		40	20	15	2552, 2553
		50	10	17	2554, 2555
		60	0	—	(*m*)
$\frac{5}{2}$ out	$\frac{5}{2}$ in	0	60	—	(*n*)
		10	50	20	2556, 2557
		20	40	20	2558, 2559
		30	30	20	2560, 2561
		40	20	20	2562
		50	10	20	2563
		60	0	—	(*o*)

(*k*) 9 circ. loops out, $V = \frac{9}{4}$.
(*l*) 15 circ. loops in, $V = \frac{15}{4}$.
(*m*) 25 circ. loops out, $V = \frac{25}{6}$.
(*n*) 15 circ. loops, out, $V = \frac{15}{4}$.
(*o*) 25 circ. loops out, $V = \frac{25}{14}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	$\frac{7}{2}$ out	0	60	—	(*a*)
		10	50	10	2564, 2565
		20	40	12	2566, 2567
		30	30	10, 18	2568, 2569
		40	20	13	2570
		50	10	16	2571
		60	0	—	(*b*)
$\frac{5}{2}$ out	$\frac{7}{2}$ in	0	60	—	(*c*)
		10	50	14	2572, 2573
		20	40	15	2574, 2575
		30	30	17	2576
		40	20	20	2577
		60	0	—	(*d*)
$\frac{5}{2}$ out	$\frac{8}{5}$ out	0	60	—	(*e*)
		10	50	15	2578, 2579
		20	40	15	2580, 2581
		30	30	15	2582, 2583
		40	20	10, 12	2584, 2585
		50	10	10	2586, 2587

(*a*) 21 circ. loops in, $V = \frac{21}{4}$.
(*b*) 7 circ. loops out, $V = \frac{7}{2}$.
(*c*) 21 circ. loops out, $V = \frac{21}{4}$.
(*d*) 35 circ. loops out, $V = \frac{35}{18}$.
(*e*) 12 circ. loops in, $V = \frac{12}{5}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	$\frac{8}{5}$ out	60	0	—	(*f*)
$\frac{5}{2}$ out	$\frac{8}{5}$ in	0	60	—	(*g*)
		10	50	10	2588, 2589
		20	40	17	2590, 2591
		30	30	15	2592
		40	20	20	2593
		60	0	—	(*h*)
$\frac{5}{2}$ out	$\frac{10}{3}$ out	0	60	—	(*i*)
		10	50	10	2594, 2595
		20	40	10, 15	2596, 2597
		30	30	12	2598, 2599
		40	20	12	2600, 2601
		50	10	15	2602, 2603
		60	0	—	(*k*)
$\frac{5}{2}$ out	$\frac{10}{3}$ in	0	60	—	(*l*)
		10	50	14	2604, 2605
		20	40	13	2606, 2607
		30	30	20	2608

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ out	$\frac{10}{3}$ in	40	20	20	2609
		60	0	—	(*m*)
$\frac{5}{2}$ in	1 in	0	60	—	(*n*)
		10	50	12	2610, 2611
		20	40	15	2612, 2613
		30	30	15	2614, 2615
		40	20	20	2616
		50	10	20	2617
		60	0	—	(*o*)
$\frac{5}{2}$ in	2 out	0	60	—	(*a*)
		10	50	10	2618, 2619
		20	40	10	2620, 2621
		30	30	10	2622, 2623
		40	20	10	2624, 2625
		50	10	10	2626, 2627
		60	0	—	(*b*)
$\frac{5}{2}$ in	2 in	0	60	—	(*c*)
		10	50	10	2628, 2629

(*f*) 20 circ. loops out, $V = \frac{20}{3}$.
(*g*) 12 circ. loops out, $V = \frac{12}{5}$.
(*h*) 20 circ. loops out, $V = \frac{20}{13}$.
(*i*) 5 consec. loops in.
(*k*) 25 circ. loops out, $V = \frac{25}{7}$.
(*l*) 5 consec. loops out.

(*m*) 25 circ. loops out, $V = \frac{25}{13}$.
(*n*) 7 circ. loops in, $V = \frac{7}{2}$.
(*o*) 5 circ. loops in, $V = \frac{5}{4}$.
(*a*) 7 consec. loops out.
(*b*) 5 consec. loops in.
(*c*) 7 consec. loops in.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	2 in	20	40	11	2630, 2631
		30	30	14	2632, 2633
		40	20	20	2634
		50	10	20	2635
		60	0	—	(*d*)
$\frac{5}{2}$ in	3 out	0	60	—	(*e*)
		10	50	12	2636, 2637
		20	40	8	2638, 2639
		30	30	8, 10	2640, 2641
		40	20	20	2642, 2643
		50	10	12	2644, 2645
		60	0	—	(*f*)
$\frac{5}{2}$ in	3 in	0	60	—	(*g*)
		10	50	12	2646, 2647
		20	40	10	2648, 2649
		30	30	15	2650, 2651
		40	20	15	2652
		50	10	15	2653
		60	0	—	(*h*)

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	4 out	0	60	—	(*i*)
		10	50	12	2654, 2655
		20	40	12	2656, 2657
		30	30	14	2658, 2659
		40	20	12, 14	2660, 2661
		50	10	12, 15	2662, 2663
		60	0	—	(*k*)
$\frac{5}{2}$ in	4 in	0	60	—	(*l*)
		10	50	16	2664, 2665
		20	40	16	2666, 2667
		30	30	15	2668
		40	20	12	2669
		50	10	12	2670, 2671
		60	0	—	(*m*)
$\frac{5}{2}$ in	6 out	0	60	—	(*n*)
		10	50	14	2672, 2673
		20	40	13	2674, 2675
		30	30	4, 8	2676, 2677

(*d*) 5 circ. loops in, $V = \frac{5}{3}$.
(*e*) 21 circ. loops out, $V = \frac{21}{2}$.
(*f*) 15 circ. loops in, $V = \frac{15}{4}$.
(*g*) 21 circ. loops in, $V = \frac{21}{2}$.
(*h*) 15 circ. loops in, $V = \frac{15}{8}$.

(*i*) 14 consec. loops out.
(*k*) 10 circ. loops in, $V = \frac{10}{3}$.
(*l*) 14 consec. loops in.
(*m*) 2 consec. loops, in.
(*n*) 21 consec. loops out.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	6 out	40	20	5, 10	2678, 2679
		50	10	12	2680, 2681
		60	0	—	(*o*)
$\frac{5}{2}$ in	6 in	0	60	—	(*a*)
		10	50	14	2682, 2683
		20	40	9	2684, 2685
		30	30	9	2686, 2687
		40	20	10	2688, 2689
		50	10	15	2690, 2691
		60	0	—	(*b*)
$\frac{5}{2}$ in	9 out	0	60	—	(*c*)
		10	50	10	2692, 2693
		20	40	10	2694, 2695
		30	30	12	2696, 2697
		40	20	15	2698, 2699
		50	10	15	2700, 2701
		60	0	—	(*d*)

(*o*) 3 consec. loops in.
(*a*) 21 consec. loops in.
(*b*) 15 circ. loops in, $V = \frac{15}{7}$.
(*c*) 63 circ. loops out, $V = \frac{63}{2}$.
(*d*) 45 circ. loops in, $V = \frac{45}{16}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	9 in	0	60	—	(*e*)
		10	50	10	2702, 2703
		20	40	10	2704, 2705
		30	30	10	2706, 2707
		40	20	15	2708
		50	10	15	2709
		60	0	—	(*f*)
$\frac{5}{2}$ in	$\frac{5}{2}$ out	0	60	—	(*g*)
		10	50	5	2710, 2711
		20	40	9	2712, 2713
		30	30	12	2714, 2715
		40	20	10	2716, 2717
		50	10	8	2718, 2719
		60	0	—	(*h*)
$\frac{5}{2}$ in	$\frac{5}{2}$ in	0	60	—	(*i*)
		10	50	11	2720, 2721
		20	40	9	2722, 2723
		30	30	9	2724, 2725

(*e*) 63 circ. loops in, $V = \frac{6}{2}$.
(*f*) 9 circ. loops in, $V = \frac{9}{4}$.
(*g*) 35 circ. loops out, $V = \frac{35}{4}$.
(*h*) 25 circ. loops in, $V = \frac{25}{6}$.
(*i*) 35 circ. loops in, $V = \frac{35}{4}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	$\frac{5}{2}$ in	40	20	17	2726
		50	10	15	2727
		60	0	—	(*k*)
$\frac{5}{2}$ in	$\frac{7}{2}$ out	0	60	—	(*l*)
		10	50	{ 4 / 10	{ 2728 / 2729
		20	40	{ 6 / 12	{ 2730 / 2731
		30	30	12	{ 2732 / 2733
		40	20	10	{ 2734 / 2735
		50	10	10	{ 2736 / 2737
		60	0	—	(*m*)
$\frac{5}{2}$ in	$\frac{7}{2}$ in	0	60	—	(*n*)
		10	50	12	2738
		20	40	10	{ 2739 / 2740
		30	30	10	2741
		40	20	10	2742
		50	10	12	2743
		60	0	—	(*o*)
$\frac{5}{2}$ in	$\frac{8}{5}$ out	0	60	—	(*a*)
		10	50	10	2744
		20	40	10	2745
		30	30	14	{ 2746 / 2747

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	$\frac{8}{5}$ out	40	20	14	{ 2748 / 2749
		50	10	12	{ 2750 / 2751
		60	0	—	(*b*)
$\frac{5}{2}$ in	$\frac{8}{5}$ in	0	60	—	(*c*)
		10	50	12	{ 2752 / 2753
		20	40	12	{ 2754 / 2755
		30	30	15	{ 2756 / 2757
		40	20	15	{ 2758 / 2759
		50	10	17	{ 2760 / 2761
		60	0	—	(*d*)
$\frac{5}{2}$ in	$\frac{10}{3}$ out	0	60	—	(*e*)
		10	50	10	2762
		20	40	11	{ 2763 / 2764
		30	30	9	{ 2765 / 2766
		40	20	9	{ 2767 / 2768
		50	10	10	2769
		60	0	—	(*f*)
$\frac{5}{2}$ in	$\frac{10}{3}$ in	0	60	—	(*g*)

(*k*) 25 circ. loops in, $V = \frac{25}{14}$.
(*l*) 49 circ. loops out, $V = \frac{49}{4}$.
(*m*) 7 circ. loops in, $V = \frac{7}{2}$.
(*n*) 49 circ. loops in, $V = \frac{49}{4}$.
(*o*) 35 circ. loops in, $V = \frac{35}{18}$.
(*a*) 28 circ. loops out, $V = \frac{28}{5}$.

(*b*) 20 circ. loops in, $V = \frac{20}{3}$.
(*c*) 28 circ. loops in, $V = \frac{28}{5}$.
(*d*) 20 circ. loops in, $V = \frac{20}{13}$.
(*e*) 35 circ. loops out, $V = \frac{35}{3}$.
(*f*) 25 circ. loops in, $V = \frac{25}{7}$.
(*g*) 35 circ. loops in, $V = \frac{35}{3}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{5}{2}$ in	$\frac{10}{3}$ in	10	50	5 10	2770 2771
		20	40	5 10	2772 2773
		30	30	12	2774 2775
		40	20	15	2776
		50	10	15	2777
		60	0	—	(*h*)
$\frac{7}{2}$ out	1 in	10	50	25	2778 2779
		20	40	20	2780 2781
		30	30	20	2782
		40	20	20	2783
$\frac{7}{2}$ out	2 out	10	50	10	2784
		20	40	10	2785
		30	30	10	2786 2787
		40	20	10	2788
		50	10	10	2789
$\frac{7}{2}$ out	2 in	10	50	10	2790
		20	40	14	2791
		30	30	16	2792 2793
		40	20	20	2794
		50	10	20	2795
$\frac{7}{2}$ out	3 out	10	50	9	2796 2797
		20	40	14	2798
		30	30	8	2799 2800

(*h*) 25 circ. loops in, $V = \frac{25}{13}$.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ out	3 out	40	20	5	2801 2802
		50	10	10	2803
$\frac{7}{2}$ out	3 in	10	50	5 10	2804 2805
		20	40	10	2806 2807
		30	30	12	2808 2809
		40	20	17	2810
		50	10	20	2811
$\frac{7}{2}$ out	4 out	10	50	12	2812 2813
		20	40	12 15	2814 2815
		30	30	15	2816 2817
		40	20	16	2818
		50	10	20	2819
$\frac{7}{2}$ out	4 in	10	50	4 10	2820 2821
		20	40	10	2822 2823
		30	30	11	2824 2825
		40	20	13	2826 2827
		50	10	10 20	2828 2829
$\frac{7}{2}$ out	6 out	10	50	9 13	2830 2831
		20	40	16	2832 2833
		30	30	5	2834
		40	20	5	2835

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ out	6 out	50	10	15	2836, 2837
$\frac{7}{2}$ out	6 in	10	50	10	2838, 2839
		20	40	4	2840, 2841
		”	”	12	2842, 2843
		30	30	12	2844
		40	20	17	2845
$\frac{7}{2}$ out	9 out	10	50	10	2846
		20	40	12	2847
		30	30	8	2848
		40	20	13	2849
$\frac{7}{2}$ out	9 in	10	50	11	2850, 2851
		20	40	6, 16	2852, 2853
		30	30	11, 15	2854, 2855
		40	20	14	2856
		50	10	17	2857
$\frac{7}{2}$ out	$\frac{5}{2}$ out	10	50	18	2858
		20	40	17	2859
		30	30	14	2860, 2861
		40	20	14	2862
		50	10	20	2863
$\frac{7}{2}$ out	$\frac{5}{2}$ in	10	50	12	2864, 2865
		20	40	17	2866, 2867
		30	30	15, 20	2868, 2869

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ out	$\frac{5}{2}$ in	40	20	20	2870
		50	10	20	2871
$\frac{7}{2}$ out	$\frac{7}{2}$ out	10	50	14	2872
		20	40	13	2873
		30	30	5, 15	2874, 2875
		40	20	7	2876, 2877
		50	10	8, 16	2878, 2879
$\frac{7}{2}$ out	$\frac{7}{2}$ in	10	50	12	2880, 2881
		20	40	14	2882, 2883
		30	30	13	2884, 2885
		40	20	15	2886
		50	10	20	2887
$\frac{7}{2}$ out	$\frac{8}{5}$ out	10	50	10	2888
		20	40	17	2889
		30	30	12	2890
		40	20	16	2891
		50	10	4, 20	2892, 2893
$\frac{7}{2}$ out	$\frac{8}{5}$ in	10	50	13	2894, 2895
		20	40	14	2896, 2897
		30	30	20	2898, 2899
		40	20	20	2900
		50	10	25	2901
$\frac{7}{2}$ out	$\frac{10}{3}$ out	10	50	12	2902

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ out	$\frac{10}{3}$ out	20	40	10	2903
		30	30	10	2904
		40	20	19	2905
$\frac{7}{2}$ out	$\frac{10}{3}$ in	10	50	12	2906
		20	40	14	2907, 2908
		30	30	20	2909
		40	20	10, 20	2910, 2911
$\frac{7}{2}$ in	1 in	20	40	10	2912
		30	30	10	2913
		40	20	10	2914
$\frac{7}{2}$ in	2 out	20	40	10	2915
		30	30	10	2916, 2917
		40	20	10	2918
$\frac{7}{2}$ in	2 in	10	50	10	2919
		20	40	10	2920
		30	30	10	2921
		40	20	12	2922
		50	10	15	2923
$\frac{7}{2}$ in	3 out	10	50	15	2924
		20	40	12	2925
		30	30	9	2926
		40	20	8	2927
$\frac{7}{2}$ in	3 in	10	50	12	2928
		20	40	10	2929
		30	30	10	2930
		40	20	10	2931
$\frac{7}{2}$ in	4 out	10	50	8	2932, 2933

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ in	4 out	20	40	10	2934, 2935
		30	30	14	2936
		40	20	14	2937
$\frac{7}{2}$ in	4 in	20	40	8	2938
		30	30	8	2939
		40	20	10	2940
		50	10	12	2941
$\frac{7}{2}$ in	6 out	10	50	12	2942
		20	40	11, 13	2943, 2944
		30	30	12	2945
		40	20	8	2946
		50	10	14	2947
$\frac{7}{2}$ in	6 in	10	50	12	2948
		20	40	11	2949
		30	30	6	2950
		40	20	10	2951, 2952
		50	10	11	2953
$\frac{7}{2}$ in	9 out	10	50	13	2954
		20	40	12	2955
		30	30	10	2956
		40	20	8	2957
$\frac{7}{2}$ in	9 in	10	50	11	2958
		20	40	12	2959
		30	30	8	2960
		40	20	10	2961
$\frac{7}{2}$ in	$\frac{5}{2}$ out	10	50	4	2962
		20	40	10	2963
		30	30	11	2964, 2965

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ in	$\frac{5}{2}$ out	40	20	11	2966
		50	10	13	2967
$\frac{7}{2}$ in	$\frac{5}{2}$ in	10	50	11	2968
		20	40	10	2969
		30	30	4	2970
		40	20	12	2971
$\frac{7}{2}$ in	$\frac{7}{2}$ out	10	50	4	2972
		20	40	6	2973
		30	30	9	2974, 2975
		40	20	12	2976
		50	10	7	2977
$\frac{7}{2}$ in	$\frac{7}{2}$ in	10	50	12	2978
		20	40	10	2979, 2980
		30	30	10	2981
		40	20	10	2982
		50	10	12	2983
$\frac{7}{2}$ in	$\frac{8}{5}$ out	10	50	10	2984
		20	40	10	2985
		30	30	10	2986, 2987
		40	20	14	2988
		50	10	12	2989
$\frac{7}{2}$ in	$\frac{8}{5}$ in	10	50	12	2990
		20	40	12	2991
		30	30	10	2992, 2993
		40	20	10	2994
		50	10	10	2995
$\frac{7}{2}$ in	$\frac{10}{3}$ out	10	50	9	2996

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ in	$\frac{10}{3}$ out	20	40	10	2997
		30	30	9	2998
		40	20	7	2999
$\frac{7}{2}$ in	$\frac{10}{3}$ in	10	50	8	3000
		20	40	4	3001
		30	30	12	3002
		50	10	12	3003
$\frac{8}{5}$ out	1 in	20	40	20	3004
		30	30	20	3005, 3006
		40	20	20	3007
$\frac{8}{5}$ out	2 out	10	50	15, 20	3008, 3009
		20	40	20	3010, 3011
		30	30	20	3012, 3013
		40	20	10, 20	3014, 3015
		50	10	15, 20	3016, 3017
$\frac{8}{5}$ out	2 in	20	40	10	3018, 3019
		30	30	16	3020
		40	20	16	3021
$\frac{8}{5}$ out	3 out	10	50	20	3022, 3023
		20	40	15	3024, 3025
		30	30	20	3026, 3027
		40	20	20	3028, 3029

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{7}{2}$ out	$\frac{10}{3}$ out	20	40	10	2903
		30	30	10	2904
		40	20	19	2905
$\frac{7}{2}$ out	$\frac{10}{3}$ in	10	50	12	2906
		20	40	14	2907, 2908
		30	30	20	2909
		40	20	10	2910
				20	2911
$\frac{7}{2}$ in	1 in	20	40	10	2912
		30	30	10	2913
		40	20	10	2914
$\frac{7}{2}$ in	2 out	20	40	10	2915
		30	30	10	2916, 2917
		40	20	10	2918
$\frac{7}{2}$ in	2 in	10	50	10	2919
		20	40	10	2920
		30	30	10	2921
		40	20	12	2922
		50	10	15	2923
$\frac{7}{2}$ in	3 out	10	50	15	2924
		20	40	12	2925
		30	30	9	2926
		40	20	8	2927
$\frac{7}{2}$ in	3 in	10	50	12	2928
		20	40	10	2929
		30	30	10	2930
		40	20	10	2931
$\frac{7}{2}$ in	4 out	10	50	8	2932, 2933

V_1				
$\frac{7}{2}$ in	4 [illegible]			
$\frac{7}{2}$ in	[illegible]			
$\frac{7}{2}$ in	6 [illegible]			
$\frac{7}{2}$ in	6 i[illegible]			
$\frac{7}{2}$ in	9 out	1[illegible]		
		20		
		30		
		40		
$\frac{7}{2}$ in	9 in	10	5[illegible]	
		20	40	
		30	30	
		40	20	
$\frac{7}{2}$ in	$\frac{5}{2}$ out	10	50	
		20	40	10
		30	30	11

…ig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
3214	$\frac{10}{3}$ out	4 in	40	20	20	3238
			50	10	20	3239
3215	$\frac{10}{3}$ out	6 out	2·3 (*a*)	57·7	10	3240
3216			10 (*b*)	50	10	3241
3217						
3218			20	40	10	3242 3243
…219			30	30	10	3244 3245
…20			40	20	10	3246
…21			50	10	15	3247
…22	$\frac{10}{3}$ out	6 in	7·5 (*b*)	52·5	10	3248 3249
…3						
			20	40	10	3250
			30	30	10	3251
			40	20	20	3252
			50	10	20	3253
		9 out	6·6 (*b*)	53·4	10	3254 3255
			20	40	5 10	3256 3257
			30	30	5 10	3258 3259
			40	20	20	3260
			…0	10	20	3261
			[illegible]	54·6	5 15	3262 3263
			[illegible]	40	5 10	3264 3265

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{8}{5}$ out	3 out	50	10	20	3030
				25	3031
$\frac{8}{5}$ out	3 in	10	50	20	3032
				25	3033
		20	40	20	3034
		30	30	20	3035
$\frac{8}{5}$ out	4 out	10	50	20	3036
		20	40	17	3037, 3038
		30	30	18	3039, 3040
		40	20	20	3041
$\frac{8}{5}$ out	4 in	10	50	23	3042, 3043
		20	40	20	3044, 3045
		30	30	20	3046
		40	20	20	3047
$\frac{8}{5}$ out	6 out	10	50	20	3048, 3049
		20	40	17	3050, 3051
		30	30	23	3052
		40	20	25	3053
$\frac{8}{5}$ out	6 in	10	50	16	3054, 3055
		20	40	15	3056, 3057
		30	30	18	3058
		40	20	25	3059
$\frac{8}{5}$ out	9 out	10	50	14	3060, 3061
		,,	,,	22	3062, 3063

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{8}{5}$ out	9 out	20	40	18	3064, 3065
		30	30	20	3066, 3067
		40	20	25	3068
		50	10	25	3069
$\frac{8}{5}$ out	9 in	10	50	20	3070, 3071
		20	40	18	3072
		30	30	8	3073
$\frac{8}{5}$ out	$\frac{5}{2}$ out	10	50	20	3074
		20	40	20	3075
		30	30	20	3076, 3077
		40	20	18	3078, 3079
		50	10	20	3080, 3081
$\frac{8}{5}$ out	$\frac{5}{2}$ in	10	50	18	3082, 3083
		20	40	12	3084, 3085
		30	30	7	3086
		40	20	10	3087
$\frac{8}{5}$ out	$\frac{7}{2}$ out	10	50	20	3088
		20	40	18	3089, 3090
		30	30	17	3091
$\frac{8}{5}$ out	$\frac{7}{2}$ in	10	50	22	3092
		20	40	22	3093
$\frac{8}{5}$ out	$\frac{8}{5}$ out	20	40	20	3094
		30	30	20	3095
		40	20	20	3096

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{8}{5}$ out	$\frac{8}{5}$ out	50	10	18	3097
$\frac{8}{5}$ out	$\frac{8}{5}$ in	20	40	15	3098
		30	30	18	3099
$\frac{8}{5}$ out	$\frac{10}{3}$ out	10	50	20	3100
		20	40	13 23	3101 3102
		30	30	16	3103 3104
		40	20	20	3105 3106
		50	10	20	3107
$\frac{8}{5}$ out	$\frac{10}{3}$ in	10	50	10 20	3108 3109
		20	40	7 20	3110 3111
		30	30	5 15	3112 3113
		40	20	10 25	3114 3115
		50	10	15 25	3116 3117
$\frac{8}{5}$ in	1 in	10	50	15	3118
		20	40	20	3119
		30	30	20	3120
		40	20	20	3121
$\frac{8}{5}$ in	2 out	10	50	20	3122
		20	40	20	3123
		30	30	10 20	3124 3125
		40	20	20	3126
		50	10	25	3127
$\frac{8}{5}$ in	2 in	10	50	10 25	3128 3129
$\frac{8}{5}$ in	2 in	20	40	20	3130 3131
		30	30	20	3132
		50	10	20	3133
$\frac{8}{5}$ in	3 out	10	50	18	3134
		20	40	20	3135
		30	30	15	3136
		40	20	20	3137
$\frac{8}{5}$ in	3 in	10	50	18	3138
		20	40	16	3139
		30	30	16	3140
		40	20	20	3141
$\frac{8}{5}$ in	4 out	10	50	14	3142
		20	40	16	3143
		30	30	16	3144
		50	10	17	3145
$\frac{8}{5}$ in	4 in	20	40	11	3146 3147
		30	30	20	3148
		40	20	20	3149
$\frac{8}{5}$ in	6 out	10	50	10	3150
		20	40	11	3151
		30	30	12	3152
		40	20	15	3153
$\frac{8}{5}$ in	6 in	10	50	12	3154
		20	40	11	3155
		30	30	11	3156
		50	10	20	3157
$\frac{8}{5}$ in	9 out	10	50	10	3158
		20	40	10	3159

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{8}{5}$ in	9 out	30	30	10	3160
		40	20	12	3161
$\frac{8}{5}$ in	9 in	10	50	10	3162
		20	40	12	3163
		30	30	11	3164
		40	20	15	3165
$\frac{8}{5}$ in	$\frac{5}{2}$ out	10	50	20	3166
		20	40	16	3167, 3168
		30	30	20	3169, 3170
		50	10	15	3171
$\frac{8}{5}$ in	$\frac{5}{2}$ in	20	40	16	3172, 3173
		30	30	17	3174
		40	20	20	3175
$\frac{8}{5}$ in	$\frac{7}{2}$ out	10	50	15	3176
		20	40	15	3177
		30	30	15	3178
		50	10	15	3179
$\frac{8}{5}$ in	$\frac{7}{2}$ in	10	50	15	3180
		20	40	17	3181
$\frac{8}{5}$ in	$\frac{8}{5}$ out	10	50	15	3182
		20	40	16	3183
		30	30	18	3184
		40	20	20	3185
$\frac{8}{5}$ in	$\frac{8}{5}$ in	10	50	15	3186
		20	40	15	3187

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{8}{5}$ in	$\frac{10}{3}$ out	10	50	20	3188
		20	40	15	3189, 3190
		30	30	15	3191
		40	20	17	3192
		50	10	17	3193
$\frac{8}{5}$ in	$\frac{10}{3}$ in	10	50	10	3194
		20	40	15	3195
		30	30	12	3196
		40	20	15	3197
$\frac{10}{3}$ out	1 in	12 (*a*)	48	20	3198
		20 (*b*)	40	20	3199
		30	30	20	3200
		40	20	20	3201
$\frac{10}{3}$ out	2 out	10	50	15	3202
		20	40	12	3203
		30 (*a*)	30 (*b*)	16	3204
		40	20	14	3205
		50	10	10, 20	3206, 3207
$\frac{10}{3}$ out	2 in	6 (*a*)	54	15	3208
		15 (*b*)	45	15	3209, 3210
		30	30	15	3211, 3212
		40	20	15	3213

(*a*) $Ex_1 : Ex :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{10}{3}$ out	3 out	12 (*a*)	48	12	3214
		20 (*b*)	40	12	3215
		30	30	12	3216
		40	20	15	3217
$\frac{10}{3}$ out	3 in	3·5 (*a*)	56·5	6	3218
		12 (*b*)	48	9	3219
		20	40	10	3220
		30	30	15	{ 3221 3222
		40	20	20	3223
$\frac{10}{3}$ out	4 out	6 (*a*)	54	{ 4 13	{ 3224 3225
		10	50	12	3226
		15 (*b*)	45	10	{ 3227 3228
		30	30	10	3229
		40	20	10	3230
		50	10	6	3231
$\frac{10}{3}$ out	4 in	2·3 (*a*)	57·7	{ 4 22	{ 3232 3233
		10 (*b*)	50	15	3234
		20	40	15	3235
		30	30	15	{ 3236 3237
$\frac{10}{3}$ out	4 in	40	20	20	3238
		50	10	20	3239
$\frac{10}{3}$ out	6 out	2·3 (*a*)	57·7	10	3240
		10 (*b*)	50	10	3241
		20	40	10	{ 3242 3243
		30	30	10	{ 3244 3245
		40	20	10	3246
		50	10	15	3247
$\frac{10}{3}$ out	6 in	7·5 (*b*)	52·5	10	{ 3248 3249
		20	40	10	3250
		30	30	10	3251
		40	20	20	3252
		50	10	20	3253
$\frac{10}{3}$ out	9 out	6·6 (*b*)	53·4	10	{ 3254 3255
		20	40	{ 5 10	{ 3256 3257
		30	30	{ 5 10	{ 3258 3259
		40	20	20	3260
		50	10	20	3261
$\frac{10}{3}$ out	9 in	5·4 (*b*)	54·6	{ 5 15	{ 3262 3263
		20	40	{ 5 10	{ 3264 3265

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{10}{3}$ out	9 in	30	30	10, 20	3266, 3267
		40	20	20	3268
		50	10	20	3269
$\frac{10}{3}$ out	$\frac{5}{2}$ out	10	50	5, 10	3270, 3271
		18·4 (*a*)	41·6	10	3272
		30	30	5, 15	3273, 3274
		40	20	15	3275
$\frac{10}{3}$ out	$\frac{5}{2}$ in	4·5 (*a*)	55·5	10	3276
		10	50	10	3277
		13·3 (*b*)	46·7	10	3278
		20	40	15	3279, 3280
		30	30	15	3281
		40	20	17	3282
		50	10	20	3283
$\frac{10}{3}$ out	$\frac{7}{2}$ out	8.3 (*a*)	51·7	6	3284
		17·1 (*b*)	42·9	8	3285
		30	30	10	3286
		40	20	5, 15	3287, 3288
		50	10	10	3289
$\frac{10}{3}$ out	$\frac{7}{2}$ in	2·8 (*a*)	57·2	8	3290

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{10}{3}$ out	$\frac{7}{2}$ in	10·9 (*b*)	49·1	5, 12	3291, 3292
		20	40	12	3293
		30	30	14	3294
		40	20	16	3295
$\frac{10}{3}$ out	$\frac{8}{5}$ out	10	50	15	3296
		21·4 (*a*)	38·6	10	3297, 3298
		37·5 (*b*)	22·5	8	3299
$\frac{10}{3}$ out	$\frac{8}{5}$ in	7·7 (*a*)	52·3	8	3300
		16·6 (*b*)	43·4	15, 20	3301, 3302
		30	30	22	3303
$\frac{10}{3}$ out	$\frac{10}{3}$ out	9·3 (*a*)	50·7	10	3304
		18 (*b*)	42	8	3305
		30	30	8	3306
		40	20	10	3307
$\frac{10}{3}$ out	$\frac{10}{3}$ in	11·2 (*b*)	48·8	10	3308
		20	40	12	3309
		30	30	15	3310
		40	20	20	3311
$\frac{10}{3}$ in	1 in	12 (*a*)	48	10	3312
		20 (*b*)	40	10	3313

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
$\frac{10}{3}$ in	2 out	10	50	12	3314
		20	40	10	3315
		30 (*a*)	30 (*b*)	5	3316
		50	10	12	3317
$\frac{10}{3}$ in	2 in	6 (*a*)	54	12	3318
		15 (*b*)	45	7	3319
		30	30	10	3320
		40	20	10	3321
$\frac{10}{3}$ in	3 out	12 (*a*)	48	8	3322
		20 (*b*)	40	{ 5, 12	{ 3323, 3324
		30	30	10	3325
		40	20	10	3326
		50	10	13	3327
$\frac{10}{3}$ in	3 in	3·5 (*a*)	56·5	10	3328
		12 (*b*)	48	7	3329
		20	40	{ 7, 10	{ 3330, 3331
		30	30	10	3332
		50	10	13	3333
$\frac{10}{3}$ in	4 out	6 (*a*)	54	{ 5, 12	{ 3334, 3335
		15 (*b*)	45	7	3336
		30	30	10	3337
$\frac{10}{3}$ in	4 out	40	20	5	3338
		50	10	8	3339
$\frac{10}{3}$ in	4 in	2·3 (*a*)	57·7	4	3340
		10 (*b*)	50	12	3341
		20	40	8	3342
		30	30	10	3343
		40	20	15	3344
		50	10	10	3345
$\frac{10}{3}$ in	6 out	2·3 (*a*)	57·7	10	3346
		10 (*b*)	50	10	3347
		20	40	10	3348
		30	30	10	3349
		40	20	6	3350
		50	10	8	3351
$\frac{10}{3}$ in	6 in	7·5 (*b*)	52·5	{ 5, 10	{ 3352, 3353
		20	40	3	3354
		30	30	10	3355
		40	20	10	3356
		50	10	10	3357
$\frac{10}{3}$ in	9 out	6·6 (*b*)	53·4	4	3358
		20	40	7	3359
		40	20	10	3360

(*a*) $Ex_1 : Ex_2 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_3	S.R.	Fig.
$\frac{10}{3}$ in	9 out	50	10	8	3361	$\frac{10}{3}$ in	$\frac{7}{2}$ out	40	20	5	3376
$\frac{10}{3}$ in	9 in	5.4 (*b*)	54·6	10	3362			50	10	10	3377
						$\frac{10}{3}$ in	$\frac{7}{2}$ in	10.9 (*b*)	49·1	2	3378
		20	40	7	3363						
		40	20	10	3364			40	20	8	3379
		50	10	8	3365	$\frac{10}{3}$ in	$\frac{8}{5}$ out	10	50	12	3380
$\frac{10}{3}$ in	$\frac{5}{2}$ out	10	50	5	3366			21·4 (*a*)	38·6	10	3381
		18·4 (*a*)	41·6	12	3367			37·5 (*b*)	22·5	5 10	3382 3383
		24 (*b*)	36	10	3368	$\frac{10}{3}$ in	$\frac{8}{5}$ in	7·7 (*a*)	52.3	8	3384
		40	20	10	3369			30	30	12	3385
$\frac{10}{3}$ in	$\frac{5}{2}$ in	4·5 (*a*)	55·5	10	3370	$\frac{10}{3}$ in	$\frac{10}{3}$ out	9·3 (*b*)	50·7	10	3386
		10	50	5	3371						
		20	40	10	3372			18	42	5 8	3387 3388
		40	20	10	3373			40	20	5	3389
$\frac{10}{3}$ in	$\frac{7}{2}$ out	8·3 (*a*)	51·7	6	3374	$\frac{10}{3}$ in	$\frac{10}{3}$ in	11.2 (*d*)	48·8	10	3390
		17·1 (*b*)	42·9	8	3375			30	30	10	3391

(*a*) $Ex_1 : Ex_3 :: 1 : n^2$. (*b*) $Ex_1 : Ex_2 :: 1 : n$, where $n = V_2 \pm 1$, according as V_2 is "in" or "out."

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
40 out	$\frac{11}{5}$ out	25	30	12	3392	$\frac{21}{4}$ in „ out	2 out „	10 10	50 36	3·5 2·5	3396
„	„	30	27	12	3393	24 in	3 out	32	8	40	3397
60 in	$\frac{7}{2}$ out	40	20	5	3394	2 out	54 in	5	50	5 9	3398 3399
40 out	$\frac{8}{3}$ out	29	31	5	3395						

The reference to the figures is continued at the end of Chapter V.

CHAPTER IV.

Discussion of the Results afforded by this investigation.

THE information to be gleaned from this somewhat tedious series will be more apparent when the figures are examined for some special purpose than by a mere cursory inspection.

The conditions, for instance, which determine the inward or outward direction of the several smaller loops can be ascertained at once; shewing, after the numerical values of V_1 and V_2 have been determined upon, the directions which they should receive respectively in order to suit any intended purpose.

Perhaps the most striking result, exemplified by many of the diagrams, is the effect produced by employing fractional values for the trains on one or both Parts: and especially when the numerator* of V_2 is a multiple of the denominator of V_1. Under such circumstances the curve takes a shorter course, and often an extraordinary one (fig. 3103, for example), compared with that which would occur if no such relationship existed. The property of a fractional value for V is that the

* An integral value can be considered as a fractional value with 1 for its denominator.

describing point has to travel as many times round the surface as are equal to the denominator of the fraction. And, provided the denominator of a fractional value for V_1 has no common factor with the numerator of V_2, this rule continues. A curve of this kind,—such as that given with $V_1 = \frac{10}{3}$, $V_2 = 4$, —is composed of dissimilar and generally unsymmetrical segments, which, by their subsequent overlapping, form a compound figure with as many equal and harmonious compartments as correspond to the value of V_2. (See fig. 3239.)

But when V_2 is a multiple of the denominator of V_1, the circulating property of the fractional value of V_1 becomes cancelled, and the curve is completed when the describing point has passed *once* round the surface. The individual segments are dissimilar as before, though symmetrically disposed with reference to each other and to an imaginary datum line through the centre: and the segments, (which are of simple outline character, as there is no opportunity for their overlapping,) are V_2 in number. An examination of figs. 3214–3223, 3242, &c., and 3262, &c., will make this clearer than any verbal explanation. The values for V_1 and V_2 to which these figures refer are comparatively low. But however great they may be taken, the principle remains the same. If a curve were described with $V_1 = \frac{171}{50}$, $V_2 = 99$, its course would be almost interminable; but if V_2 were changed from 99 to 100, or to any other multiple of 50 (supposing the apparatus to permit such extreme values), the curve would be completed when the point had passed once wholly round the surface.

When the numerator of V_2 and the denominator of V_1 possess some common factor only, the course of the curve is affected to that extent, without being so completely reduced as when the former is a multiple of the latter, $V_1 = \frac{13}{6}$, $V_2 = 15$, would yield a curve of this character: and all such combinations, whether V_2 be integral or fractional, would be sure to give interesting and often unexpected results.

There are several instances, such as figs. 807 and 813, where the cusped or nodated phases of the curve are invisible, and require an increase of eccentricity, sometimes at one of the Chuck slides, but generally at S.R., to produce them.

Another singular feature of the series is that there are some curves, which though described by perfectly different methods, are nevertheless identical in form and character. Examples of curves possessing this alternative origin may be noticed among those described with Part II. arranged for the ellipse, *i.e.*, with V_2 = 2 "out." Thus, the following results are equal :—

Fig.	V_1	V_2	Ex_1	Ex_2	S.R.		V_1	V_2	Ex_1	Ex_2	S.R.	Fig.
228	1 in	2 out	10	50	10	=	2 out	2 out	50	10	10	...
250	"	"	50	10	10	=	"	"	10	50	10	...
636	2 in	2 out	10	50	10	=	3 out	2 out	50	10	10	832
634	"	"	50	10	10	=	"	"	10	50	10	821
1084	3 in	2 out	10	50	10	=	4 out	2 out	50	10	10	1277
1092	"	"	50	10	10	=	"	"	10	50	10	1268
2618	$\frac{5}{2}$ in	2 out	10	50	10	=	$\frac{7}{2}$ out	2 out	50	10	10	2789
2627	"	"	50	10	10	=	"	"	10	50	10	2784

although the corresponding figures differ somewhat in the size of loops, because the values employed for S.R. were not in all cases 10, as stated above.

The lithographed figures do not contain further instances of identity, the series of values for V_1 and V_2 not having been selected as consecutive integers beyond this point. But any number of experiments will confirm the fact that, while V_2 remains equal to 2 "out," the same correspondence occurs, whatever be the two values successively adopted for V_1 : provided that the value of V_1 when "out," is greater by unity than the value of V_1 when "in." From which it appears that the same curve is produced, retaining V_2 = 2 out, and keeping S.R. undisturbed, by altering the direction of V_1 from "in" to "out," adding 1 to its numerical value, and transposing the eccentricities of Part I. and Part II.

For instance, whether we have

	V_1	V_2	Ex_1	Ex_2	S.R.	
	9 in	2 out	25	75	10	(a)
or,	10 out	2 out	75	25	10	

the same curve is produced, viz., one of 20 loops, turned outwards, and arranged, in each case, in the periphery of an ellipse of the same dimensions.

But if an attempt be made to extend this relationship to other values of V_2, besides that of 2 out,—such as expecting a coincidence to occur between

	V_1	V_2	Ex_1	Ex_2	S.R.
	3 in	3 out	10	50	10
and,	4 out	3 out	50	10	10

it will not be found to succeed: and a comparison of figs. 1104 and 1297, though it happens that the number of loops is the same in both, will show that they are sufficiently distinct.

The reason, however, of the identity in the values of V_2 in the cases first mentioned is not far to seek. When treating of Part I. singly we saw that there were, in all instances, two ways of describing the same curve, depending upon the substitution of $\frac{1}{n}$ for n in the second value of V. Thus, a simple 7-looped figure could be described by either of the two following methods:—

V.	Ex.	S.R.
7 out	10	50
$\frac{7}{6}$ out	50	10

Now, when V = 2 "out," n, which is in that case = V - 1, becomes = 1: and $\frac{1}{n}$ is therefore also = 1. And the second value for V, which is $= \frac{1}{n} + 1$, becomes also = 2, and is identical with its former value. Consequently, though $V_2 =$ 2 "out" in all the above pairs of values, its second value in every pair, though numerically identical with the first, is really derived from an exchange of $\frac{1}{n}$ for n, as just explained. It is therefore probable that a similar treatment of any other value of V_2 will afford a second value which, in combination with a second value assumed for V_1, changed in direction and increased by unity, should, by the same transposition of eccentricities as before, yield the same result as may have been previously obtained. The second value of V_2, for example, in the pair last suggested should probably be corrected in this manner: The first value of V_2 is 3 "out," therefore $n = V - 1 = 2$, and $\frac{1}{n} = \frac{1}{2}$; and the second value of $V_2 = \frac{1}{n} + 1 = \frac{1}{2} + 1 = \frac{3}{2}$. This would indicate that the same curve should be given by either of the two following sets of adjustments :—

V_1	V_2	Ex_1	Ex_2	S.R.	
3 in	3 out	10	50	10	(*a'*)
4 out	$\frac{3}{2}$ out	50	10	10	

and on examination this proves to be the fact, fig. 1104 being produced in either case.

Similarly, the following adjustments equally produce fig. 1862 :—

V_1	V_2	Ex_1	Ex_2	S.R.	
6 in	3 out	20	40	5	(*b*).
7 out	$\frac{3}{2}$ out	40	20	5	

But, since both V_1 and V_2 may be either "in" or "out," there are four ways in which these quantities may be combined :—

1. V_1 may be "in," and V_2 "out."
2. V_1 ,, "out," ,, V_2 "out."
3. V_1 ,, "in," ,, V_2 "in."
4. V_1 ,, "out," ,, V_2 "in."

And (1), is the combination for which an alternative method has been established, as indicated by the instances classified on page 121, and by the pairs marked (*a*) and (*b*) above.

For (2), the original adjustments may be represented by—

	V_1	V_2	Ex_1	Ex_2	S.R.
Fig. 1672 ...	6 out	3 out	20	40	11 (*c*),

and the second value for V_2 is $\frac{3}{2}$ "out" as before; while the second value for V_1 is by analogy clearly 5 "in." Therefore—

V_1	V_2	Ex_1	Ex_2	S.R.
5 in	$\frac{3}{2}$ out	40	20	11

is the set of adjustments required to make a pair with those last stated.

For (3), keeping the same numerical values for V_1 and V_2, but varying their direction, we may take—

	V_1	V_2	Ex_1	Ex_2	S.R.
Fig. 1870 ...	6 in	3 in	10	50	6......(*d*);

and the second value for V_1 will be 7 "out" as previously. To find the second value for V_2 we have $n = V_2 + 1 = 4$, and the second value of $V_2 = \frac{1}{n} - 1 = \frac{1}{4} - 1 = -\frac{3}{4}$. Therefore the numerical value of V_2 is $\frac{3}{4}$, and the minus sign indicates that the direction is to be changed from "in" to "out," or the other element of the pair is—

V_1	V_2	Ex_1	Ex_2	S.R.
7 out	$\frac{3}{4}$ out	50	10	6.

Lastly, taking for an example of the directions of motion stated in (4), the curve shewn at fig. 1682, whose adjustments are—

V_1	V_2	Ex_1	Ex_2	S.R.
6 out	3 in	20	40	8......(*e*),

we find that the corresponding changes follow those already found for these original values of V_1 and V_2, viz., the second value of V_1 becomes 5 "in," and for the second value of V_2 3 "in" is transformed "reciprocally" as in (3), into $\frac{3}{4}$ "out."

The alternative adjustments for this figure are therefore—

V_1	V_2	Ex_1	Ex_2	S.R.
5 in	$\frac{3}{4}$ out	40	20	8.

And without venturing upon any proof in justification of these equivalent expressions, it may be confidently stated that a similar treatment of all other values of V_1 and V_2 will be uniformly successful; and that every compound curve produced by the two-part Geometric Chuck can be described in two different ways.

But the single Geometric Chuck possesses the same facility; every simple curve, as the reader was recently reminded, being capable of description by two methods, one "direct," the other "reciprocal." It is, therefore, to be expected that the two-part Geometric Chuck, with its two eccentric slides and two trains of wheels, should possess twice the variety of the simple Chuck, or *four* methods, in all, of producing the same curve.

And since the pairs of adjustments quoted above depend on the substitution of $\frac{1}{n}$ for n in the value of V_2, it is reasonable to anticipate that the third and fourth values of V_1 (which remain to be ascertained) should be derived in a similar manner by the substitution of $\frac{1}{n}$ for n in its first and second values, viz., where the direction of motion differs and the numerical value for V_1 "in" is 1 less than for V_1 "out." It is further probable that the third and fourth values of V_2 (which have also to be found) will have some such relation to each other as that which distinguishes the first and second values of V_1.

The most likely curve to afford a clue to the third and fourth values of V_1 and V_2 is the ellipse, which first pointed out the coincidence of results for their first and second values, and the law upon which they depend. Reverting to the adjustment for 20 loops outwards in the periphery of an ellipse, (*a*) page 123, we see that substituting $\frac{1}{n}$ for n, in the first value for V_1 of 9 "in," the *third* value for V_1 would become

$\frac{9}{10}$ "out". Thus, $n = V + 1 = 10$, and $V_1 = \frac{1}{n} - 1, = \frac{1}{10} - 1,$ $= -\frac{9}{10}$, or $\frac{9}{10}$ "out," the direction of motion being changed.

In the same manner, the *fourth* value for V_1 would be derived from its second value of 10 "out", and would become $\frac{10}{9}$ "out". Thus, $n = V - 1 = 9$, and $V_1 = \frac{1}{n} + 1 = \frac{1}{9} + 1$ $= \frac{10}{9}$; the direction of motion remaining the same, viz., "out".

But these presumed values for V_1 could not be tested alone, and for the rest of the problem, the third and fourth values of V_2, there was nothing to indicate a solution; and many fruitless experiments were made until the influence upon V_2 of fractional values for V_1 was observed. This effect, which will be more fully noticed subsequently, is to divide V_2, when division is possible without a remainder, by the denominator of V_1. From this property, (which is here recorded only, without attempt at explanation,) it was inferred, and to all appearance with correctness, that the third and fourth values of V_2 should be such as, when divided by denominators of the third and fourth values respectively of V_1, would each leave a quotient representing the general contour of the original figure, *i.e.*, 2, for the ellipse.

Hence for the 20-looped curve last mentioned, for which two methods of description have been already found, if we suppose the *third* value of V_1 to be $\frac{9}{10}$ out, and the *fourth* value of V_1 to be $\frac{10}{9}$ out, as above conjectured, the corresponding values of V_2 would probably be $10 \times 2 = 20$ for the *third*, and $9 \times 2 = 18$ for the fourth. The directions of motion for these last values of V_2 might be either "in" or "out," and the distribution of the three quantities 10, 25 and 75, among the several eccentricities denoted by Ex_1, Ex_2 and S.R., also remained to be ascertained by experiment.

But this was readily accomplished, and in this particular case the scheme of values now adopted proved to answer perfectly, and the four following sets of adjustments, the first two of which are those marked (*a*) on page 122, were found each to produce the curve in question, 20 loops outwards in the periphery of an ellipse.

V_1	V_2	Ex.	Ex.	S.R.			
9 in	2 out	25	75	10	—	(i)	A.
10 out	2 out	75	25	10	—	(ii)	
$\frac{9}{10}$ out	20 out	10	75	25	—	(iii)	
$\frac{10}{9}$ out	18 in.	10	25	75	—	(iv)	

In applying this theory of constructing four equivalent sets of adjustments for any compound curve, to other values of V_1 and V_2, it is to be borne in mind that the value 2 of V_2 in the set marked (ii) has not the same origin as the same figure 2 in the set marked (i): the distinction between the two has been already drawn.

To complete the series (*b*) on page 123 we have, for the *third* value of V_1, $\frac{6}{7}$ "out", obtained reciprocally from the first value; and, for the *third* value of V_2, 7 "out" × 3, or 21 "out". And the order of eccentricities, following the example in A, stands 5, 40, 20. Similarly, for the *fourth* value of V_1 we should have $\frac{7}{6}$ "out", obtained reciprocally from the second value; and, for the *fourth* value of V_2, 6 "in" × $\frac{3}{2}$ ($\frac{3}{2}$ being the second value of V_2) or 9 "in". And the eccentricities, following the corresponding example in A, take the order 5, 20, 40.

In the next series, of which the first term is marked (*c*) on page 124, V_2 retains the same direction as in the last; but V_1 is changed, V_1 and V_2 being now both "out", and the second value of V_1 being 1 less than that of the first, instead of 1 more as in (*b*). The *third* value of V_1 is, nevertheless, as before, a fraction with the first value of V_1 for numerator, and the second value for denominator, *i.e.*, $\frac{6}{5}$; and the *fourth* value of V_1, also as before, consists of its third value inverted, or $\frac{5}{6}$. The *third* value of V_2 becomes 5 "in" × 3, or 15 "in"; and the *fourth* value of V_2 is 6 "out" × $\frac{3}{2}$, or 9 "out". The eccentricities are transposed, as in the completed series (*b*).

For the series of which the first term is (*d*), page 124, the *third* and *fourth* values of V_1 will be identical with the same values of V_1 in the series (*b*); so will the third value of V_2, but with a change of direction, for since the first value of V_2 is 3 "in", the *third* value becomes 21 "in". Then for the *fourth* value of V_2, the denominator of the fourth value of V_1 with its original direction, "in", as expressed in the first value of V_1 multiplied by the second numerical value of V_2, *i.e.*, 6 "in" × $\frac{3}{4}$, gives $\frac{9}{2}$ "in."

For the remaining combination of V_1 "out" V_2 "in", series (*e*), page 124, the *third and fourth* values of V_1 will be the same as those in the series (*c*). The *third* value of V_2 will be 3 "in" × 5 "in", and it proves necessary on trial that this product should be 15 "out", not 15 "in". The *fourth* value of V_2 is 6 "out" × $\frac{3}{4} = \frac{9}{2}$ "out."

The four completed series assume the following form; each of the four sets of adjustments, bracketed to the same letter of reference and fig., yields the same curve precisely. But they are by no means equally eligible practically, those cases where V is less than 1 being always unfavourable to the mechanism of the chuck, and only admissible exceptionally by way of experiment.

V_1	V_2	Ex_1	Ex_2	S.R.		V_1	V_2	Ex_1	Ex_2	S.R.	
6 in	3 out	20	40	5		6 out	3 out	20	40	11	
7 out	$\frac{3}{2}$ out	40	20	5	B Fig. 1862	5 in	$\frac{3}{2}$ out	40	20	11	C Fig. 1672
$\frac{6}{7}$ out	21 out	5	40	20		$\frac{6}{5}$ out	15 in	11	40	20	
$\frac{7}{6}$ out	9 in	5	20	40		$\frac{5}{6}$ out	9 out	11	20	40	
6 in	3 in	10	50	6		6 out	3 in	20	40	8	
7 out	$\frac{3}{4}$ out	50	10	6	D Fig. 1870	5 in	$\frac{3}{4}$ out	40	20	8	E Fig. 1682
$\frac{6}{7}$ out	21 in	6	50	10		$\frac{6}{5}$ out	15 out	8	40	20	
$\frac{7}{6}$ out	$\frac{9}{2}$ in	6	10	50		$\frac{5}{6}$ out	$\frac{9}{2}$ out	8	20	40	

There is a little uncertainty in this investigation as to the *directions* to be assigned to the third and fourth values of V_2, but the rule appears to be that when like directions are multiplied, the product is to be considered "out," and when the directions are unlike, their product is to be considered "in." Thus: 7 out × 3 out = 21 out; 6 in × $\frac{3}{2}$ out = 9 in; 7 out × 3 in = 21 in; and 5 in × 3 in = 15 out. And further, it seems that in each column of values, for both V_1 and V_2, there are three which are "out" and only one that is "in," or *vice versâ*. A connection between the last two values and the first two can also be expressed thus:—the 3rd value of V_1 is the 1st divided by the 2nd; and the 4th value of V_1 is the 3rd value inverted: the 3rd value of V_2 is the 1st of V_2 multiplied by the 2nd of V_1; and the 4th value of V_2 is the 2nd of V_2 multiplied by the 1st of V_1.

The following table of general algebraical expressions will indicate by inspection the three methods by which, besides that belonging to the curve as first described, the same curve may be produced:—

1	2	3	4	5	6	7	8	9
V_1 in	V_2 out	V_2 in	Ex_1	Ex_2	S.R.	V_1 out	V_2 out	V_2 in
r in	s out	s in	a	b	c	r out	s out	s in
$(r+1)$ out	$\frac{s}{s-1}$ out	$\frac{s}{s+1}$ out	b	a	c	$(r-1)$ in	$\frac{s}{s-1}$ out	$\frac{s}{s+1}$ out
$\frac{r}{r+1}$ out	$s(r+1)$ out	$s(r+1)$ in	c	b	a	$\frac{r}{r-1}$ out	$\frac{s}{(r-1)}$ in	$\frac{s}{(r-1)}$ out
$\frac{r+1}{r}$ out	$\frac{rs}{s-1}$ in	$\frac{rs}{s+1}$ in	c	a	b	$\frac{r-1}{r}$ out	$\frac{rs}{s-1}$ out	$\frac{rs}{+1s}$ out

Let r and s denote the numerical values of V_1 and V_2, respectively, whether integral or fractional. Let the directions of motion in each "Part" be denoted as hitherto by the words "in" or "out" appended to the values of V_1 and V_2; where "in" signifies that the number of arbors in the train of each

Part is *odd*, and "out" that they are *even*; those being the conditions which, in simple geometric turning, and under ordinary circumstances, determine the direction of the individual loops, inwards or outwards.

If V_1 be "in" for a given curve, the whole four values of V_1 will be found in column 1 of the above table; and the corresponding values for V_2 will appear either in columns 2 or 3, according as V_2 is "out" or "in."

If V_1 be "out," its successive values are to be taken from column 7, and the corresponding values of V_2 from columns 8 or 9, as the case may be, according as V_2 is "out" or "in."

And whether V_1 and V_2 be "in" or "out" in the first instance, the quantities *a*, *b*, and *c*, which represent the values of the eccentricities of the slides of Parts I. and II. and of the Slide Rest, placed in that order to begin with, will require to be transposed for each of the three other equivalent sets of adjustments in the manner shown in columns 4, 5 and 6.

This theoretical statement has been arrived at by induction only, from comparison of numerous observations, based upon the principles above described. It may seem hazardous to assume the truth of the rules now given upon these grounds only; but they have been proved to hold for all successive values, whether of V_1 or V_2, which have been tried, as well as for all promiscuous values arbitrarily selected, whether integral or fractional; and there seems no reason to apprehend the failure of the theory in any instance.

The four sets of equivalent adjustments have been sufficiently exemplified in the case of integral values of V_1 and V_2 by those marked A to E in the preceding pages. As an instance of fractional values the following may be interesting; any one of these four methods will produce the figure 2585:—

V_1	V_2	Ex_1	Ex_2	S.R.
$\frac{5}{2}$ out	$\frac{8}{5}$ out	40	20	12
$\frac{3}{2}$ in	$\frac{8}{3}$ out	20	40	12
$\frac{5}{3}$ out	$\frac{12}{5}$ in	12	20	40
$\frac{3}{5}$ out	$\frac{20}{3}$ out	12	40	20;

and the same treatment may be applied to any other two-part curve by proper substitution in the general expressions tabulated on page 129.

On the whole, the various conditions which apply to the complete adjustments of the two-part Geometric Chuck appear to be these, so far as one continuous curve only is concerned :—

1. V_1 and V_2 may be of moderate amount, say not exceeding 10, and equal in value or nearly so*. Values below unity are not taken into account.

2. V_1 may be considerably greater than V_2, say 15 times or more.

3. V_2 may be considerably greater than V_1, say 15 times or more.

4. V_1 and V_2 may both be integral.

5. " " fractional.

6. V_1 may be integral and V_2 fractional.

7. V_2 " " V_1 "

8. The denominator of V_1 when fractional, may be prime or otherwise to V_2 when V_2 is integral, and to the numerator of V_2 when V_2 is fractional.

9. V_1 and V_2 may be both "out."

10. " " "in."

11. V_1 may be "out," and V_2 "in."

12. V_2 " " V_1 "

13. Ex_1 may be equal to Ex_2 or nearly so.

14. Ex_1 may be decidedly greater than Ex_2.

15. Ex_2 " " Ex_1.

16. The first motion wheel of Part I. may be clamped in one of the two symmetrical positions, or at some intermediate point producing an irregular curve.

17. S.R. may have any value whatever, though seldom exceeding 20 hundredths of an inch ; so also may V_1 and V_2 within the limits of the change wheels provided, and Ex_1 and Ex_2 within the limits of their slides.

And these conditions are taken in combination. Thus, No.

* The value of V_1 or V_2 when fractional may be of moderate amount, though consisting of high numbers, as $\frac{80}{27}$, $\frac{95}{13}$, &c

1 will be associated with one of those numbered 4 to 7 (No. 8 applying specially to 5 and 7), and each of these pairs with Nos. 9, 10, 11, or 12. Again to each of these sets of three Nos. 13, 14, or 15 will apply; and lastly, specific values, in harmony with the conditions agreed upon, have to be assigned to the five several quantities.

As regards No. 1, all its accompanying combinations have been sufficiently displayed. No. 2 scarcely requires examples in addition to figs. 215 and 216; but figs. 3392—3395 are of the same class. No. 3 is illustrated by 3398, 3409, and 3425, as regards integral values of V_1 and V_2; and fractional values for both, of considerable difference in intrinsic amount, will receive further attention in the next chapter. High numbers, whose virtual effect is not reduced by the fact of V_2 being a multiple of the denominator of V_1, give too crowded results. Low integral values, however, for V_1, and fractional values between 1 and 2 for V_2, give very singular curves. No. 16 may, perhaps, repay further investigation, and some of the irregular phases due to a purposely incorrect adjustment of the first motion wheel of Part I., of which fig. 217 is an instance, could possibly be combined with ornamental effect.

But the beauty of geometric turning, treated as an engraving process, depends chiefly upon the happy association of various curves. From all that precedes, the amateur will not have much difficulty in recognizing the conditions necessary to produce a single curve of any given character; it only remains therefore to ascertain how repetitions of any curve, with some slight variation, may be used to complete a design. Now, as long as the change wheels are unaltered, there are evidently five different ways of varying the curve :—

(i.) By changing the quantity spoken of as S.R., *i.e.*, the distance of the describing point from the axis of the mandrel.

(ii.) By changing the point of clamp contact of the first motion wheel of Part I.—and this may be briefly denoted by $F.M_1$.

(iii.) By changing the point of clamp contact of the first motion wheel of Part II.—which may be called $F.M_2$.

(iv.) By changing the eccentricity of the rectilinear slide of Part I. or Ex_1.

(v.) By changing the eccentricity of the rectilinear slide of Part II. or Ex_2.

And it would be practicable to take two or more of these variations together, such as varying all three of the quantities Ex_1, Ex_2, and S.R. simultaneously and preserving the proportion which previously existed between them, in order to produce a given curve on a larger or smaller scale; or moving $F.M_1$ forwards while $F.M_2$ is moved backwards; or adopting any other combinations of the five adjustments. But for the present purpose it will be sufficient to trace the effect of each change, separately, upon the same curve. Any figure, not too complicated, would answer this end; the one selected is $V_1 = \frac{5}{2}$ "out" $V_2 = 7$ "out," whose outline is not unlike that of fig. 2473, with 7 members instead of 3.

Fig. 3448 shows the effect of change (i.); the adjustments were $Ex_1 = 30$, $Ex_2 = 70$, and S.R. varied by intervals of 2½ from 7 to 19½; six curves in all, the chuck remaining entirely unaltered.

Fig. 3449 shows the effect of change (ii.); and it will be at once observed how pleasingly the curves are varied and combined by this simple alteration; the adjustments were $Ex_1 = 30$, $Ex_2 = 70$, S.R. = 12; and there are only five curves. The first was described with a careful adjustment of $F.M_1$ for symmetry of position; and then two equally distant positions, each producing discordant curves, regarded singly, were taken on $F.M_1$ on either side of that at which the first curve was described. In this case these positions were six teeth apart, or the sixteenth part of the circumference of $F.M_1$.

Fig. 3450 shows the effect of change (iii.); the adjustments were $Ex_1 = 30$, $Ex_2 = 70$, S.R. = 20; and $F.M_2$ was moved six teeth between each of the four curves. An alteration of $F.M_2$ makes no corresponding alteration in the curve; it merely causes the same curve to be repeated in what may be termed another axial position. There is, therefore, no necessity to select one point of clamp contact for $F.M_2$ more than another, except as regards the arrangement of the design with reference to some other upon the same surface.

On proceeding to examine the effect of the two remaining changes (iv.) and (v.); it appears that in both cases the association of curves is no longer symmetrical as a whole. This has been proved in a former part of this work to be an inevitable accompaniment of any alteration in Ex_1, and allusion has also been made to the similar disturbance introduced by any alteration of Ex_2. A system of compensation is, therefore, required in each case; first, to maintain the symmetry, or correct outline, of each individual curve, notwithstanding an alteration of Ex_1; and secondly, to maintain the same axial position for all the curves, notwithstanding an alteration of Ex_2. The former of these two kinds of compensation has been provided for experimentally, by practically ascertaining the amount which would be necessary, for $V_1 = 1$, at any part of that eccentric slide. The method is described, and the corrections tabulated, on page 36; and the same course has proved successful in determining a system of compensation for any alteration of Ex_2.

The procedure detailed with some minuteness at page 35, for Part I., was repeated for Part II., and an average of several observations enabled the following Table to be constructed:—

Ex_2 slide moved from	Correction when $V_2 = 1$.	Ex^2 slide moved from	Correction when $V_2 = 1$.
0 to 10	0·40	80 to 90	0·73
10 — 20	0·43	90 — 100	0·77
20 — 30	0·47	100 — 110	0·81
30 — 40	0·51	110 — 120	0·86
40 — 50	0·56	120 — 130	0·90
50 — 60	0·60	130 — 140	0·95
60 — 70	0·64	140 — 150	0·99
70 — 80	0.68	150 — 160	1·04

From the smaller size of Part II., the range of its eccentric slide is not so extended as that of Part I.; while for the same reason, the disturbance, and consequently the correction, is greater, for the same intervals of eccentricity in Part II., than in Part I.

This table is used in the same manner as its predecessor; the amount of correction is taken out, by interpolation if necessary, to correspond with the increase or diminution of eccentricity which the slide of Part II. is to receive; that amount is multiplied by the value of V_2 for the time being, and the first motion wheel of Part II. ($F.M_2$) is released, and reclamped at the distance thus indicated—being moved backwards if V_2 is "out," forwards if V_2 is "in." But here a serious disadvantage exists as compared with the facility for expressing at $F.M_1$ any required distance. This distance is given in both tables in decimals of a tooth; and the calculated distance for any required increase of Ex_1 or Ex_2 is pretty certain to include parts of a tooth, as well as a whole number of teeth, of $F.M_1$ or $F.M_2$. At $F.M_1$ the vernier adjustment of the detent plate is all that could be wished for, moving any distance accurately, to the tenth part of a tooth or even less. But $F.M_2$ has no vernier or other contrivance to fulfil the same office, and can only, therefore, be moved for one or more teeth as a whole number, the accompanying decimal being, perforce, neglected. Some provision of this kind could, no doubt, be made, but even in its absence, very satisfactory correction can be achieved; especially if some care be taken to select such an interval on the eccentric slide (where a less quantity than ·01 inch can be estimated very fairly), as will require very nearly a whole number of teeth in correction at $F.M_2$. And the greater is the value of V_2, the more easily may this be managed.

As a tolerably severe test of the system of correction for any alteration in Ex_2, it was applied in the following manner to the description of a series of squares, one inside another, with their adjacent sides strictly parallel. If no such correction were applied, it is hardly necessary to point out that the squares, as they increased in size, would increasingly differ from positions parallel to that first described, and would intersect each other instead of being ranged truly side by side. Fig. 3451 shows the result of the experiment; V_2 was, of course, 4 "out" for the whole series. S.R. also remained undisturbed at 7; V_1 was increased somewhat in proportion to the lengths of the sides of the successive squares, and Ex_1, Ex_2, were always in the proper ratio for producing a rectilinear figure, as fully explained when treating of Part I.:—

V_1.	Ex_1.	Ex_2.	Tabular Correction.		Teeth moved at $F.M_2$.
			$V_2 = 1$.	$V_2 = 4$.	
14	1	9	...	...	...
22	3	27	0·799	3·196	3
30	5	45	0·931	3·724	4
38	7	63	1·072	4·288	4
46	9	81	1·201	4·804	5
54	11	99	1·360	5·440	5
62	13	117	1·489	5·956	6
70	15	135	1·633	6·532	7
78	17	153	1·777	7·108	7

The addition of the last column is 41 teeth, and of the last but one 41·048; shewing that the distance is correct in the aggregate, though its successive increments could not be expressed so accurately as might be desired. The innermost square is the least satisfactory, doubtless owing to the point of the tool not being rigidly adjusted for height of centre, an error whose effect is always greatest at the centre of the work. No correction was made at $F.M_1$ for the small alterations in Ex_1. For, it will be remembered that a change in Ex_1 affects the curve individually; and in the curves here used, the loops are so numerous and similar, and their intersections so frequent, that their individual symmetry is hardly disturbed.

To recapitulate briefly,—an alteration in Ex_1 disturbs the symmetry of the curve, and requires a correction at $F.M_1$. And an alteration in Ex_2 changes the axial position of the curve, and requires a correction at $F.M_2$. A system of compensation has now been described for each of these two alterations, and we can therefore proceed to examine the effects of the changes (iv.) and (v.) stated on page 133.

Fig. 3452 shews the effect of change (iv.):—Ex_2 was 70 and S.R. 7; Ex_1 was moved from 30 to 40 by intervals of 2½;

there are five curves in all. The tabulated correction corresponding to that interval, at the part of the slide specified, and multiplied by the value of V_1 is 0·315; and that amount of compensation was made at F.M_1 between each of the curves.

Fig. 3453 shews the effect of change (v.):—Ex_1 was 30, and S.R. 7; Ex_2 was moved from 55 to 67½ by intervals of 2½; there are six curves in all. The tabulated correction corresponding to that interval at the part of the slide specified, and multiplied by the value of V_2, is 1·085; and a correction of one tooth at F.M_2 was made between each of the curves.

Any curve whatever, produced by the two-part Geometric Chuck, may be repeated with one or more of these variations, not omitting to apply the proper compensation at F.M_1 or F.M_2 whenever Ex_1 or Ex_2 undergoes an alteration. But the most remarkable change is that marked (ii.) above; for if new clamping positions be selected *in pairs*, at equal distances from that point at which the curve has been found to be the most symmetrical, the addition of such pairs of unsymmetrical curves will form a perfectly regular design. And although one illustration only, fig. 3449, has been offered of the result of this variation, it is strongly commended to the attention of the amateur; for it is at once the most simple, and the most fertile in ornamental effect, of all adjustments of the Chuck. When the whole circumference of F.M_1 is passed round, and clamped at equal intervals, the entire figure presents a complete or filled-up appearance, as distinguished from the partial or scattered aspect produced by the addition of two or more pairs only. Fig. 3454 is constructed in this way, being a repetition on a larger scale, and with slightly different eccentricities, of fig. 2518—though it is, perhaps, doubtful if any amateur, unless more credulous than mechanicians usually are, will accept that statement without putting it to the test of experiment.

Very frequently a figure may consist of a single but complicated curve, whose entanglements are sufficient to create a pleasing and complete design without further assistance. But when this is not fully satisfactory, and it is desired to arrange a complicated pattern consisting of several members, it will much facilitate their correct distribution to reduce the Chuck, after every alteration in either train of change wheels, to its initial position of parallelism of the eccentric slides while their verniers are at zero; and then to apply the proper compensation at $F.M_1$ and $F.M_2$ for the amounts of eccentricity imparted to Ex_1 and Ex_2 respectively.

The execution of diagrams by pen and lithographic ink, which answered very fairly for the simpler curves, did not prove satisfactory when the figures became more complicated, as the process of illustration advanced. The method was therefore abandoned, from fig. 3435 onwards, in favour of the more reliable system of wood engraving.

CHAPTER V.

Further consideration of related fractional values.

THE general aspect or characteristic feature of any compound curve obtained by the two-part Geometric Chuck is determined almost altogether by the value of the train of wheels on Part II., for which the symbol V_2 has been adopted. Thus, if $V_2 = 2$ "out," the resulting figure, whatever be the value of the train on Part I., *i.e.*, V_1, will be one whose external boundary is more or less elliptical. Similarly, if $V_2 = 6$ "in," the completed figure will generally have six internal loops, of greater or less solidity, according as the greater or less value of V_1 may yield a greater or less number of intersecting lines. And, when V_2 is fractional, it appears that the general aspect of the compound curve is mostly defined by the numerator of that fraction. Thus, when $V_2 = \frac{5}{2}$ or $\frac{8}{5}$, of which various examples occur in the series which has been illustrated in the preceding pages, the figures possess for the most part 5 or 8 decided loops respectively, in or out, as the other conditions may decide, and more or less filled up with intersecting lines, according to the higher or lower value of V_1.

But this rule only holds good so long as V_1 is integral, and so long as the denominator of V_1, when fractional, possesses no factor in common with V_2 when integral, or with the numerator of V_2 when fractional. When the case is otherwise, that is to say, when there is some factor common to both the denominator of V_1 and the numerator of V_2, the general aspect of the figure no longer corresponds to the integral value, or to the numerator of a fractional value, of V_2. In that event, the course of the curve is always shortened and simplified, and very frequently the number of characteristic loops it would otherwise possess appears to be reduced by the division which can take place (in the ordinary manner of "cancelling" fractions) between the denominator of V_1 and the numerator of V_2. It is not to be inferred, however, that the privilege of "cancelling," as in ordinary multiplication of fractions, can be extended to the numerator of V_1 with the denominator of V_2. There is no material difference, for example, between the equally crowded figures described with $V_1 = \frac{22}{3}$, $V_2 = \frac{25}{11}$, and those with $V_1 = \frac{23}{3}$, $V_2 = \frac{25}{11}$, although, in the former conditions of adjustment, the numerator of V_1 is divisible exactly by the denominator of V_2, and in the latter it is not.

The first instance which occurs in the series is when $V_1 = \frac{5}{2}$ out, and $V_2 = 2$ out, and 2 in. The figures are manifestly more simple than would have been expected from previous results, and, without showing any decided tendency to the cardioid, are altogether different from figures which would be given by $V_1 = \frac{5}{3}$, $V_2 = 2$, between which values no such relation exists. Next, it will be observed that with the same value of $\frac{5}{2}$, whether "in" or "out," for V_1, and 4 for V_2, some of the figures possess two principal compartments, and others give indications of the ellipse. Similarly, when $V_2 = 6$, a three-looped or triangular character is visible; and when $V_2 = \frac{8}{5}$ and $\frac{10}{3}$, four-sided and five-sided figures respectively are apparent.

Effects of the same nature are observable for these values of V_2 when $V_1 = \frac{7}{2}$; and both sets of figures, arising under these conditions, are altogether distinct from those which have been traced with like values for V_2 but with $V_1 = \frac{8}{5}$.

Again, when $V_1 = \frac{8}{5}$, the course of the curve is perceptibly changed by the values $\frac{5}{2}$, and $\frac{10}{3}$ (whose numerators are divisible by 5, the denominator of V_1) being used for V_2; many of the figures being unusually curious, and offering no clue to their origin. And when $V_1 = \frac{10}{3}$, the curves are condensed in the same manner when $V_2 = 3$, 6, or 9; their general aspect being reduced to 1, 2, or 3 compartments respectively, in accordance with this law of division which appears to regulate their features.

A more decided illustration of this principle is offered in fig. 3400, where $V_1 = \frac{35}{18}$ out, and $V_2 = 54$. V_2 is here precisely three times the denominator of V_1, and the figure has three very decided compound loops. So in fig. 3404, V_2 is equal to twice the denominator of V_1, and the general aspect is that of a two-looped figure. These figures are composed of what appears to be the ellipse in circulation, the reason evidently being that their values for V_1 are very nearly equal to 2 "out." And in selecting fractional values for V_1, to produce figures of this class, the amateur will be guided by the proportions of the elementary figure from the repetition of which in certain sequence it is proposed to build up, as it were, the complete design. If the ellipse is to be employed for this purpose, and this is the most effective, the numerator of the fractional value for V_1 will be a little less or a little greater than twice its denominator. If the approximate triangle or square, or some other form of the 3 or 4 looped figure, be proposed for this process of repetition, the numerator of V_1 will have to be about three times, or four times, as the case may be, greater than its denominator. And, for the most part, V_1 will give better results when "out" than when "in," though fig. 3433 shows that experiments with "in" values may be sometimes interesting.

Further investigation brings to light another element upon which, when the denominator of V_1 and the numerator of V_2 are divisible by the same factor, the general aspect of the curve depends. And that is, the amount by which the numerator of V_1 differs from some multiple of its denominator. When that difference is unity, the characteristic outline of the complete figure is simply that indicated by V_2, after its division by the highest number which is found to be a common factor of the denominator of V_1 and the numerator of V_2. Thus in fig. 3400, whose adjustments have been stated above, the numerator of V_1 is twice its denominator, *minus one;* and the characteristic outline of the figure is *once* the quotient (3) obtained from the division of 54, this numerator of V_2, by 18, the denominator of V_1. But in fig. 3406, though V_2 is only *twice* the denominator of V_1, there are *four* principal loops or compartments instead of two: the reason being that here the numerator of V_1 is twice its denominator, *minus two;* and the characteristic outline of the figure is *twice* the quotient (2) obtained from the division of 54, the numerator of V_2, by 27, the denominator of V_1. And again, in fig. 3414, the numerator of V_1 is three times its denominator, *minus two;* and the characteristic outline of the figure is *twice* the quotient (3) obtained from the division of 33, the numerator of V_2, by 11, the denominator of V_1. And it will be found that when the numerator of a fractional value for V_1 differs from some multiple of its denominator by any other number than 1, then the general aspect of the figure is represented by that number of difference multiplied into the reduced value of V_2, as obtained from the division of its numerator by the denominator of V_1.

This principle may be stated in general language as follows: Let P denote any number which is to be taken for the denominator of a fractional value of V_1, and let the numerator of V_1 be $m\,P \pm r$, where m is any integer (seldom exceeding 6 with advantage) and r is the least difference between one multiple of P and the next [*e.g.*, if $V_1 = \frac{23}{7}$, it is to be expressed as $\frac{3\,P + 2}{P}$, not as $\frac{4\,P - 5}{P}$]. Lastly, let an integral value, equal to $n\,P$, be taken for V_2. Then the general aspect of the figure, that is, its number of compartments or groups of intersections, will be represented by $n\,r$.

A further peculiarity will be noticed, viz., that when r is positive, V_2 being "in," the general aspect of the figures is one of external loops, and one of internal loops when r is negative; and *vice versâ* when V_2 is "out." For instance, in fig. 3400, where $r = -1$, and $n = 3$, there are 3 distinct loops *inwards*; and fig. 3401, where $r = +1$ and $n = 3$, is of the triangular character given by adjustments for 3 loops *outwards*. Figs. 3405 and 3406 are a similar pair, but as it happens, fig. 3405 was described with V_2 "out," V_1 being the same both as to value and direction for both figs.; while in fig. 3406, V_2, having the same value as before, was "in"; and the result proves to be almost, though not quite, identical with that obtained with $V_1 = \frac{56}{27}$ "out," $V_2 = 54$ "in." In the same way figure 3410 proved to be equally attainable as to general aspect with $V_1 = \frac{44}{15}$ "out," $V_2 = 30$ "in"; and with $V_1 = \frac{46}{15}$ "out," $V_2 = 30$ "out"; the latter figure being rather the more closely filled of the two. So fig. 3411 could be described either with $V_1 = \frac{44}{15}$ "out," $V_2 = 30$ "out," or with $V_1 = \frac{46}{15}$ "out," $V_2 = 30$ "in." And, in like manner, it will be always found that whether we take for the numerator of V_1, $mP - r$, with V_2 "in," or $mP + r$, with V_2 "out," the results will be exceedingly similar.

And this gives a convenient choice in the selection of wheels, a desired figure being probably attainable by one method, if not by the other. Thus, if $P = 26$, and the fractional value for V_1 be intended to be $\frac{2P+1}{P}$ or $\frac{53}{26}$, it may be more convenient, in the absence of a 53 wheel, to use the other form of $\frac{2P-1}{P}$, or $\frac{51}{26}$, whose numerator is not, like 53, a prime number, changing the direction of V_2 accordingly.

But when V_2 is fractional ($= \frac{nP}{s}$, suppose, instead of nP), a further exception may arise; for when the difference r, which occurs in the numerator of V_1, can be divided by s, the general outline of the figure is "circulating," and contains $\frac{nr}{s}$, instead of nr, loops; and the describing point travels s times round the surface before the curve is completed. For example, take $V_1 = \frac{64}{33}$, $V_2 = \frac{99}{2}$ [*i.e.*, $V_1 = \frac{2P-2}{P}$, $V_2 = \frac{3P}{2}$, where $P = 33$:] then, in accordance with the statement just made, the general aspect of the figure will be $\frac{nr}{s} = \frac{3 \times 2}{2} = 3$; and accordingly we find a three-looped figure (internal, r being negative), and the pen or cutting tool goes s times, *i.e.*, twice, round the figure in describing it. Again, when $V_1 = \frac{77}{40} = \frac{2P-3}{P}$, and $V_2 = \frac{160}{3}$

$= \frac{4\,P}{3}$, P being = 40, (centre portion of fig. 3445), the general aspect of the figure $= \frac{n\,r}{s} = \frac{4 \times 3}{3} = 4$, and the describing point goes three times ($s = 3$) round the surface before the figure is completed. Strictly speaking, it should be said that the surface travels s times round the describing point; as is the fact, for the point is fixed and the surface is in motion. Another instance is found in fig. 3444.

Now in these last two examples, it so happens that $r = s$, and the compound loops, though described by a repetition of the course of the point s times, almost in the same path, are consecutive; this approximate retracing of the curve serving only to fill up the loops more closely. But when r and s have no common factor (in the general formula $V_1 = \frac{m\,P \pm r}{P}$, $V_2 = \frac{n\,P}{s}$), the loops are nr in number, external, if r be positive, internal, if r be negative; and when each loop is once commenced it is completed, without subsequent addition of other portions of the curve, before it is left for another. But the loops are circulating, not consecutive; the describing point going s times round the surface before the figure is completed, though making fresh loops on each occasion. In illustration of this, if we have $V_1 = \frac{2\,P + 4}{P}$, $V_2 = \frac{4\,P}{3}$, whatever P may be, there will be 16 loops *outwards*, described at thrice; and if the numerator of V_1 be $2\,P - 4$, other values remaining the same, there will be 16 loops *inwards*, also described at thrice. See fig. 3446 for an example of both these cases. P being 35 in the first, and 55 in the second; also figs. 3434 and 3435. And the principle still applies, although the denominator of V_1 and the numerator of V_2 are only divisible by some common factor, instead of the latter being a complete multiple of the former. Thus, in fig. 3447 these two quantities can be both divided by 11, and the resulting quotient 7, for the numerator of V_2, decides the general aspect of the figure, which is circulating and obtained by repetition.

For experiments on this relation between V_2 and the denominator of V_1, the one-looped figure will be as useful as any. Fig. 3436 was described with $V_1 = \frac{2P+1}{P}$ with $V_2 = P$ "in," and the curve is hardly distinguishable from that given by $V_1 = \frac{112}{55} = \frac{2P+2}{P}$ with $V_2 = \frac{55}{2} = \frac{P}{2}$. There is rather more difference when $V_1 = \frac{108}{55} = \frac{2P-2}{P}$ with $V_2 = \frac{55}{2}$ "out" $= \frac{P}{2}$ "out;" more than would be found from $V_1 = \frac{109}{55} = \frac{2P-1}{P}$, with $V_2 = 55$ "out" $= P$ "out," if that fractional value for V_1 could be expressed by the change wheels provided, which is not the case. But the general effect produced by figures of this class can be obtained with almost equal advantage by any of these four sets of adjustments which follow:—

V_1		V_2
$\frac{mP-1}{P}$ "out",	taken with	nP "in"
$\frac{mP-2}{P}$ "	" "	$\frac{nP}{2}$ "
$\frac{mP+1}{P}$ "	" "	nP "out"
$\frac{mP+2}{P}$ "	" "	$\frac{nP}{2}$ "

thus fig. 3412 might be obtained very approximately by either of the following sets of values:—

V_1		V_2
$\frac{3P-1}{P} = \frac{32}{11}$ "out",	with	$3P$ "in" $= 33$ "in"
$\frac{3P-2}{P} = \frac{31}{11}$ "	"	$\frac{3P}{2}$ " $= \frac{33}{2}$ "
$\frac{3P+1}{P} = \frac{34}{11}$ "	"	$3P$ "out" $= 33$ "out"
$\frac{3P+2}{P} = \frac{35}{11}$ "	"	$\frac{3P}{2}$ " $= \frac{33}{2}$ "

and, especially in dealing with high numbers, this choice of arrangement will often enable the amateur to avoid prime numbers, and to select those whose factors can conveniently be represented by the proper change wheels.

Of course these comparatively equivalent methods have nothing in common with those stated at page 130, by which the same identical curve can be described in four different ways. The formulæ there given remain in force for the curves of the class now being examined, as well as apparently for all others. Fig. 3417, for instance, may be equally described by any of the four following sets of adjustments; of which the first was the one employed, and is the most eligible; the other three being determined by the formulæ in question.

V_1	V_2	Ex_1	Ex_2	S.R.
$\frac{20}{7}$ out	28 out	20	40	5
$\frac{13}{7}$ in	$\frac{28}{27}$ out	40	20	5
$\frac{20}{13}$ out	52 in	5	40	20
$\frac{13}{20}$ out	$\frac{80}{27}$ out	5	20	40

The second of these sets indicates a method of obtaining unusually high numbers on Part II., subject to the condition that both the numbers selected, and also that number increased or diminished by 1, can be resolved into appropriate factors. Thus: let $V_1 = \frac{25}{13}$ out, $V_2 = 221$ in; V_2 being 17 times the denominator of V_1. And if it were possible to give so great a value to V_2, we should obtain, with about $Ex_1 = 12$, $Ex_2 = 80$, S.R. $= 10$, seventeen fan-like groups placed in the circumference of a circle. But with the help of the formulæ referred to, the same figure could be described as follows:—

V_1	V_2	Ex_1	Ex_2	S.R.
$\frac{12}{13}$ in	$\frac{221}{222}$ out	80	12	10;

and the change wheels for this fractional value of V_2 would be $\frac{221}{444} = \frac{13 \times 17}{37 \times 12} = \frac{34}{37} \times \frac{26}{48}$. At the same time, such an arrangement, consisting of values nearly equal to unity for both V_1 and V_2, would place more strain upon the chuck than it can be fairly expected to bear, unless the driving power were applied in front.

Figs. 3438 and 9 give the one-looped figure described at twice; $V_2 = \frac{P}{2}$ for both directions of motion; and figs. 3440 and 3441 show the effect of a ratio nearly equal to 3 : 1, applied to the same figure, showing the triangle in circulation instead of the ellipse. Figs. 3401, 2, 3, and 5, exhibit the external forms of the compound 2, 3, and 4 looped figures, and it will be observed that 3405 is described by the formula $V_1 = \frac{2P-2}{P}$ with $V_2 = 2P$; instead of by $V_1 = \frac{2P-1}{P}$ with $V_2 = 4P$. Examples of the repetition of the three-looped figure, yielding compound loops of various numbers, follow at fig. 3409 and subsequently; fig. 3424 being an interesting development of a blank square by a continuous curve consisting of a succession of three cusps inwards. Figs. 3425 and 3426 are the two symmetrical positions, obtained by clamping the first motion wheel of Part I. at opposite points, of a curve described with a high value for V_2, and four loops outwards for V_1. The square in circulation affords some singular results, and adapts itself to the production of these compound loops as easily as the triangle and the ellipse. Figs. 3429, 3431, and 3432 are composed in this way, and have the general aspect of 2, 3, and 4 loops respectively: figs. 3442 and 3443 are of the same class, each consisting of a square of squares; but fig. 3442 is hardly as symmetrical as it might be made by a closer attention to the strict parallelism of the eccentric slides. Figs. 3444 and 5 are rather more intricate, and have been referred to already. They are derived from fractional values of higher numbers, and show how varied and extensive is the application of the principle of relationship between V_2 and the denominator of a fractional value for V_1.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	Relation between V_1 and V_2.	
$\frac{35}{18}$ out	54 in	15	47	14	3400	$2\frac{P-1}{P}$ out*	3 P in
$\frac{37}{18}$ out	,,	10	55	10	3401	$2\frac{P+1}{P}$,,	,, ,,
$\frac{55}{27}$ out	,,	14	50	6	3402	$2\frac{P+1}{P}$,,	2 P ,,
,,	,,	33	27	11	3403	,, ,,	,, ,,
$\frac{55}{28}$ out	56 in	20	45	15	3404	$2\frac{P-1}{P}$,,	,, ,,
$\frac{52}{27}$ out	54 out	9	55	14	3405	$2\frac{P-2}{P}$,,	,, out
,,	54 in	15	50	18	3406	,, ,,	,, in
$\frac{37}{20}$ out	60 in	10	50	8	3407	$2\frac{P-3}{P}$,,	3 P ,,
,,	60 out	15	45	12	3408	,, ,,	,, out
3 out	50 out	10	50	6	3409		
$\frac{44}{15}$ out	30 in	20	40	14	3410	$3\frac{P-1}{P}$ out	2 P in
,,	30 out	15	45	10	3411	,, ,,	,, out
$\frac{32}{11}$ out	33 in	15	45	5	3412	$3\frac{P-1}{P}$,,	3 P in
$\frac{34}{11}$ out	,,	15	45	5	3413	$3\frac{P+1}{P}$,,	,, ,,
$\frac{31}{11}$ out	,,	12	50	6	3414	$3\frac{P-2}{P}$,,	,, ,,
$\frac{35}{11}$ out	,,	12	50	8	3415	$3\frac{P+2}{P}$,,	,, ,,
$\frac{20}{7}$ out	28 out	15	45	10	3416	$3\frac{P-1}{P}$,,	4 P out

* See page 141.

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	Relation between V_1 and V_2.	
$\frac{20}{7}$ out	28 out	20	40	5	3417	$\frac{3P-1}{P}$ out	4 P out
,,	,,	40	20	15	3418	,, ,,	,, ,,
,,	,,	50	10	15	3419	,, ,,	,, ,,
,,	28 in	10	50	5	3420	,, ,,	,, in
,,	,,	20	40	7	3421	,, ,,	,, ,,
$\frac{20}{7}$ in	,,	20	50	3·5	3422	,, in	,, ,,
$\frac{20}{7}$ in	28 out	40	20	10	2423	,, ,,	,, out
,,	,,	55	5	10	3424	,, ,,	,, ,,
4 out	32 in	10	54	1·5	{ 3425 3426		
,,	32 out	10	54	1·5	3427		
$\frac{63}{16}$ out	32 in	25	40	8	3428	$\frac{4P-1}{P}$ out	2 P in
,,	32 out	20	40	5	3429	,, ,,	,, out
$\frac{39}{10}$ out	30 in	25	55	13	3430	$\frac{4P-1}{P}$,,	3 P in
,,	30 out	25	55	3	3431	,, ,,	,, out
$\frac{31}{8}$ out	32 in	20	50	4	3432	$\frac{4P-1}{P}$,,	4 P in
$\frac{31}{8}$ in	32 out	48	17	8	3433	,, in	,, out
$\frac{31}{16}$ out	$\frac{128}{3}$ in	18	60	15	3434	$\frac{2P-1}{P}$ out	$\frac{8P}{3}$ in
$\frac{63}{32}$ out	,,	25	55	21	3435	$\frac{2P-1}{P}$,,	$\frac{4P}{3}$,,
$\frac{111}{55}$,,	55 out	30	55	27	3436	$\frac{2P+1}{P}$,,	P out
,, ,,	55 in	35	45	30	3437	,, ,,	,, in
,, ,,	$\frac{55}{2}$ out	30	55	27	3438	,, ,,	$\frac{P}{2}$ out

V_1	V_2	Ex_1	Ex_2	S.R.	Fig.	Relation between V_1 and V_2.	
$\frac{111}{55}$ out	$\frac{55}{2}$ in	30	55	27	3439	$\frac{2P+1}{P}$ out	$\frac{P}{2}$ in
$\frac{164}{55}$ out	55 in	40	60	16	3440	$\frac{3P-1}{P}$,,	P ,,
,, ,,	out	,,	,,	,,	3441	,, ,,	,, out
$\frac{45}{11}$ out	44 in	85	25	9	3442	$\frac{4P+1}{P}$ out	4 P in
,,	,,	40	35	5	3443	,, ,,	,,
$\frac{32}{11}$,,	99 in	15	90	13	3444	$\frac{3P-1}{P}$ out	9 P in
$\frac{24}{11}$,,	$\frac{99}{2}$ in	14	40	14		$\frac{2P+2}{P}$,,	$\frac{9P}{2}$,,
$\frac{19}{8}$,,	$\frac{176}{3}$,,	15	100	12	3445	$\frac{2P+3}{P}$,,	$\frac{22P}{3}$,,
$\frac{77}{40}$,,	$\frac{160}{3}$,,	15	40	11		$\frac{2P-3}{P}$,,	$\frac{4P}{3}$,,
$\frac{106}{55}$,,	$\frac{220}{3}$,,	13	90	13	3446	$\frac{2P-4}{P}$,,	$\frac{4P}{3}$,,
$\frac{74}{35}$,,	$\frac{140}{3}$,,	18	40	18		$\frac{2P+4}{P}$,,	$\frac{4P}{3}$,,
$\frac{64}{33}$,,	$\frac{77}{2}$,,	25	75	25	3447	$\frac{2P-1}{P}$	$\frac{7}{3} \times \frac{P}{2}$,,
$\frac{5}{2}$ out	7 out	30	70	7	3448	S. R. varied	
,,	,,	30	70	12	3449	F. M_1 varied	
,,	,,	30	70	20	3450	F. M_2 varied	
78 in	4 out	17	153	7	3451	(See page 136.)	
$\frac{5}{2}$ out	7 out	30	70	7	3452	Ex_1 varied	
,,	,,	30	55	7	3453	Ex_2 varied	
,,	6 in	20	70	17	3454	F. M_1 moved round.	

Reference to the figures continued at the end of Chapter VII.

CHAPTER VI.

The Geometric Chuck combined with the Epicycloidal Cutting Frame.

THERE is a method of describing epicycloidal curves independently of either the Geometric Chuck, or a cutting frame on the same principle, which will readily occur to anyone at all conversant with the subject. It has been frequently re-invented, and has been described in the pages of the "English Mechanic" and elsewhere, as well as in the "Amateur Mechanics' Quarterly Journal," No. 4 (for October, 1871), p. 121. It consists in placing a revolving cutter in the slide rest and connecting it by toothed wheels with the axis of the mandrel, so that there may be a definite proportion between the rotations of the cutter and the rotations of the mandrel. The revolving cutter may be the usual Eccentric Cutting Frame, carrying a toothed wheel centrally at either end of the axis, or the Elliptical Cutting Frame designed by Captain Ash and improved by Mr. Perigal; or, better still, the extension of the latter instrument, introduced by Messrs. Holtzapffel & Co., and known as the Epicycloidal Cutting Frame.

The geared connection between the cutting frame and the mandrel will have to be made in the best manner that the other arrangements of the lathe will permit. But supposing that the lathe is already furnished with the "spiral apparatus,"* and supposing, also, that this mechanism is attached in the most favourable position, viz., at *the back* of the lathe head, and not by the medium of a special chuck in front, the necessary connection between the axis of the cutting frame and mandrel can be made with ease; and with the further

* "The Lathe and its Uses," p. 103.

advantage that this combination of apparatus can be used with any chuck whatever. The driving power will, of course, be conveyed from the large bevil wheel of the lathe to the overhead motion, and thence to the pulley of the cutting frame, from whence it passes, with diminishing velocity, through the spiral apparatus to the mandrel. And it will be found very desirable, in order to secure uniformity of motion, that the driving pulley of the cutting frame should be of good size, and also that as slow a speed as is practicable should be communicated to the overhead motion shaft from the main driving wheel.

For an arrangement of this kind the Epicycloidal Cutting Frame is especially adapted, both from the large diameter of its pulley and from there being ample space upon the boss at the back of that pulley for the reception of a broad-toothed wheel of suitable pitch: while its facilities for the production of simple geometric curves, consecutive or circulating, render it the most appropriate instrument for the conversion of these simple into compound figures.

When the spiral apparatus takes its origin from the back of the mandrel, a light steel shaft, terminating in a double Hook's joint, by which it is ordinarily united to the S. R. screw, extends in a direction parallel to the lathe bearers from the axis of the last wheel of the spiral train. The shaft possesses due provision for its support at the proper elevation, and also for a considerable length of adjustment endwise. The Hook's joint enables the slide rest to be placed at any angle, though its screw be still attached by this shaft to the spiral apparatus, and also corrects any irregularity in motion which would otherwise occur when the shaft and screw are intended to be in the same straight line, but have not been so placed with sufficient accuracy.

And when this contrivance is modified for the purpose of combining the independent rotations of cutting frame and mandrel, the light shaft in question is disconnected with the S. R. screw and is made to terminate in the prolonged axis of a wheel which is the first of a set of five, appropriately mounted in a vertical frame, carried by a separate support, like the hand-rest socket, and bolted in the same manner upon the lathe bearers. The last of this set of wheels is brought into gear with that already referred to as being fixed on the boss behind the pulley of the cutting frame, and whose breadth is sufficient to allow a certain amount of traverse in the cross slide of the slide rest, so as to permit the approach of the cutting tool to the slowly revolving surface carried by the mandrel without interrupting the contact of the toothed wheels. The proper depth of gear-contact between these last two wheels is secured by an arm attached at one end to the axis of the last wheel of those in the separate vertical frame, and at the other to an eccentric fitting screwed into a convenient part of the brass platform on which the upper S. R. slide traverses. The five wheels forming this supplementary train are mounted in their frame upon three axes linked together by radial arms, so that the distance between the first and last may be varied at pleasure within the limits of about an inch, and that thus the cutting frame may be moved laterally upon the slide rest to that extent without disconnecting any of the wheels. The diminishing value of this short train is 4; and its effect, in all that follows by way of remark or tabular description, is included with that of the spiral apparatus, under the abbreviation "Sp." Theoretically such a combination as this should be available for the production of all kinds of epicyclic curves, however small may be the velocity-ratio employed; but unless the diminishing value of the spiral apparatus and supplementary train be at least 6 —and even that is not always sufficient—the combined motion of this apparatus will not be so perfectly uniform, and consequently the curve will not be so evenly and truly described, as would be the case if the geometric chuck were used alone; and the greater can be the value given to this train of wheels "Sp." the better will be the result.

The amateur who may possess the resources now described can execute, by their means alone, a large proportion of the more interesting varieties of simple and compound geometric designs; and when to this apparatus, the simple Geometric Chuck is added—and sometimes the second "part" of the chuck besides—a wide range of the class of figures spoken of as three-part and four-part geometric turning can be attained. As regards the construction and use of the Geometric Chuck the preceding pages will probably afford all necessary information; and for full particulars of the Epicycloidal Cutting Frame the author begs to refer to his Notes upon that instrument published by Messrs. Trübner.

In adjusting the apparatus, the axis of the cutting frame should be made strictly to coincide with that of the mandrel for height of centre; and when the Geometric Chuck is brought into play in the manner indicated, "loss of time" should be eliminated from the wheels as far as possible, and the front terminal wheel should be caused to move somewhat stiffly on its axis. Otherwise, in certain positions of the chuck, the progress of the front wheel will be disturbed by the weight of the train, and move intermittently.

1. But, in the first place, it will be well to ascertain what effect is produced by the simplest form of arrangement, viz., when the cutting frame describes a circle only, and the mandrel carries nothing but a plain fixing chuck; the cutting frame making a certain specified number of rotations for one of the mandrel.

This number will be determined by the value given to Sp.; and to obtain a circle with the Epicycloidal cutting frame all that is required is to arrange the instrument for the ellipse, and to reduce the ellipse to a circle by making the flange central. The distance of the axis of the cutting frame from that of the mandrel, being measured on the slide rest as usual, will be best denoted by S.R., and the amounts of eccentricity given to the frame and flange can be represented by Fr. and Fl. respectively; Fl. for the present having no value.

Let Sp. = 8, S.R. = 45, and Fr. = 15, the two latter quantities being expressed in hundredths of an inch. Then if the total number of arbors engaged from the wheel fixed centrally behind the pulley of the cutting frame to that on the mandrel, inclusive or exclusive of both, be even, the loops produced by the twofold rotation will be external, and the resulting figure will be similar in all respects to fig. 35, but if that number of arbors be odd, the loops will turn inwards. The loops can be repeated at different angles, in the manner represented by fig. 202, either by a readjustment of the clamp of the spiral apparatus (which in the construction above described is placed at the end of the mandrel between the wheel on that axis and the lathe head) or by the graduations of the tangent wheel and screw, which form so important a feature of the Epicycloidal cutting frame. And any design whatever in simple Geometric turning, depending on either fractional or integral values for V, can be accomplished in this way, provided the values which have to be given to Sp. are not too low for the uniform rotation of the mandrel.

2. Next, let the flange of the Epicycloidal Cutting Frame be deprived of its central position, the same change wheels being retained.

The instrument thus becomes an elliptical cutting frame, and the entire combination is now equivalent to a two-part Geometric Chuck where $V_1 = 2$, and V_2 is equal to the value that may be given to Sp. There will, therefore, be two symmetrical positions, giving with the same adjustments the distinct but related curves, which have been termed "com-"panion figures" in the previous pages, and have been distinguished by a bracket prefixed to their reference numbers. The adjustment for "initial position," corresponding to that required for the Geometric Chuck by making both sides horizontal together, is at once obtained by bringing the frame of the E.C.F. into a vertical position while its flange is horizontal, in the manner explained when treating of that instrument, and which will be familiar to all who possess it. And the related or companion figure is found by giving 24 turns to the screw of the tangent wheel, equal to one-fourth of its circumference; that being the amount necessary to convert the ellipse from the vertical to the horizontal condition. For example, let Sp.=6 "in," the eccentricities of Fr. and Fl. be 10 and 20 respectively, and the eccentricity of E.C.F. on S.R. be 50. Then, when the ellipse prescribed by these adjustments is situated vertically, fig. 494 will be produced; and when, by giving 24 turns to the tangent screw, the ellipse has been made horizontal, the companion fig. 493 appears.

In further illustration of the same arrangement, let the change wheels of the epicycloidal cutting frame be altered from 2 "out" to 3 "out," Sp. remaining 6 "in" as before. Let Fr.=20, Fl.=20, S.R.=40, and let the E.C.F. be carefully adjusted in the usual manner, Fl. being made horizontal, while at zero (by the coincidence of the lines engraved for that purpose on the boss of the pulley and on the adjacent collar of the square stem of the instrument), and Fr. being made simultaneously perpendicular by the action of the tangent wheel, and tested by a set square placed upon the bearers of the lathe. This being done, the resulting compound curve will be found, probably to the surprise of the experimenter, to be altogether devoid of symmetry, resembling one described by the two-part Geometric Chuck when the initial position of parallelism of the slides has been neglected. The reason of this appears to be that the describing curve—if that expression may be used to indicate the figure properly belonging to E.C.F.—requires to be presented to the other curve (which is due solely to Sp. and the eccentricity of S.R.), with some one of its sides, or of its pointed or rounded corners, in such a manner as to be bisected by a horizontal line passing through the axis of the mandrel. Thus, the ellipse may be roughly said to consist of two sides, and two ends or rounded corners; and, after the first adjustment has been satisfied, a movement of the tangent wheel by one-fourth of its circumference at a time makes a side horizontal in place of an end, or vice versâ. But the three-looped figure, of which the triangular condition is the most favourable for this investigation, does not so readily accommodate itself to this rule. It will be found, with E.C.F. as first adjusted, to have one side horizontal, and the opposite angle pointing downwards bisected by a vertical line; and the side, so to speak, presented to the simple curve of 6 internal loops with which it is to be combined, is neither vertical nor horizontal, but inclined at an angle of 30°. When, however, the tangent wheel is moved by 8 turns of its screw through the corresponding part—one-twelfth—of its circumference, or 30°, one side of the triangular figure becomes vertical, and the opposite angle is presented fairly in a horizontal line passing through the centre; and the result, with the conditions supposed, is equivalent to fig. 930. To obtain the companion figure, since the three-looped curve has three sides and three loops or corners, it will be requisite to move the tangent wheel through one-sixth of its circumference (*i.e.*, 16 turns of the tangent screw), in order to exchange an angle for a side, and this having been effected, the figure is again symmetrical, and fig. 931 is produced.

Again, preserving the other conditions unchanged, let V_1, that is to say the change wheels of E.C.F., be altered from 3 out to 4 out, and Fr. be reduced to 15 from its last value of 20. The usual adjustment of E.C.F. for initial position now gives a symmetrical compound curve at once, fig. 1440, and it now only takes 12 turns of the tangent screw, equal to one-eighth of the circumference of the tangent wheel, to find the companion figure, fig. 1441; for it is, in the simple four-looped curve, only one-eighth of the circle from a corner to a side.

Similarly, the value of V_1—*i.e.* of the train of E.C.F.—may be further increased to 5 or 6, or even more if the supplementary arbor has been added, which the instrument is capable of receiving; and, for further variety, fractional values may be substituted for integral: so the train defined as Sp.—*i.e.*, now V_2—can receive almost any value, not too small, and if not less than 20 all the better; and an extensive series of a certain class of two-part geometric curves will be thus available, which may be combined and varied at pleasure, and with great certainty of correct adjustment. We see, therefore, that by using the Epicycloidal Cutting Frame and Spiral apparatus in combination, without anything but a plain fixing chuck on the mandrel, we have all the elements of a two-part

Geometric Chuck, limited as formerly to a value for V_2 not less than 6, and limited also, as regards V_1, to a value not greater than 6, or 10 if the E.C.F. has received the extension lately referred to. Resuming the notation of previous pages, the several adjustments correspond as follows :—

V_1 = value of train of wheels contained in E.C.F.
V_2 = " " from outside of E.C.F. to mandrel.
Ex_1 = eccentricity given to frame of E.C.F.
Ex_2 = " " slide rest.
S.R. = " " flange of E.C.F.
F.M.$_1$ = tangent wheel and screw of E.C.F.
F.M.$_2$ = divided wheel and clamp of Sp.

3. The next step in adding to the capabilities of the combined apparatus hitherto described, will be to place the first "part" of the geometric chuck upon the mandrel. We have then, in the first place, another arrangement for the two-part turning, obtained by reducing the Epicycloidal cutting-frame, as in (1) to the function of a circle producer only : and by taking

for V_1 the value of the train Sp.
" V_2 " " of G. Chuck, Part I.
" Ex_1 the eccentricity given to the slide rest.
" Ex_2 " " G. Chuck.
" S.R. " " Fr. of E.C.F.
" F.M.$_1$ the divided wheel and clamp of Sp.
" F.M.$_2$ motion wheel and detent of G. Chuck ;

where it will be observed the offices fulfilled by the several parts of the apparatus differ altogether from those in the corresponding list at the end of the last section. For low values of V_1 this method is not so suitable ; but for high values of V_1, which E.C.F. is not calculated to produce, this combination would be effective, affording figures of the class illustrated by fig. 216 and 3392 to 3395, and, in fact, beginning to be useful for two-part turning just where the previous method fails.

4. When, however, the E.C.F. is again permitted to describe the ellipse, and other simple geometric curves, we find all the facilities for three-part geometric turning, subject as before to the conditions that V_2 is not less than 6, nor V_1 greater than 6, or possibly 10. And we can now take any simple geometric figure of tolerably large proportions, and embellish its outline by overlaying loops, which need be no longer circular, but may assume an elliptical, or 3 or 4 fold character, or more, or be derived from any fractional value within the limits of E.C.F. The most obvious figure to select for such treatment is the ellipse, and figs. 3455 and 3456 illustrate its application: V_1 (now E.C.F.) was 2 "out," V_2 (now Sp.) might be of any convenient large value; and in this case 80 "out" was employed; and the new element of V_3, represented by the train of Part I. of the Geometric Chuck, was also 2 "out." But for this special purpose, and for any other where V_3 has the same value, the elliptical, or so-called oval, chuck could be substituted for the geometric in the absence of the latter. In fig. 3455 the ellipse produced by the epicycloidal cutting frame was vertical, and in fig. 3456 it was horizontal.

Now, in two-part geometric turning we have seen that there are always two "companion figures" for the same values (as to magnitude and direction) of V_1 and V_2, and (as to amount of eccentricity) of Ex_1, Ex_2 and S.R. These equivalent, but not identical, figures are obtained by any adjustment of $F.M_1$, which preserves the horizontality of both eccentric slides constituting the "initial position." It proves to be a matter of indifference whether the slide of Part I. is made horizontal with its screw head to the right or to the left; but when the slide of Part II. is removed (by $F.M_1$) from one horizontal position to the other, that alteration effects a change from one symmetrical curve to the other. This variation, therefore, between the two companion figures depends on the manner in which the eccentric slide of Part II. is made horizontal; and this can be done in two ways (with the screw head to the right or with screw head to the left), no doubt corresponding to the number of companion figures producible by two-part turning.

In "three-part" turning, of which the two figures last introduced are really specimens, the same principle will doubtless hold; and though we have not, under present circumstances, to discuss the action of a Geometric Chuck with three actual slides, we may consider in what number of ways they are susceptible of being harmoniously arranged; and, since the slide of Part I. can be changed from one horizontal position to the other without varying the figure, the second and third slides only need to be taken into account. These can be made horizontal in four different ways, viz.: both screw heads to the right,—both to the left,—second to the right and third to the left,—or, second to the left and third to the right. But as we are now dealing with E.C.F. as the first "Part" of a three-part chuck, and as *its* normal adjustment requires the "frame" to be *vertical*, it is not surprising to find (as is the fact) that one of the symmetrical positions of the Ex. slide of G.C., when associated with E.C.F., is also vertical. Consequently, in three-part turning, there are always four "companion figures," not that they are always distinguishable, for where V_1 or V_2, or both, are of considerable magnitude, the figures are mostly too crowded for more than two of the four to be of distinctive character. Figures 3455 and 3456, for example, have V_2 far too large to render this difference of their respective companions manifest; but when V_2 is considerably reduced, the several phases become very evident, and the figures 3458, and three following, give an instance of their effect. In all four figures the tabulated numerical adjustments, both in amount and direction, remain the same; but for two of them the ellipse of E.C.F. is vertical, and for the other two horizontal; while for one of each of those pairs the Ex. slide of the Geometric Chuck was horizontal, and for the remaining two vertical.

These terms horizontal and vertical apply to the simultaneous adjustment of the chuck and E.C.F. The amateur will promptly recognise the necessity for "initial position," when the two instruments are united by a continuous system of wheel-work; and the analogy of previous examples of adjustment points to the chuck slide being made horizontal, at the same moment that the flange and frame of E.C.F. are respectively horizontal and vertical. This gives one of the symmetrical conditions of the apparatus; another will be found by making Fr. vertical in the opposite direction, (*i.e.* with the screw-head downwards,) the Fl. and Ex. slide being still horizontal; and the other two of the four companion figures are obtained by making the Ex. slide vertical, instead of horizontal, for each of these two positions of E.C.F. It is to be noted, however, that when the train value of E.C.F. is 3, or any other odd number, these vertical positions of Fr. will require correction, according to the particular value employed, in the manner explained at page 156. And although when V_2 is large, and V_3 not less than 4 or 5, the stated positions for Ex. slide may be adopted without qualification, yet with comparatively low values for V_2 and V_3 (as in the four figures just noticed), the "loss of time" is so much more sensible, that it becomes needful to correct by trial the final position of the Geometric chuck. It will not be found to deviate very much from the true horizontal or vertical position, but the most symmetrical result can only be obtained experimentally. And when this initial position as regards V_2 has been determined, its counterpart is given at once by moving the divided wheel of Sp. one quarter round.

In preference to this divided wheel, whose clamp is not always easy of access, it is desirable to employ the large tangent wheel which forms part of the "segment engine,"* behind the mandrel pulley. The reading of the graduations of this wheel can be taken when the chuck slide is strictly horizontal, and any slight necessary deviation from that point, to suit any particular values of the several trains, can be observed and recorded. And by this means the position of the chuck with reference to the usual initial position of E.C.F. can be regulated

* See "The Lathe and its Uses," page 304.

with the utmost nicety. It is only requisite to release the clamp of the light shaft connecting E.C.F. with the train of wheels belonging properly to the spiral apparatus; then to bring E.C.F. and the Ex. slide respectively into position ; and lastly, to re-clamp the shaft. Initial position is thus provided for V_1 and V_2 ; V_3 requiring none, the effect of its circular adjustment (here $F.M_1$) being to change the situation of the figure upon the surface where it is described.

Fig. 3457 is composed of three separate single curves of the same class as 3455, and is adapted from a design* by Captain Ash. The triplication of the figure was effected by the detent of the first motion wheel, which was moved through *one-third* of its circumference, in order to obtain *one-sixth* at the front terminal wheel. Fig. 3462 is an example with V_1, producing ellipses as before, and with a fractional value for V_3 ; giving a compound circulating figure, whose elementary form is similar to that of fig. 46.

To show the influence of various low values for V_1 (*i.e.* E.C.F.) in decorating a simple foundation figure, we may select for the latter that phase of the simple curve with four loops outwards which forms a square so approximately. Figs. 3463 and 3464 exhibit the effect of the alternative positions of ellipse for V_1, and in subsequent figures examples are given of the three-looped, and of the four-looped (external) figures as assigned to V_1, with the two positions in each case; fig. 3467 being an instance of a small fractional value.

A favourite border pattern, which may be seen in Mr. Savory's work, and also in some of the beautiful specimens of Mr. Hartley's engraving occasionally to be met with in private hands, is a repetition of groups of narrow ellipses, reduced almost to the straight line condition, inscribed in a simple curve, of from about 8 to 20 loops, inwards or outwards. And figs. 3470 to 3473 may be useful in showing how this variety of pattern can be diversified by changing the direction of V_3, and the position of the describing ellipse

* See "Double Counting on the Lathe," page 44.

from vertical to horizontal. Designs of a somewhat similar class are obtainable, it may be remembered, in "two-part" turning only, arising from a relationship between V_2 and the fractional value used for V_1; but the two methods are distinct in effect as well as in procedure.

5. We now pass on to the complete combination of the whole apparatus, and add Part II. of the Geometric Chuck to the Part I. already in use with the Spiral Apparatus and the Epicycloidal Cutting Frame. Beginning, as on former occasions, with the latter as a circle producer only, we have the facility for placing a large number of closely intersecting circular loops along the course of any compound figure, of which so many suitable examples are to be found in the preceding lithographed series, and so many more could be readily designed. The difficulty is not where to find a foundation-figure, but which to select among so numerous a collection as that which the two-part chuck, when moderately low values are employed for V_1 and V_2, affords almost spontaneously. However, from the figures in the lithographed series, one of rectilinear character, No. 964, may be selected, and No. 1331 from those of continuously curved outline; and figs. 3474 and 3475 shew, on a rather large scale, one kind of the amplification which they may thus receive.

With the arrangement now in operation, Part II. of the chuck necessarily moves but slowly; and when the eccentricity of its slide is considerable, any "loss of time" occurring between the wheels (including those of Part I. also) becomes unpleasantly manifest by slight jerks, interfering with the due progression of the moving surface, when the chuck passes what may be considered its dead points. To mitigate this evil, the front terminal wheels of each part may be screwed up, so as to move more stiffly than is to be desired when the double chuck revolves at its usual speed; and, for additional security, it is well to maintain a steady and moderate pressure, by the hand,—always in the same direction,—upon the edge of the wood, or other material, whose surface is being engraved.

The process employed for the production of the last two figures is still one of "three-part" turning, where V_1 (*i.e.* Sp.) can acquire much greater values than E.C.F.—which represented V_1 in the last section (4)—is capable of receiving. Another "two-part" outline figure frequently used as a basis for three-part turning, is one where $V_2 = 2$ out, and V_3 is of any value from about 10 to 30, corresponding with the number of segments of ellipses which it may be desired to use for the foundation figure; V_1 being of any considerable value which may be convenient. The "in," or "out," condition of V_2 is here of some importance, and so is also the value of S.R. For it will be evident on examination of figs. 483, 493, 503 and 504, and by making other experiments in the same direction, that there are more ways than one of determining whether the portion of an ellipse, of whose repetition such outline figures consist, shall be concave or convex towards the circumference of the design; and it will further appear that, according to the method selected, the segment of the ellipse will be (with the same values for Ex. and S.R., as regards the foundation figure) of different length and proportion. Figs. 3476 and 3477, are illustrations of two varieties, but many more would result from slight changes in the several adjustments for eccentricity.

Still retaining the Epicycloidal cutting frame in the same condition, as equivalent to an Eccentric cutting frame, another illustration may be taken from fig. 430, which apparently resembles the foundation figure of a charming example of a "true lovers' knot,"—perhaps a useful hint to some aspiring bachelor,—given at plate 40 of the volume recently published by Mr. Elphinstone: * and, with slightly different proportions, fig. 3478 is a similar treatment of the same subject.

If the radius, *i.e.* Fr., of E.C.F. be reduced to about 5, and V_1 as at present arranged (*i.e.*, Sp.) be made very large, the intersecting circles will lie so closely as to trace out the foundation curve by a broad continuous band. This naturally suggests a reference to the practice of "drilling out" geometric patterns; a system not without advantage for some of the designs which the simple geometric chuck is capable of producing,

* "Patterns for Turning," Longmans, 1872.

and for the two-part chuck a most effective method. The drill used for such a purpose may be one for plain fluting, or of complex form; the penetration may be very considerable, if so desired; and when the foundation figure is so contrived as to be free from intersections, such as figs. 924, 1280, 2518, &c., some pleasing results may be obtained by drilling out a solid core with an ornamental drill. The method to be followed hardly needs describing; but, taking any not too elaborate curve for the foundation figure, the drilling instrument, carrying a suitable drill, is substituted in the slide rest for the fixed tool or pencil with which that curve has been described. The drill is driven with the requisite high velocity from the principal bevil wheel of the lathe, while the chuck is slowly turned by a winch handle, fitted on to the tangent screw of the large racked wheel of the segment engine. A more convenient arrangement is possible when—as is presumed in this chapter—the spiral apparatus is applied at the hinder end of the mandrel. For then a mahogany, or other hard wood, pulley may be fitted to the prolonged axis of one of the change wheel arbors of that apparatus; and that pulley can be driven from another of about equal size, placed on the main crank shaft of the lathe, behind the bevel wheel. The whole mechanism employed thus becomes self-acting, requiring no further attention, when the depth of cut is assured, than is requisite to keep the treadle in motion.

6. But with the full combination now described, and used for the production of the last five figures, the course of any two-part curve may be filled in not merely with circular loops, but with groups of ellipses or of other elementary figures within the province of E.C.F. Thus, the fig. 430, just exemplified in fig. 3478, can be traced with ellipses instead of circles; and in figs. 3479 and 3480 are shown the effect of that alteration, the describing ellipse being vertical in the one, and horizontal in the other. Again, fig. 1651, or other of similar construction, is likely to prove a good foundation figure for overlaying with ellipses, or three or four looped figures. Fig. 3481 gives the result of the former, the describing ellipse being horizontal;

the effect with a vertical ellipse being curious, but not particularly pleasing.

We have now arrived at "four-part" turning, and, as with "two-part" there are two "companion figures," and with three part, four, so it will be found that the addition of a fourth "part," has increased the number of companion figures to eight. Four of these, however, only possess distinctive individuality, when all the velocity ratios are low.

And, the first four of the eight companion figures are obtained precisely as already described, viz., by making the Ex. slide of Part I. both vertical and horizontal, and bringing E.C.F. alternately into like conditions of adjustment. Then the other four are found by changing the foundation figure, yielded by the two-part chuck alone, to its other equivalent (by the necessary adjustment of F.M_1) and then repeating the process of inversion of E.C.F. in connection with the vertical and horizontal positions of the Ex. slide of Part I. An instance for verification of this statement may be offered, though its illustration by figures would not be sufficiently interesting. Take V_1, V_3, and V_4, each equal to 2 "out," and V_2, to 6 in. Let Fr., Fl., and S.R. be each equal to about 12, and Ex_1 and Ex_2 be 20 and 40 respectively. The distinctness of the eight several "companion figures," which are all strictly symmetrical, and which are obtained by changes of position only, without alteration in the several numerical values for V, or any of the eccentricities, will be at once apparent.

When V_2 (*i.e.*, Sp. under present conditions) is large, it is not of much moment that the Chuck and E.C.F. should be connected by clamping the light shaft already described, at the instant when they are each in initial position ;—though this is a good rule to follow on every occasion. But when V_2 is of small, or moderate, amount, the respective initial positions of chuck and E.C.F. must be united simultaneously, as explained above (page 162), when treating of the combination of the latter with Part I. only.

The direction, used with the several values given to E.C.F. in its association with the spiral apparatus, has so far been "out" exclusively. But, though that is probably the most favourable condition, there is no reason why a simple figure with internal loops should not be adopted occasionally for the "describing curve." And figs. 3482 and 3483 are examples of this character In the latter figure, a decorated oval is placed upon a block of elliptical section; and the white spot marks the original centre of the work, with reference to which the oval assumes of its own accord an eccentric position to the extent thus indicated.

It is needless to multiply examples of "four-part" turning; the few now given are sufficient to prove that the course of any two-part curve can be clothed with a repetition in distinct groups of any simple figure which E.C.F. can produce, and for this purpose no simple figure is more suitable and effective than the ellipse.

CHAPTER VII.

Fractional values, in the several trains, applied to this combination of Apparatus.

THE Amateur who may be conversant with the Epicycloidal Cutting Frame, will recollect that it is employed [at least as frequently with fractional values for its train of wheels, and consequently with "circulating" curves, as with integral values resulting in the more familiar variety of curves termed "consecutive." And it will be evident, by consideration of the arrangements detailed in the last chapter, that the whole class of figures illustrated by the diagrams Nos. 3400 to 3447, arising from a certain relation between the value of V_2 and the fractional value of V_1, and possessing at first sight the characteristics of three-part turning—are within the compass of the simplest combination described, viz. the E.C.F. connected by the Spiral Apparatus with the mandrel simply, without special chuck of any kind. For there are thus provided the two separate trains of wheels, and the several adjustments for eccentricity, in fact, the full equivalent for a two-part Geometric Chuck and fixed describing point, such as were employed in the actual preparation of the diagrams referred to. True, the E.C.F. possesses from the resources of its own wheels a less extended range of the fractional values suited to this system; and Sp. also is much more restricted than Part II. of G. C., in its power of affording the necessary allied values for V_2. But still the choice will be seen to be amply sufficient; and it may be increased by borrowing from the change wheels belonging to G. C., any, not larger than 72, which would be temporarily serviceable to E.C.F.

For example, a fractional value yielding the approximate ellipse in circulation at E.C.F. may be had by substituting for the usual $\frac{32}{48}$ on the change wheel arbor of that instrument, any of such pairs as the following, $\frac{33}{45}$, $\frac{37}{54}$, $\frac{45}{65}$, $\frac{60}{72}$, thus giving for V_1 the respective values of $\frac{33}{16}$, $\frac{37}{15}$, $\frac{45}{22}$, $\frac{25}{12}$. And the corresponding values for Sp. to be used with any of these four pairs would be any desired multiple of the denominators of the fractional numbers last stated. Sp., with the change wheels supplied with that apparatus, will give many such multiples, but not all; for example, with the fraction $\frac{33}{16}$, it will give 16 multiplied by 2, 3, 4, 5, 6, 8, 9, 10, 12, 15 or 18. A change of direction may be procured either by adding another arbor to the Spiral train, or by varying the fractional form of the train in E.C.F. from $\frac{m\,P + 1}{P}$ to $\frac{m\,P - 1}{P}$. In fact, all the rules enunciated in Chapter V, as to the proportion of the fractional value taken for V_1 and the consequent direction in which the principal compartments of the figure will be disposed,—as to the influence of that proportion upon the actual number of those compartments—and as to the number of different ways in which the same "general aspect" is attainable,—are equally applicable to the present method, which dispenses, for that class of figures, with the Geometric Chuck altogether.

For the three-looped figure in circulation, the wheels $\frac{47}{48}$ or $\frac{49}{48}$ would be the most suitable; but a 46 or 50 may be substituted for either of those numerators, giving $V = \frac{23}{8}$ or $\frac{25}{8}$; or somewhat higher numbers can be adopted, in about the same proportion. Similarly $\frac{47}{36}$ or $\frac{49}{36}$, or other pairs of wheels nearly in the same ratio would give the approximate four looped figure in any desired phase; and for the requisite associated values of Sp. convenient numbers could be selected without difficulty. With so many variable elements as have now been introduced, an examination of all their conditions is impossible within moderate compass; V_1 will therefore be here restricted to those values only which produce the ellipse in circulation.

(1.) In considering the application of fractional values to the system of two-part turning as accomplished by E.C.F. connected simply with the mandrel, there is not much to add to the remarks on the same subject in Chapter IV. accompanying diagrams 3400 *et seq.* But it will be observed, when experimenting in this direction, that figures of this class—viz., where the numerator of V_2 is a multiple of the denominator of V_1,—whether executed by the two-part chuck and fixed describing point, or by E.C.F. combined with Sp.—have no "companion." No alteration of $F.M_1$ or $F.M_2$, in the former method, nor of E.C.F. tangent wheel or of Sp. contact, in the latter, though changing the incidence of the curve as regards its position on the surface, makes any perceptible difference in the curve.

It may also be pointed out here, that figures of this class, though apparently belonging to three-part turning, do not share that origin, and are not, strictly speaking, so producible. Fig. 3400, for instance, might very probably be expected to be equally obtainable by such adjustments as these, $V_1 = 2$ out, $V_2 = 18$ (in or out), $V_3 = 3$ in, with Fr., Fl., and Ex. equal to the previous values respectively of S.R., Ex_1 and Ex_2. But, besides Fr., Fl. and Ex., there is another element of eccentricity introduced in three-part turning, which, as described in the last chapter, stands as S.R.: and, even when this S.R. is made equal to zero, the additional velocity ratio (of which there are now three) makes itself felt; and a totally distinct figure arises, having with the adjustments supposed, six compartments instead of three.

While S.R. remains at zero, in this instance, an inversion of Fr. fails to elicit any companion figure; the result is a duplicate of the proceeding. But when S.R. receives even a small value, the alternate compartments of the curve at once undergo considerable modification; and the companion figures are perfectly distinct. See Figs. 3484 and 3485, which are specimens of integral three-part turning, and have no reference to the fractional methods under discussion in this chapter.

(2.) The next step will be to add the first Part of the Geometric Chuck as V_3, using related fractional values between V_1 and V_2, and, if so desired, between V_2 and V_3 also. This combination is very fertile in interesting results; and, though only sparingly illustrated here, will be found an abundant source of original designs. Figs. 3486 and 3487 exemplify the simple relation where V_2 is twice the denominator of V_1, V_2 and V_3 being integral. Due regard to "initial position" is necessary even here, though the frame of E.C.F. continually changes its inclination, as compared with the flange, at every revolution. The adjustment is to be made as usual,—the eccentric slide of G.C. being horizontal;—the Fr. of E.C.F. either vertical, or inverted, while Fl. is horizontal;—and the clamp contact of Sp. being effected when those three conditions are simultaneously satisfied. In the last-mentioned figure the position of E.C.F. was varied in this manner, thus producing two "companion figures;" for though there is only a single figure in two-part related fractional turning, a second, or companion, appears when the method is extended by the addition of a third Part. And, just as in the similar class of figures developed by fractional values in "two-part" turning, there is one curve only, without companion; so, in these fractional figures belonging to "three-part" turning, when four companion figures would be expected, we find only two. That is to say, with the apparatus now described the same curve results, whether we have Ex. horizontal and E.C.F. vertical, or Ex. vertical and E.C.F. inverted:—the latter being the condition of E.C.F., which causes the curve to commence with a horizontal ellipse. On this account it is more convenient to retain Ex. always in the horizontal position, and to obtain the two companion figures by inversion of the frame of E.C.F. only. Sometimes E.C.F. may occupy an intermediate, *i.e.*, horizontal position, with good effect; with the adjustments of Fig. 3486, for instance, if Fr. be so placed at starting, the curve assumes the form of a ribbon with inclined folds;—better seen with V_3 "in," and of higher value than 8.

When V_2 is three times the denominator of V_1, as in Figs. 3488 and 9, and again when that relation is four times as in Figs. 3491 and 2, the pleasing intricacy of the curve increases, without being too complicated to be distinct. And it will be observed that figs. 3488 and 3491, between which a certain affinity may be said to exist, were described with E.C.F. in opposite positions: "vert" in the one case, "invert" in the other. The principle could, no doubt, be carried further, making V_2

ten or twenty times the denominator of V_1, especially when the fractional value of V_1 is composed of lower numbers, such as $\frac{25}{12}$ or $\frac{19}{9}$.

But V_2 may be fractional also, its numerator being some multiple of the denominator of V_1; and again, its denominator may be advantageously related to V_3. A single example only is offered of this condition, fig. 3493, and without companion figure; but others will readily suggest themselves. The only point to bear in mind is that the multiples selected should be even and odd alternately; in order that V_2, though related in this way to both V_1 and V_3, may still be a fraction in its lowest terms.

So far, V_2 in this section has uniformly had an "out" direction. When this is changed to "in," a striking difference arises in the constitution of the curve, which is equally susceptible of ornamental treatment. Figs. 3494 and 3495 are illustrations, and companion figures, of the condition when V_2 is three times the denominator of V_1; and the "in" direction may be imparted to V_2 with excellent effect for any other related fractional values which may be devised.

When V_2 receives a considerable value,—integral, and a multiple (say ten times) of the denominator of V_1,—while V_3 is calculated to produce a simple curve, such as 2 out, 4 out, &c.,—the result is to accumulate groups of the other simple figure which is due to V_1 in the periphery of that determined by V_3. For instance, with $V_1 = \frac{31}{16}$ out, $V_2 = 128$, $V_3 = 2$ out, a succession of fan-like assemblages will be arranged in an elliptical outline, like, but not equal to, the design of fig. 3481. If V_2 be "out," the groups are on the inside of the figure; if V_2 be "in," these groups are placed externally. And a similar arrangement with the triangle or square for the foundation figure can be made by modifying V_3 accordingly.

This, in effect, is a method of executing what is apparently four-part turning, with apparatus for three "parts" only; and is suggestive of the nominal three-part figures 3400, &c., obtained with the two-part geometric chuck.

The value for V_1 which seems most generally useful is $\frac{33}{16}$, because the wheels of the spiral apparatus readily interpret multiples of 16. But other similar values can frequently be used with advantage; and, further, the character of the describing figure itself can be changed, if so desired, from the approximate ellipse (which is being used exclusively in investigating the class of figures now under discussion) to other curves of approximate simple form, whether internal or external.

(3.) Lastly, we may complete the combination by the addition of the second part of the geometric chuck, thus being provided, as at the end of the last chapter, with four independent "parts," each with separate train-value, direction, and eccentricity. And, for present purposes, it is to be understood that at least the first velocity ratio (V_1), and preferably others also, shall receive fractional values.

First, any elementary compound figure with few intersections may be selected, and its boundary may be diversified by groups, varying in form and magnitude according to the course of the foundation figure, of the simple curve whose repetition is provided for by V_1. Thus, in fig. 3496, V_3 and V_4 are arranged to produce an outline similar to that of fig. 436; and the relation between V_2 and the fractional value of V_1 is such as to decorate that outline with groups of quasi-ellipses in the manner exhibited.

The next variation would be to give as value to V_2 a fraction whose numerator shall be a multiple of the denominator of V_1, and whose denominator shall be a factor of V_3; V_3 and V_4 still being integral. But unless the last two are of decidedly small amount, the entire design becomes too complicated; and of this combination no example is printed.

The better way of keeping the foundation figure within moderate limits is to adopt a fractional value for V_3, related both to the integral value of V_4, and to the preceding fractional value of V_2; in fact, to make the system complete by having all four values mutually dependent: and the concluding examples of this collection are based on that principle. The connection between the successive values will be recognised at once on consulting the tabular reference to the figures. These figures, however, are only a faint indication of the infinite variety of results which are at the disposal of the amateur. One only of each kind is given, but three others (at least) possibly superior, and certainly distinct from that engraved, could be traced by reversing the initial positions of E.C.F., and of the eccentric slide of Part II., without disturbing any of the adjustments for eccentricity, train-value, or direction. While for every change in direction, from "in" to "out," or the reverse, in one or more of the train-values, another series of four companion figures will arise. It would evidently be quite practicable to impart a fractional value to V_4 also, whose numerator shall be in relation with V_3; such a modification, however, causing the whole compound curve to be circulating instead of being completed when its path has once passed round the circumference of the design, is hardly to be recommended.

The actual process of engraving these rather intricate fractional figures is a singular one. The curve, it will be remembered, is single and continuous, and, for a considerable part of its course, the several portions of which it is (so far) composed appear discordant, and to have no prospect of forming a harmonious whole. But as the delineation proceeds, the irregular convolutions of the curve recur at such intervals as to overlap symmetrically, or to adopt such positions with reference to one another as to render the effect both complete and ornamental.

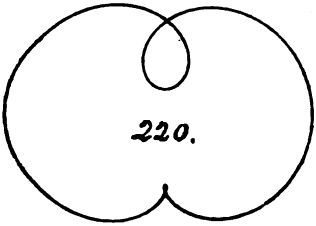
To secure an evenly-balanced distribution of the more prominent parts of the design, the greatest care is necessary in first making "all at centre," and in clamping the spiral train at the precise instant when both eccentric slides of the chuck are horizontal (as tested by the spirit-level), and when the frame and flange of E.C.F. are at the same time perpendicular to one another. These combined adjustments are not easy; and if the method described in this chapter were ever adopted for purposes of practical ornamental engraving, it might be expedient to accumulate all four of the train-bearing "parts" upon the same centre; using a fixed tool for the description of the curve, and placing the mandrel, which would have to carry so formidable a chuck, in a vertical position.

E.C.F.	Sp.	Pt. I.	E.C.F.			Pt. I.		Fr. of
V_1	V_2	V_3	Fr.	Fl.	S.R.	Ex.	Fig.	E.C.F.
2 out	80 out	2 out	22	12	20	70	3455	vert.
„	„	„	„	„	„	„	3456	invert.
„	60 in	„	27	12	60	60	3457	vert.
„	6 in	„	9	10	10	60	3458	vert. (Ex. hor.)
„	„	„	„	„	„	„	3459	„ („ vert.)
„	„	„	„	„	„	„	3460	invert. („ hor.)
„	„	„	„	„	„	„	3461	„ („ vert.)
„	60 out	$\frac{7}{2}$ out	23	10	45	75	3462	vert.
„	48 out	4 out	20	12	10	90	3463	„
„	64 out	„	18	12	40	75	3464	invert.
3 out	32 out	„	20	23	11	80	3465	vert. + 8 turns T.S.
„	„	„	„	„	„	„	3466	do. + 16 turns more.
$\frac{5}{2}$ out	„	„	14	25	12	75	3467	vert.
4 out	48 out	„	10	40	9	70	3468	„
„	„	„	6	25	13	80	3469	do. + 12 turns T.S.
2 out	„	8 in	12	12	10	100	3470	vert.
„	„	„	11	„	12	„	3471	invert.
„	32 out	8 out	14	15	14	90	3472	vert.
„	40 out	„	11	12	9	100	3473	invert.

Sp.	Pt. I.	Pt. II.	E.C.F.		G. C.				
V_1	V_2	V_3	Fr.	Fl.	S.R.	Ex_1	Ex_2	Fig.	
48 out	3 out	9 in	7	0	19	50	100	3474	From fig. 964.
„	4 out	6 out	6	„	25	40	85	3475	From fig. 1333.
32 out	2 out	18 out	15	„	25	20	90	3476	
„	„	15 in	20	„	30	20	90	3477	
48 in	„	2 in	9	„	34	34	17	3478	From fig. 430.

E.C.F.	Sp.	Pt. I.	Pt. II.	E.C.F.			G.C.			Fr. of
V_1	V_2	V_3	V_4	Fr.	Fl.	S.R.	Ex_1	Ex_2	Fig.	E.C.F.
2 out	48 in	2 out	2 in	12	12	34	34	17	3479	vert. (*a*)
,,	,,	,,	,,	,,	,,	,,	,,	,,	3480	invert.
,,	48 out	6 out	2 out	7	9	10	16	80	3481	,, (*b*)
4 in	32 out	2 out	4 out	7	11	29	70	70	3482	vert. (*c*)
6 in	,,	3 out	1 in	7	20	25	20	100	3483	,, (*d*)
2 out	18 in	3 in	—	15	13	7	50	—	3484	,,
,,	,,	,,	—	,,	,,	,,	,,	—	3485	invert.
$\frac{33}{16}$ out	32 out	8 out	—	10	11	30	80	—	3486	vert.
,,	,,	,,	—	19	18	20	80	—	3487	invert.
,,	48 out	7 out	—	20	19	21	80	—	3488	vert.
,,	,,	5 out	—	23	20	13	70	—	3489	invert.
,,	,,	8 in	—	18	19	32	80	—	3490	vert.
,,	64 out	6 out	—	17	18	30	75	—	3491	invert.
,,	,,	5 in	—	14	8	32	80	—	3492	vert.
,,	$\frac{128}{3}$ out	6 out	—	18	9	35	70	—	3493	invert.
$\frac{37}{18}$ out	54 in	6 in	—	12	11	35	80	—	3494	vert.
,,	,,	,,	—	11	10	40	80	—	3495	invert.
$\frac{31}{15}$ out	75 out	2 out	3 out	9	10	45	10	80	3496	,,
$\frac{33}{16}$ out	$\frac{128}{3}$ out	$\frac{9}{2}$ out	4 out	11	9	25	30	80	3497	,,
,,	,, in	,,	,,	7	8	30	30	80	3498	,,
,,	$\frac{192}{5}$ in	$\frac{5}{2}$ out	8 out	7	8	30	30	95	3499	vert.
,,	$\frac{128}{3}$ in	$\frac{9}{4}$ out	,,	8	9	30	36	96	3500	,,

(*a*) Derived from fig. 340.
(*b*) ,, ,, ,, 1651.
(*c*) ,, ,, ,, 466.
(*d*) ,, ,, ,, 807.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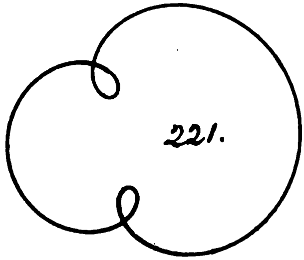
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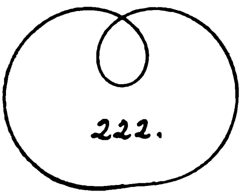
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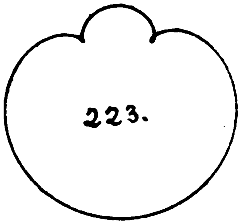
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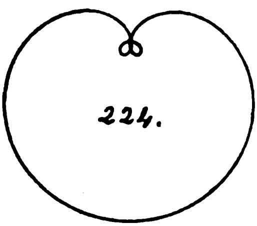
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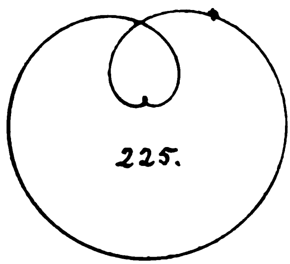
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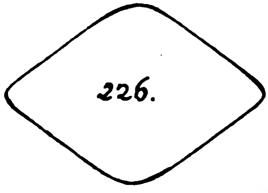
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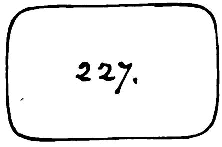
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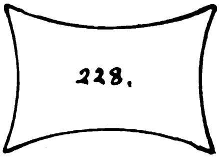

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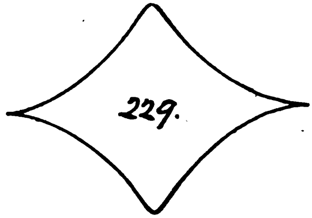

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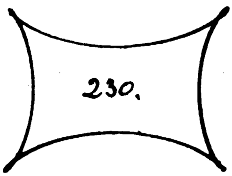

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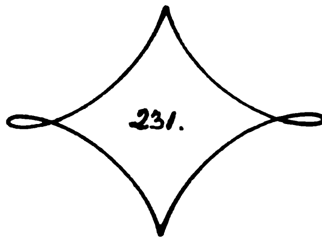

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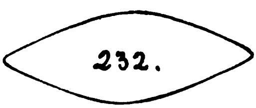

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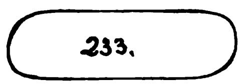

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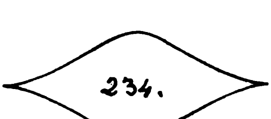

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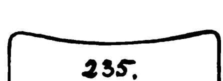

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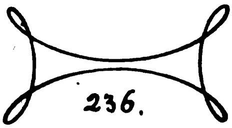

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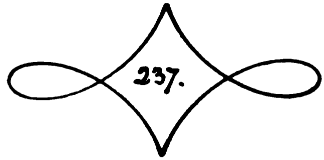

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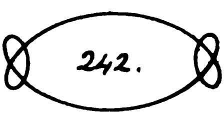

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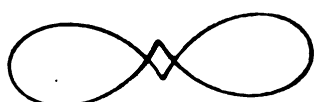

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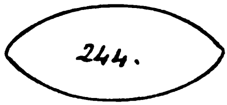
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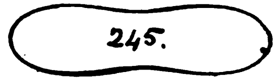
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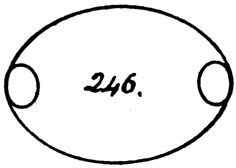
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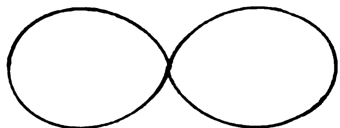
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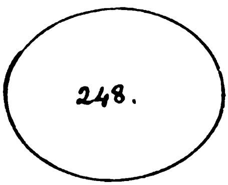
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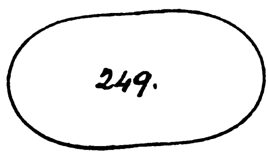
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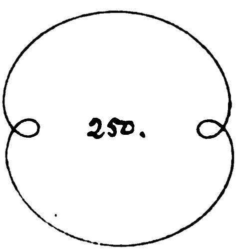
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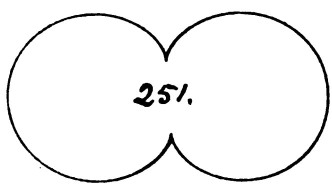
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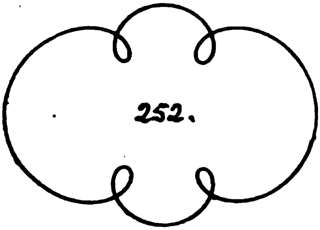
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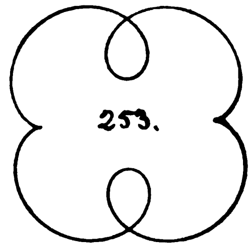
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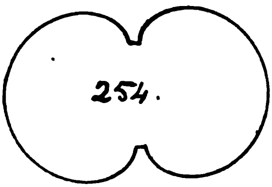
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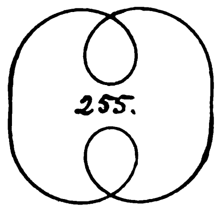
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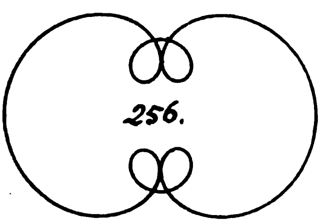
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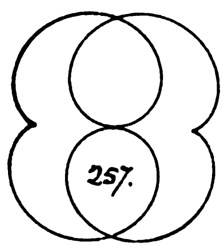
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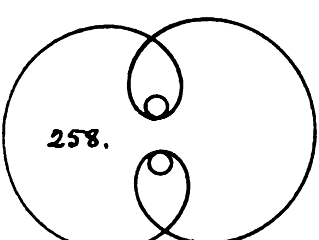
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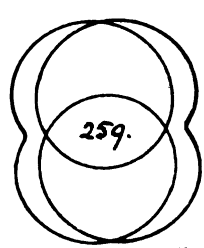
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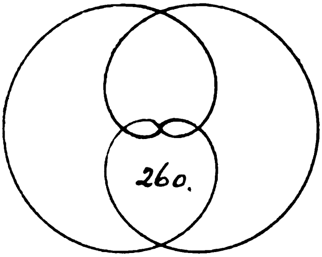

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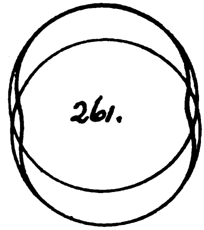

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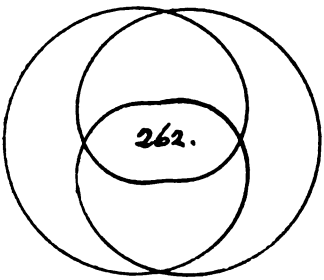

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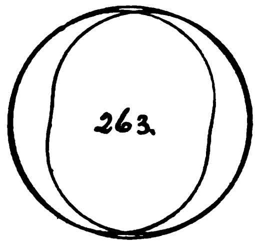

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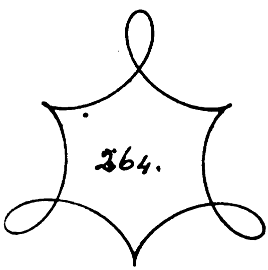

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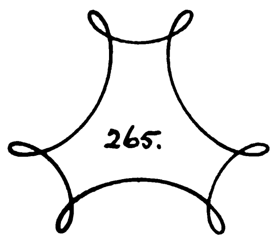

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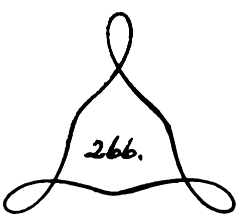

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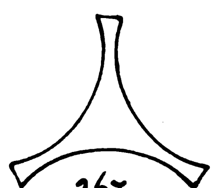

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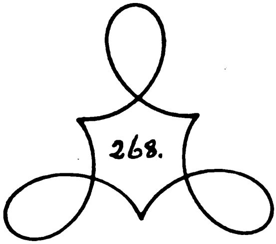
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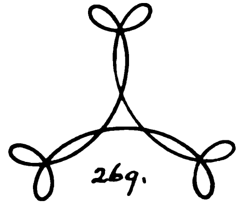
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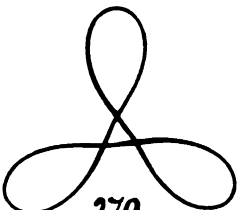
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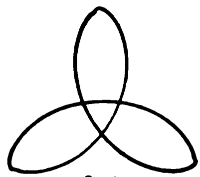
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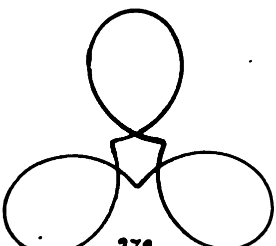
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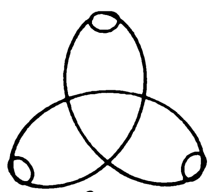
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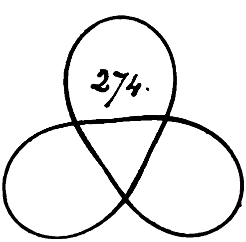
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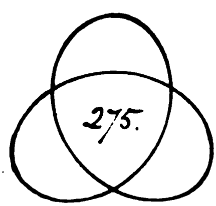
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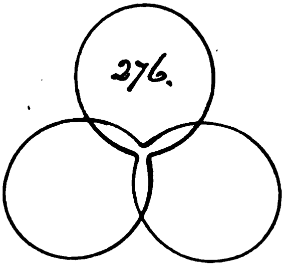
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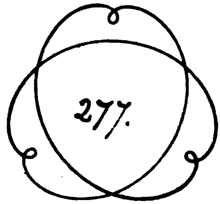
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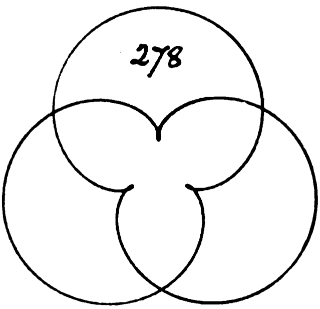
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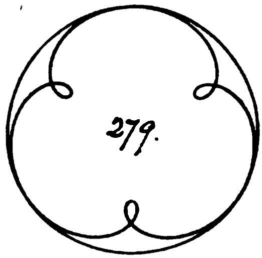
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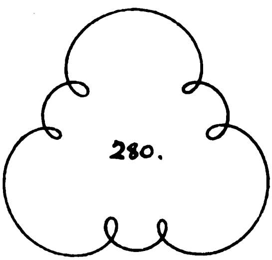
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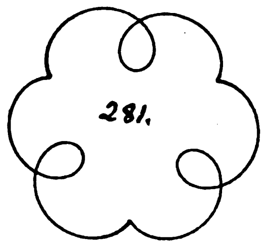
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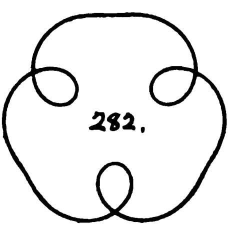
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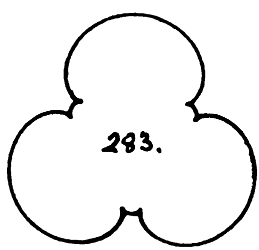
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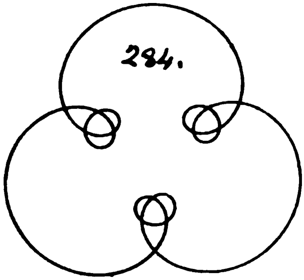
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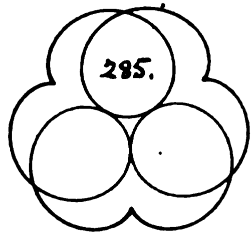
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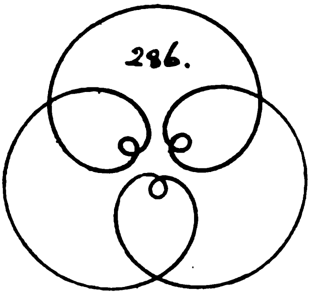
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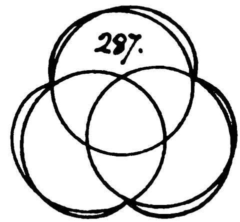
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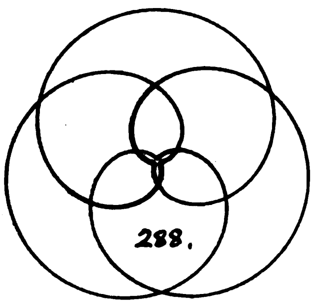
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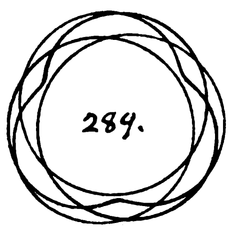
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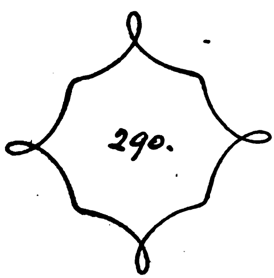
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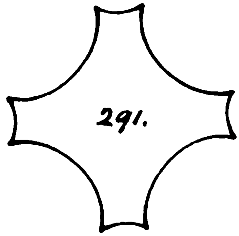
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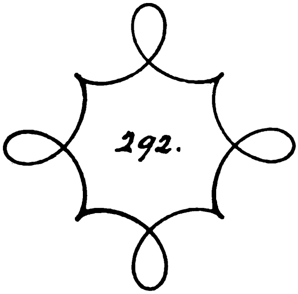
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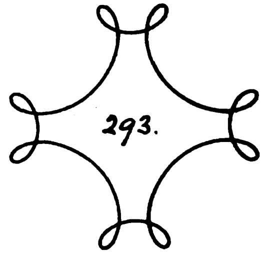
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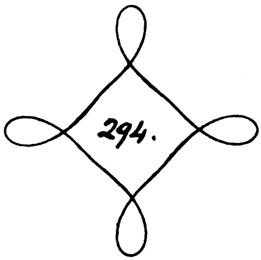
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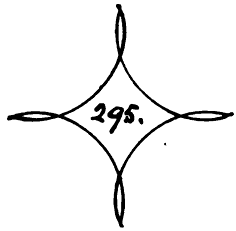
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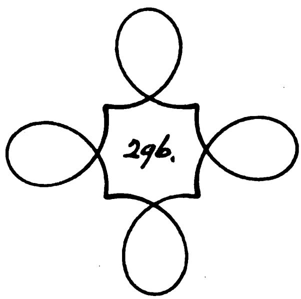
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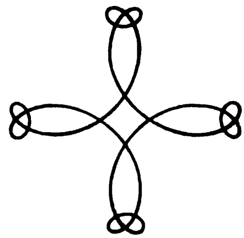
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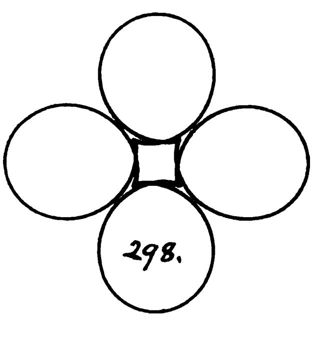
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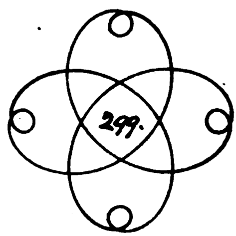
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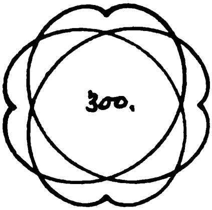

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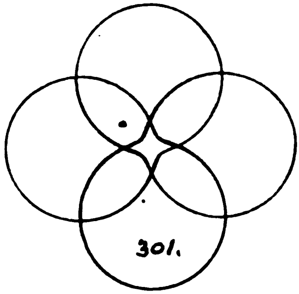

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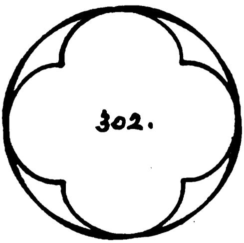

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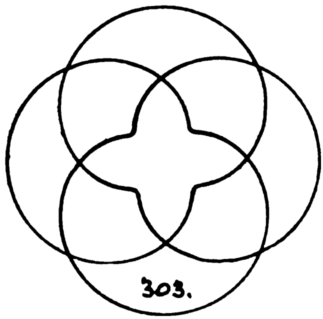

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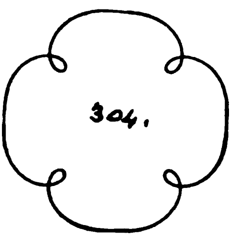

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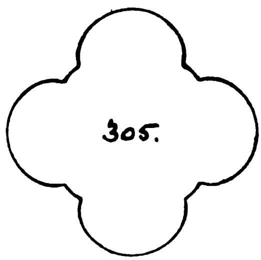

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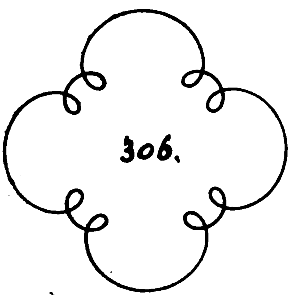

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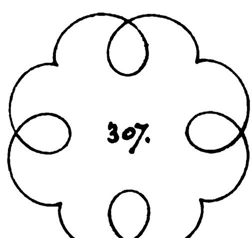

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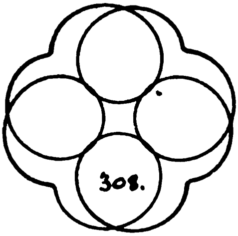

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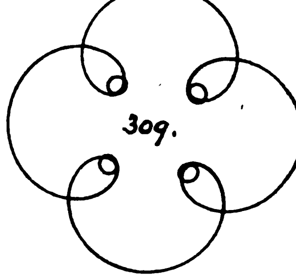

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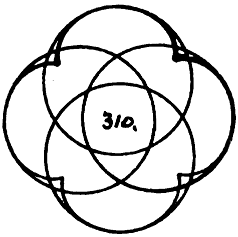

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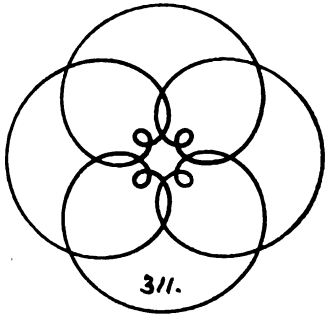

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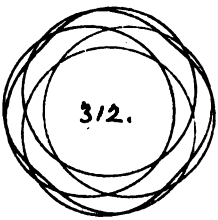

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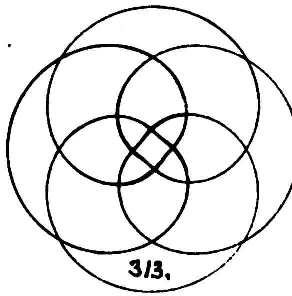

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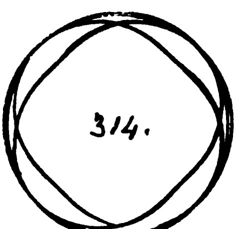

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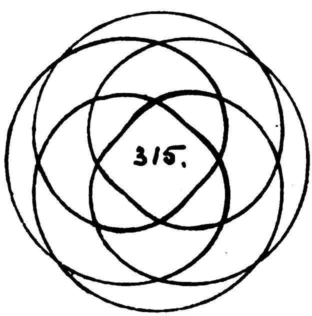

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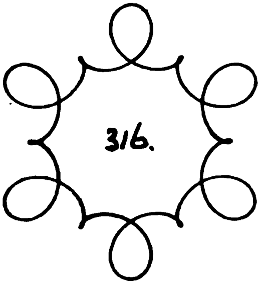

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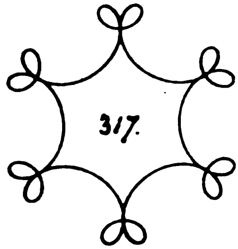

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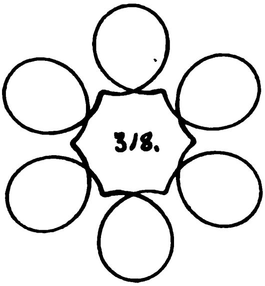

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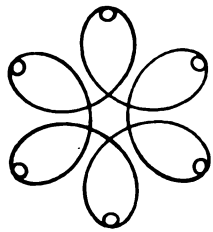

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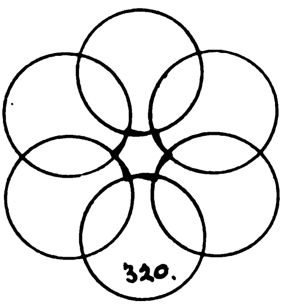

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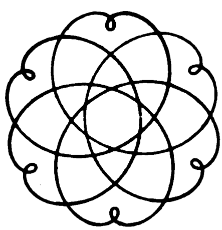

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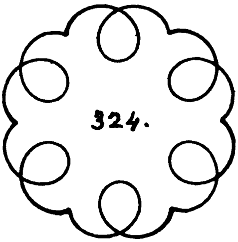

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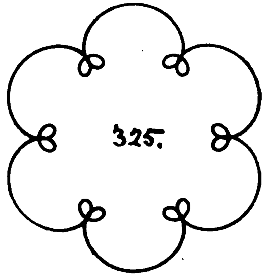

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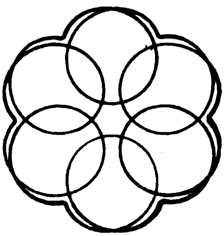

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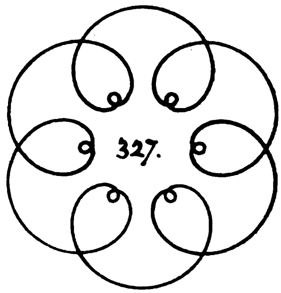

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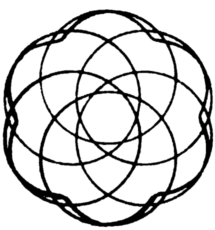

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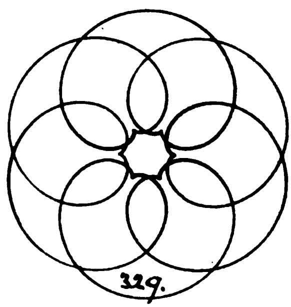

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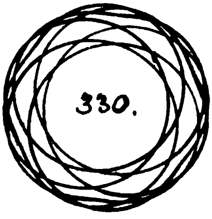

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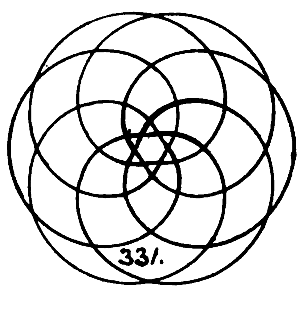

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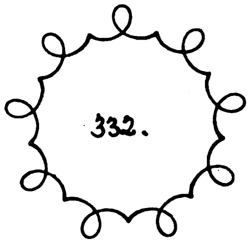

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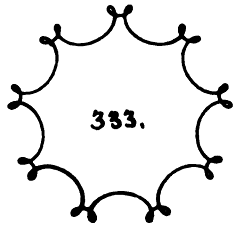

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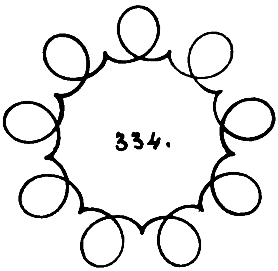

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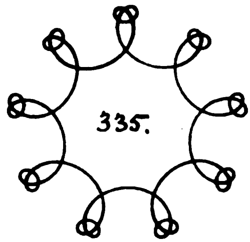

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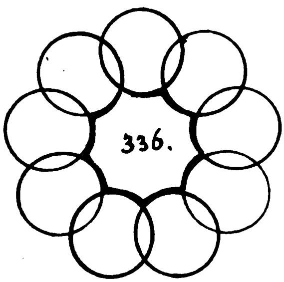

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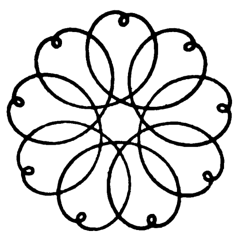

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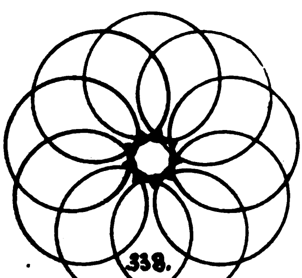

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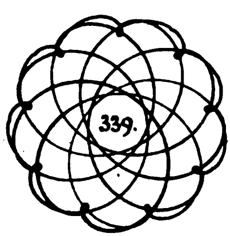

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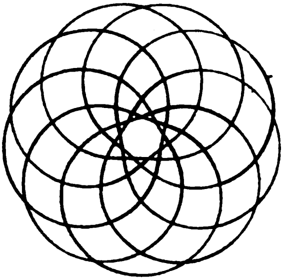

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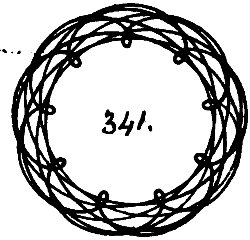

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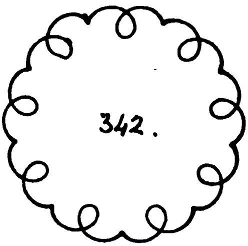

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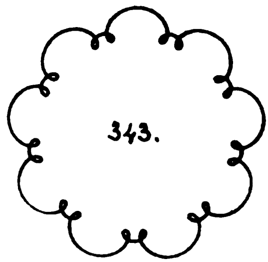

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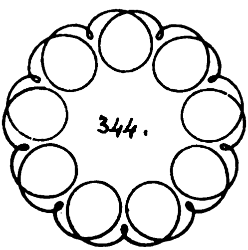

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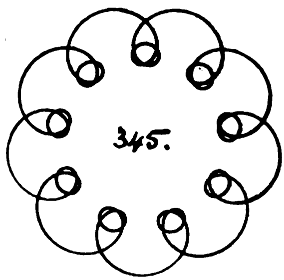

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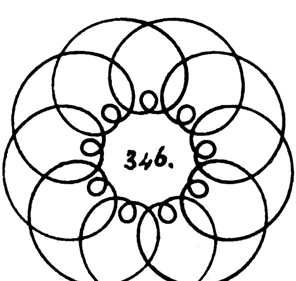

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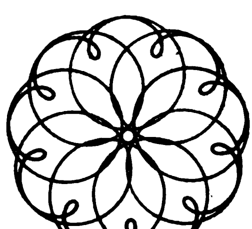

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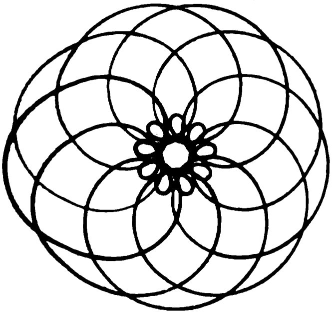

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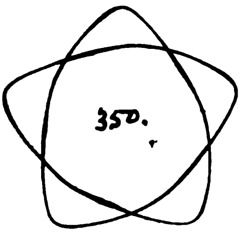

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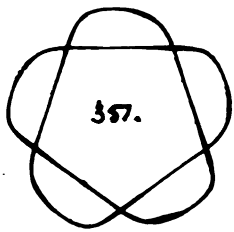

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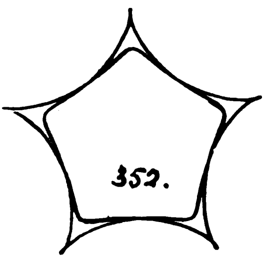

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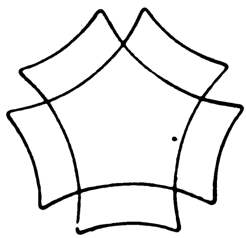

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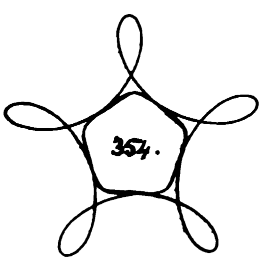

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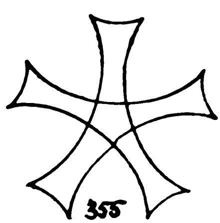

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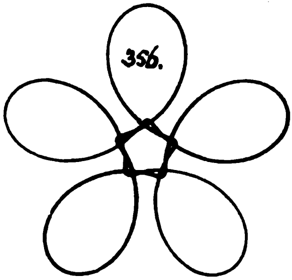
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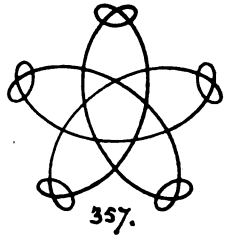
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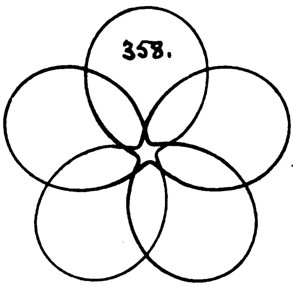
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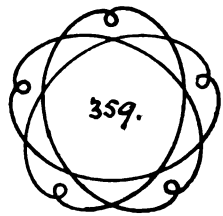
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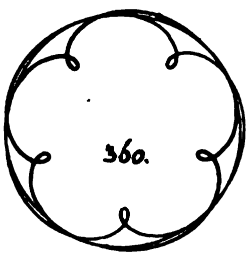
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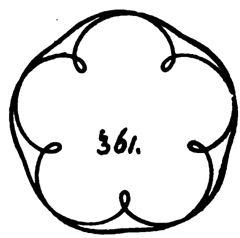
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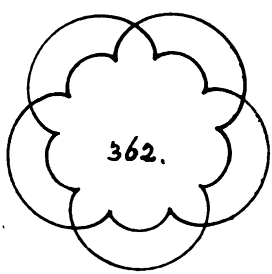
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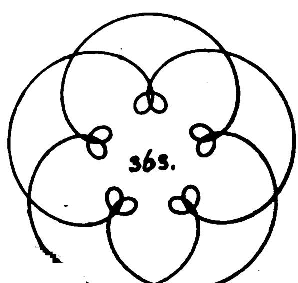
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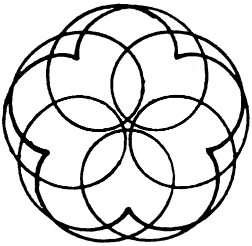

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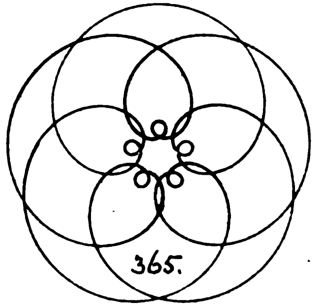

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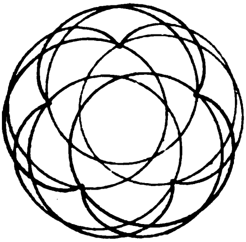

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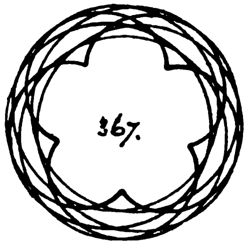

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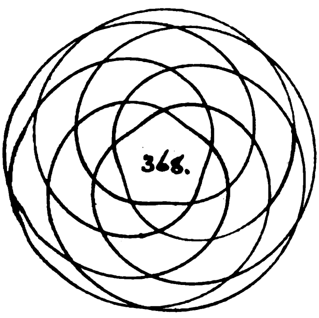

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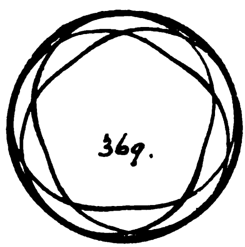

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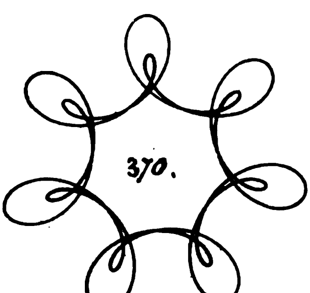

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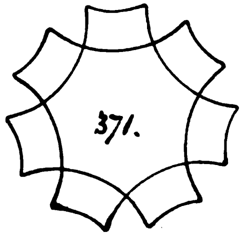

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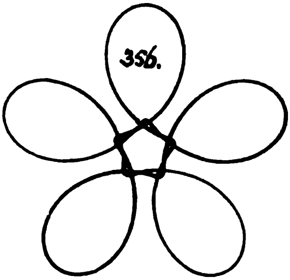

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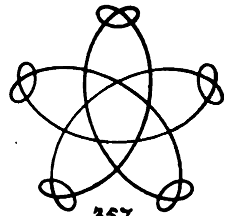

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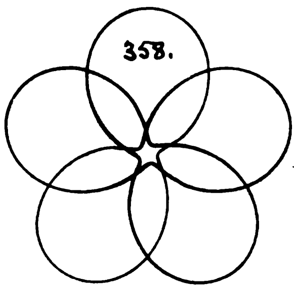

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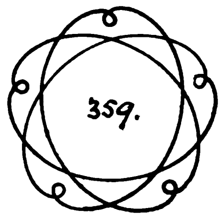

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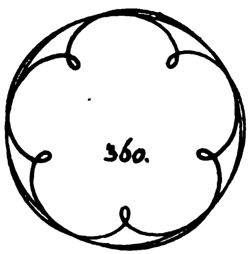

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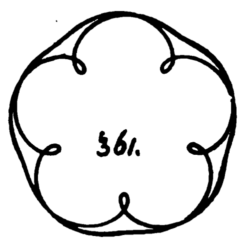

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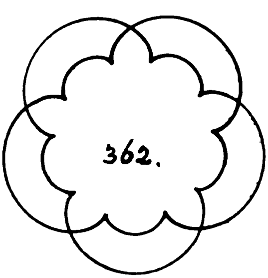

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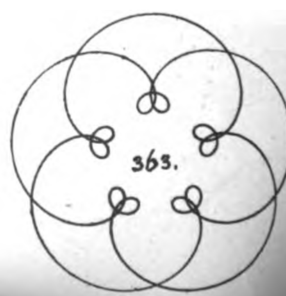

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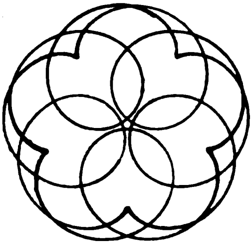

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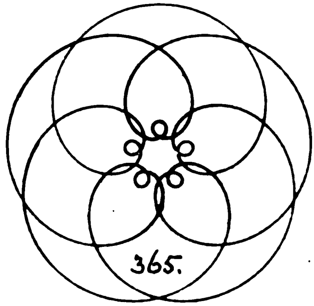

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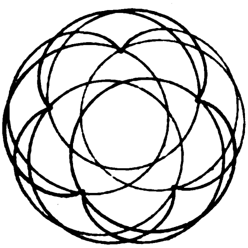

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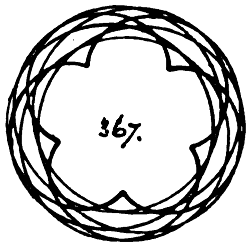

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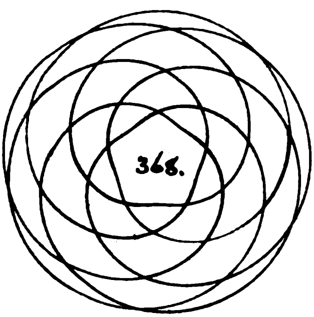

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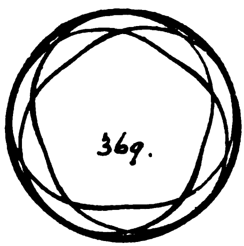

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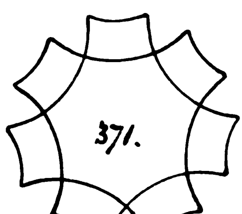

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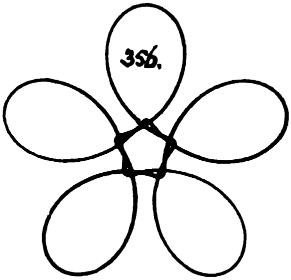

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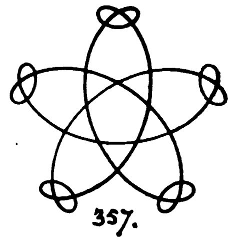

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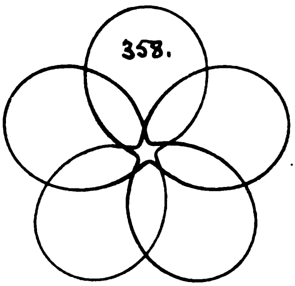

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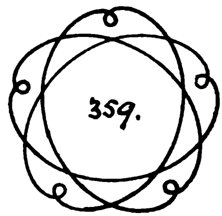

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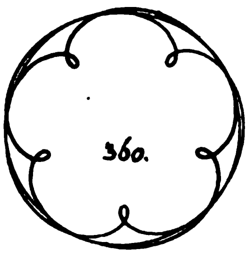

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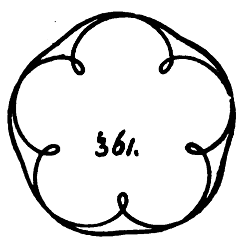

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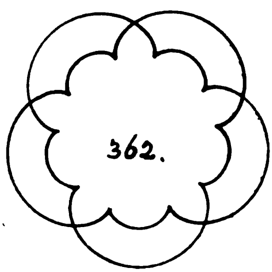

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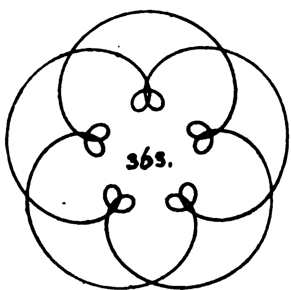

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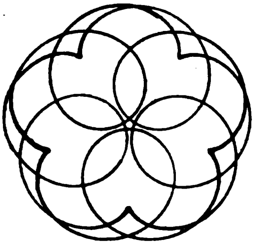

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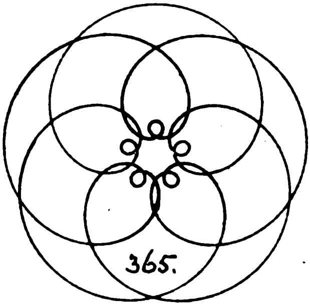

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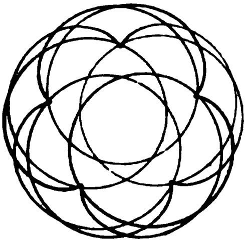

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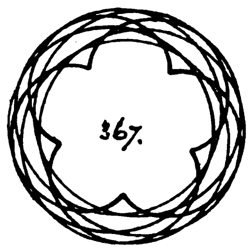

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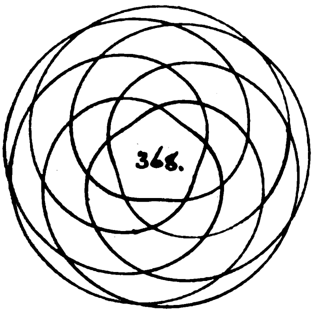

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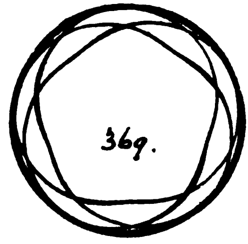

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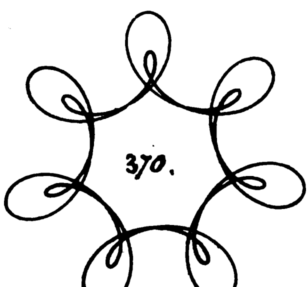

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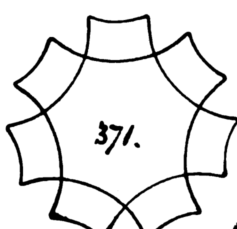

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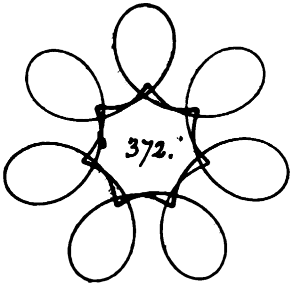

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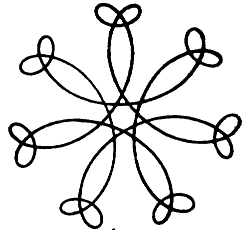

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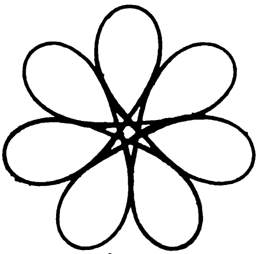

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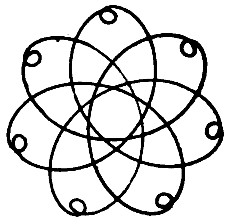

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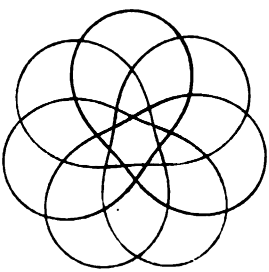

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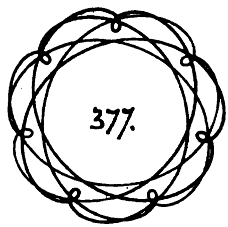

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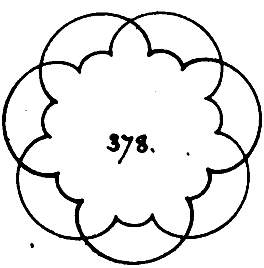

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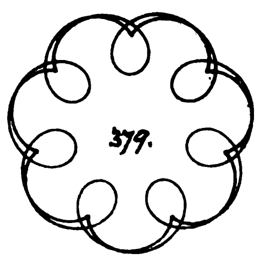

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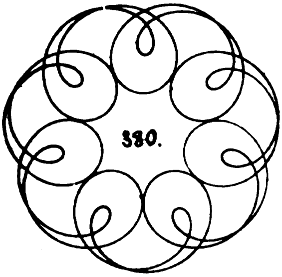

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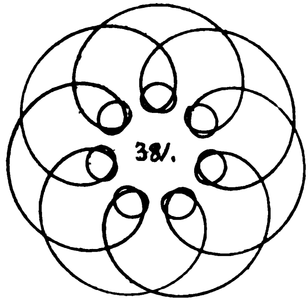

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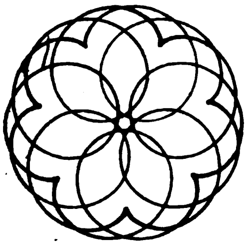

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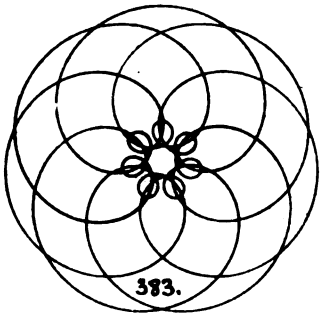

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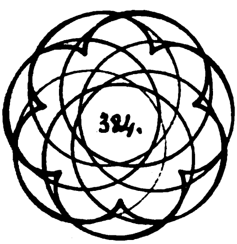

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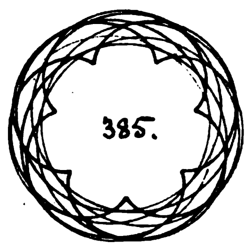

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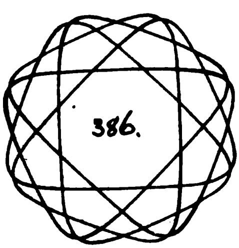

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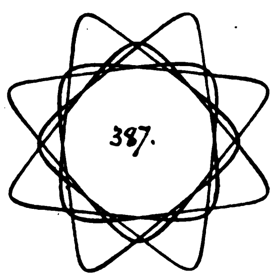

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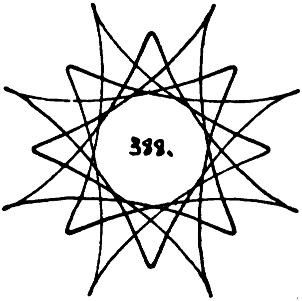

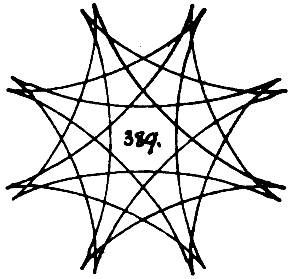

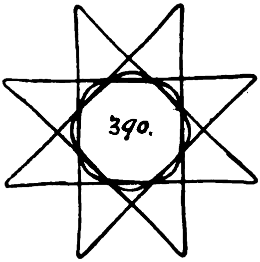

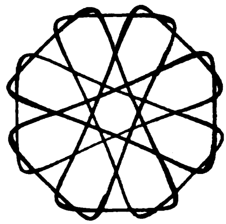

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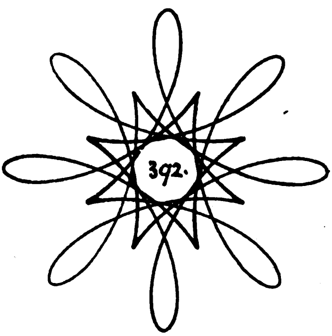

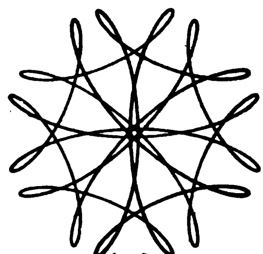

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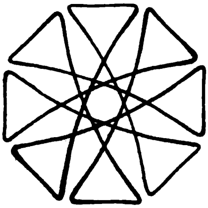

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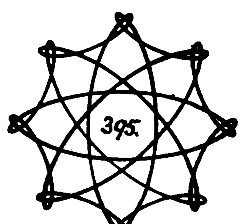

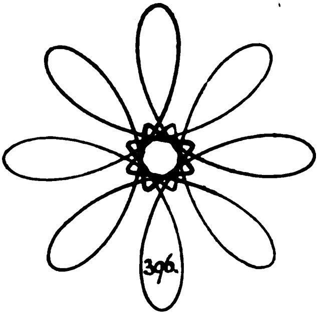
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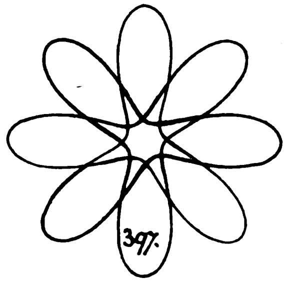
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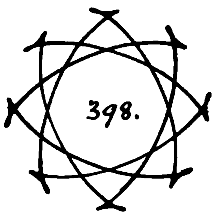
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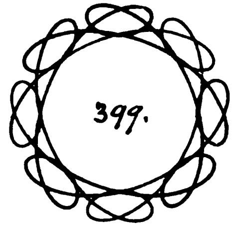
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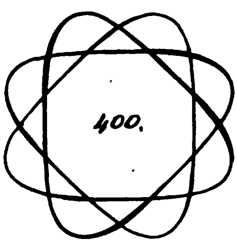
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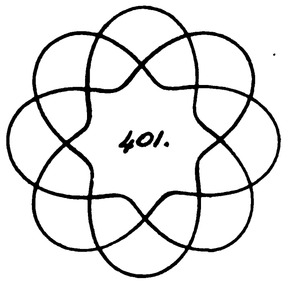
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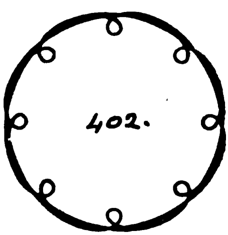
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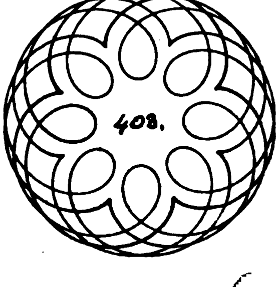
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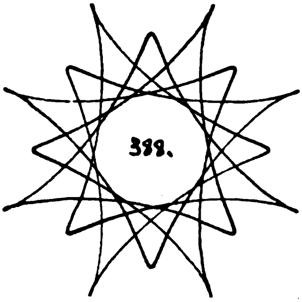

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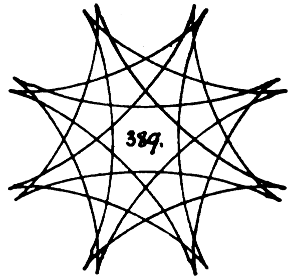

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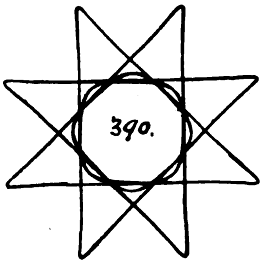

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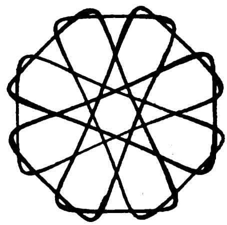

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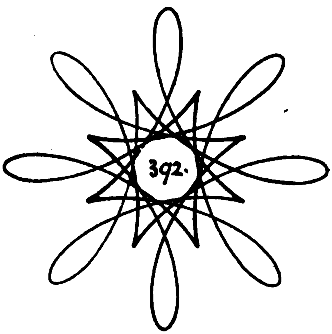

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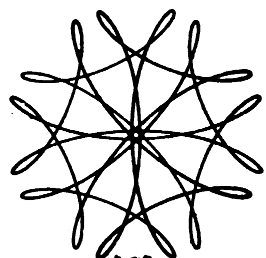

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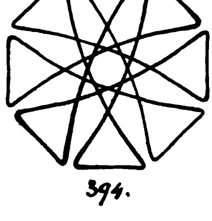

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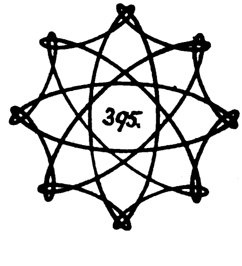

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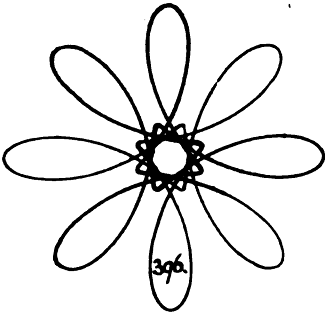
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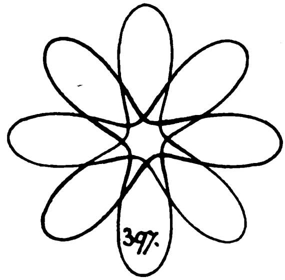
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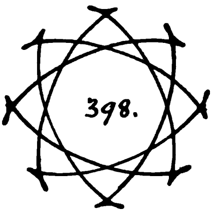
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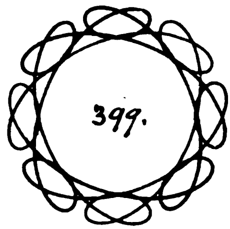
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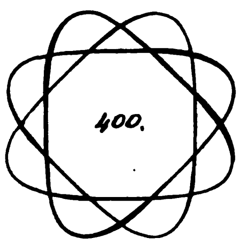
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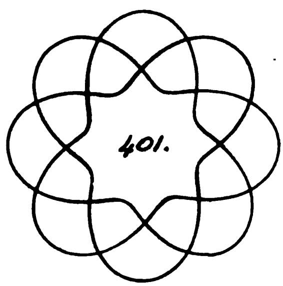
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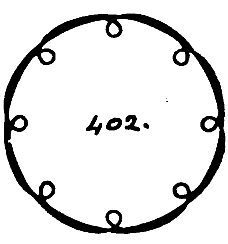
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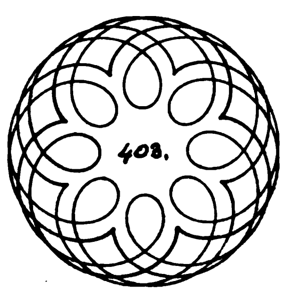
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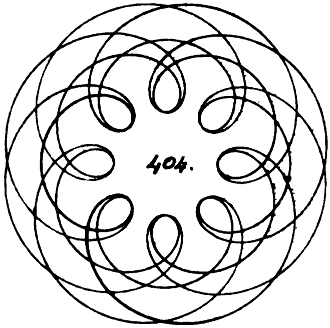

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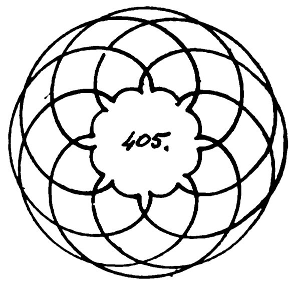

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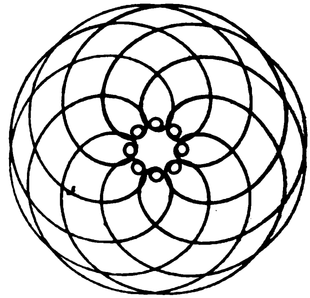

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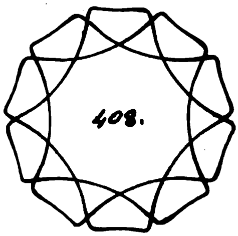

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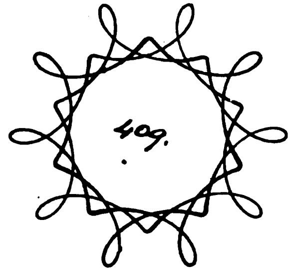

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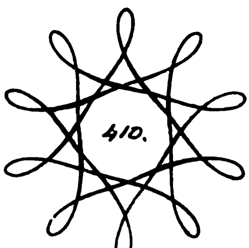

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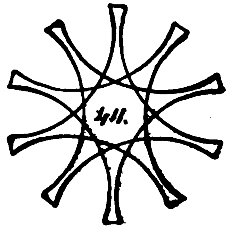

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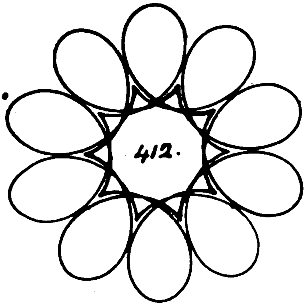

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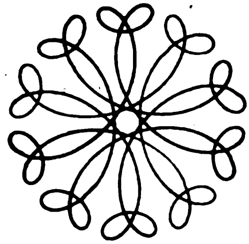

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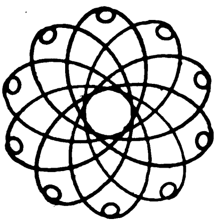

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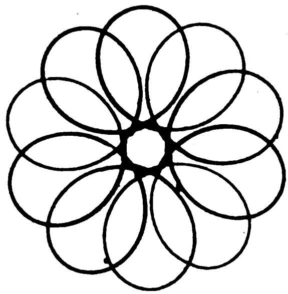

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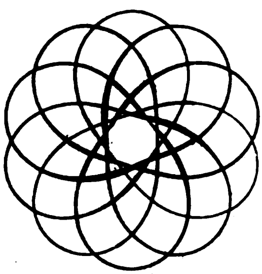

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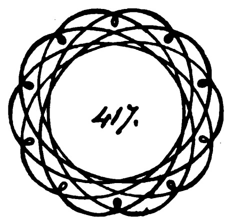

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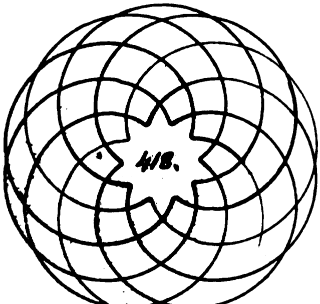

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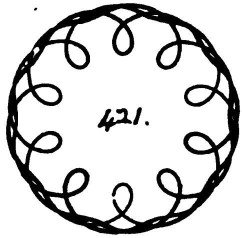

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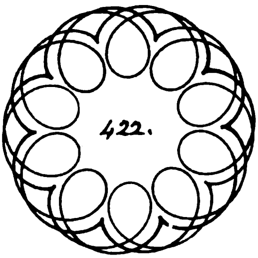

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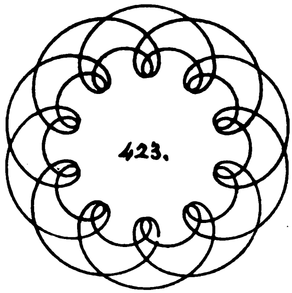

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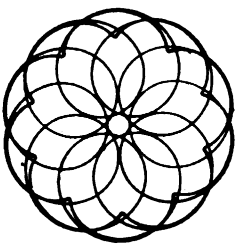

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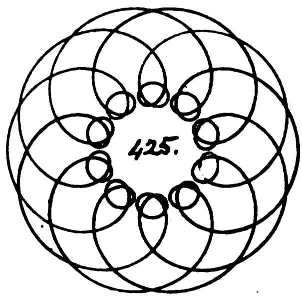

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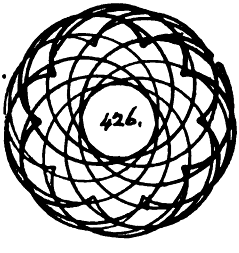

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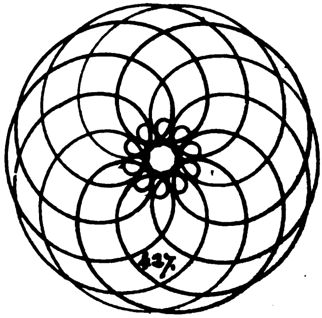

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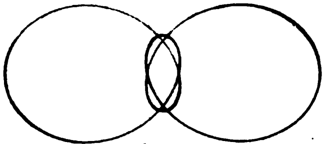

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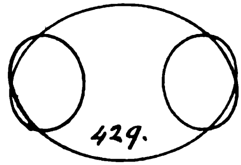

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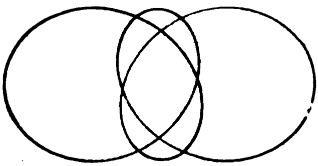

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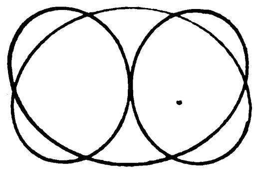

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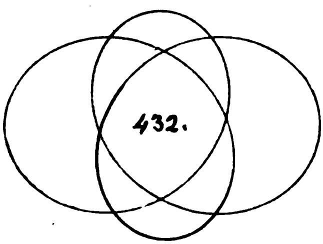

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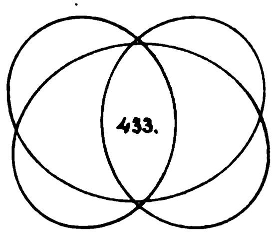

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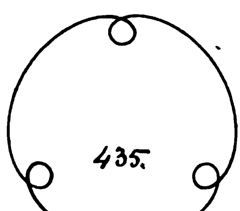

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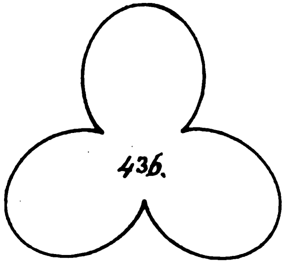
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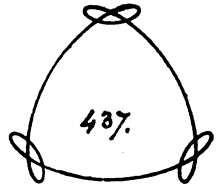
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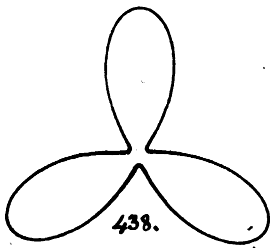
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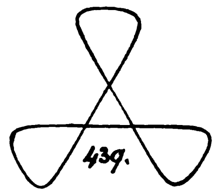
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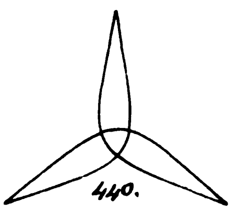
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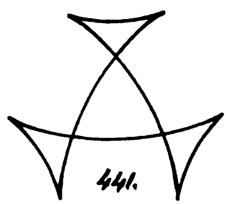
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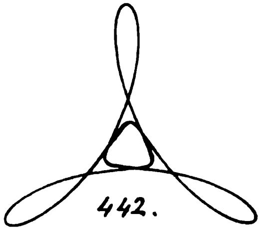
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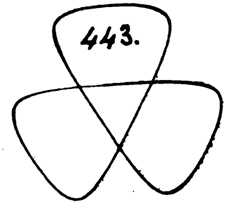
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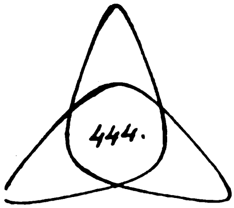
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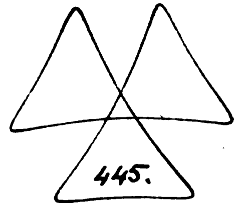
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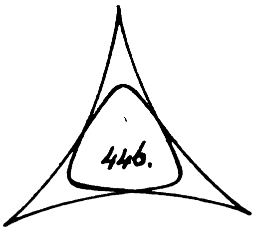
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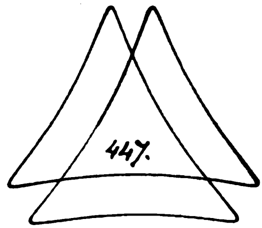
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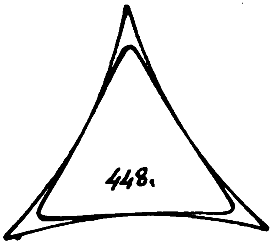
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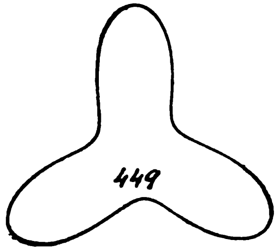
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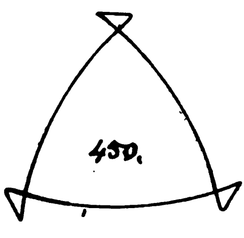
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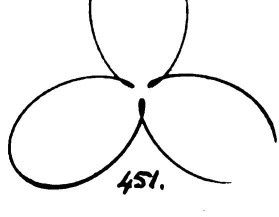
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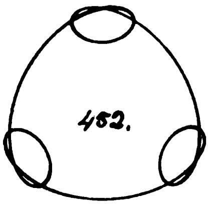
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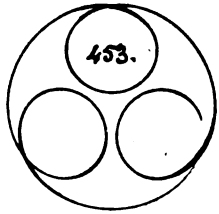
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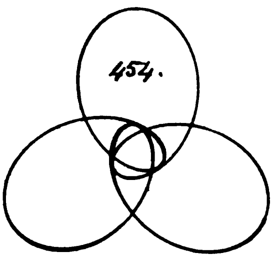
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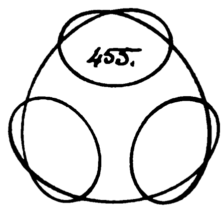
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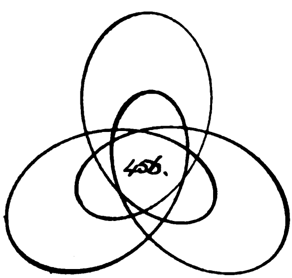
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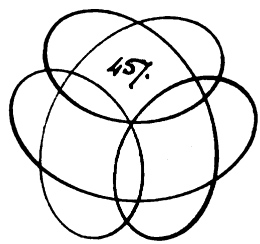
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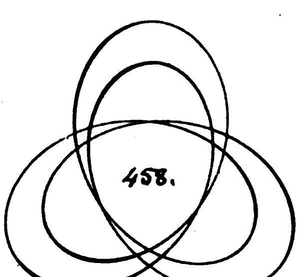
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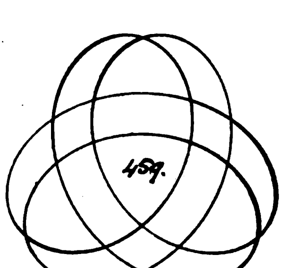
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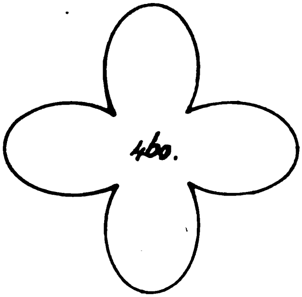
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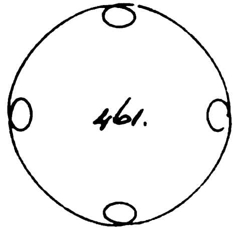
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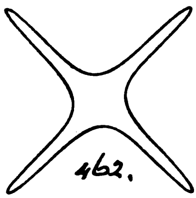
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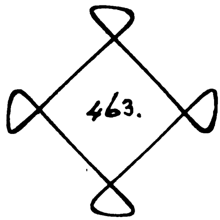
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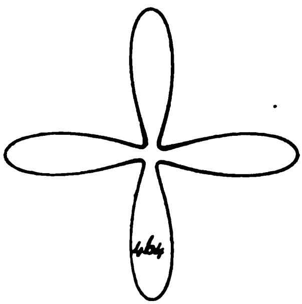
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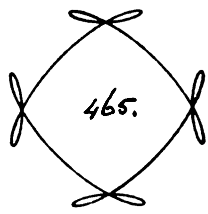
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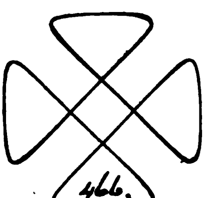
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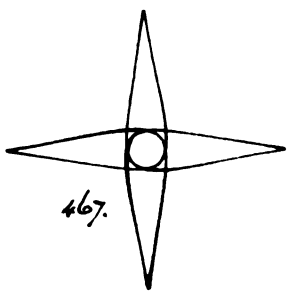
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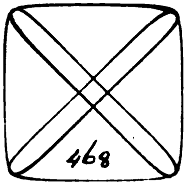
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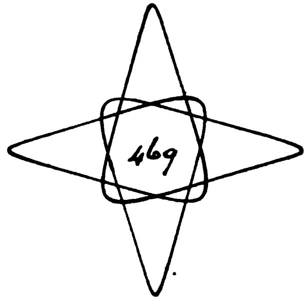
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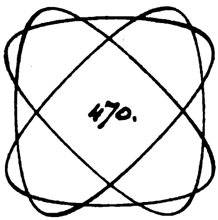
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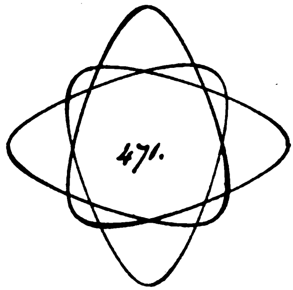
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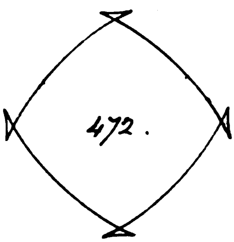
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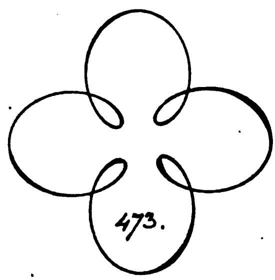
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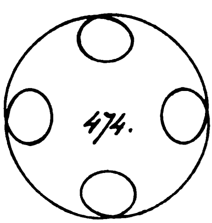
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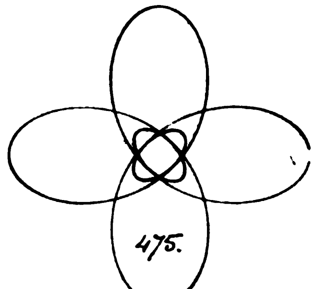
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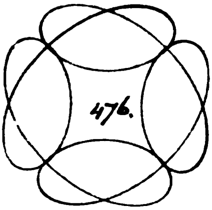

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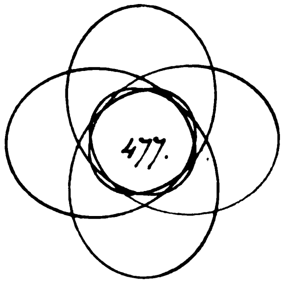

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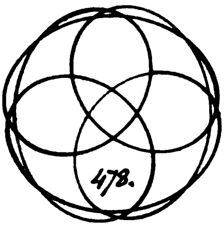

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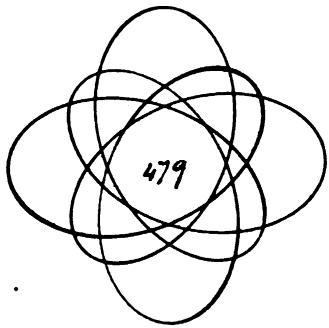

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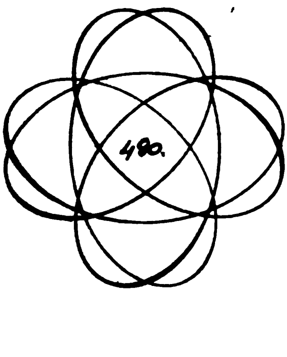

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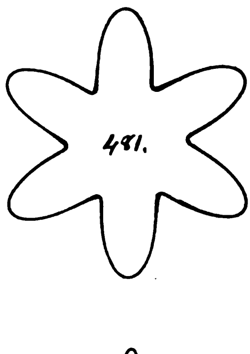

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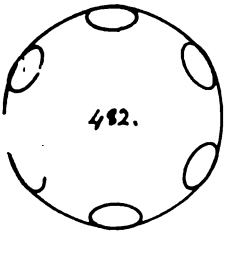

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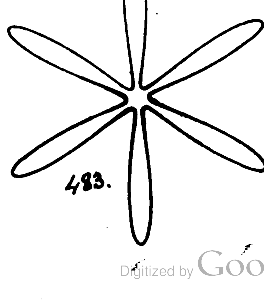

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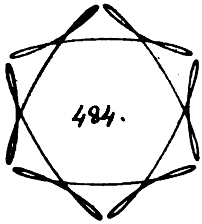

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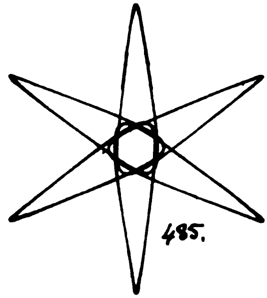

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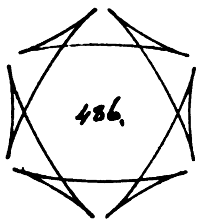

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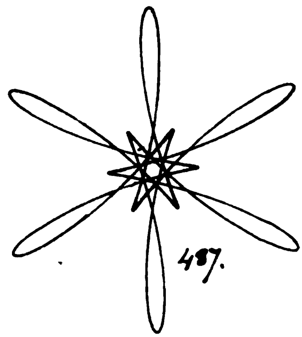

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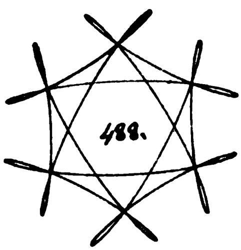

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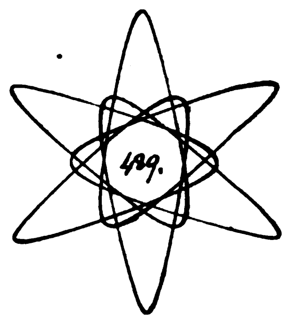

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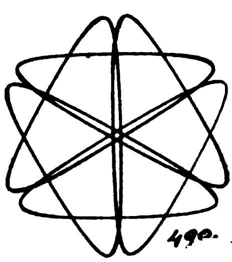

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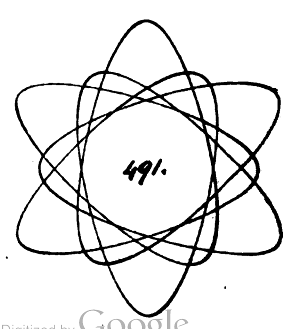

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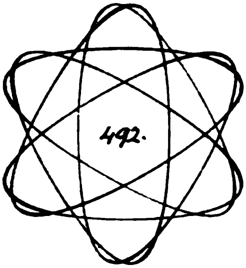
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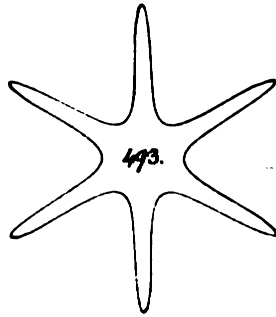
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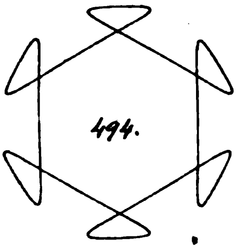
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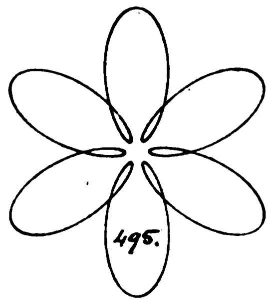
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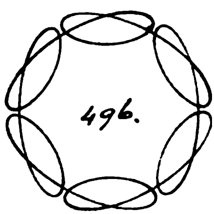
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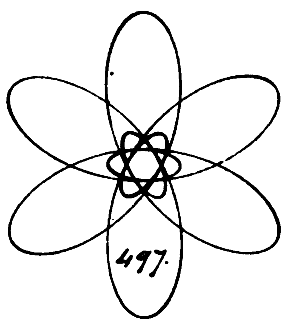
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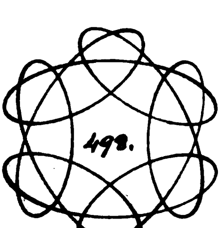
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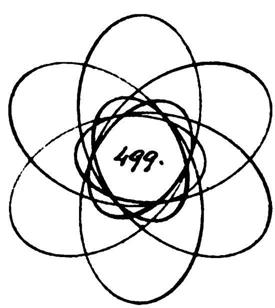
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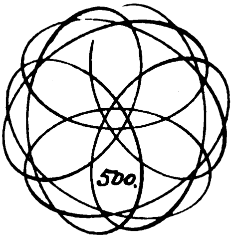

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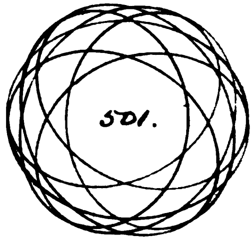

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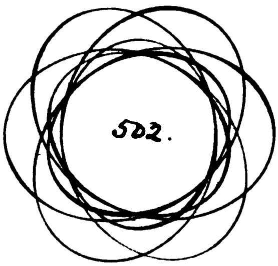

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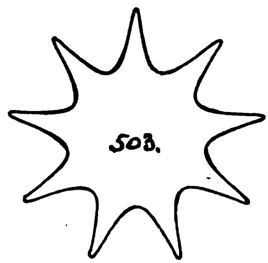

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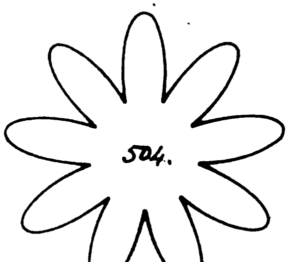

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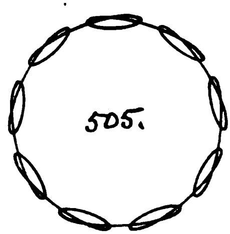

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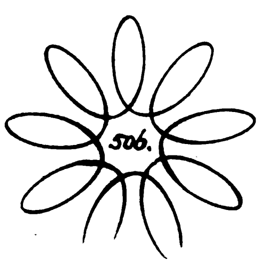

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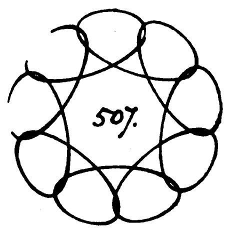

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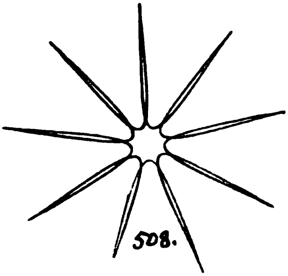

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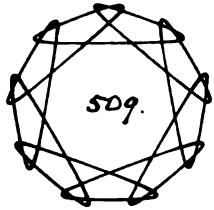

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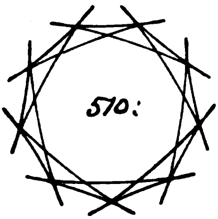

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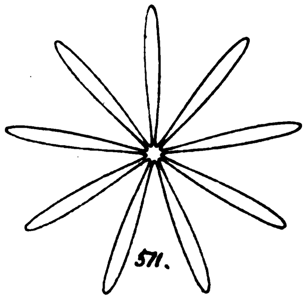

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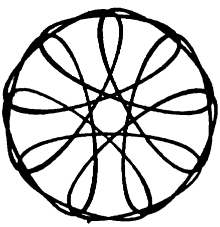

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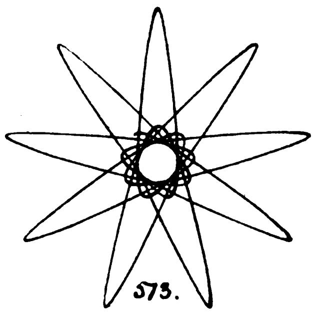

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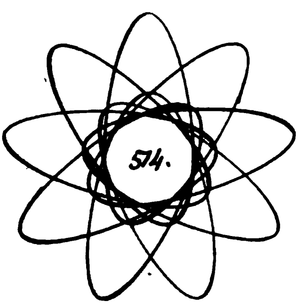

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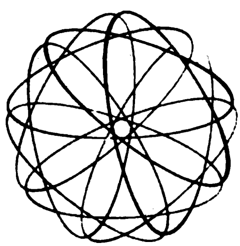

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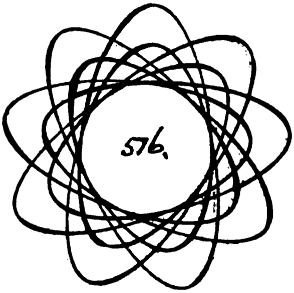
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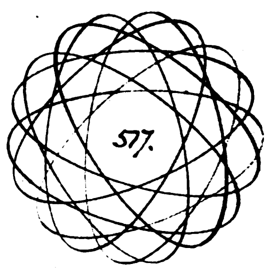
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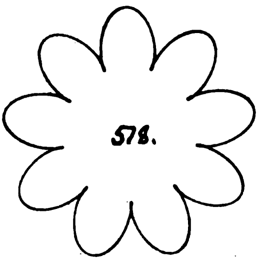
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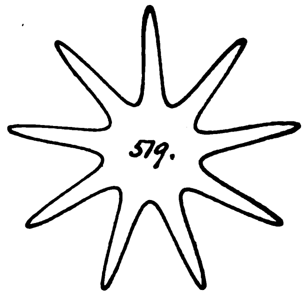
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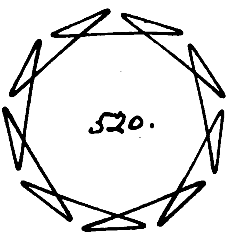
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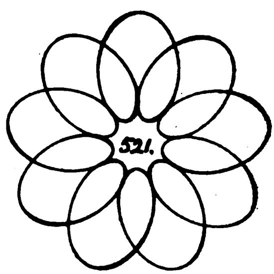
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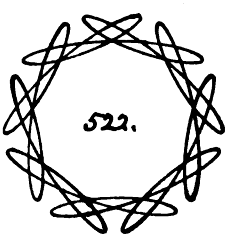
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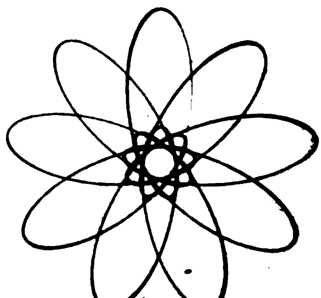
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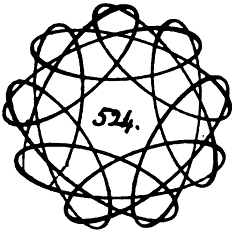

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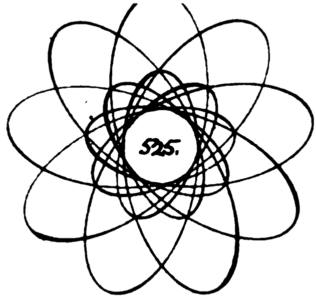

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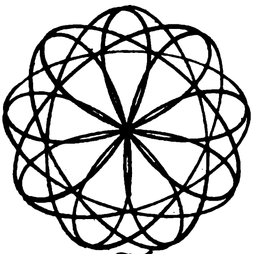

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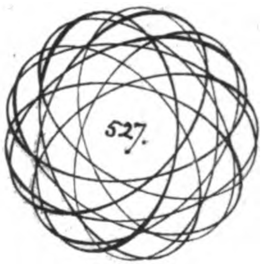

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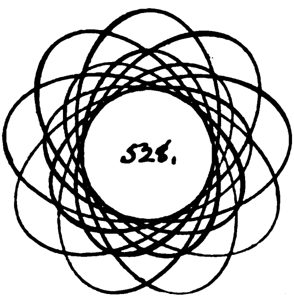

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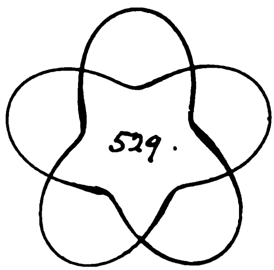

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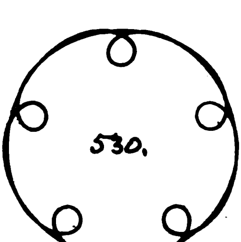

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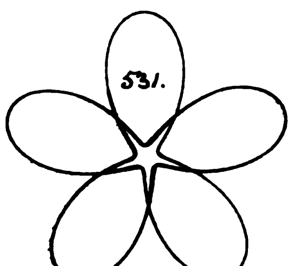

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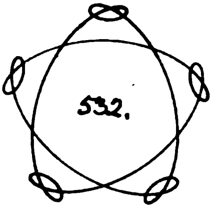

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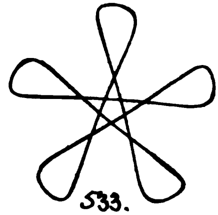

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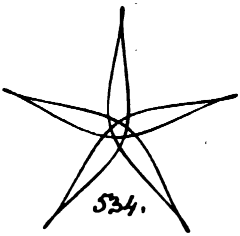

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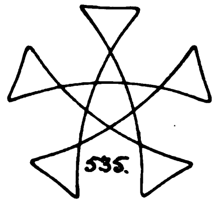

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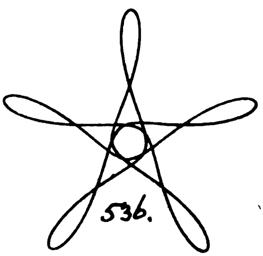

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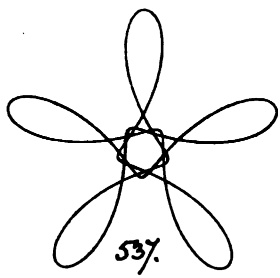

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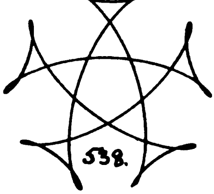

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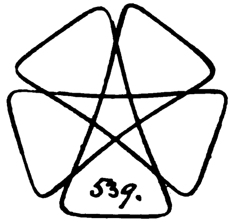

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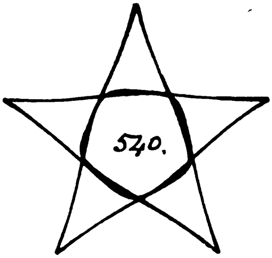
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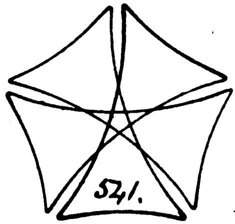
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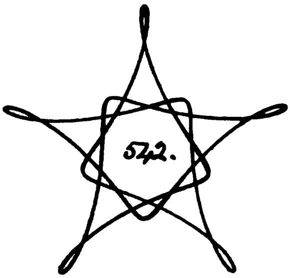
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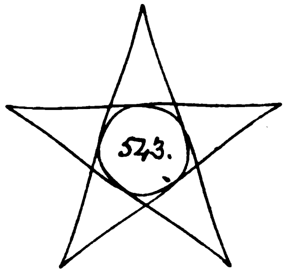
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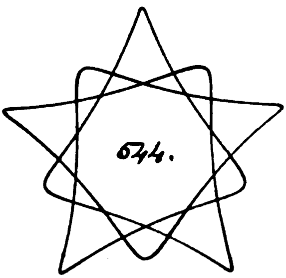
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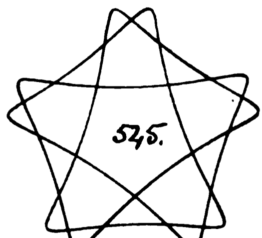
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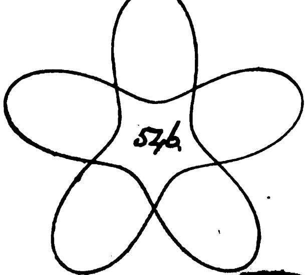
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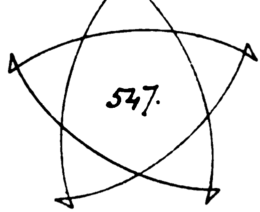
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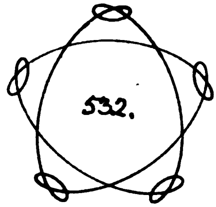

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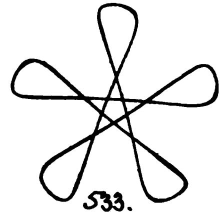

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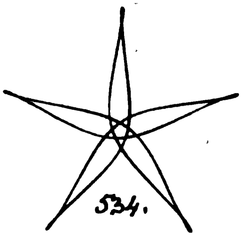

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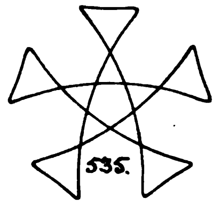

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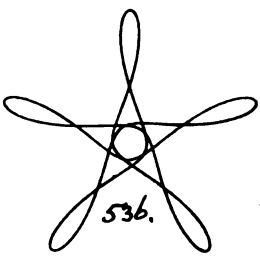

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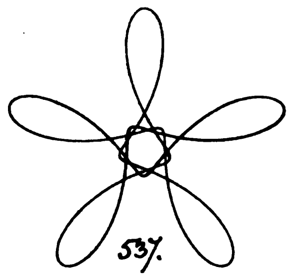

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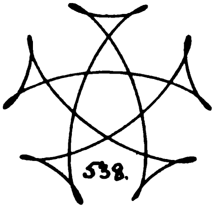

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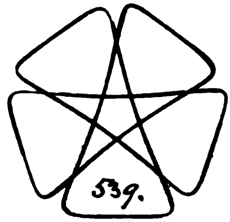

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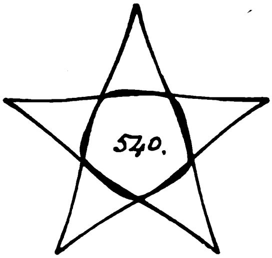
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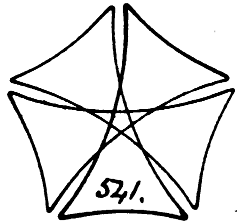
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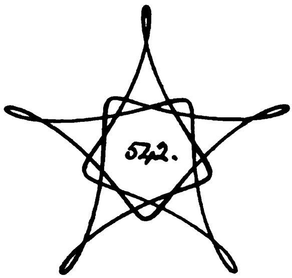
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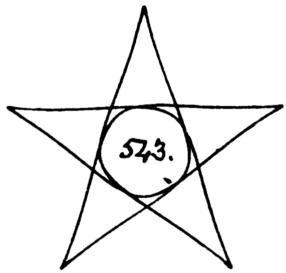
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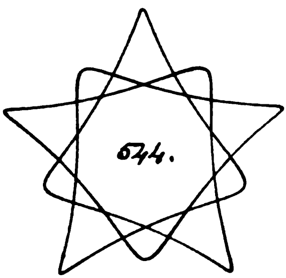
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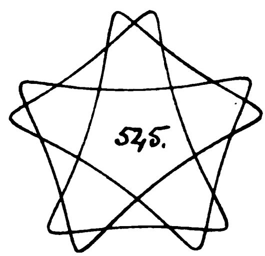
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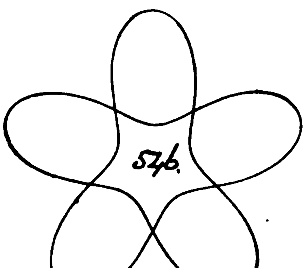
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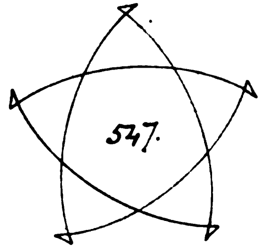
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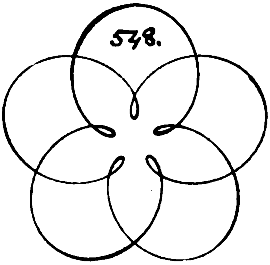

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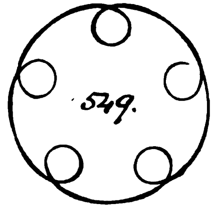

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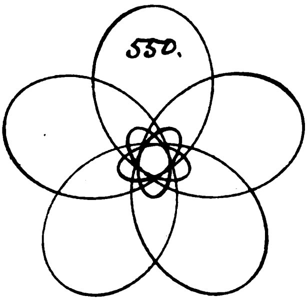

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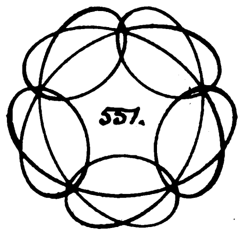

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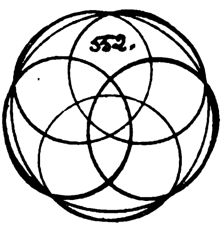

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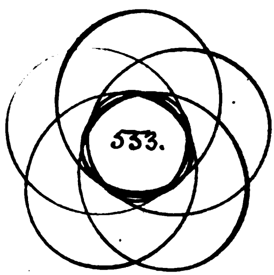

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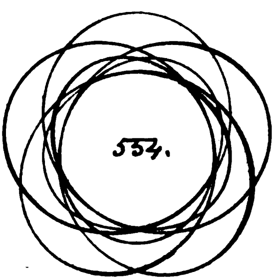

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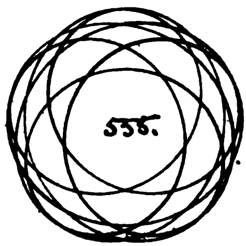

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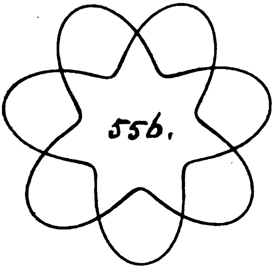

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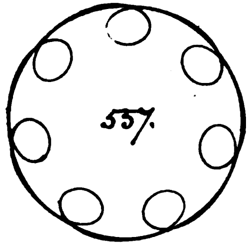

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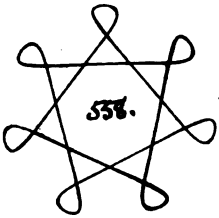

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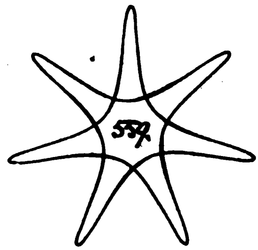

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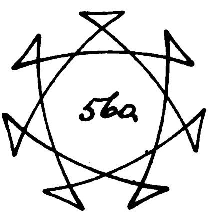

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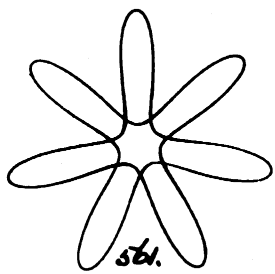

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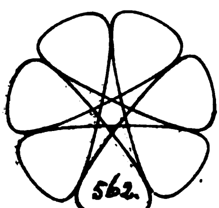

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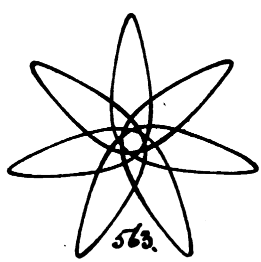

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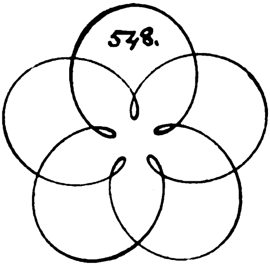
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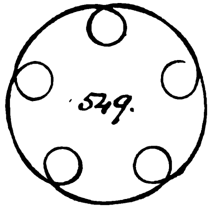
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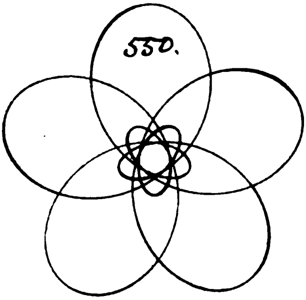
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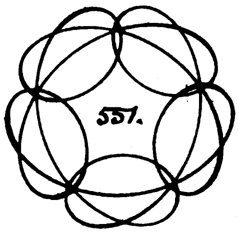
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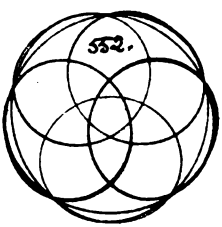
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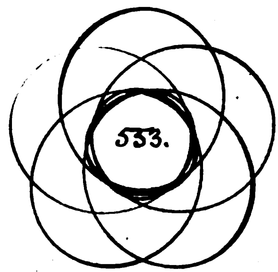
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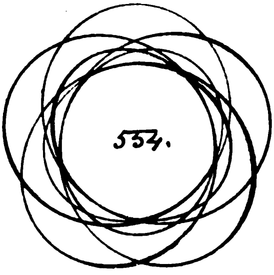
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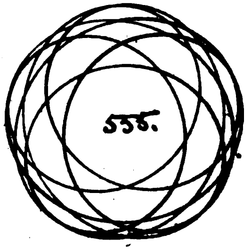
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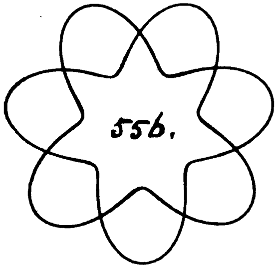
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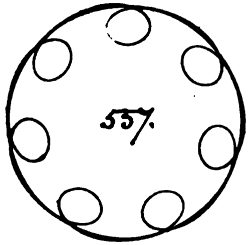
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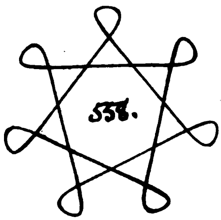
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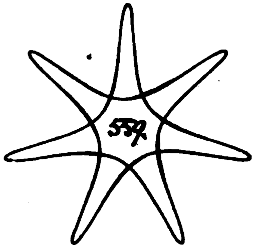
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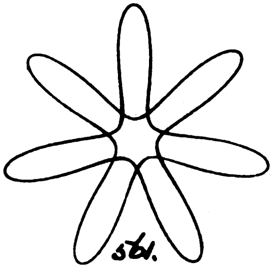
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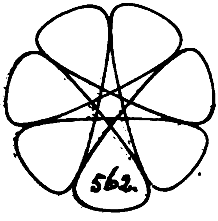
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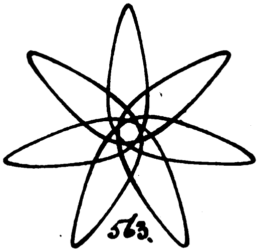
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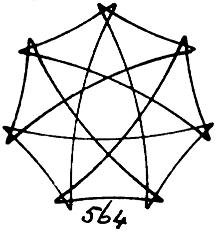
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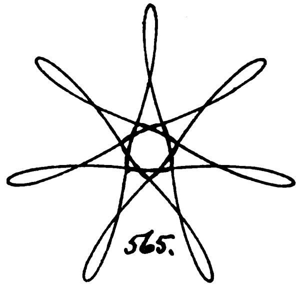
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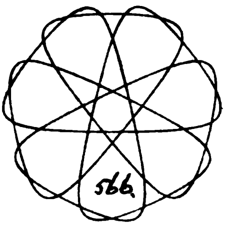
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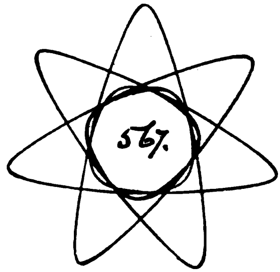
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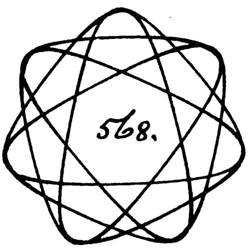
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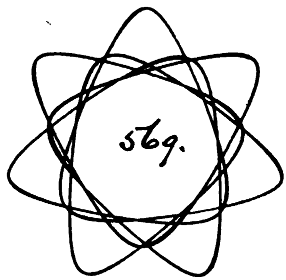
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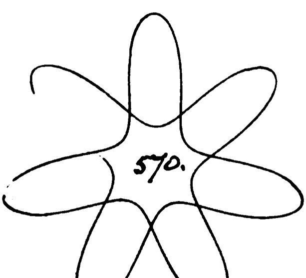
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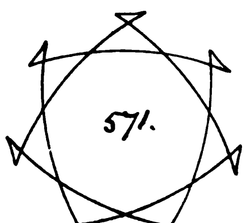
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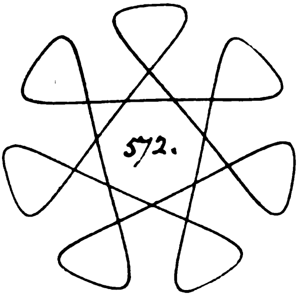

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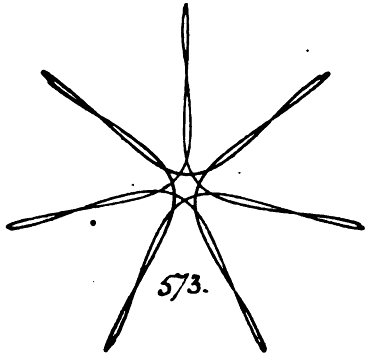

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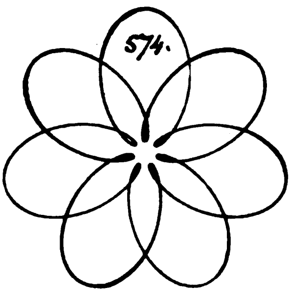

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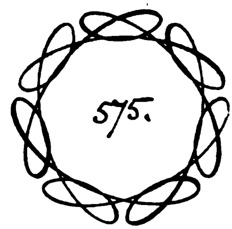

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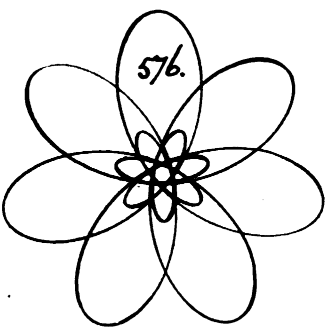

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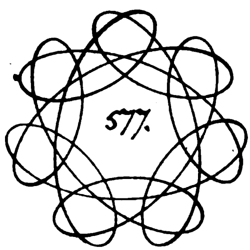

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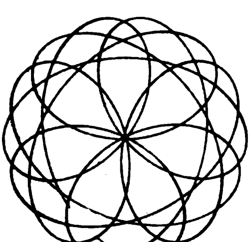

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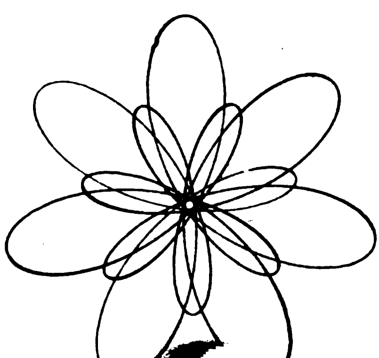

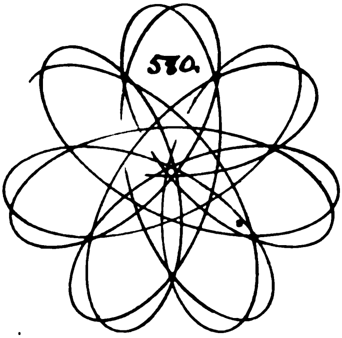
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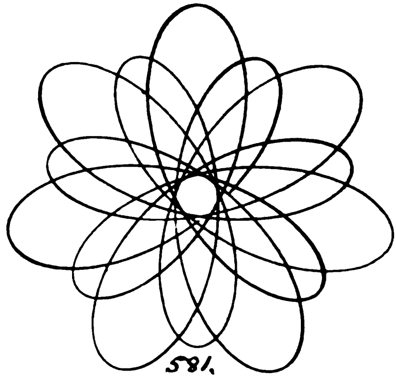
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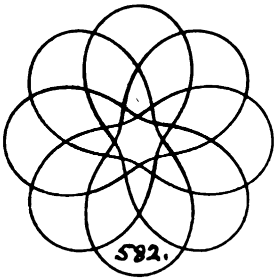
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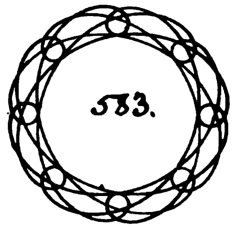
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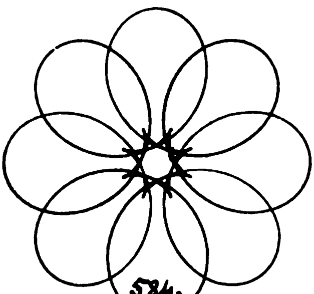
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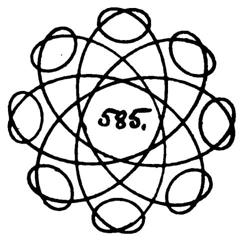
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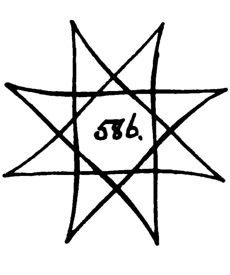
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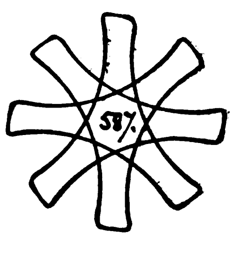
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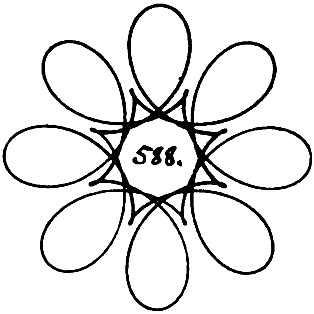

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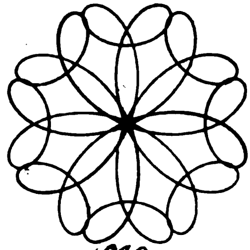

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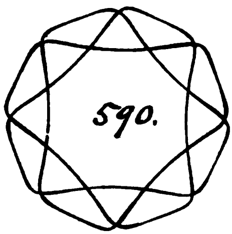

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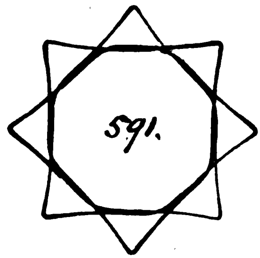

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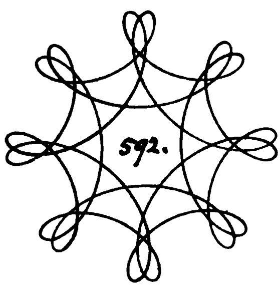

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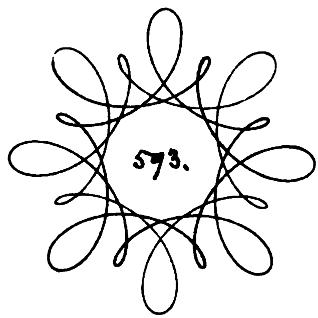

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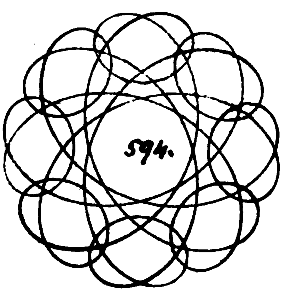

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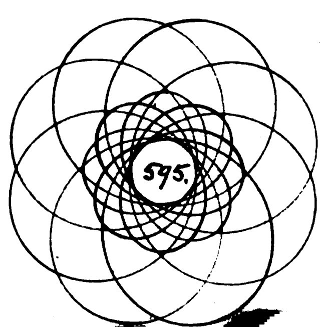

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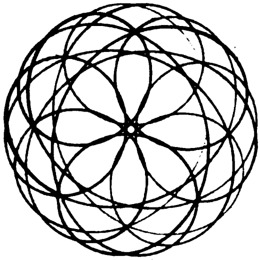

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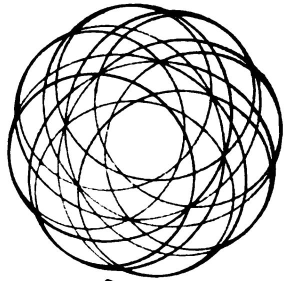

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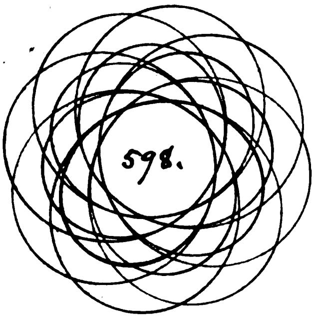

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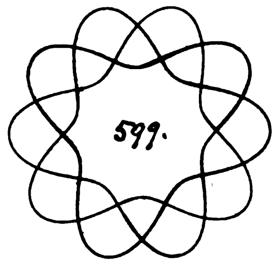

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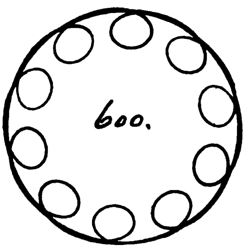

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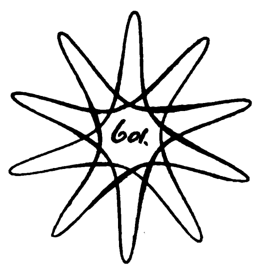

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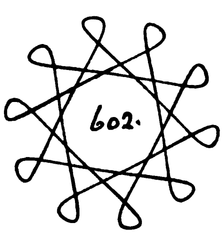

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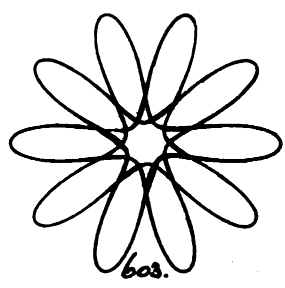

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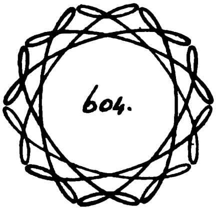

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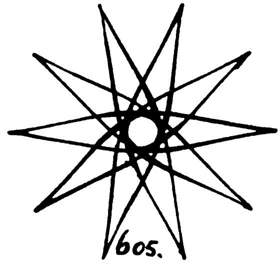

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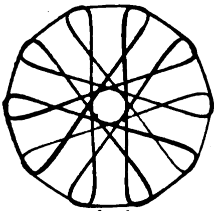

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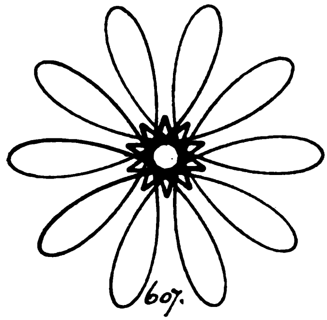

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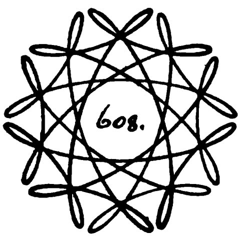

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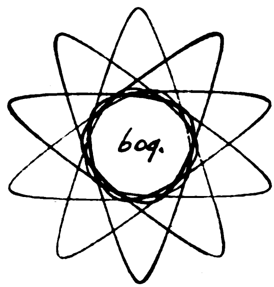

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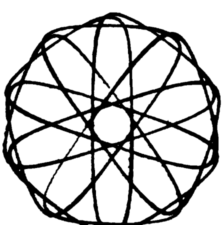

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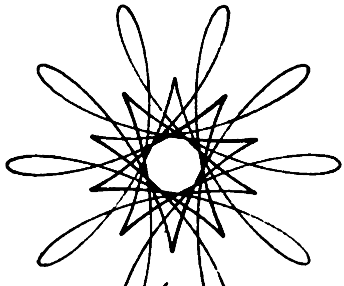

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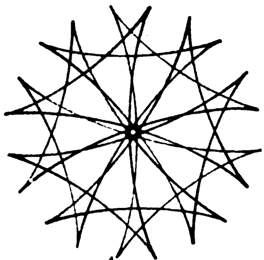
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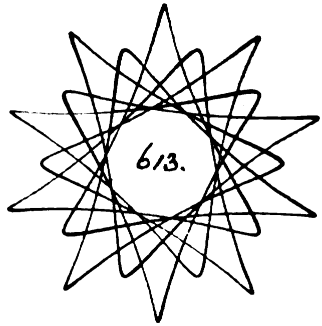
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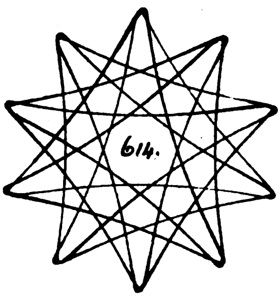
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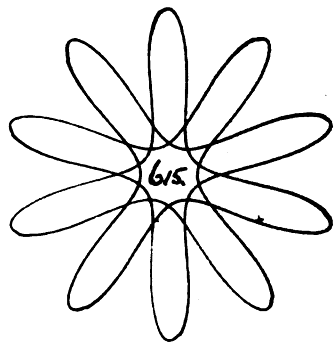
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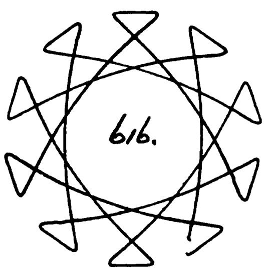
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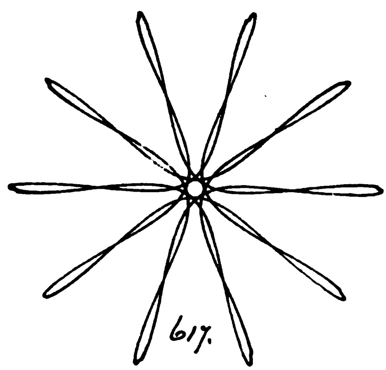
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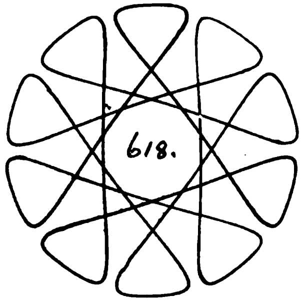
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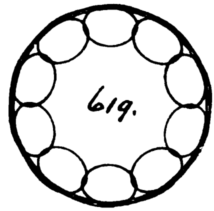
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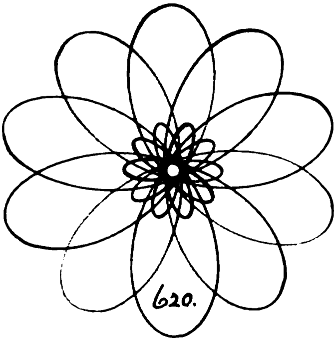

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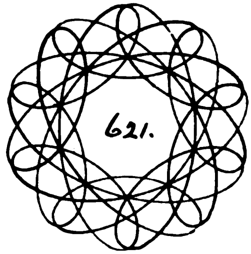

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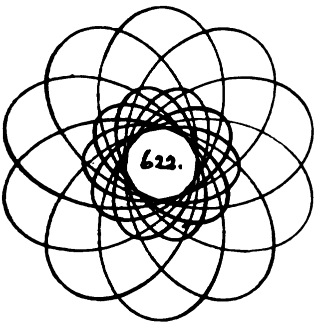

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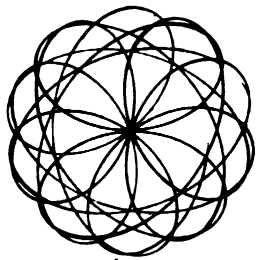

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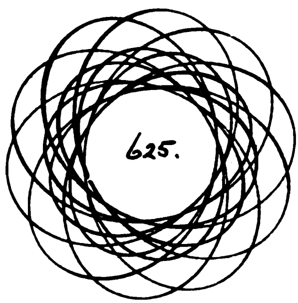

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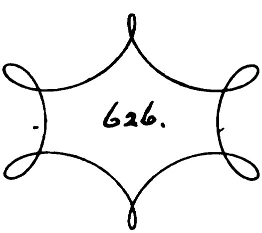

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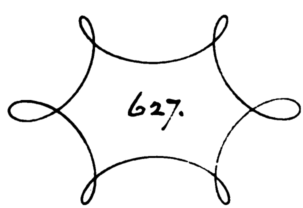

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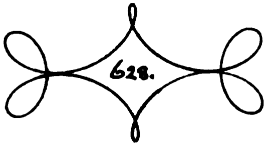

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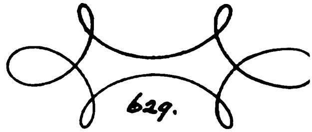

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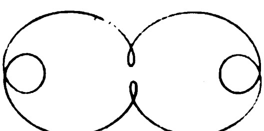

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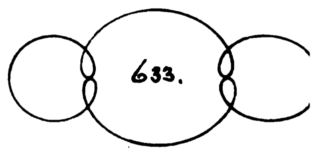

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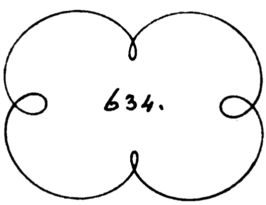

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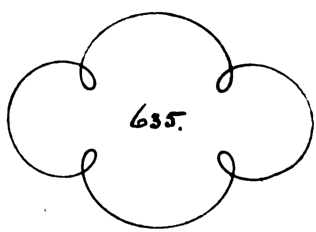

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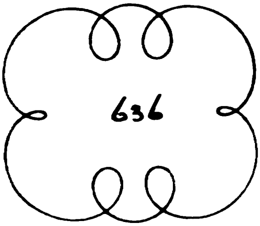
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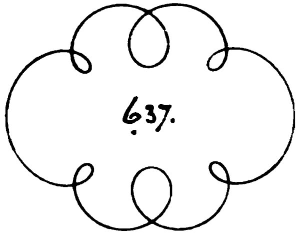
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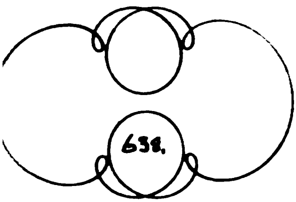
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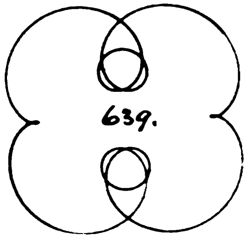
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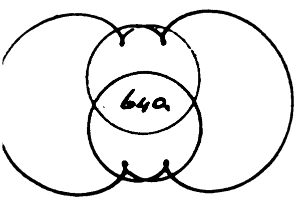
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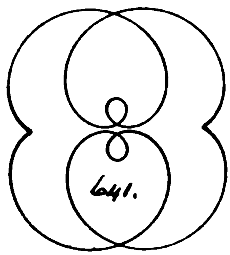
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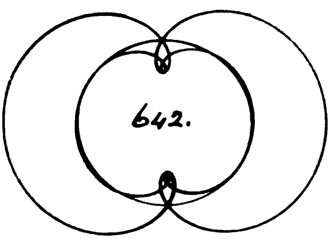
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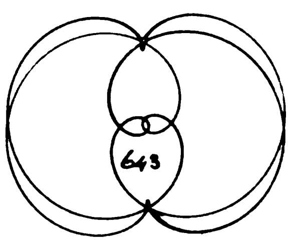
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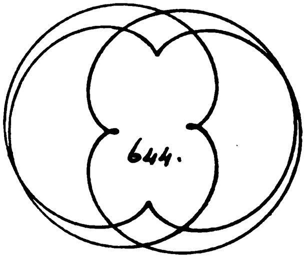

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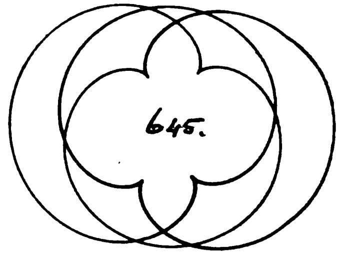

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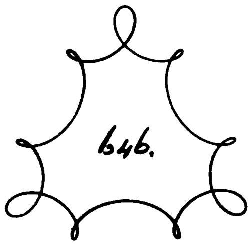

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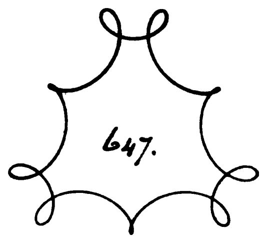

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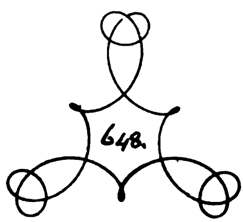

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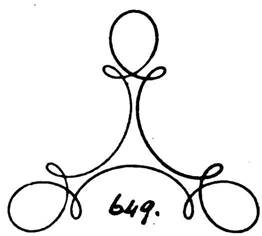

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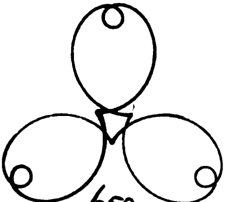

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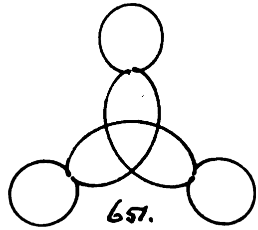

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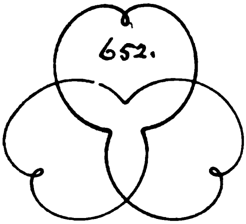
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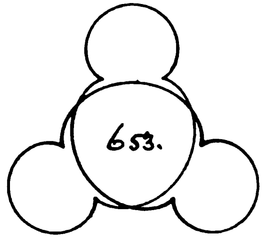
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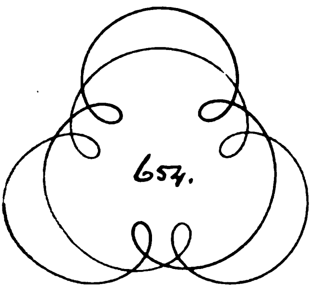
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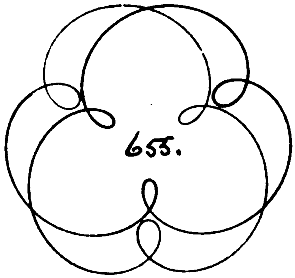
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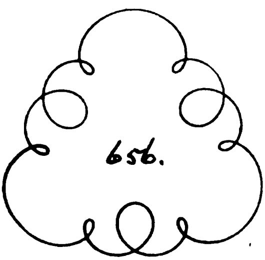
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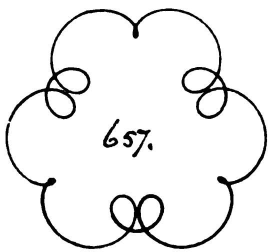
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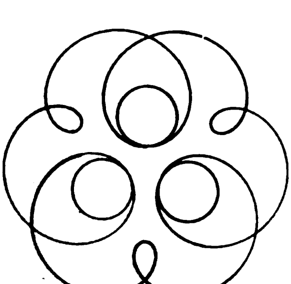
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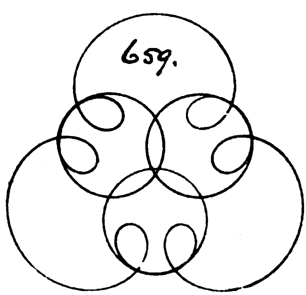
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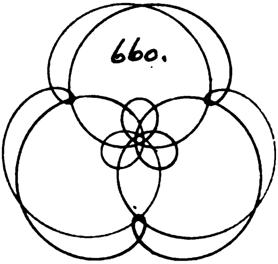
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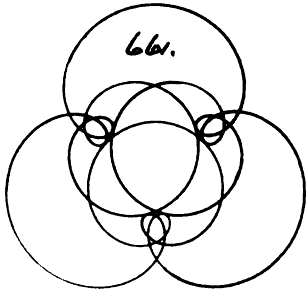
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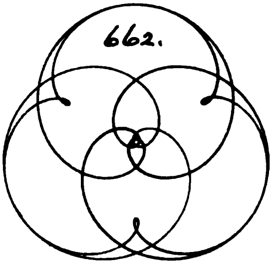
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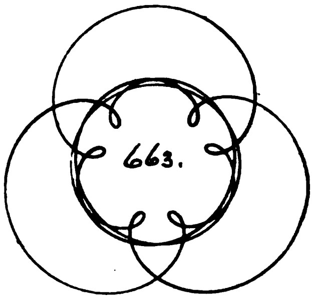
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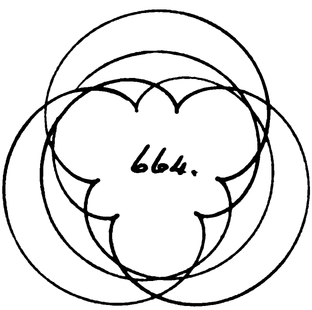
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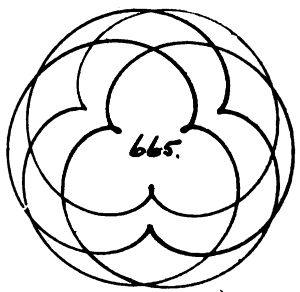
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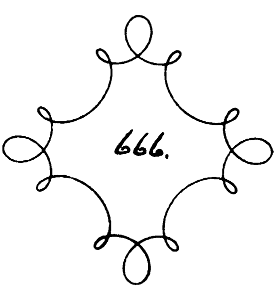
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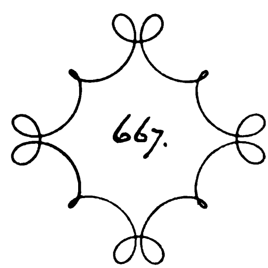
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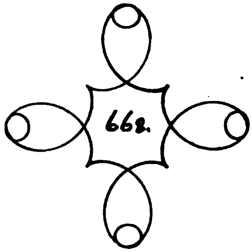
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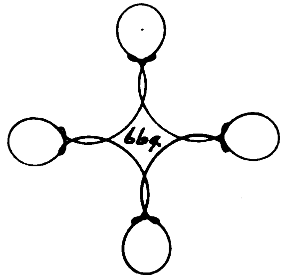
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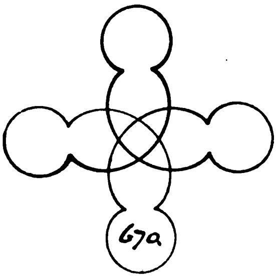
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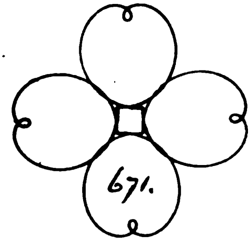
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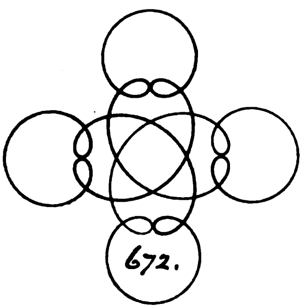
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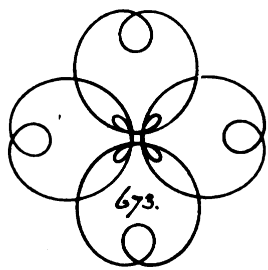
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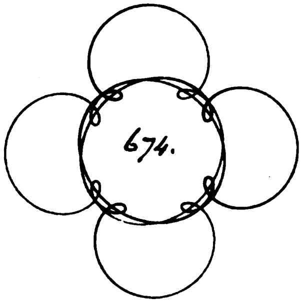
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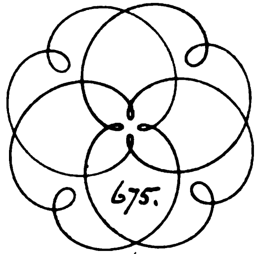
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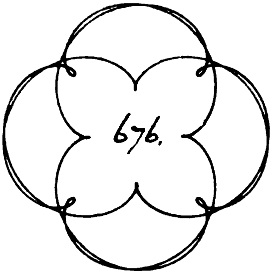
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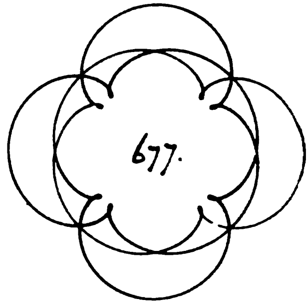
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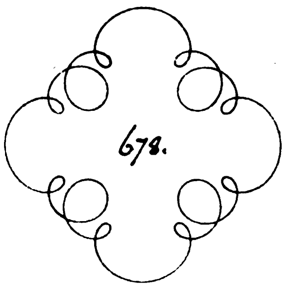
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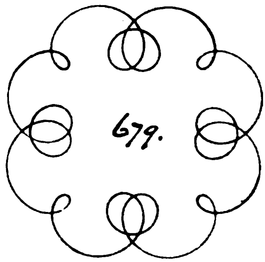
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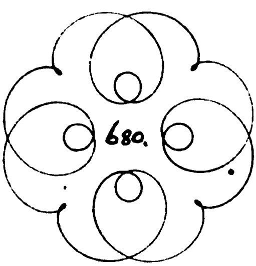
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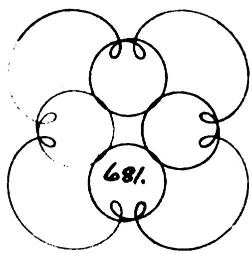
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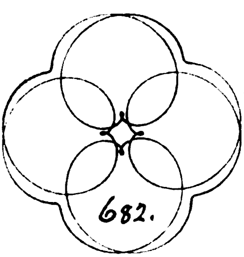
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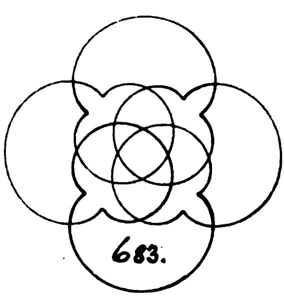
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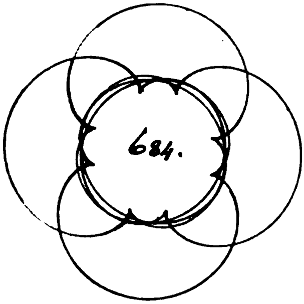
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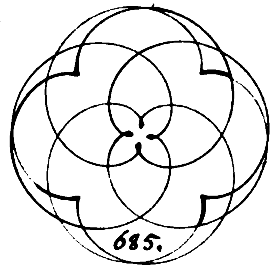
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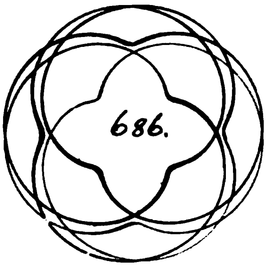
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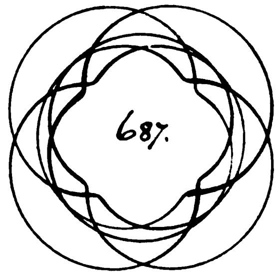
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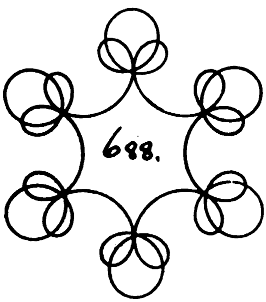
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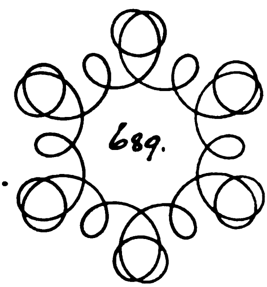
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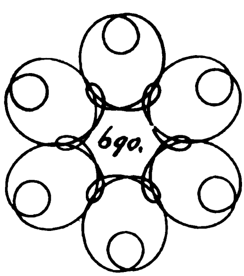
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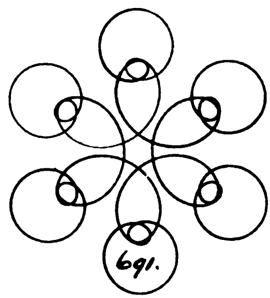
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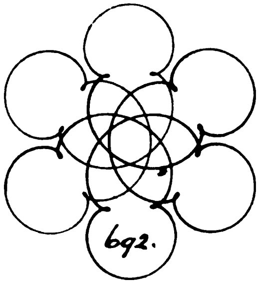
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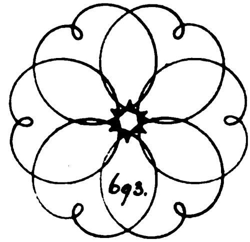
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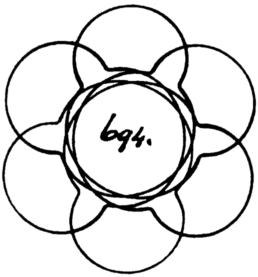
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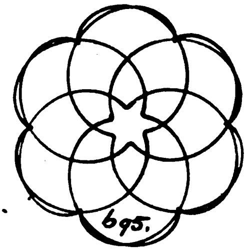
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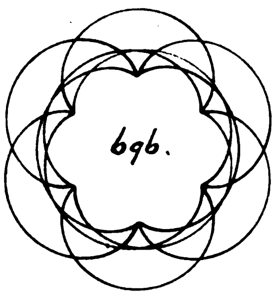
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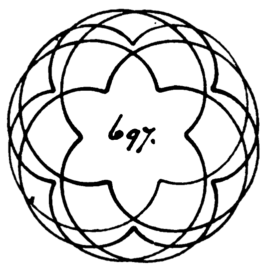
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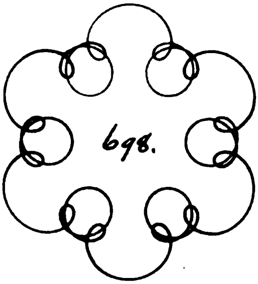
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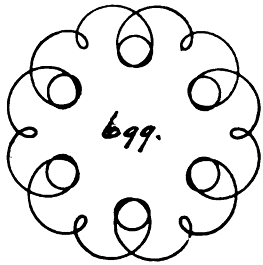
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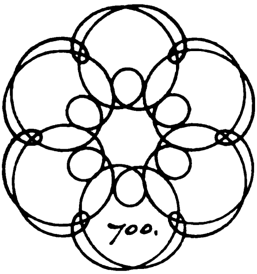

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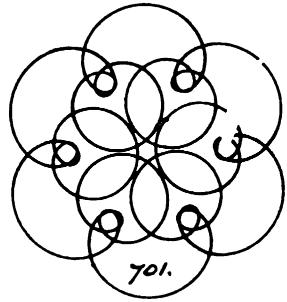

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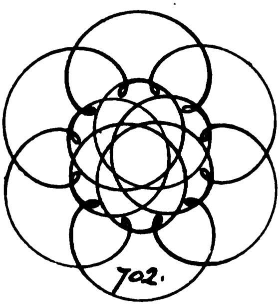

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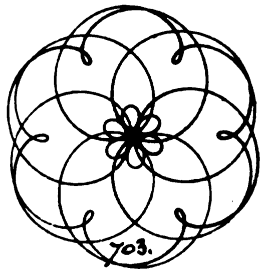

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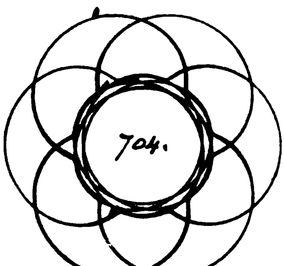

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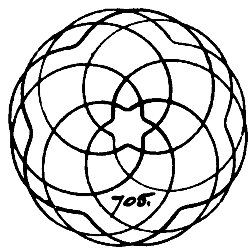

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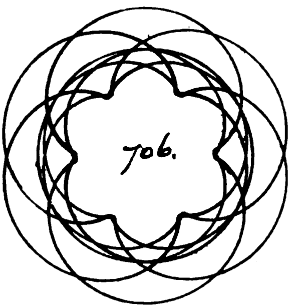

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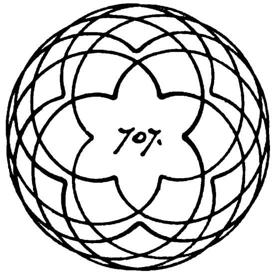

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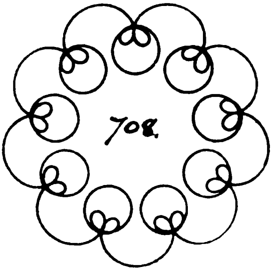

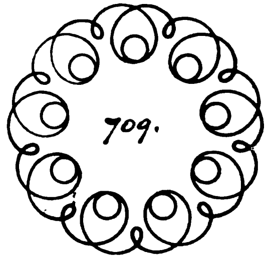

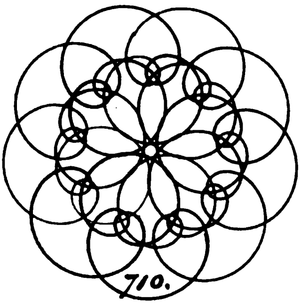

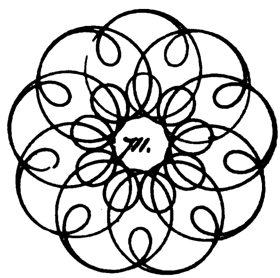

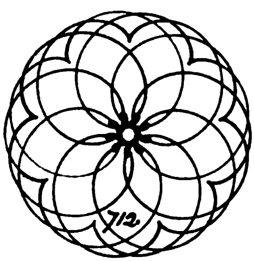

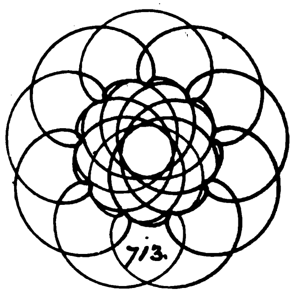

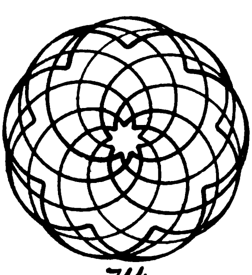

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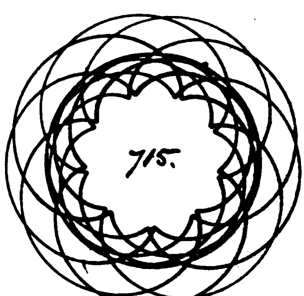


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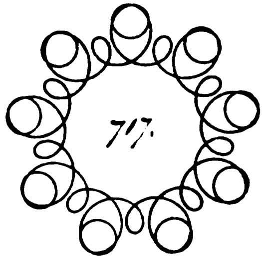
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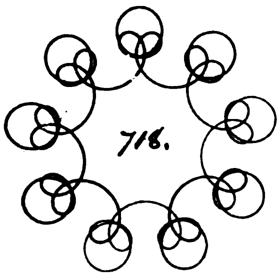
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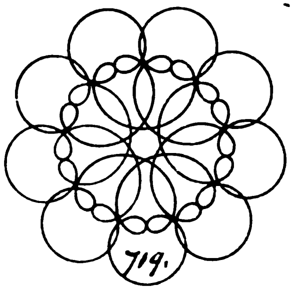
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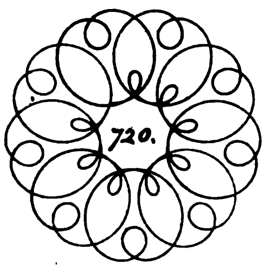
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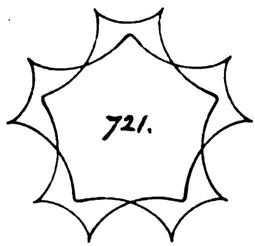
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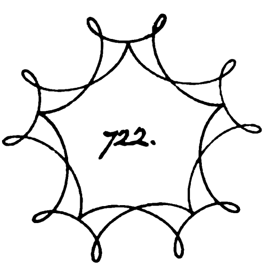
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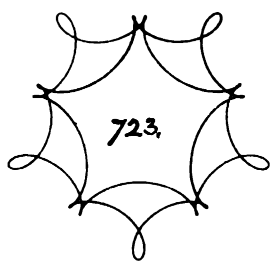
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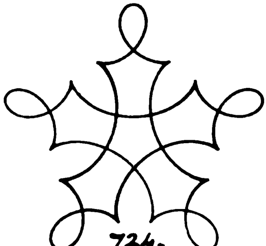

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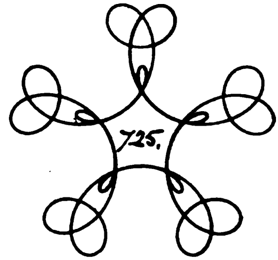

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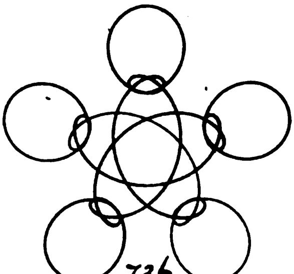

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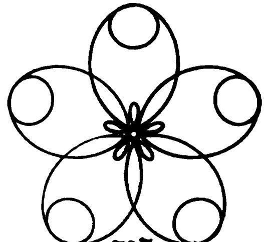

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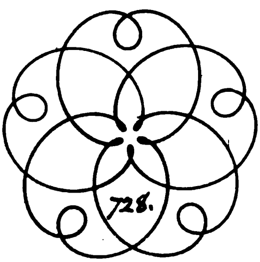

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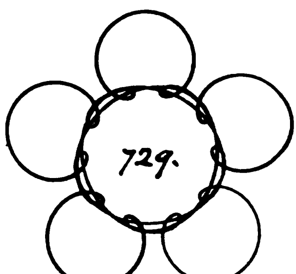

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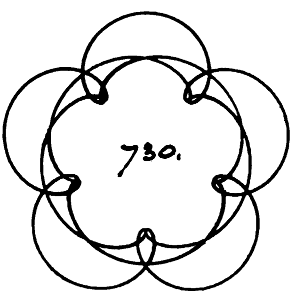

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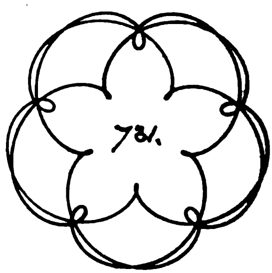

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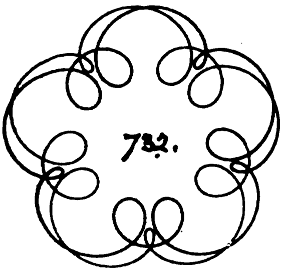
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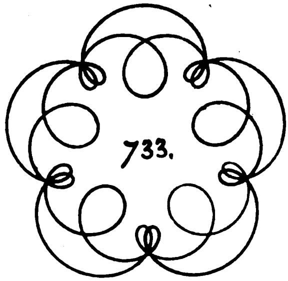
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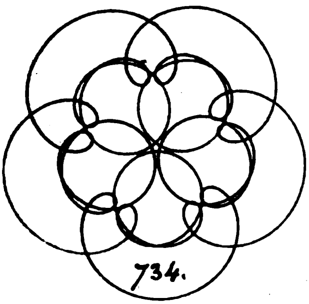
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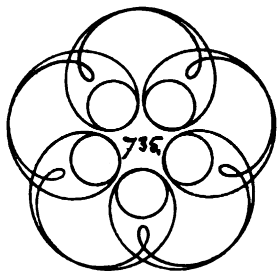
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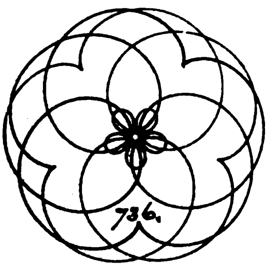
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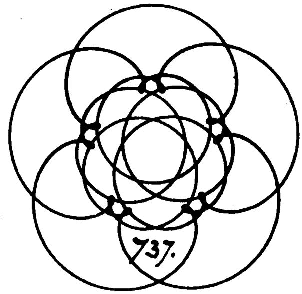
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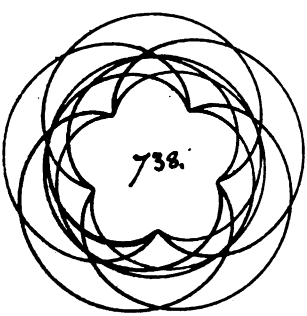
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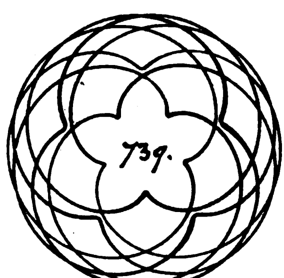
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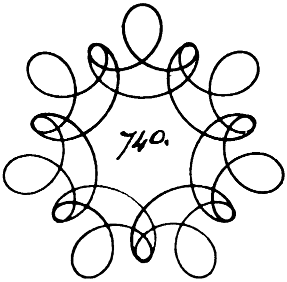

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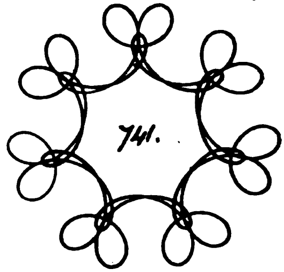

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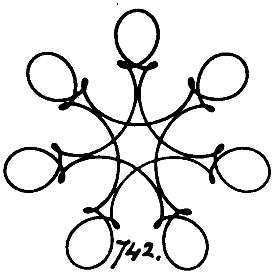

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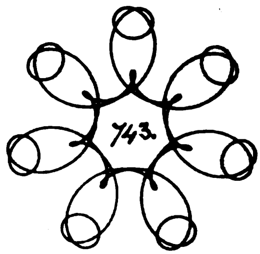

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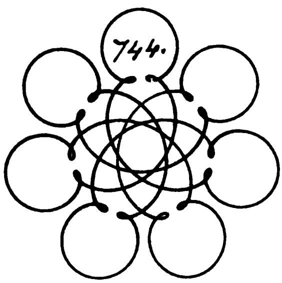

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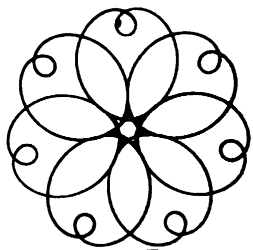

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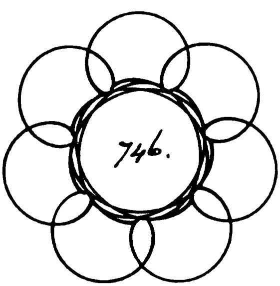

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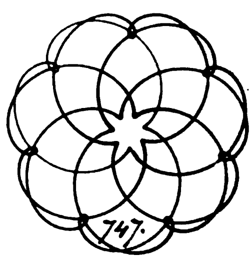

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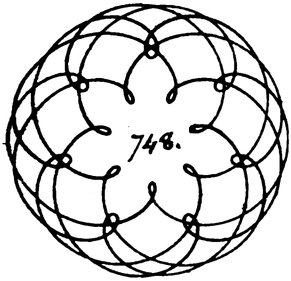

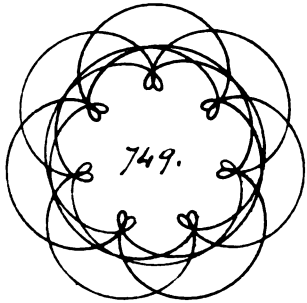

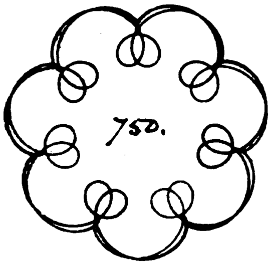

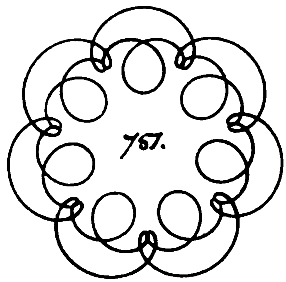

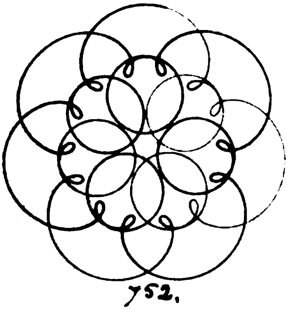

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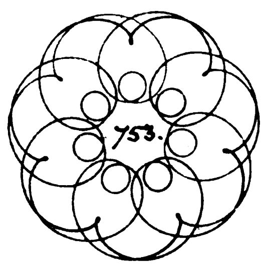

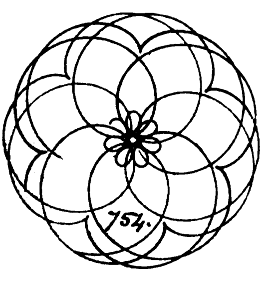

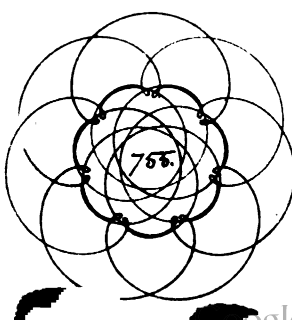

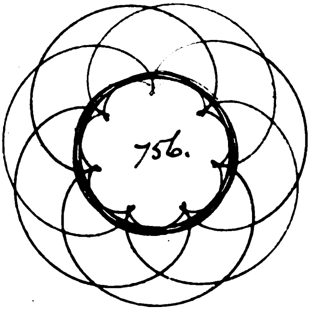
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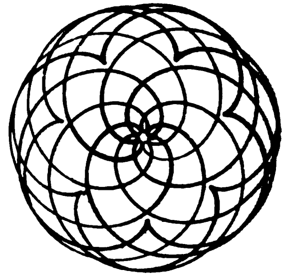
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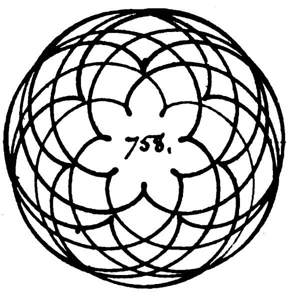
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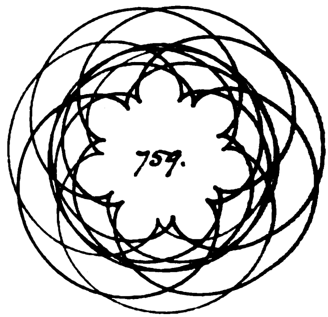
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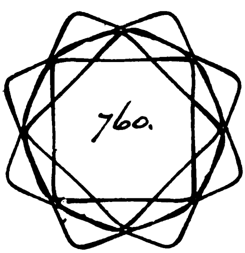
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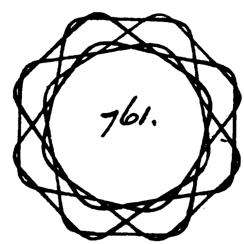
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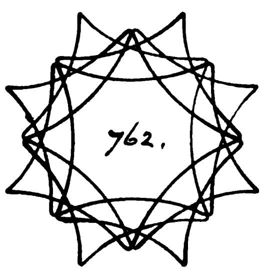
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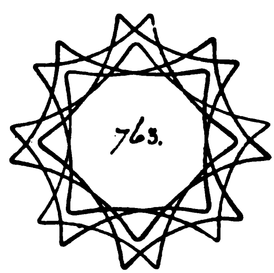
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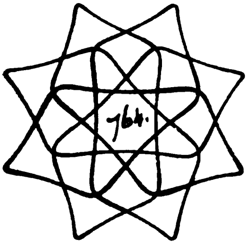

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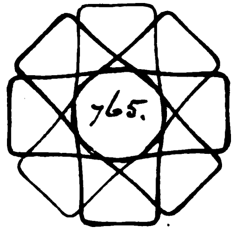

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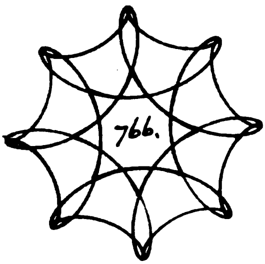

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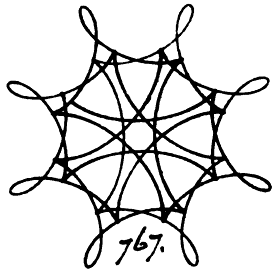

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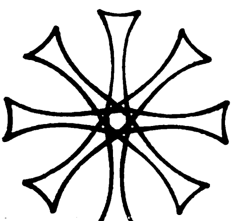

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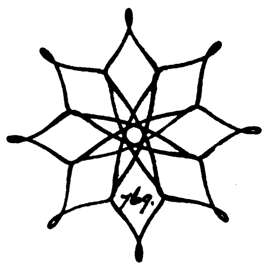

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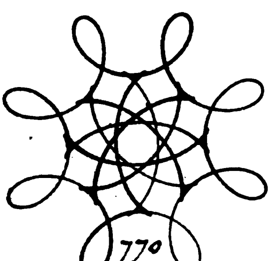

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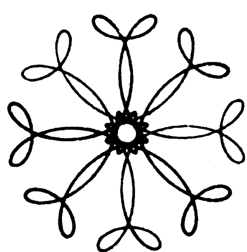

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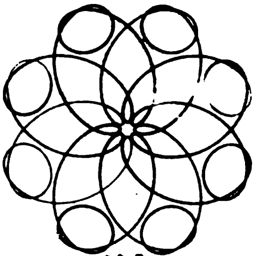

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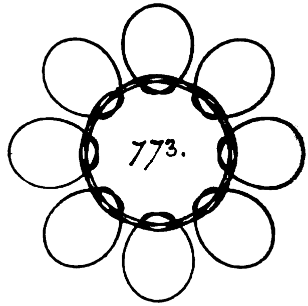

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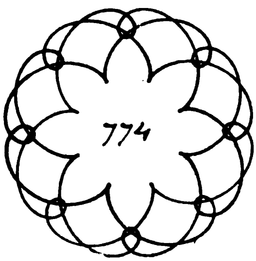

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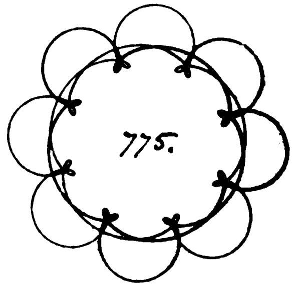

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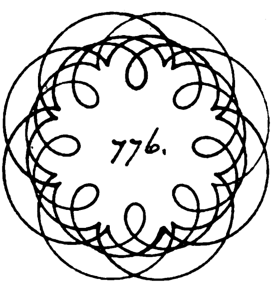

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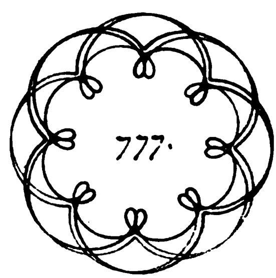

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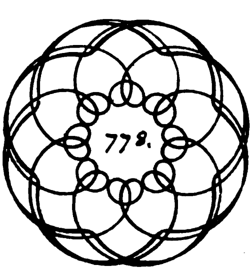

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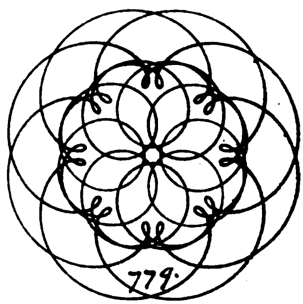

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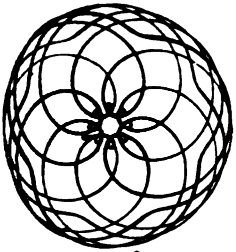

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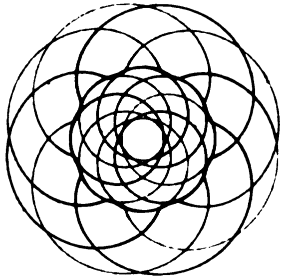

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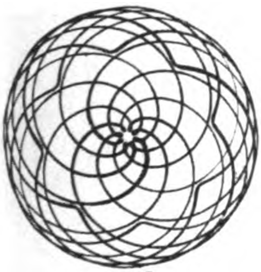

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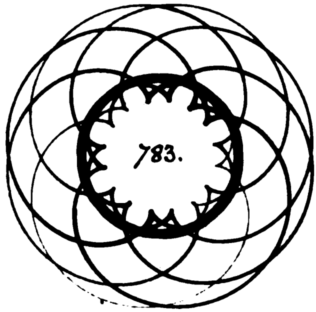

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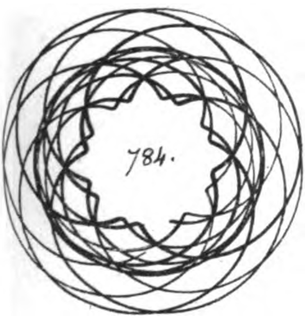

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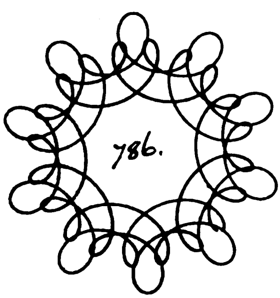

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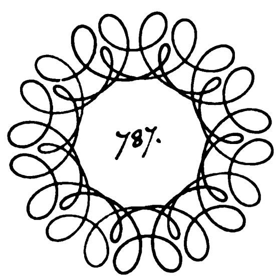

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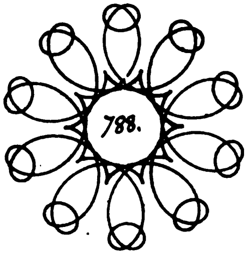

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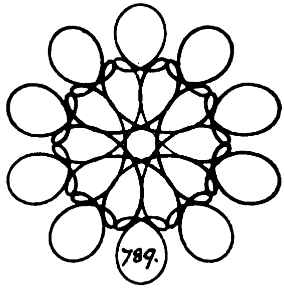

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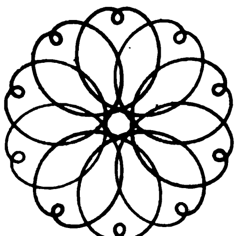

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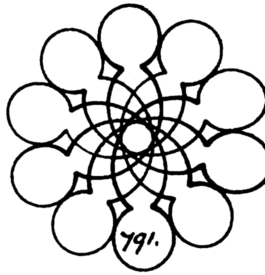

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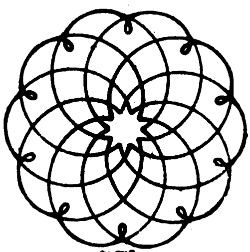

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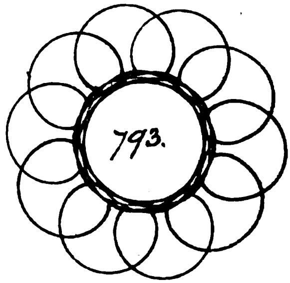

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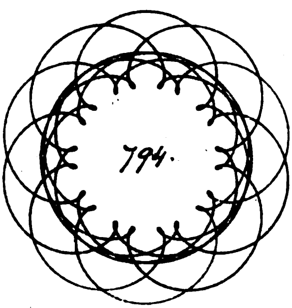

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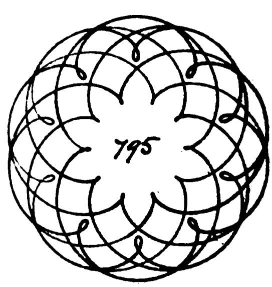

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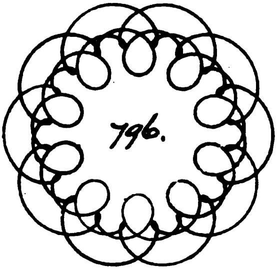

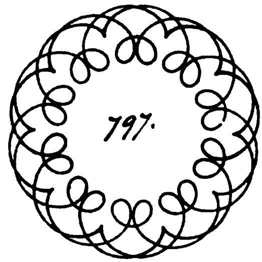

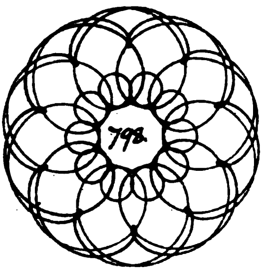

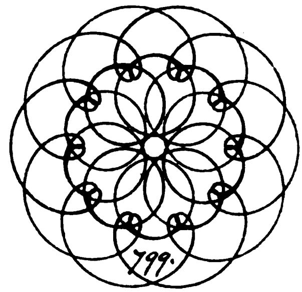

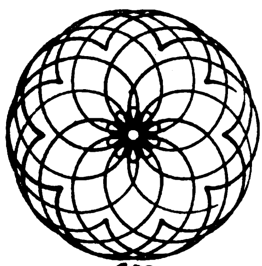

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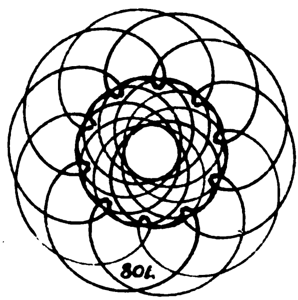

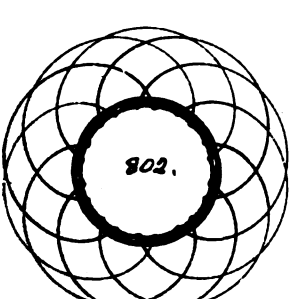

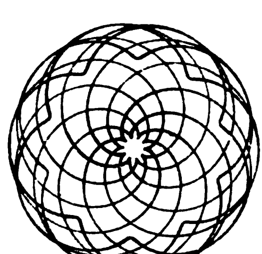

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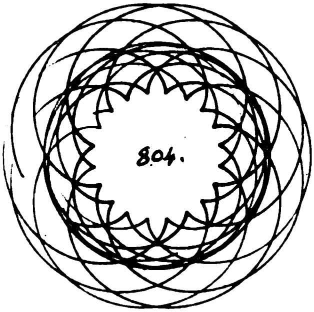
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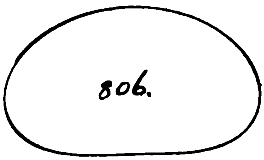
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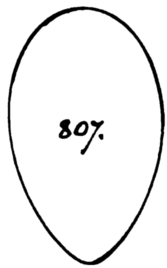
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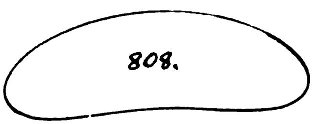
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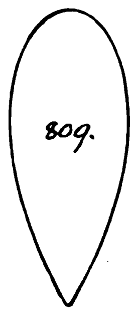
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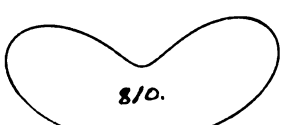
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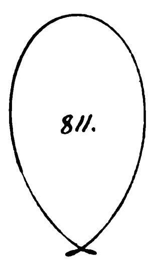
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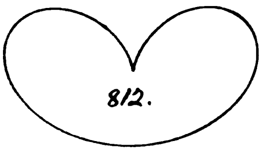

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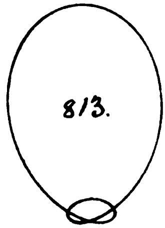

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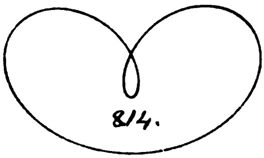

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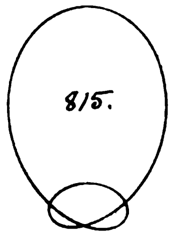

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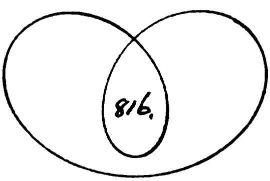

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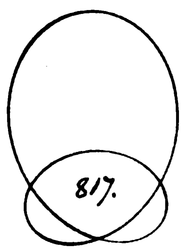

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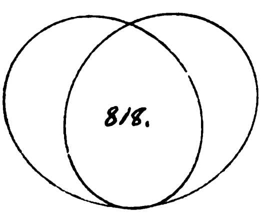

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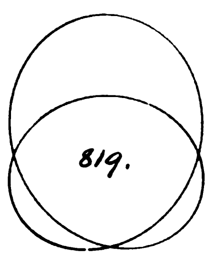

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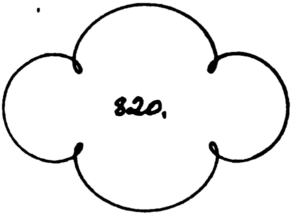

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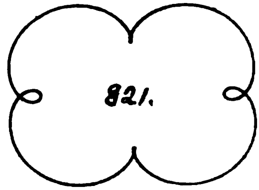

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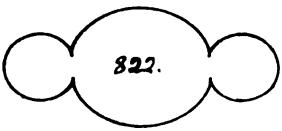

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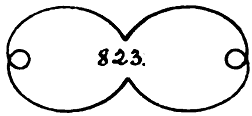

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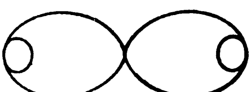

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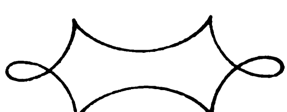

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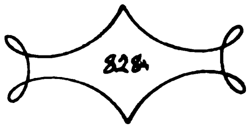

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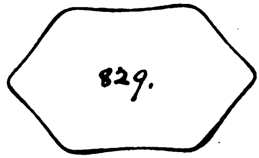

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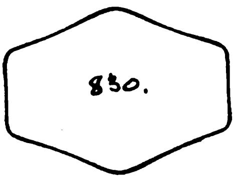

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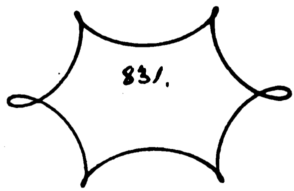

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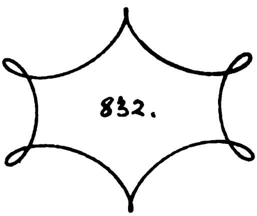

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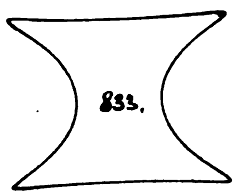

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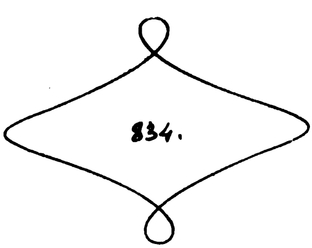

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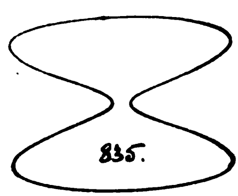

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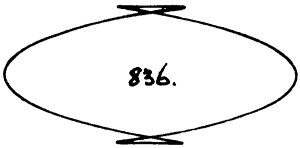

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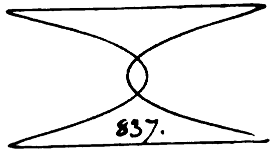

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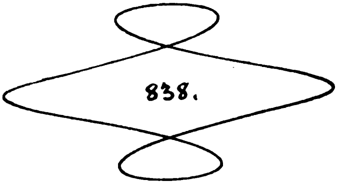

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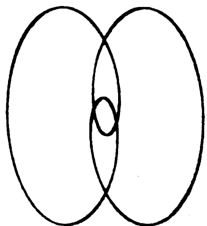

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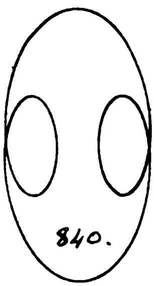

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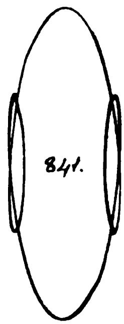

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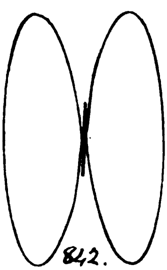

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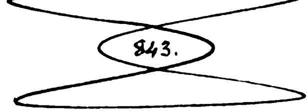

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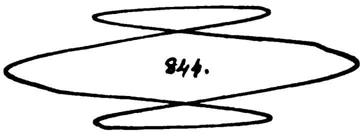
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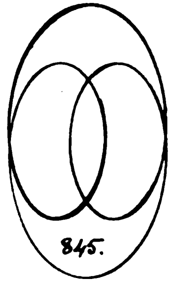
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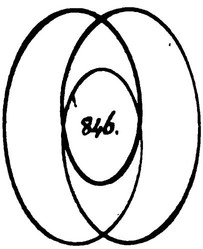
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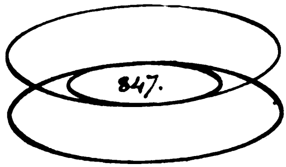
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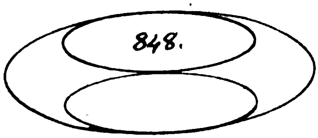
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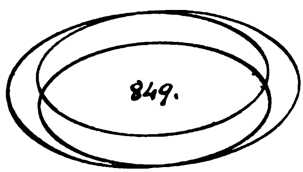
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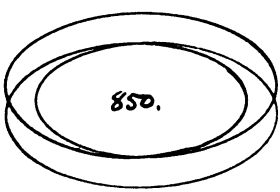
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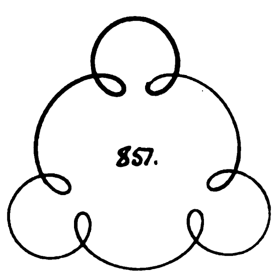
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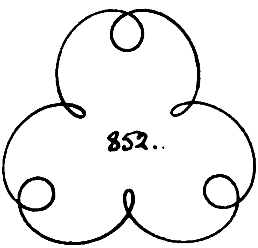
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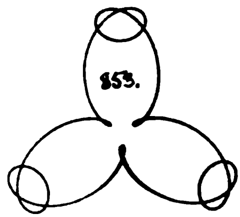
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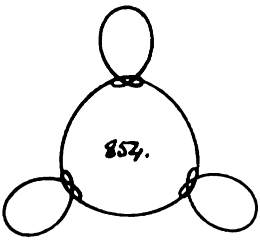
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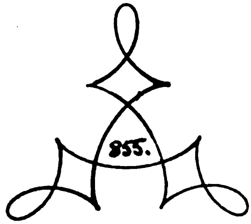
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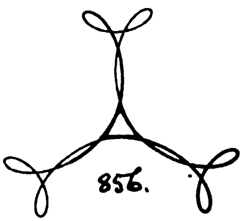
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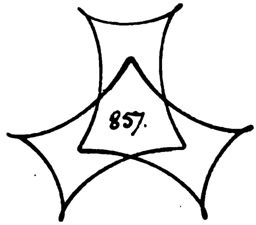
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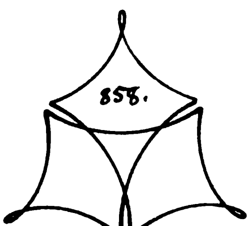
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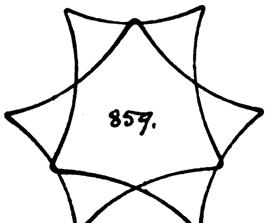
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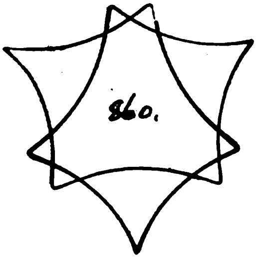

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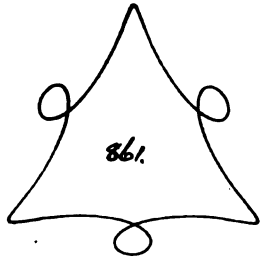

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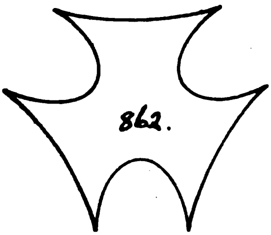

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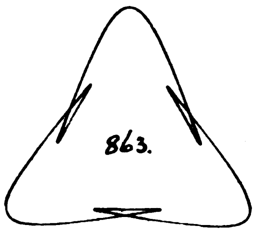

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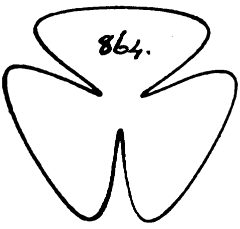

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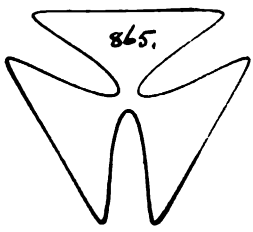

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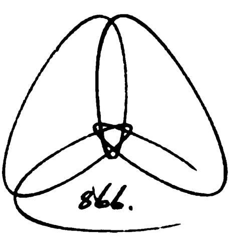

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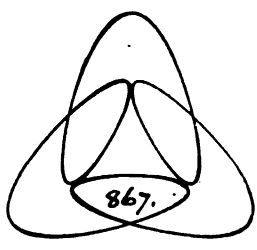

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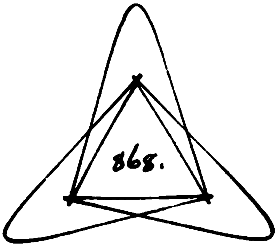

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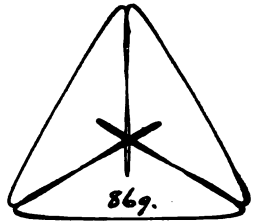

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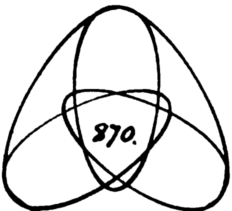

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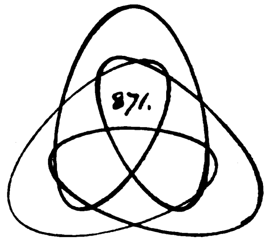

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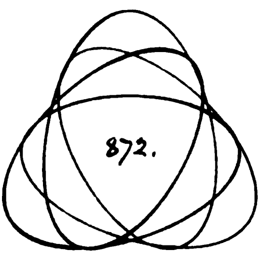

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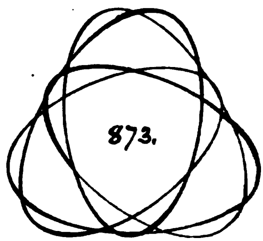

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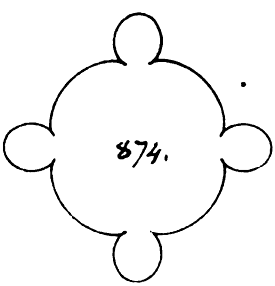

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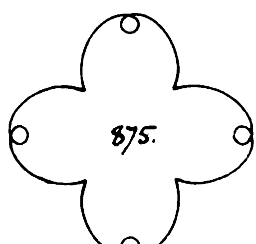

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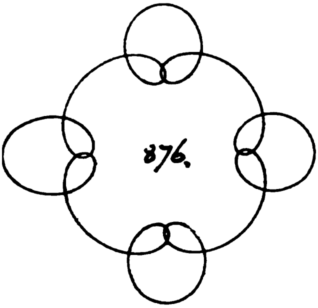

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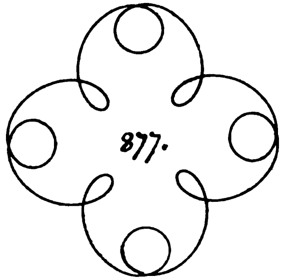

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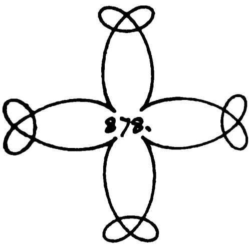

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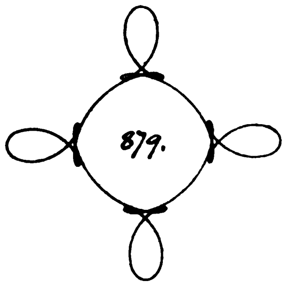

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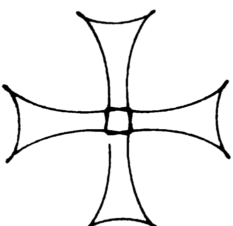

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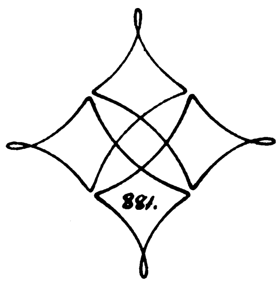

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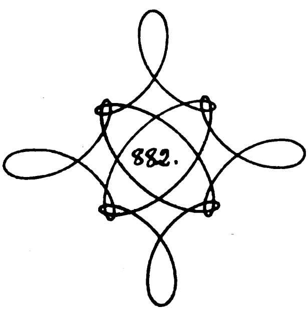

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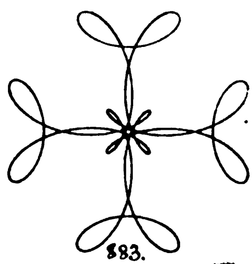

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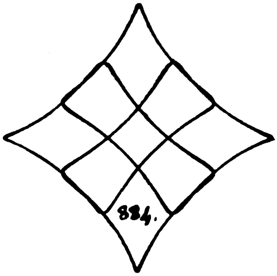

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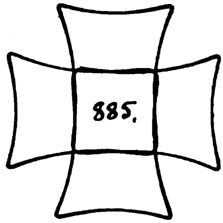

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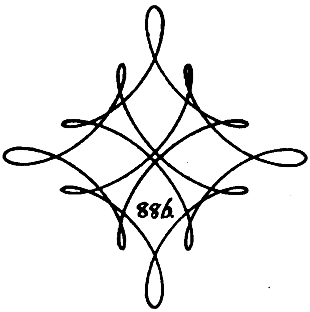

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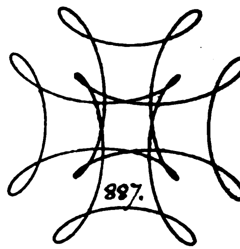

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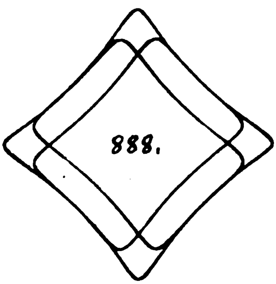

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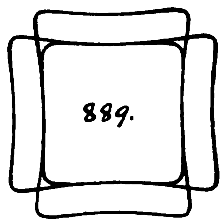

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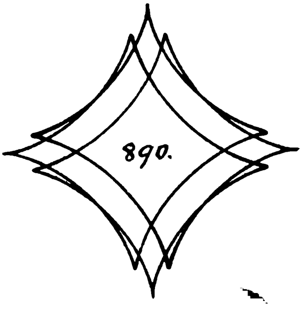

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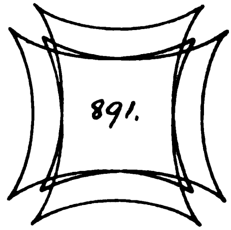

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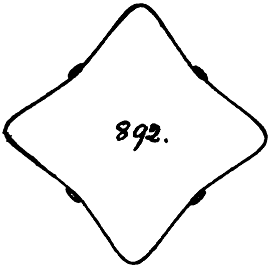
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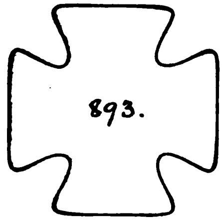
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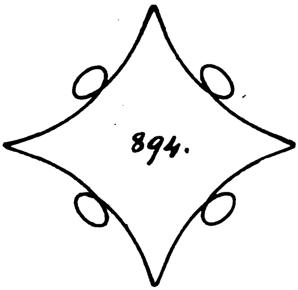
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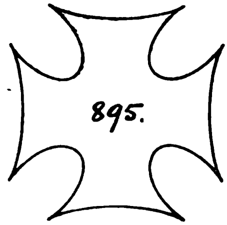
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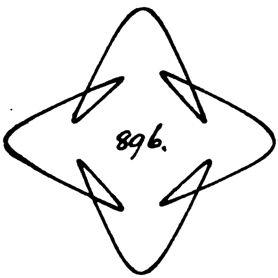
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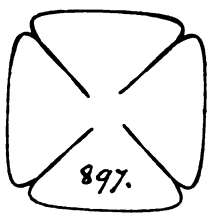
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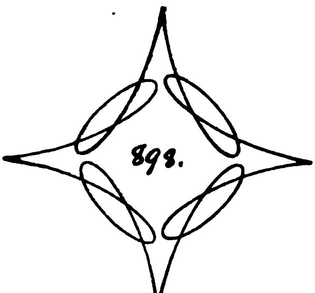
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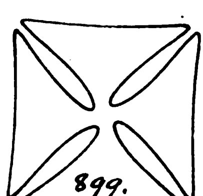
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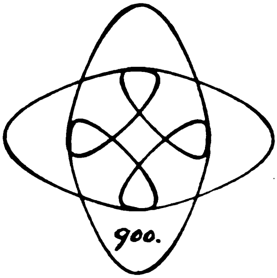
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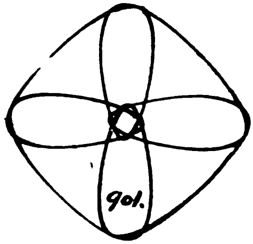
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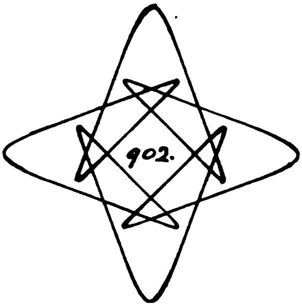
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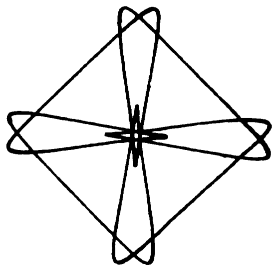
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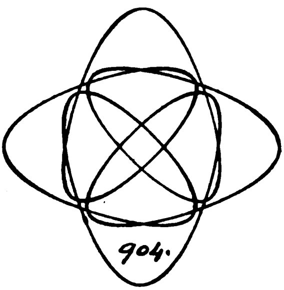
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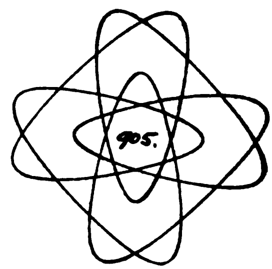
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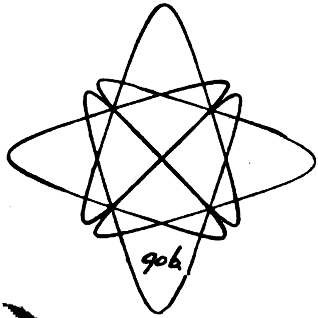
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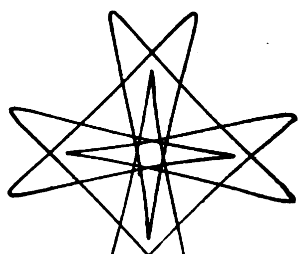
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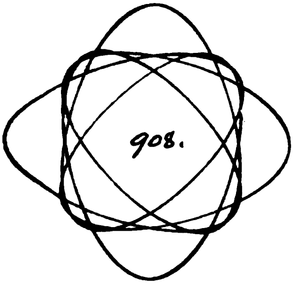

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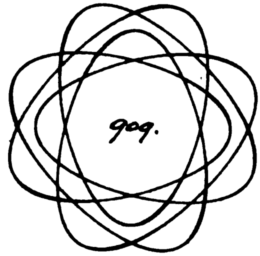

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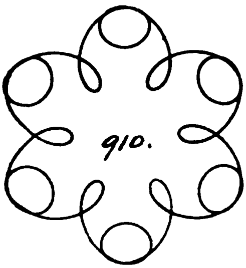

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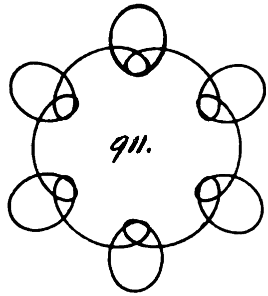

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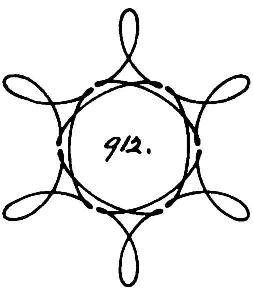

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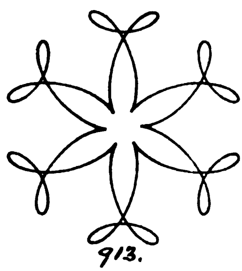

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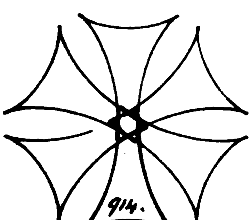

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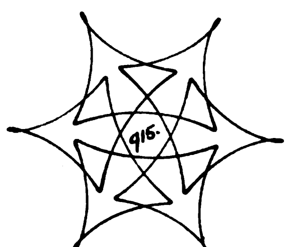

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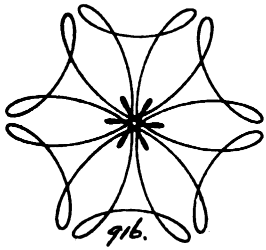

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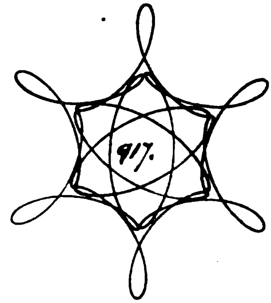

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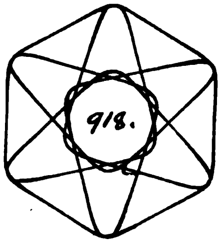

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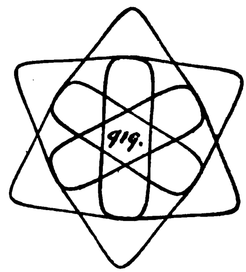

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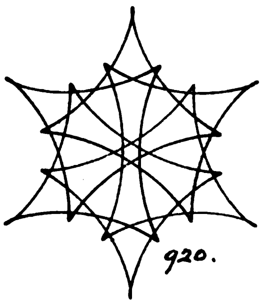

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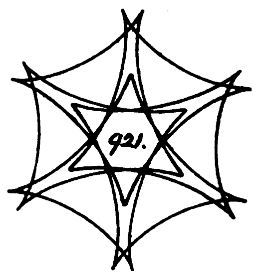

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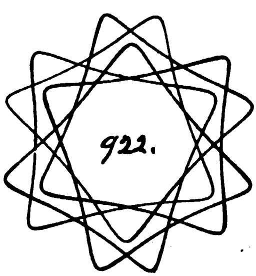

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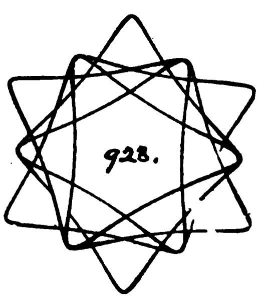

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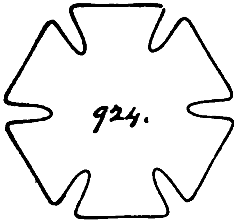
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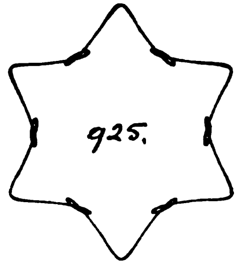
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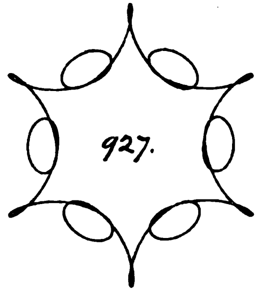
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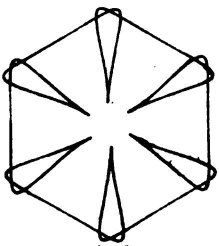
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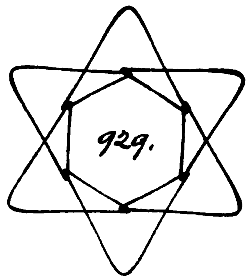
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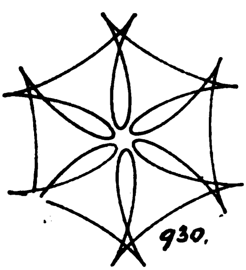
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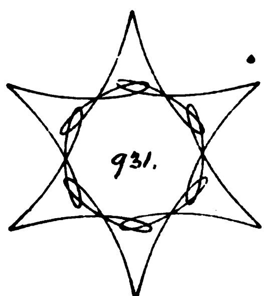
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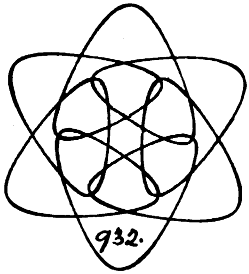

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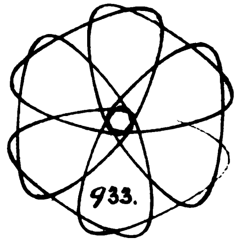

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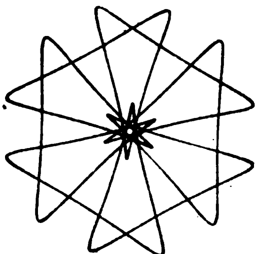

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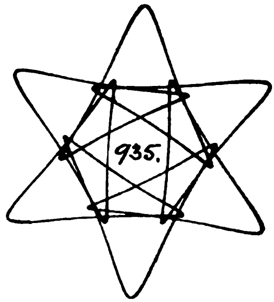

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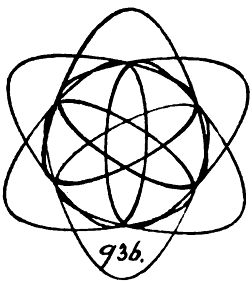

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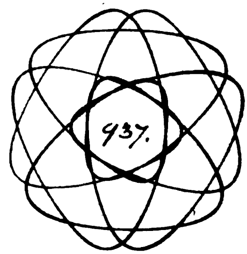

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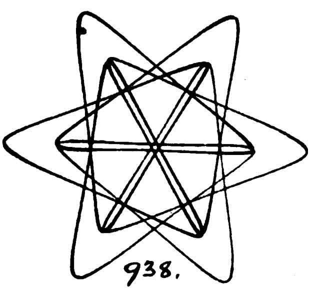

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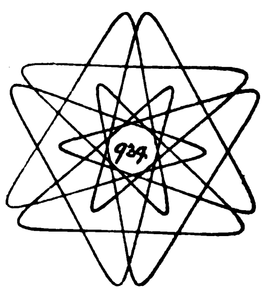

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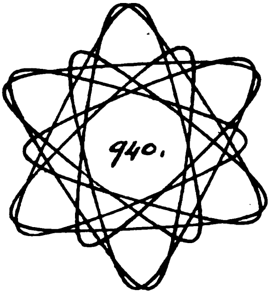

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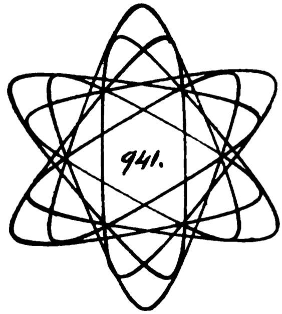

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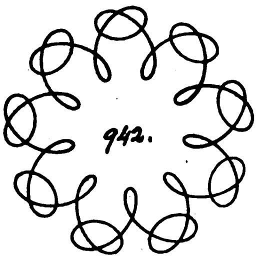

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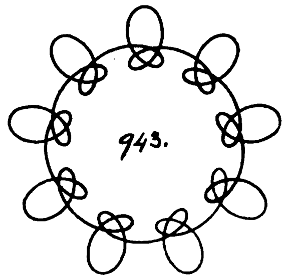

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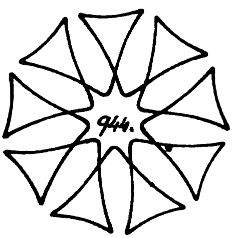

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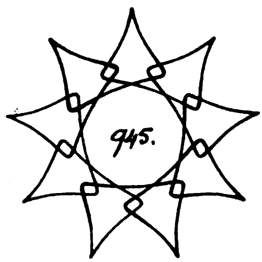

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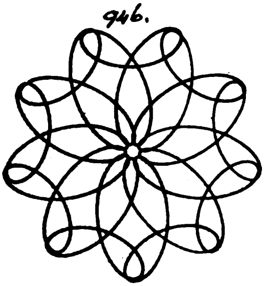

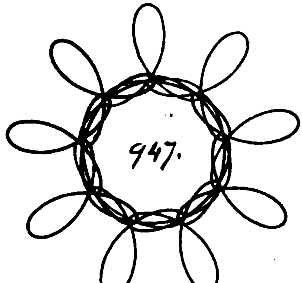

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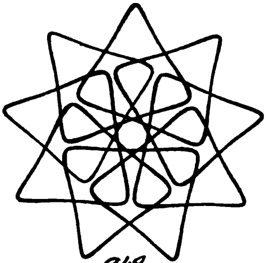

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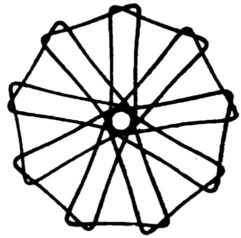

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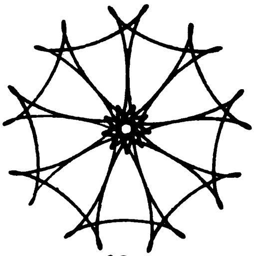

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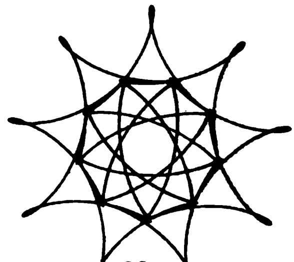

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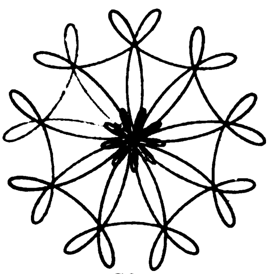

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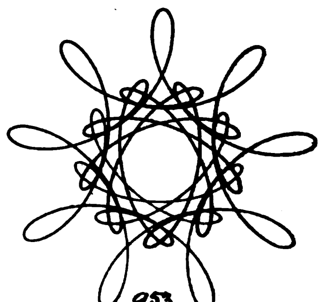

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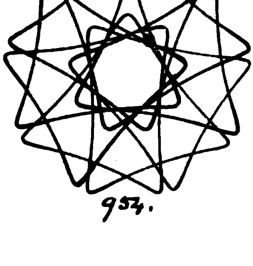

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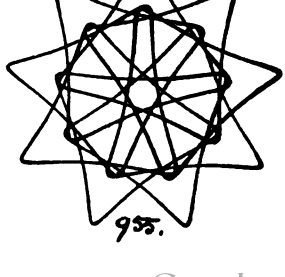

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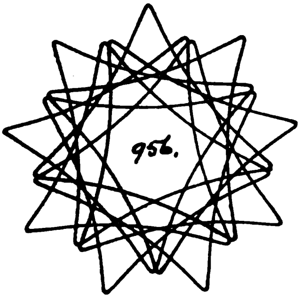
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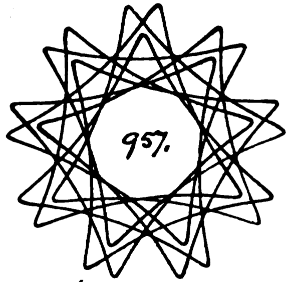
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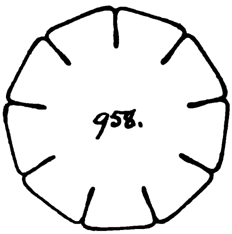
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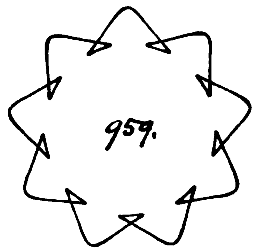
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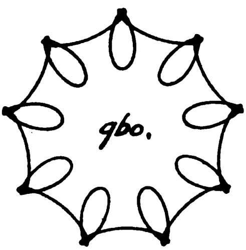
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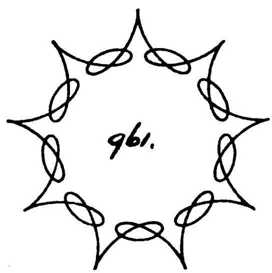
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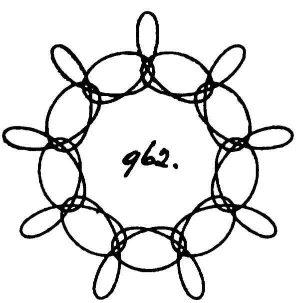
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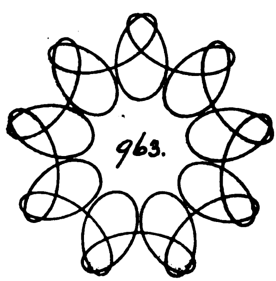
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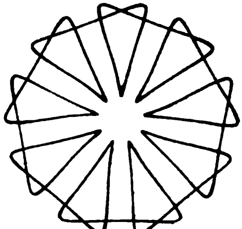

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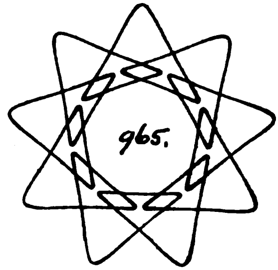

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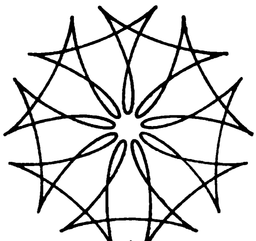

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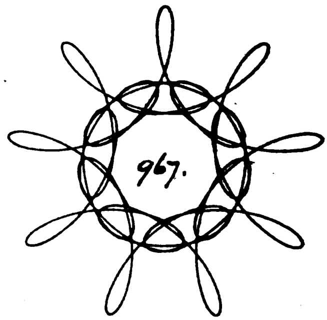

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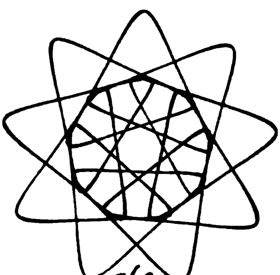

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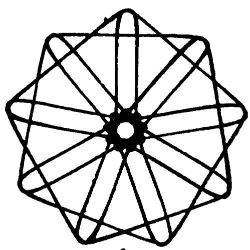

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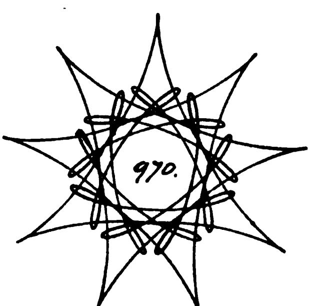

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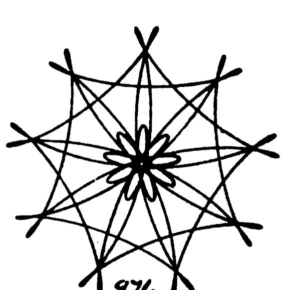

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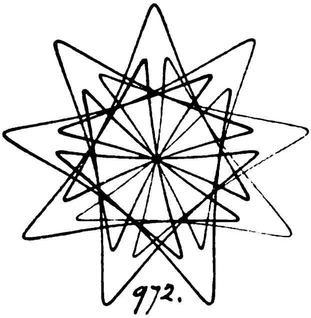

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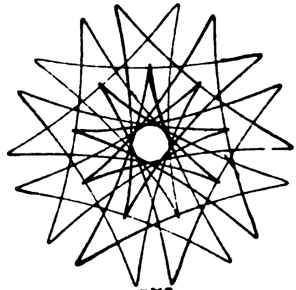

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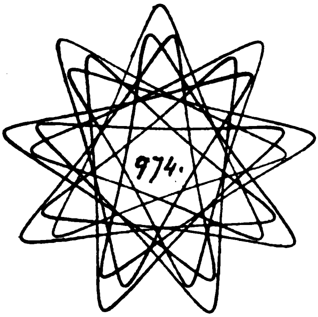

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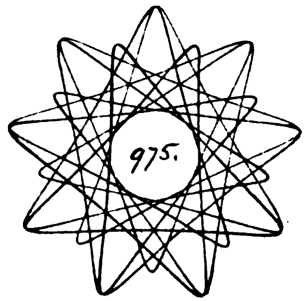

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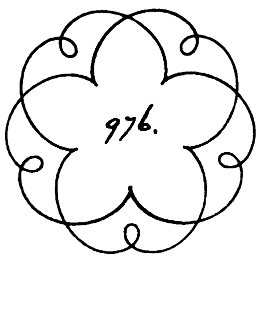

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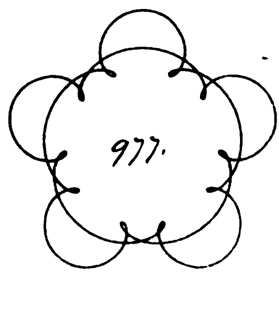

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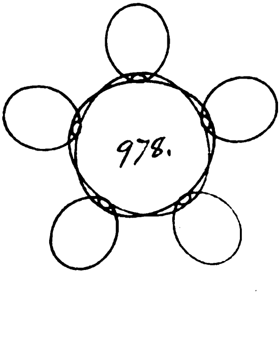

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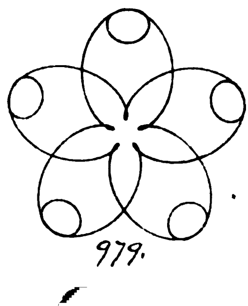

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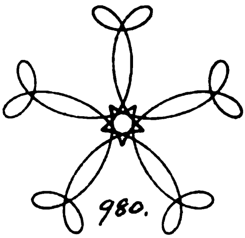
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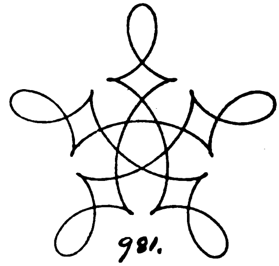
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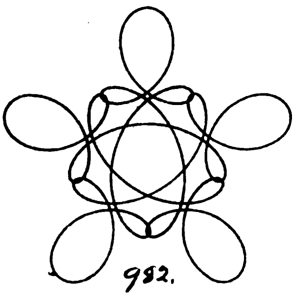
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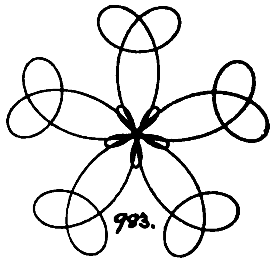
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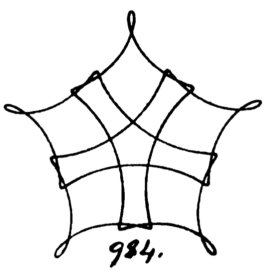
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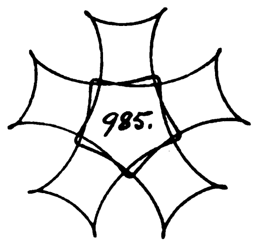
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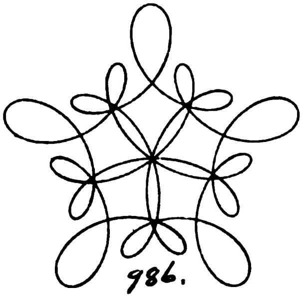
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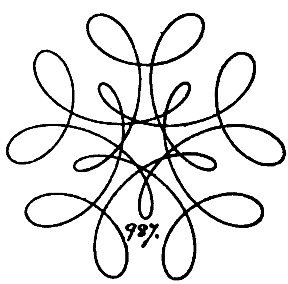
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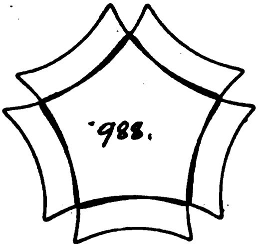
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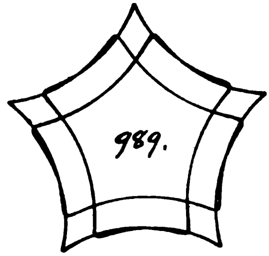
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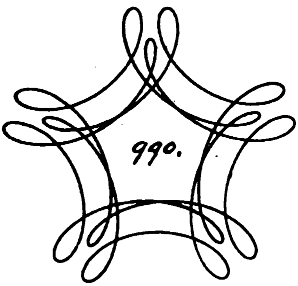
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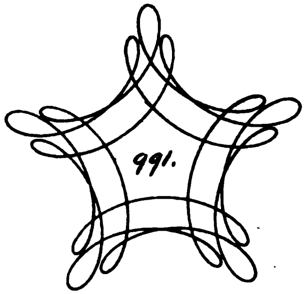
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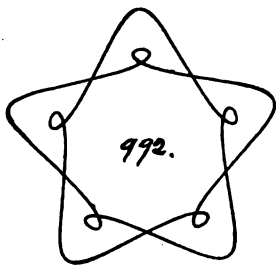
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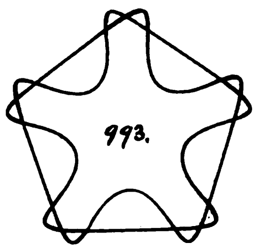
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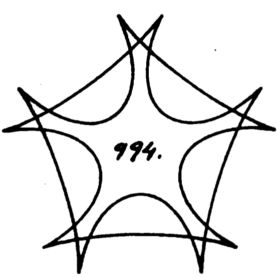
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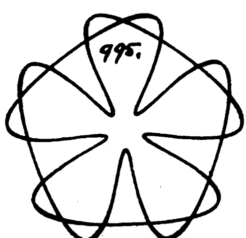
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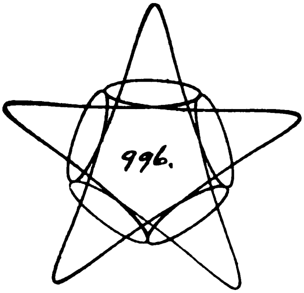
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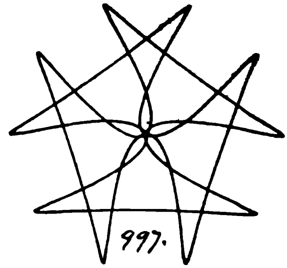
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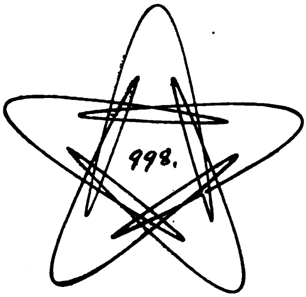
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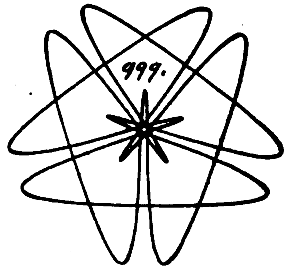
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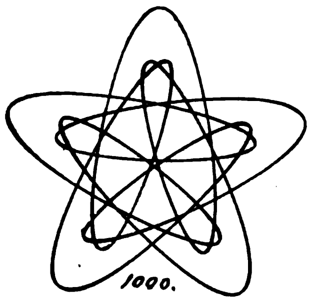
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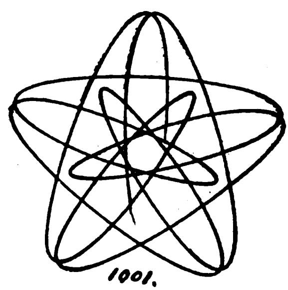
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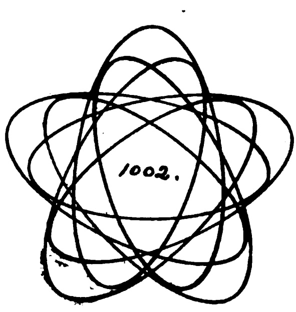
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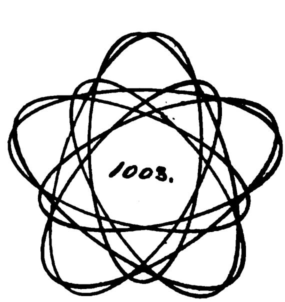
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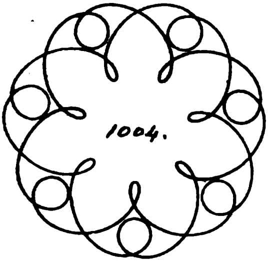

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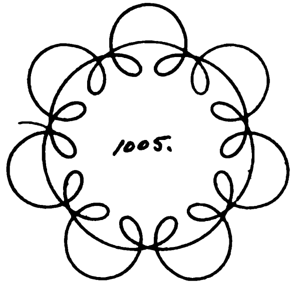

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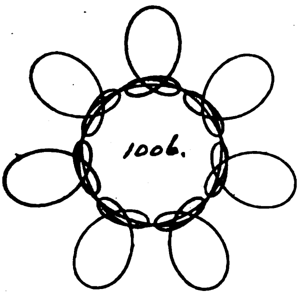

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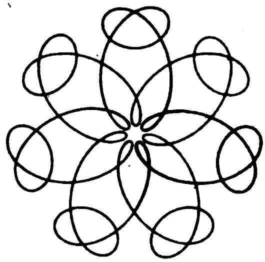

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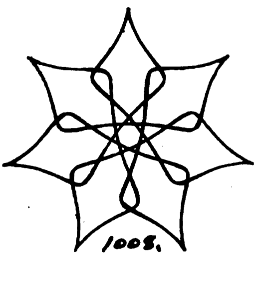

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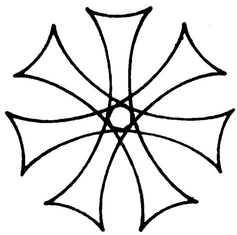

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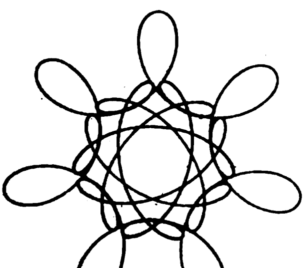

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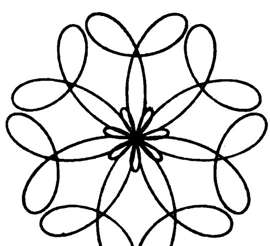

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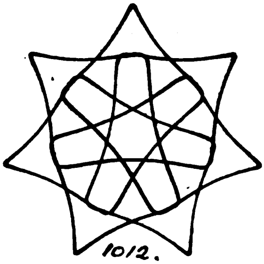

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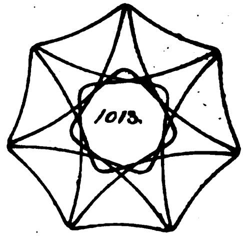

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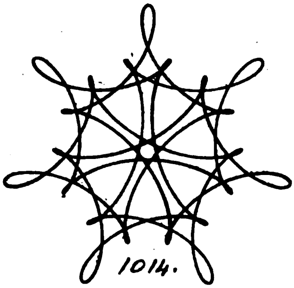

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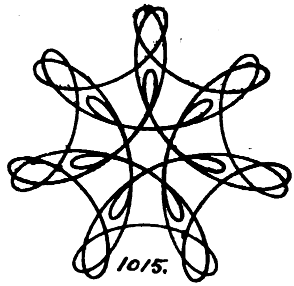

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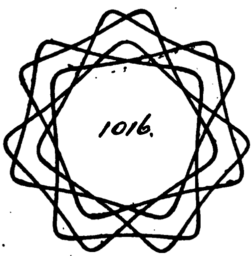

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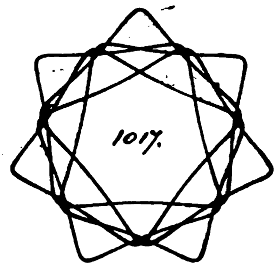

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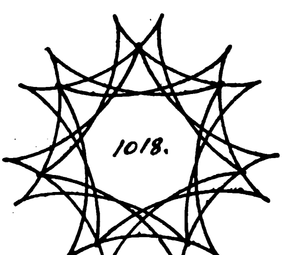

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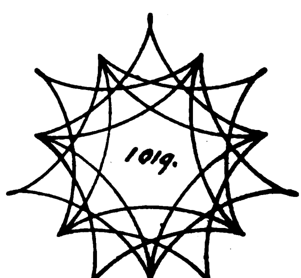

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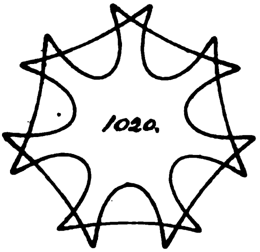

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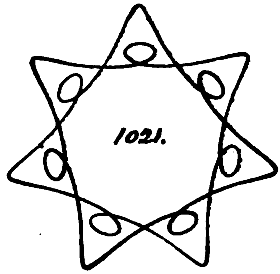

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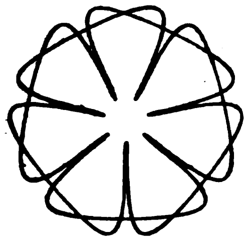

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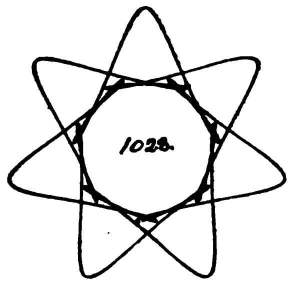

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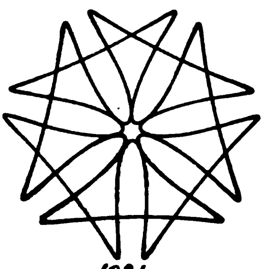

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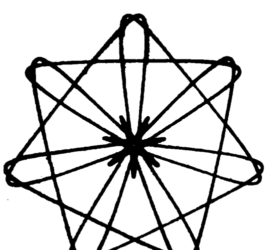

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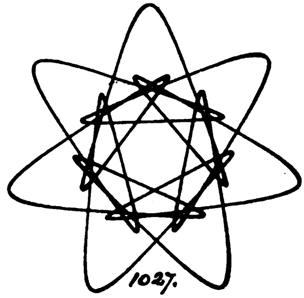

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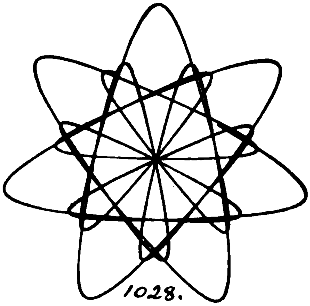

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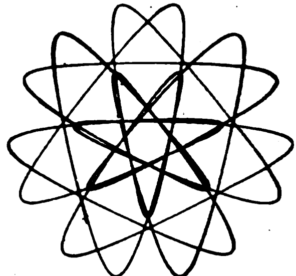

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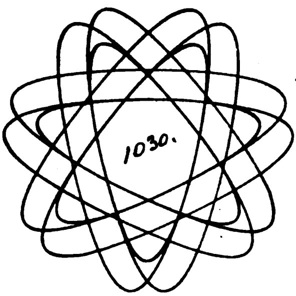

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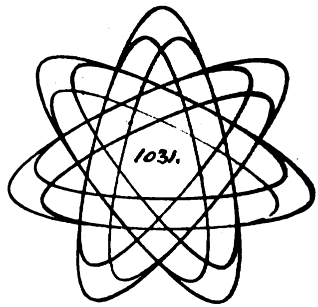

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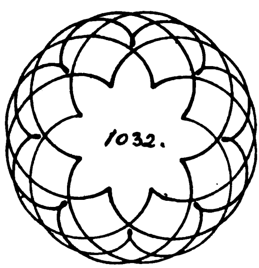

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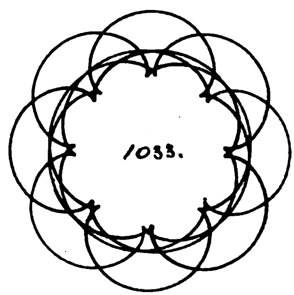

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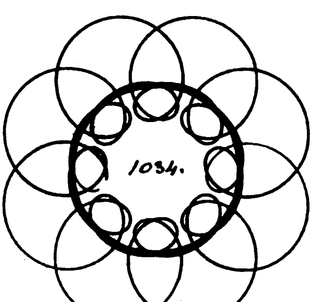

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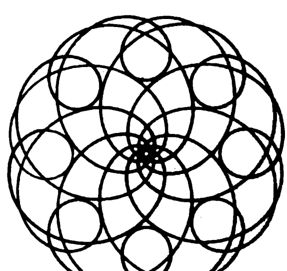

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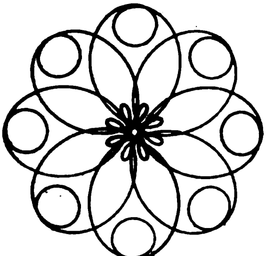

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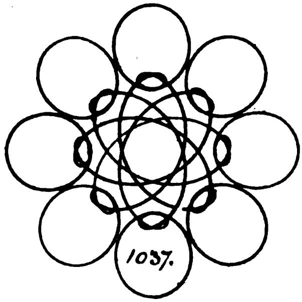

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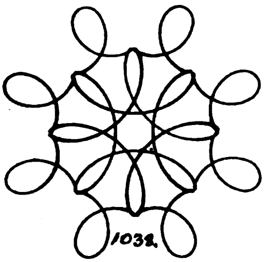

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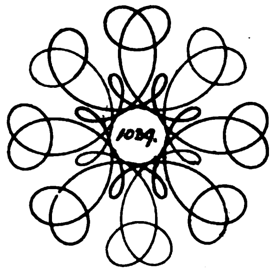

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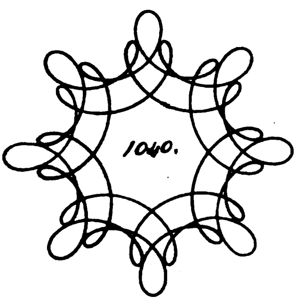

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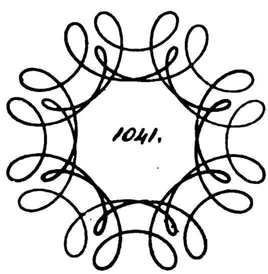

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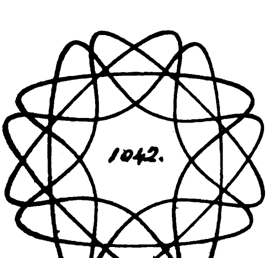

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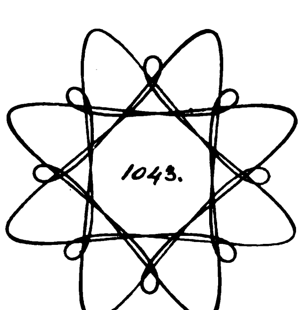

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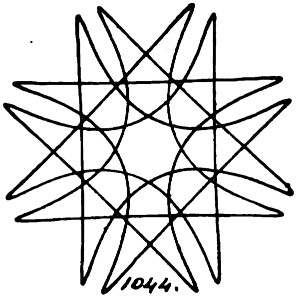

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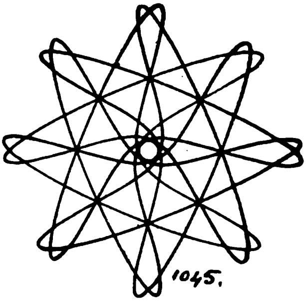

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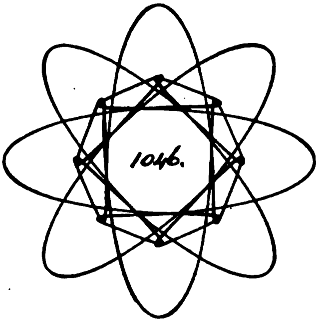

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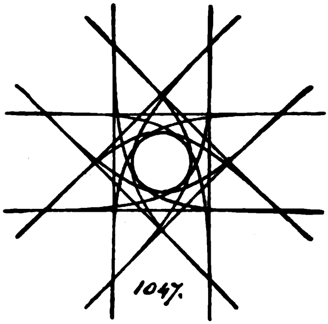

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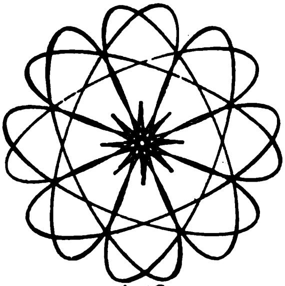

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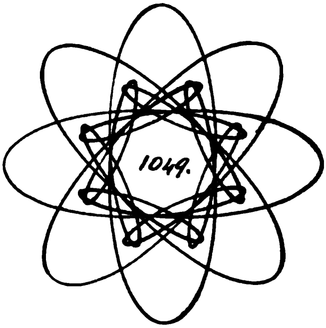

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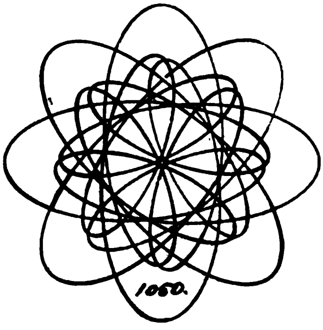

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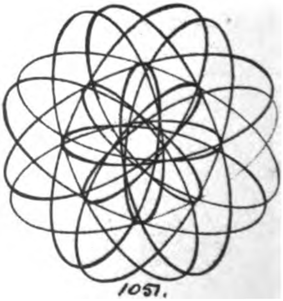

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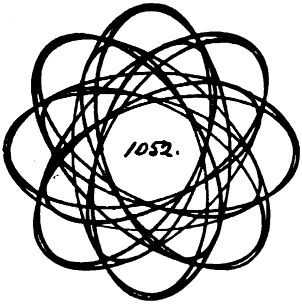

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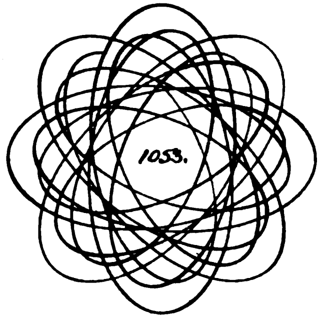

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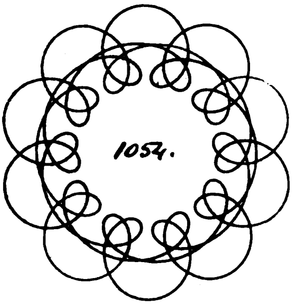

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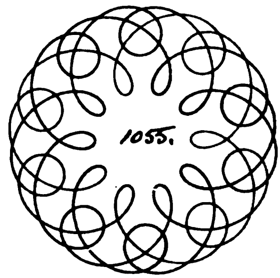

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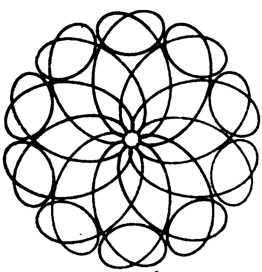

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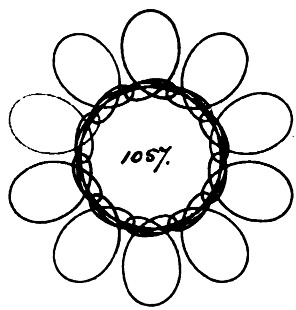

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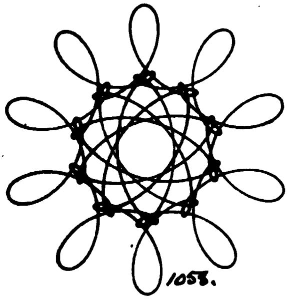

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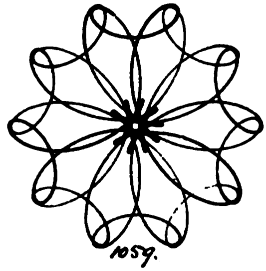

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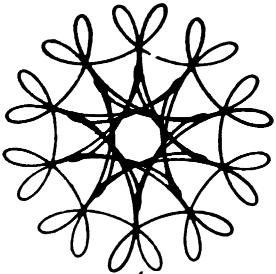

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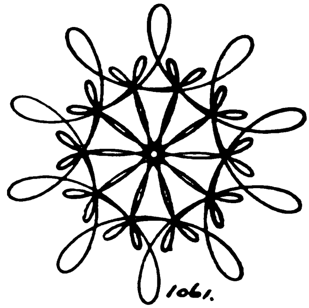

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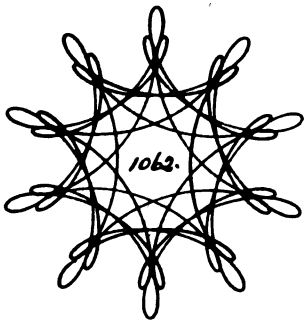

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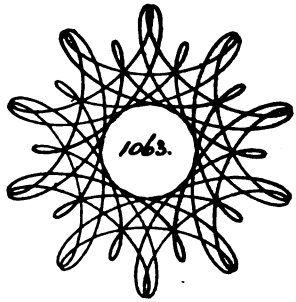

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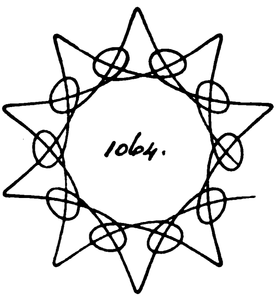

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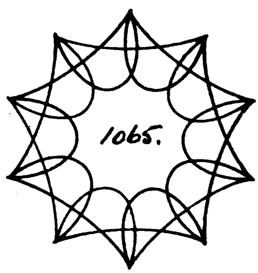

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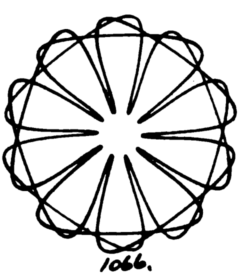

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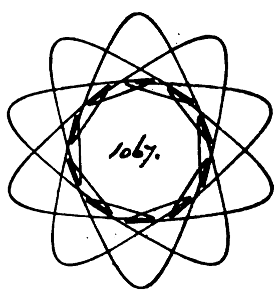

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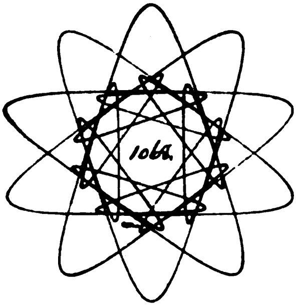
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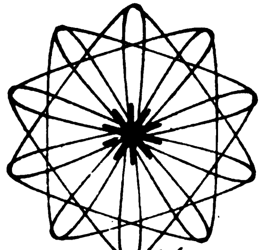
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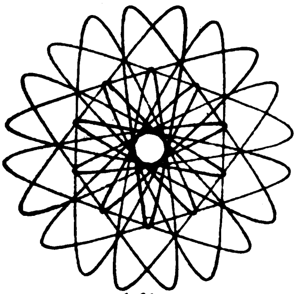
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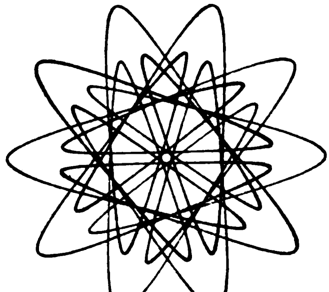
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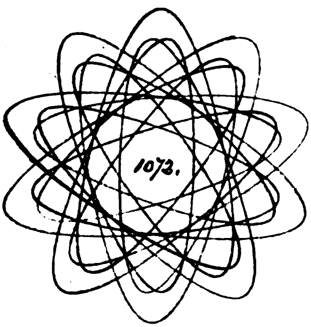
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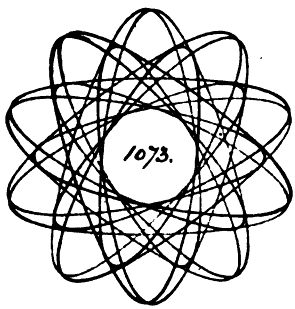
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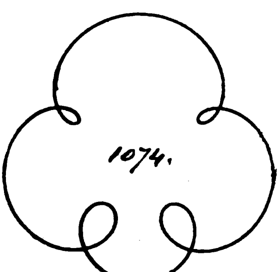
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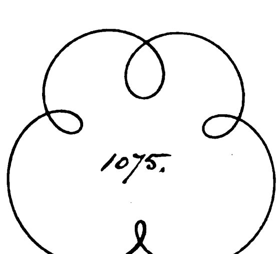
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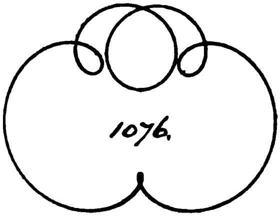
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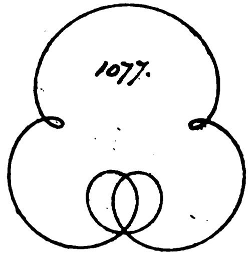
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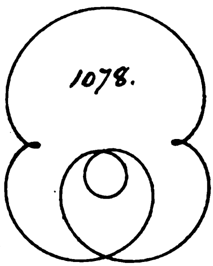
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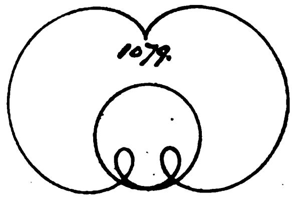
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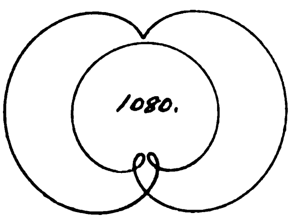
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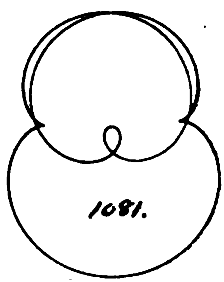
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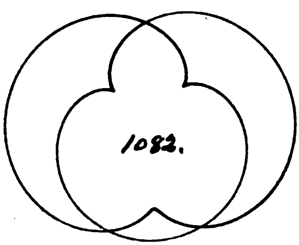
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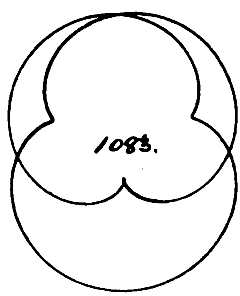
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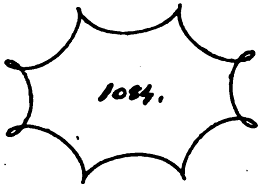

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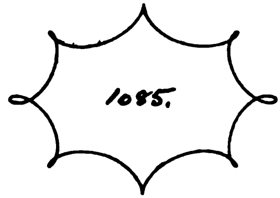

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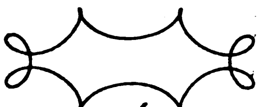

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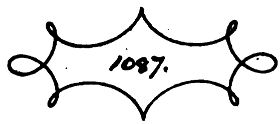

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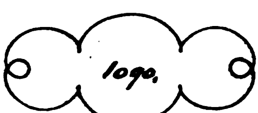

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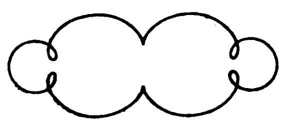

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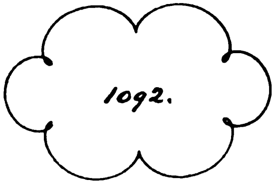
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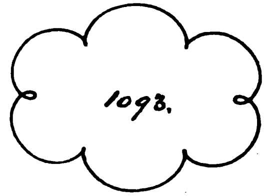
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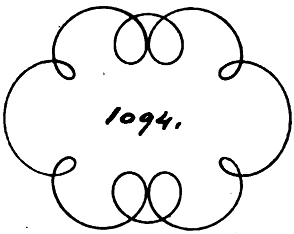
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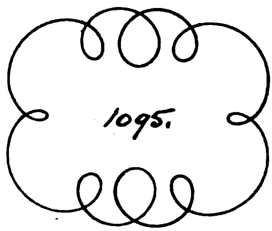
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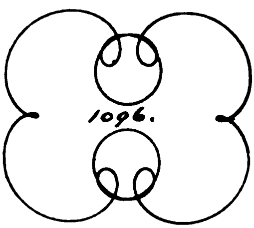
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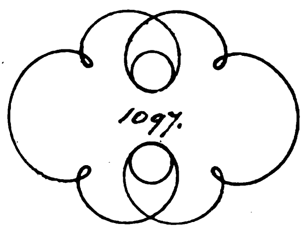
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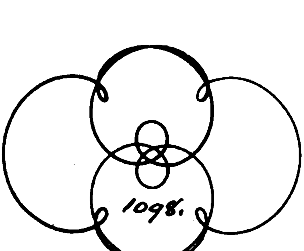
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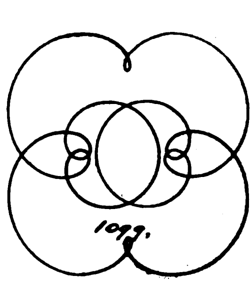
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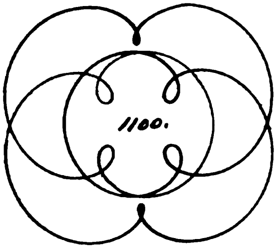

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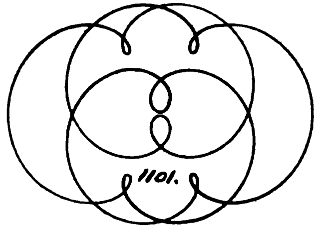

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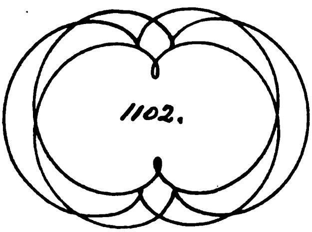

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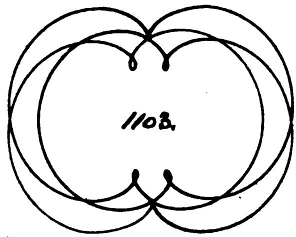

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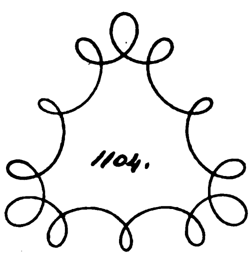

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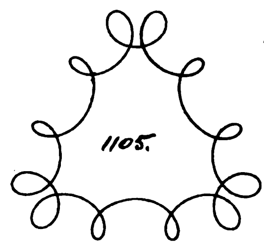

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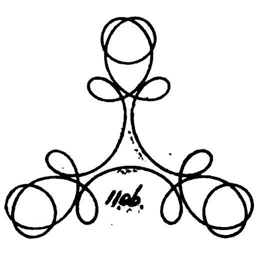

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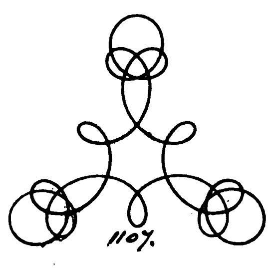

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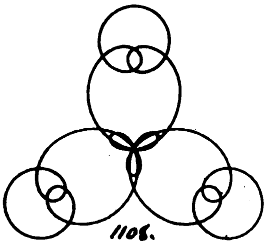
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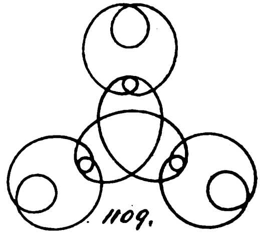
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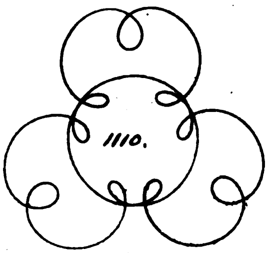
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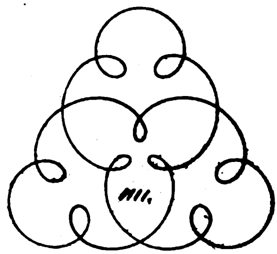
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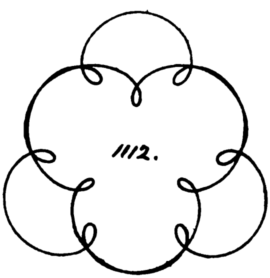
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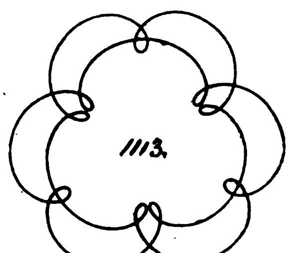
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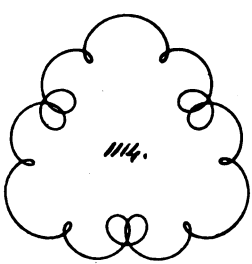
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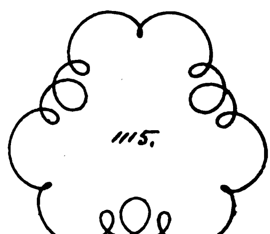
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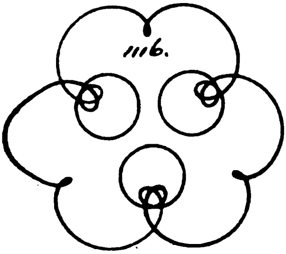

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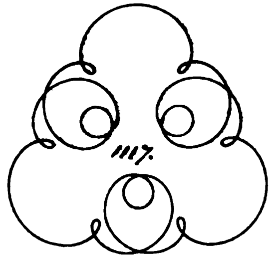

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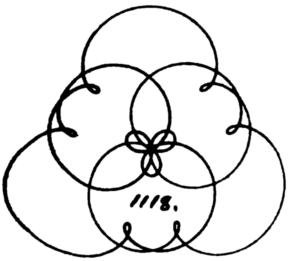

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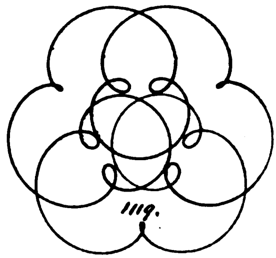

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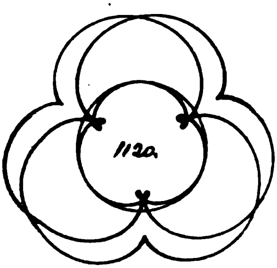

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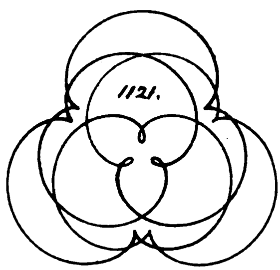

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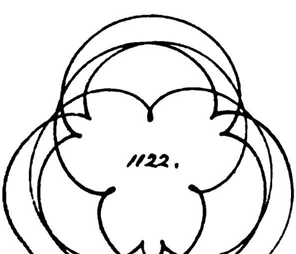

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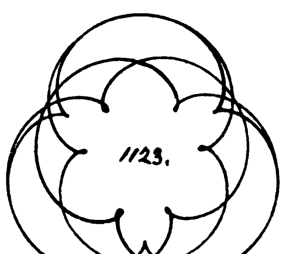

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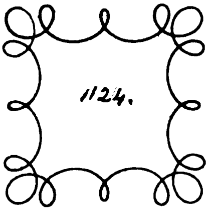
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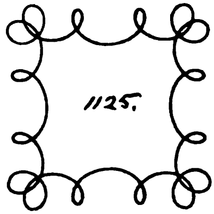
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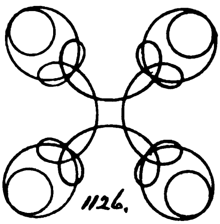
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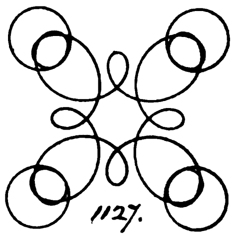
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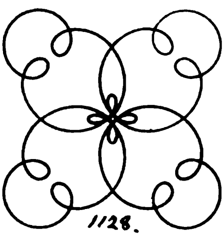
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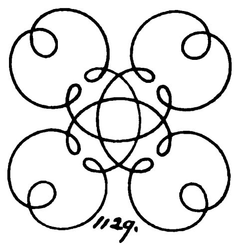
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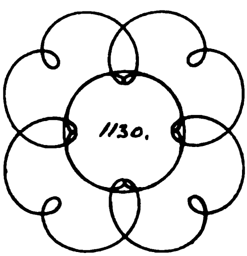
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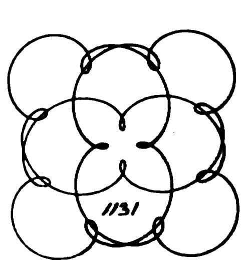
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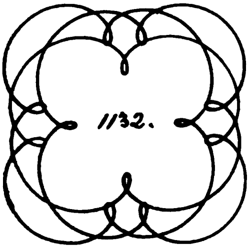

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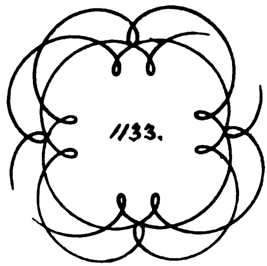

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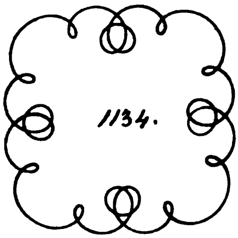

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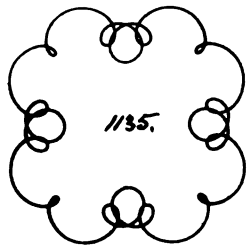

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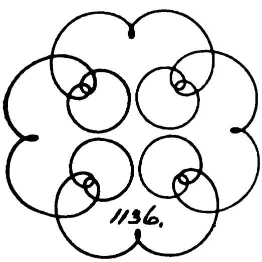

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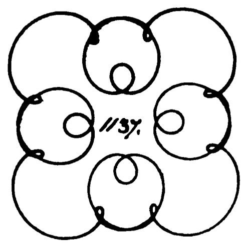

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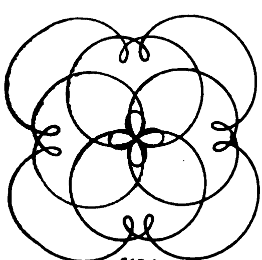

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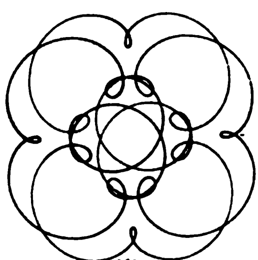

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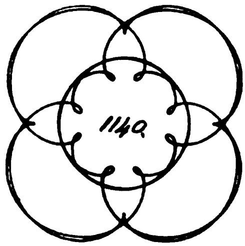

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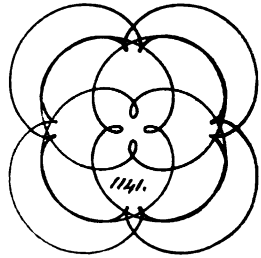

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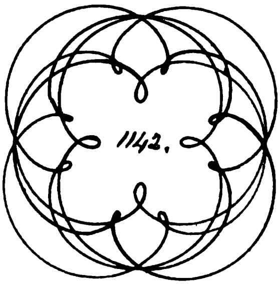

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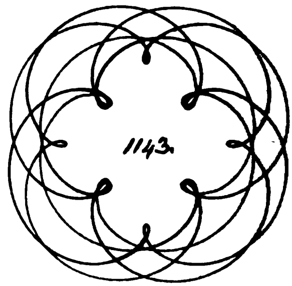

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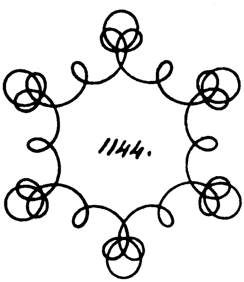

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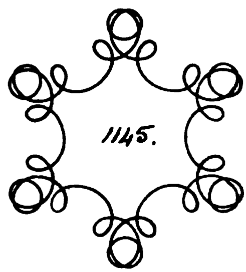

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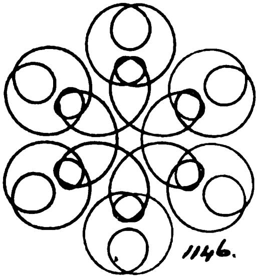

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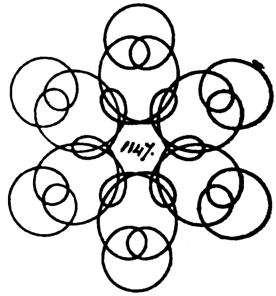

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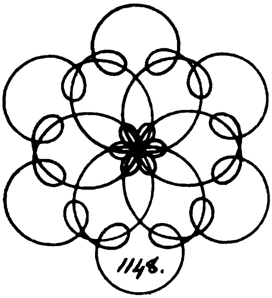

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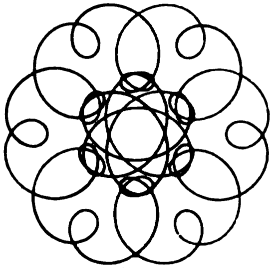

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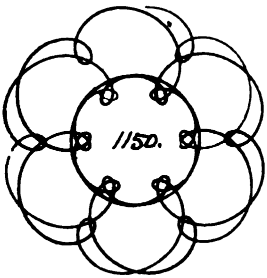

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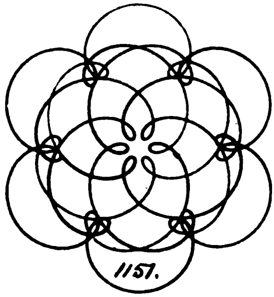

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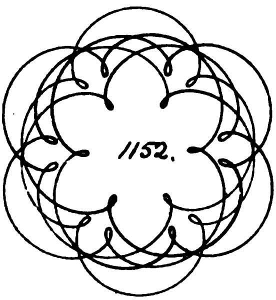

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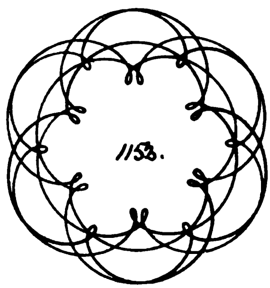

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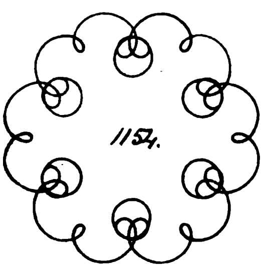

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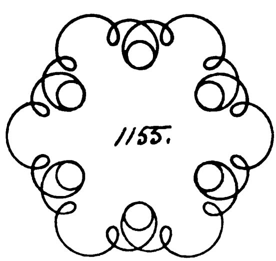

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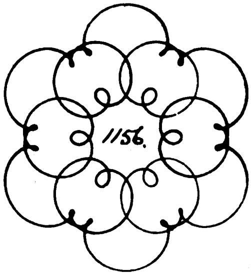
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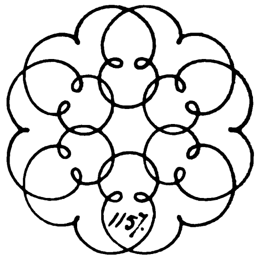
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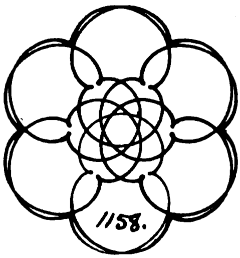
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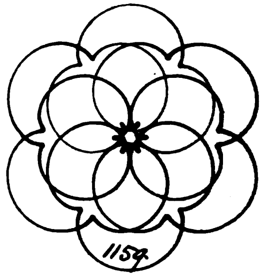
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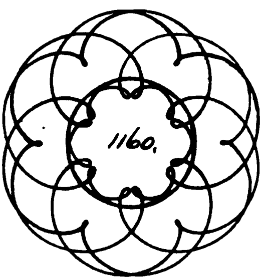
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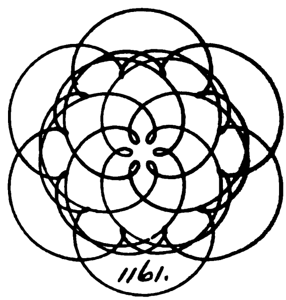
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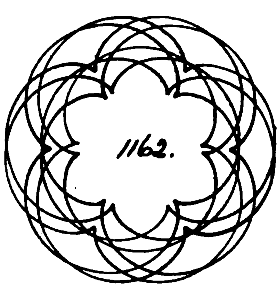
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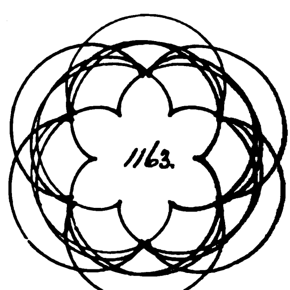
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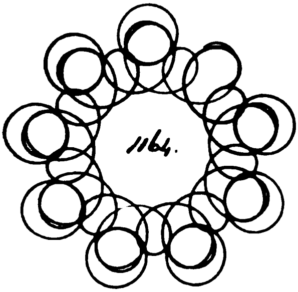

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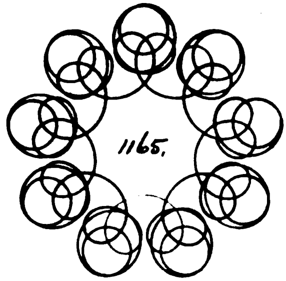

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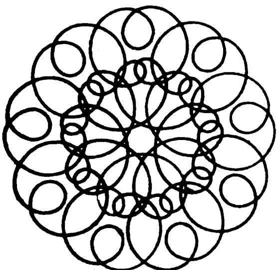

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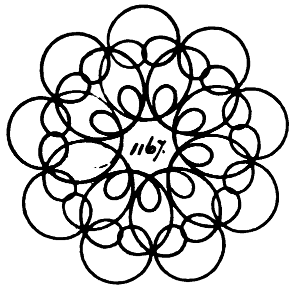

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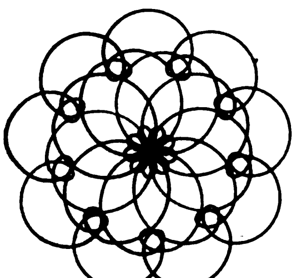

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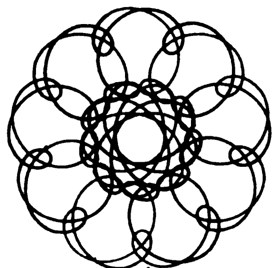

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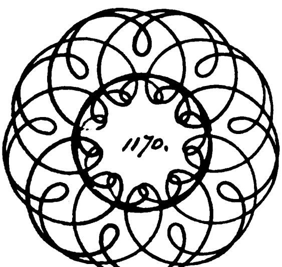

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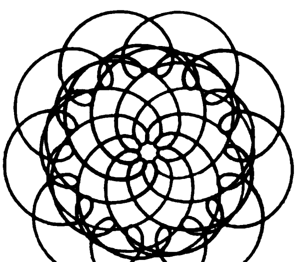

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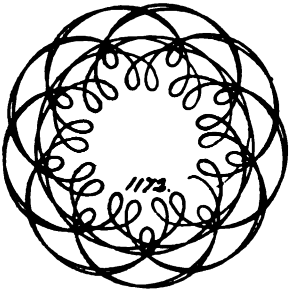

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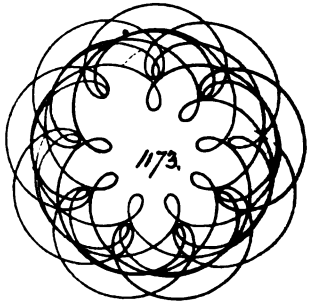

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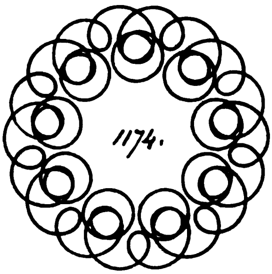

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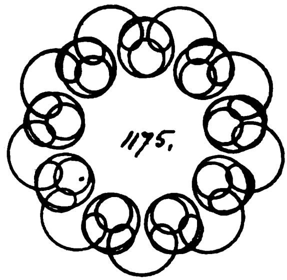

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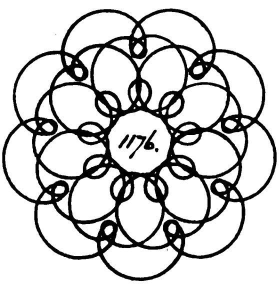

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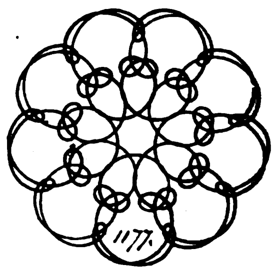

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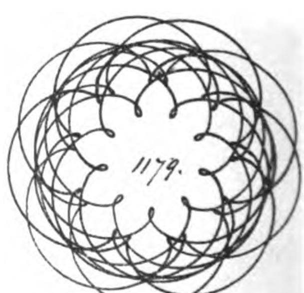

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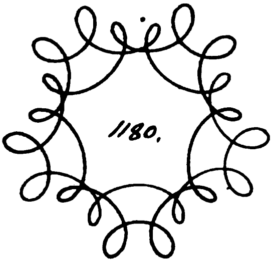
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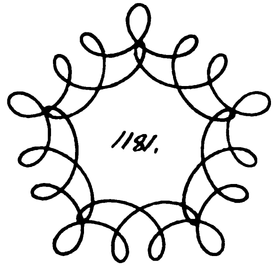
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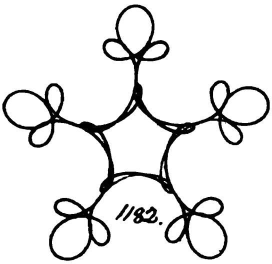
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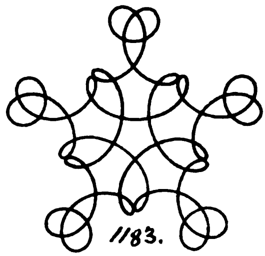
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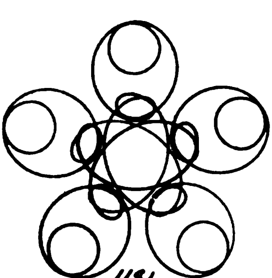
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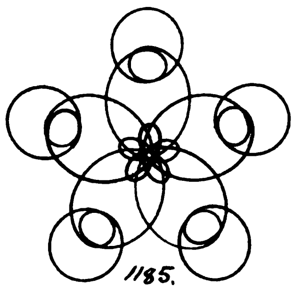
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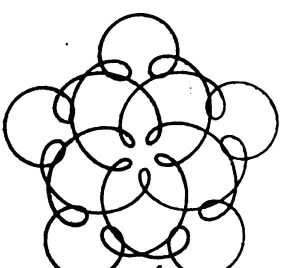
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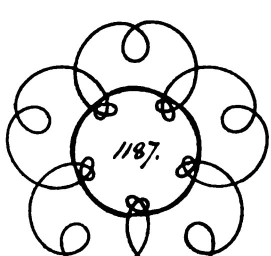
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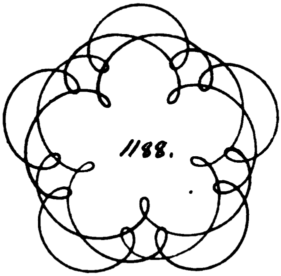

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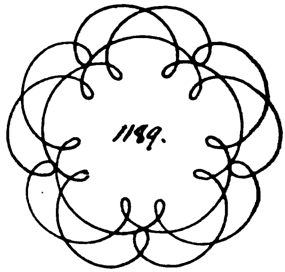

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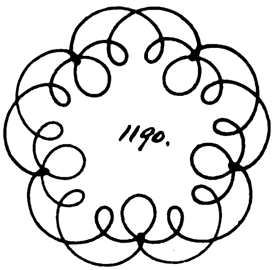

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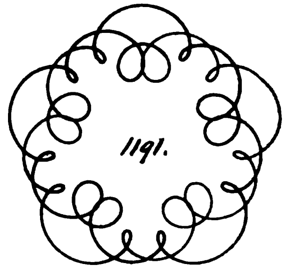

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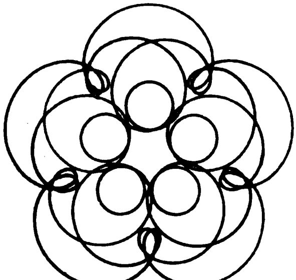

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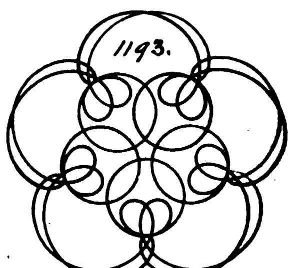

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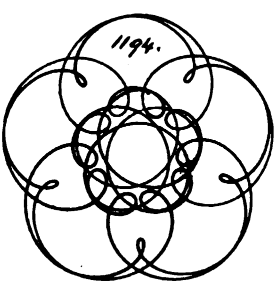

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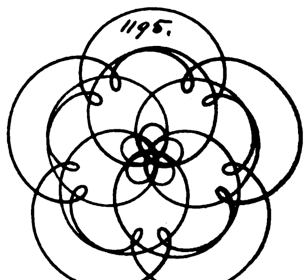

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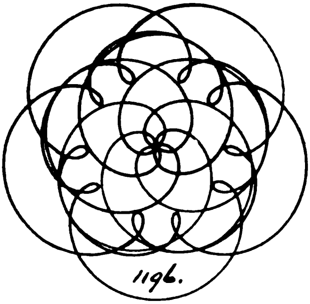
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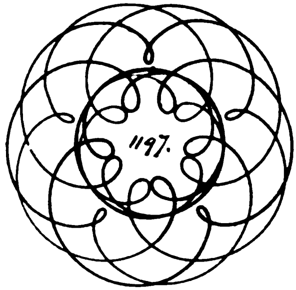
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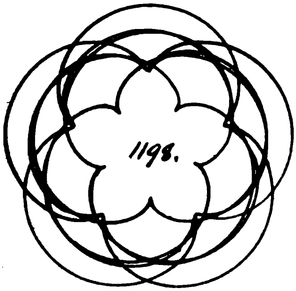
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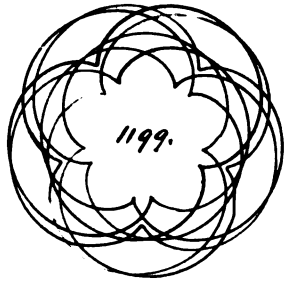
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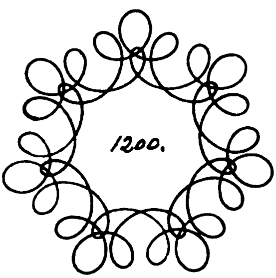
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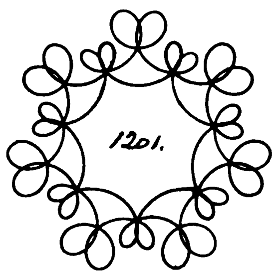
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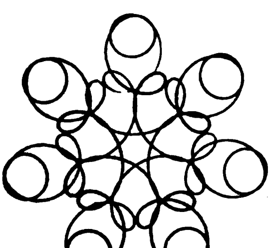
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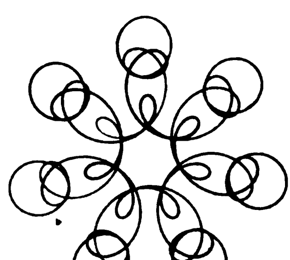
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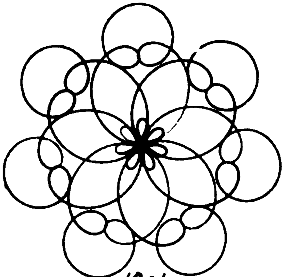

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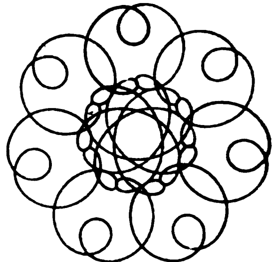

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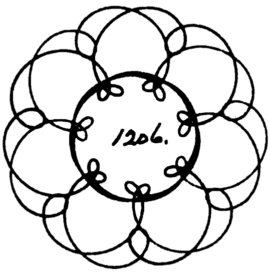

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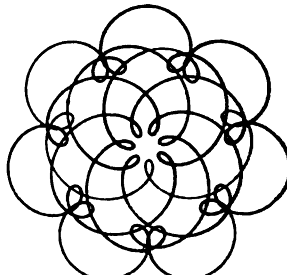

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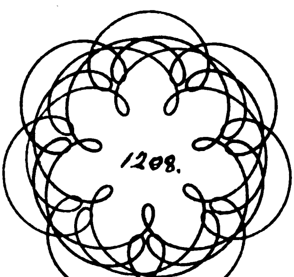

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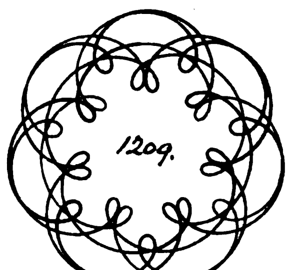

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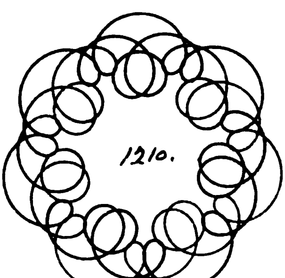

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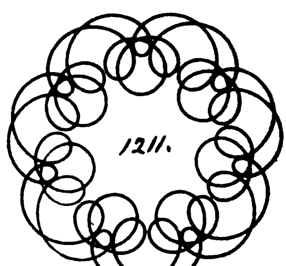

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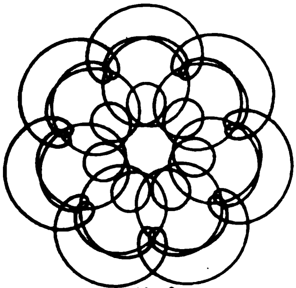

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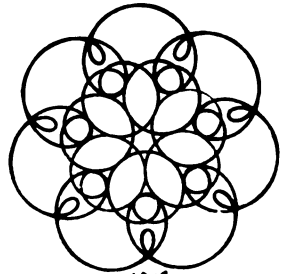

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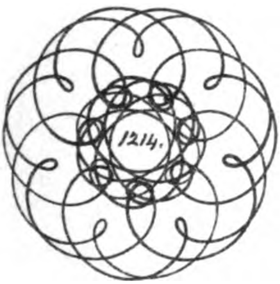

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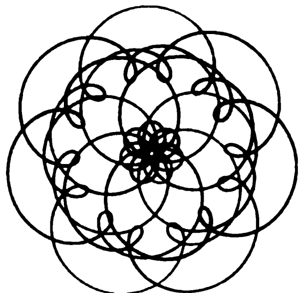

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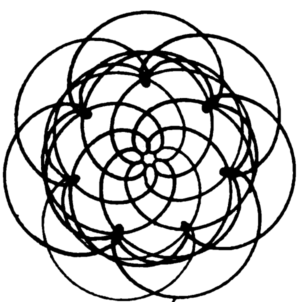

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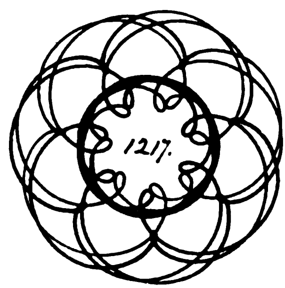

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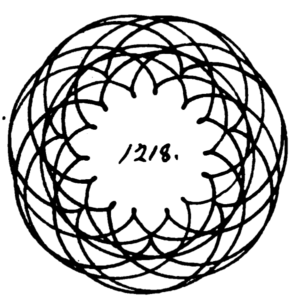

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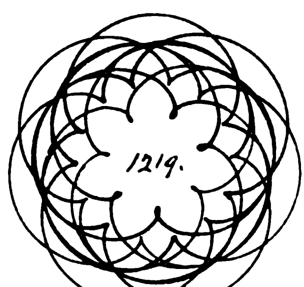

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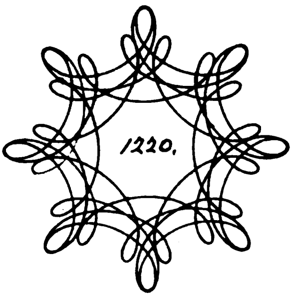

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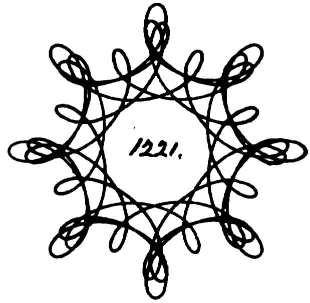

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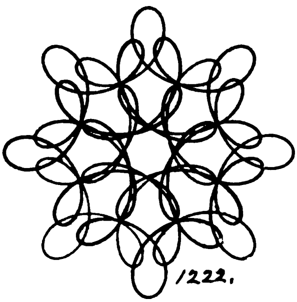

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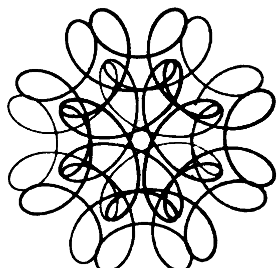

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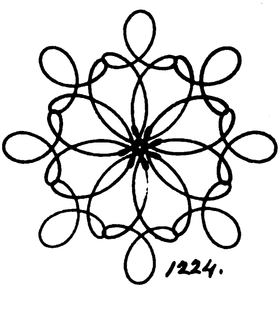

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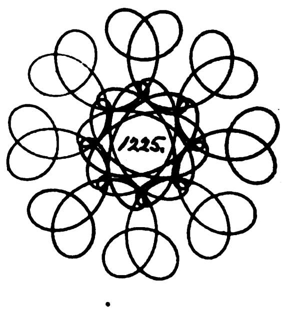

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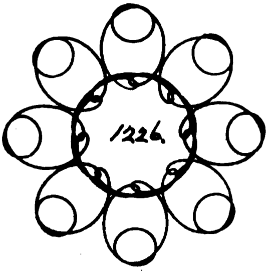

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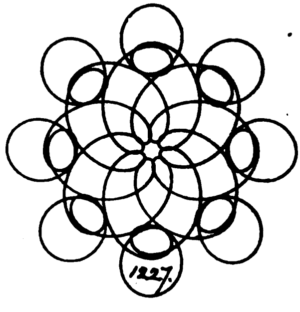

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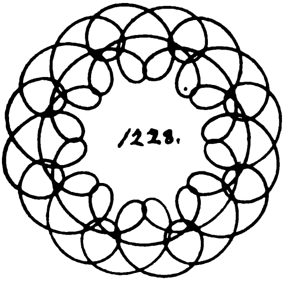

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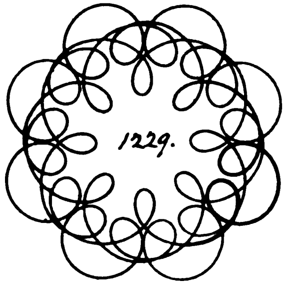

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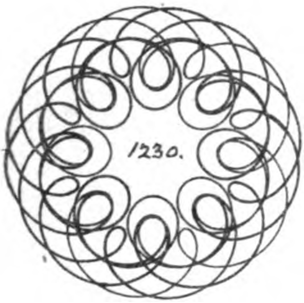

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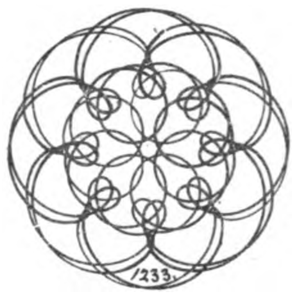

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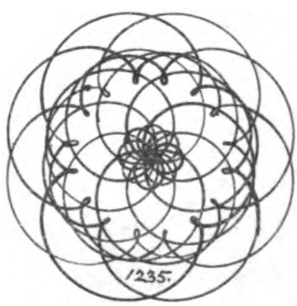

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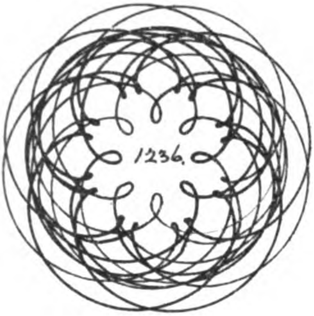

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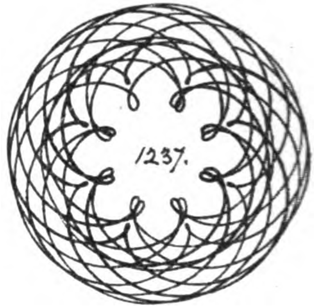

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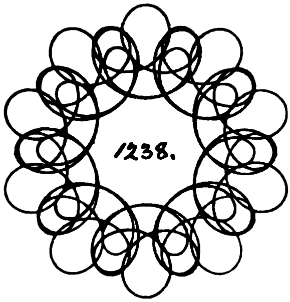

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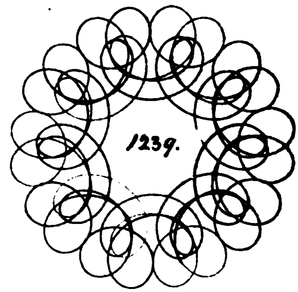

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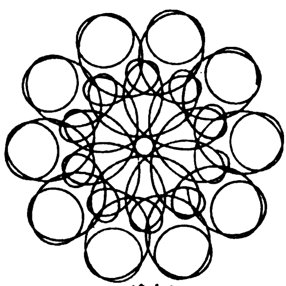

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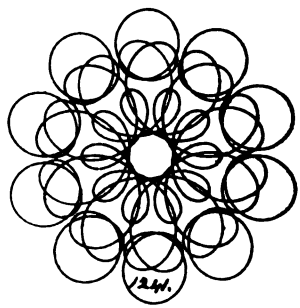

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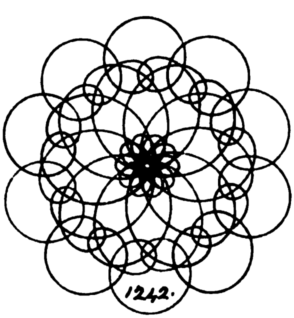

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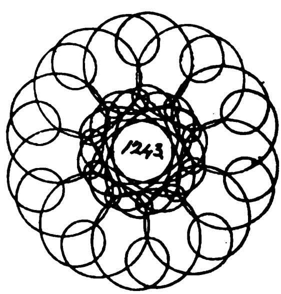

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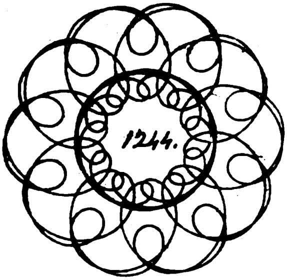

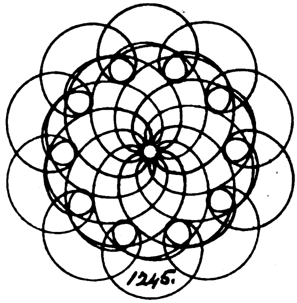

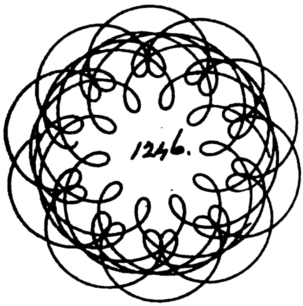

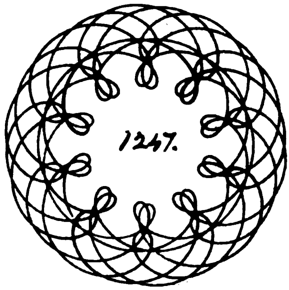

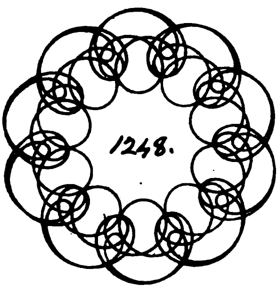

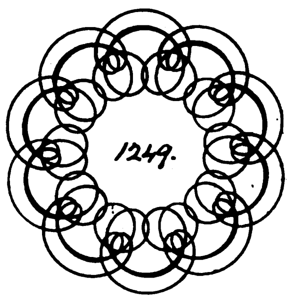

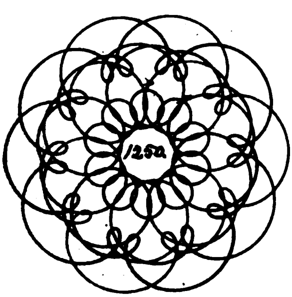

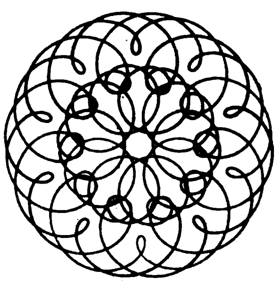

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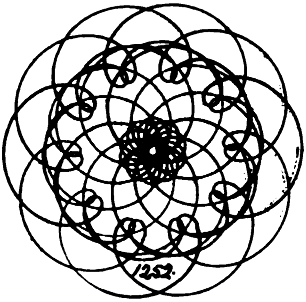

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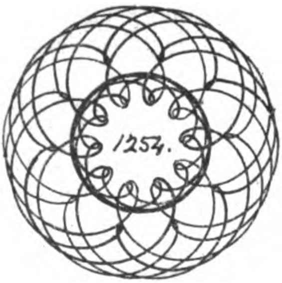

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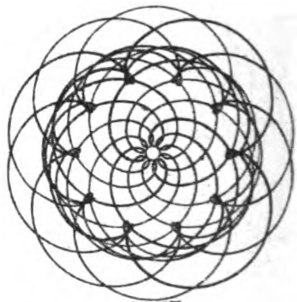

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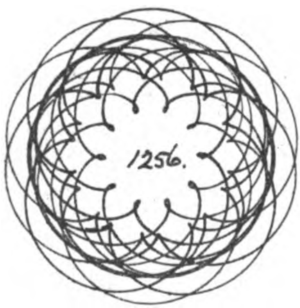

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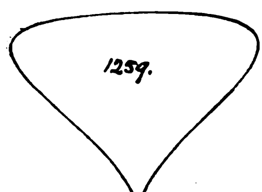

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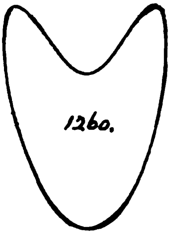

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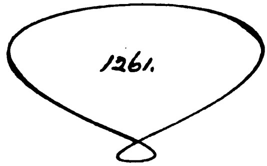

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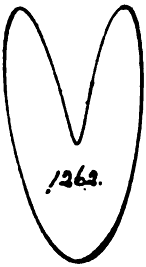

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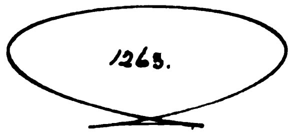

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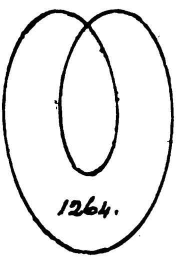

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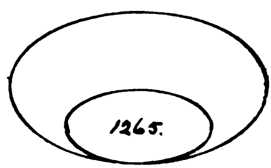

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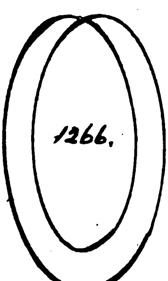

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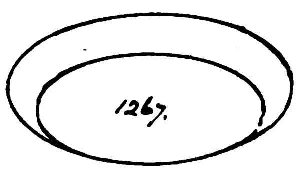

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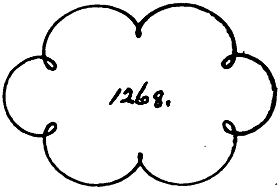

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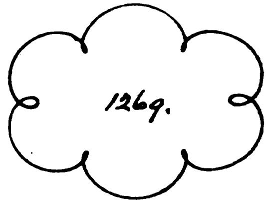

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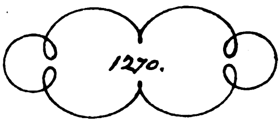

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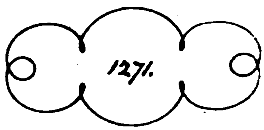

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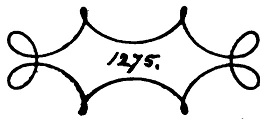

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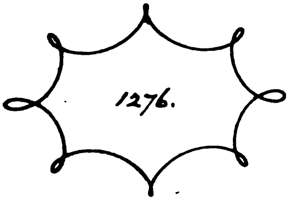
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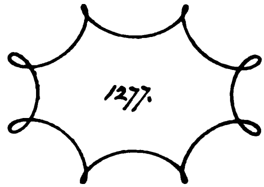
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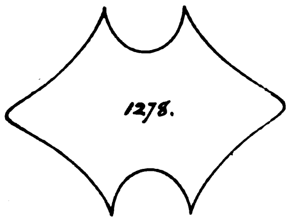
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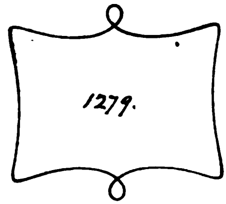
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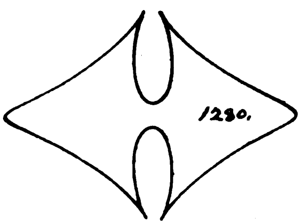
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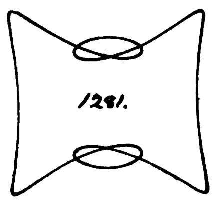
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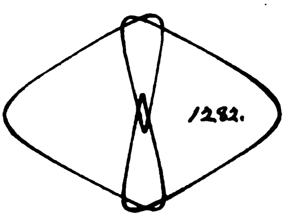
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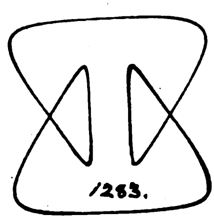
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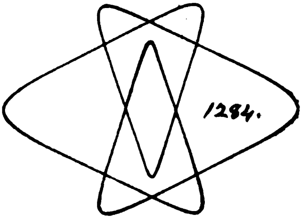

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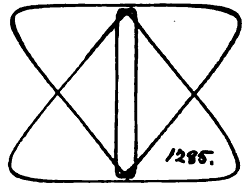

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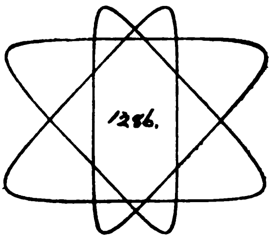

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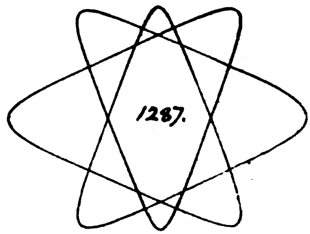

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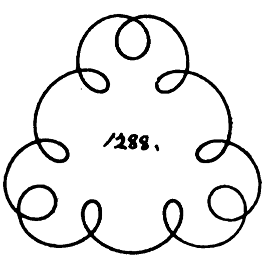

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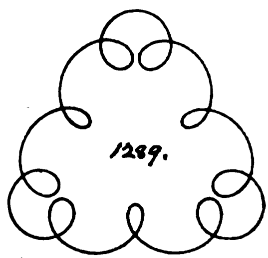

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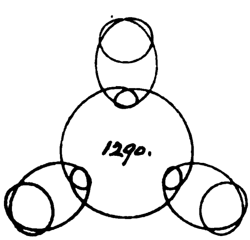

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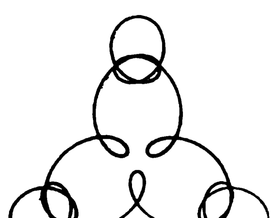

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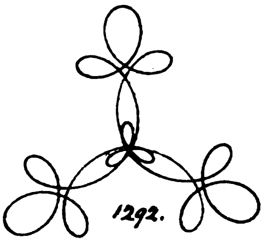

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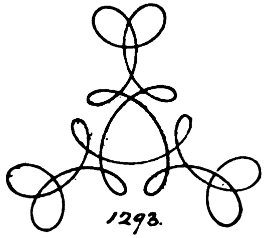

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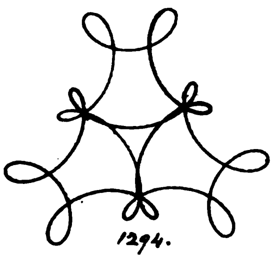

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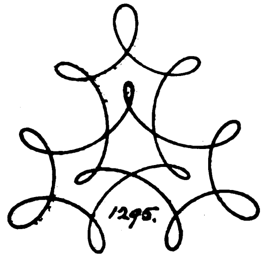

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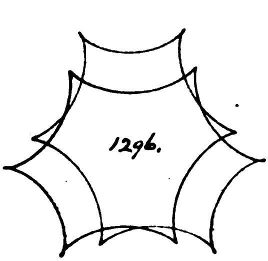

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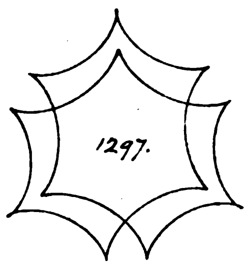

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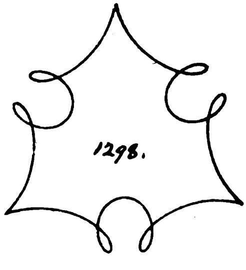

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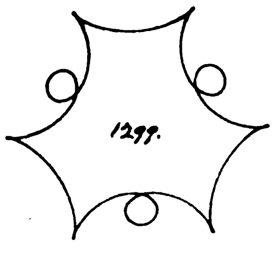

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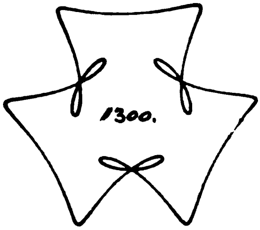

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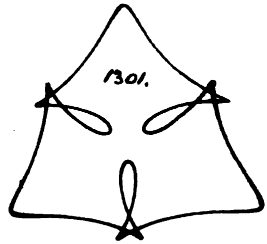

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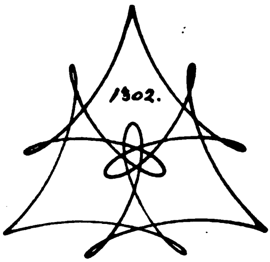

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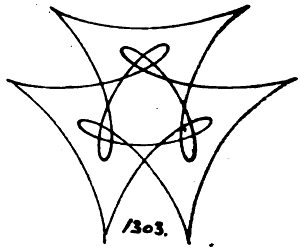

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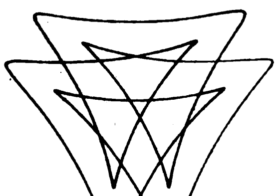

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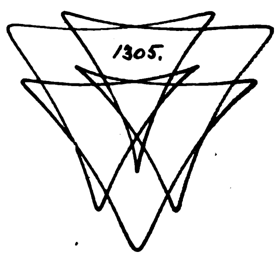

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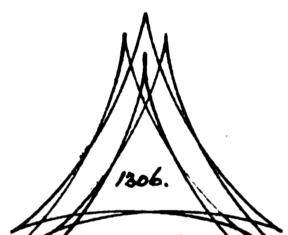

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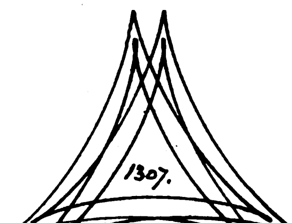

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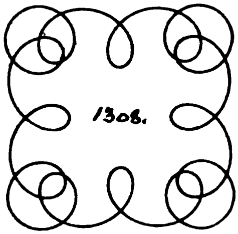

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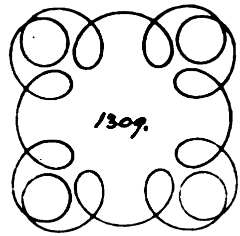

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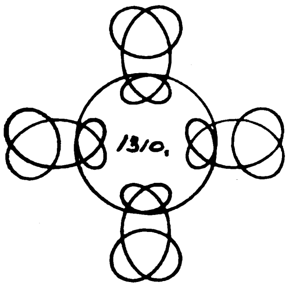

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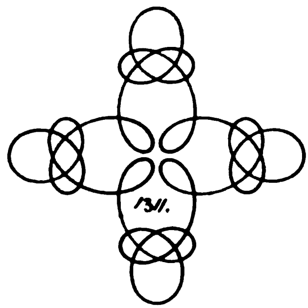

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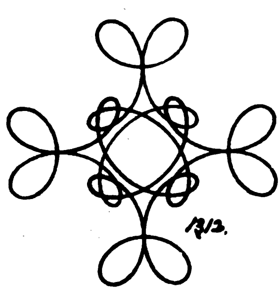

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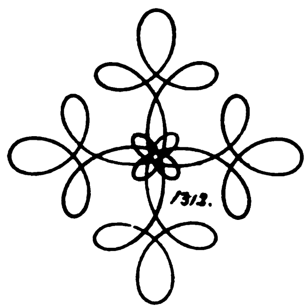

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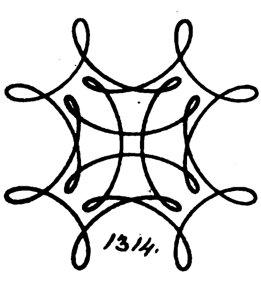

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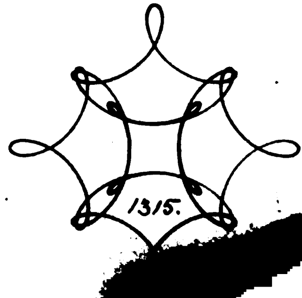

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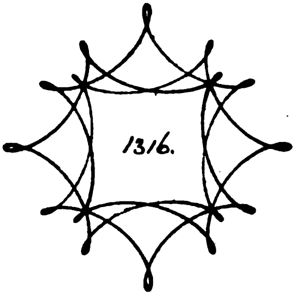

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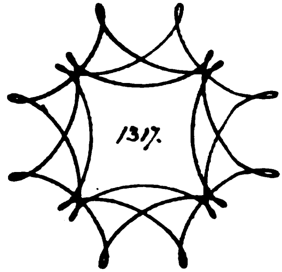

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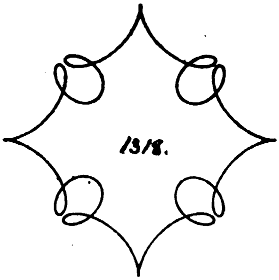

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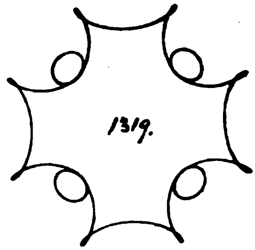

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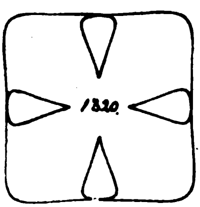

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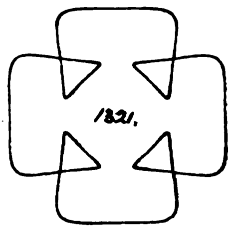

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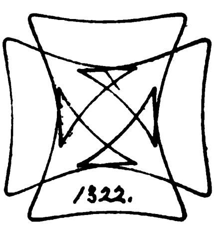

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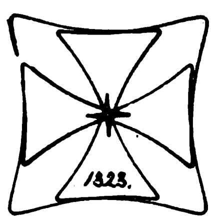

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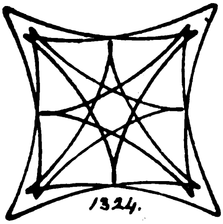

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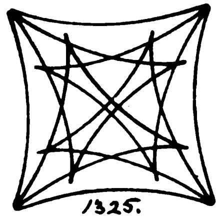

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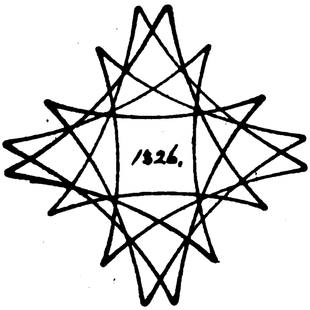

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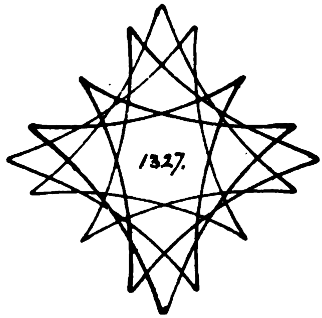

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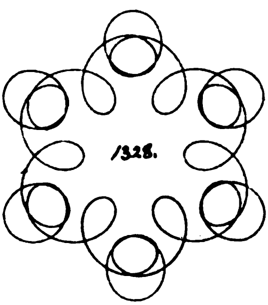

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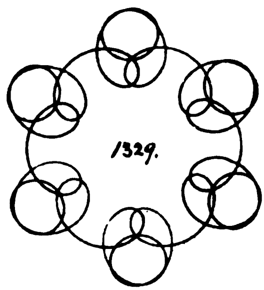

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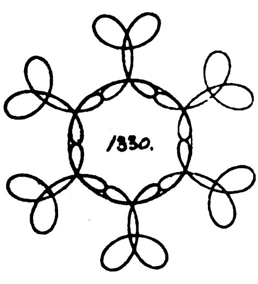

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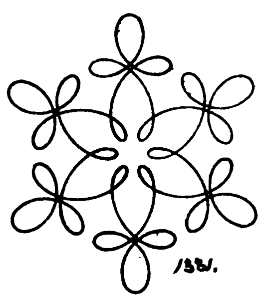

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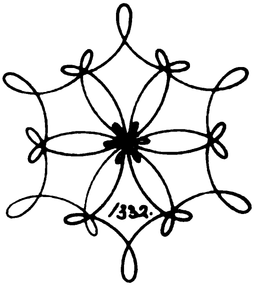
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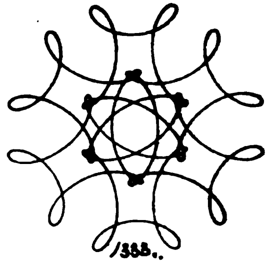
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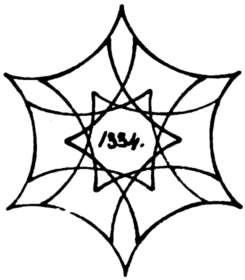
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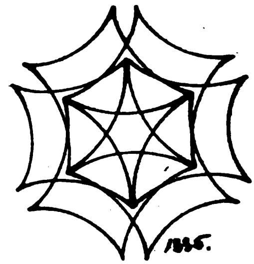
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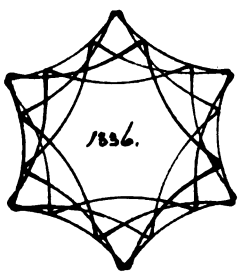
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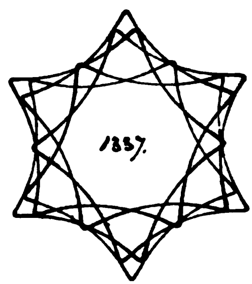
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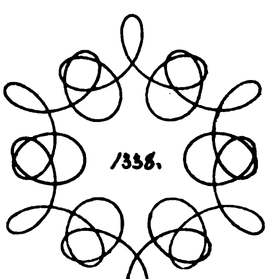
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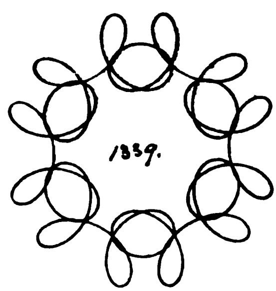
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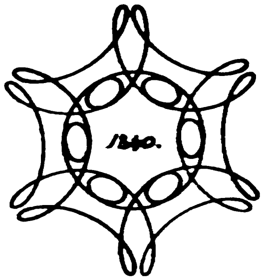
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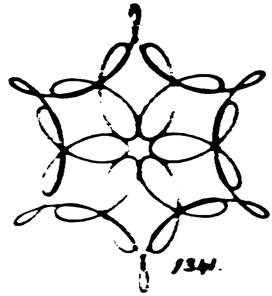
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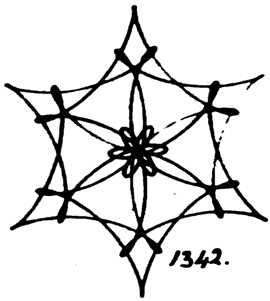
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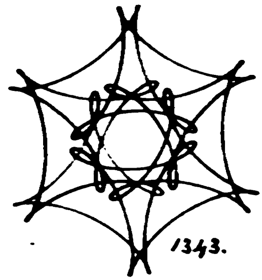
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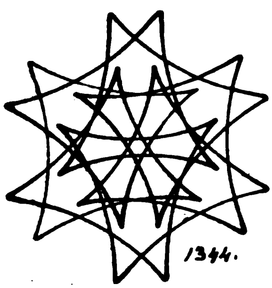
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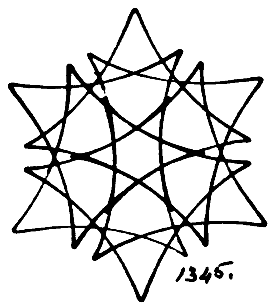
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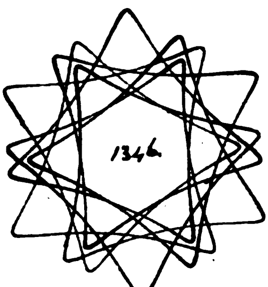
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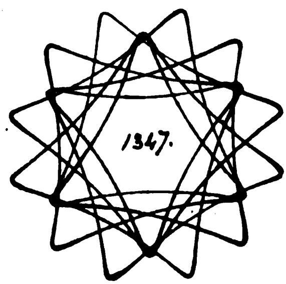
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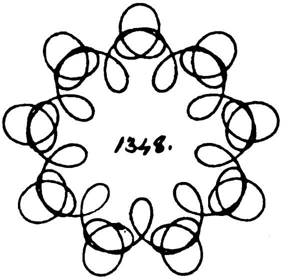

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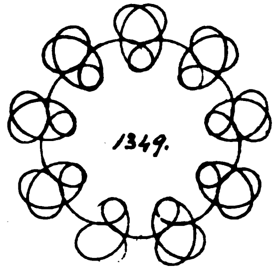

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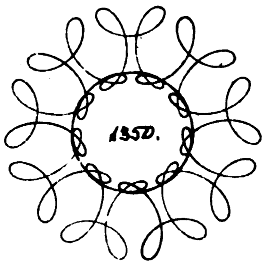

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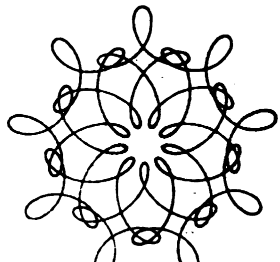

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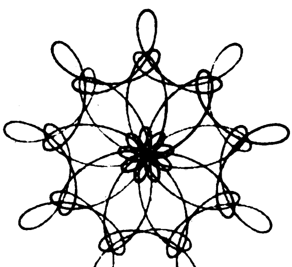

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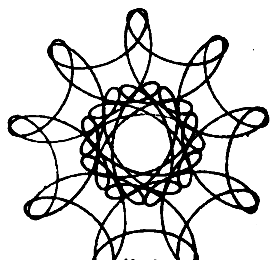

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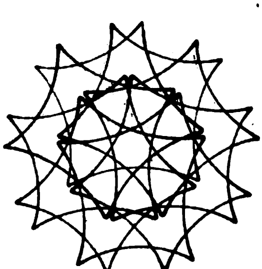

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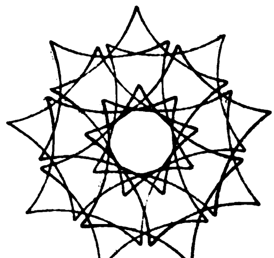

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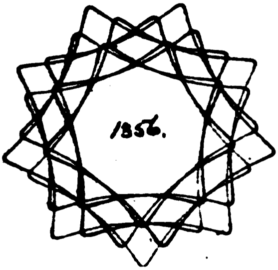

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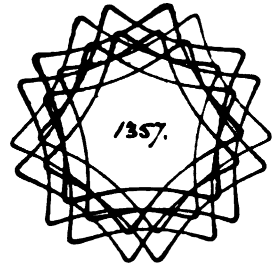

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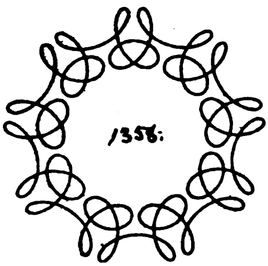

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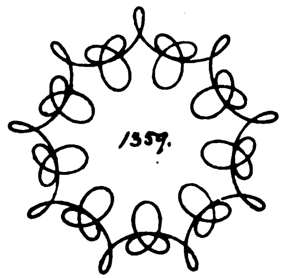

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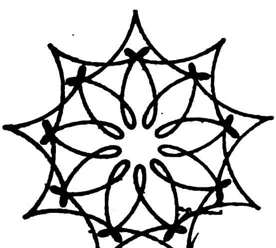

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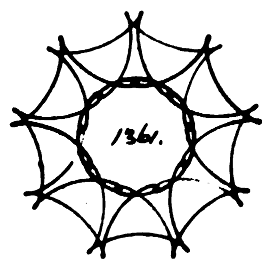

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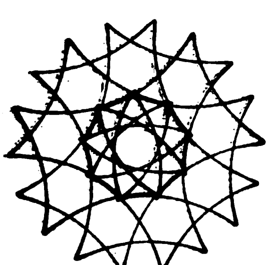

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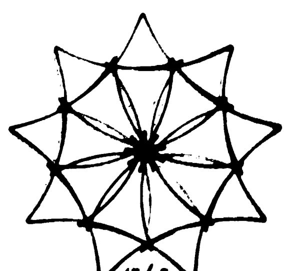

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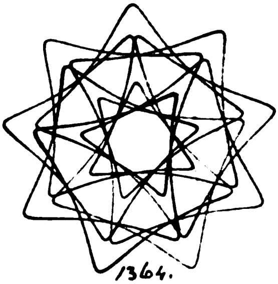

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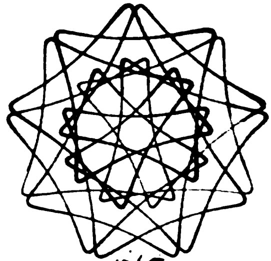

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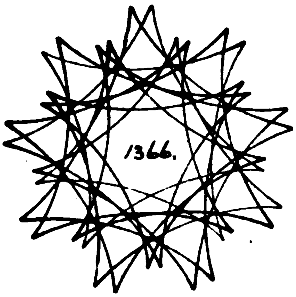

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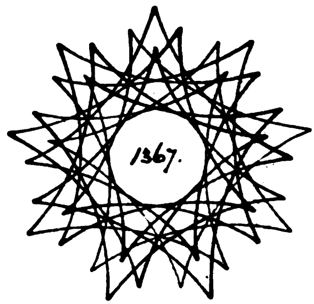

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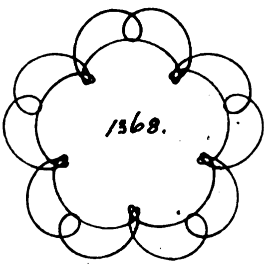

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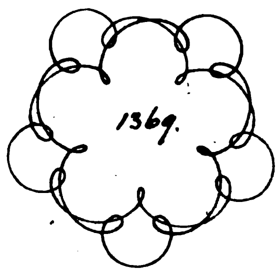

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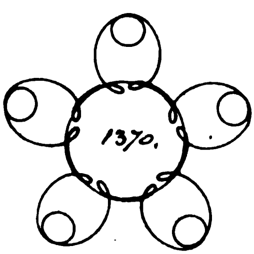

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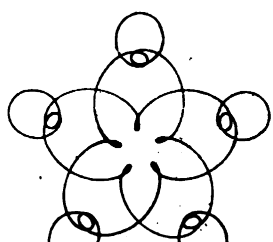

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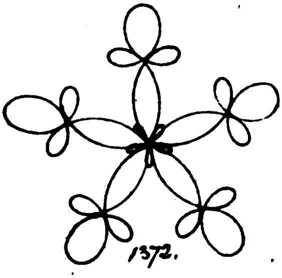
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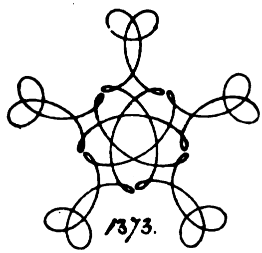
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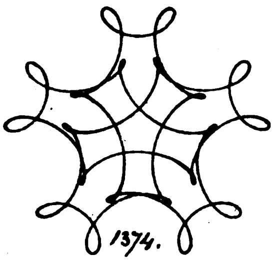
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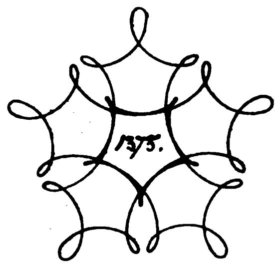
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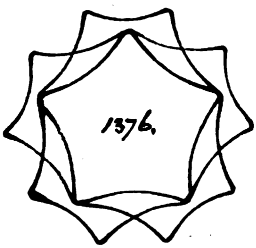
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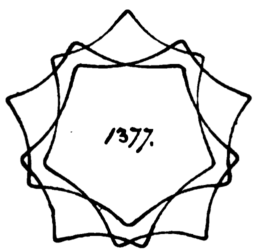
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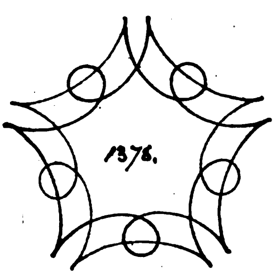
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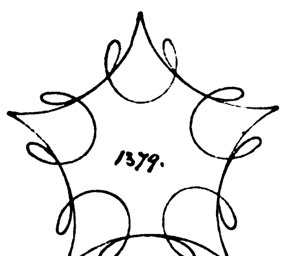
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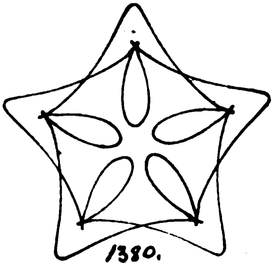
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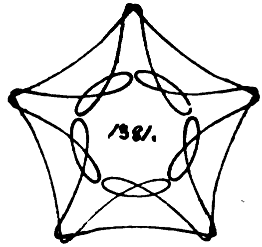

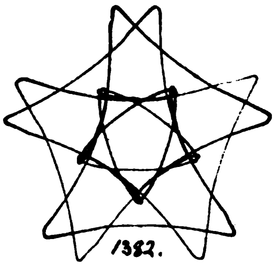
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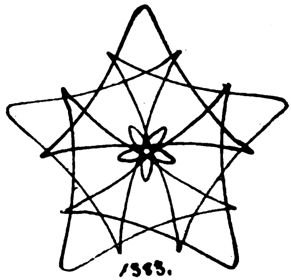
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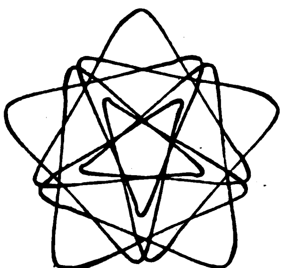
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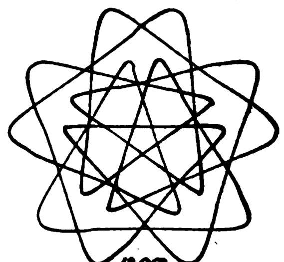
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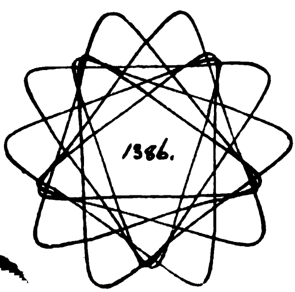

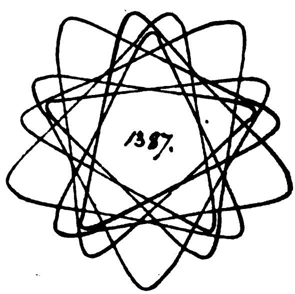

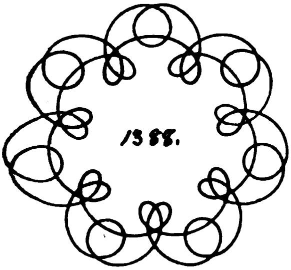

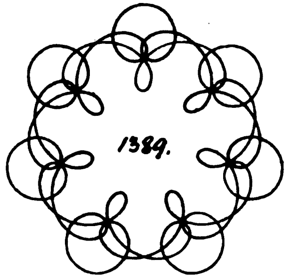

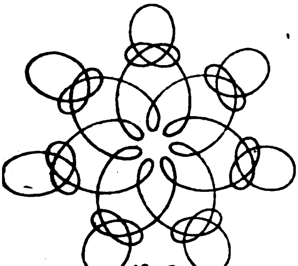

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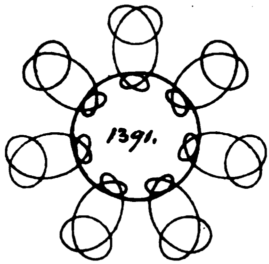

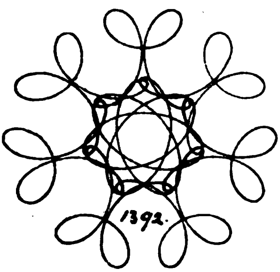

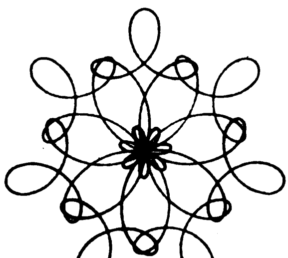

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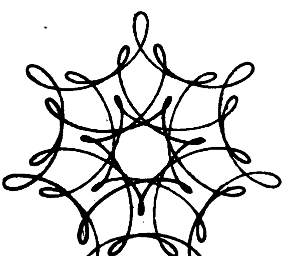

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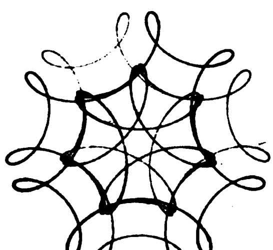

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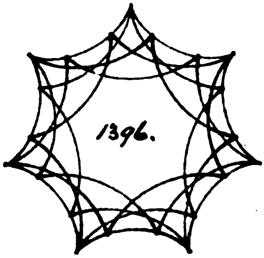
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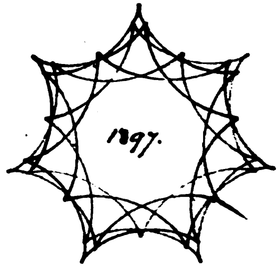
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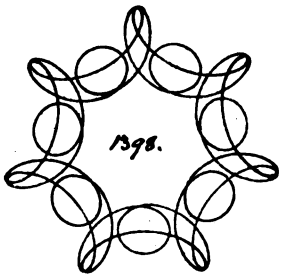
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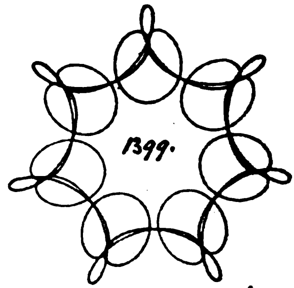
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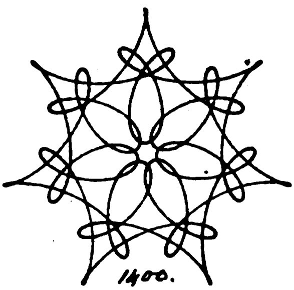
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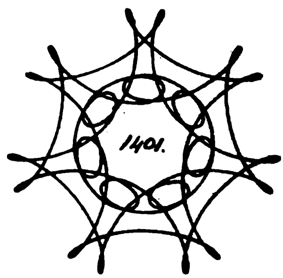
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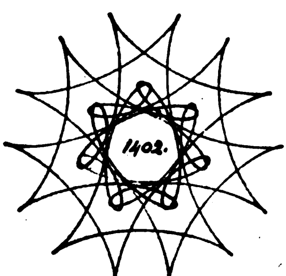
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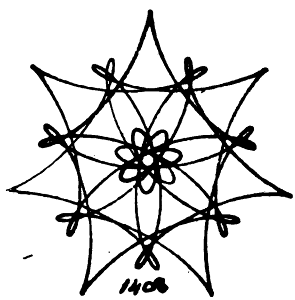
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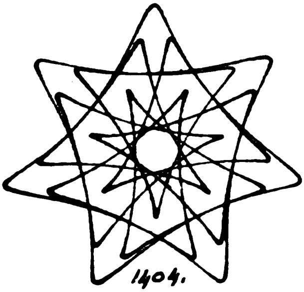

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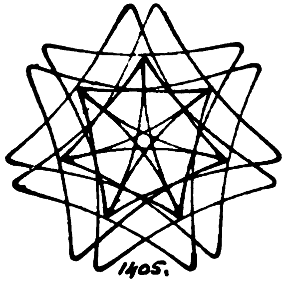

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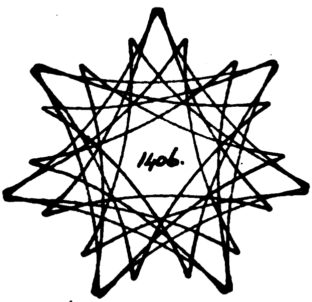

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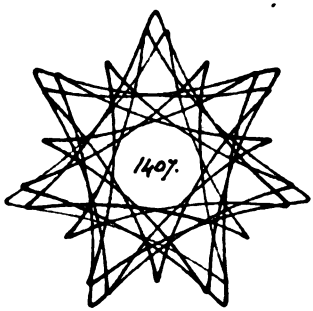

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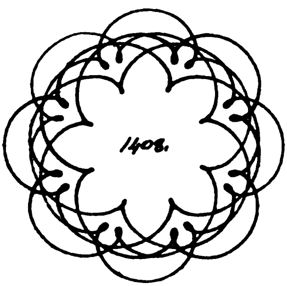

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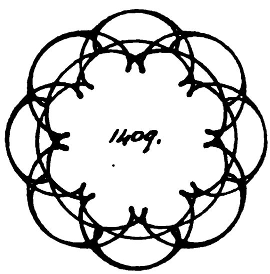

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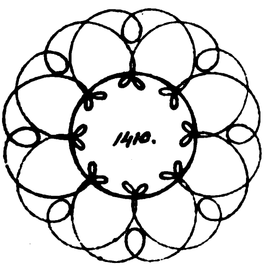

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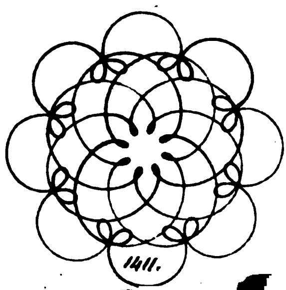

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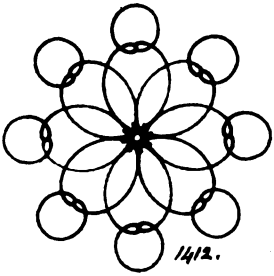

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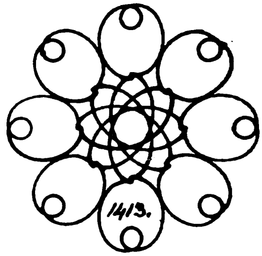

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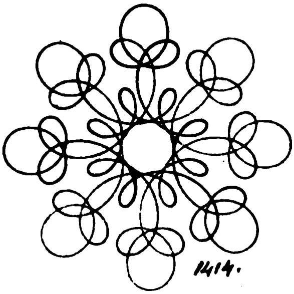

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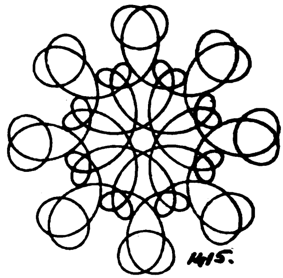

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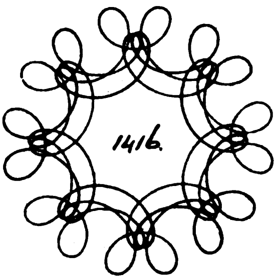

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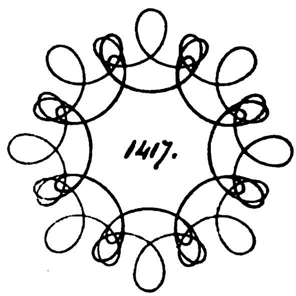

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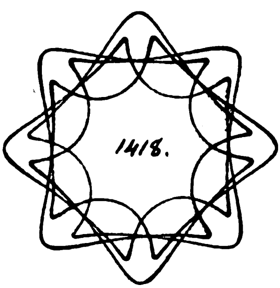

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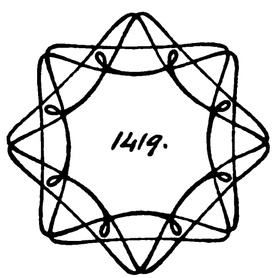

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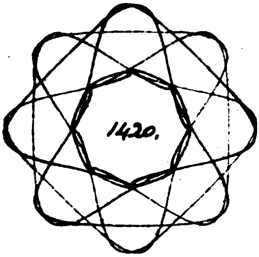

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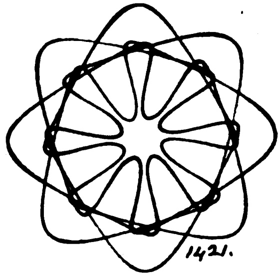

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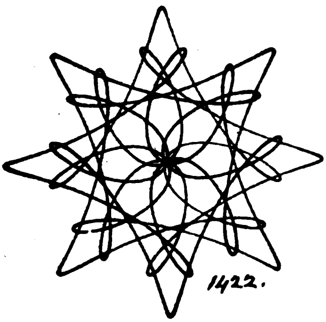

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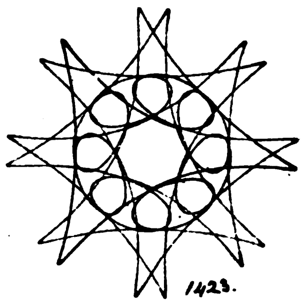

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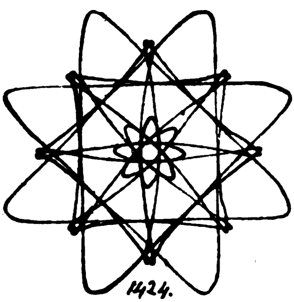

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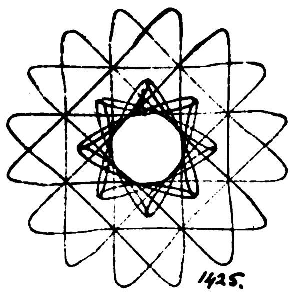

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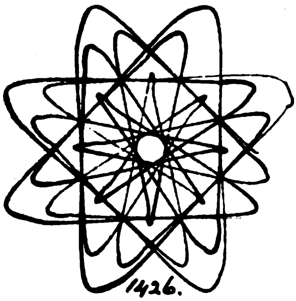

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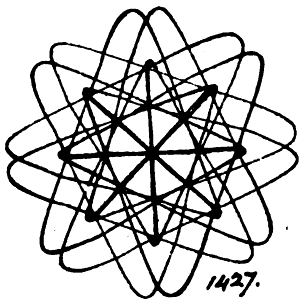

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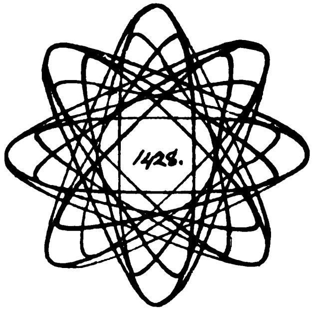

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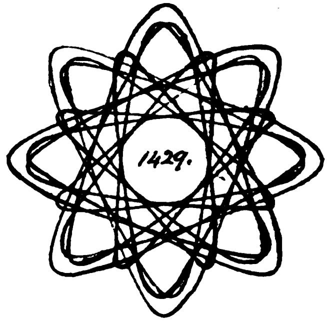

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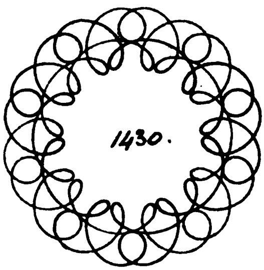

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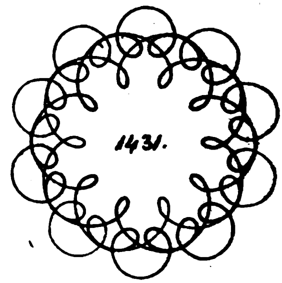

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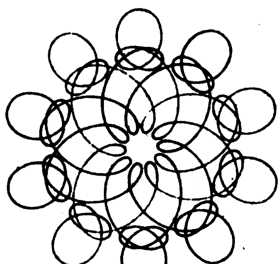

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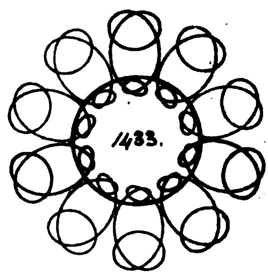

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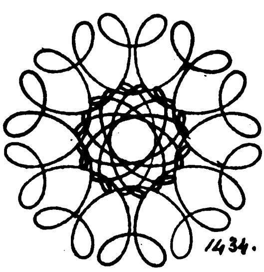

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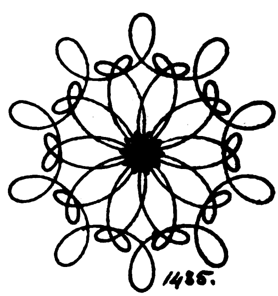

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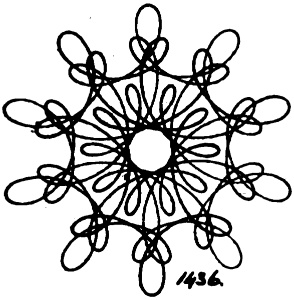

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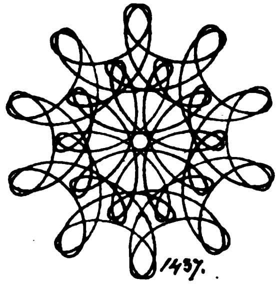

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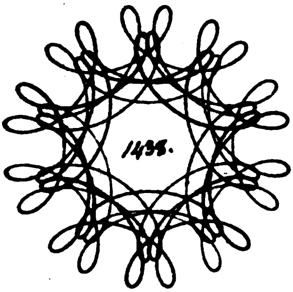

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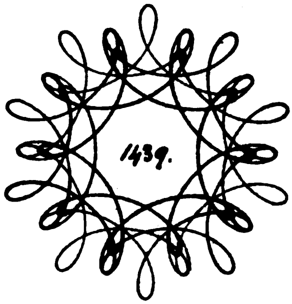

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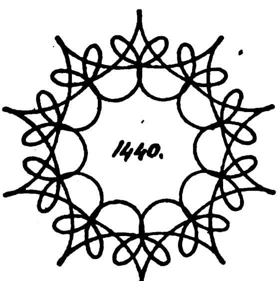

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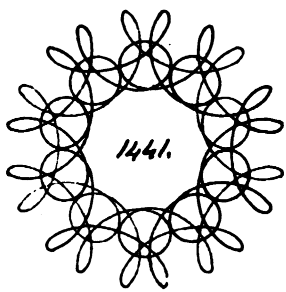

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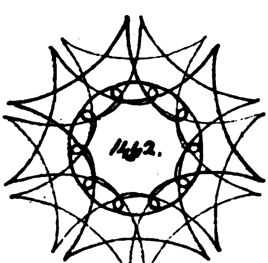

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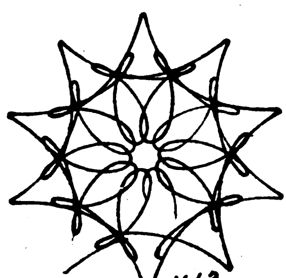

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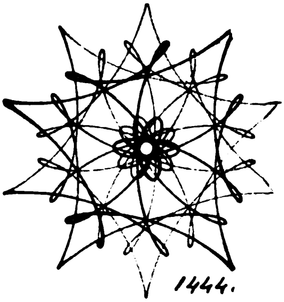

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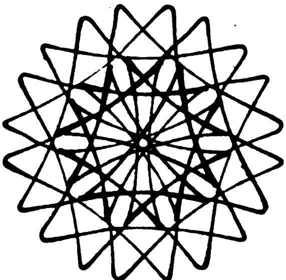

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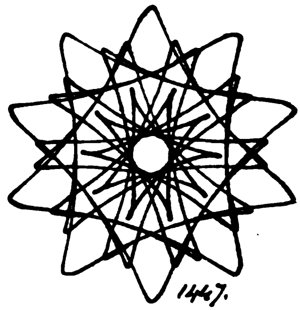

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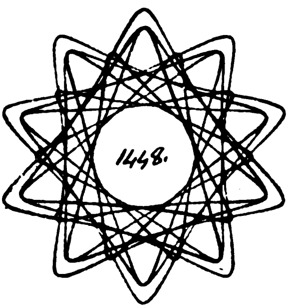

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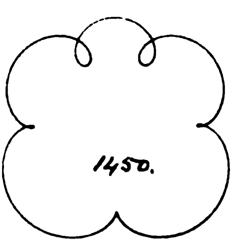

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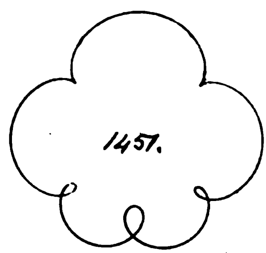

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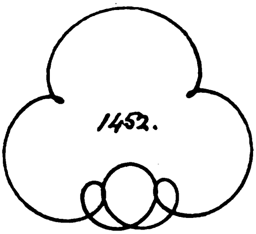

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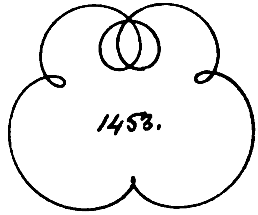

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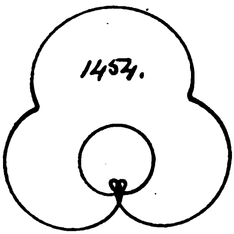

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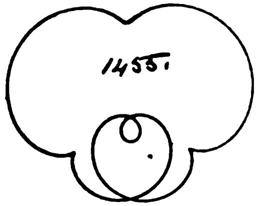

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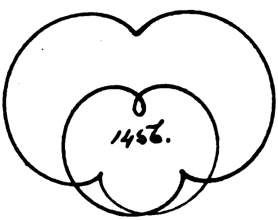

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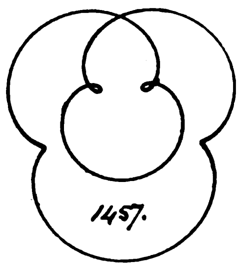

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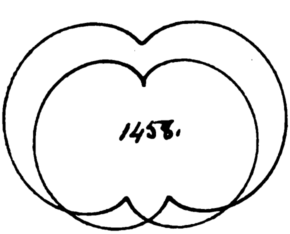

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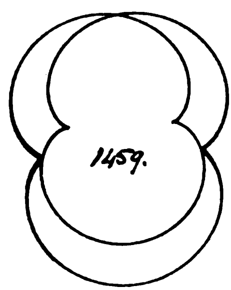

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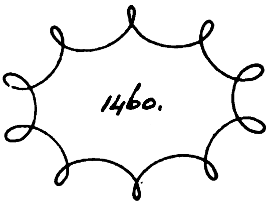

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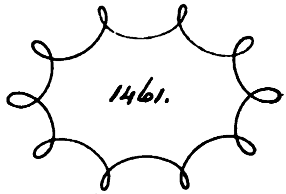

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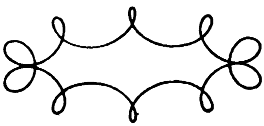

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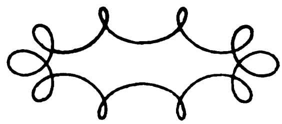

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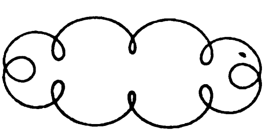

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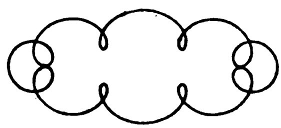

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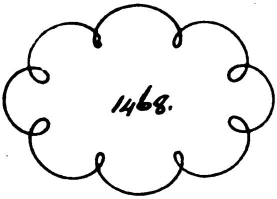
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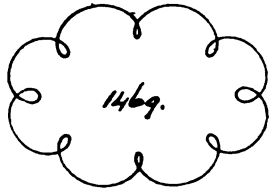
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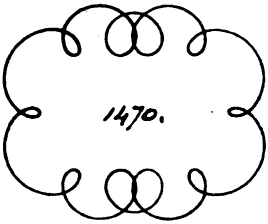
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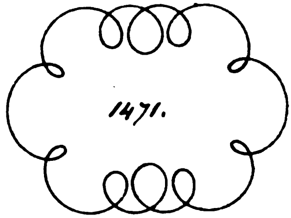
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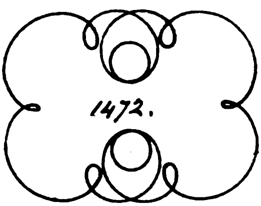
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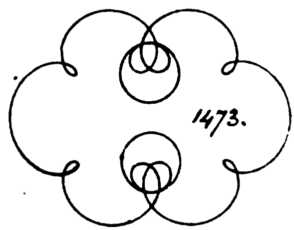
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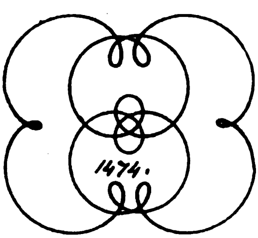
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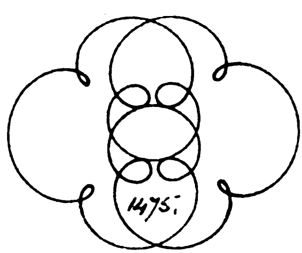
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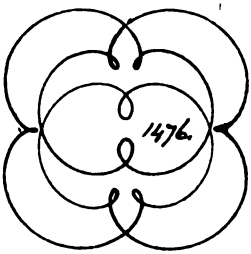
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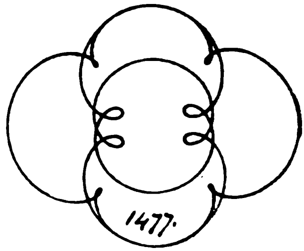
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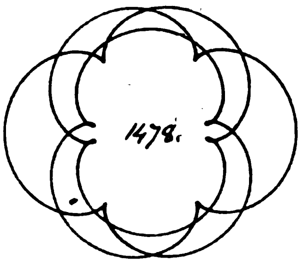
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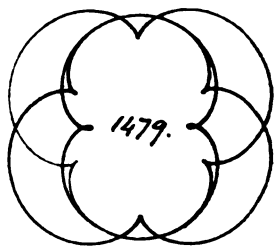
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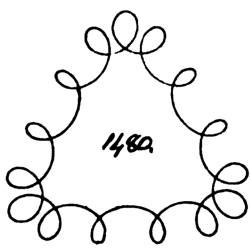
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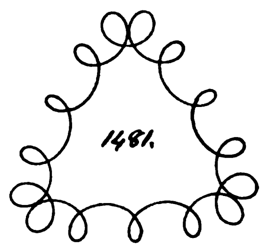
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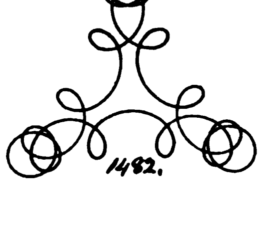
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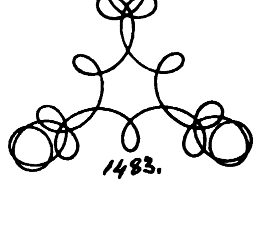
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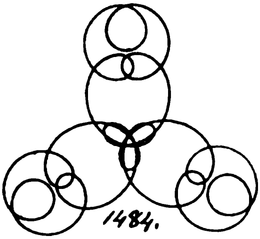

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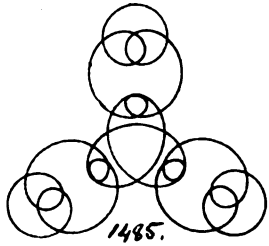

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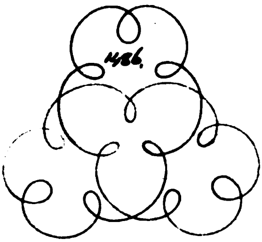

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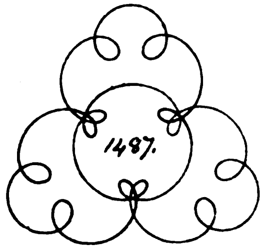

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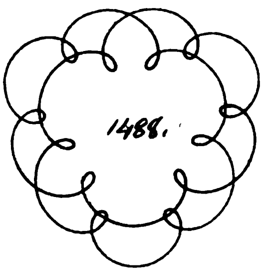

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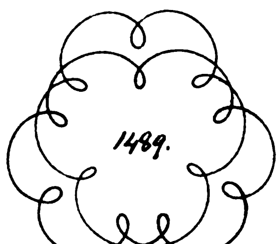

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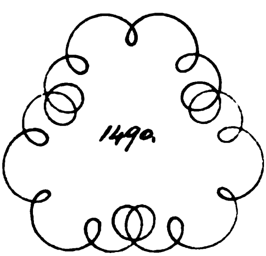

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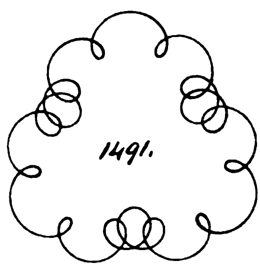

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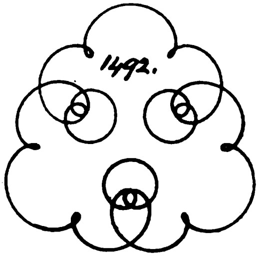
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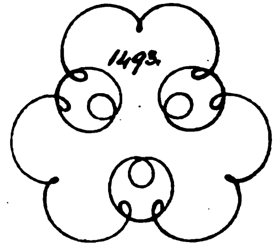
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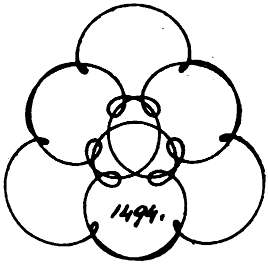
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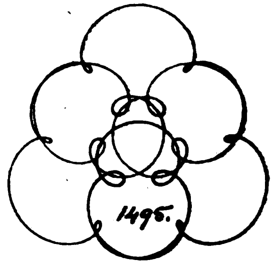
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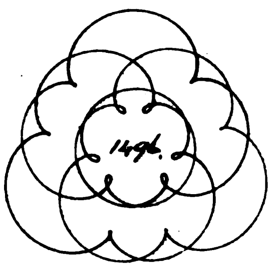
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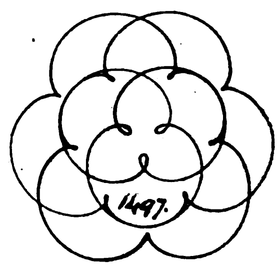
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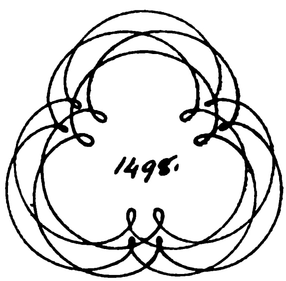
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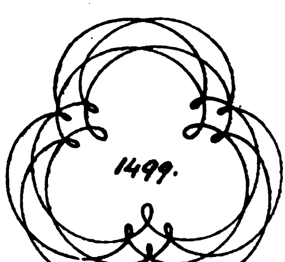
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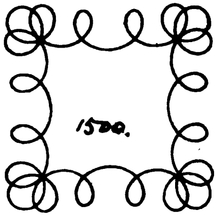

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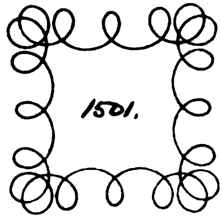

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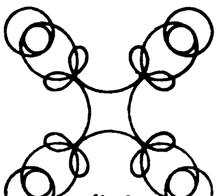

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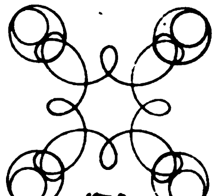

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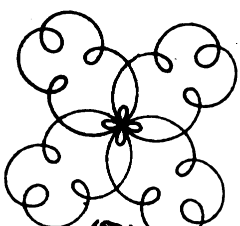

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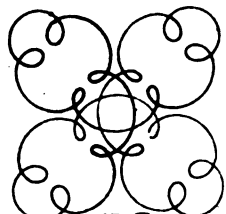

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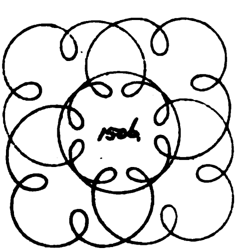

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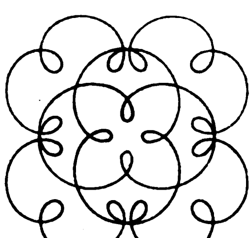

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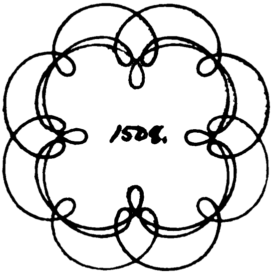
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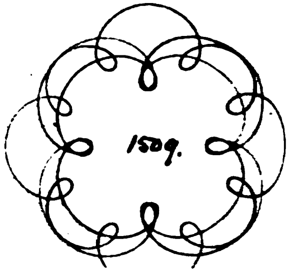
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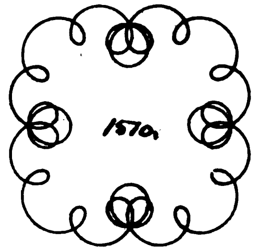
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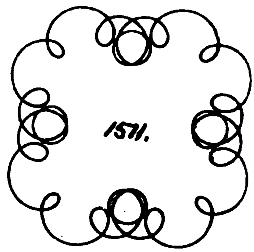
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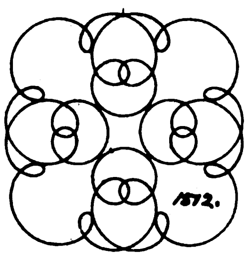
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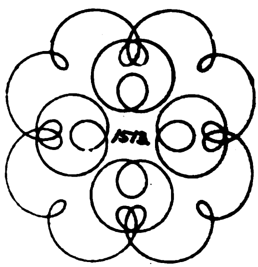
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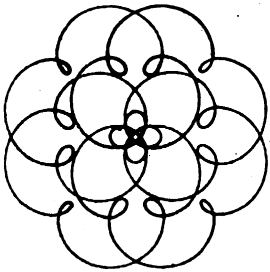
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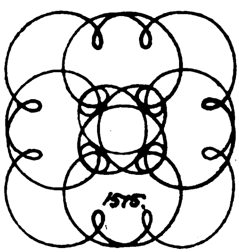
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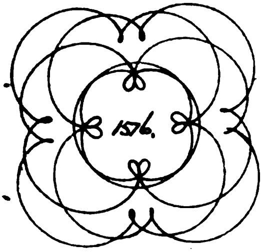

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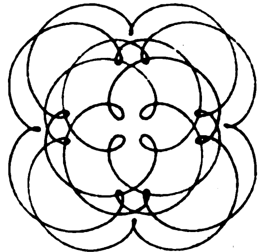

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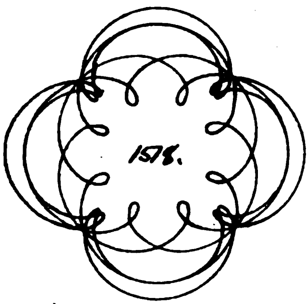

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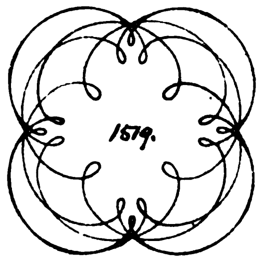

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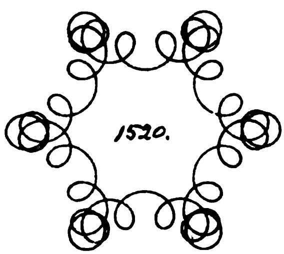

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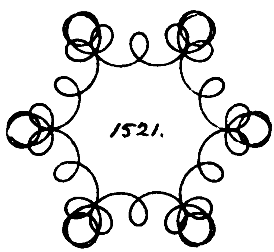

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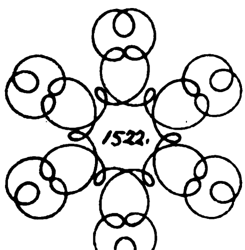

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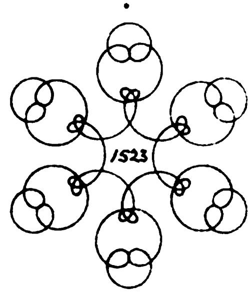

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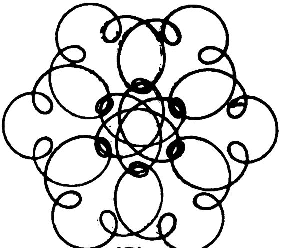

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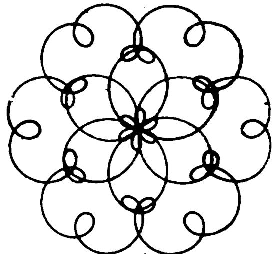

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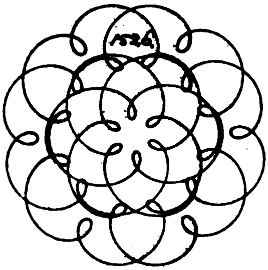

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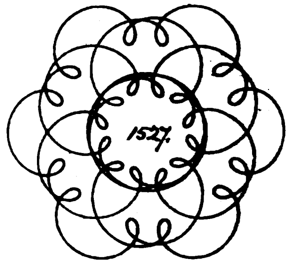

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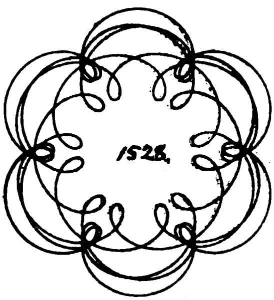

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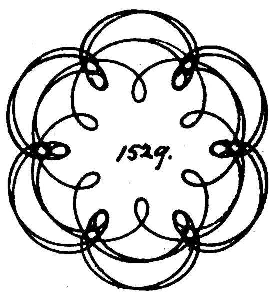

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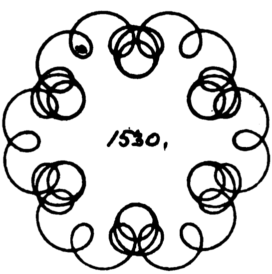

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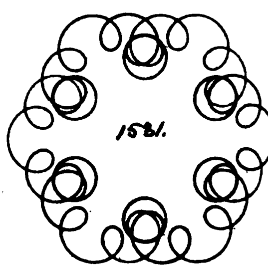

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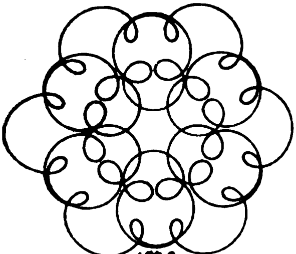

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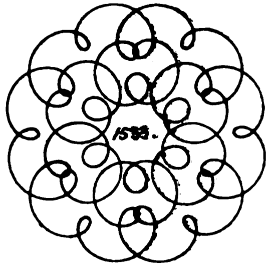

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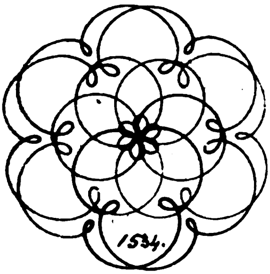

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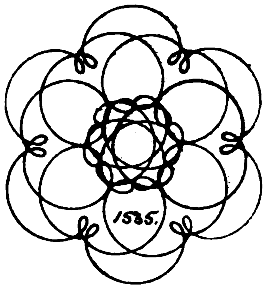

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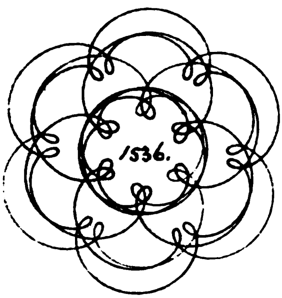

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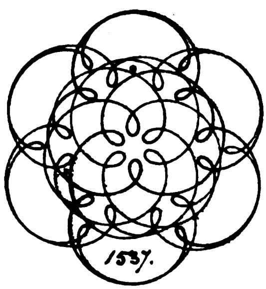

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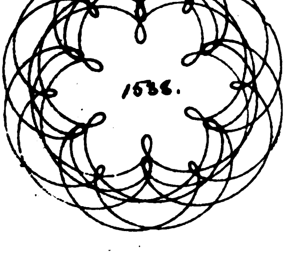

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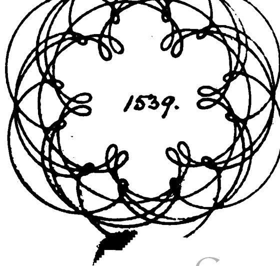

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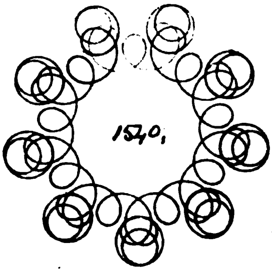

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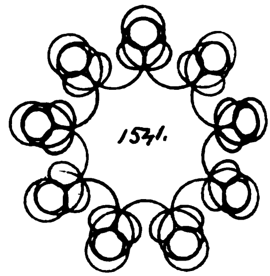

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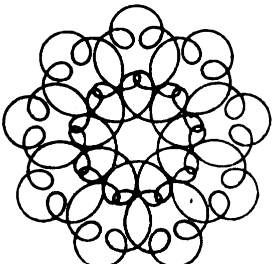

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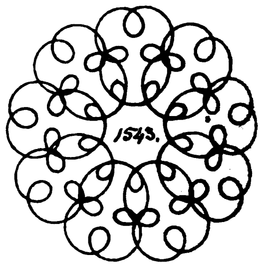

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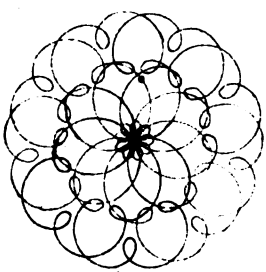

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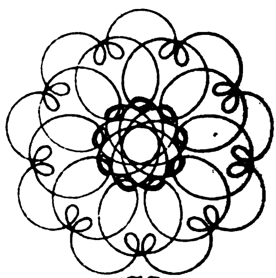

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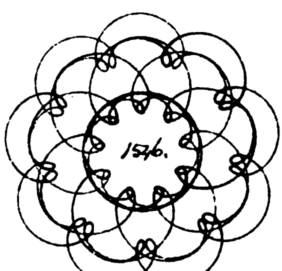

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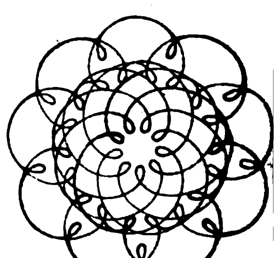

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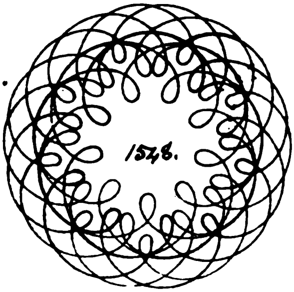

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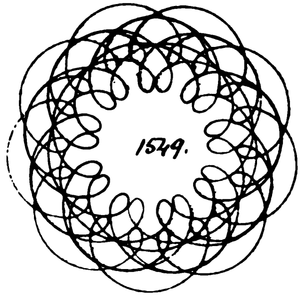

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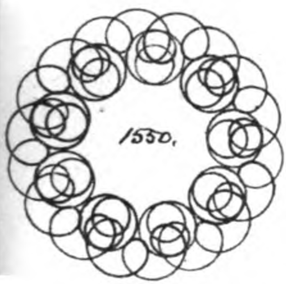

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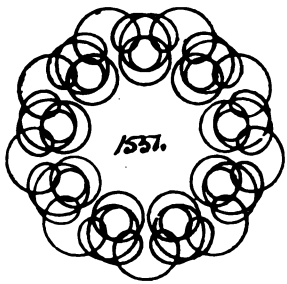

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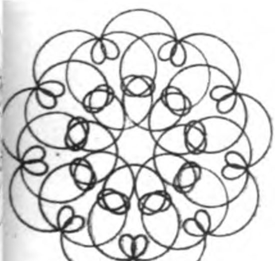

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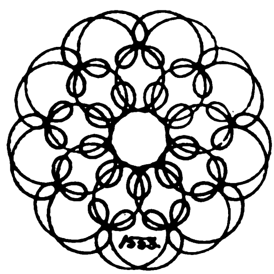

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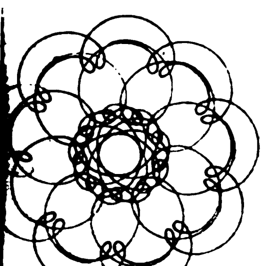

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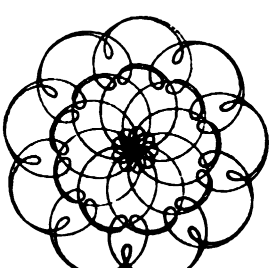

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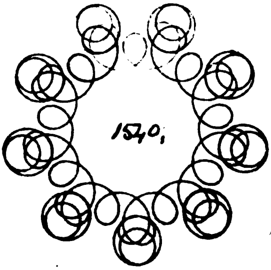

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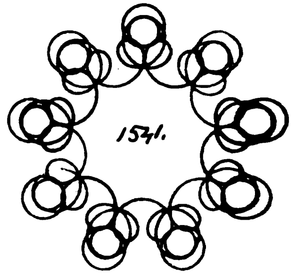

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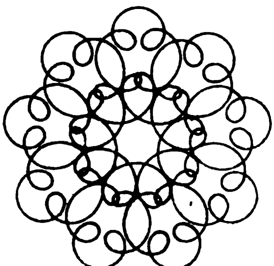

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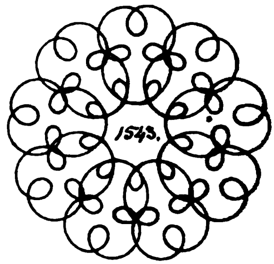

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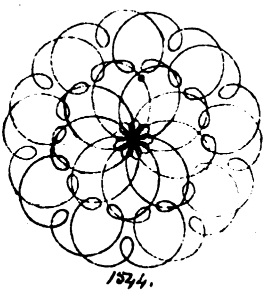

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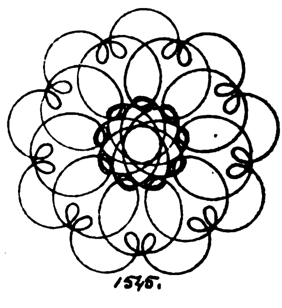

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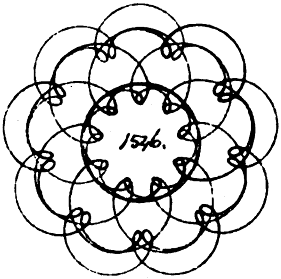

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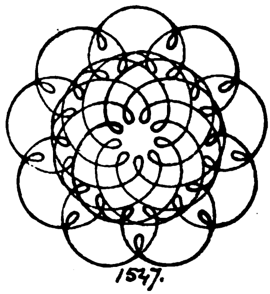

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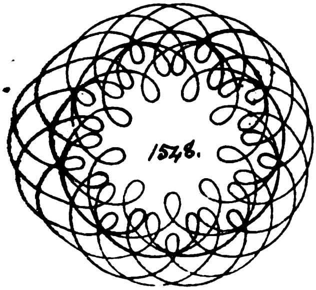

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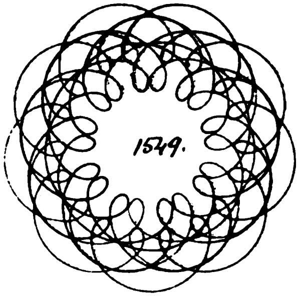

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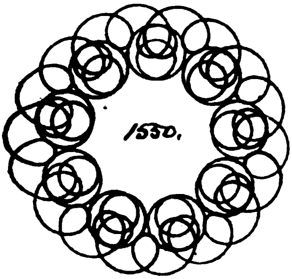

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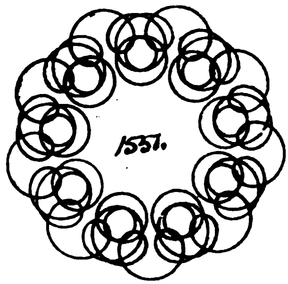

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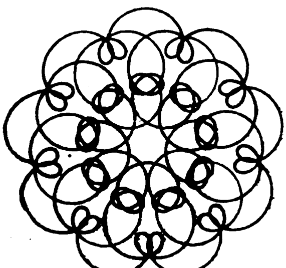

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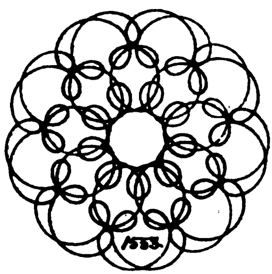

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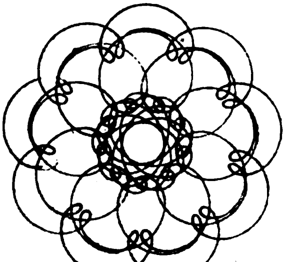

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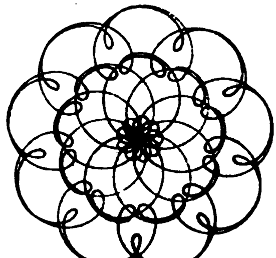

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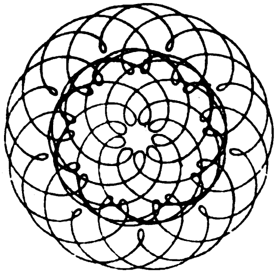

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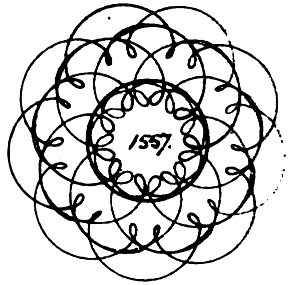

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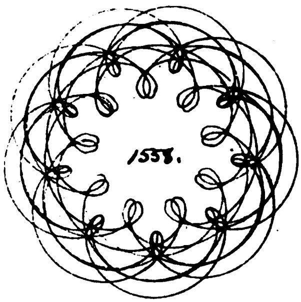

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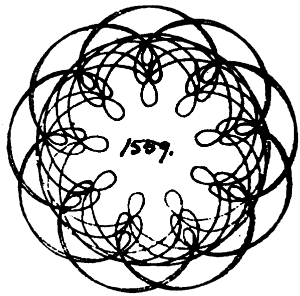

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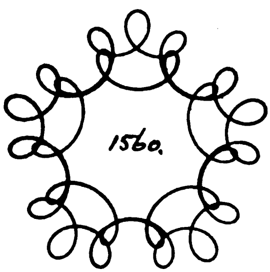

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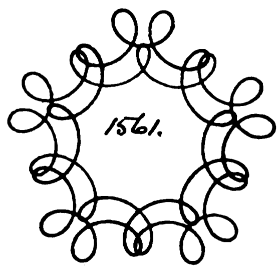

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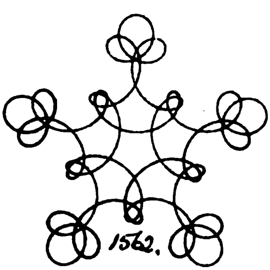

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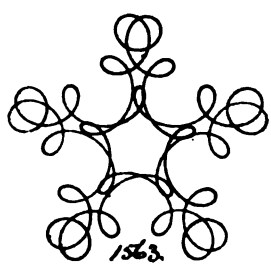

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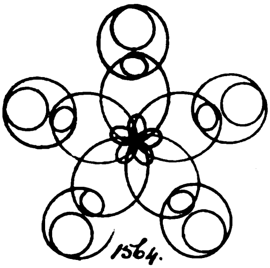

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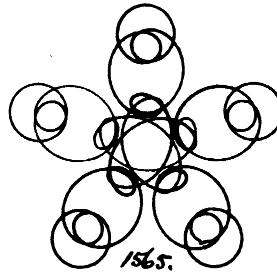

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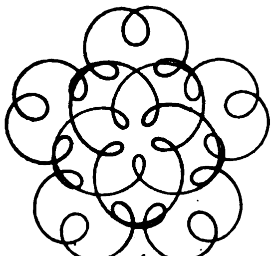

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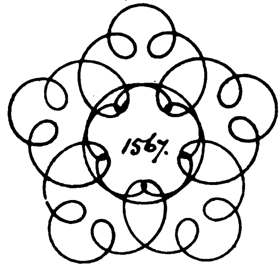

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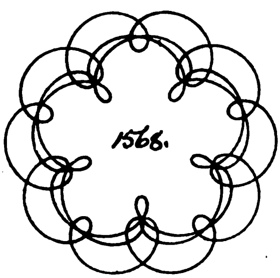

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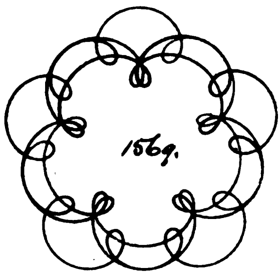

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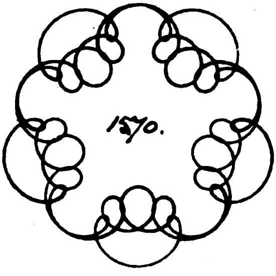

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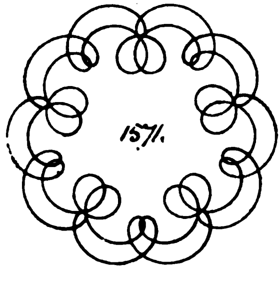

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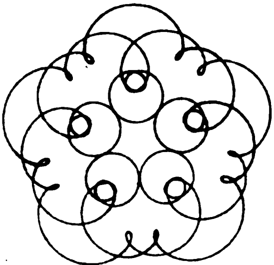
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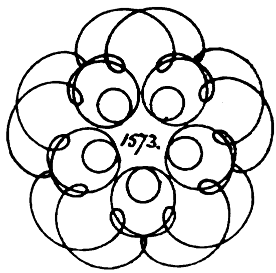
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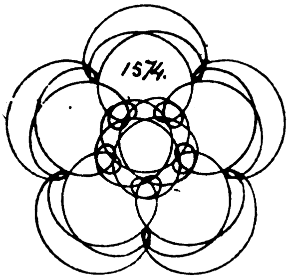
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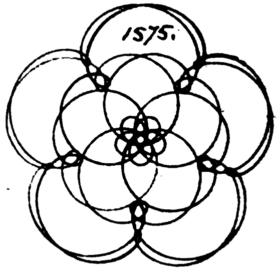
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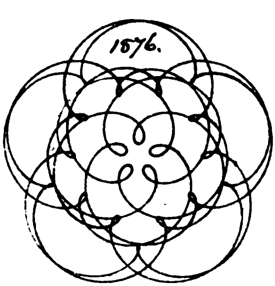
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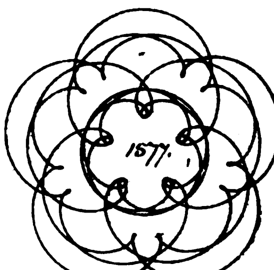
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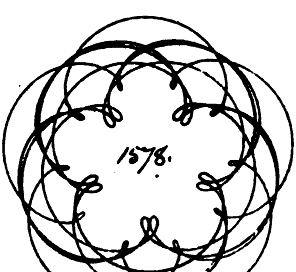
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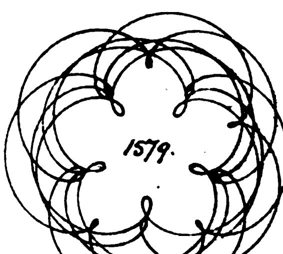
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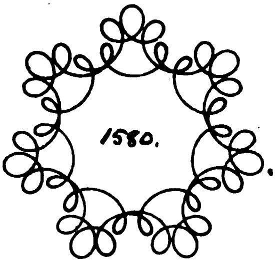

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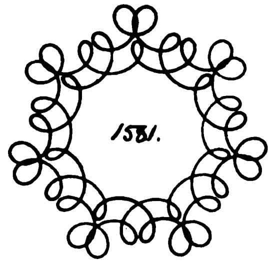

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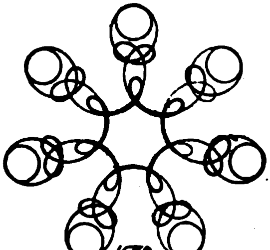

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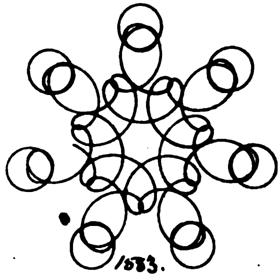

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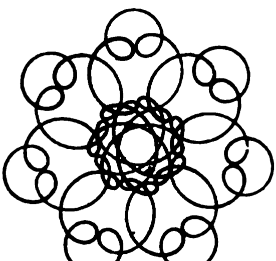

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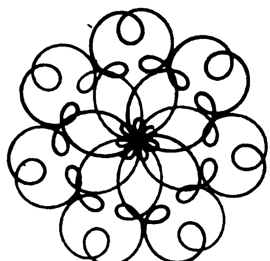

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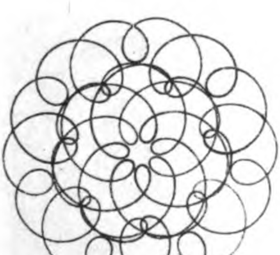

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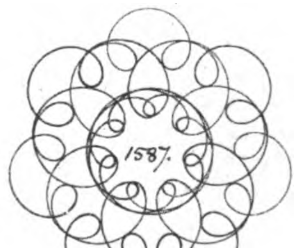

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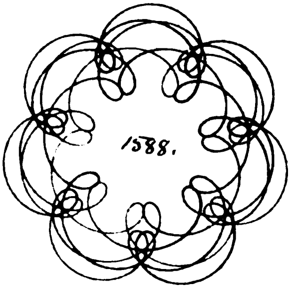

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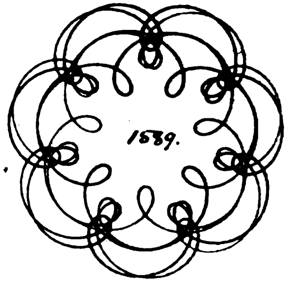

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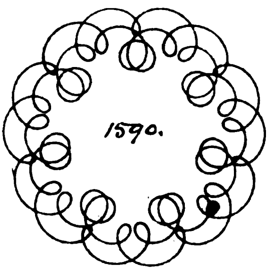

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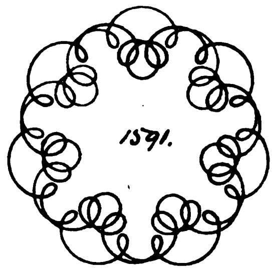

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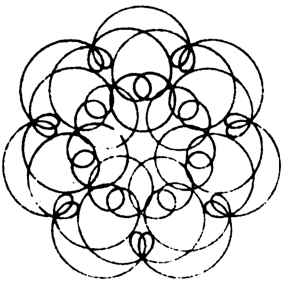

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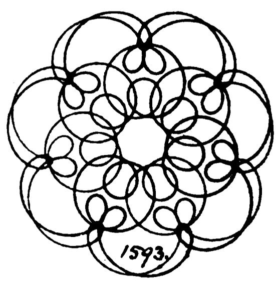

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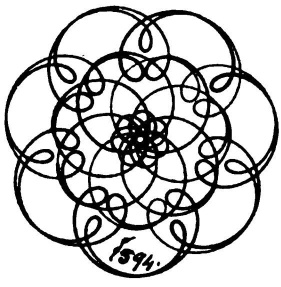

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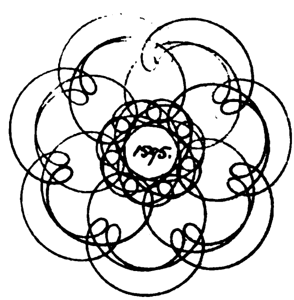

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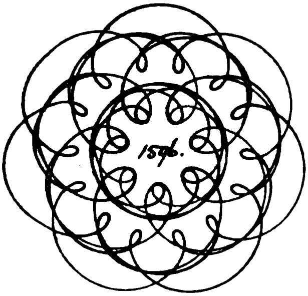

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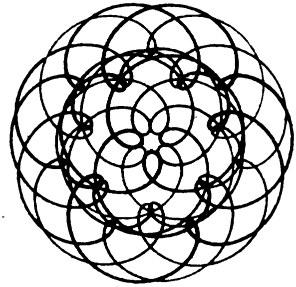

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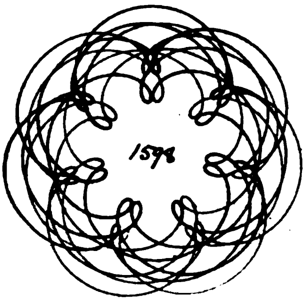

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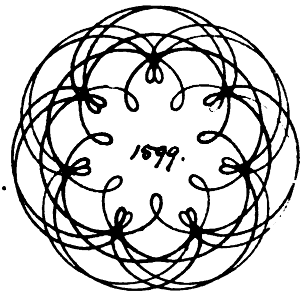

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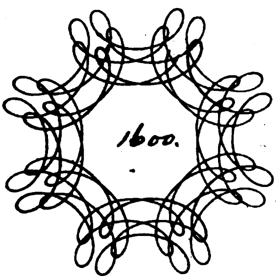

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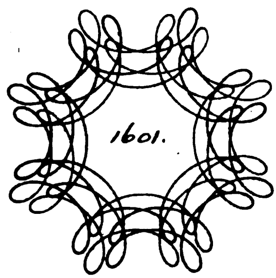

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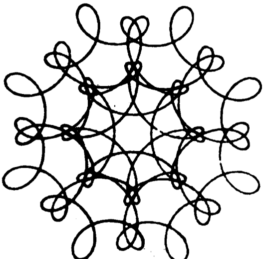

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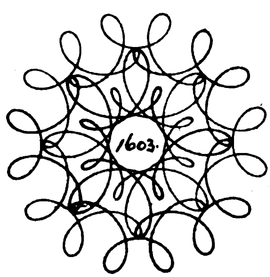

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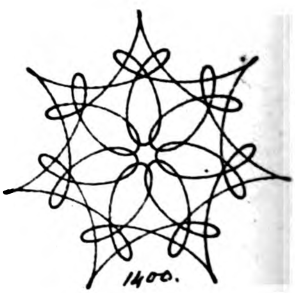
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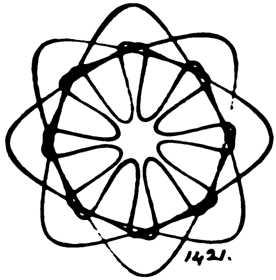

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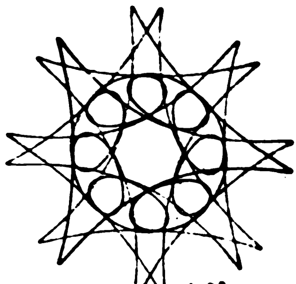

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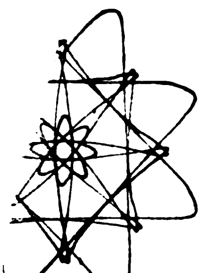

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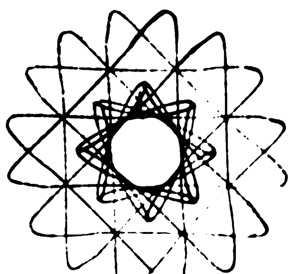

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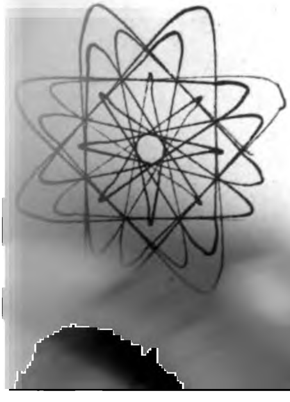

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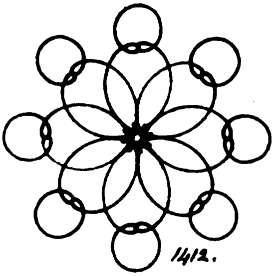

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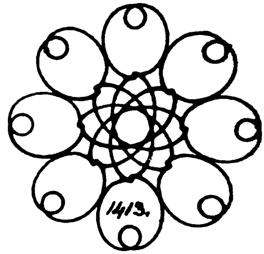

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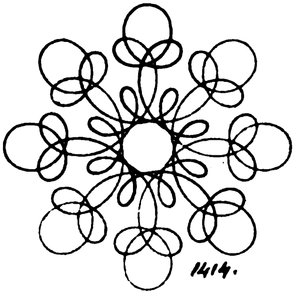

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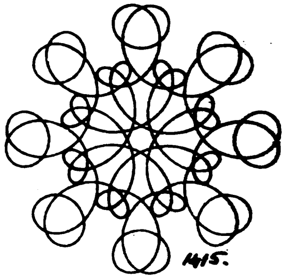

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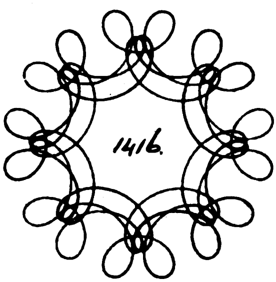

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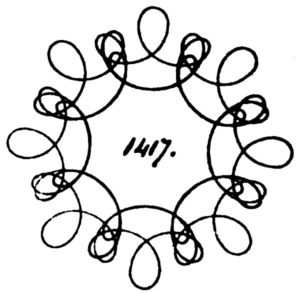

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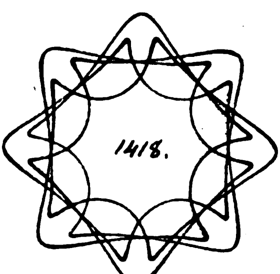

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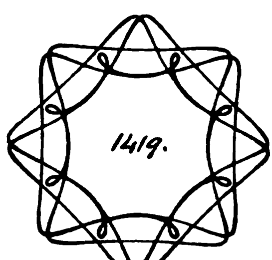

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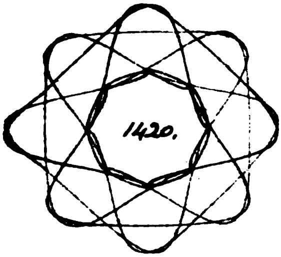

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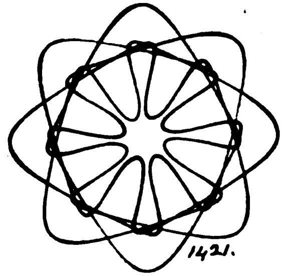

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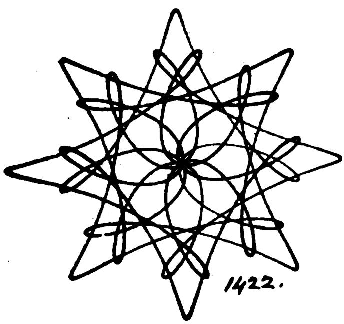

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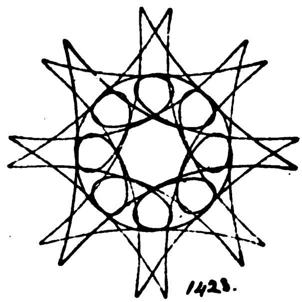

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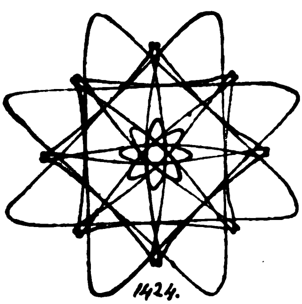

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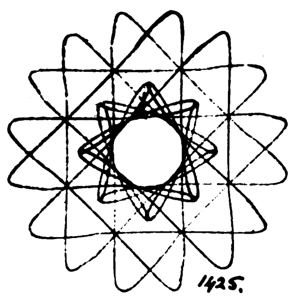

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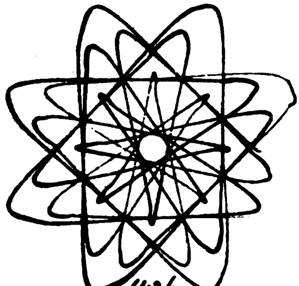

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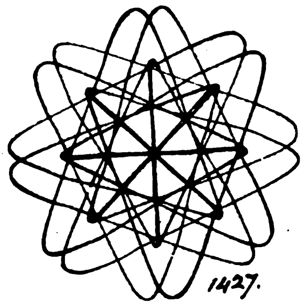

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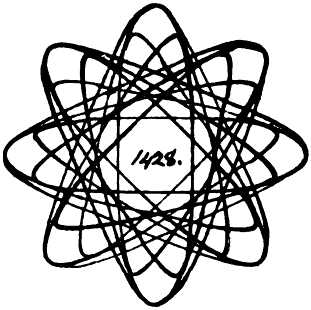

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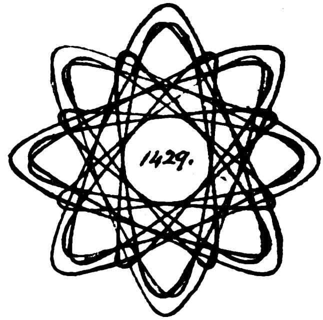

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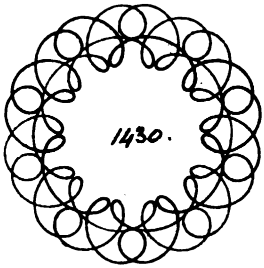

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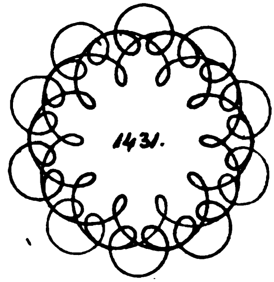

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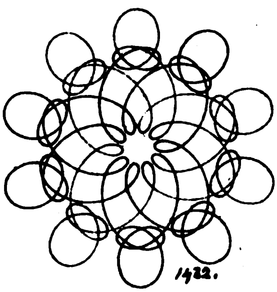

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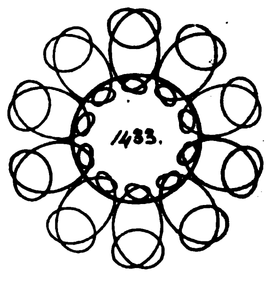

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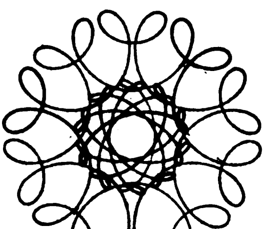

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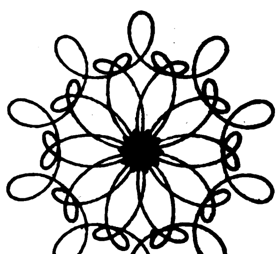

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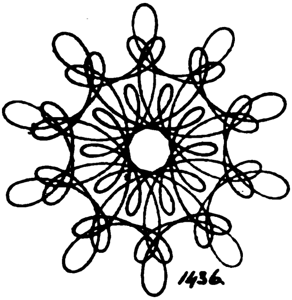

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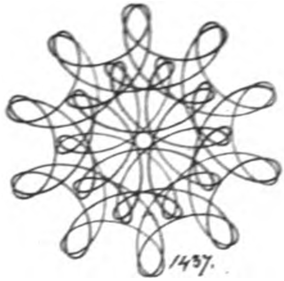

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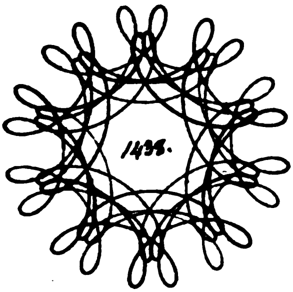

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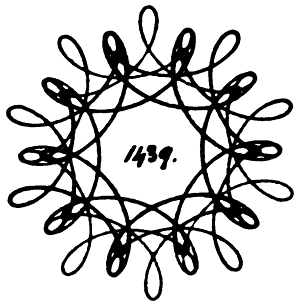

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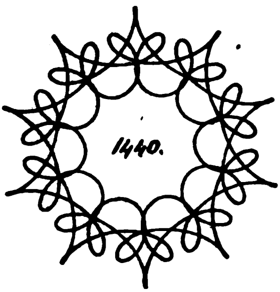

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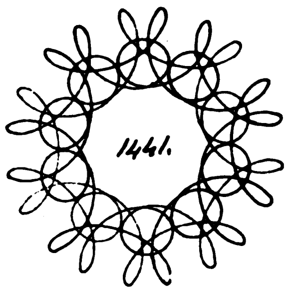

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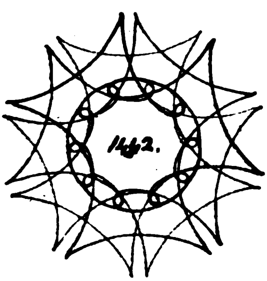

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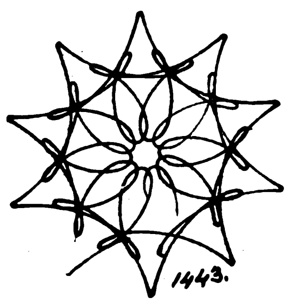

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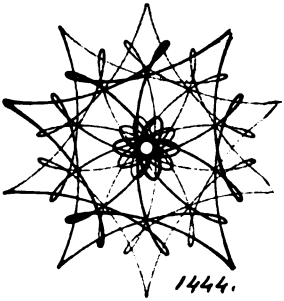

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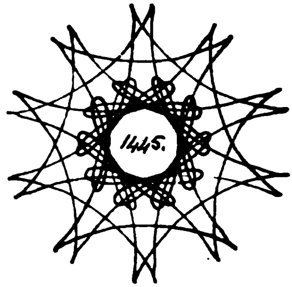

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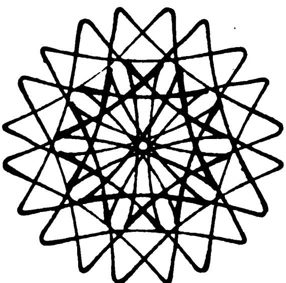

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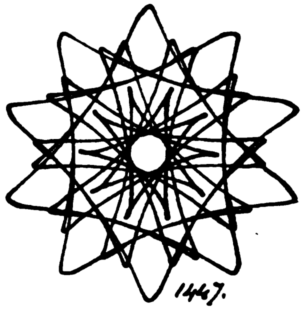

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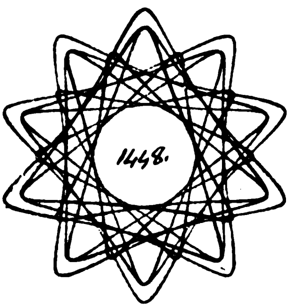

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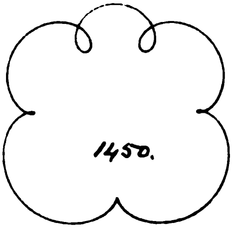

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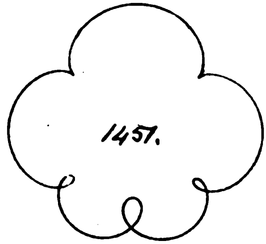

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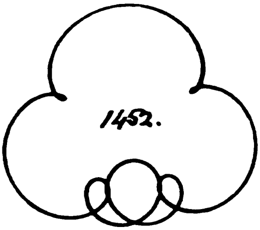
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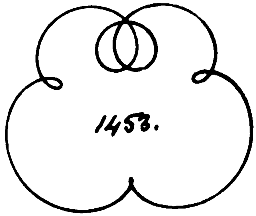
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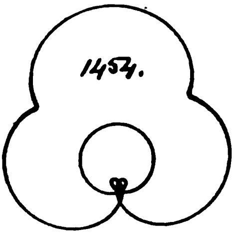
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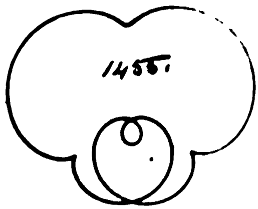
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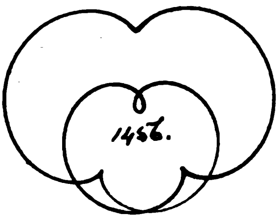
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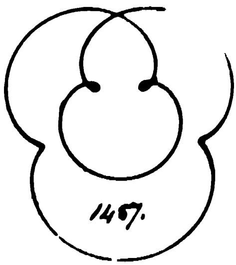
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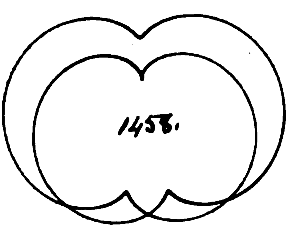
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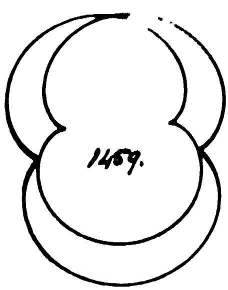
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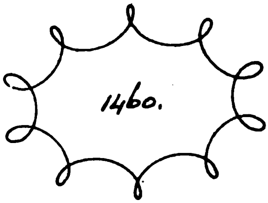

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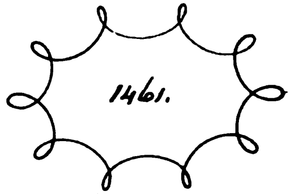

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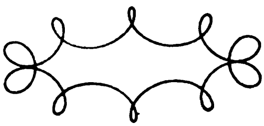

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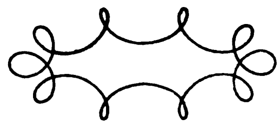

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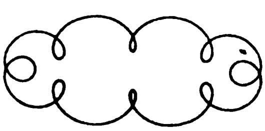

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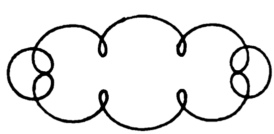

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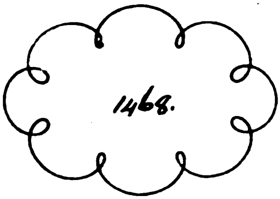
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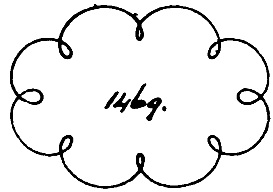
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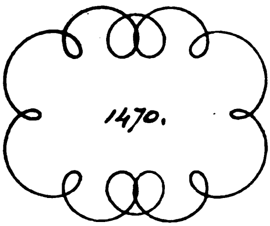
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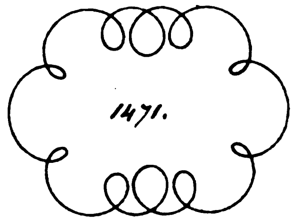
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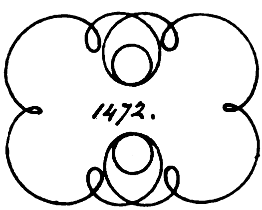
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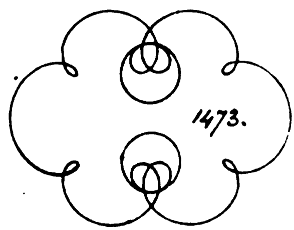
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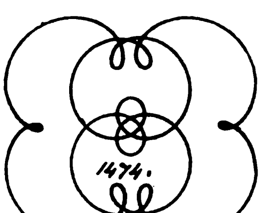
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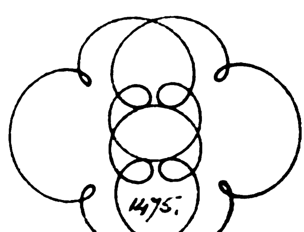
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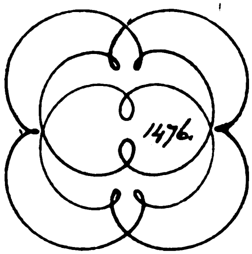
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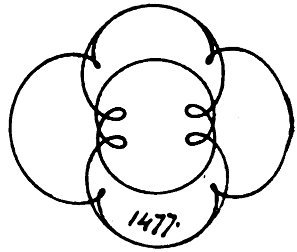
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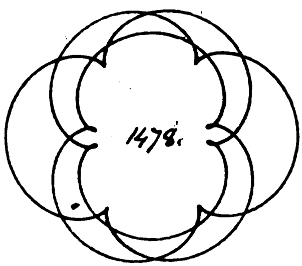
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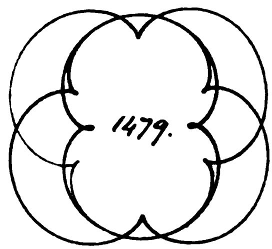
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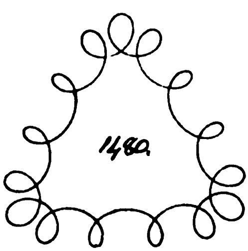
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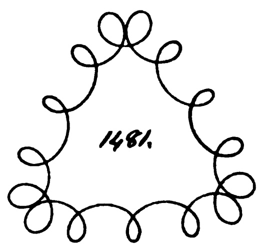
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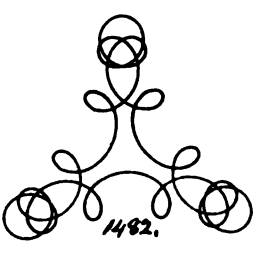
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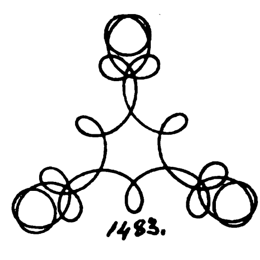
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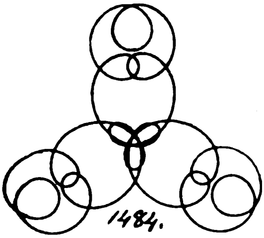

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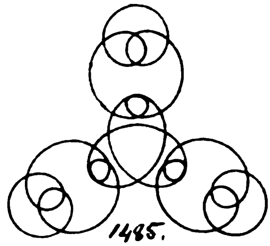

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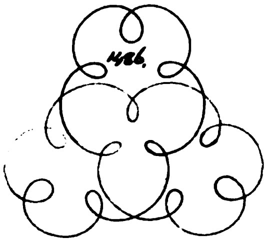

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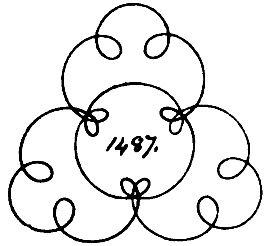

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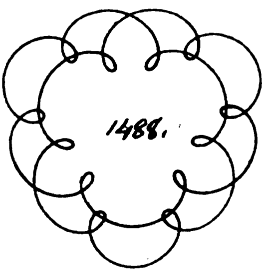

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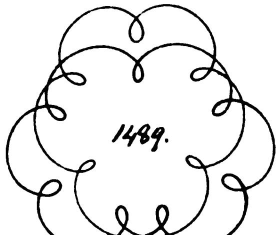

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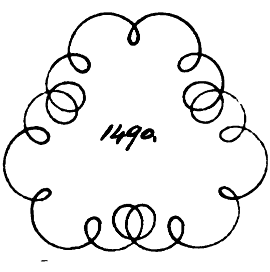

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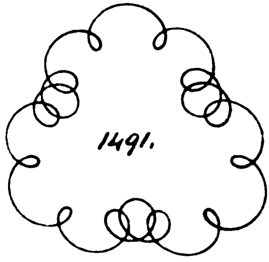

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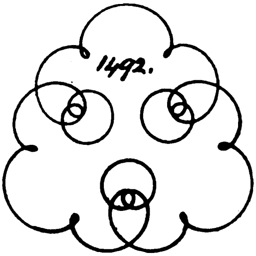
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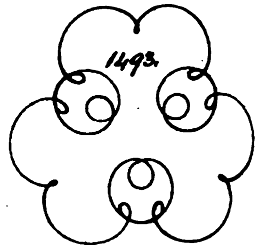
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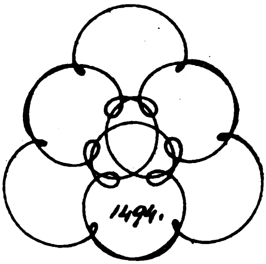
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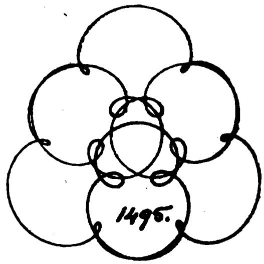
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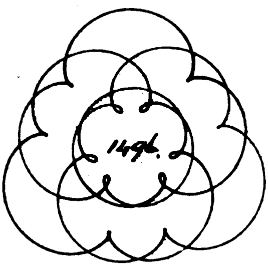
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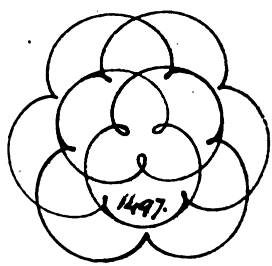
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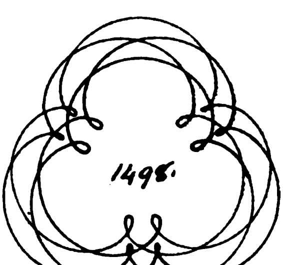
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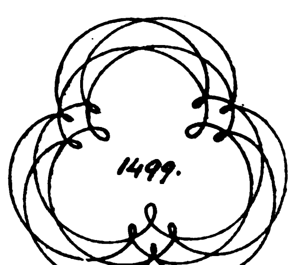
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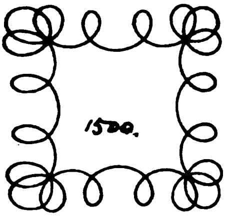
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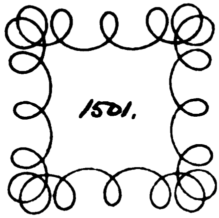
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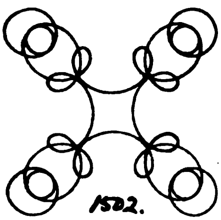
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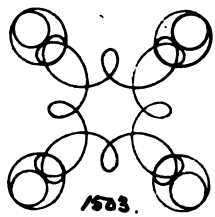
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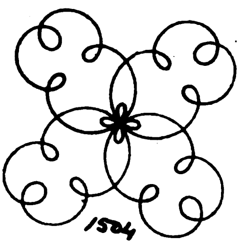
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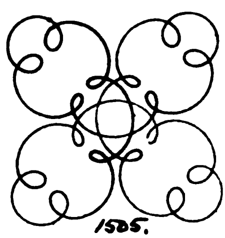
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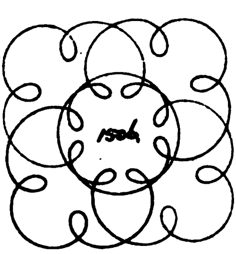
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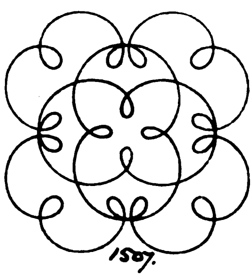
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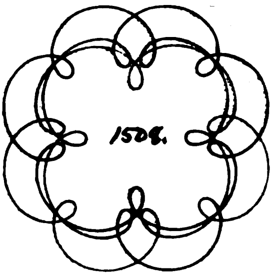
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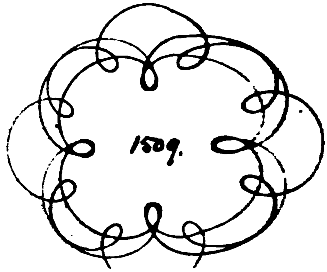
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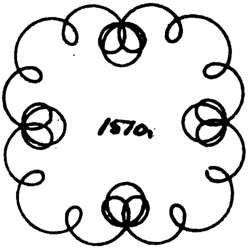
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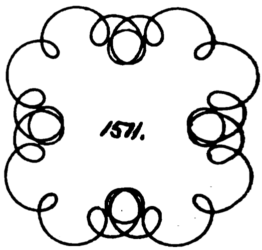
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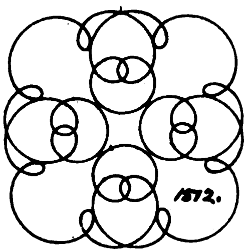
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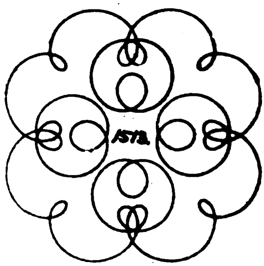
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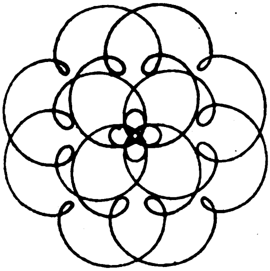
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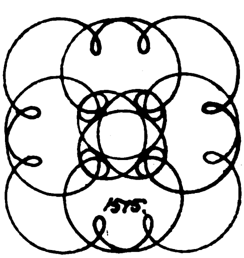
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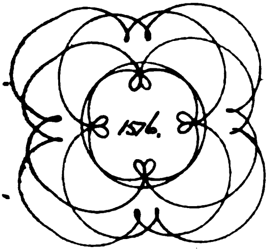

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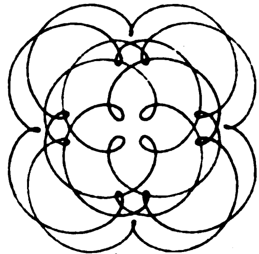

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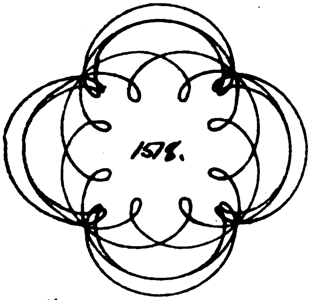

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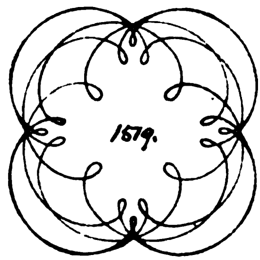

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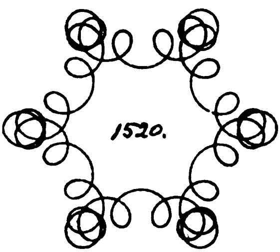

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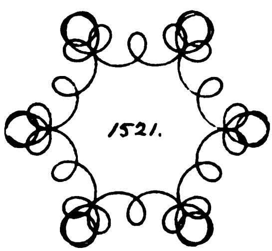

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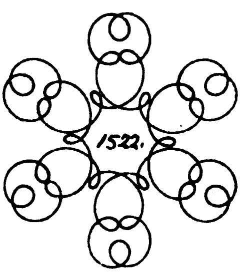

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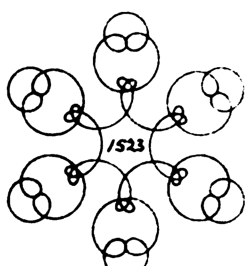

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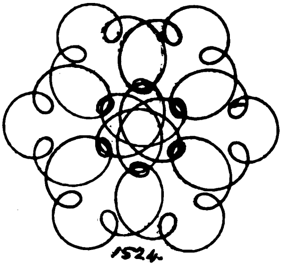

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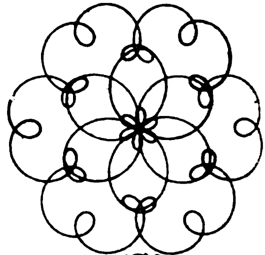

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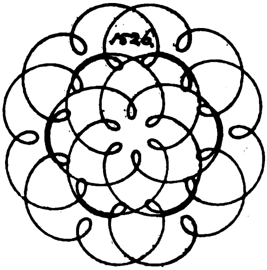

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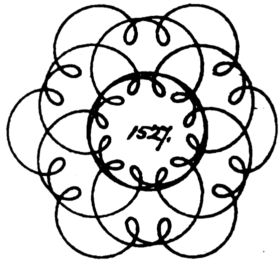

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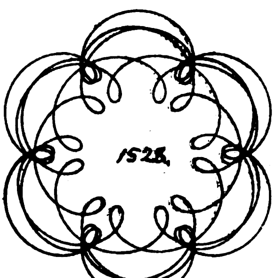

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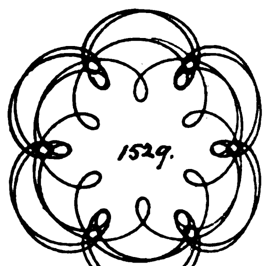

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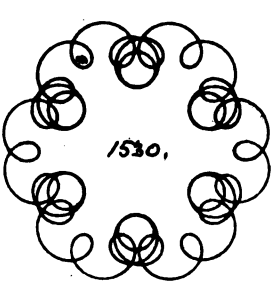

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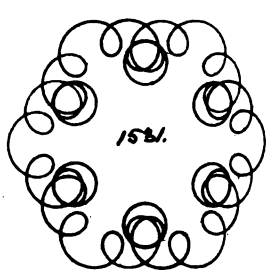

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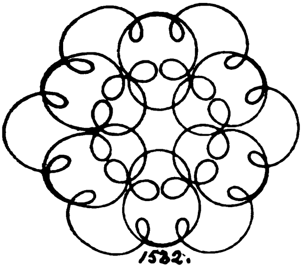

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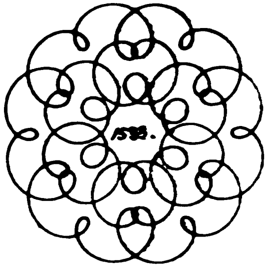

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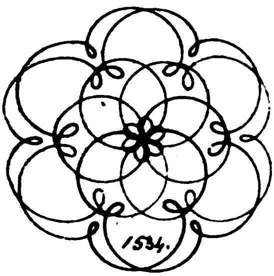

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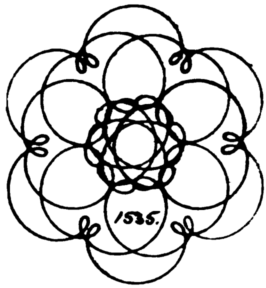

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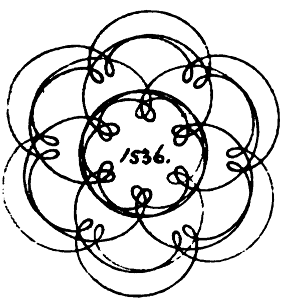

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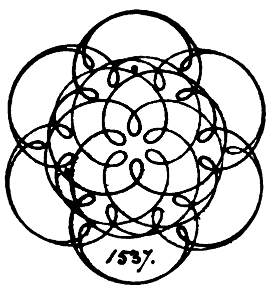

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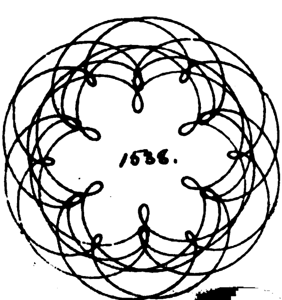

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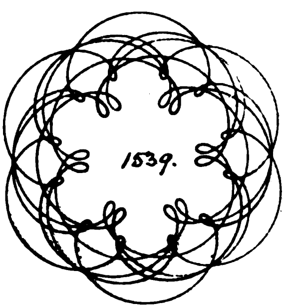

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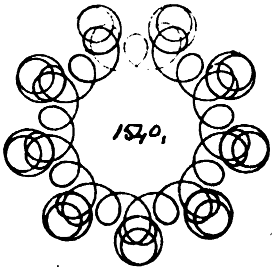

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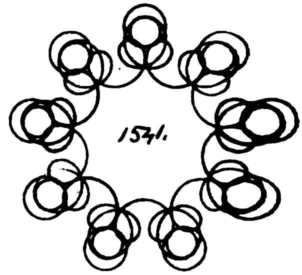

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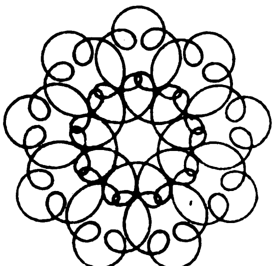

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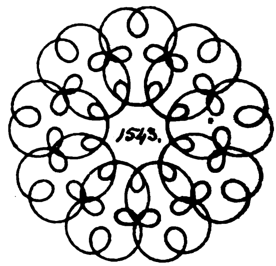

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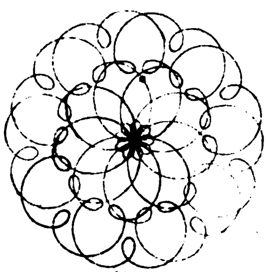

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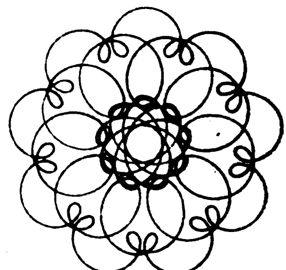

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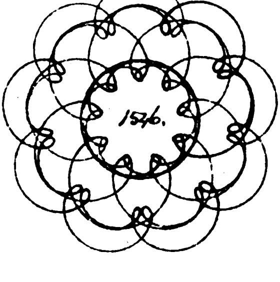

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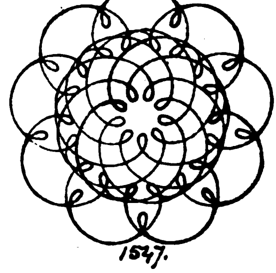

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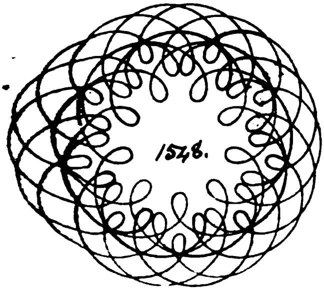

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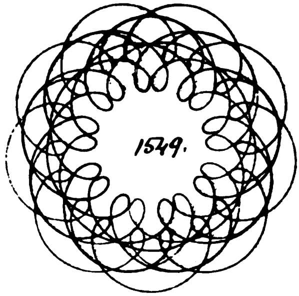

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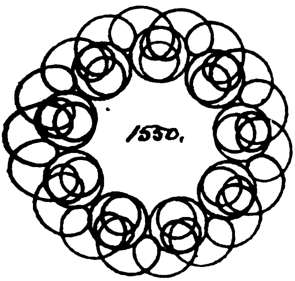

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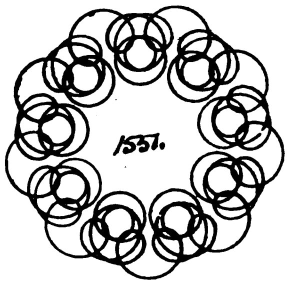

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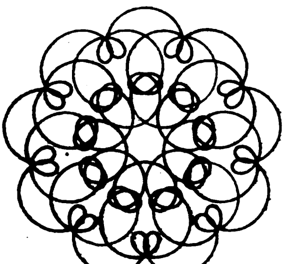

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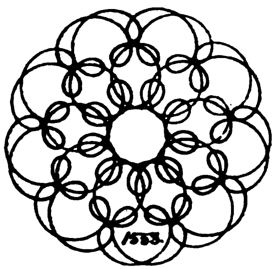

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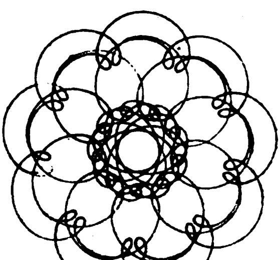

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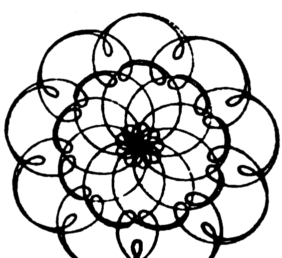

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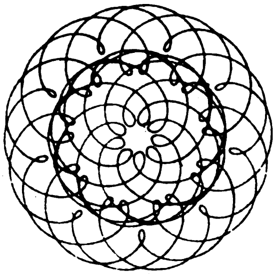

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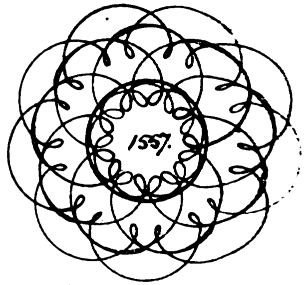

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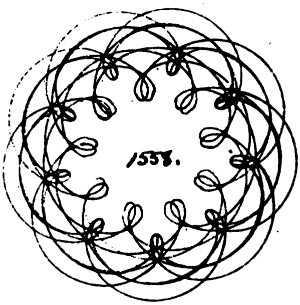

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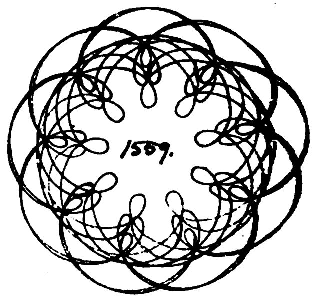

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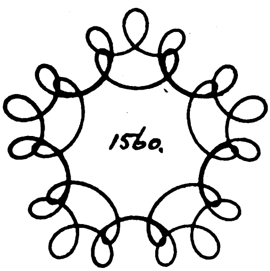

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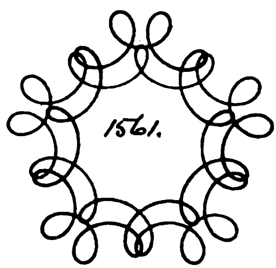

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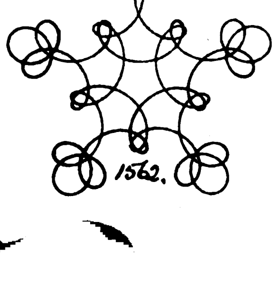

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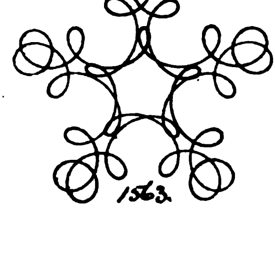

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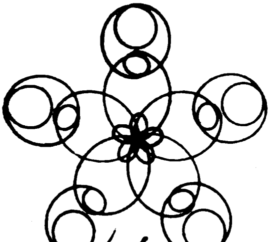

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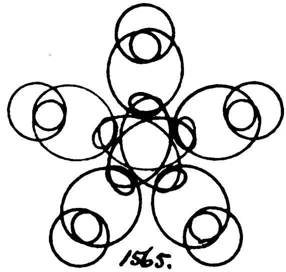

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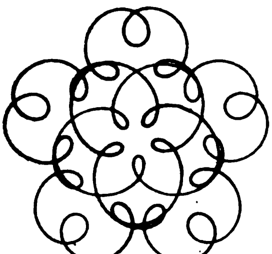

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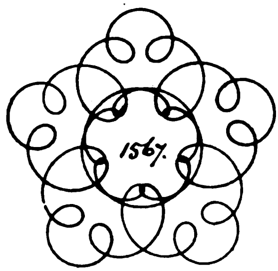

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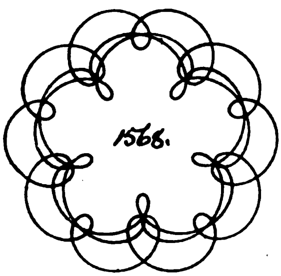

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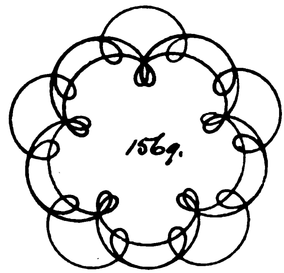

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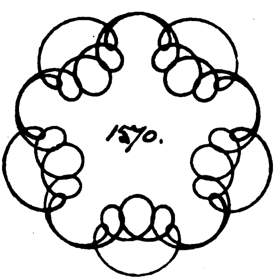

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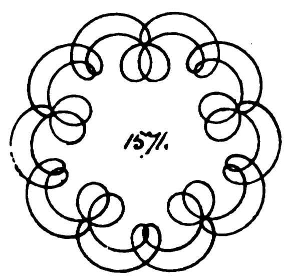

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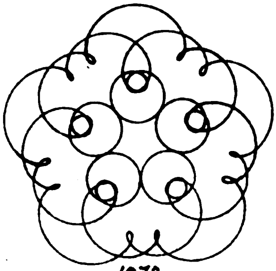

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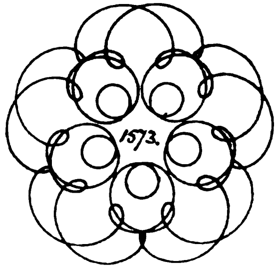

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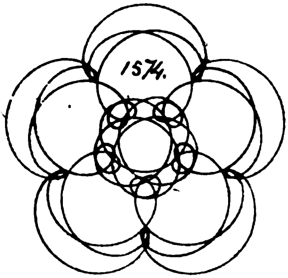

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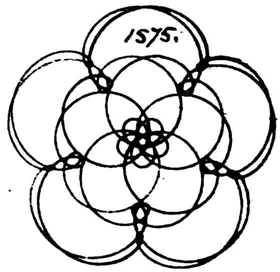

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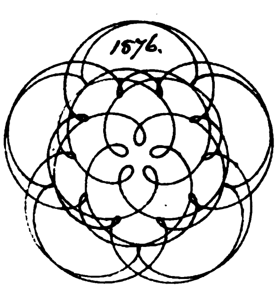

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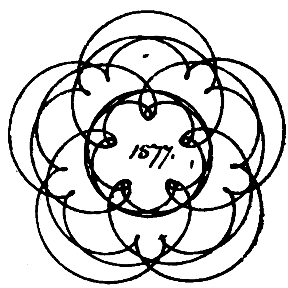

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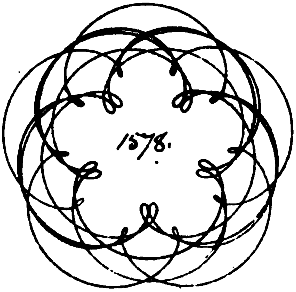

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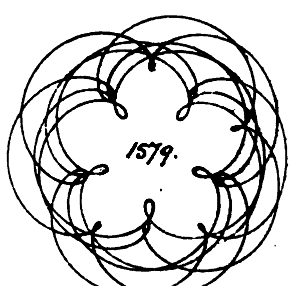

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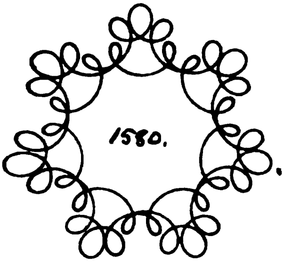

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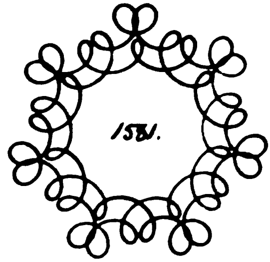

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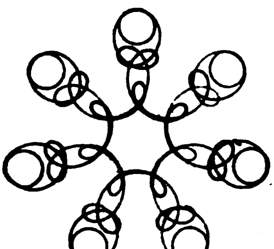

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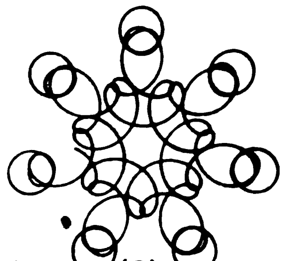

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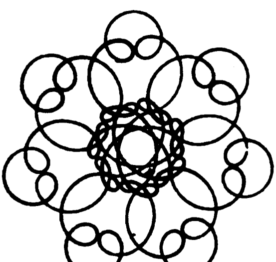

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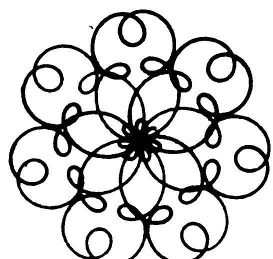

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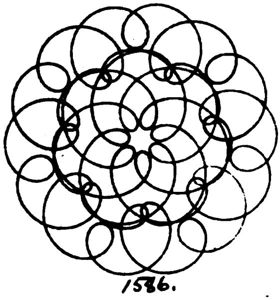

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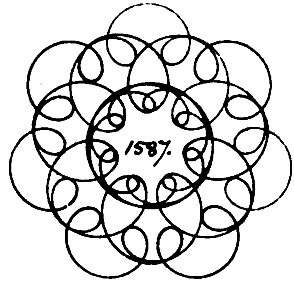

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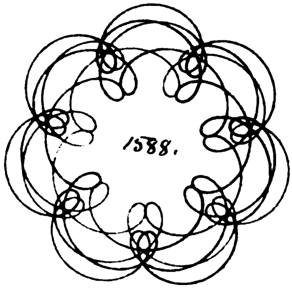

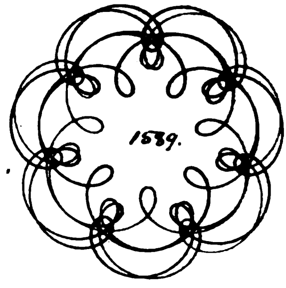

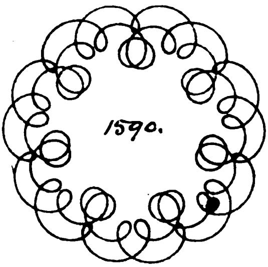

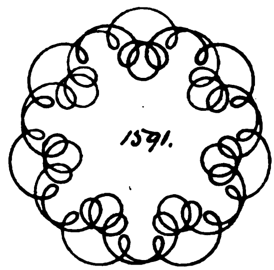

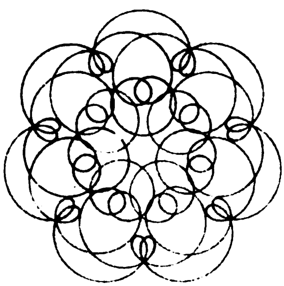

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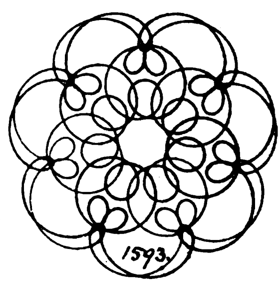

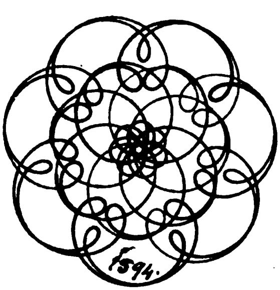

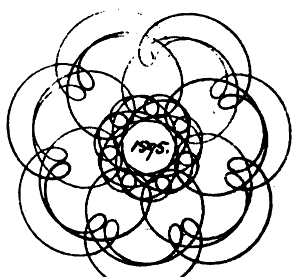

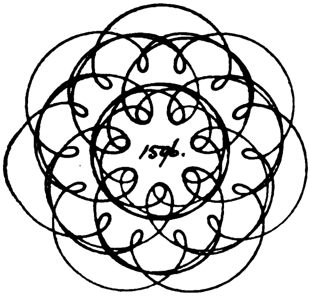

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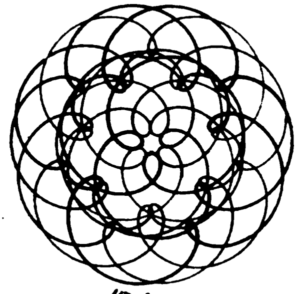

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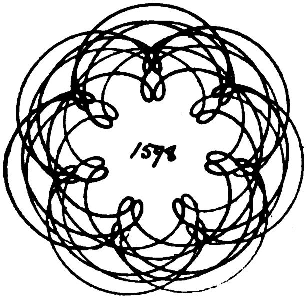

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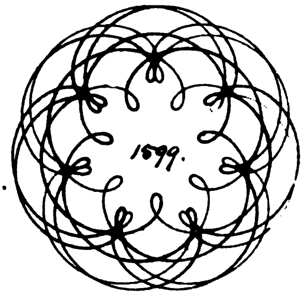

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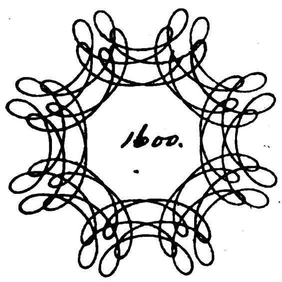

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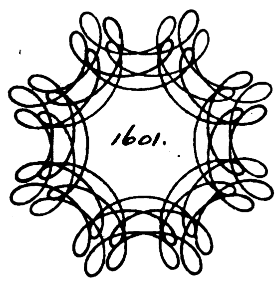

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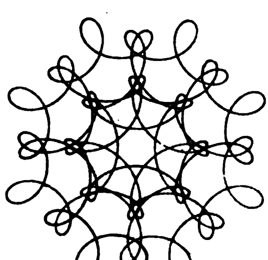

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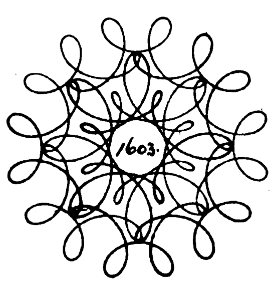

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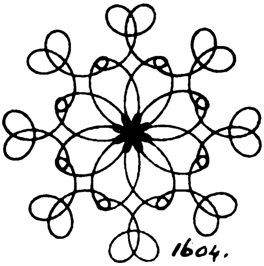
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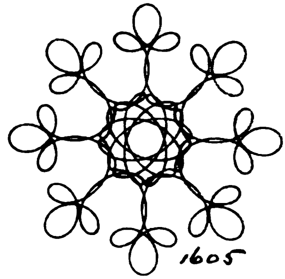
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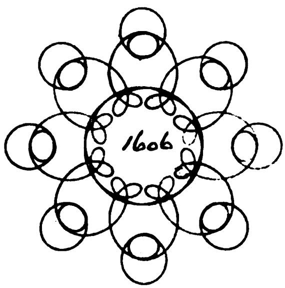
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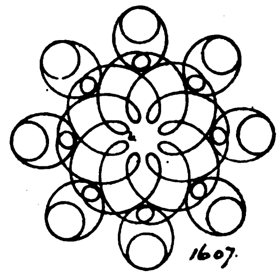
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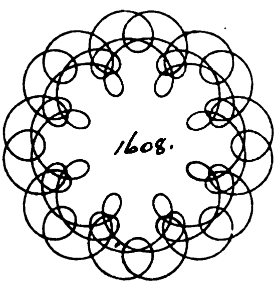
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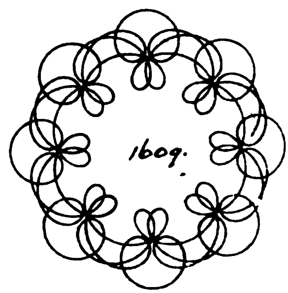
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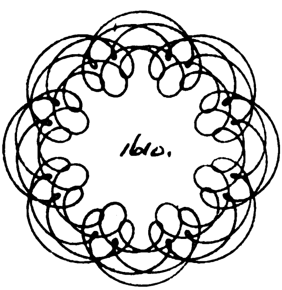
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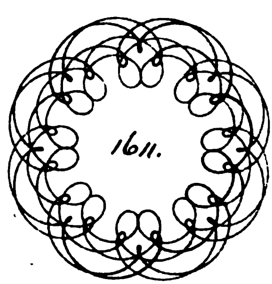
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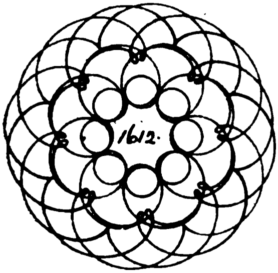

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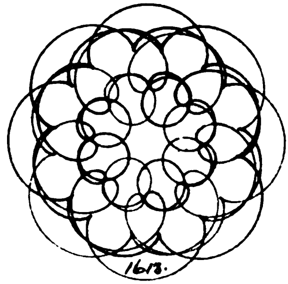

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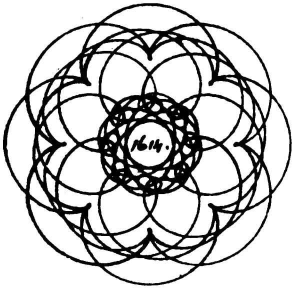

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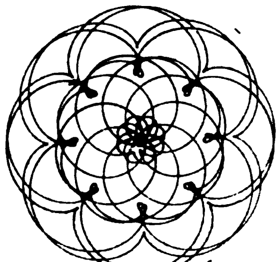

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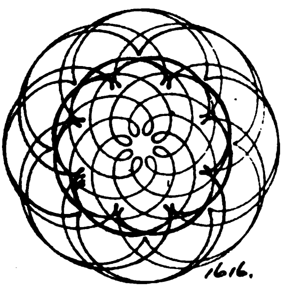

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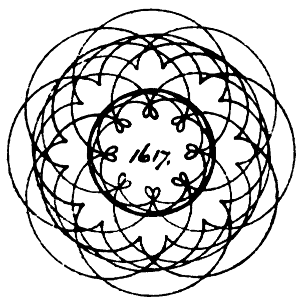

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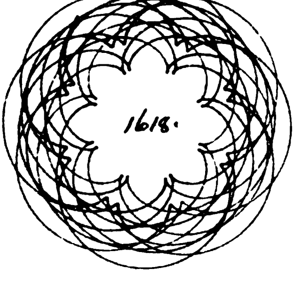

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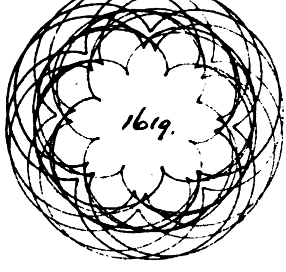

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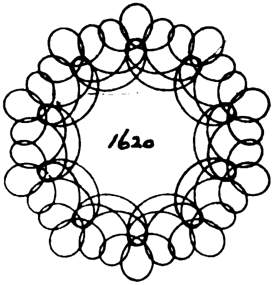
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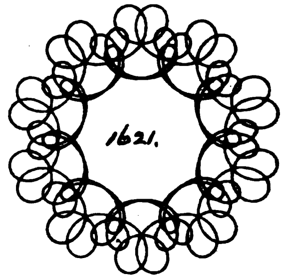
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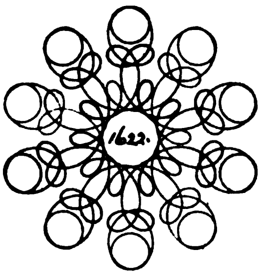
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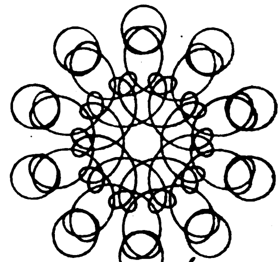
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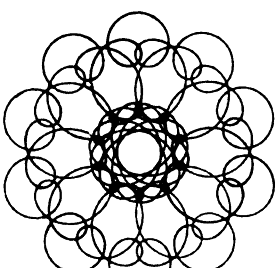
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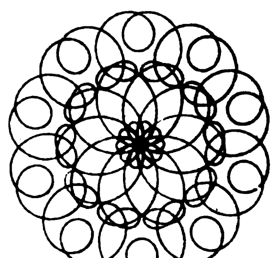
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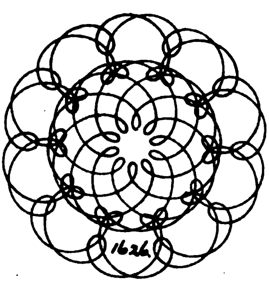
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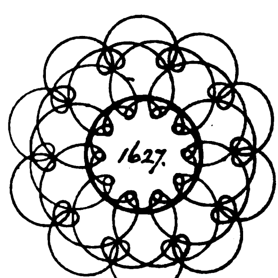
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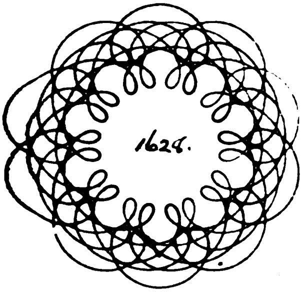

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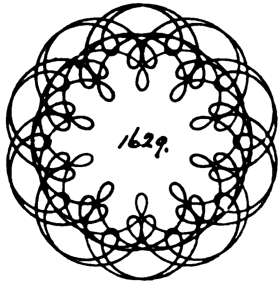

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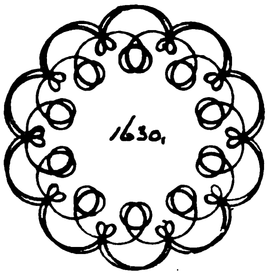

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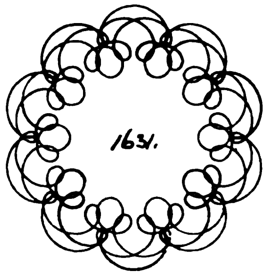

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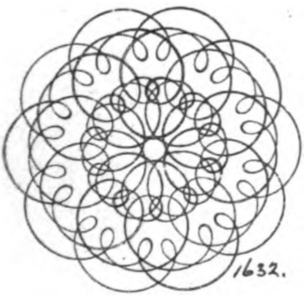

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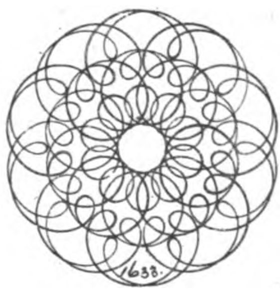

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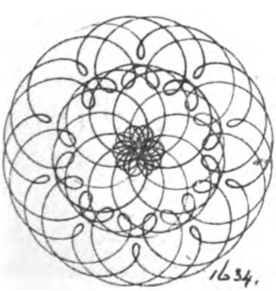

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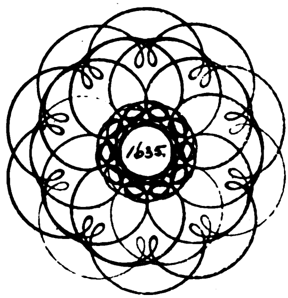

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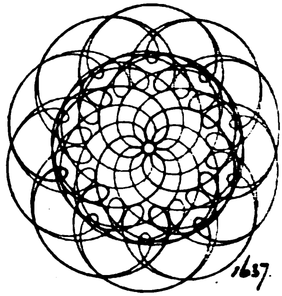

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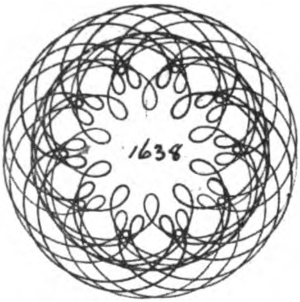

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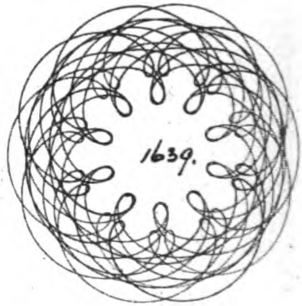

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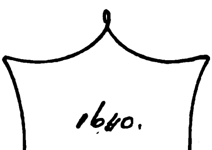

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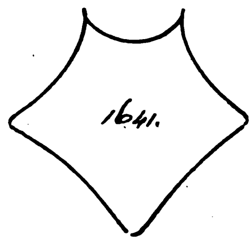

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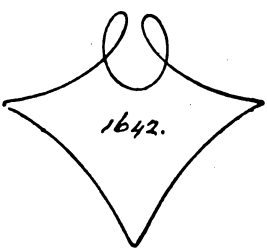

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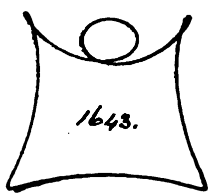

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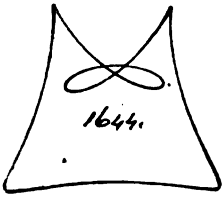
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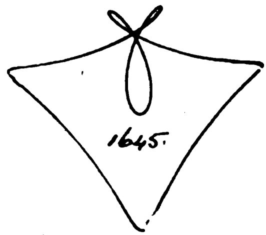
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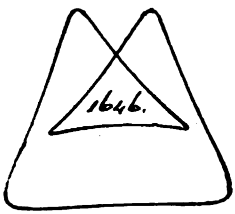
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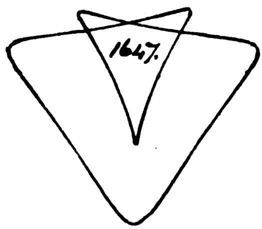
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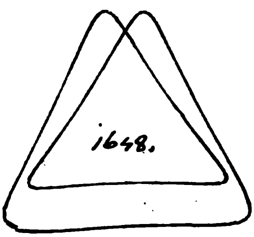
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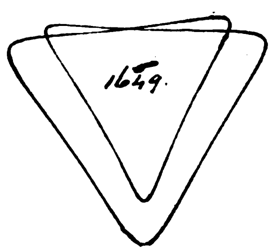
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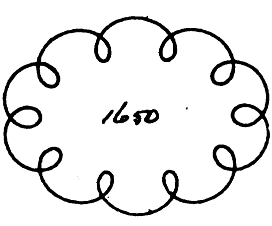
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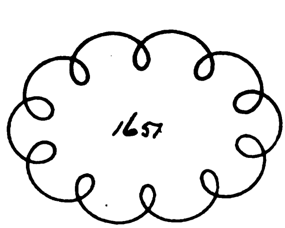
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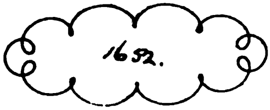

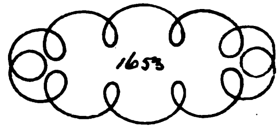

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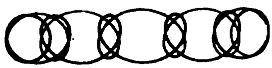

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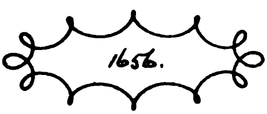

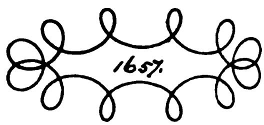

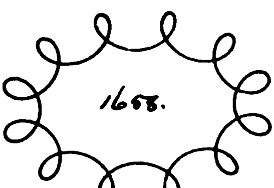

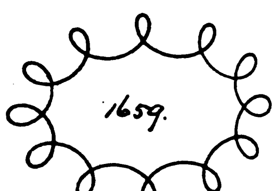

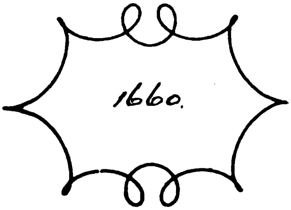
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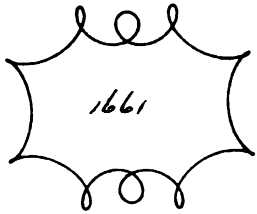
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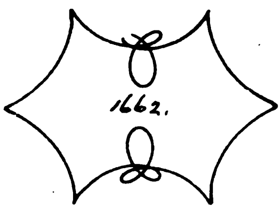
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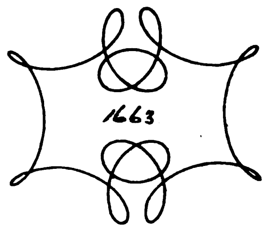
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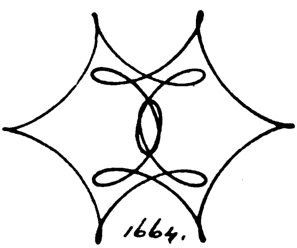
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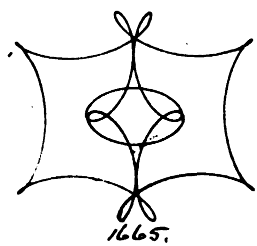
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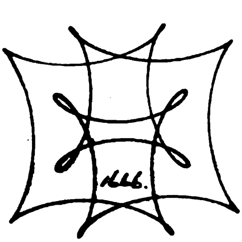
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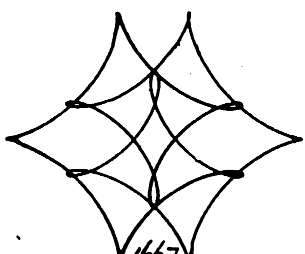
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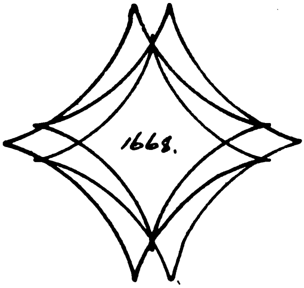

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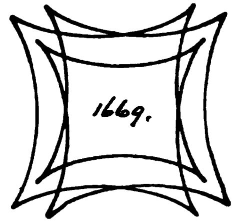

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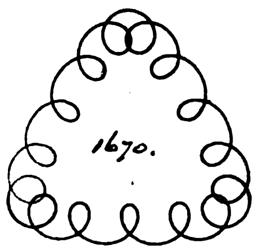

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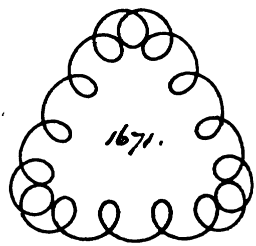

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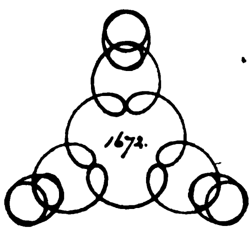

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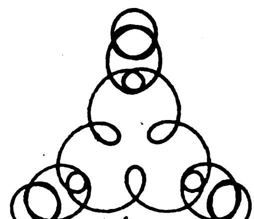

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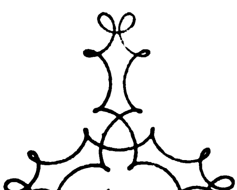

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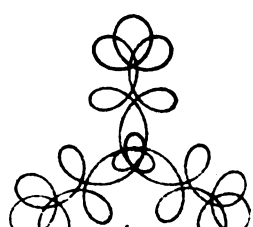

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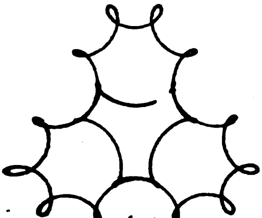

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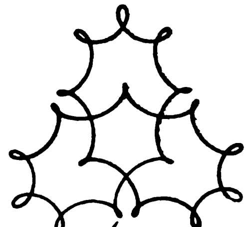

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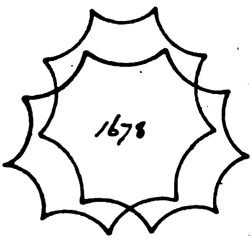

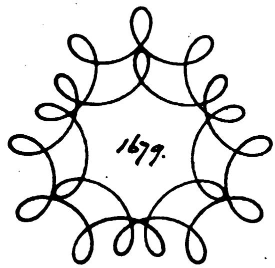

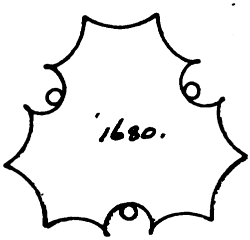

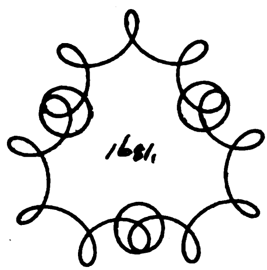

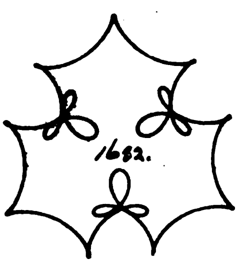

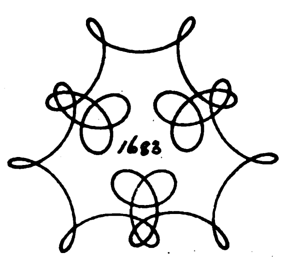

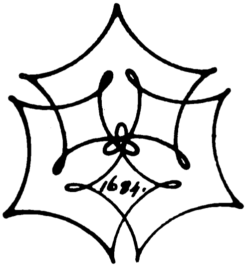
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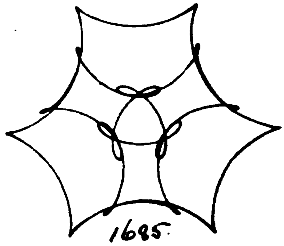
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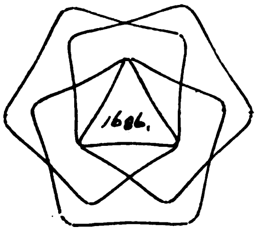
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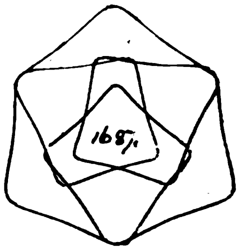
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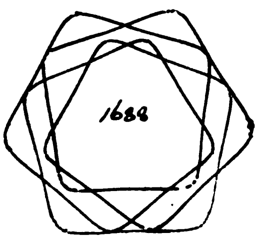
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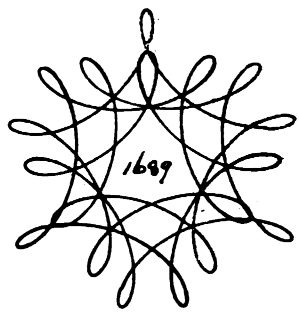
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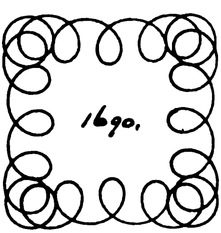
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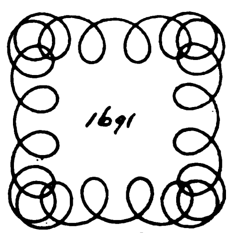
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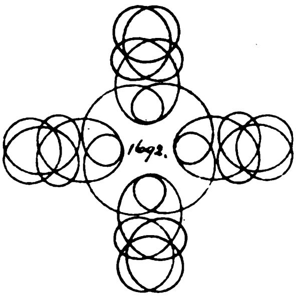

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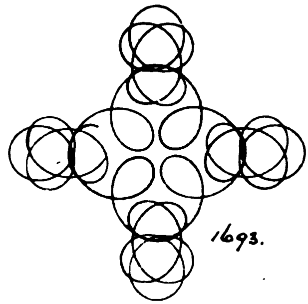

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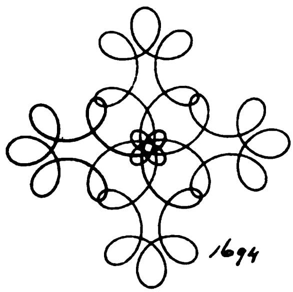

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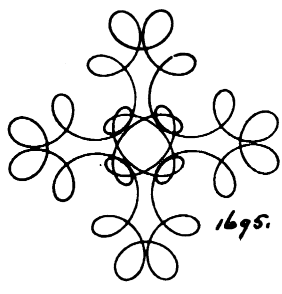

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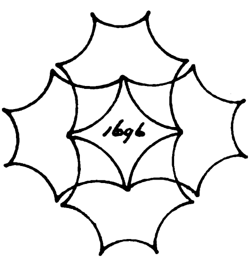

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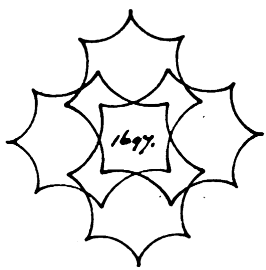

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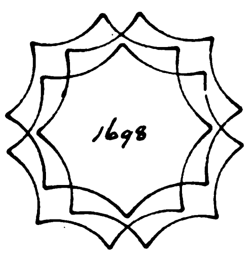

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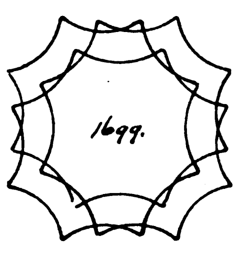

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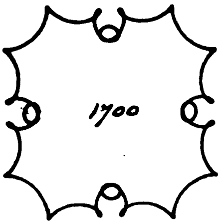
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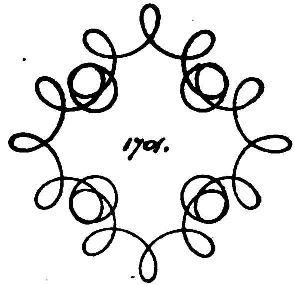
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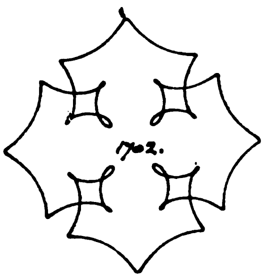
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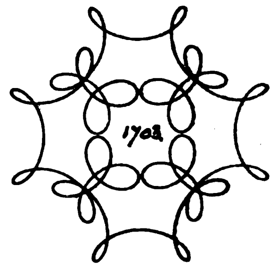
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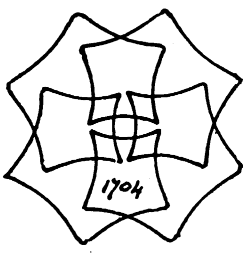
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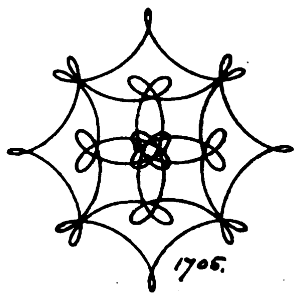
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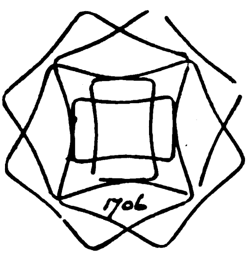
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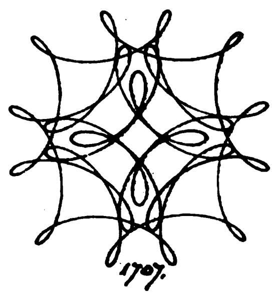
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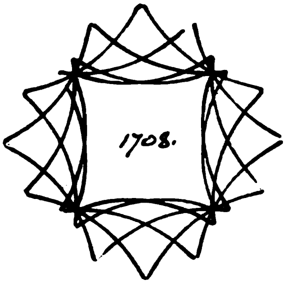
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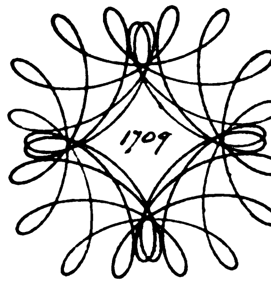
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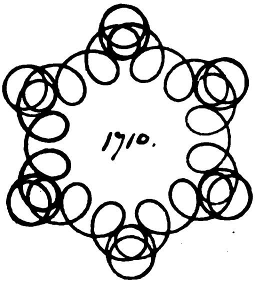
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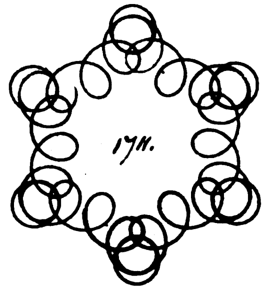
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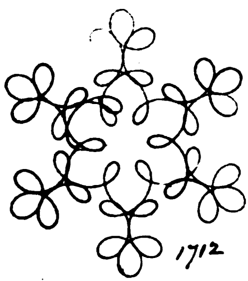
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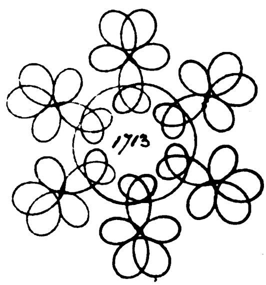
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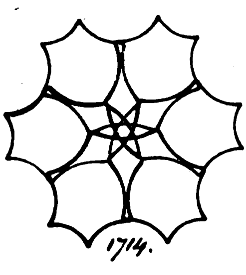
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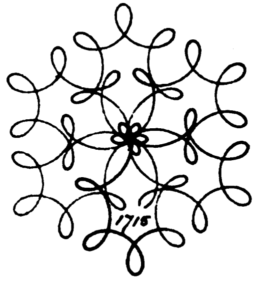
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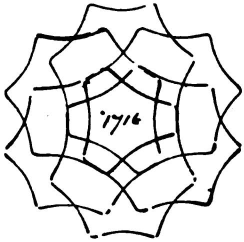
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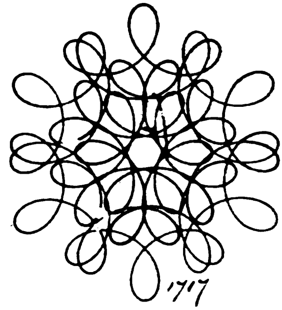
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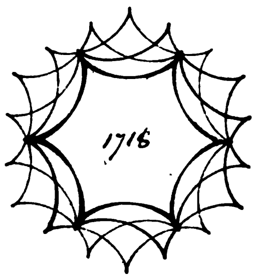
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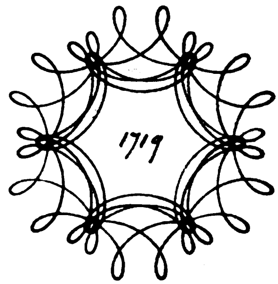
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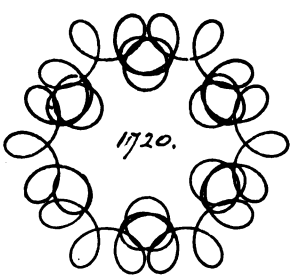
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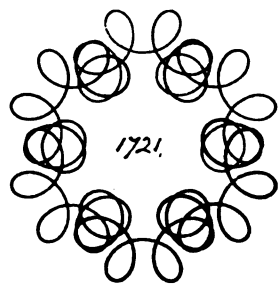
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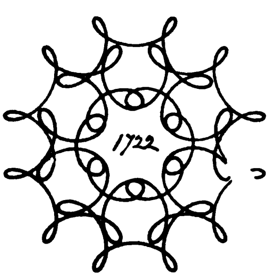
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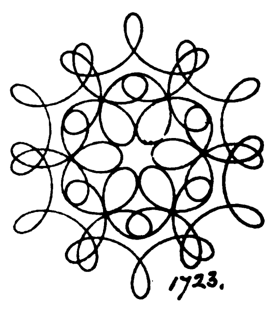
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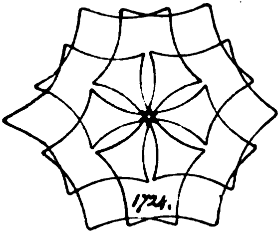

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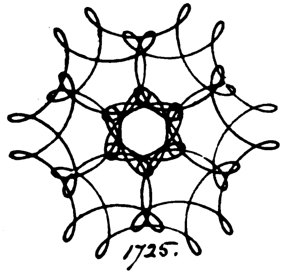

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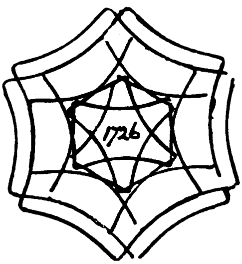

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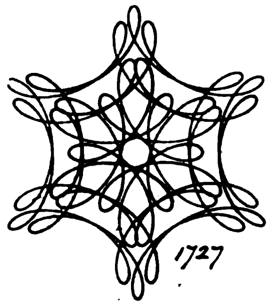

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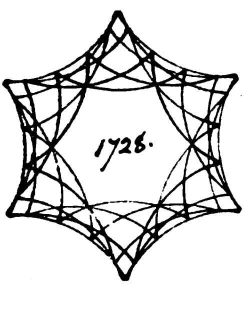

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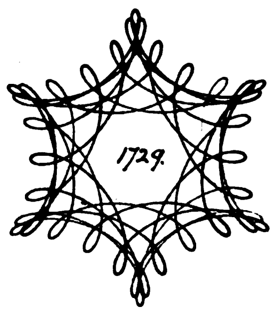

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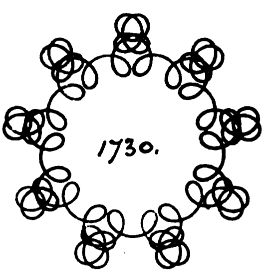

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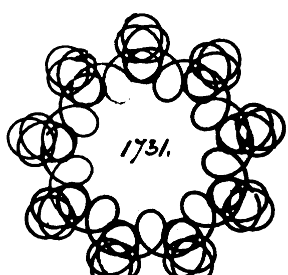

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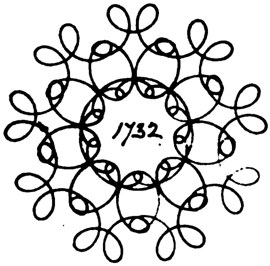

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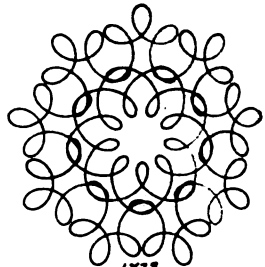

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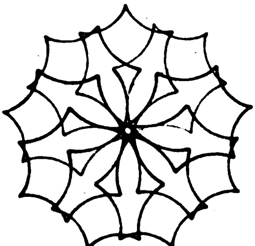

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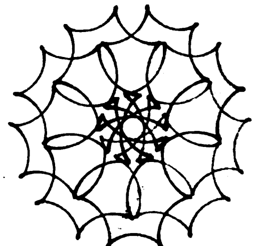

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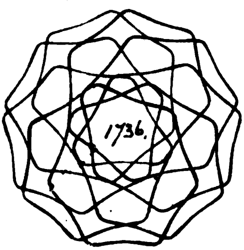

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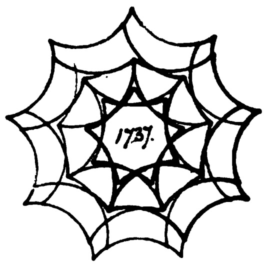

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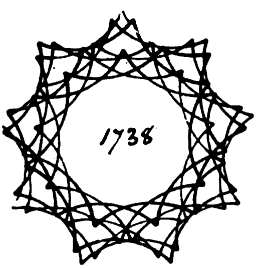

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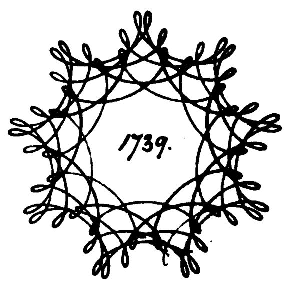

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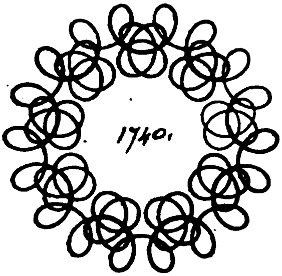

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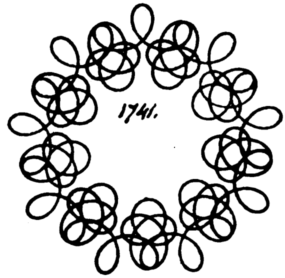

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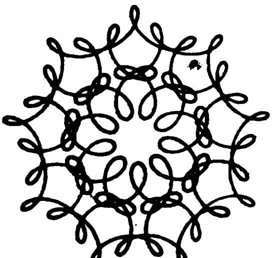

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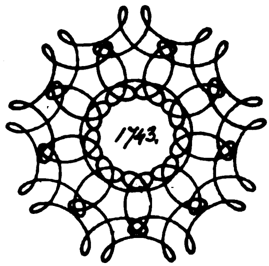

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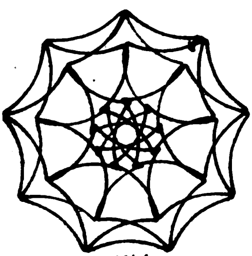

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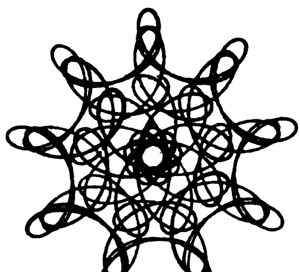

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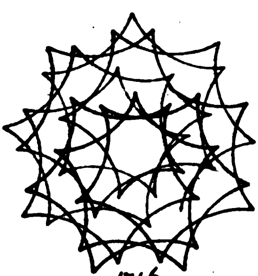

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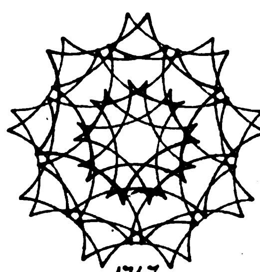

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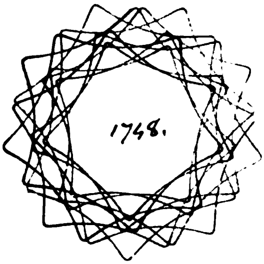

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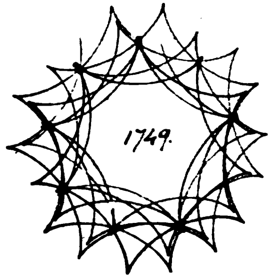

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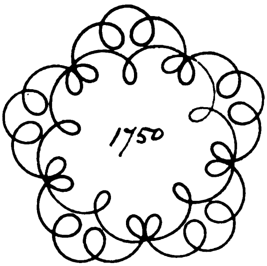

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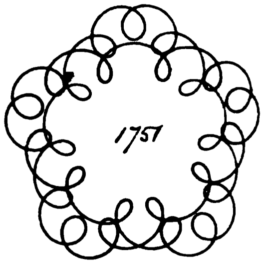

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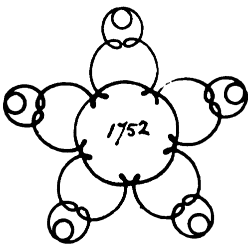

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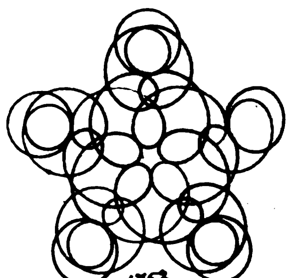

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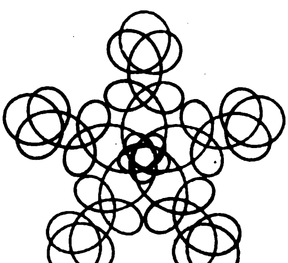

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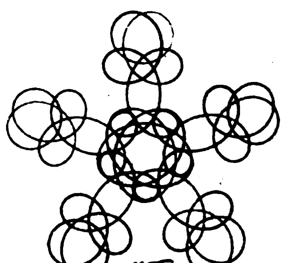

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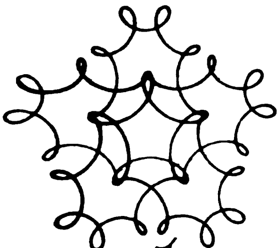
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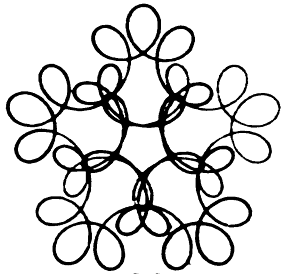
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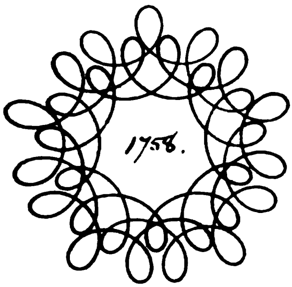

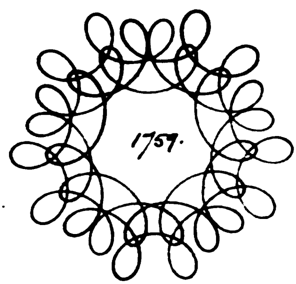

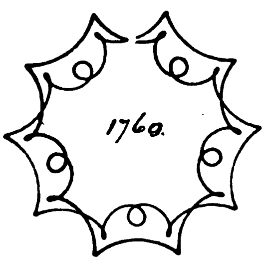

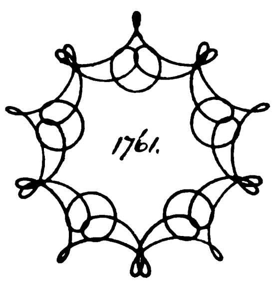

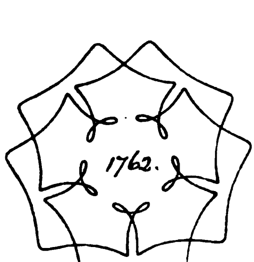

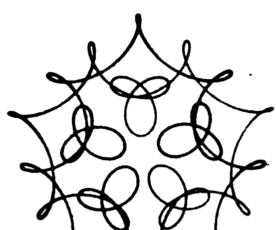
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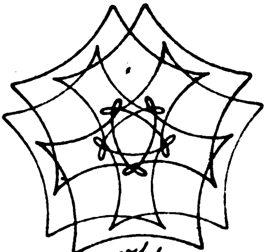

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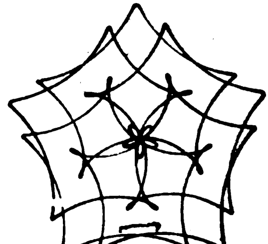

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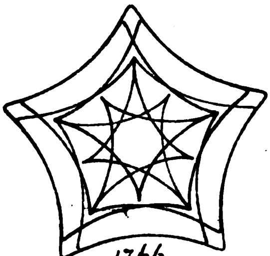

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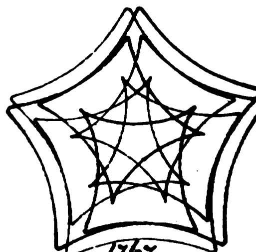

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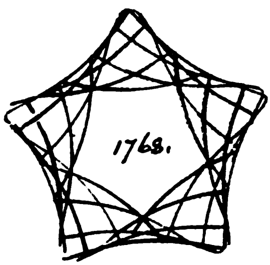

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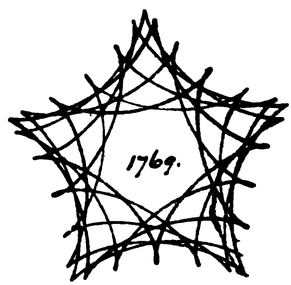

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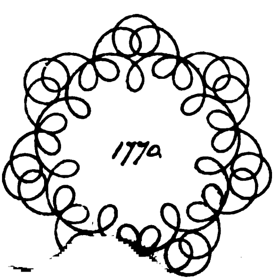

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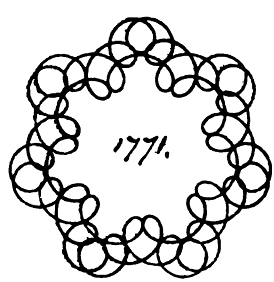

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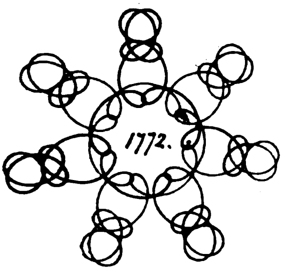

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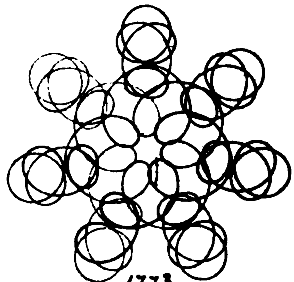

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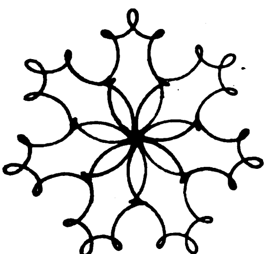

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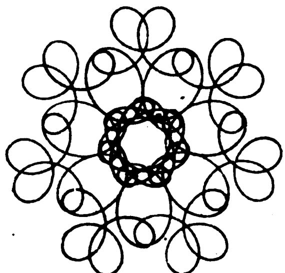

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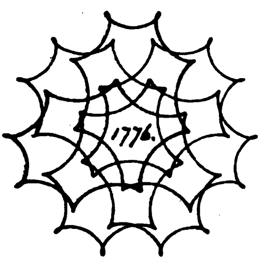

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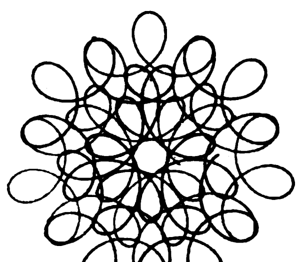

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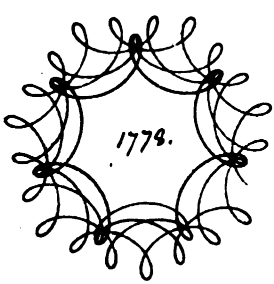

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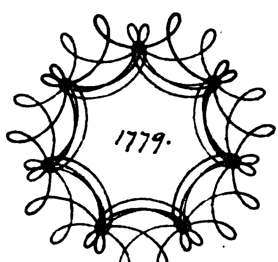

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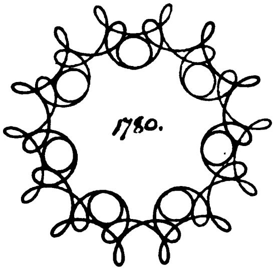

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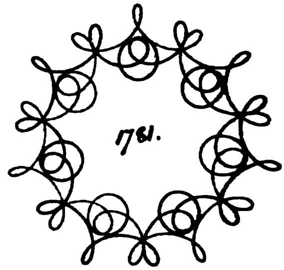

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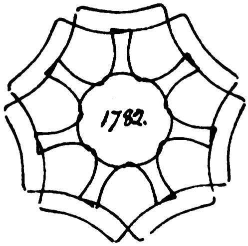

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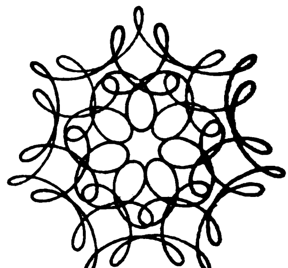

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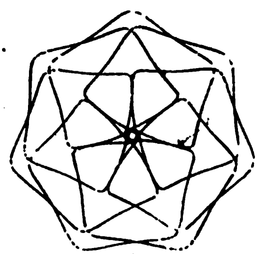

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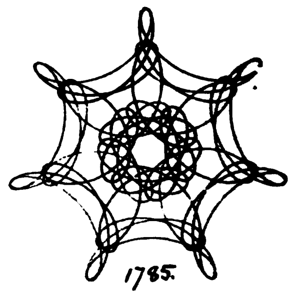

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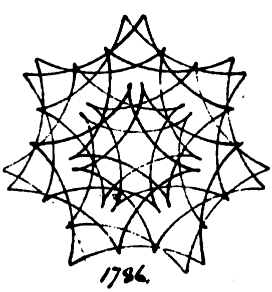

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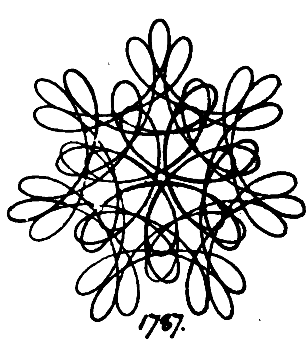

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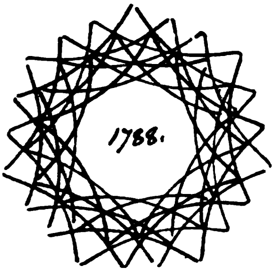
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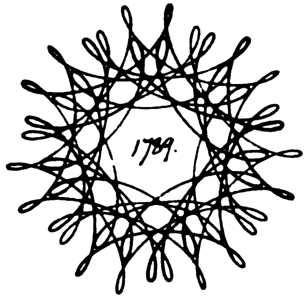
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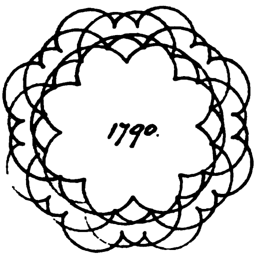
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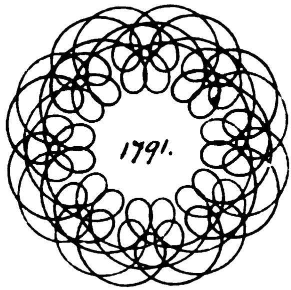
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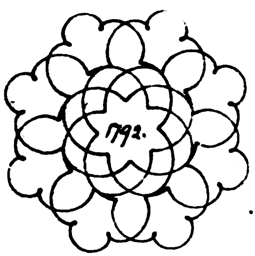
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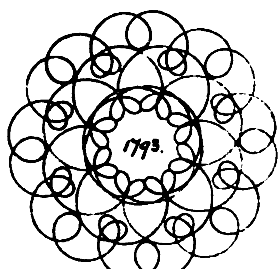
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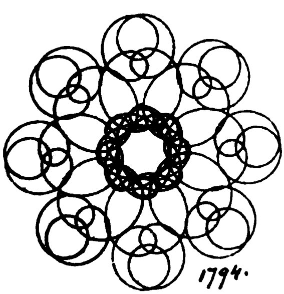
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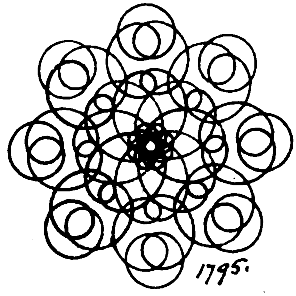
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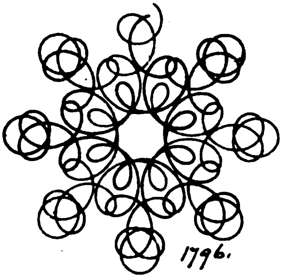
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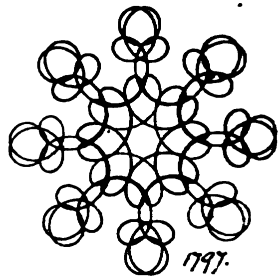
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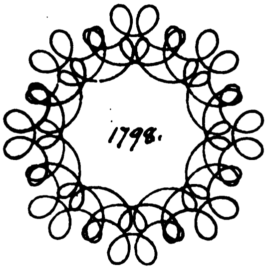
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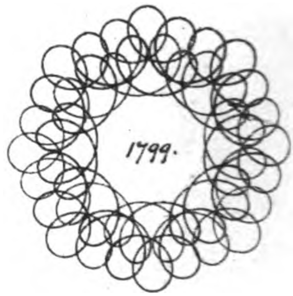
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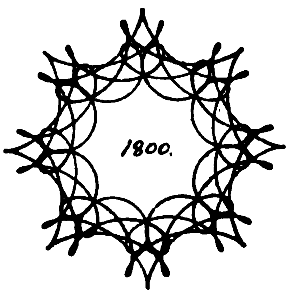
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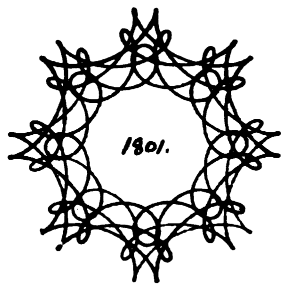
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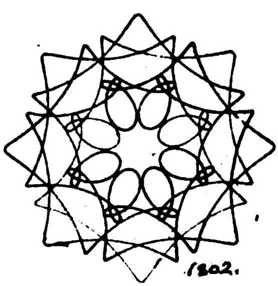
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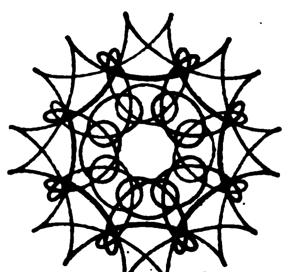
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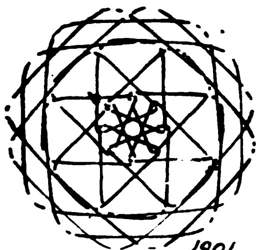

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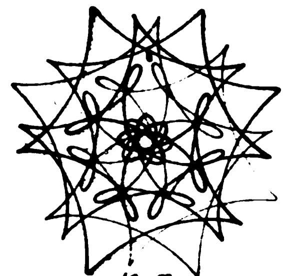

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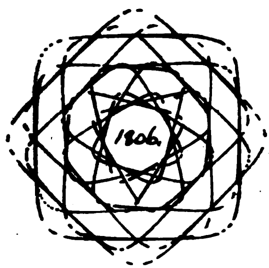

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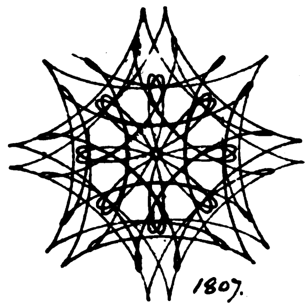

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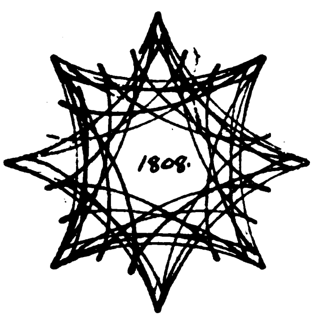

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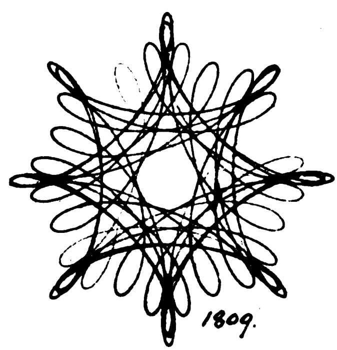

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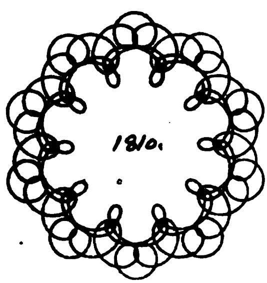

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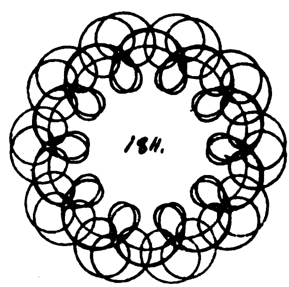

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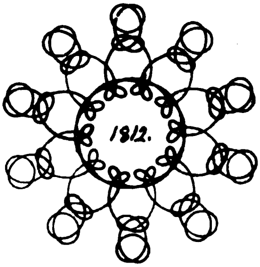

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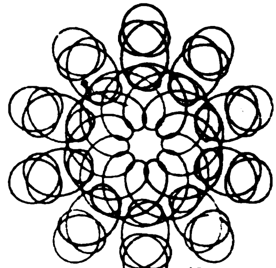

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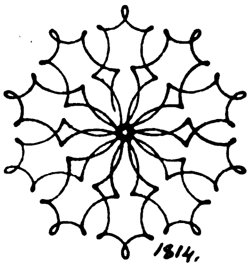

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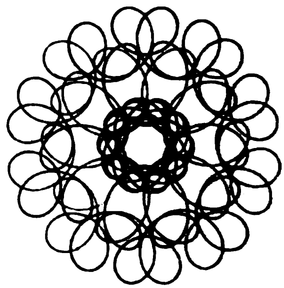

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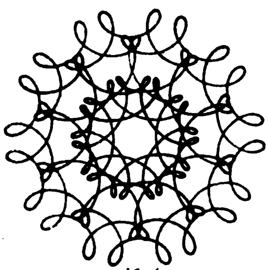

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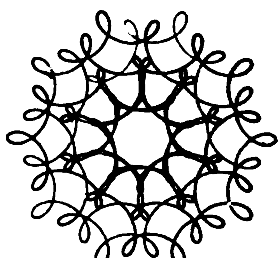

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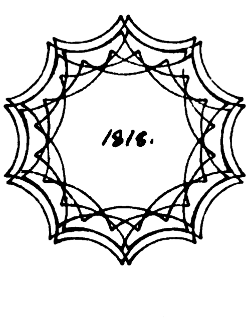

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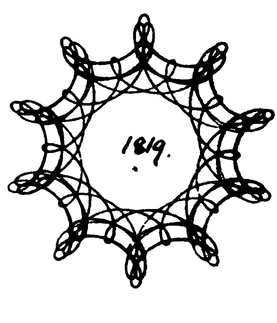

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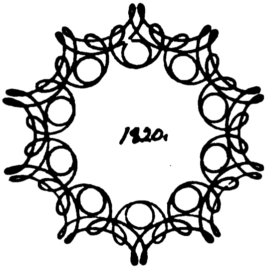

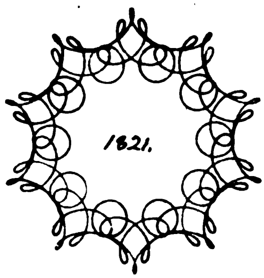

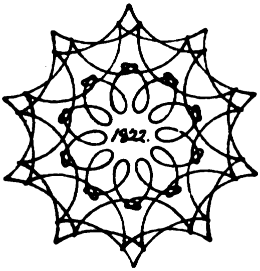

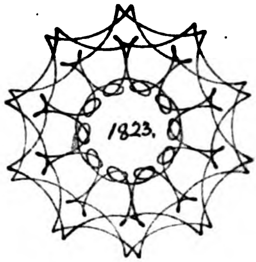

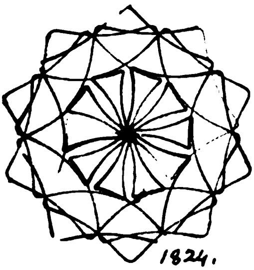

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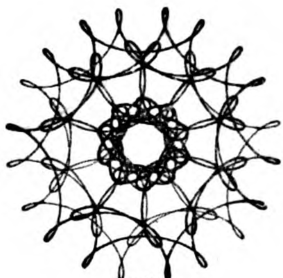

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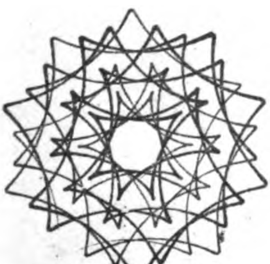

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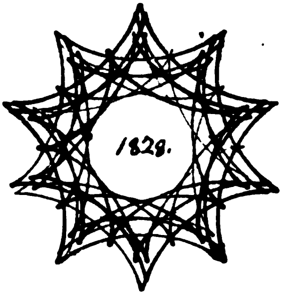
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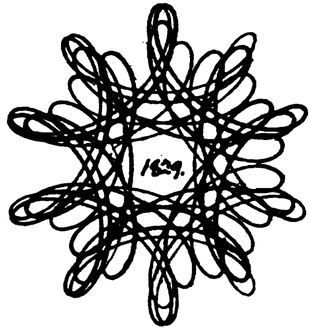
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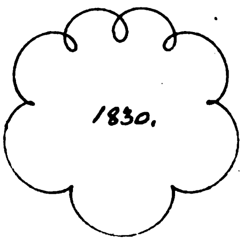
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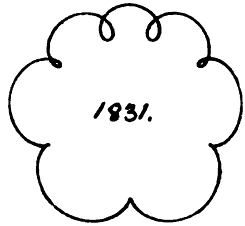
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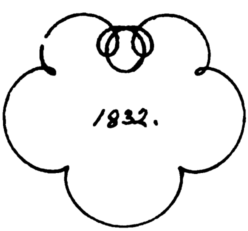
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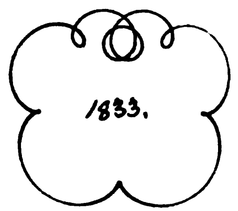
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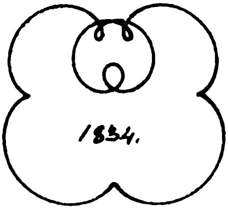
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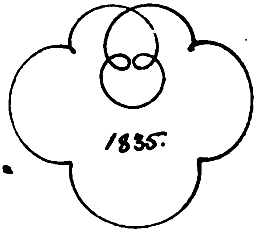
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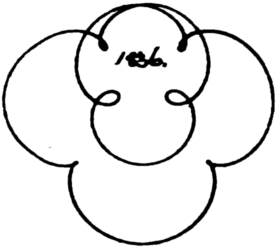

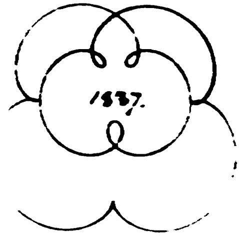

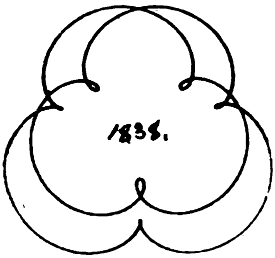

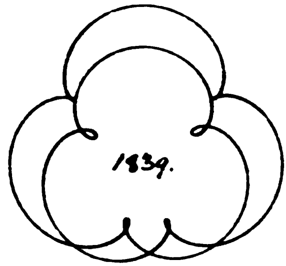

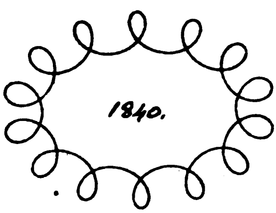

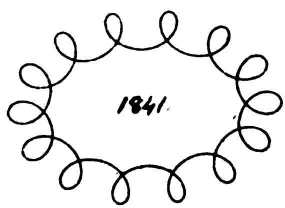

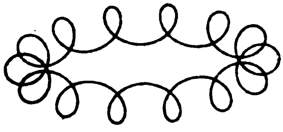

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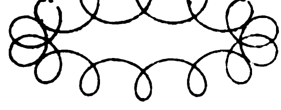

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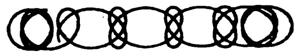

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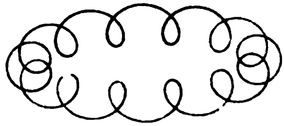

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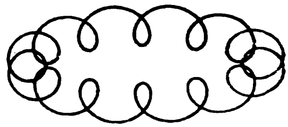

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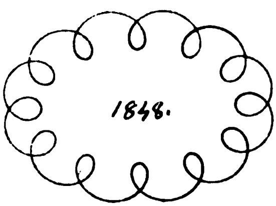

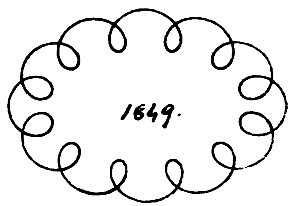

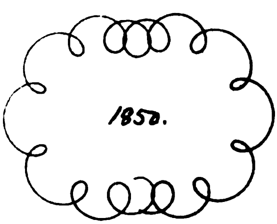

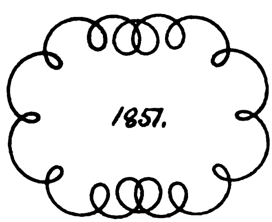

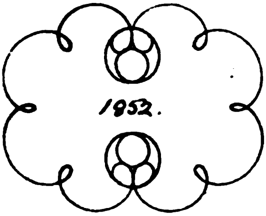

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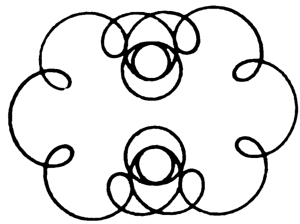

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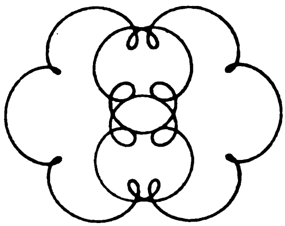

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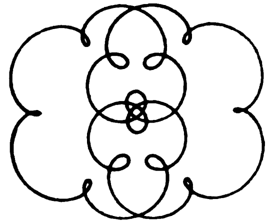

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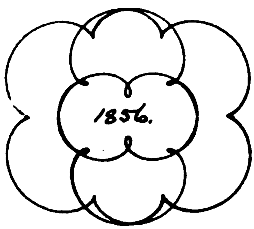

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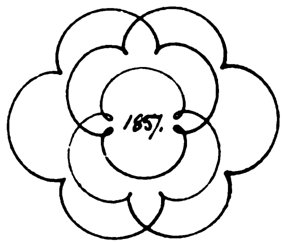

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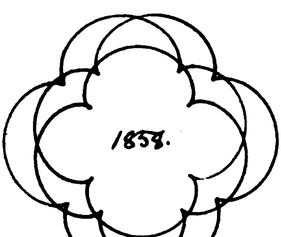

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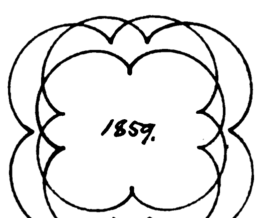

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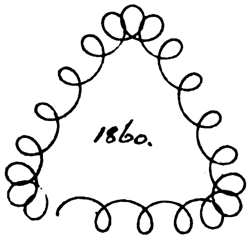

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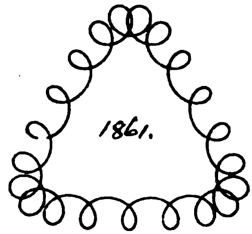

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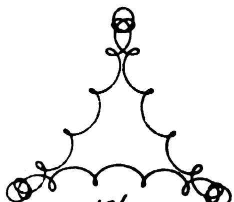

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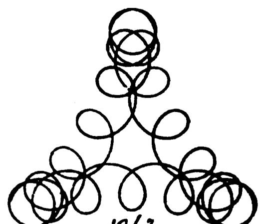

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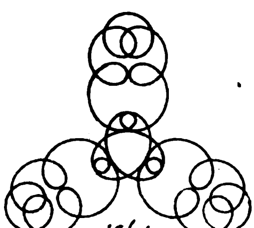

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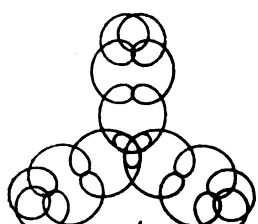

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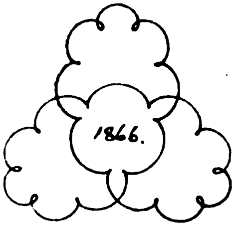

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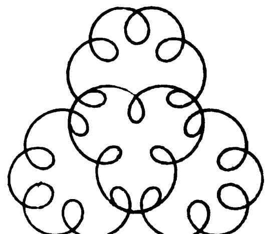

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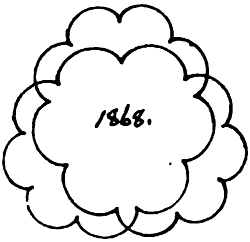

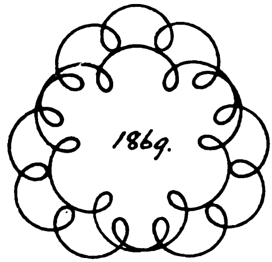

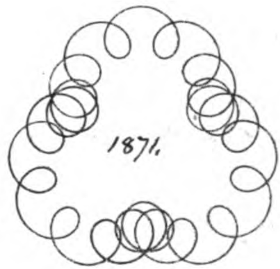

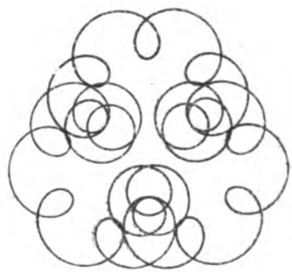

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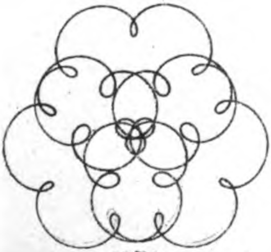

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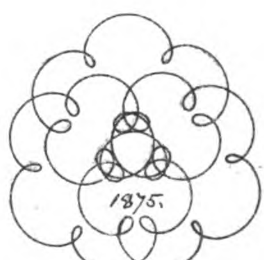

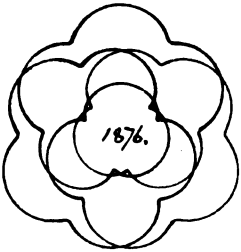

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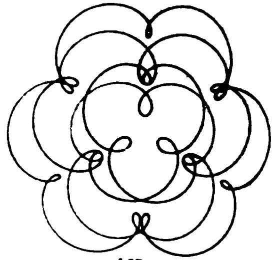

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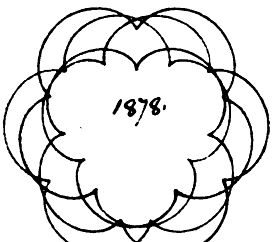

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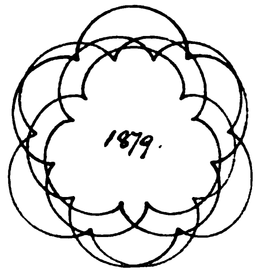

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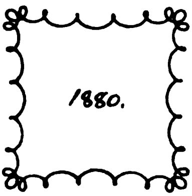

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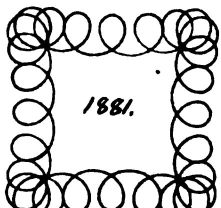

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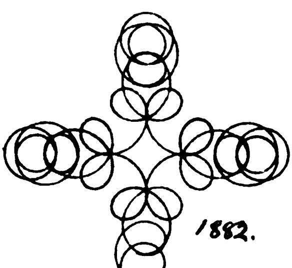

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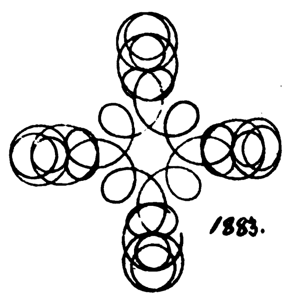

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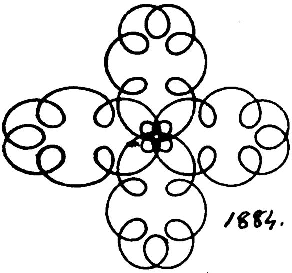

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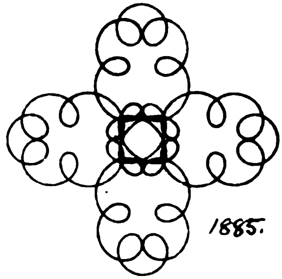

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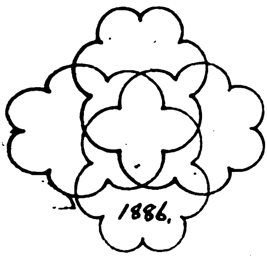

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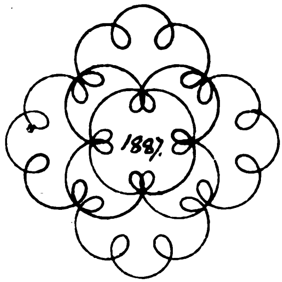

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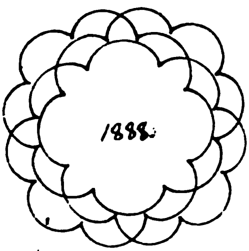

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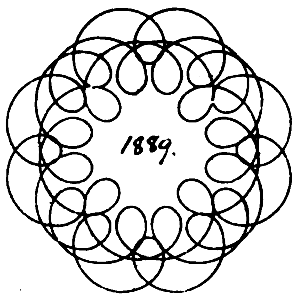

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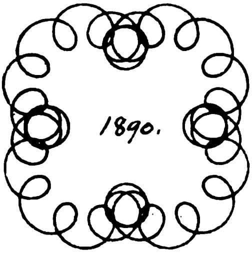

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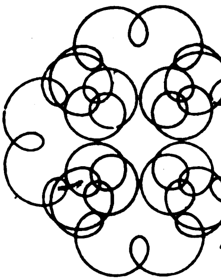

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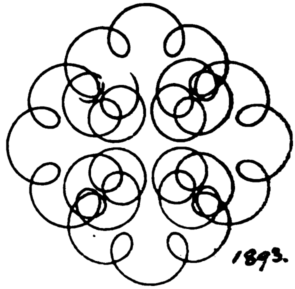

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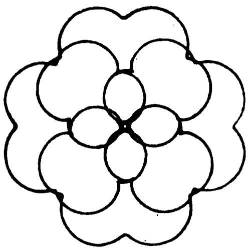

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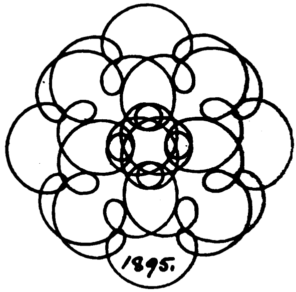

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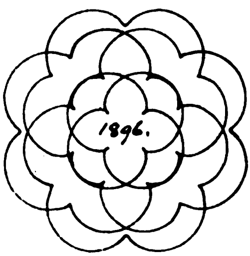

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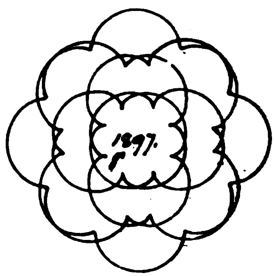

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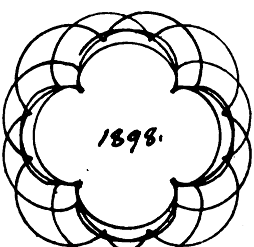

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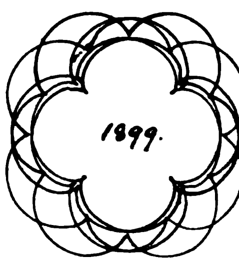

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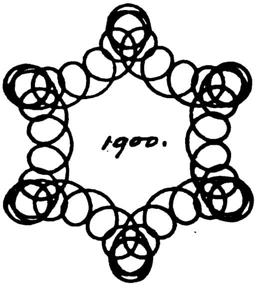

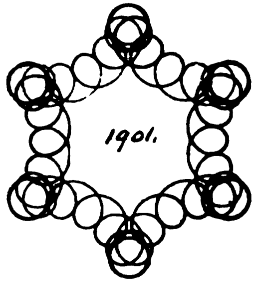

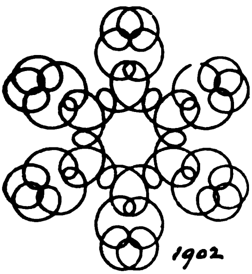

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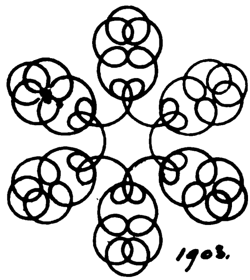

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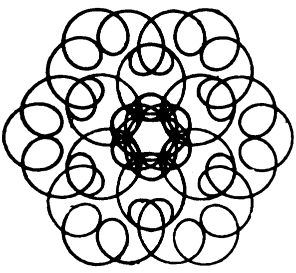

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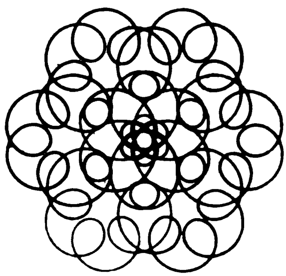

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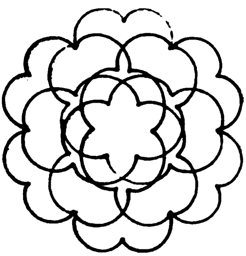

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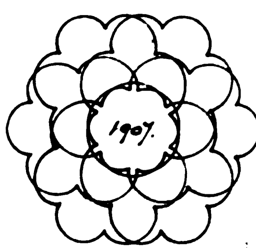

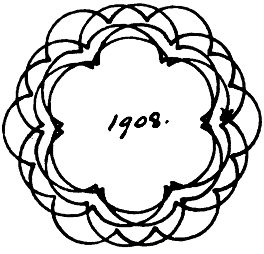

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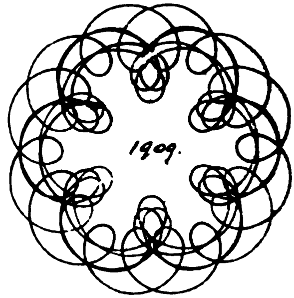

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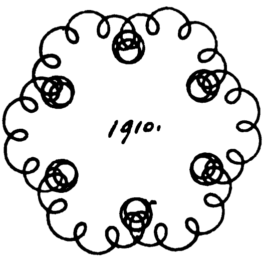

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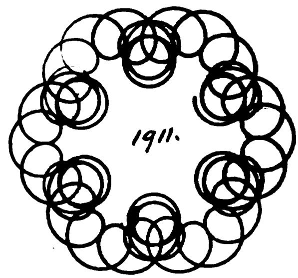

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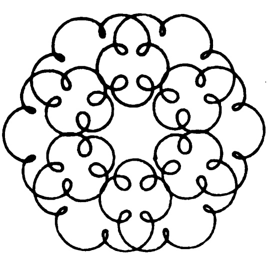

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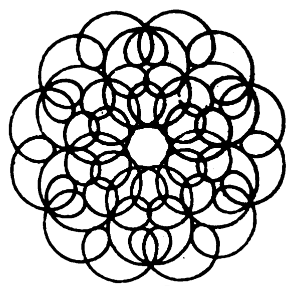

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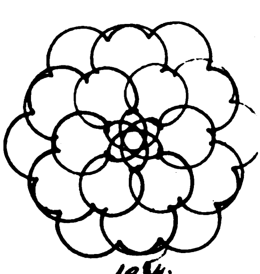

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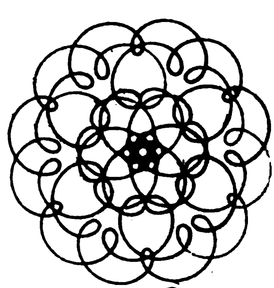

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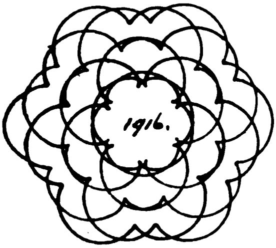

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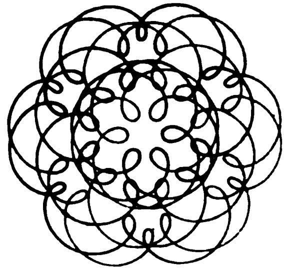

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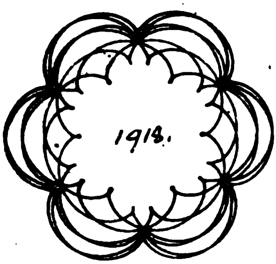

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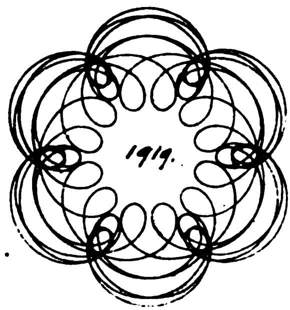

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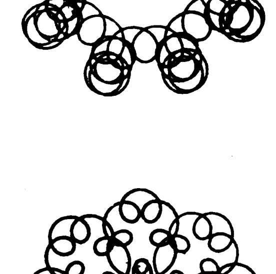

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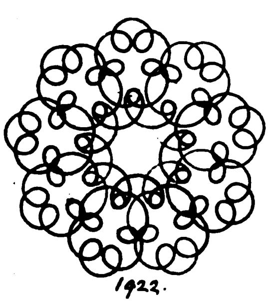

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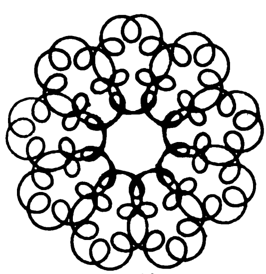

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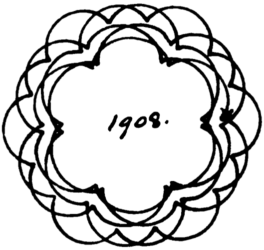

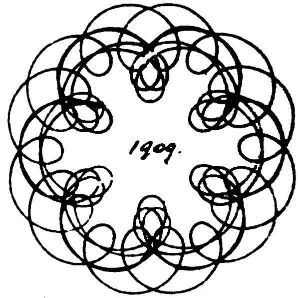

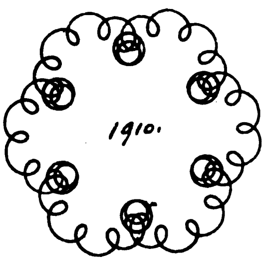

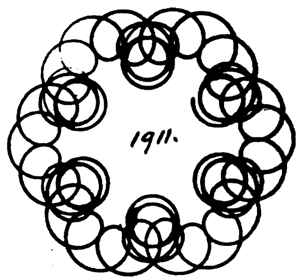

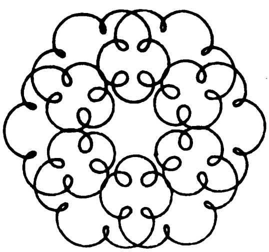

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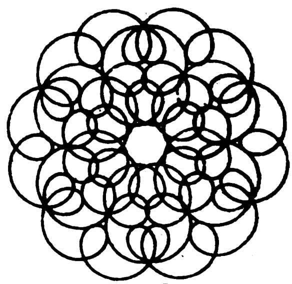

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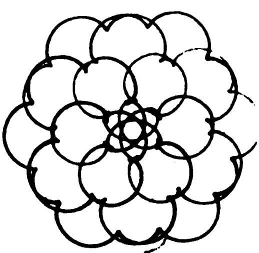

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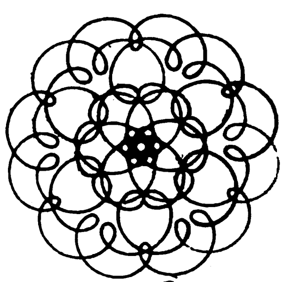

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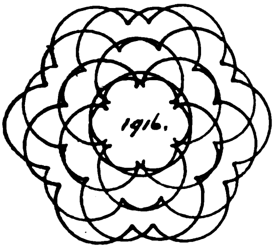

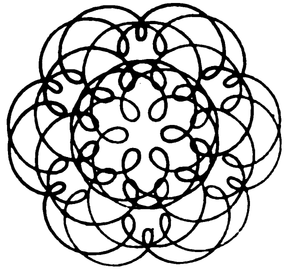

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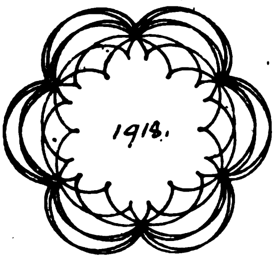

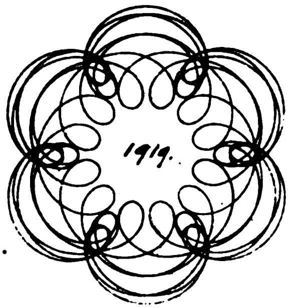

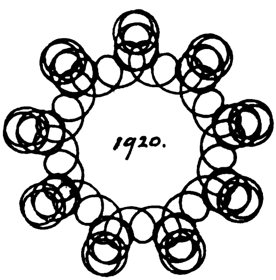

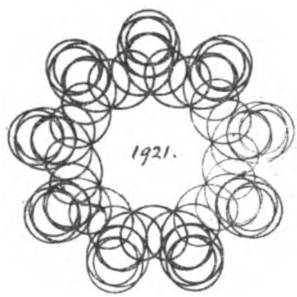

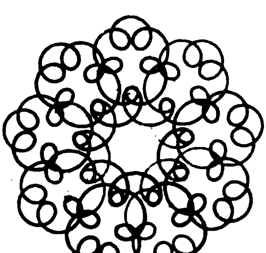

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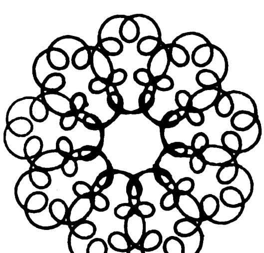

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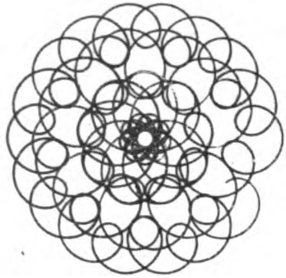

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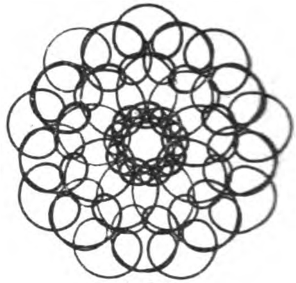

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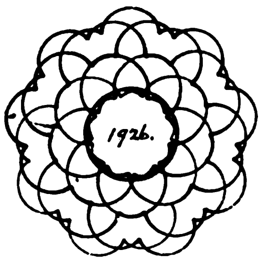

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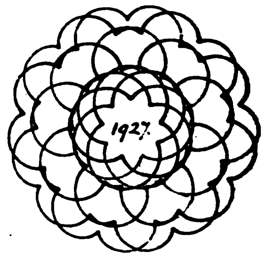

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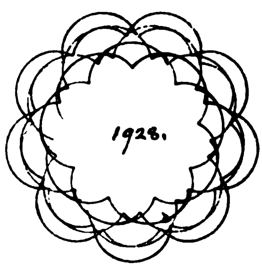

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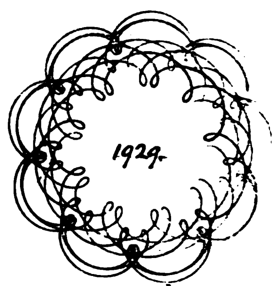

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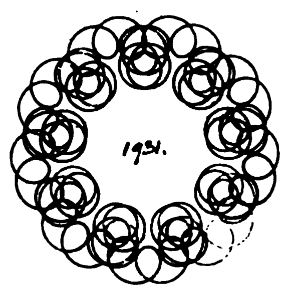

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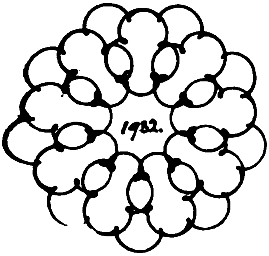

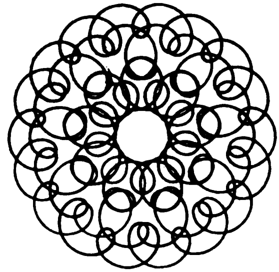

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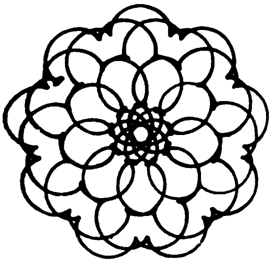

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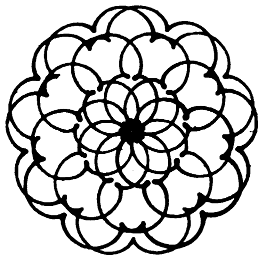

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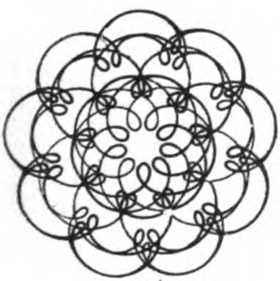

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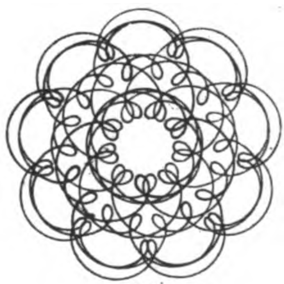

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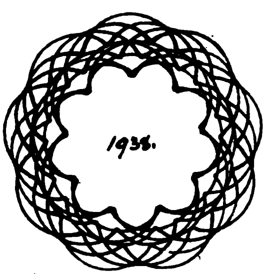

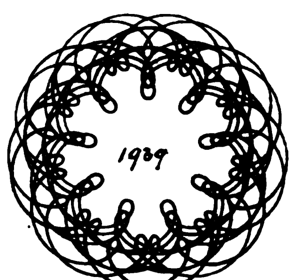

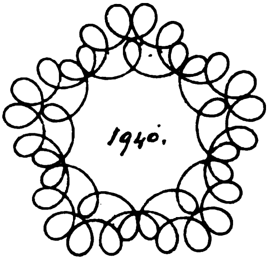

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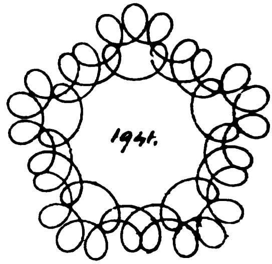

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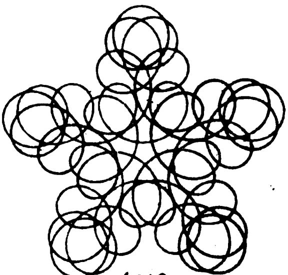

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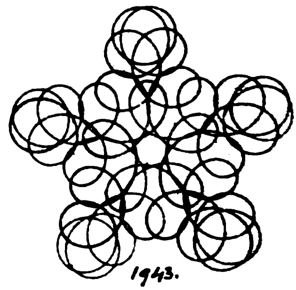

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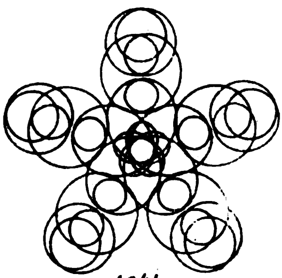

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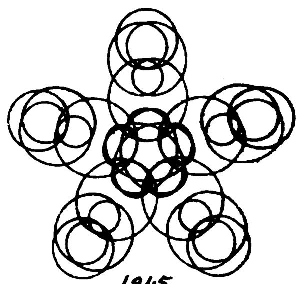

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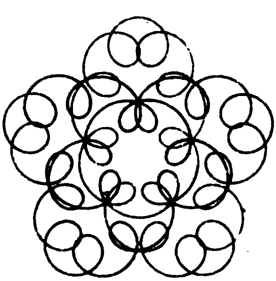

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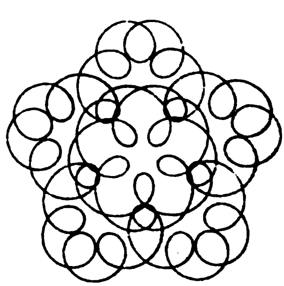

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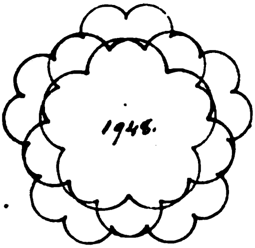

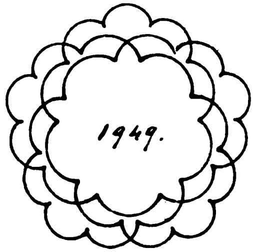

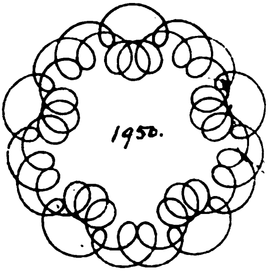

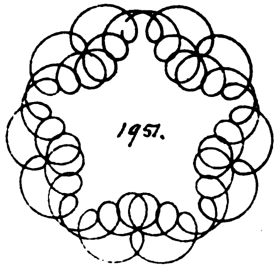

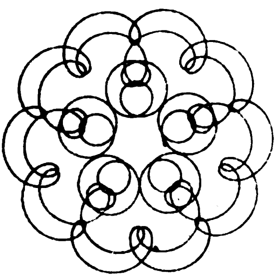

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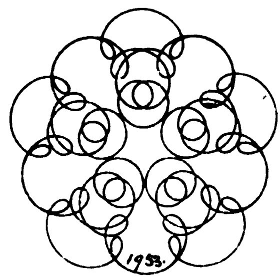

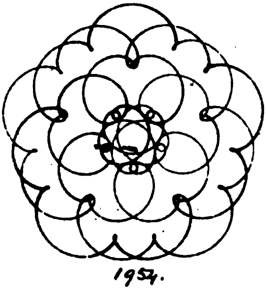

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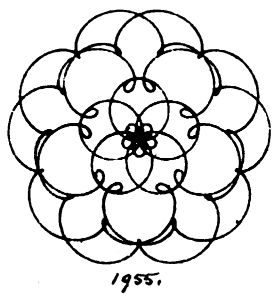

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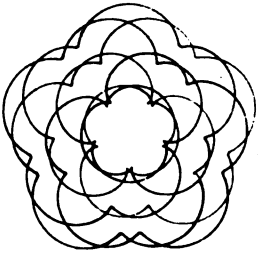

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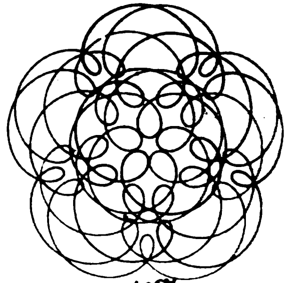

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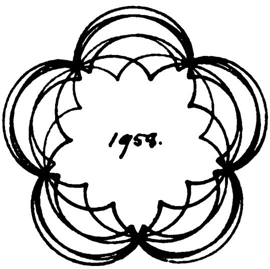

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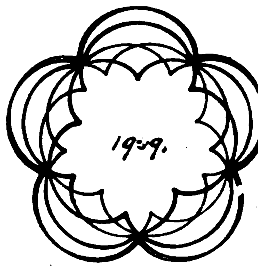

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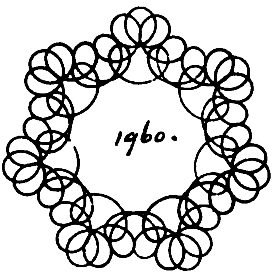

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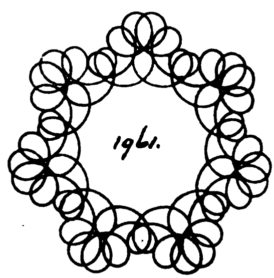

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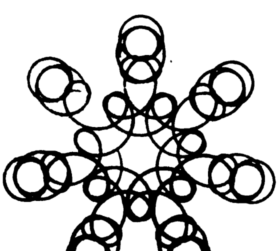

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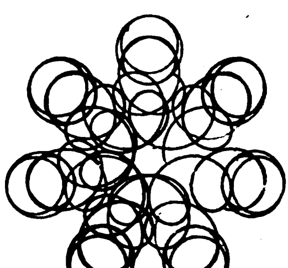

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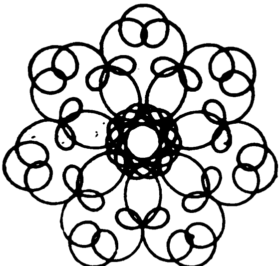

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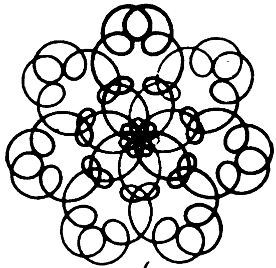

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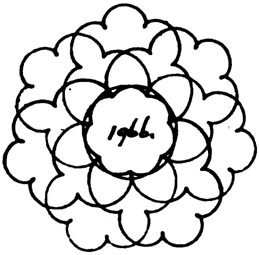

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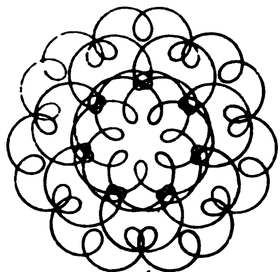

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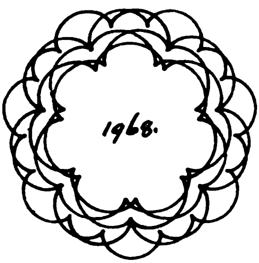

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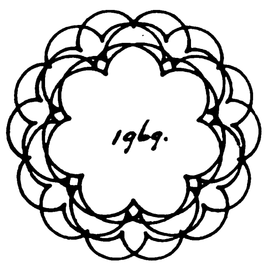

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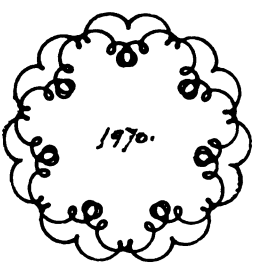

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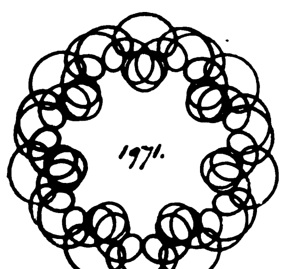

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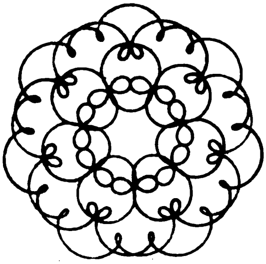

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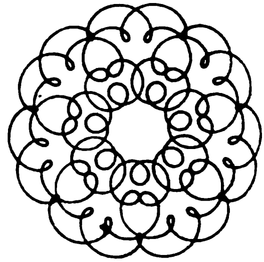

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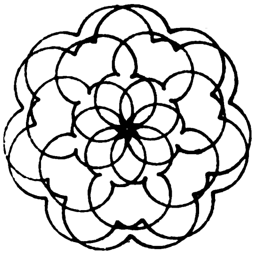

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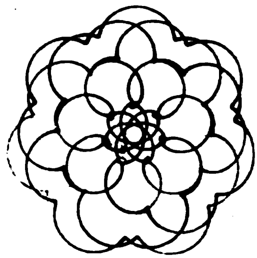

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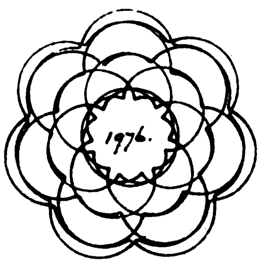

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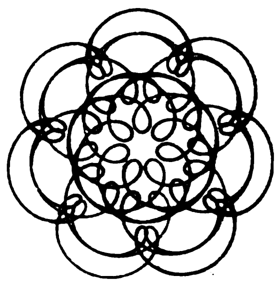

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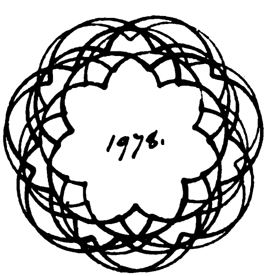

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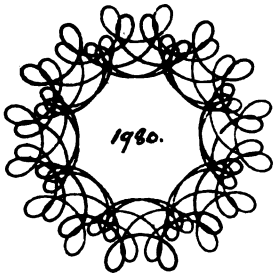

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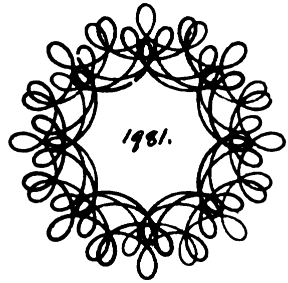

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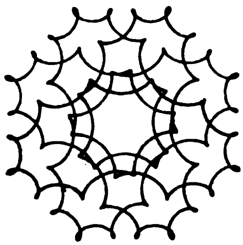

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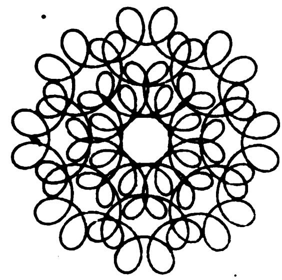

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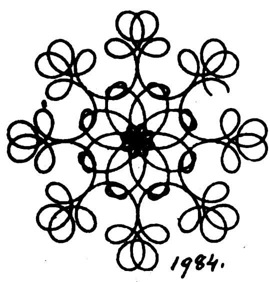

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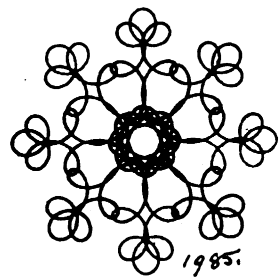

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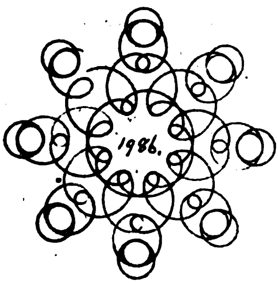

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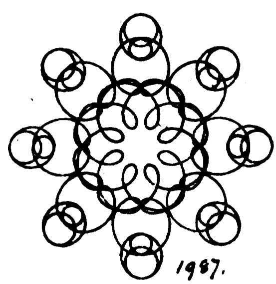

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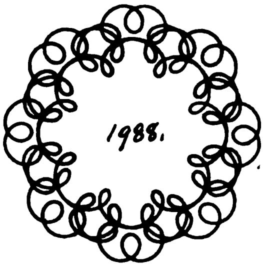

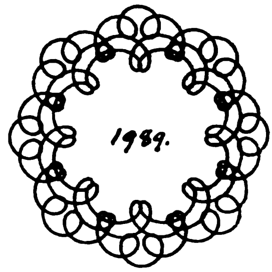

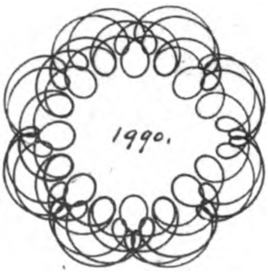

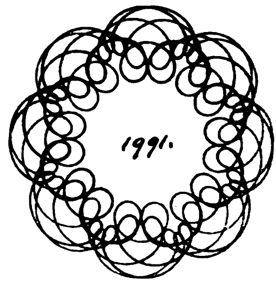

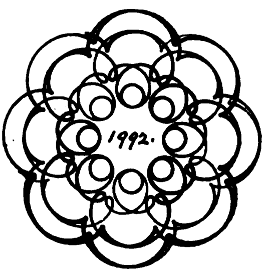

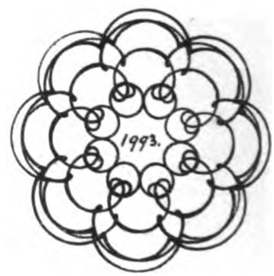

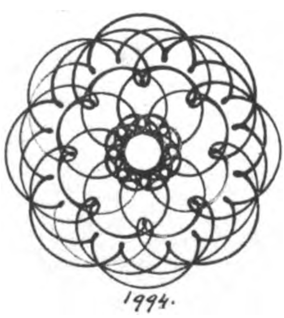

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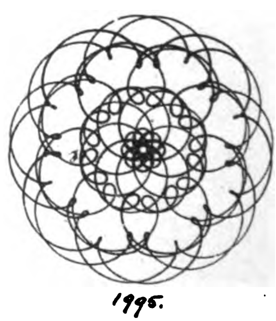

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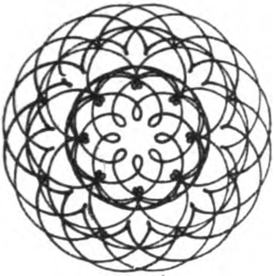

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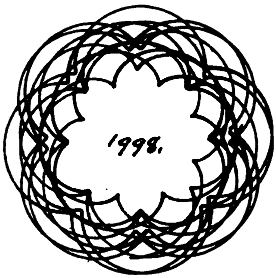

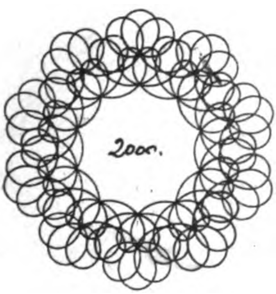

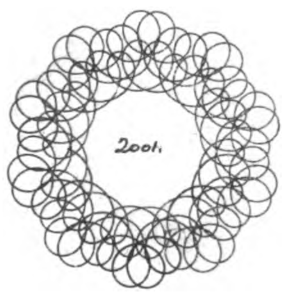

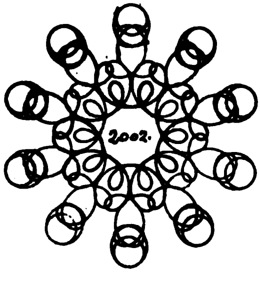

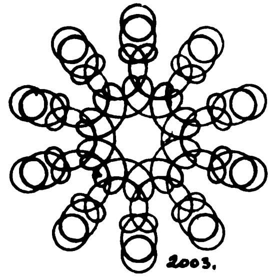

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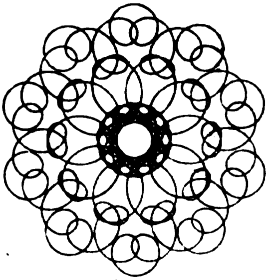

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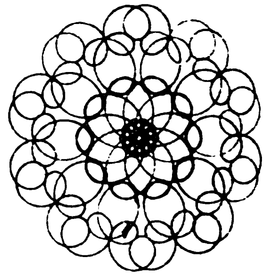

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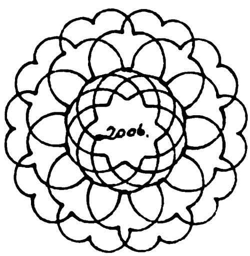

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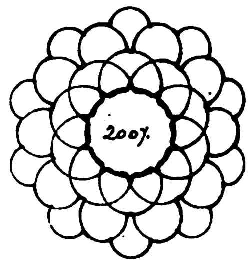

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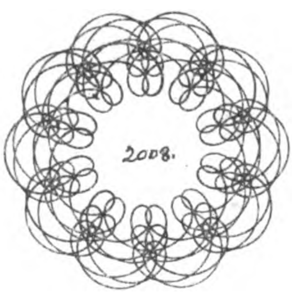

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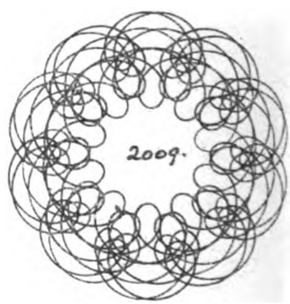

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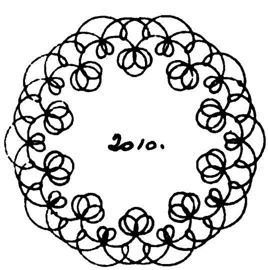

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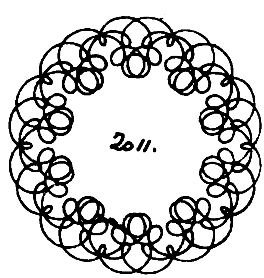

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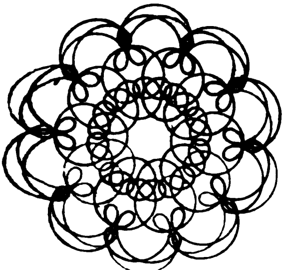

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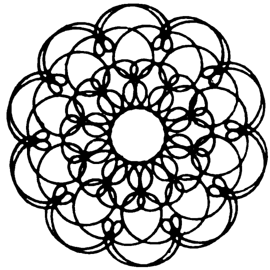

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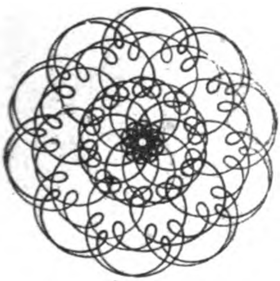

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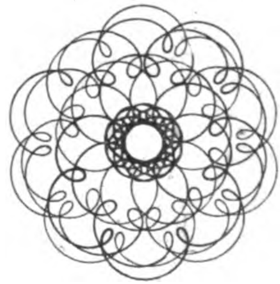

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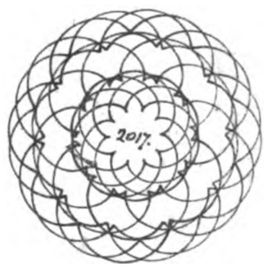

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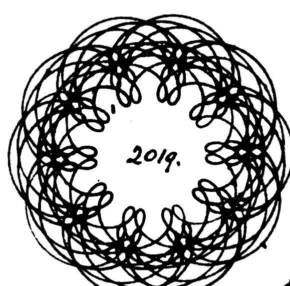

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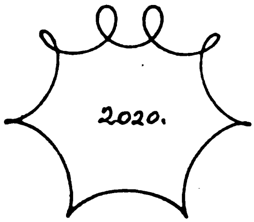
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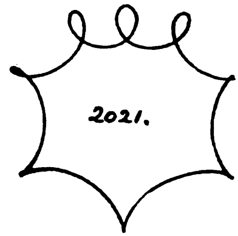
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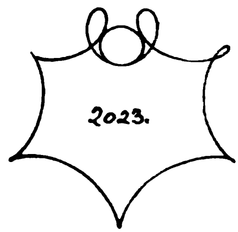
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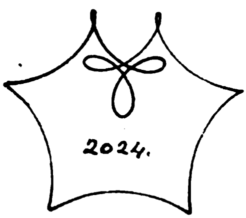
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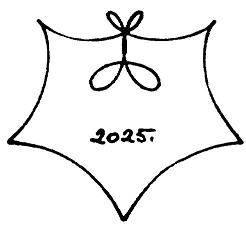
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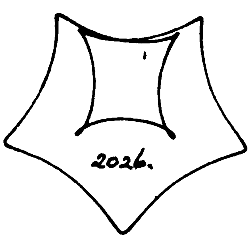
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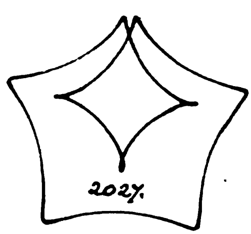
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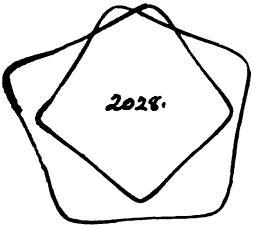

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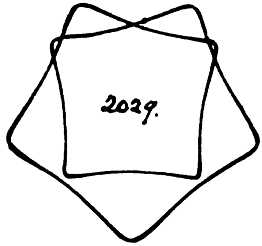

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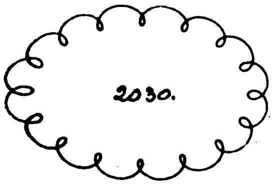

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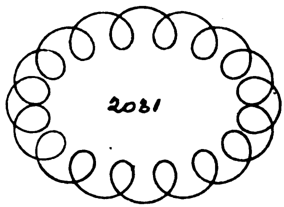

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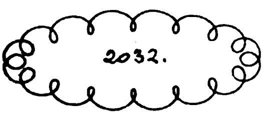

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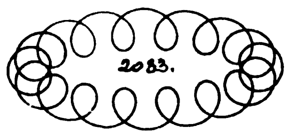

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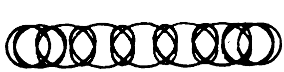

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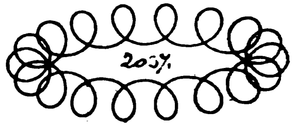

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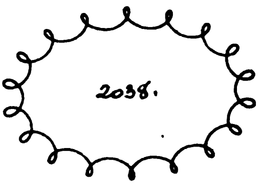

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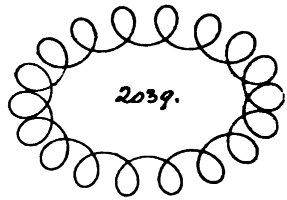

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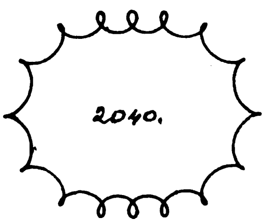

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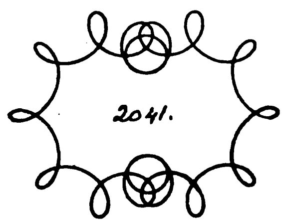

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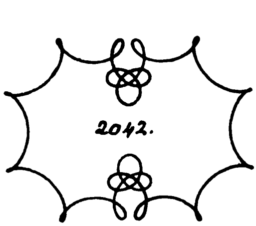

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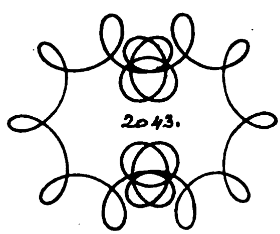

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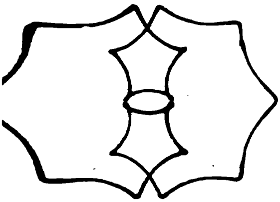

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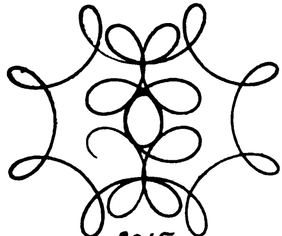

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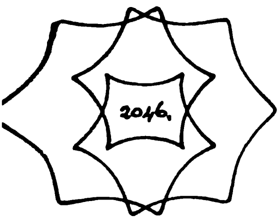

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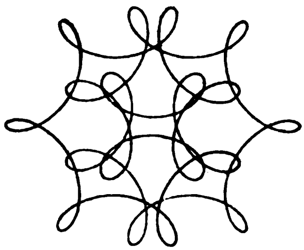

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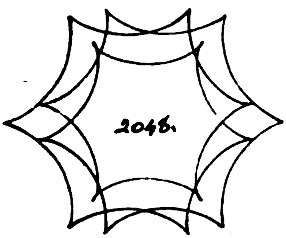

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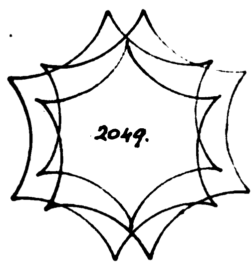

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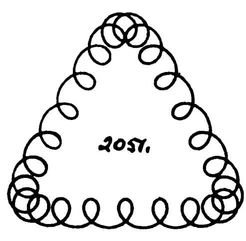

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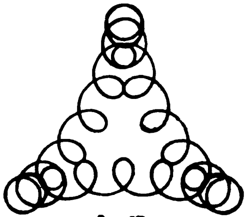

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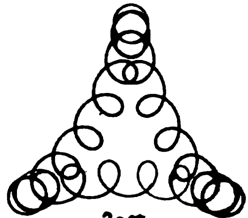

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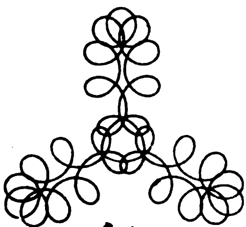

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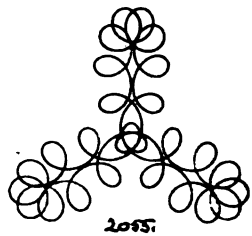

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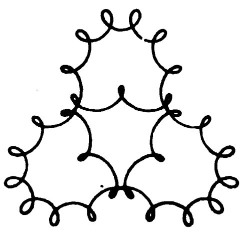

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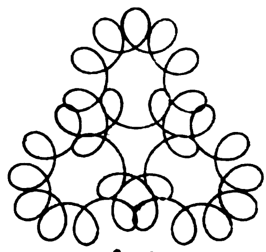

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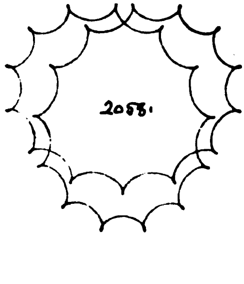

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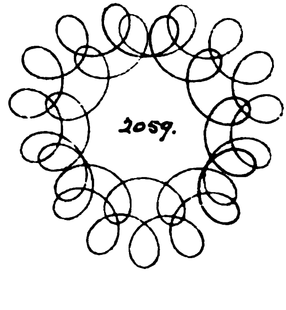

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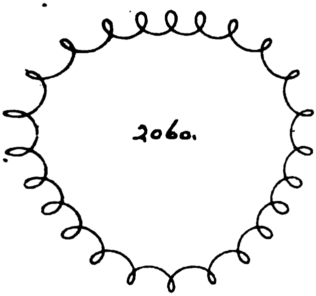
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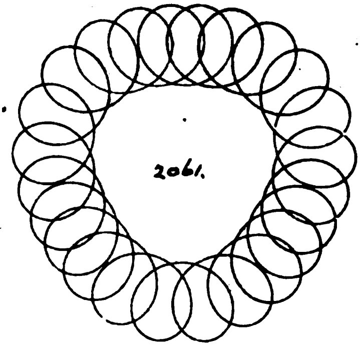
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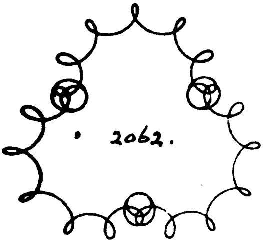
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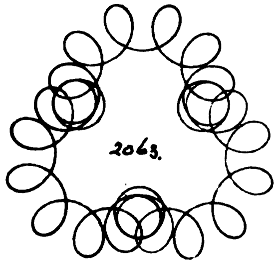
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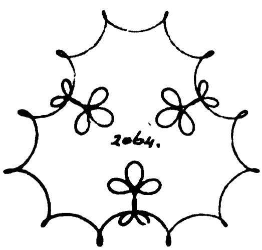
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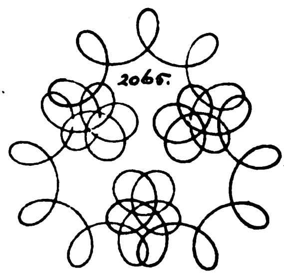
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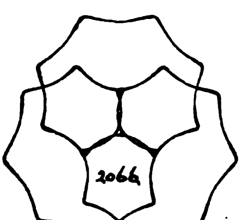
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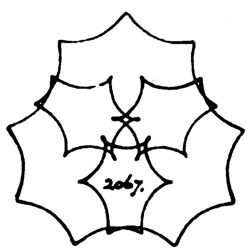
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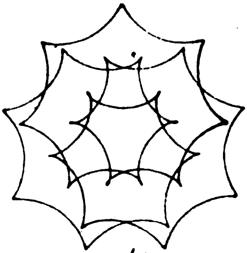

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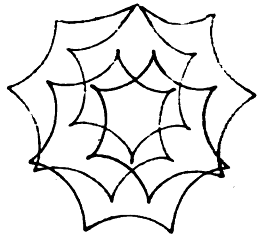

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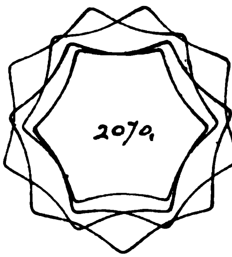

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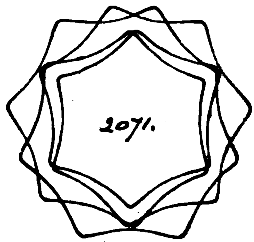

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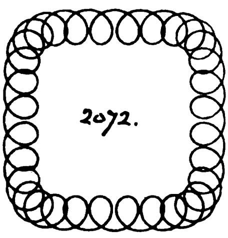

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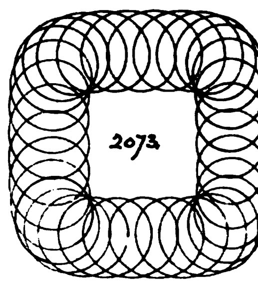

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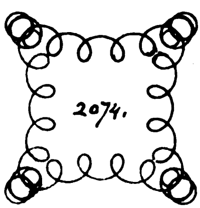

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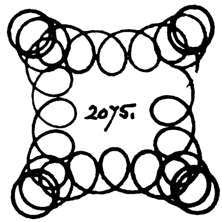

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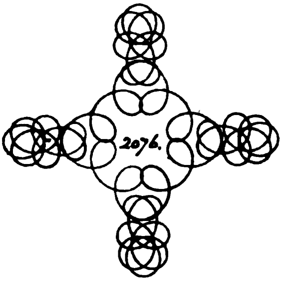

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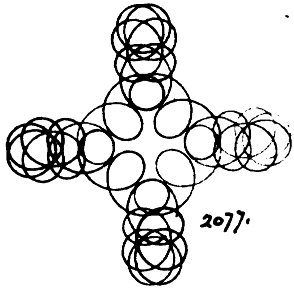

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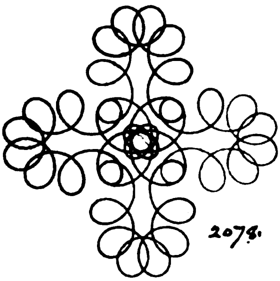

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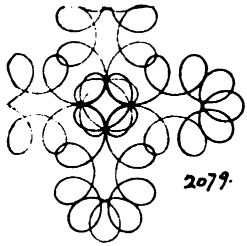

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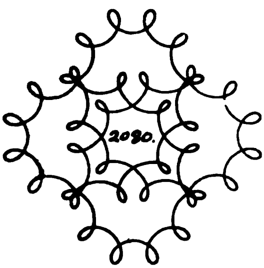

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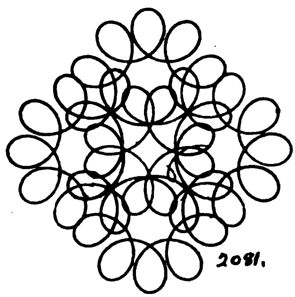

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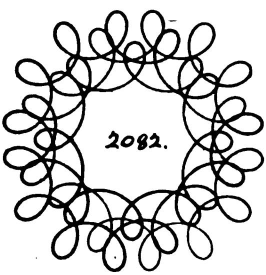

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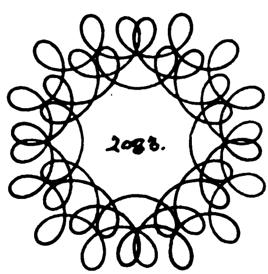

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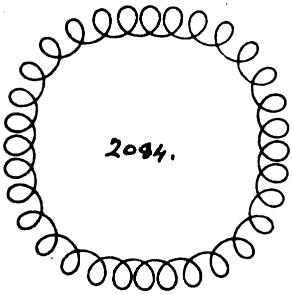

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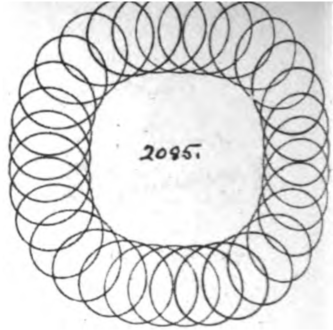

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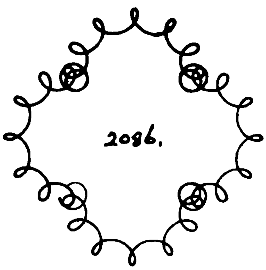

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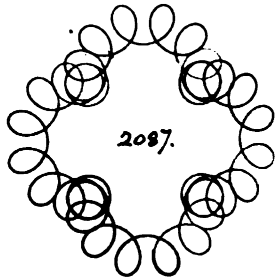

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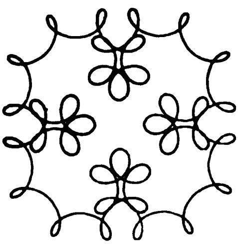

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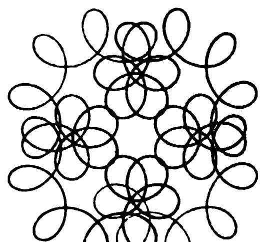

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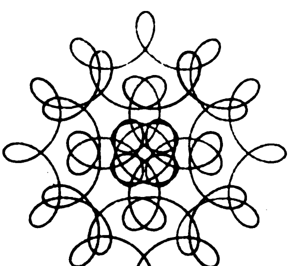

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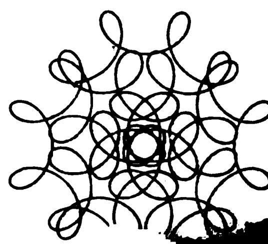

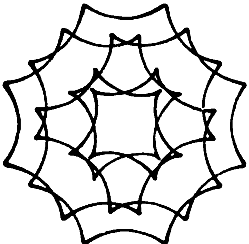

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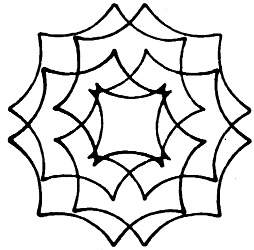

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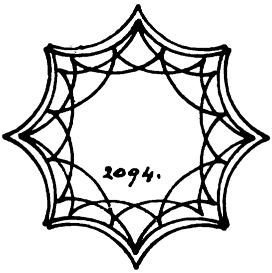

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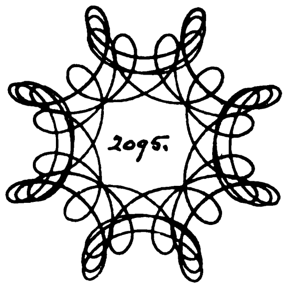

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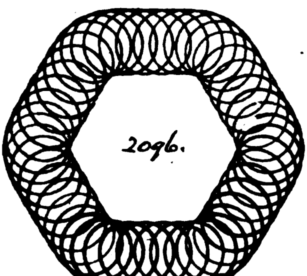

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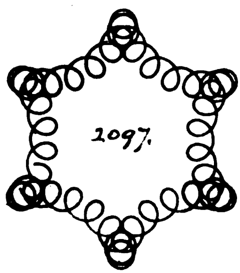

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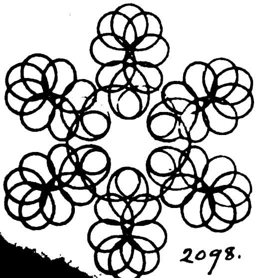

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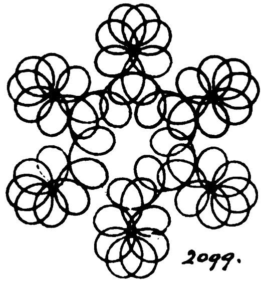

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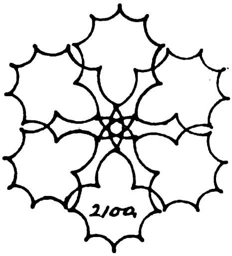

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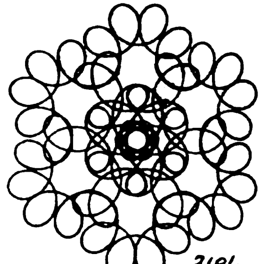

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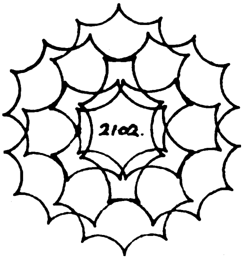

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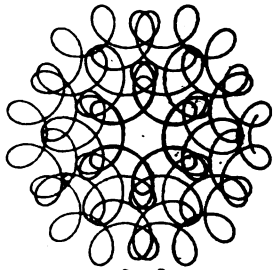

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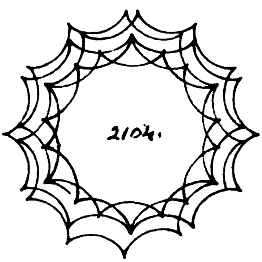

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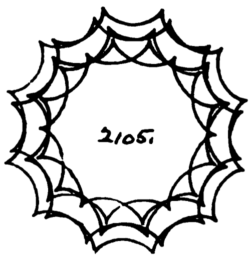

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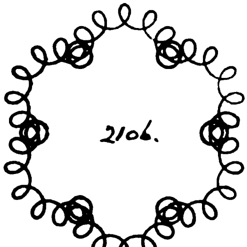

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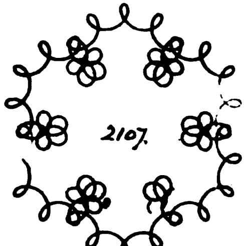

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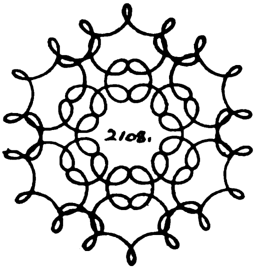

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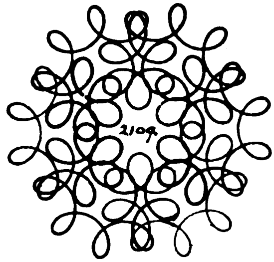

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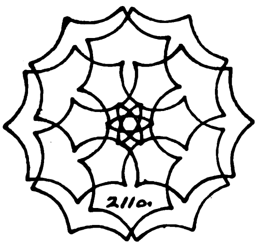

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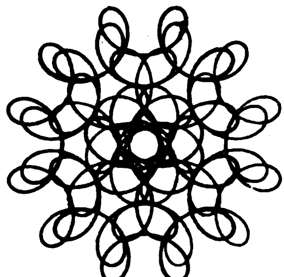

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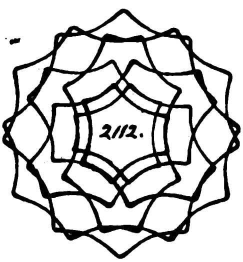

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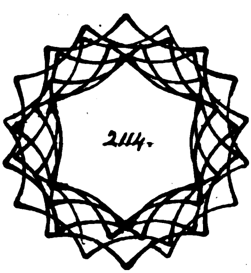

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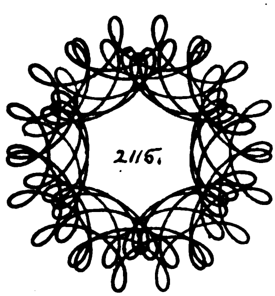

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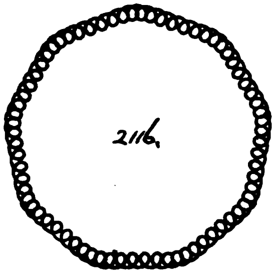
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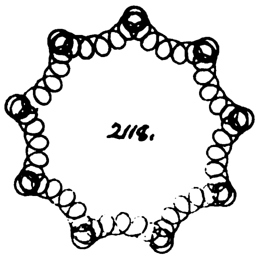
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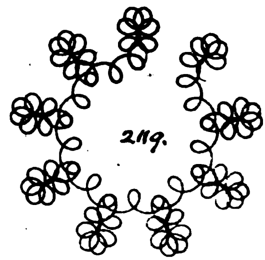
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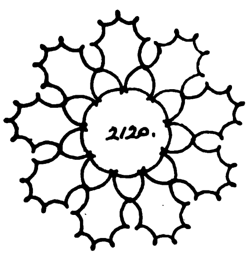
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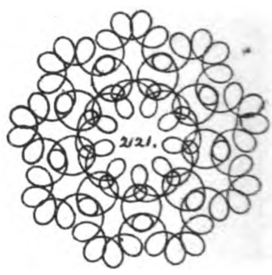
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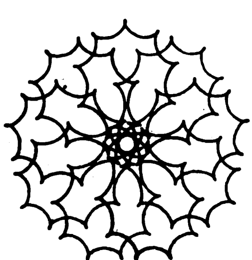
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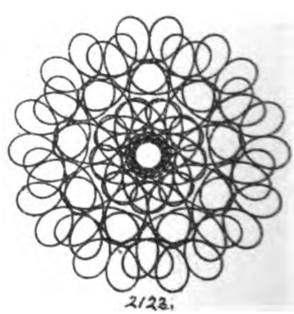
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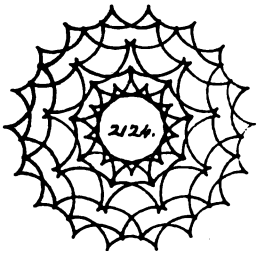

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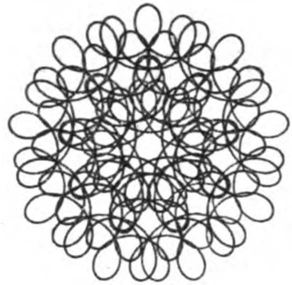

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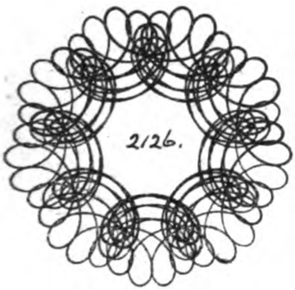

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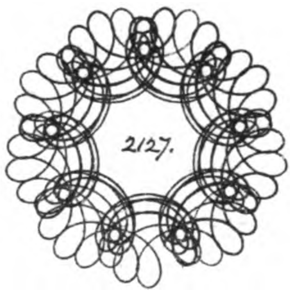

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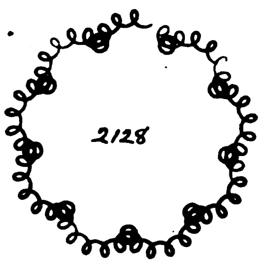

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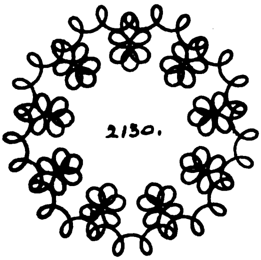

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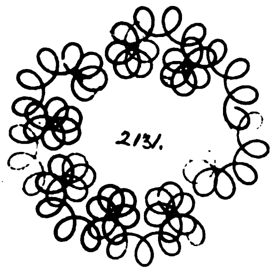

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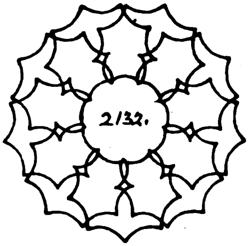

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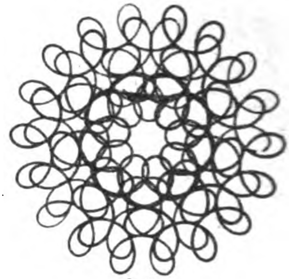

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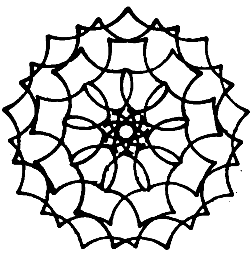

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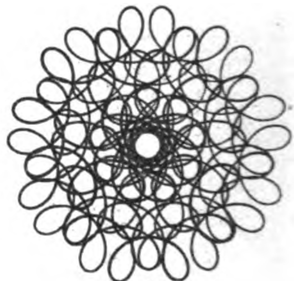

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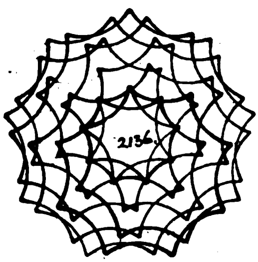

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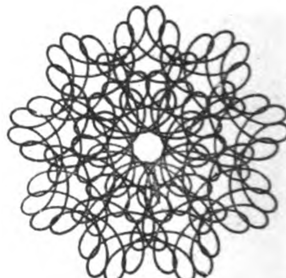

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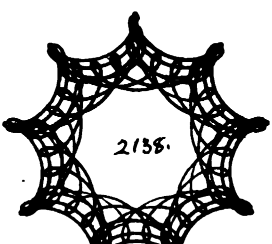

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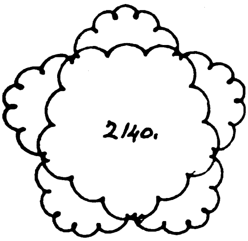

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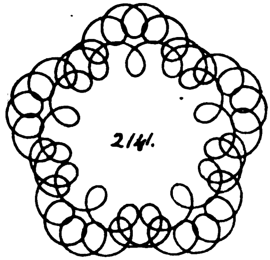

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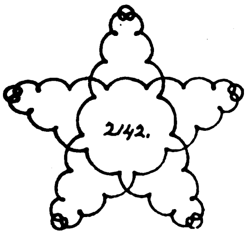

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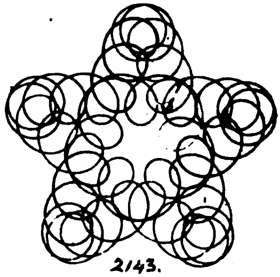

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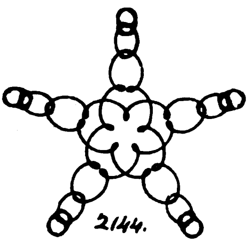

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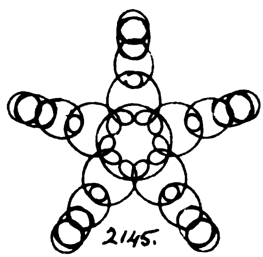

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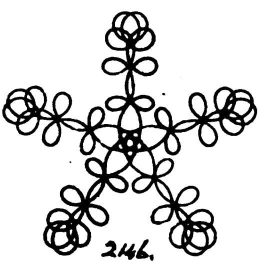

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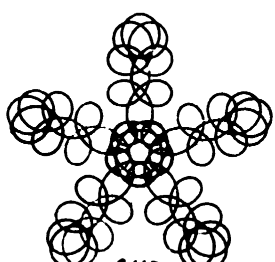

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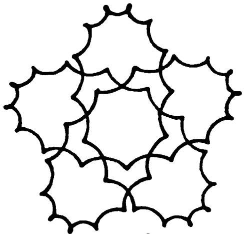

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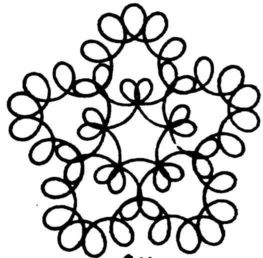

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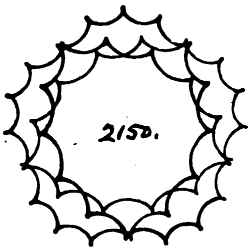

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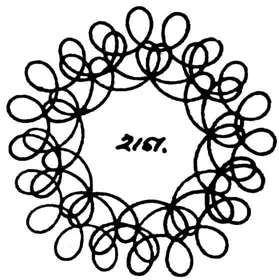

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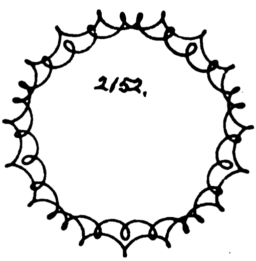

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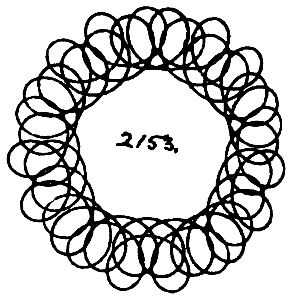

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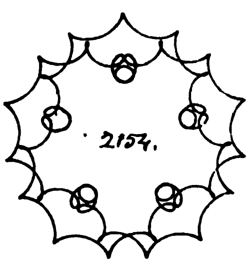

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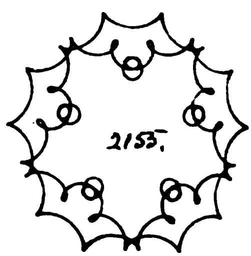

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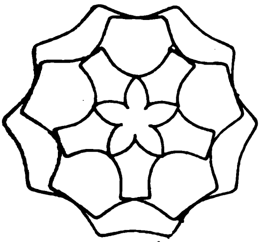

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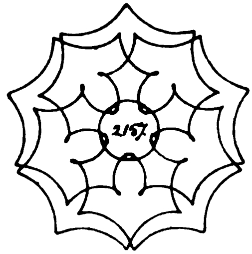

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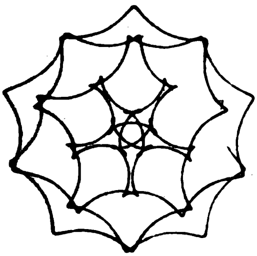

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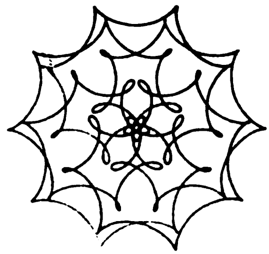

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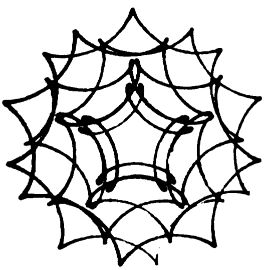

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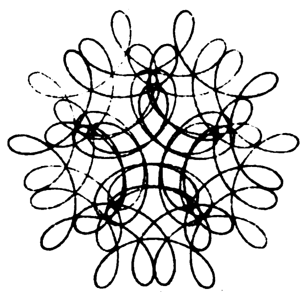

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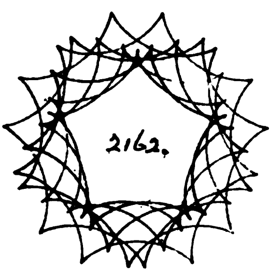

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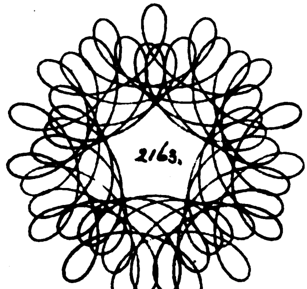

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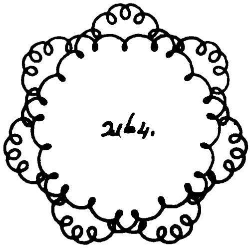
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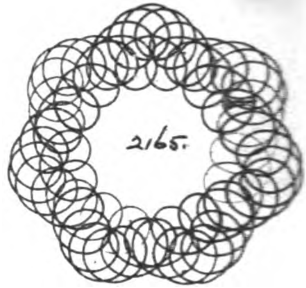
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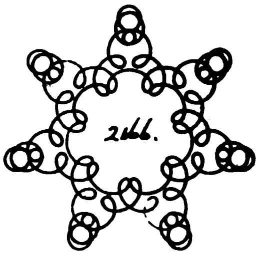
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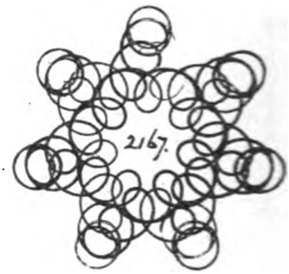
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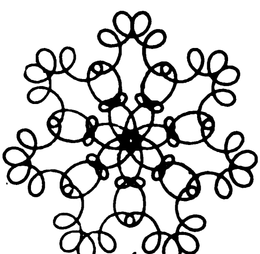
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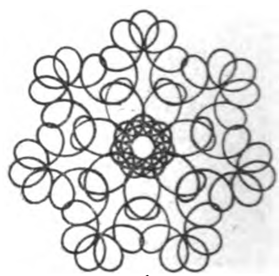
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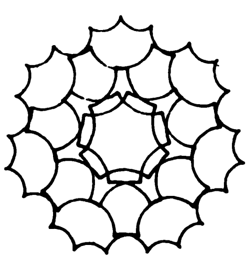
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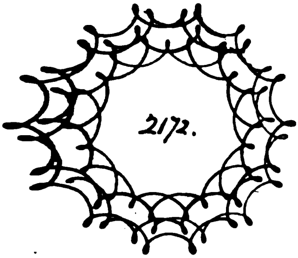

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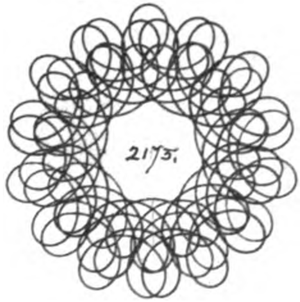

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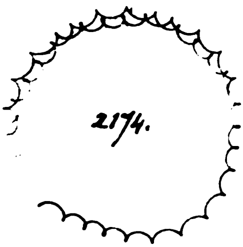

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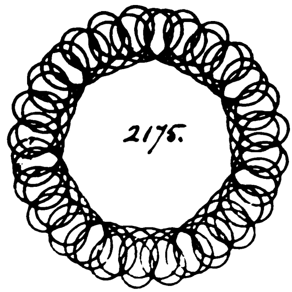

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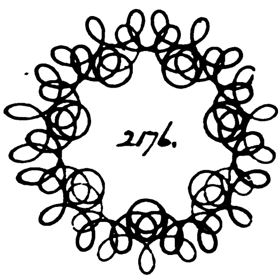

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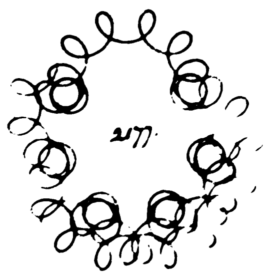

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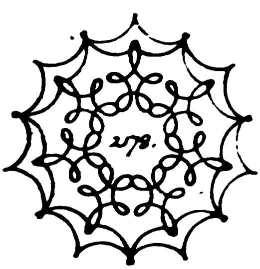

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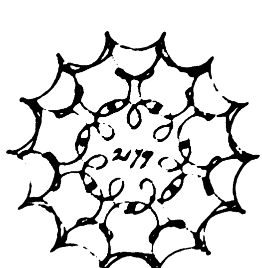

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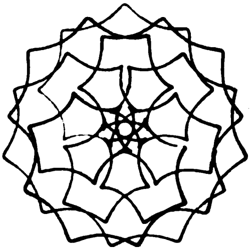

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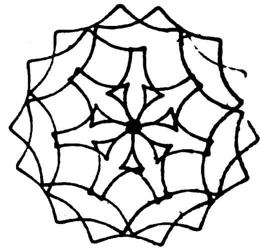

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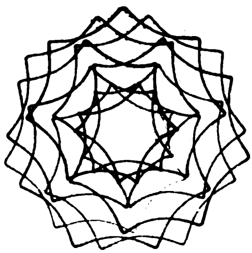

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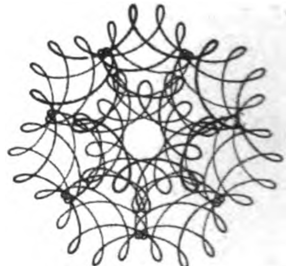

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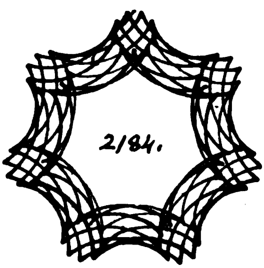

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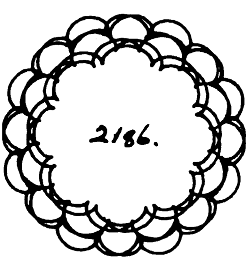

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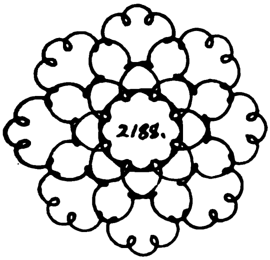

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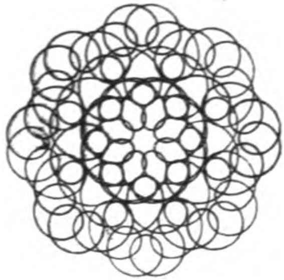

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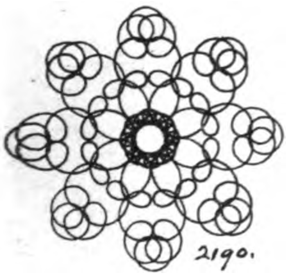

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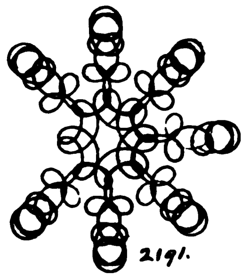

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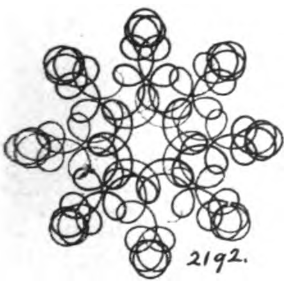

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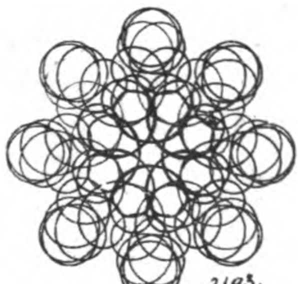

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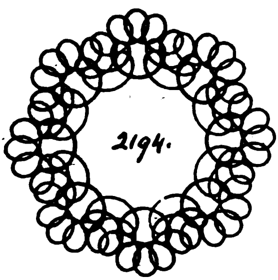

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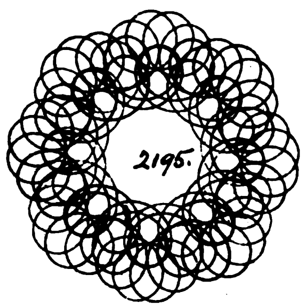

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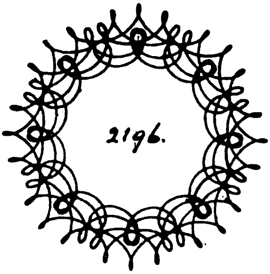
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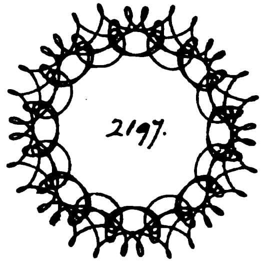
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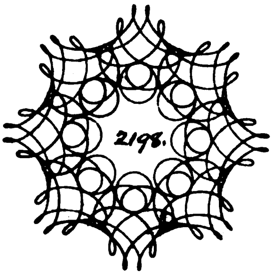
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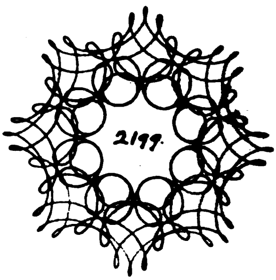
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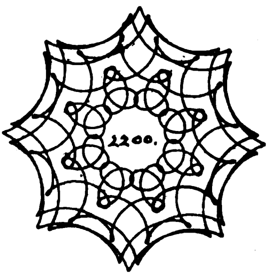
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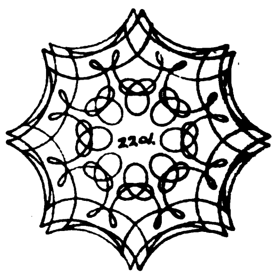
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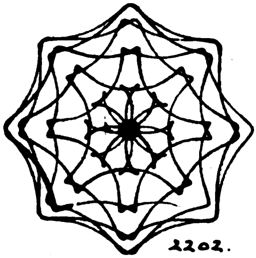
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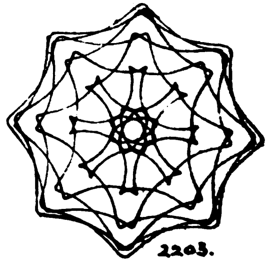
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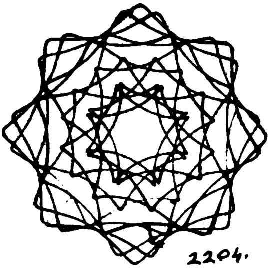
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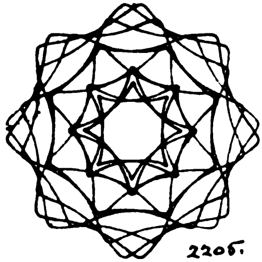
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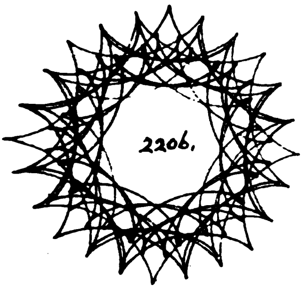
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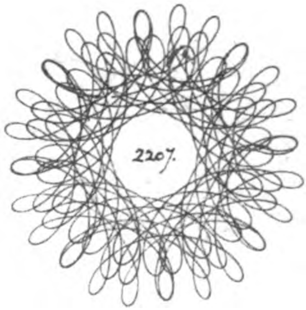
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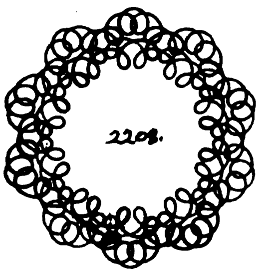
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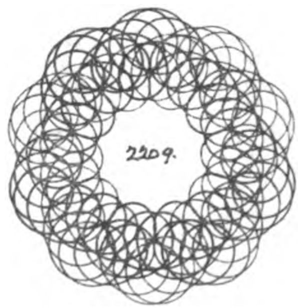
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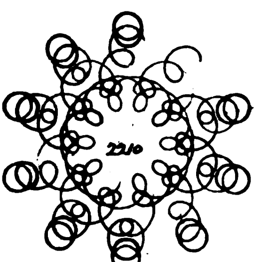
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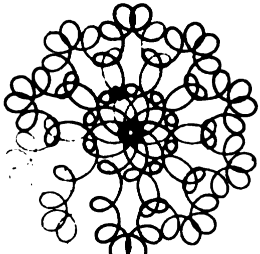

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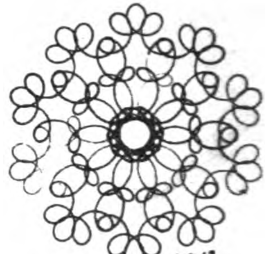

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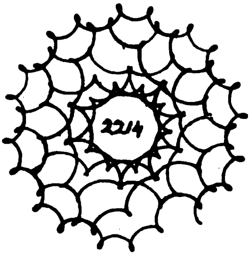

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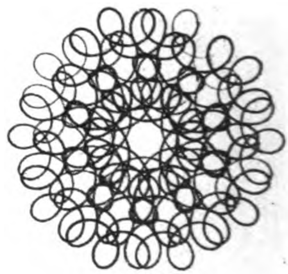

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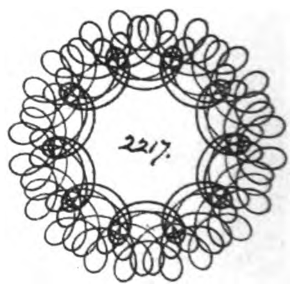

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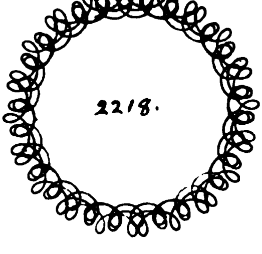

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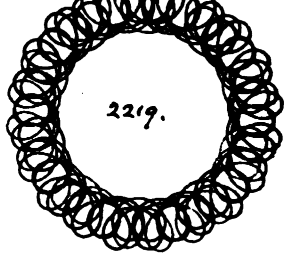

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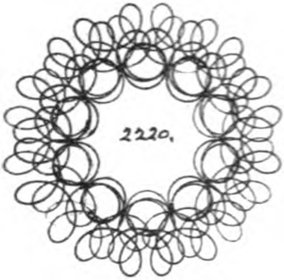

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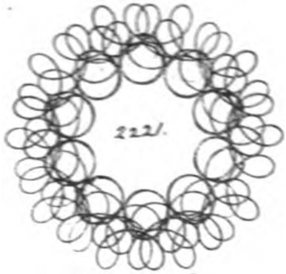

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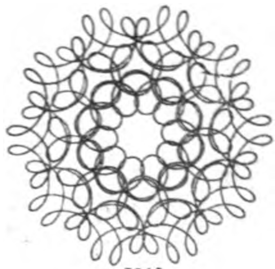

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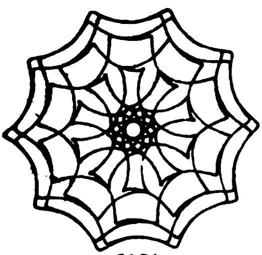

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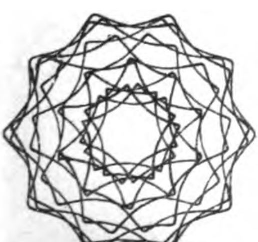

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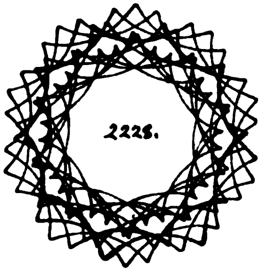
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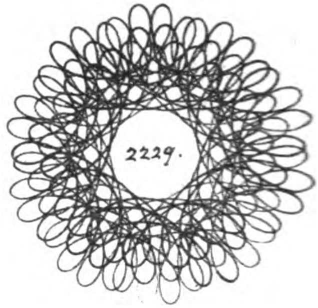
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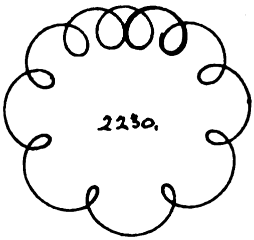
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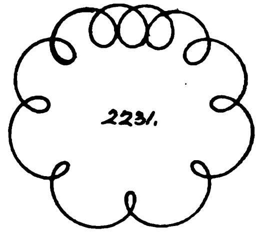
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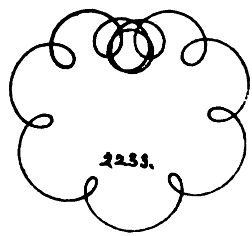
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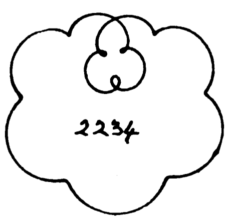
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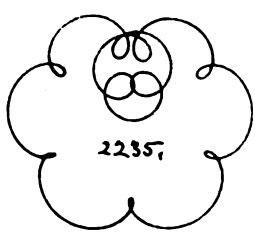
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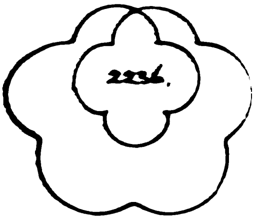
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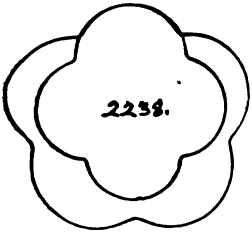
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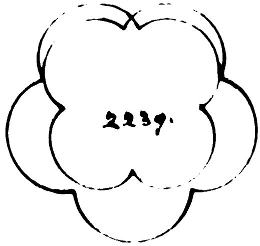
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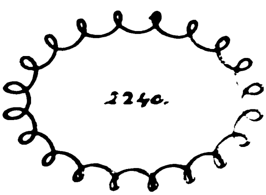
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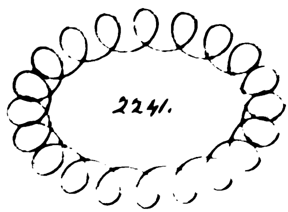
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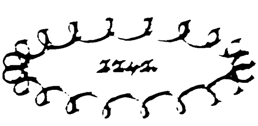
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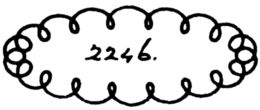

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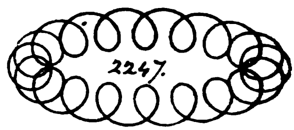

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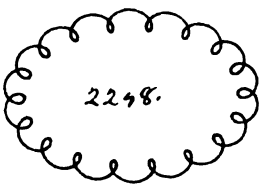

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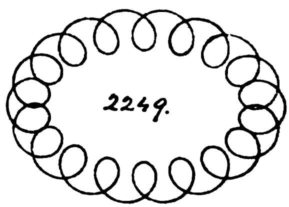

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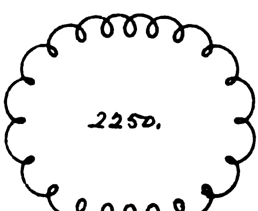

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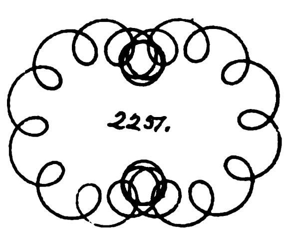

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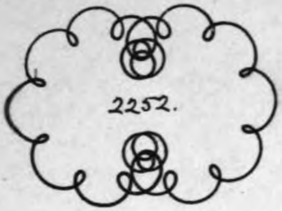

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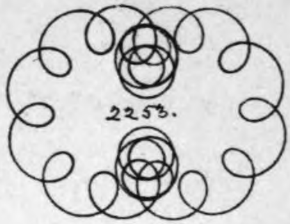

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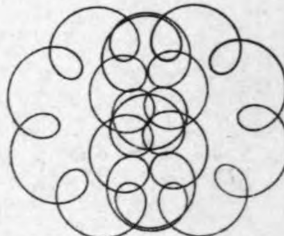

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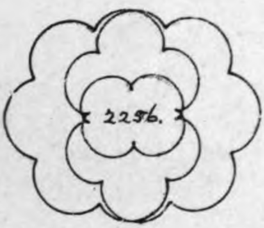

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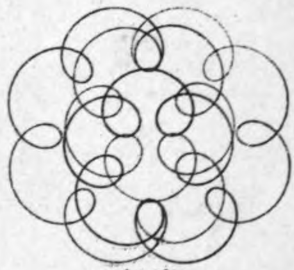

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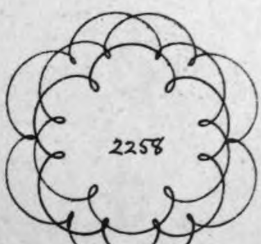

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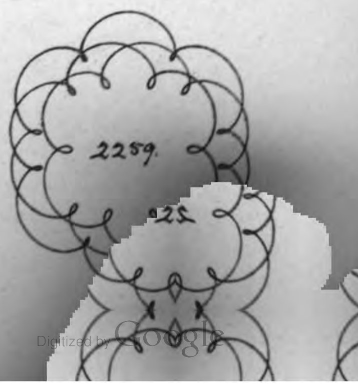

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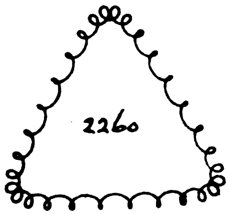

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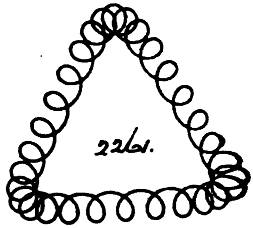

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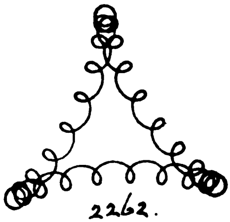

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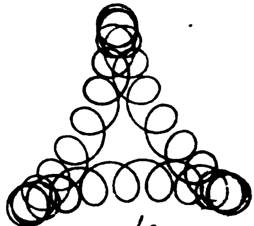

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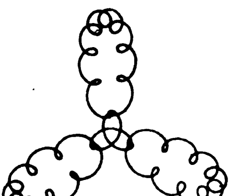

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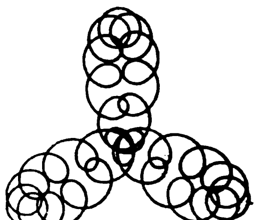

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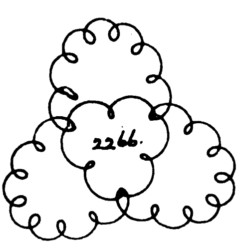

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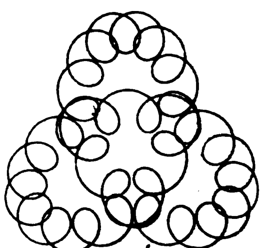

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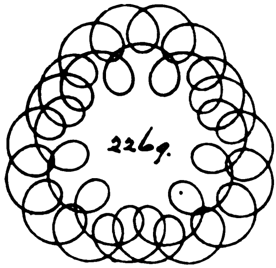
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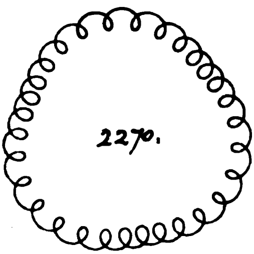
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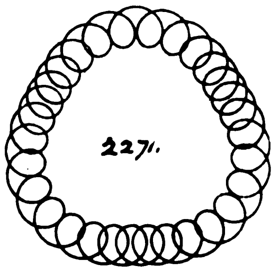
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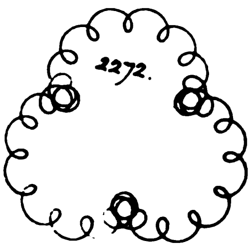
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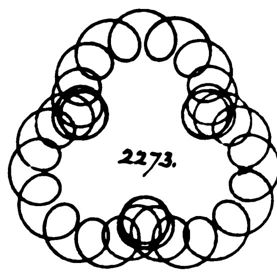
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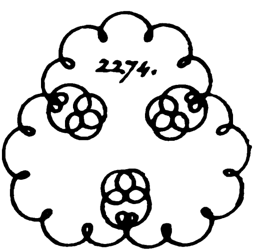
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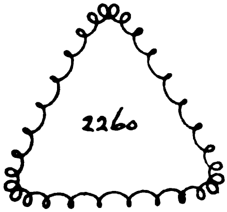

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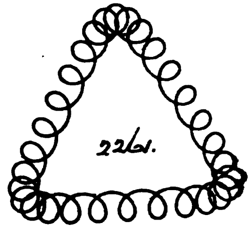

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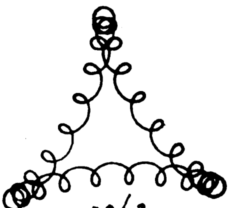

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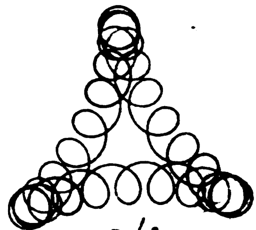

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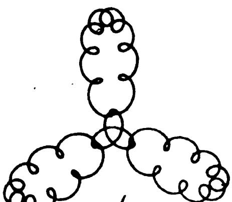

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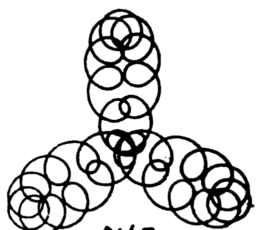

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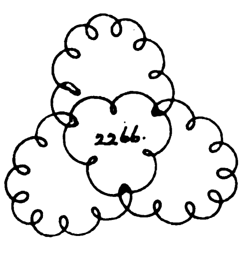

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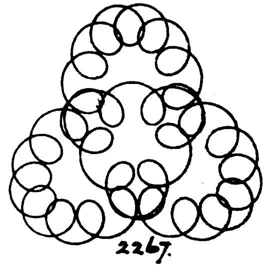

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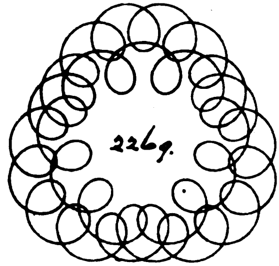

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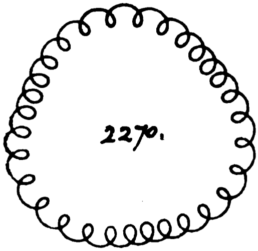

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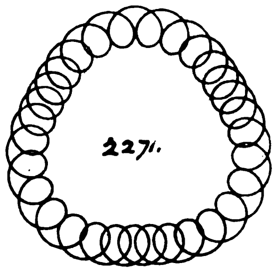

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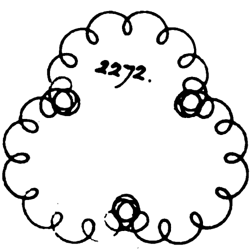

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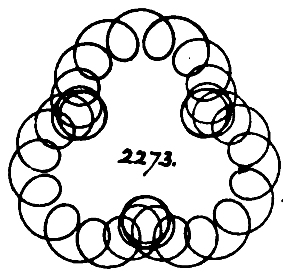

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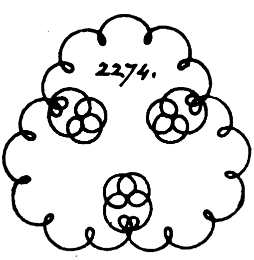

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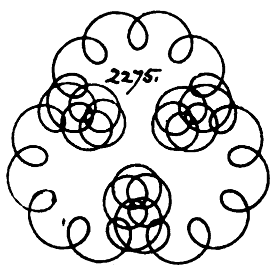

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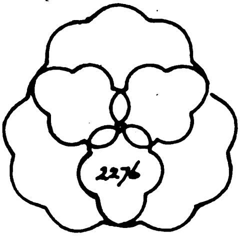
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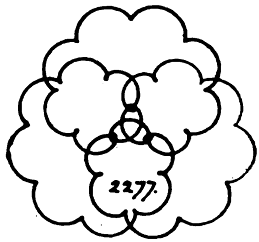
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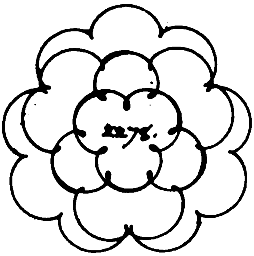
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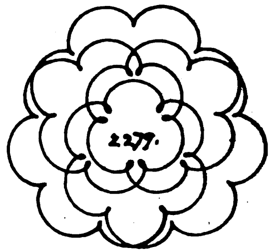
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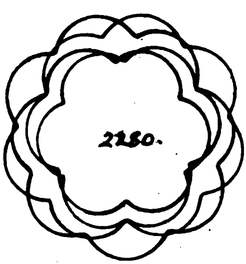
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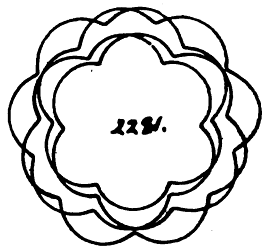
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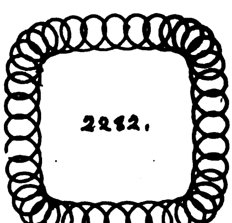
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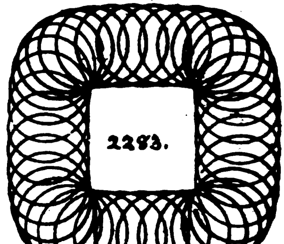
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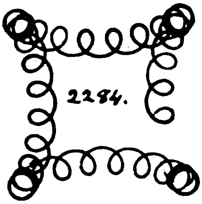

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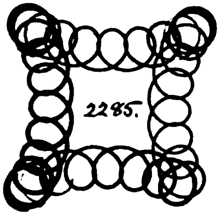

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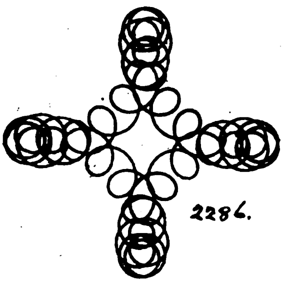

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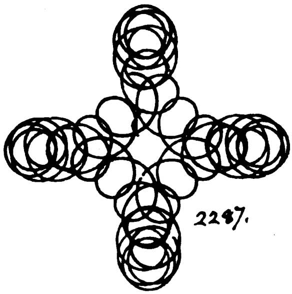

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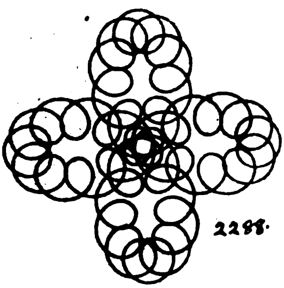

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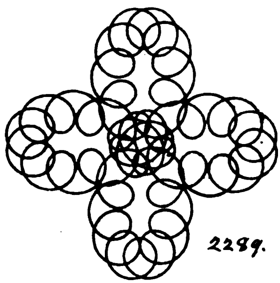

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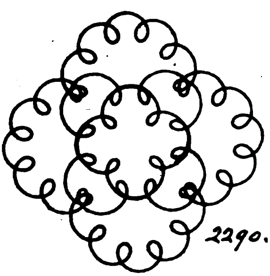

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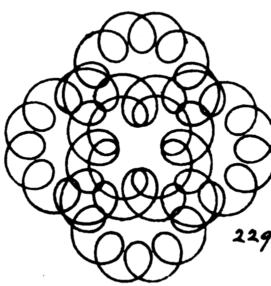

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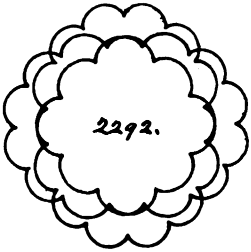

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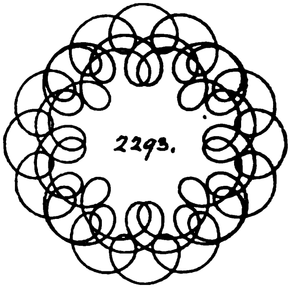

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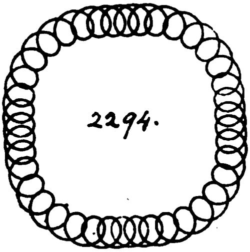

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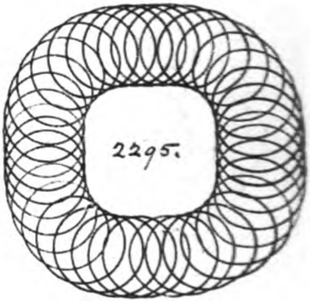

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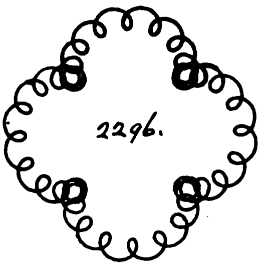

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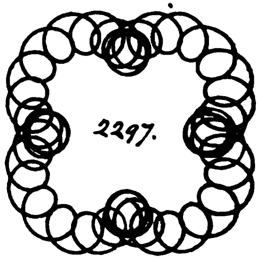

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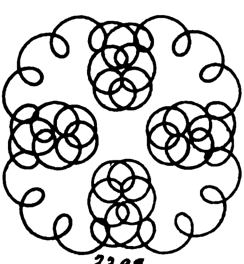

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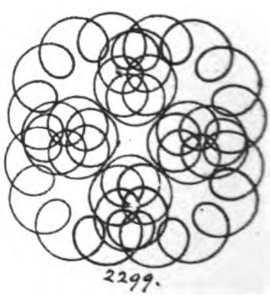

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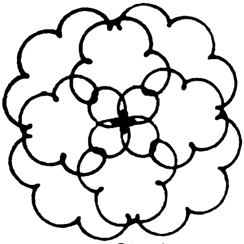

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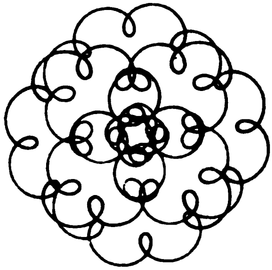

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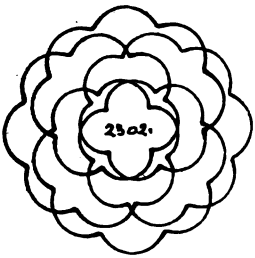

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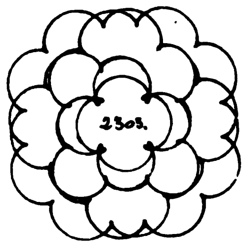

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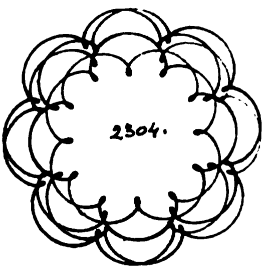

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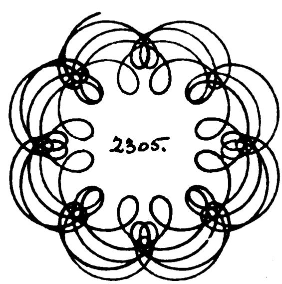

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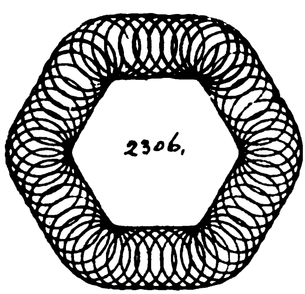

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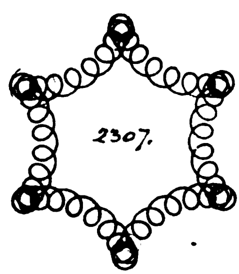

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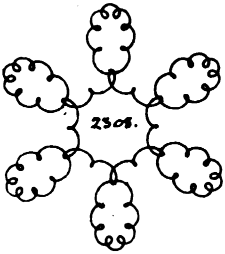

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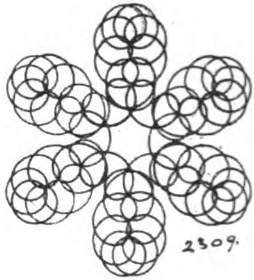

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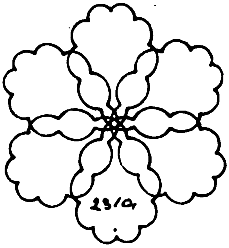

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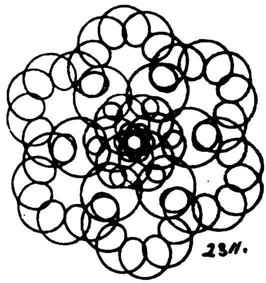

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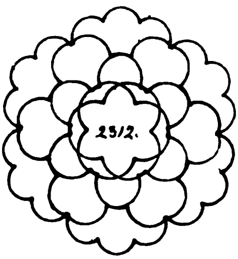

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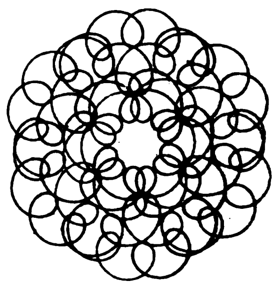

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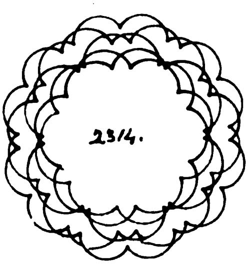

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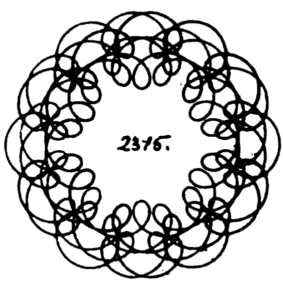

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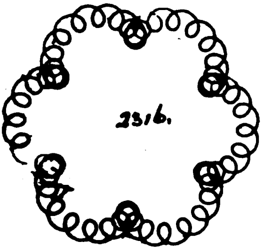

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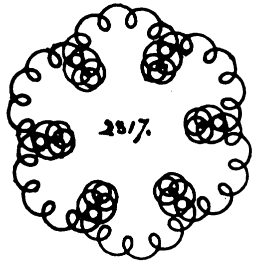

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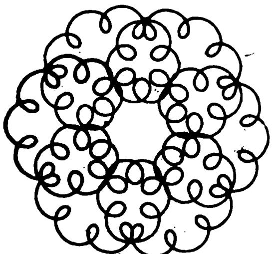

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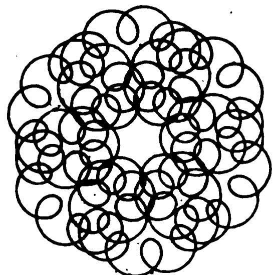

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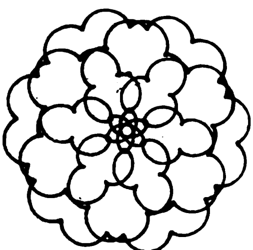

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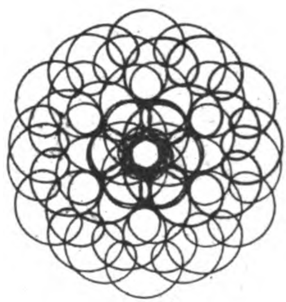

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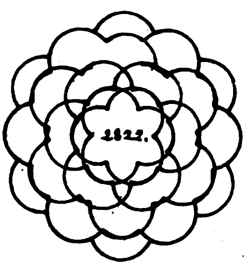

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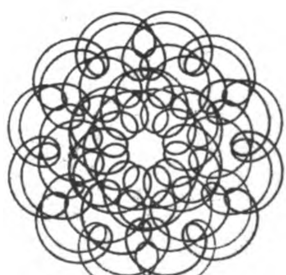

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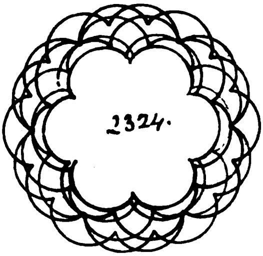
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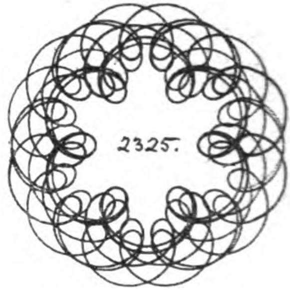
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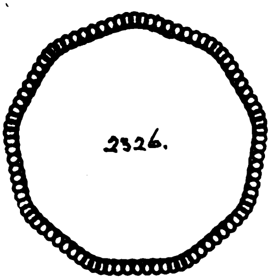
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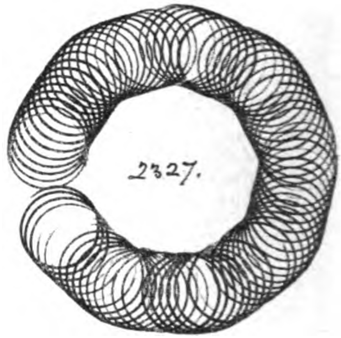
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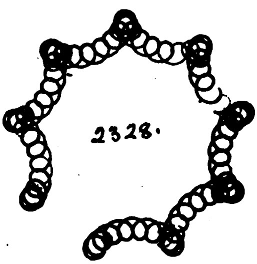
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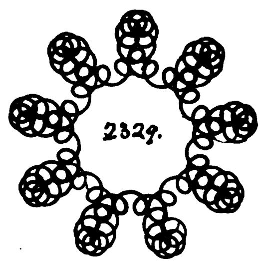
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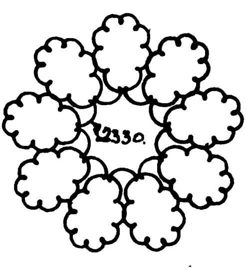
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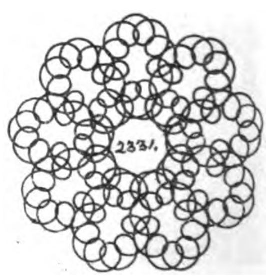
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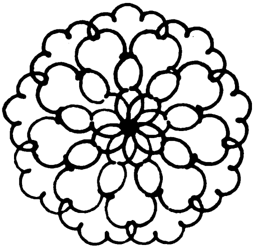

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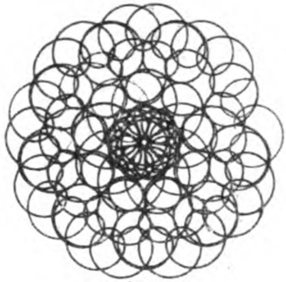

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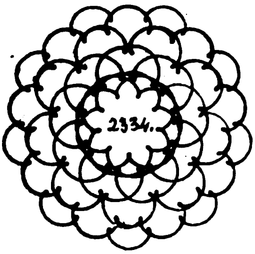

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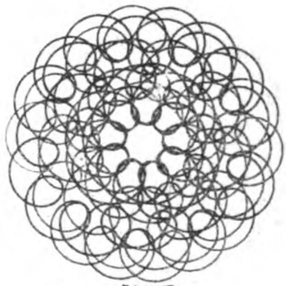

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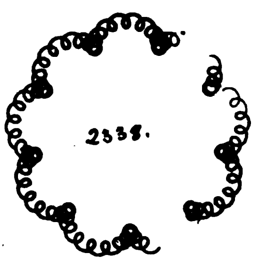

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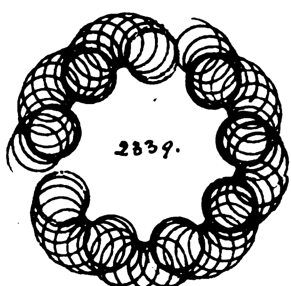

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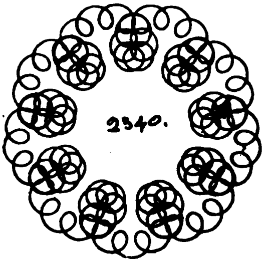

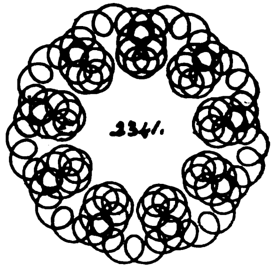

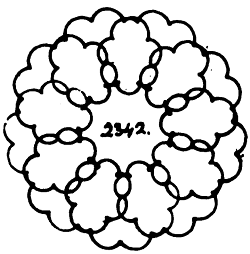

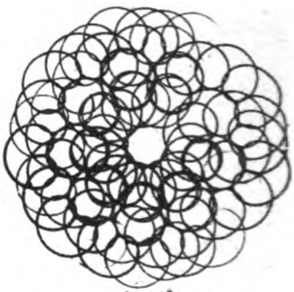

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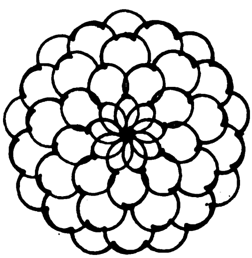

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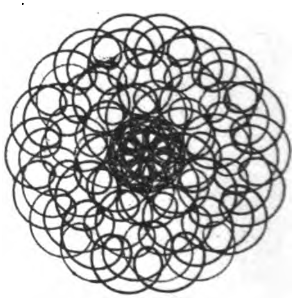

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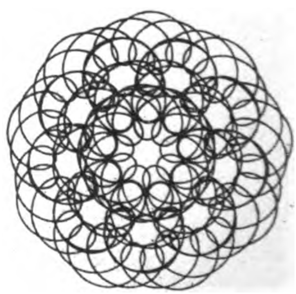

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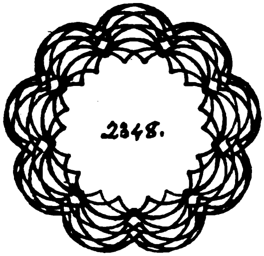

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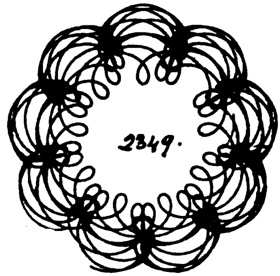

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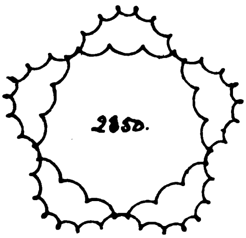

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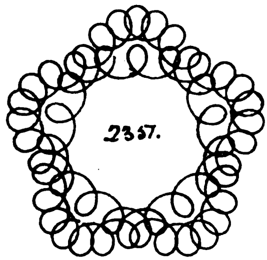

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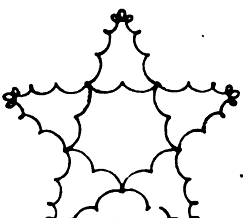

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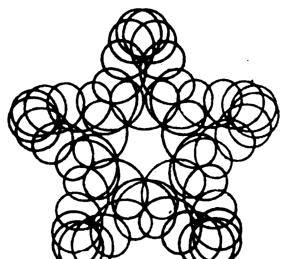

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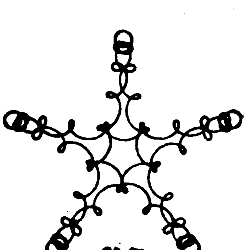

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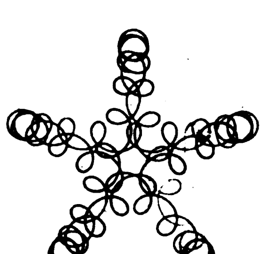

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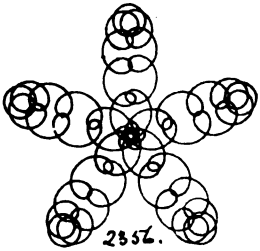
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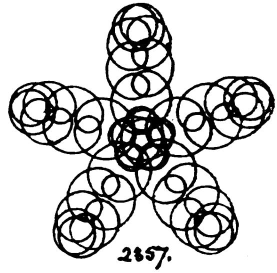
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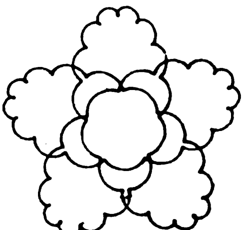
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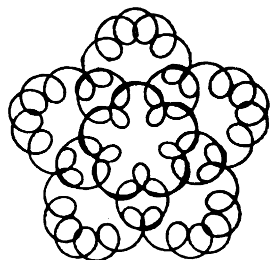
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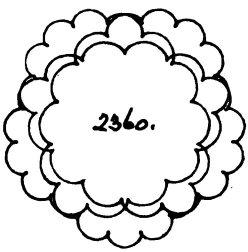
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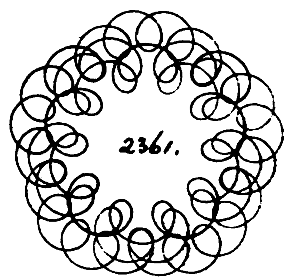
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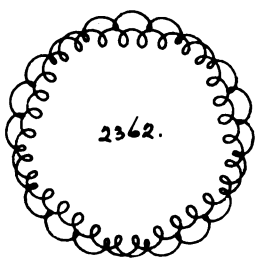
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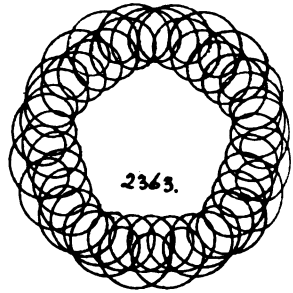
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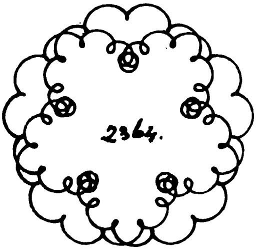

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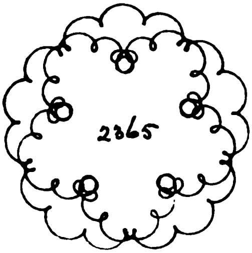

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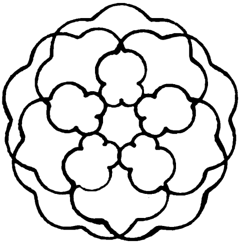

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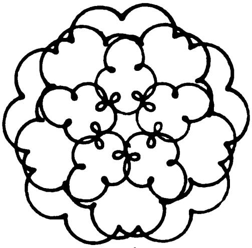

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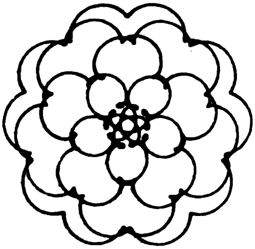

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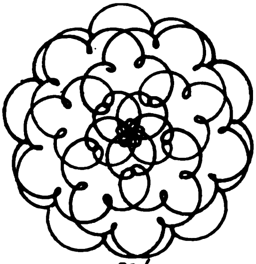

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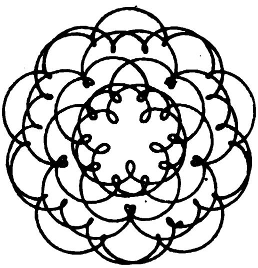

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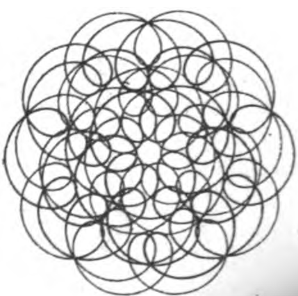

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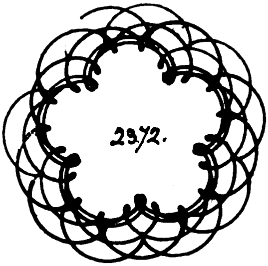

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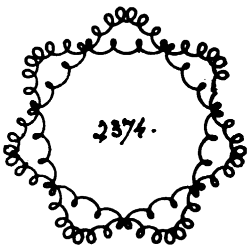

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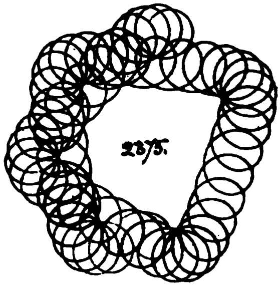

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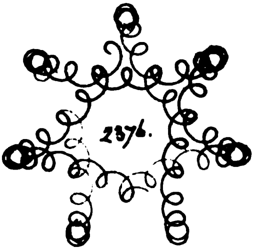

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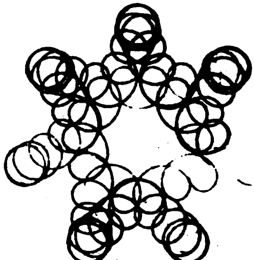

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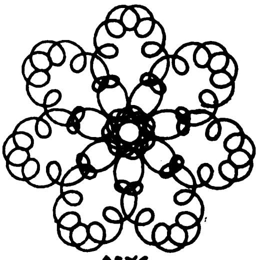

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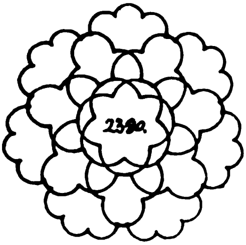

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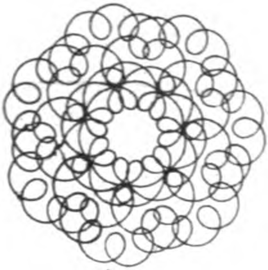

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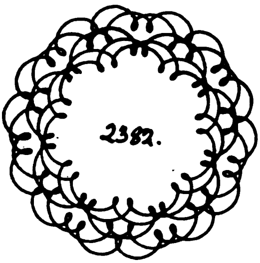

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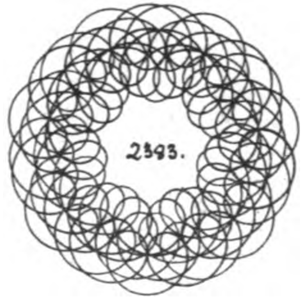

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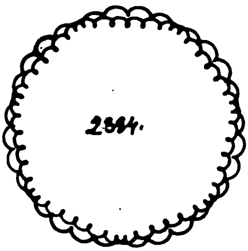

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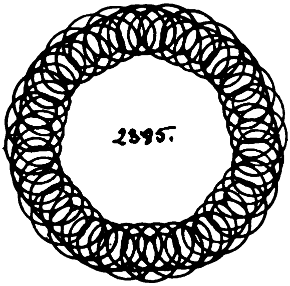

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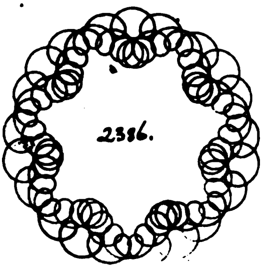

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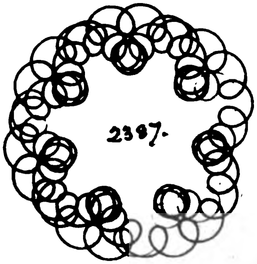

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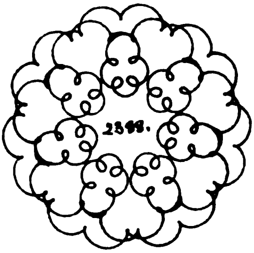

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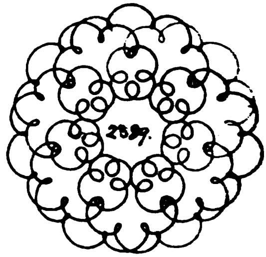

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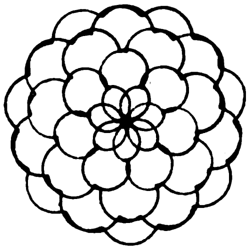

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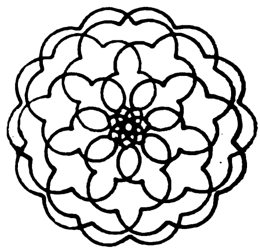

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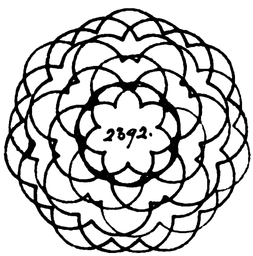

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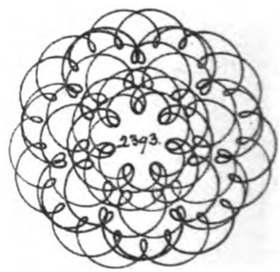

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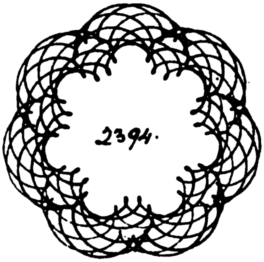

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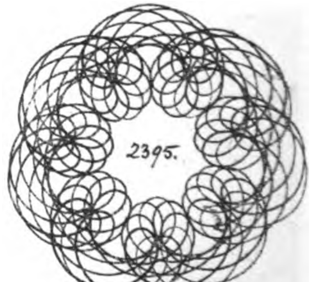

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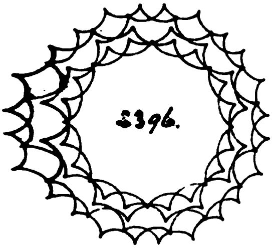

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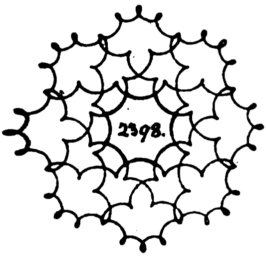

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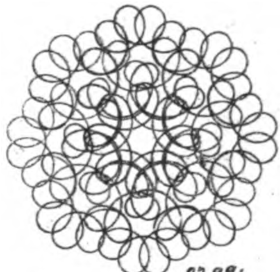

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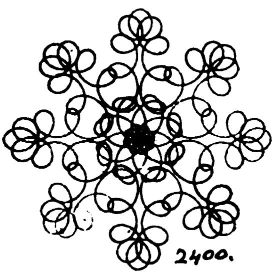

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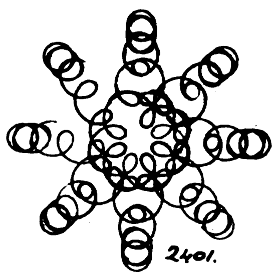

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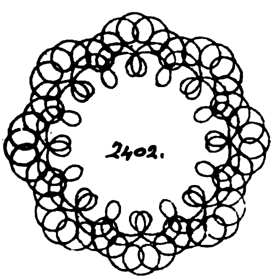

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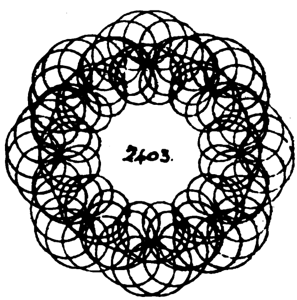

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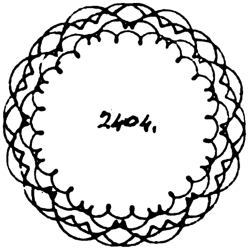

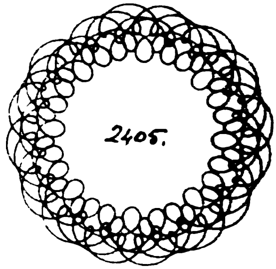

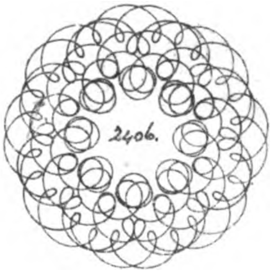

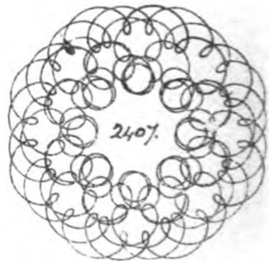

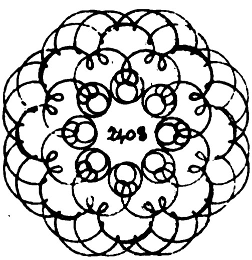

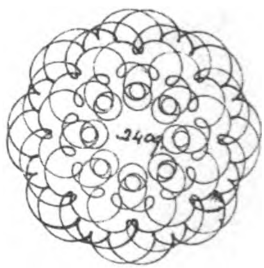

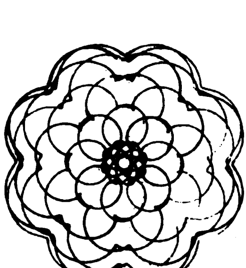
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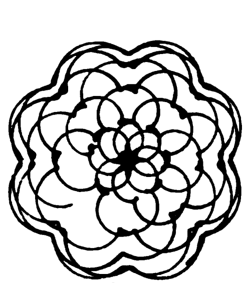
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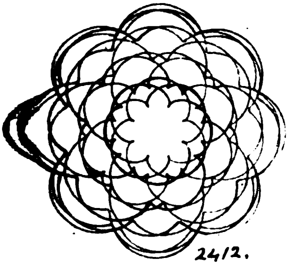

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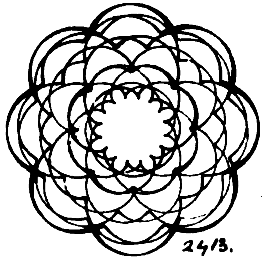

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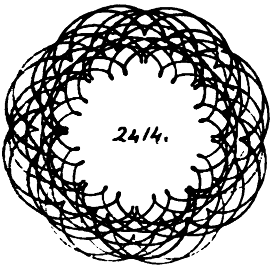

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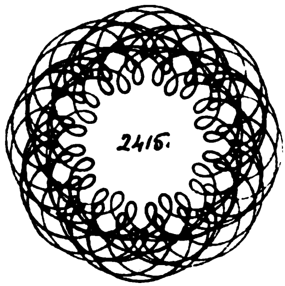

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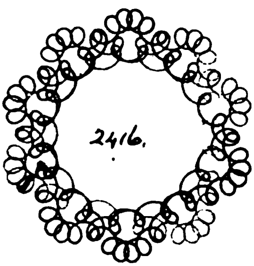

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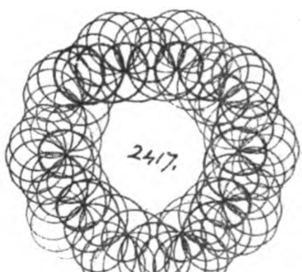

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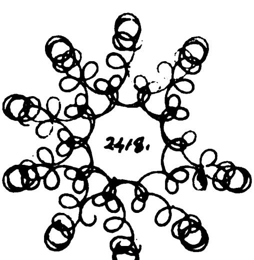

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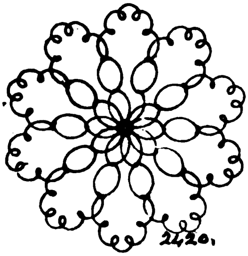

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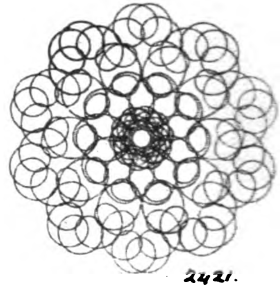

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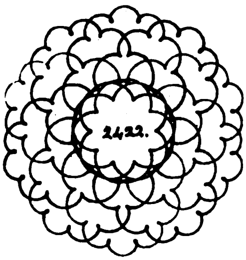

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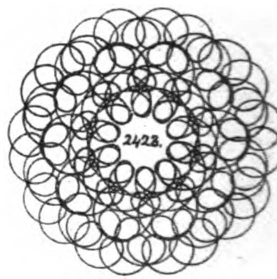

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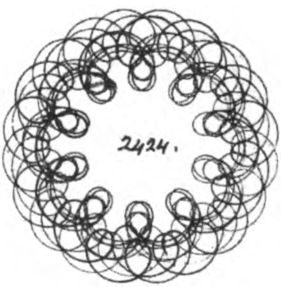

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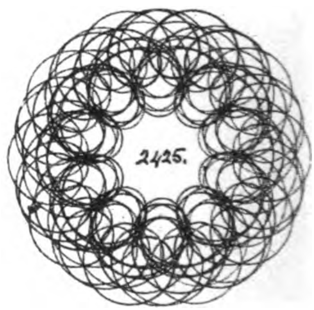

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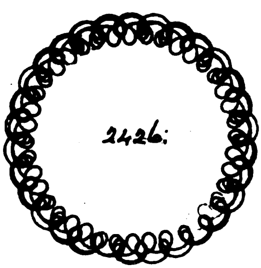

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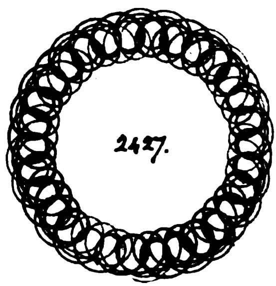

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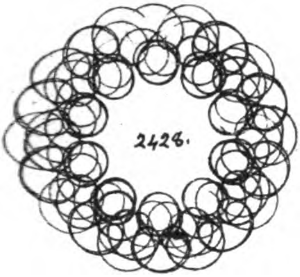

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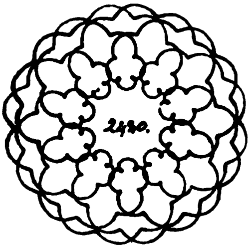

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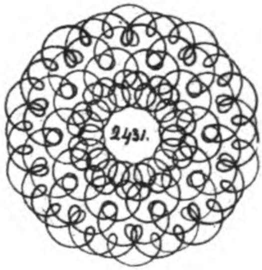

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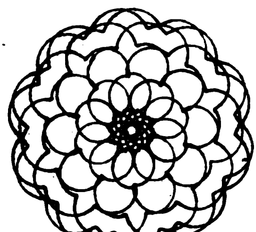

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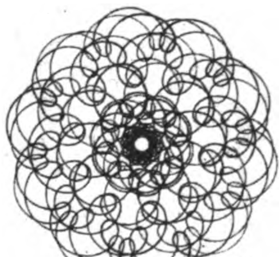

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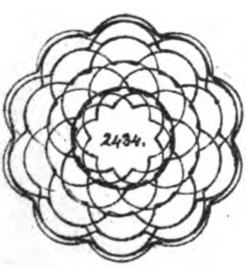

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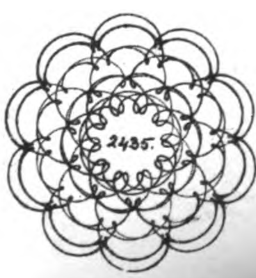

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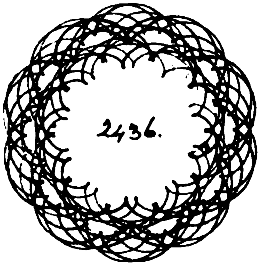

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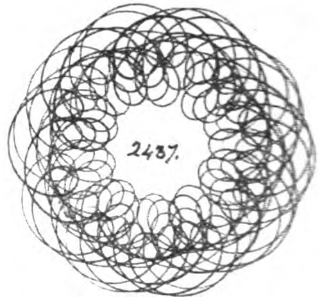

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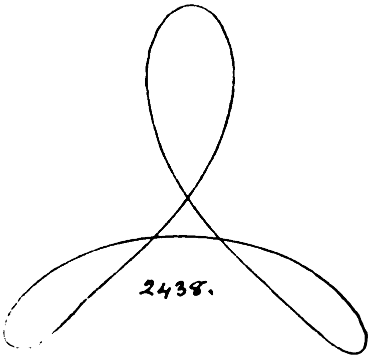

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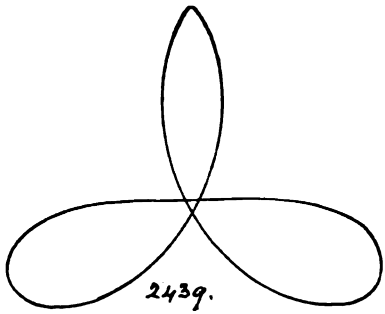

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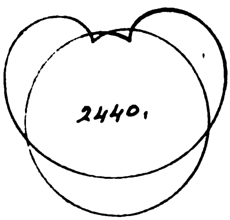

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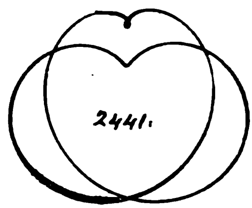

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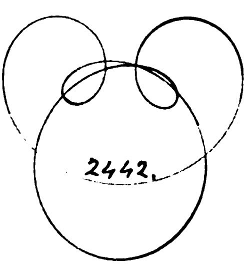

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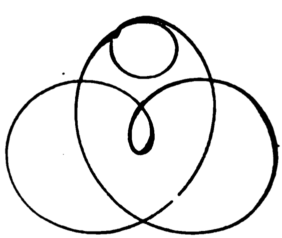

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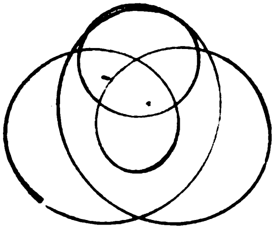

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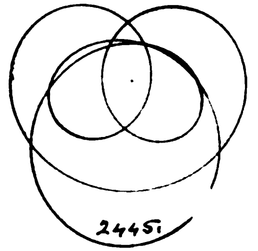

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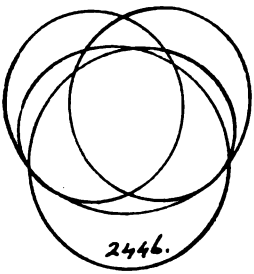

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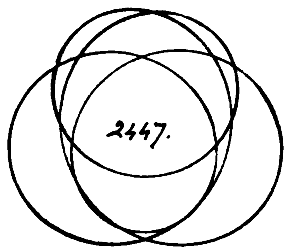

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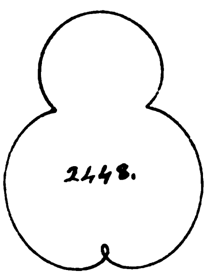

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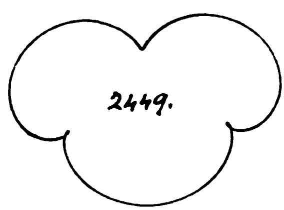

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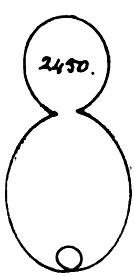

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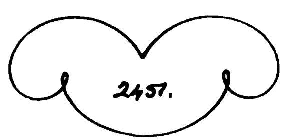

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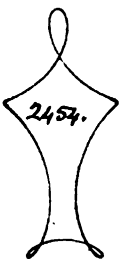

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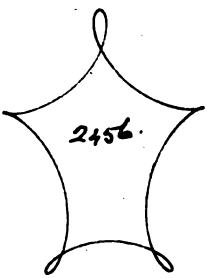

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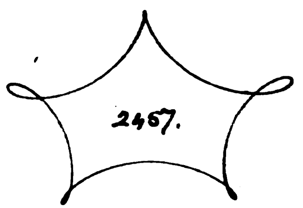

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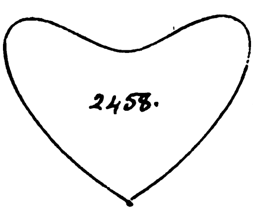

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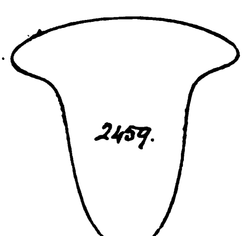

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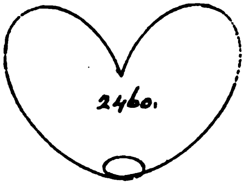

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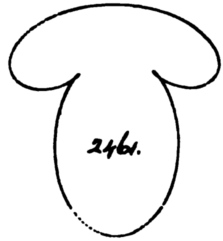

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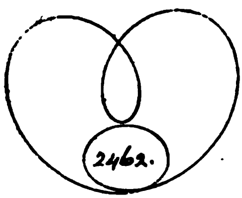

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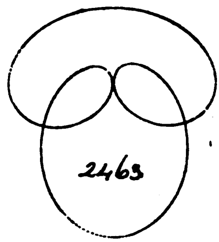

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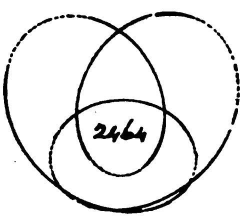

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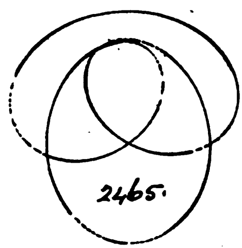

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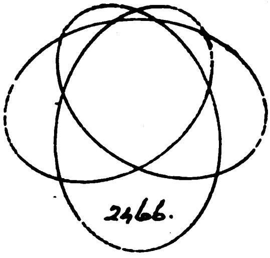

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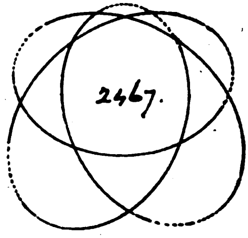

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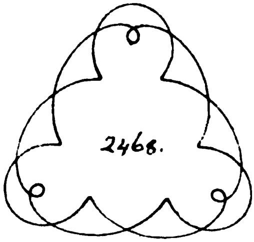

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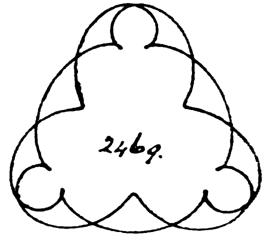

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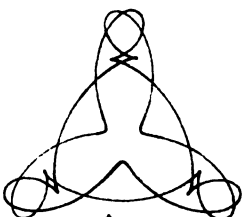

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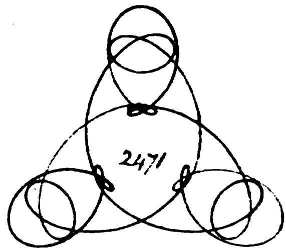

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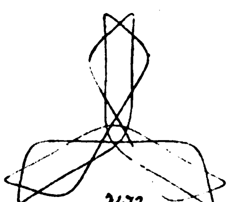

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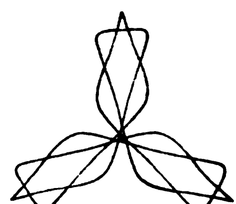

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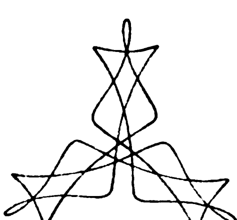

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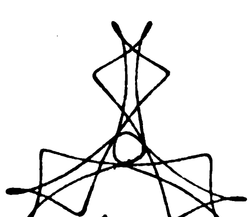

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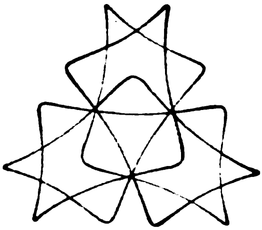

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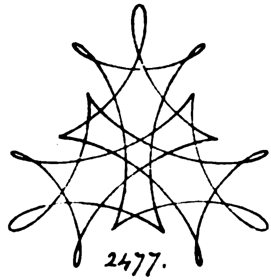

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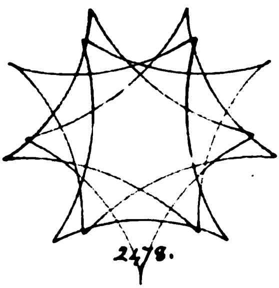

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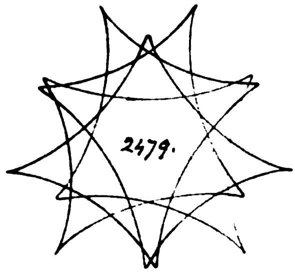

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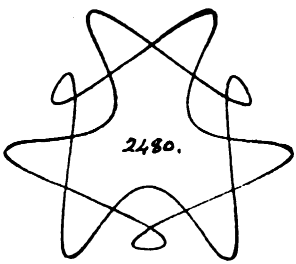

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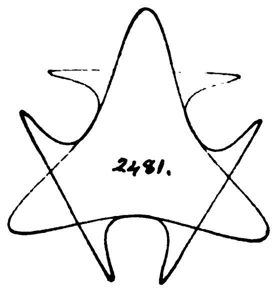

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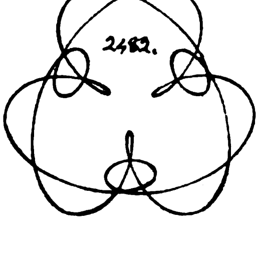

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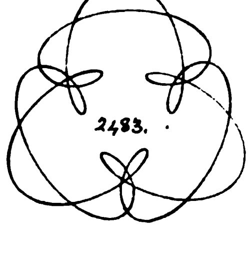

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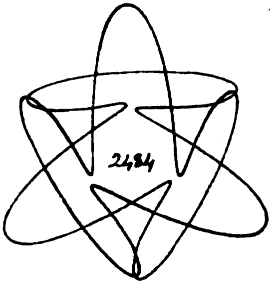

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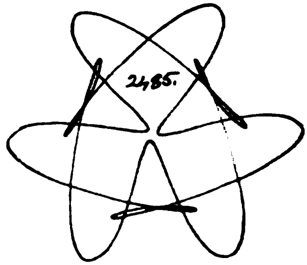

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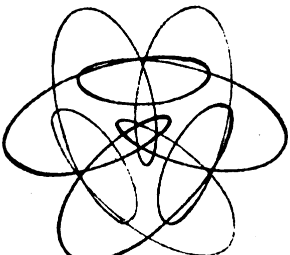

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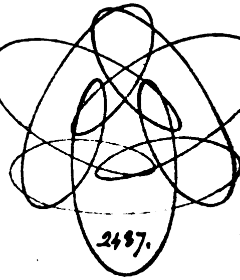

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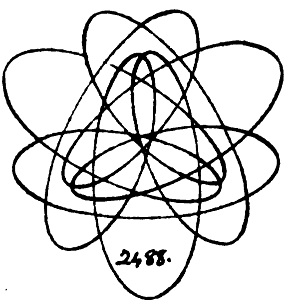

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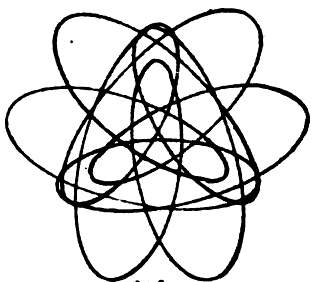

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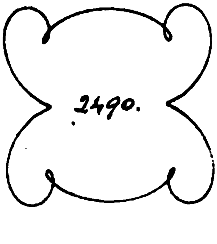

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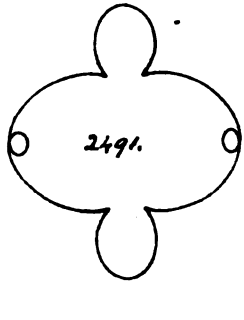

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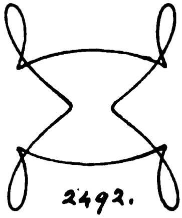

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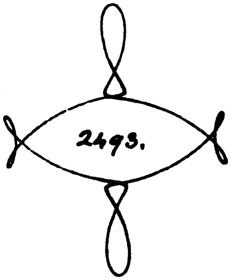

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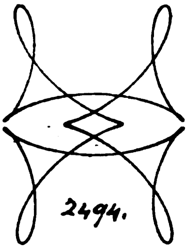

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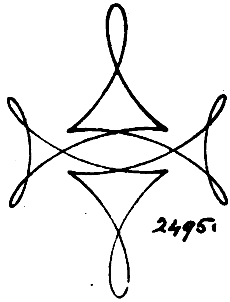

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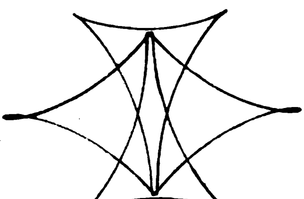

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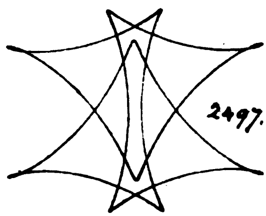

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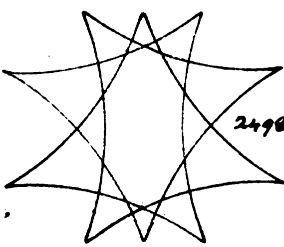

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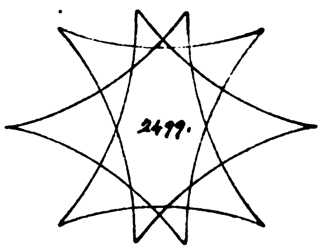

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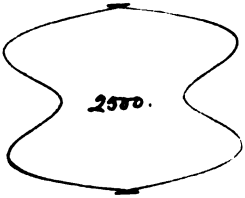

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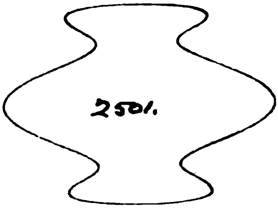

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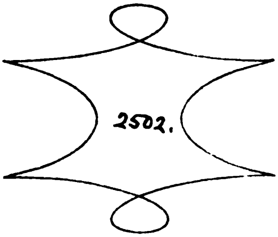

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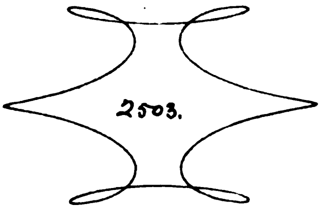

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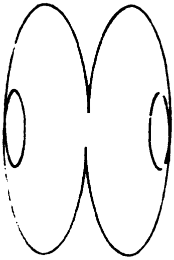

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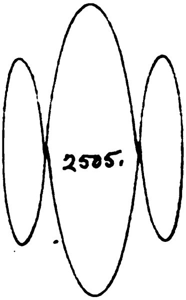

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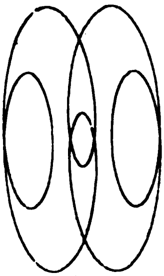

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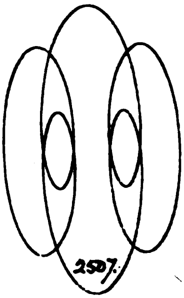

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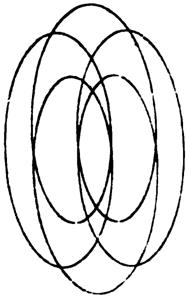

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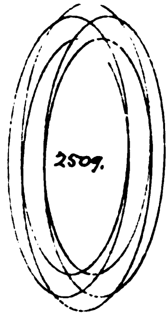

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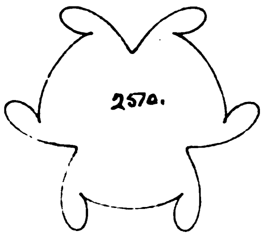

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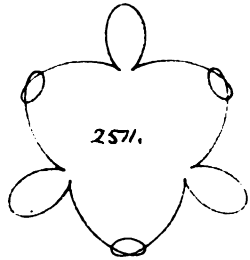

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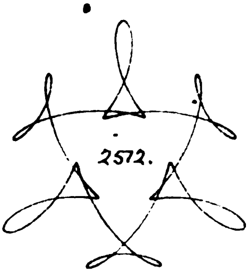

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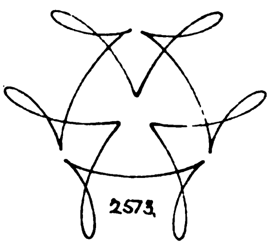

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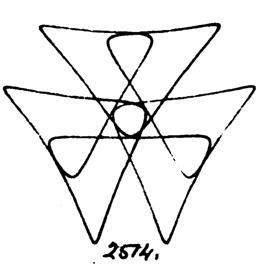

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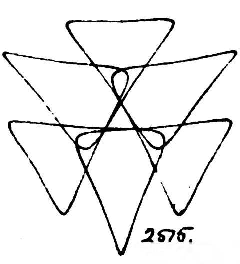

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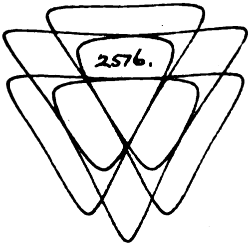

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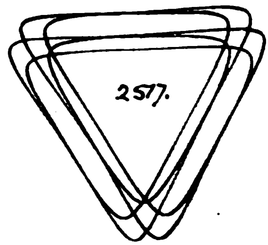

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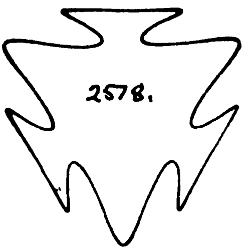

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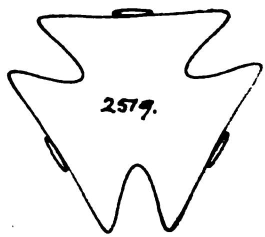

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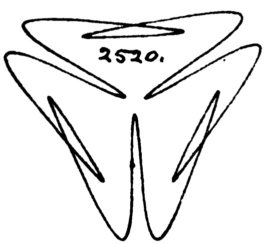

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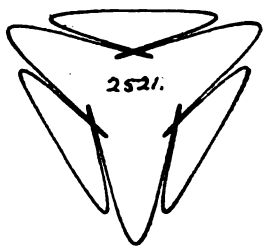

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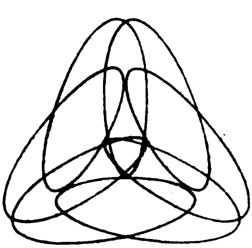

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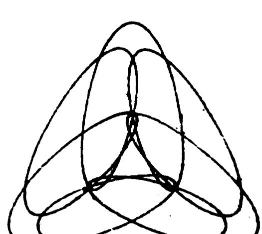

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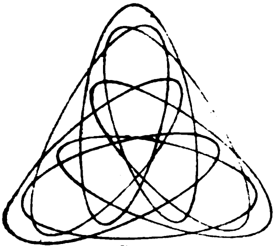

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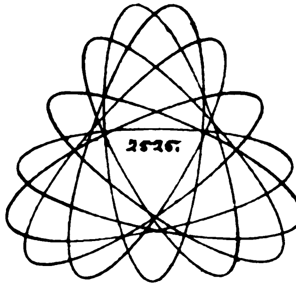

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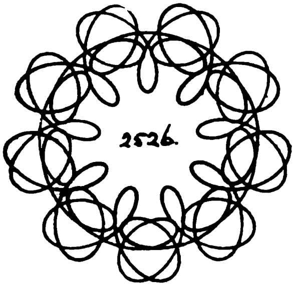

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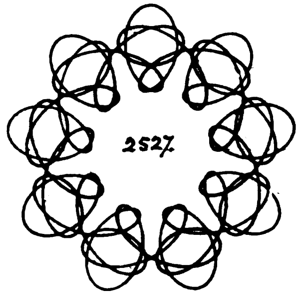

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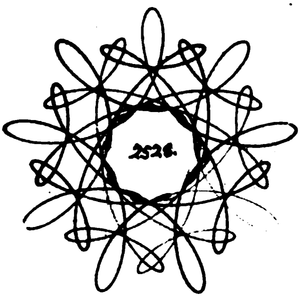

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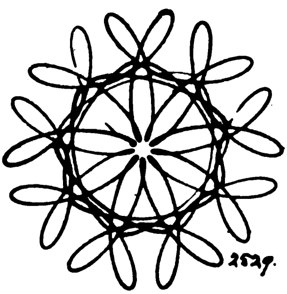

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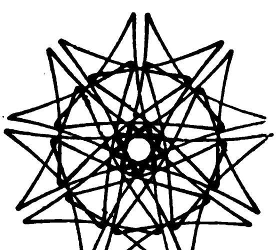

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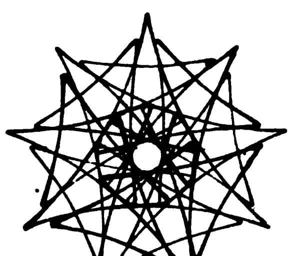

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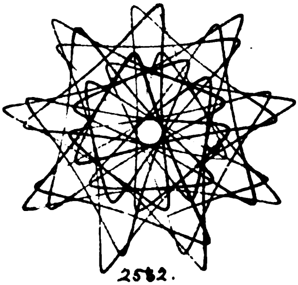

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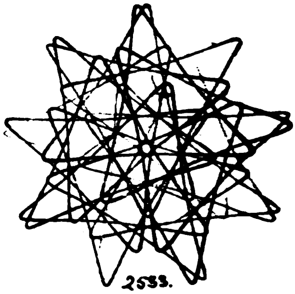

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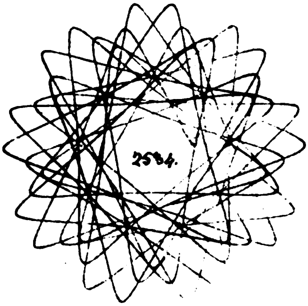

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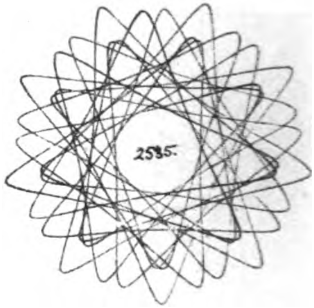

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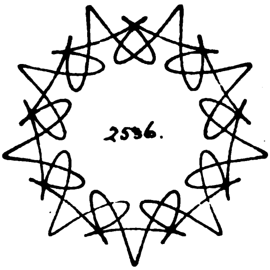

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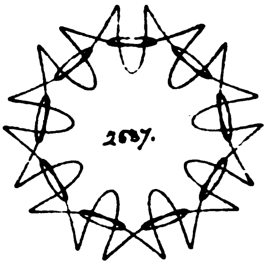

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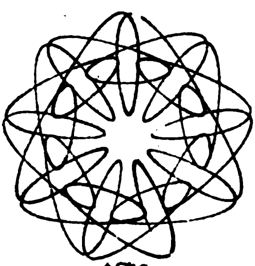

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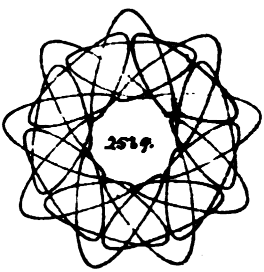

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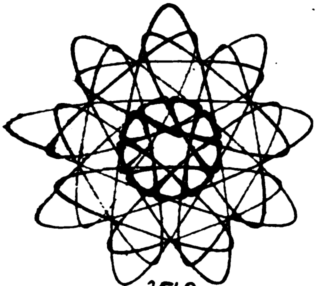

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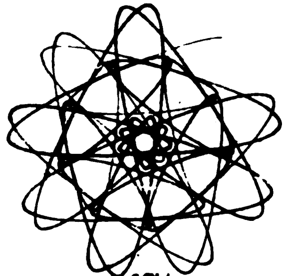

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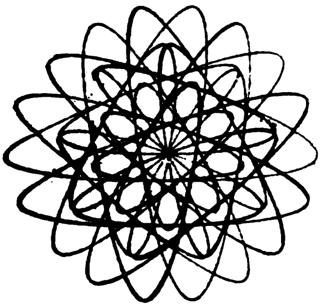

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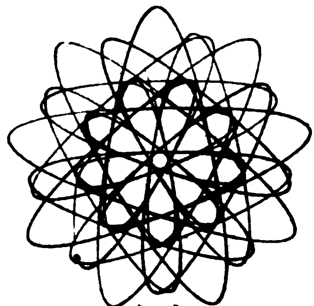

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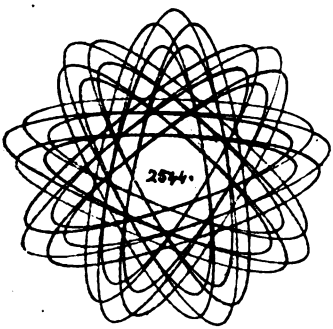

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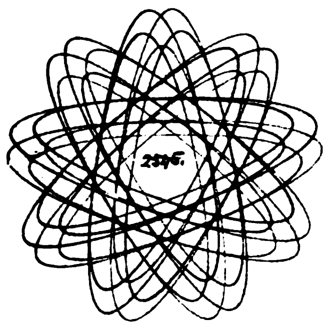

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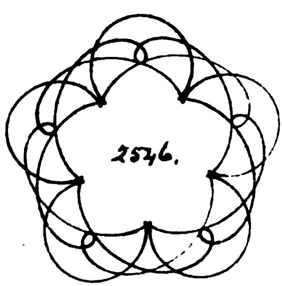

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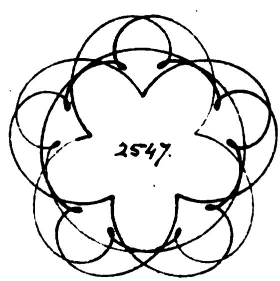

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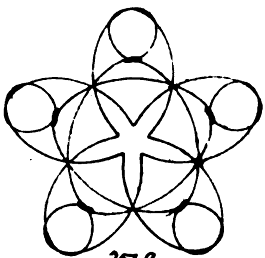

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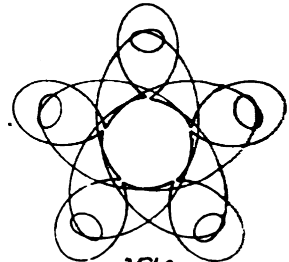

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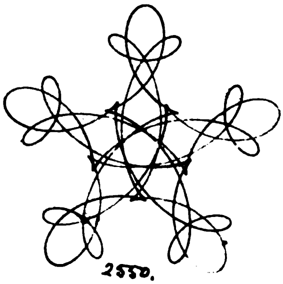

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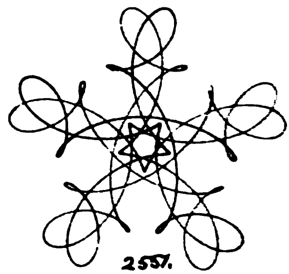

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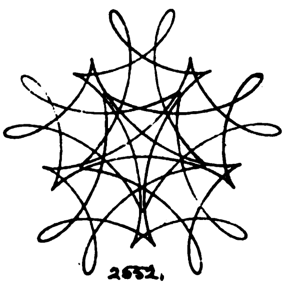

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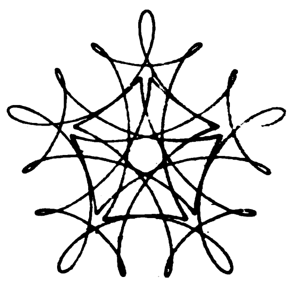

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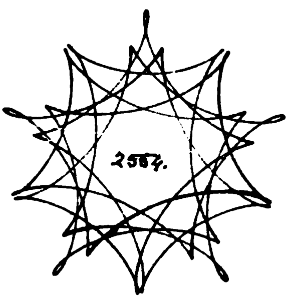

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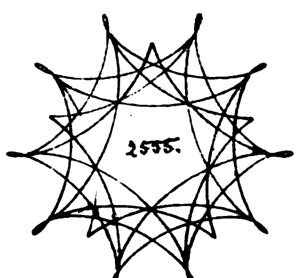

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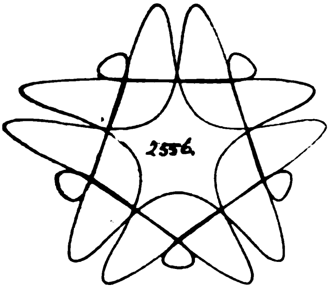

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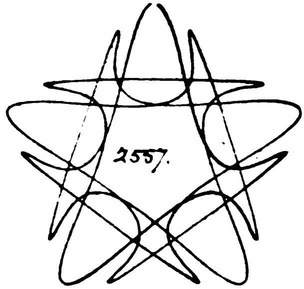

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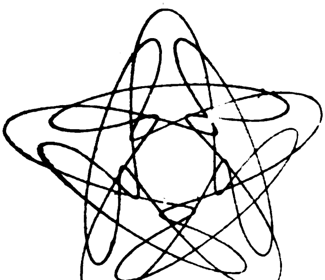

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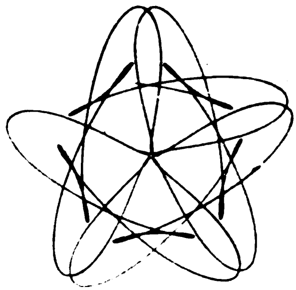

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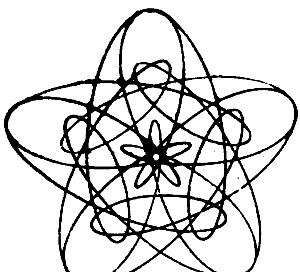

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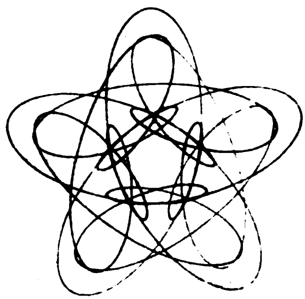

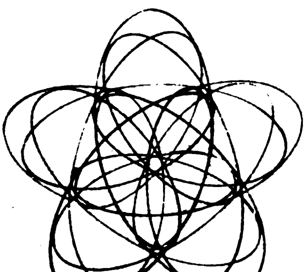

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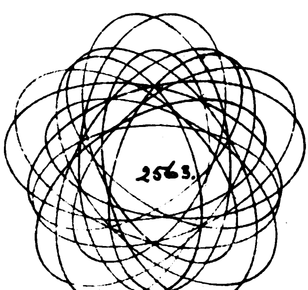

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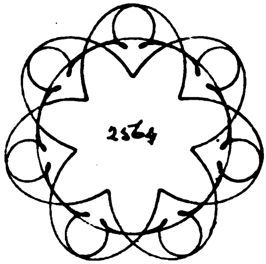

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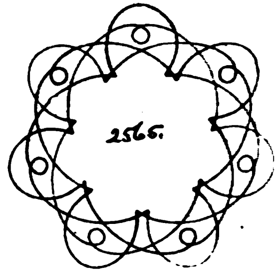

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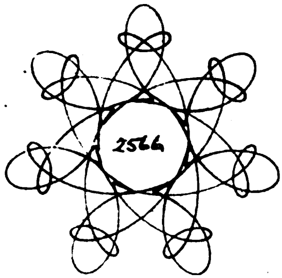

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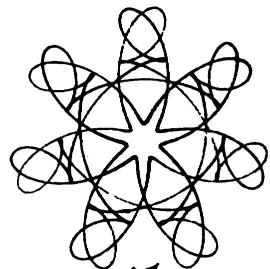

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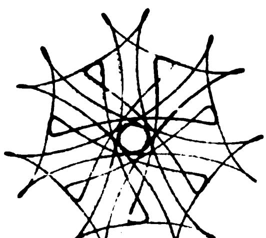

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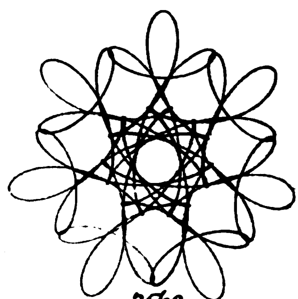

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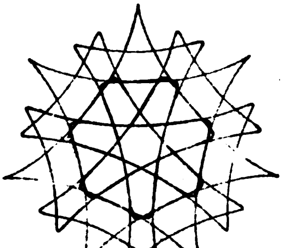

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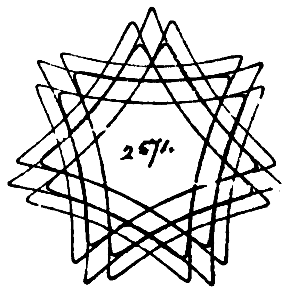

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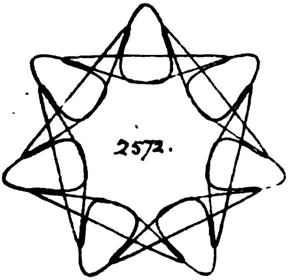

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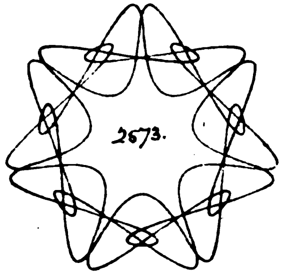

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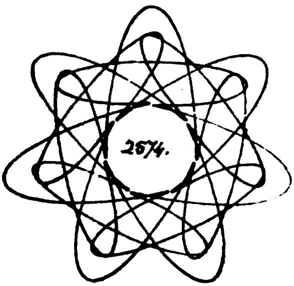

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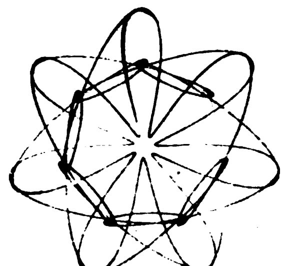

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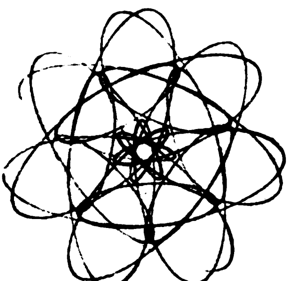

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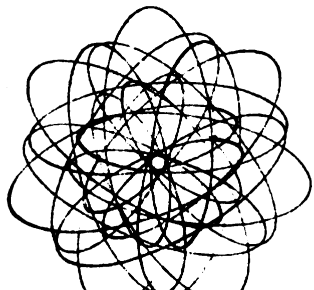

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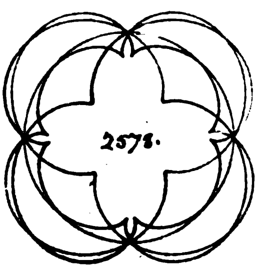

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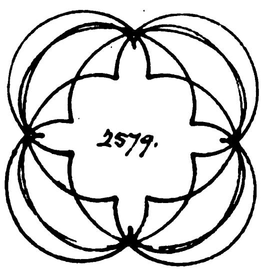

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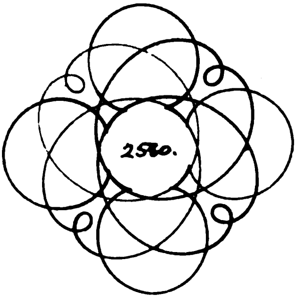

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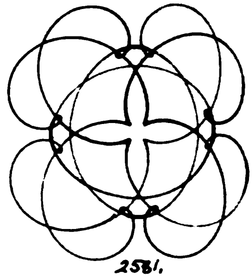

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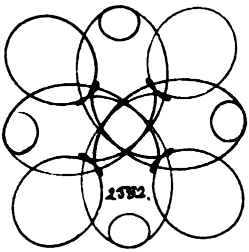

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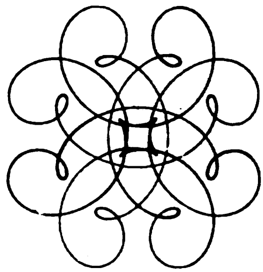

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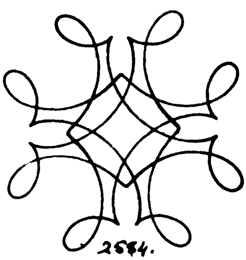

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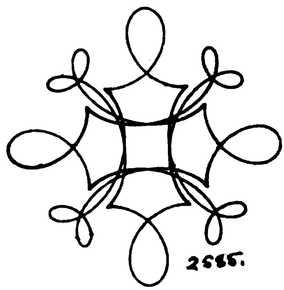

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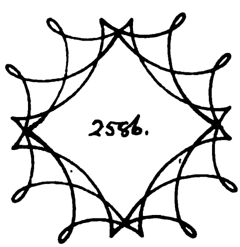

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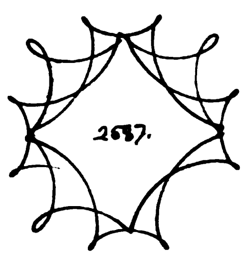

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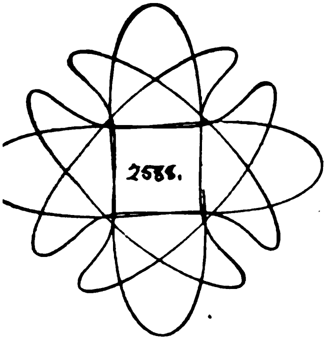

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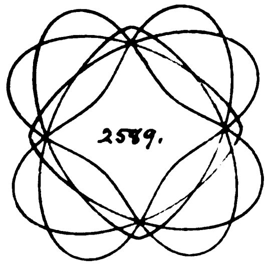

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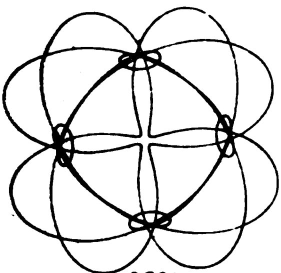

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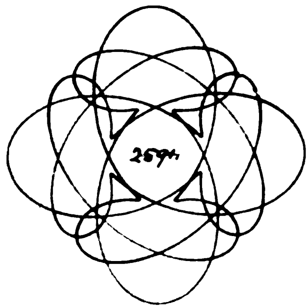

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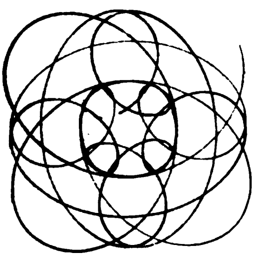

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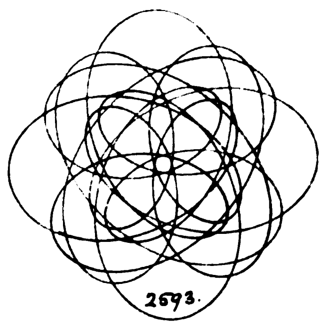

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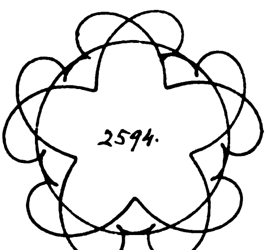

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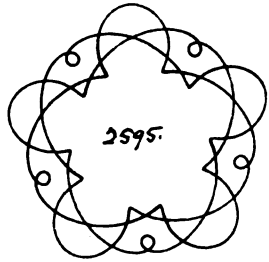

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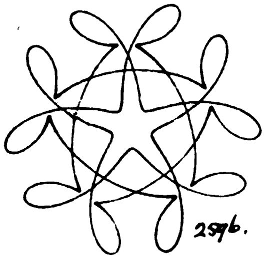

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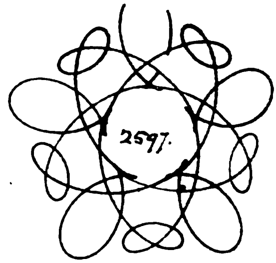

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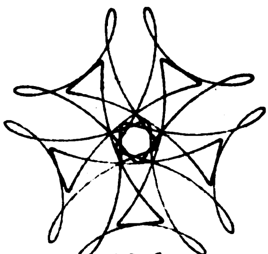

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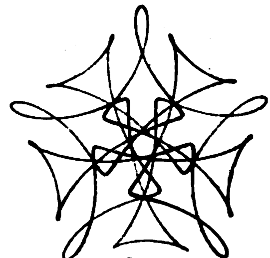

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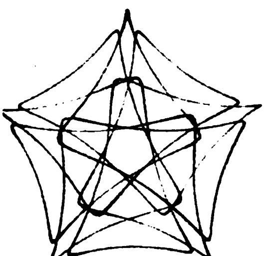

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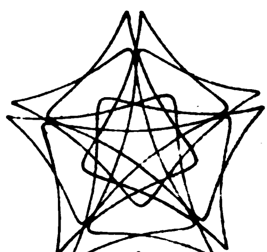

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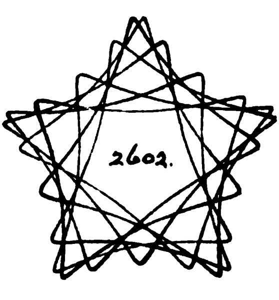

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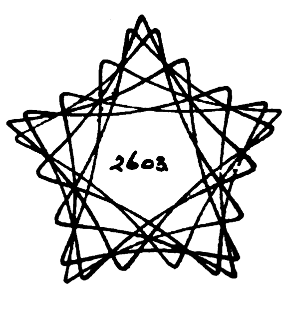

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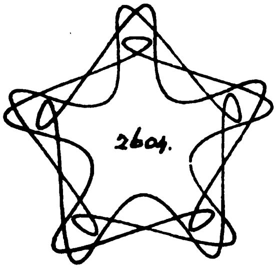

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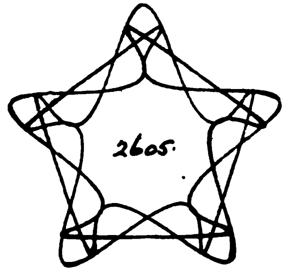

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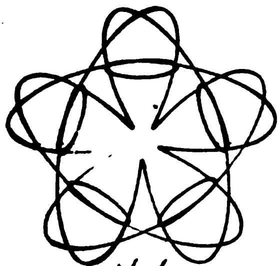

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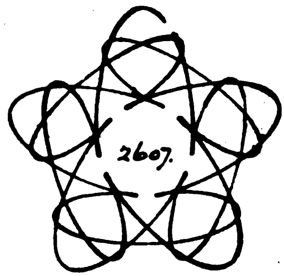

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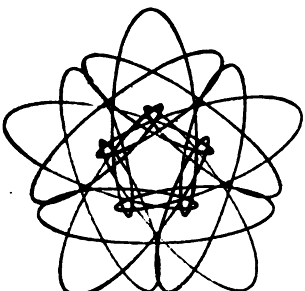

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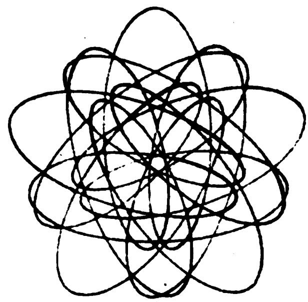

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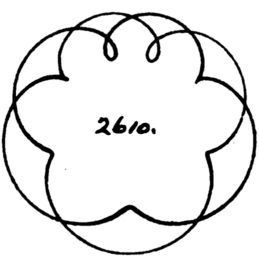

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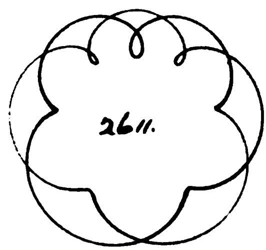

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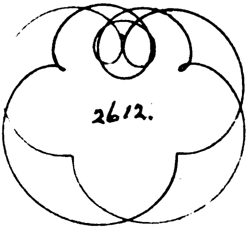

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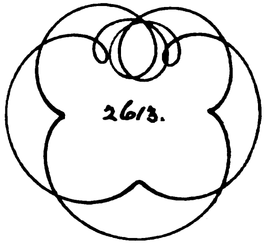

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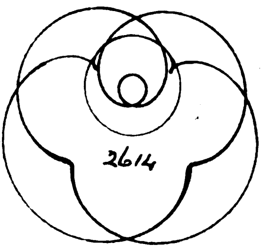

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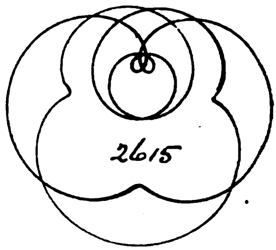

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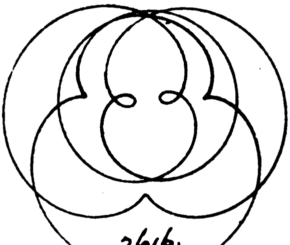

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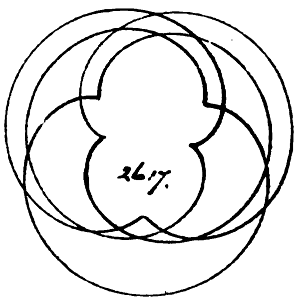

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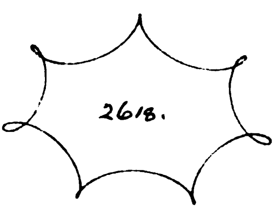

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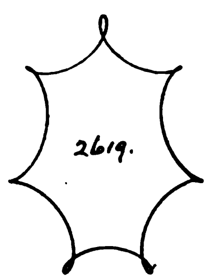

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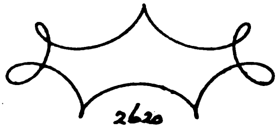

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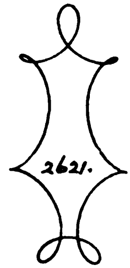

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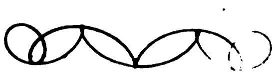

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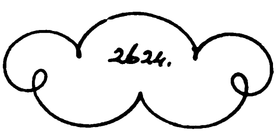

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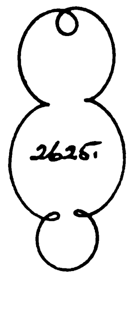

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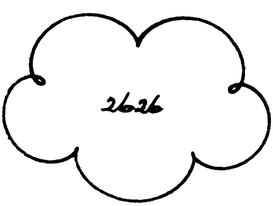

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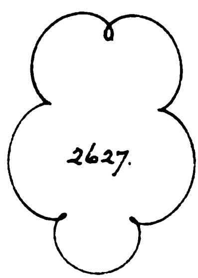

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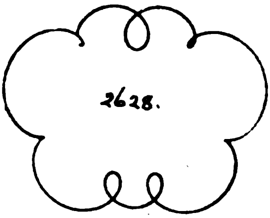
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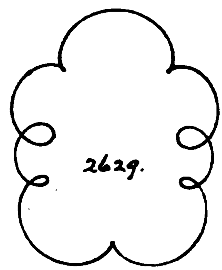
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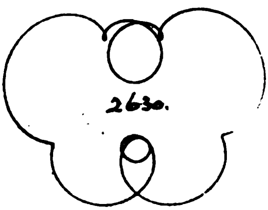
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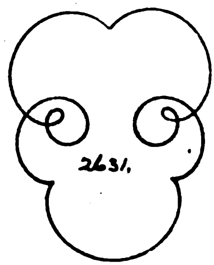
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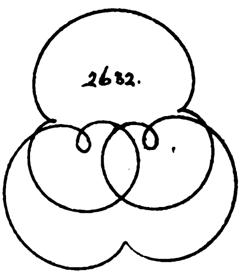
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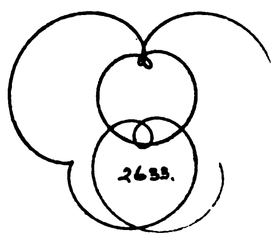
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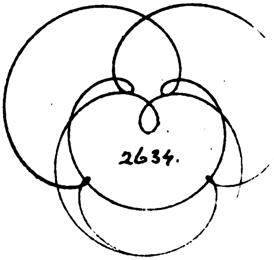
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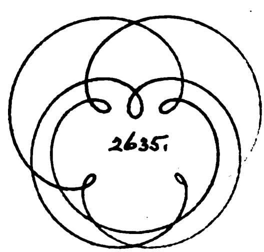
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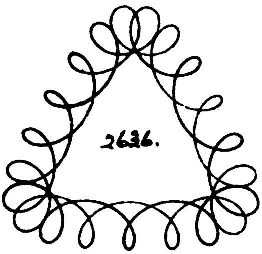
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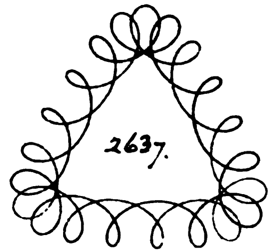
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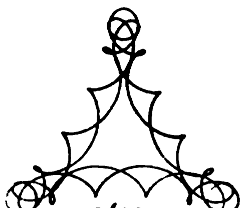
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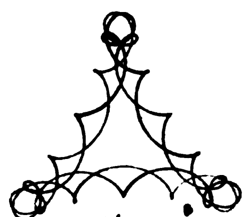
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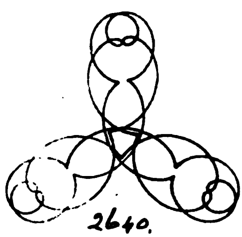
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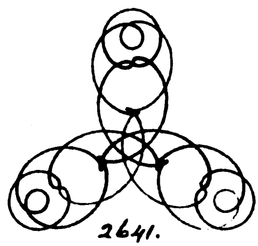
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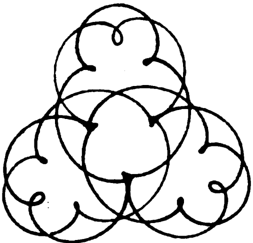
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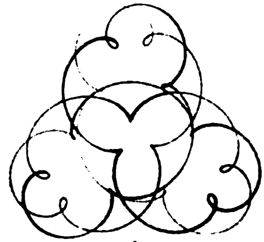
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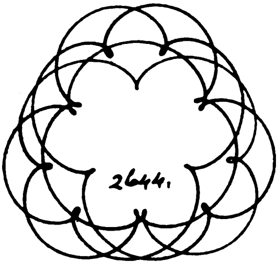

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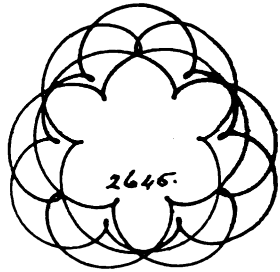

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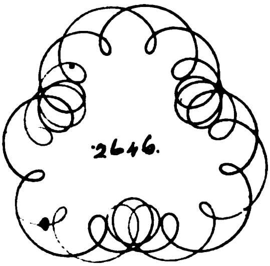

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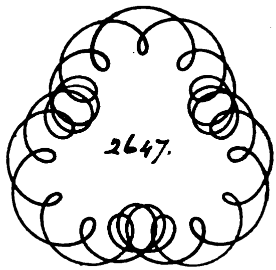

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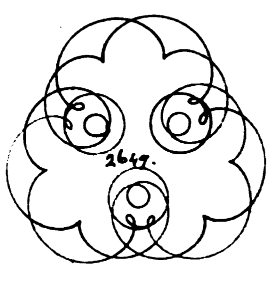

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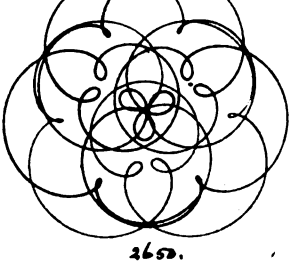

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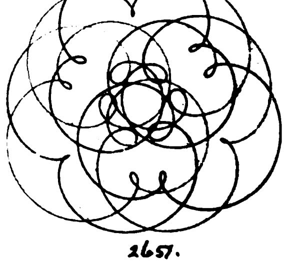

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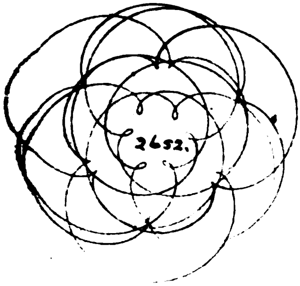

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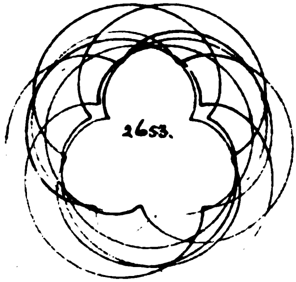

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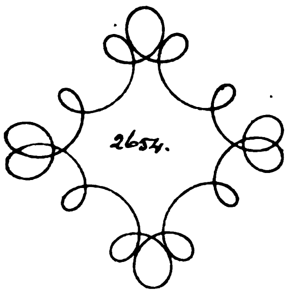

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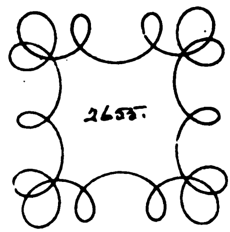

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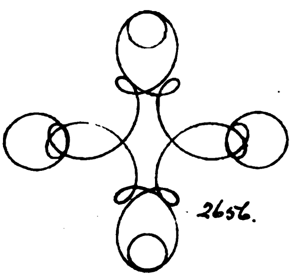

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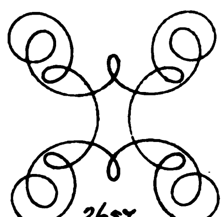

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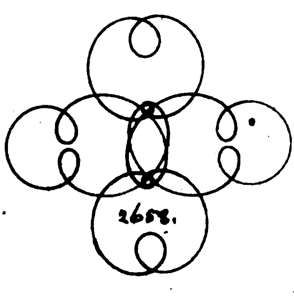

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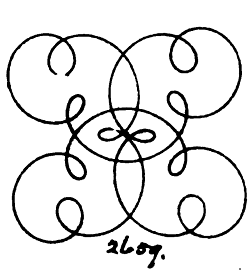

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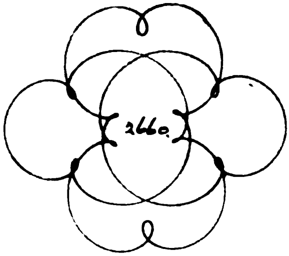
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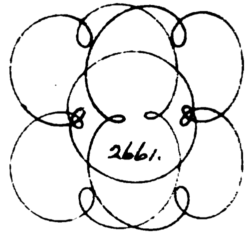
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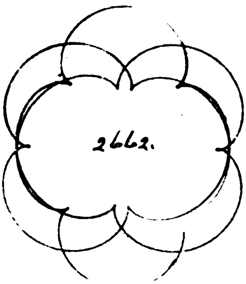
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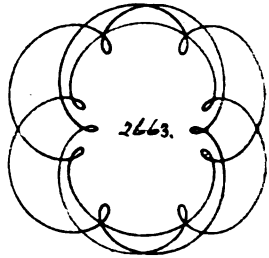
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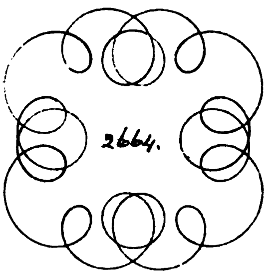
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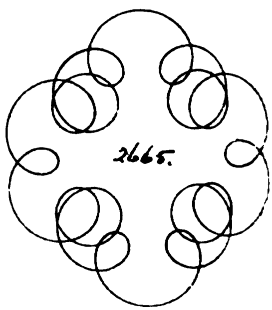
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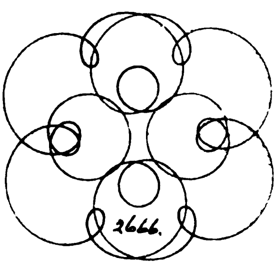
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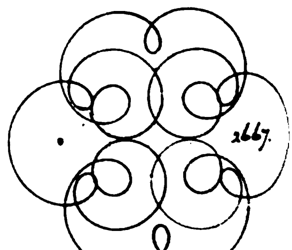
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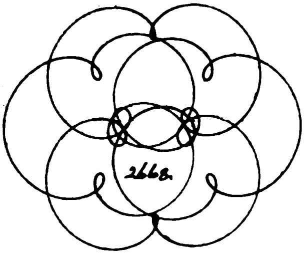

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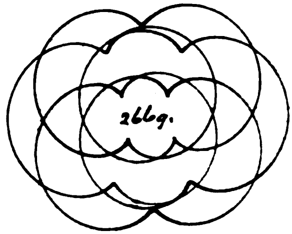

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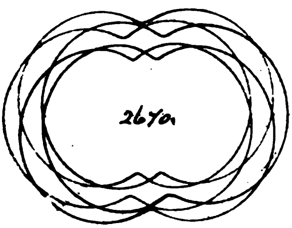

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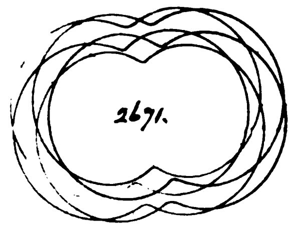

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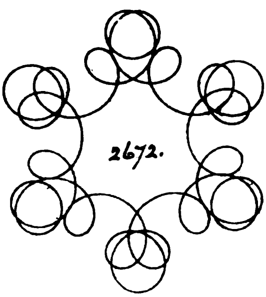

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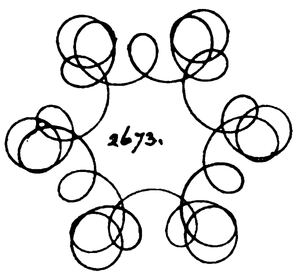

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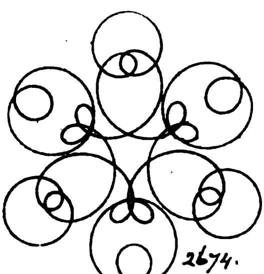

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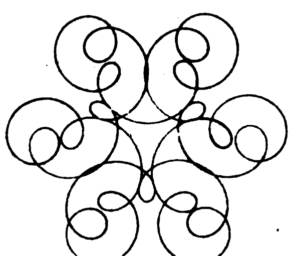

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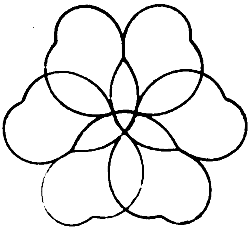

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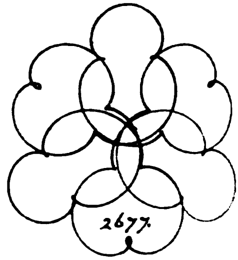

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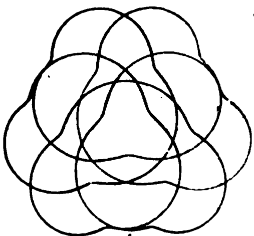

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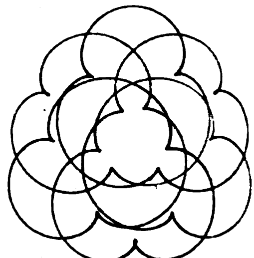

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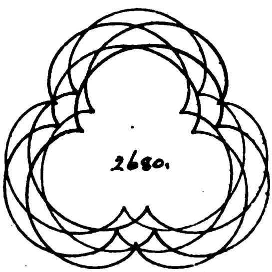

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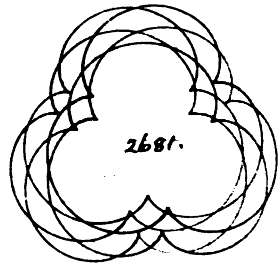

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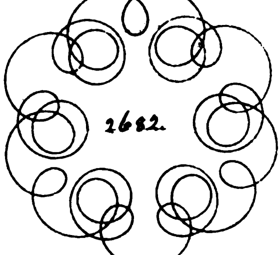

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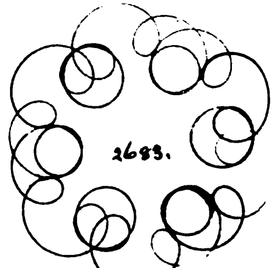

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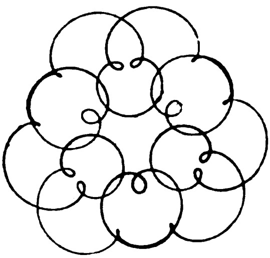

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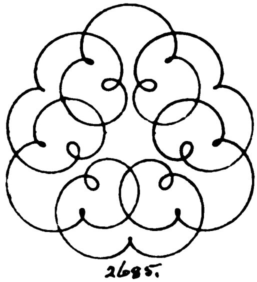

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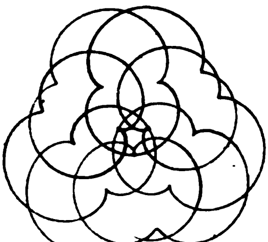

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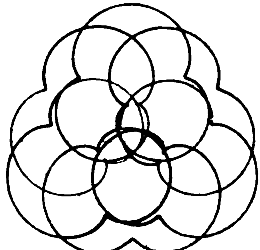

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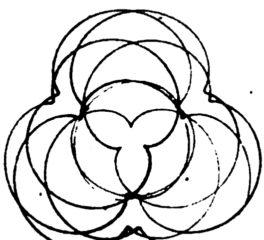

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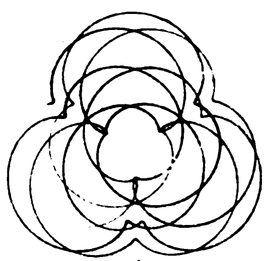

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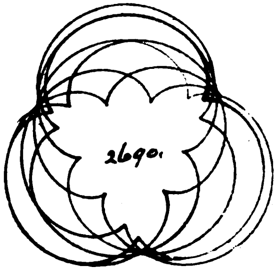

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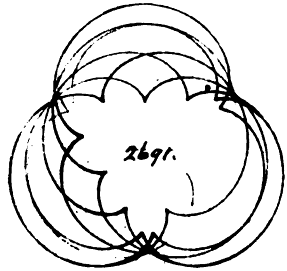

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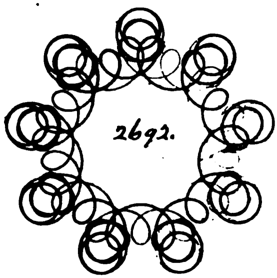

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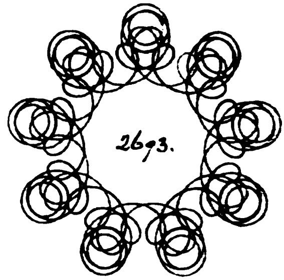

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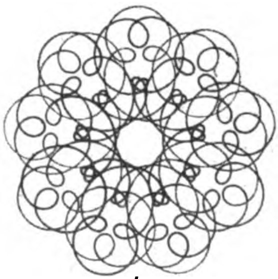

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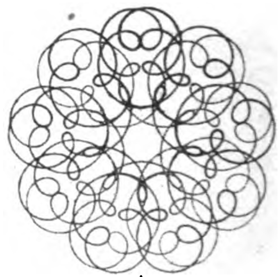

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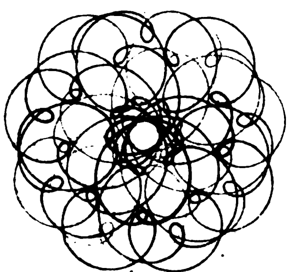

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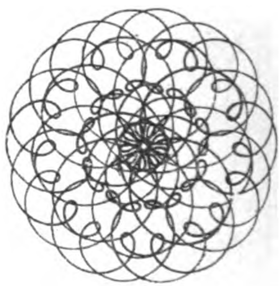

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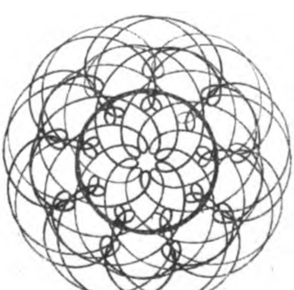

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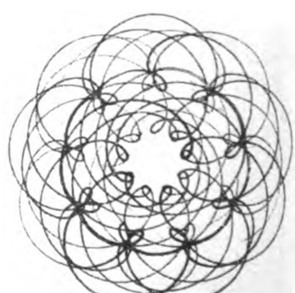

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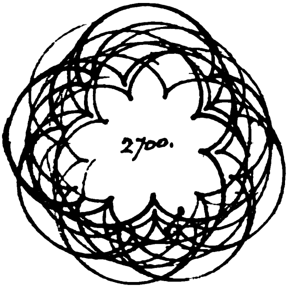

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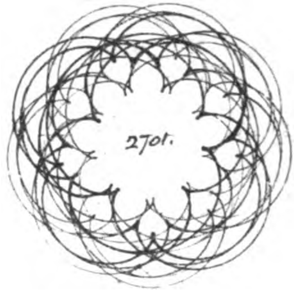

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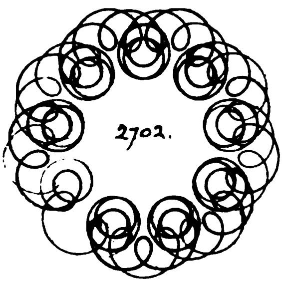

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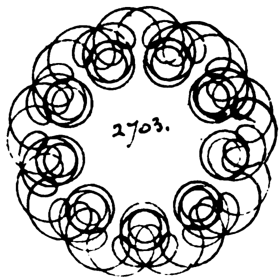

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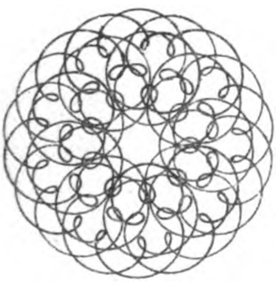

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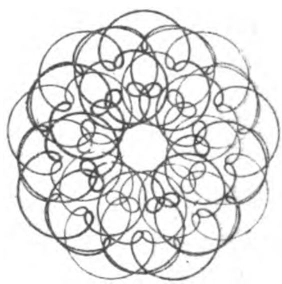

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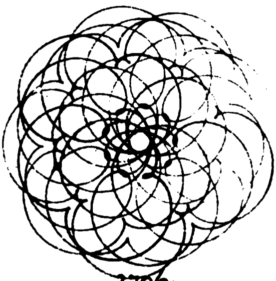

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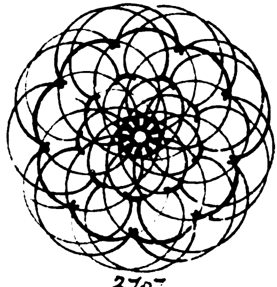

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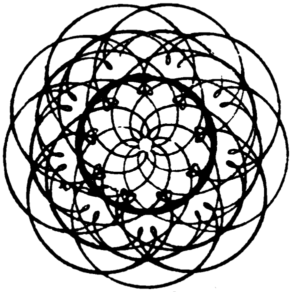

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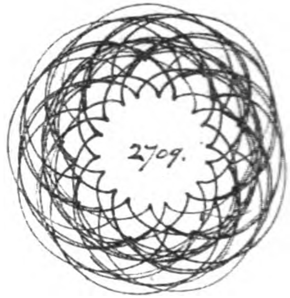

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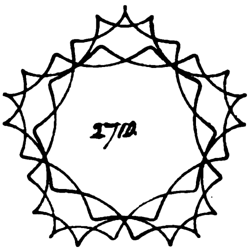

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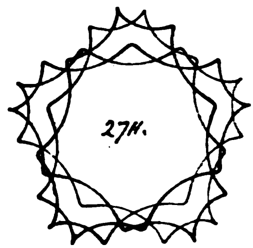

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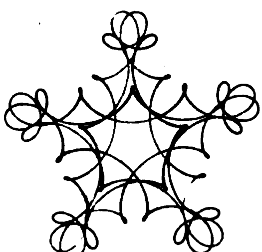

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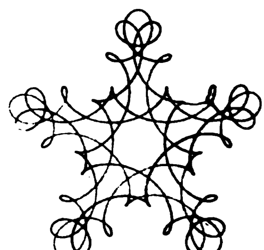

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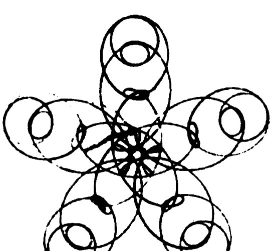

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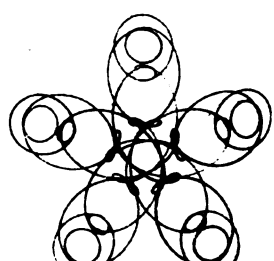

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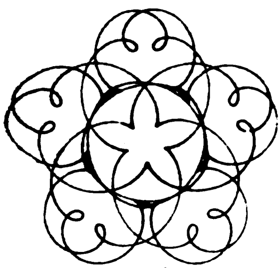

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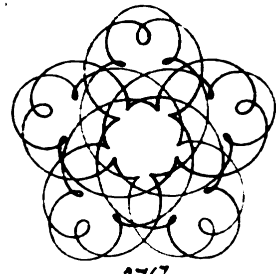

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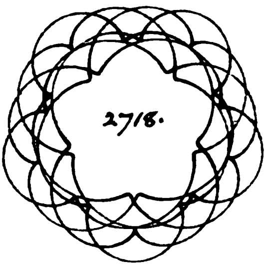

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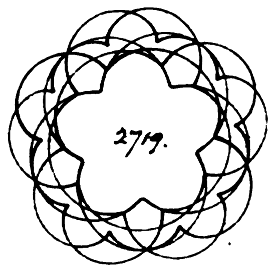

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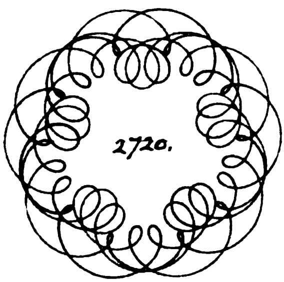

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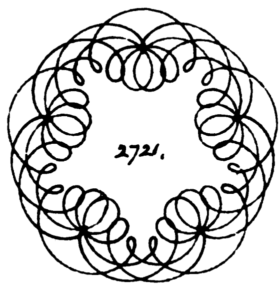

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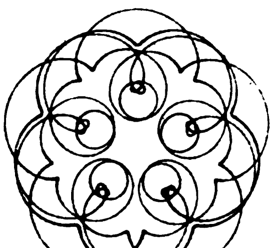

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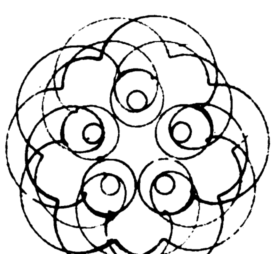

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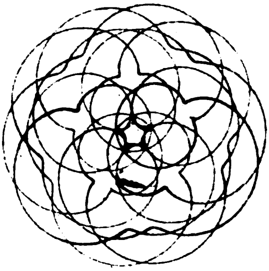

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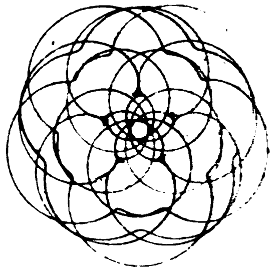

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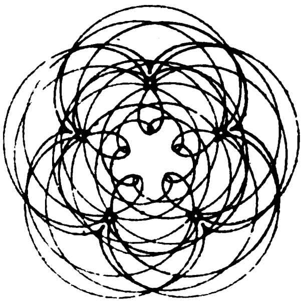

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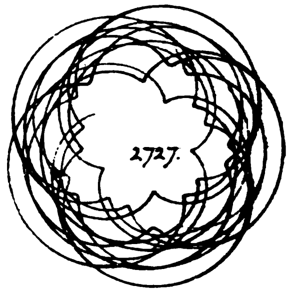

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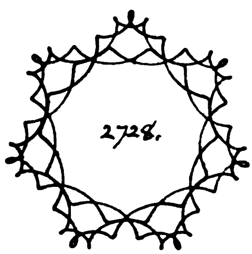

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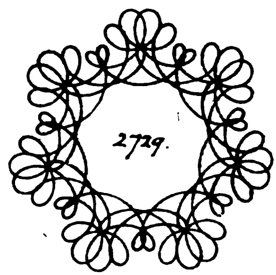

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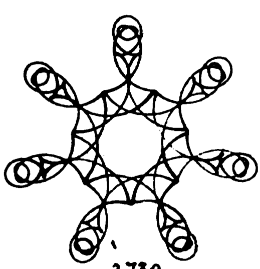

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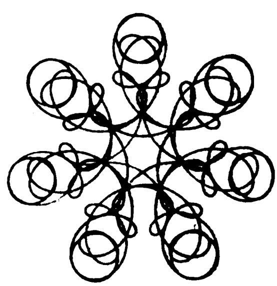

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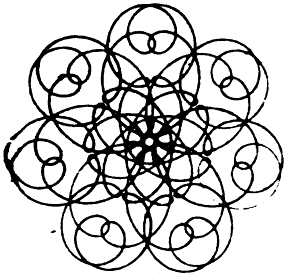

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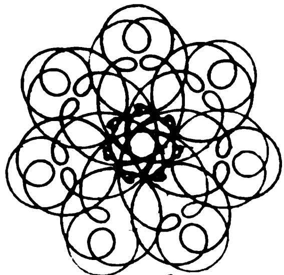

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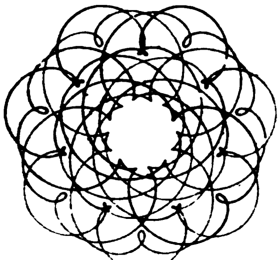

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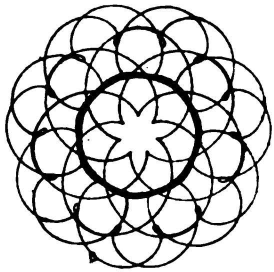

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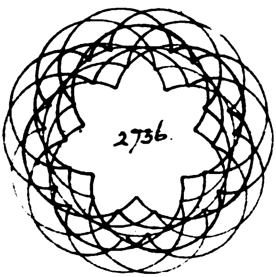

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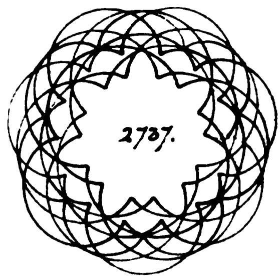

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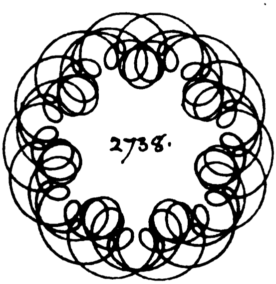

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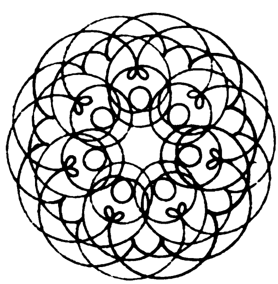

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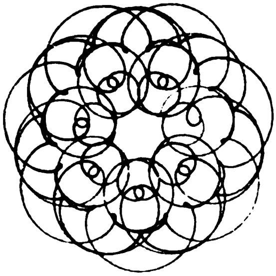

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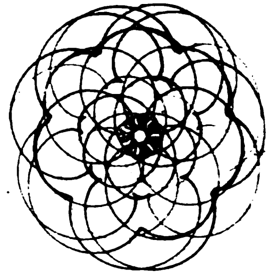

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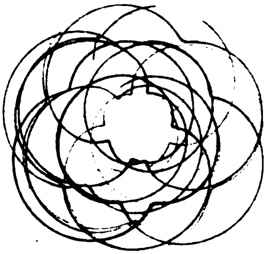

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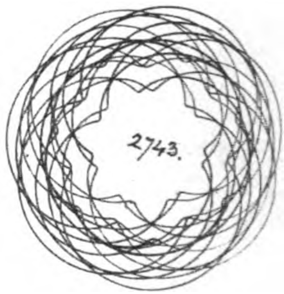

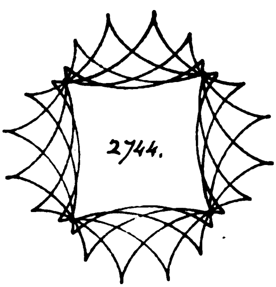

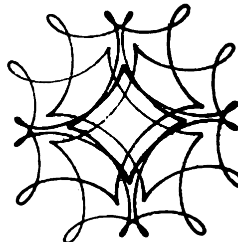

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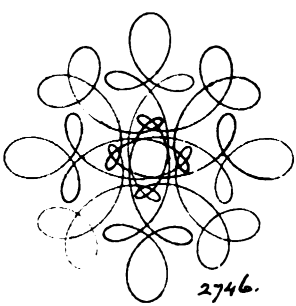

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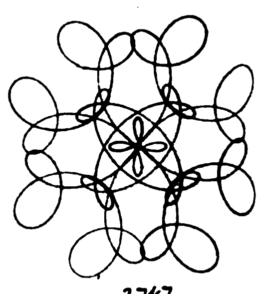

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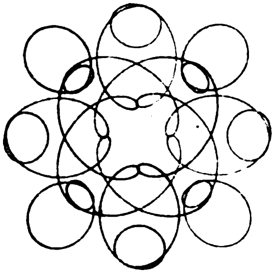

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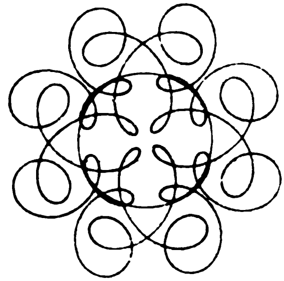

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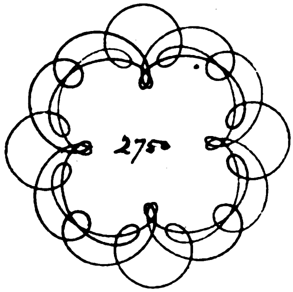

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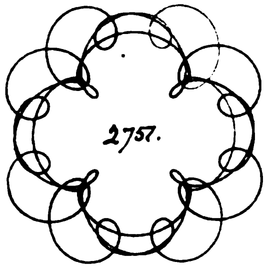

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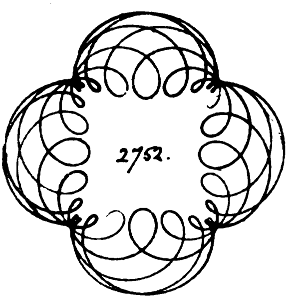

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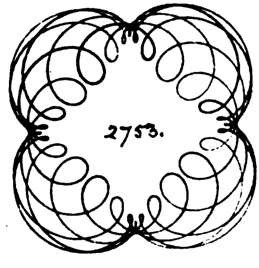

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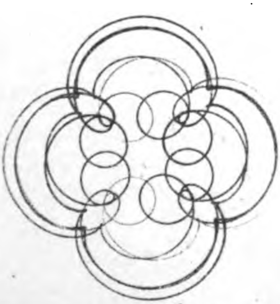

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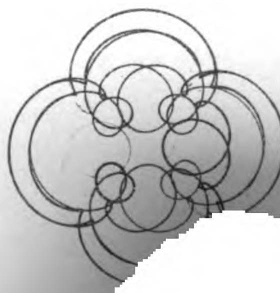

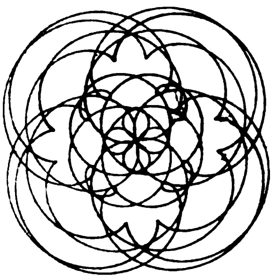
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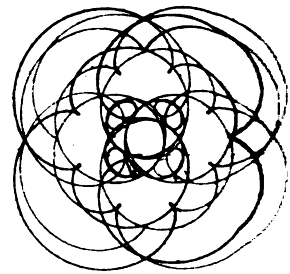
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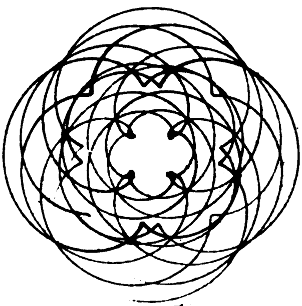
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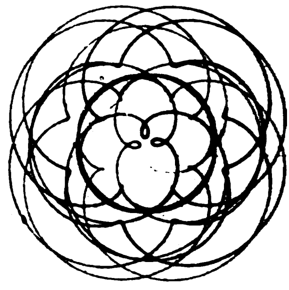
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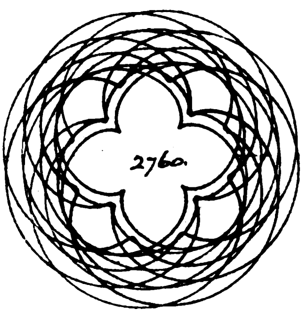
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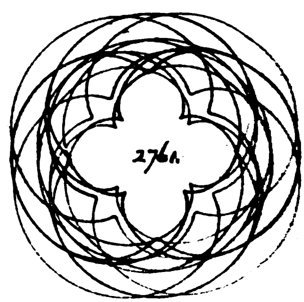
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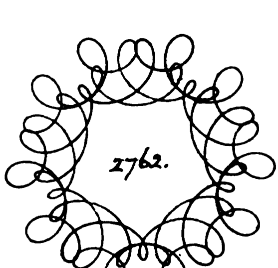
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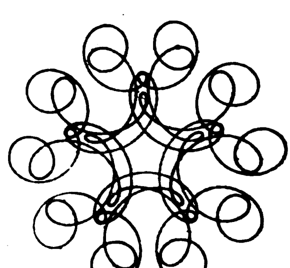
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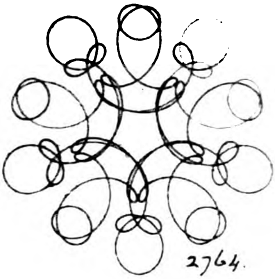

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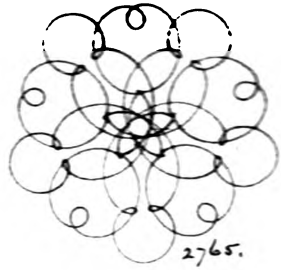

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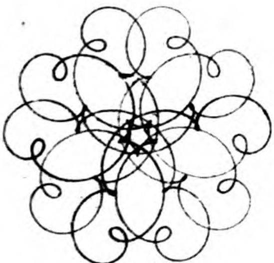

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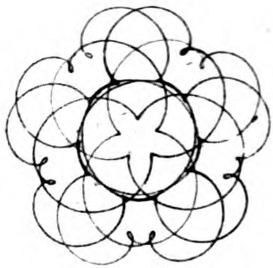

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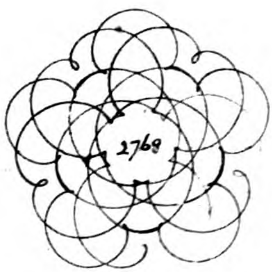

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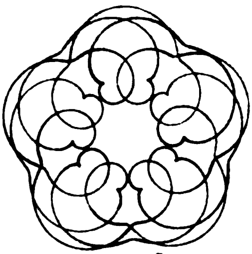

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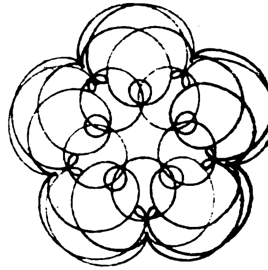

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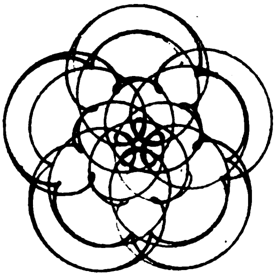

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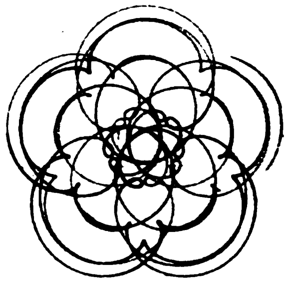

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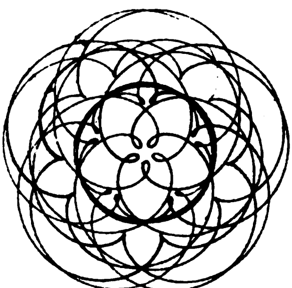

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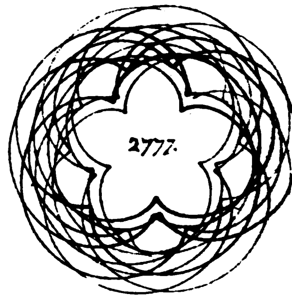

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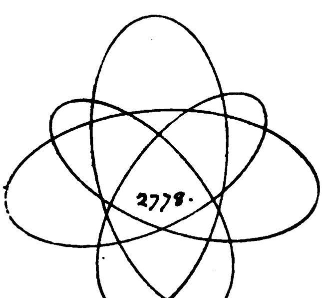

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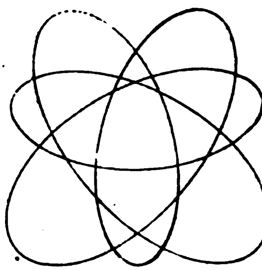

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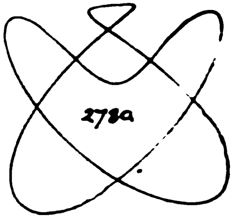

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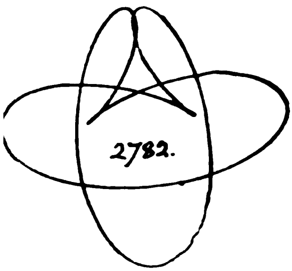

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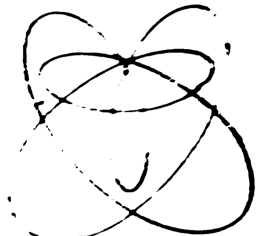

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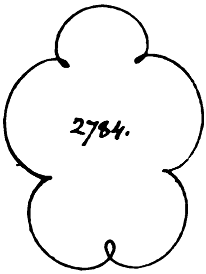

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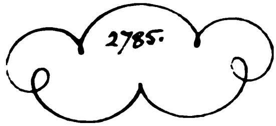

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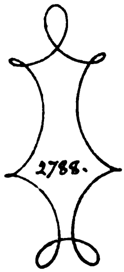

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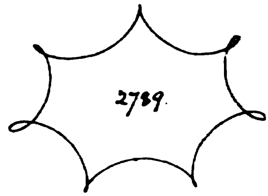

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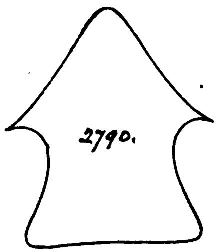

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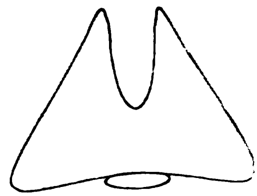

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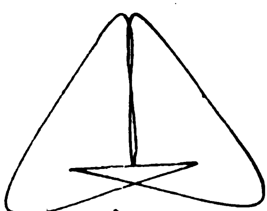

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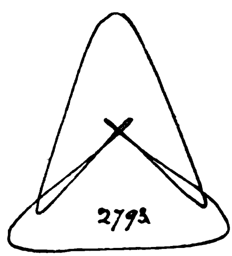

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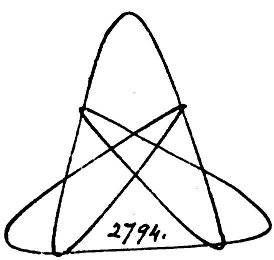

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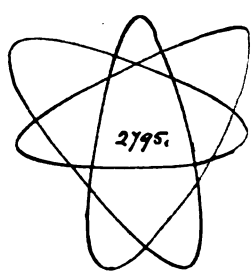

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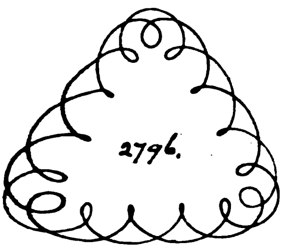

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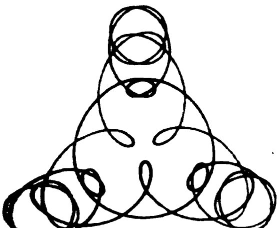

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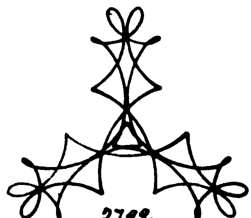

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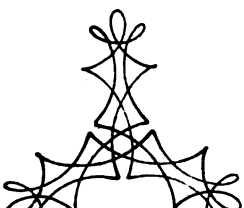

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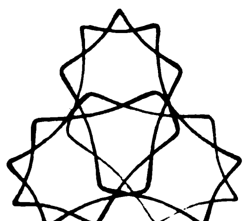

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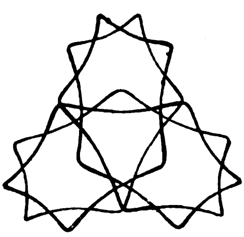

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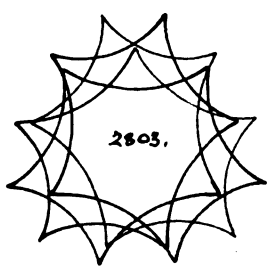

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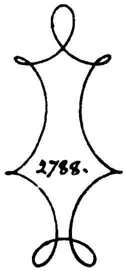

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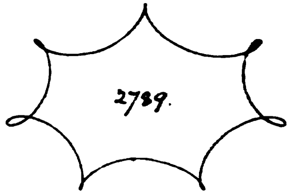

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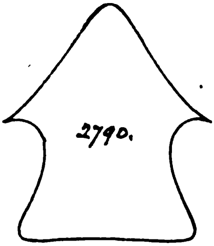

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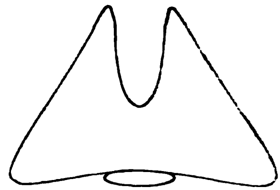

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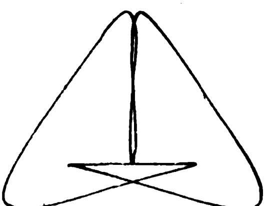

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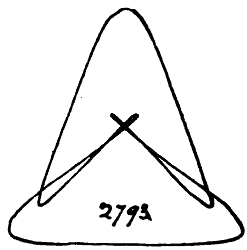

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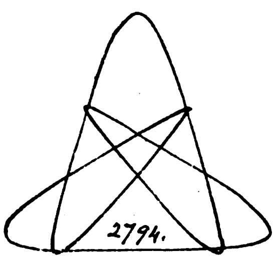

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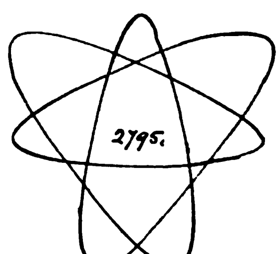

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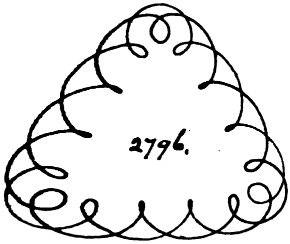

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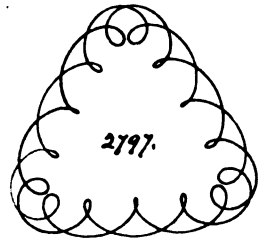

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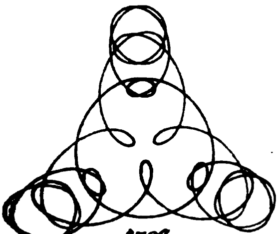

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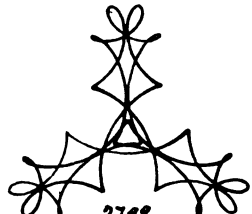

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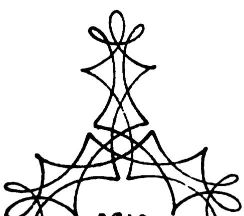

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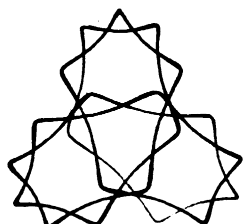

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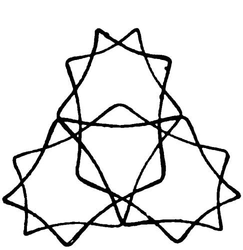

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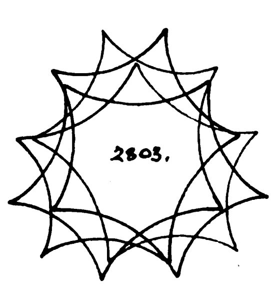

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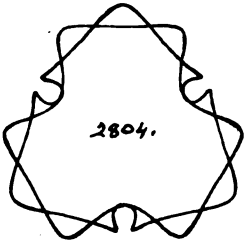

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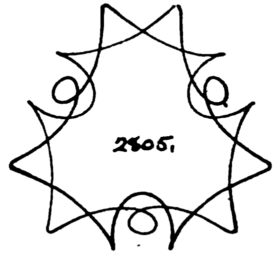

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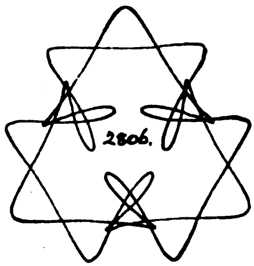

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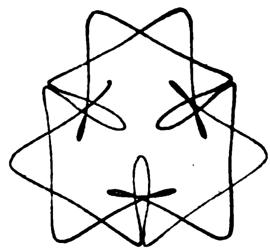

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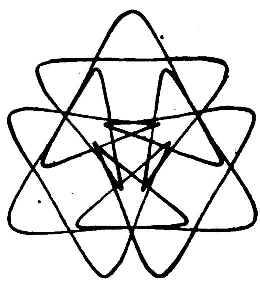

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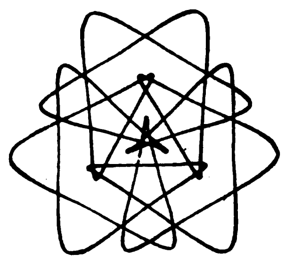

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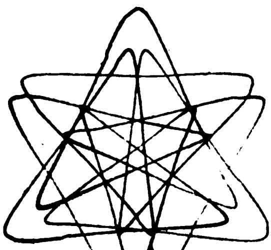

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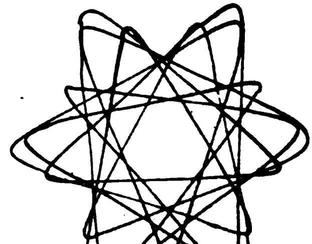

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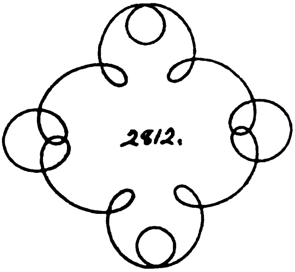

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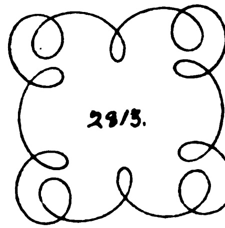

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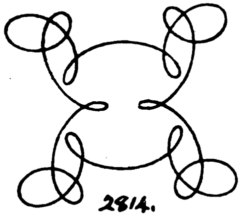

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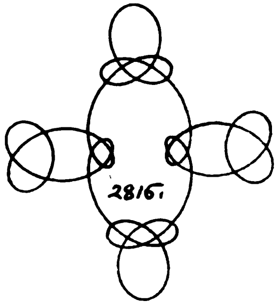

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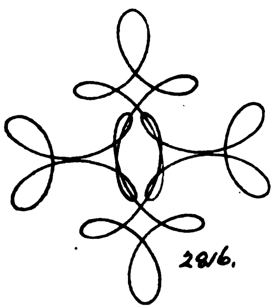

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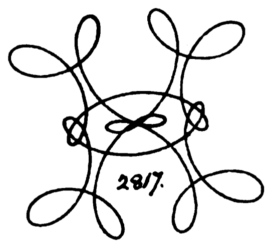

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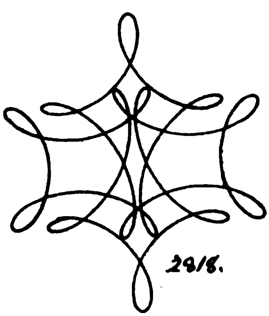

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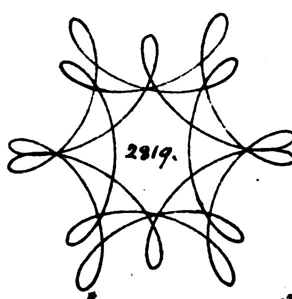

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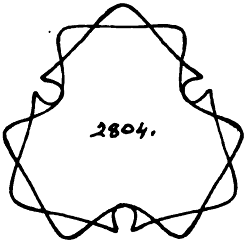

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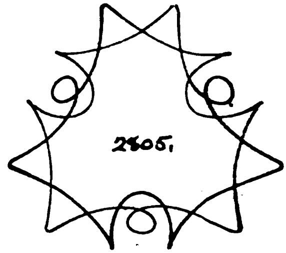

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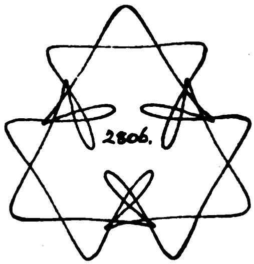

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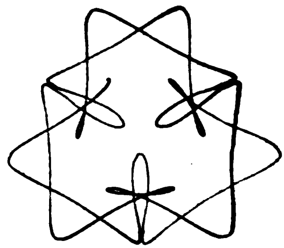

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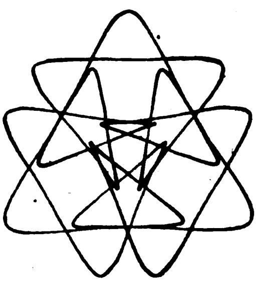

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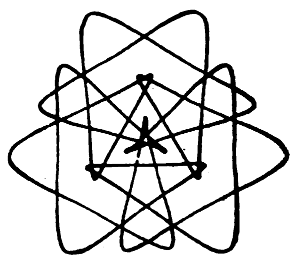

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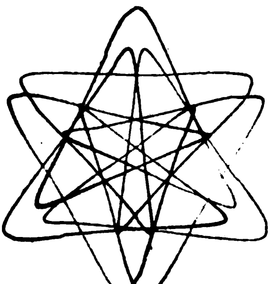

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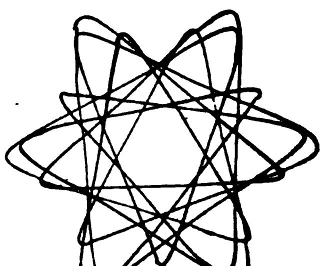

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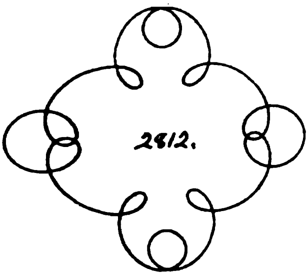

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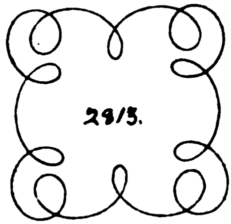

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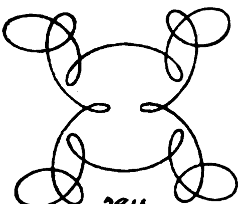

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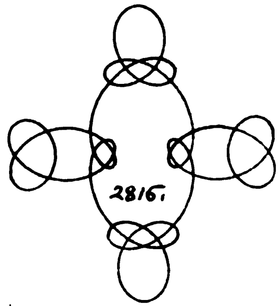

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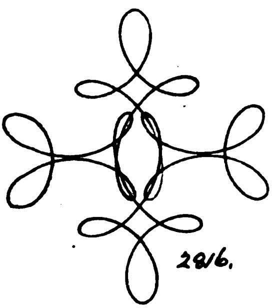

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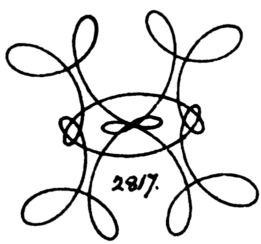

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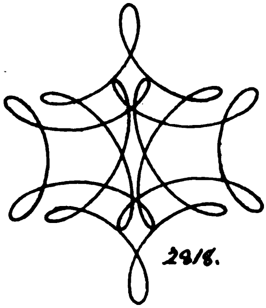

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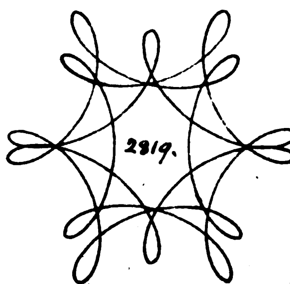

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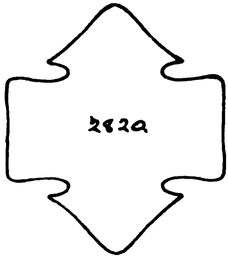
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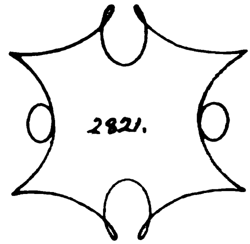
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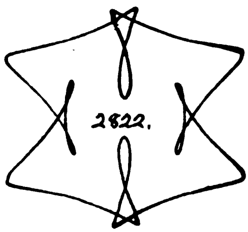
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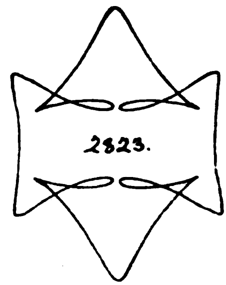
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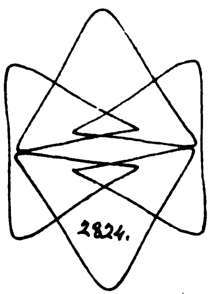
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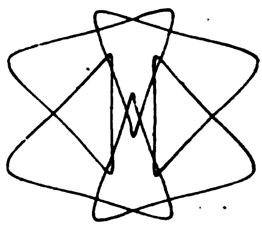
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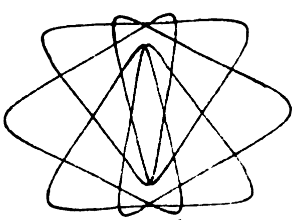
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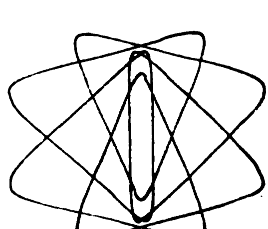
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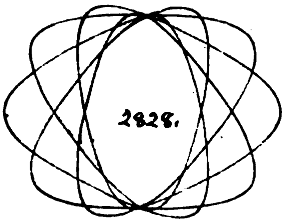

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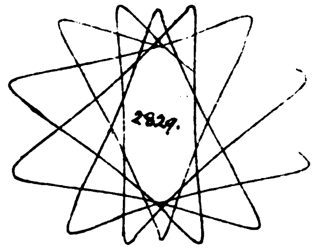

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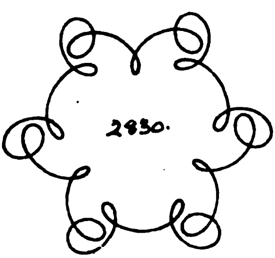

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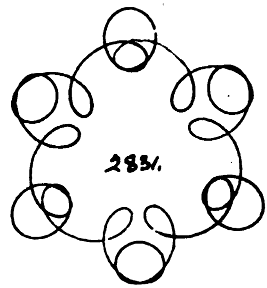

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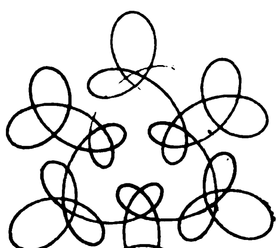

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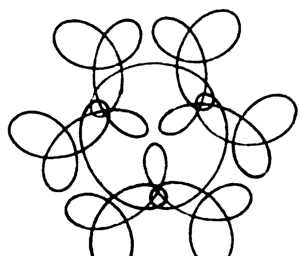

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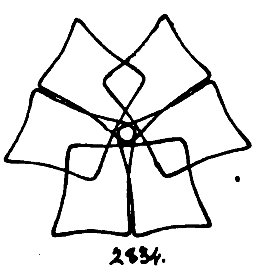

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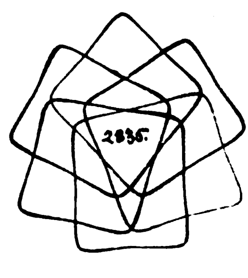

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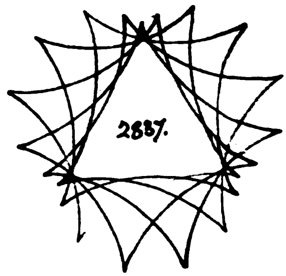

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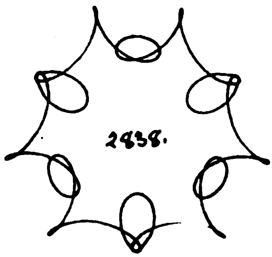

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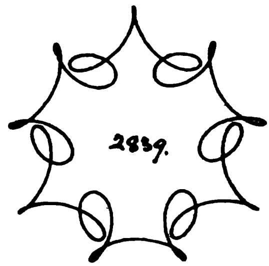

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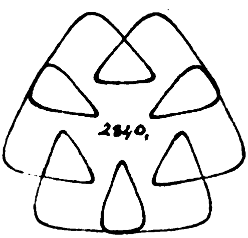

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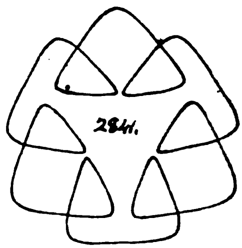

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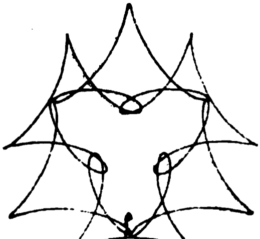

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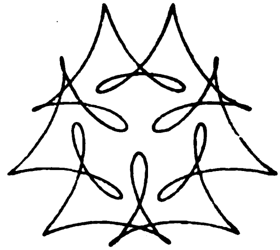

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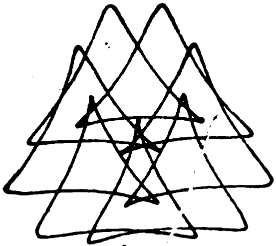

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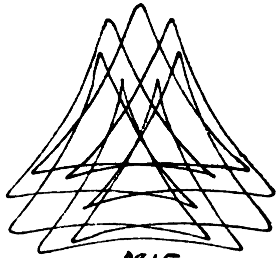

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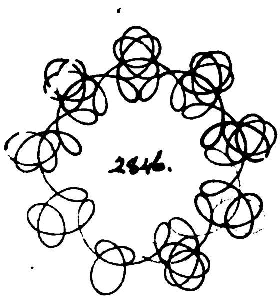

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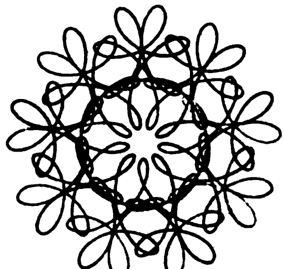

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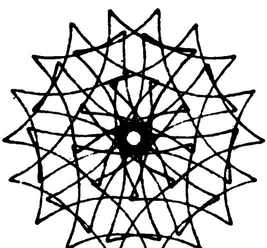

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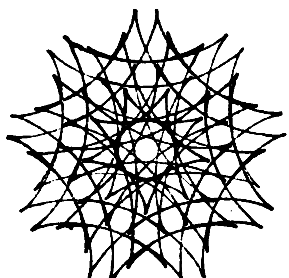

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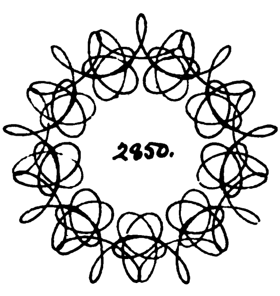

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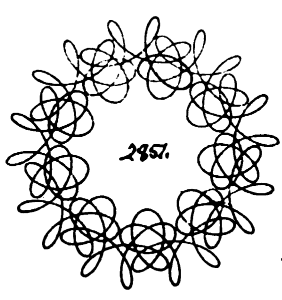

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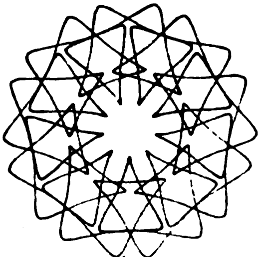

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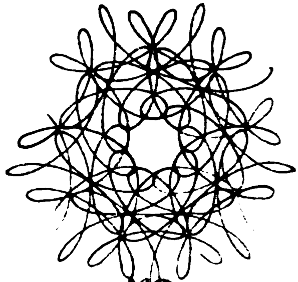

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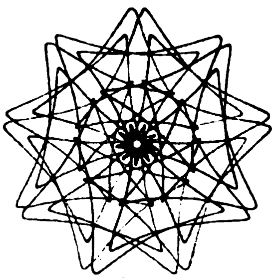

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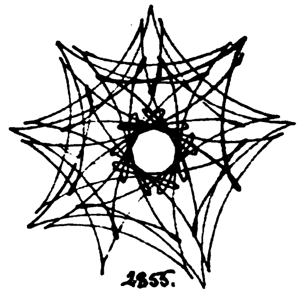

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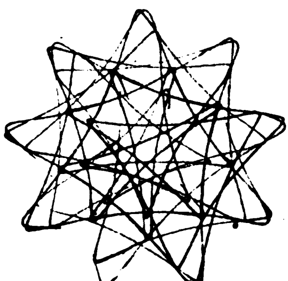

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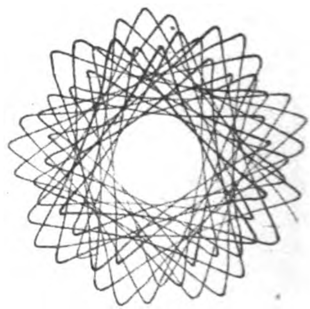

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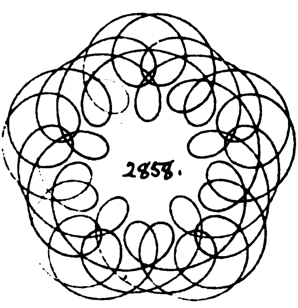

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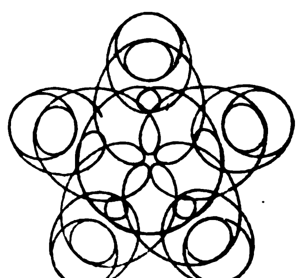

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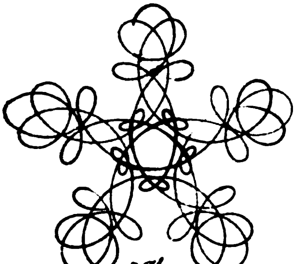

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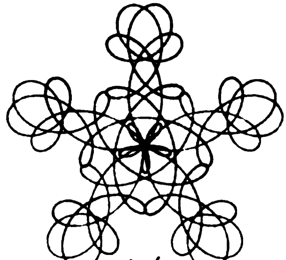

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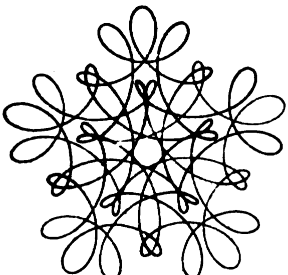

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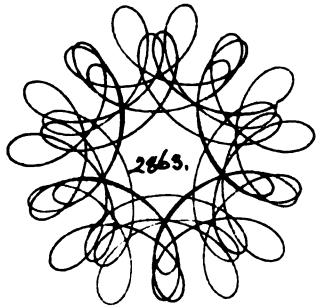

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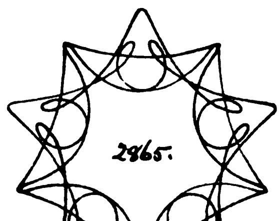

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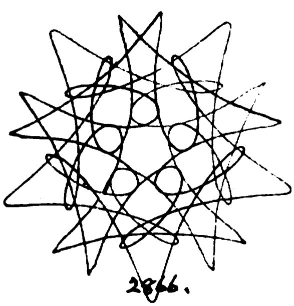

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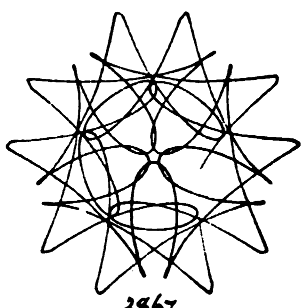

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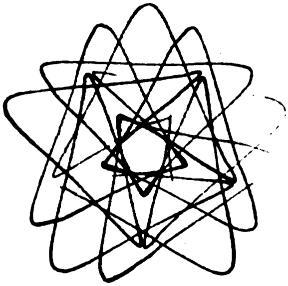

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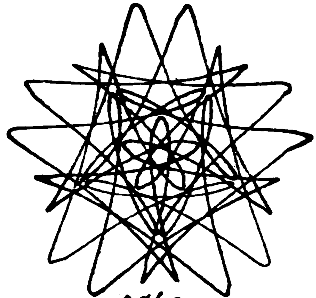

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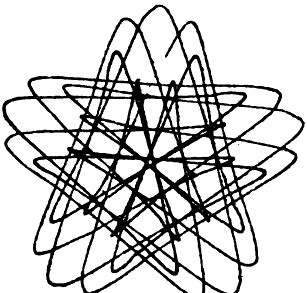

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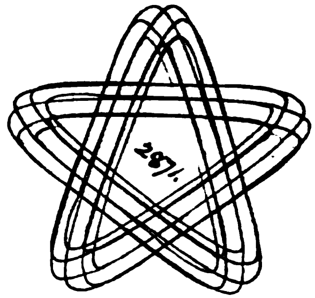

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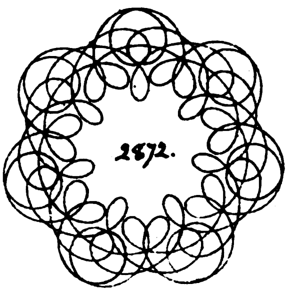

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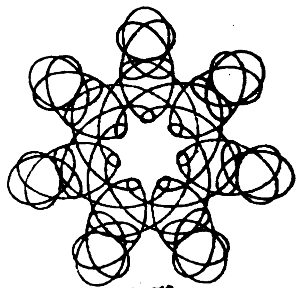

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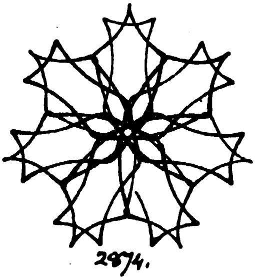

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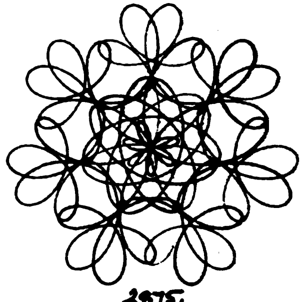

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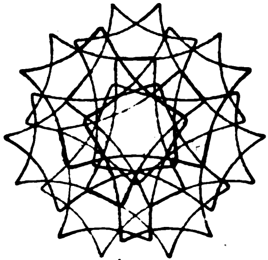

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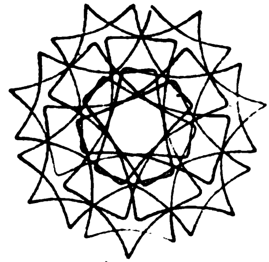

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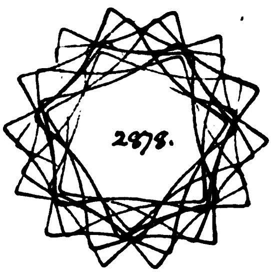

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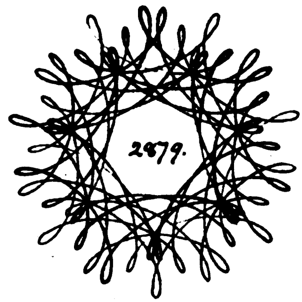

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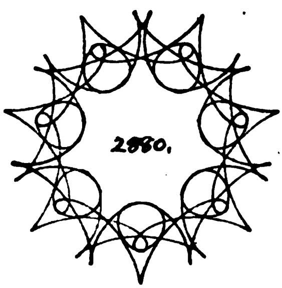

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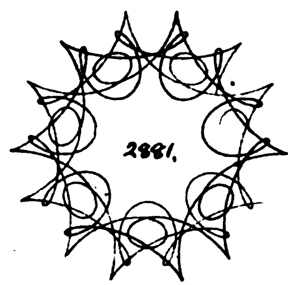

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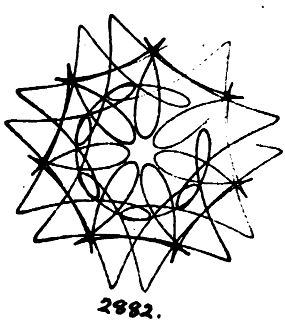

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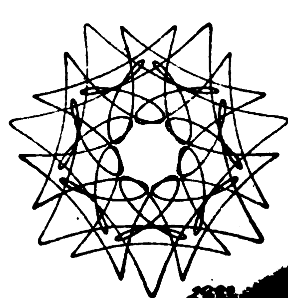

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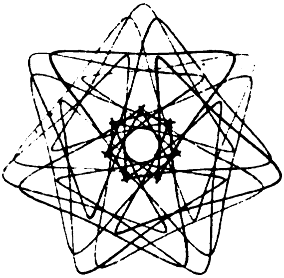

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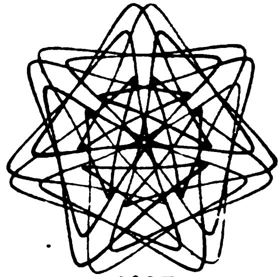

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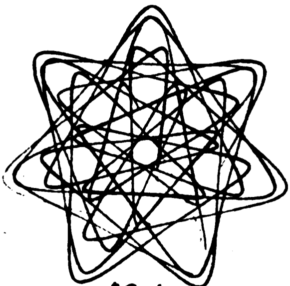

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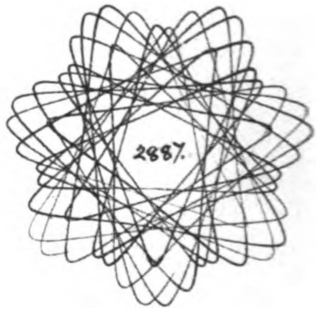

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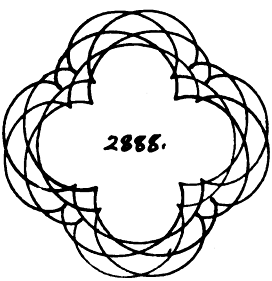

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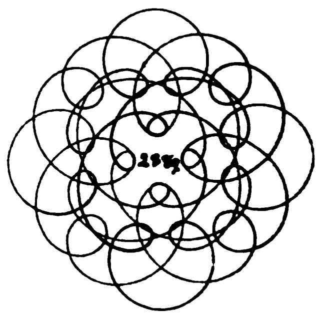

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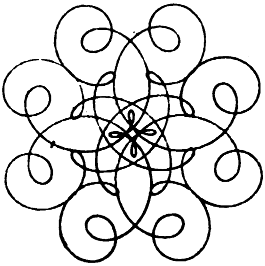

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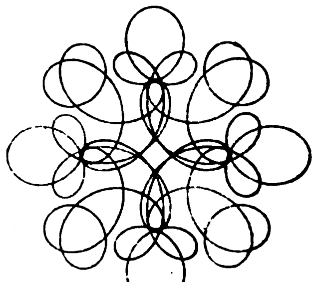

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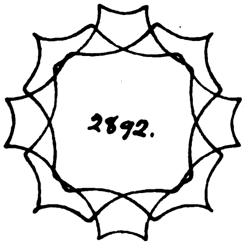
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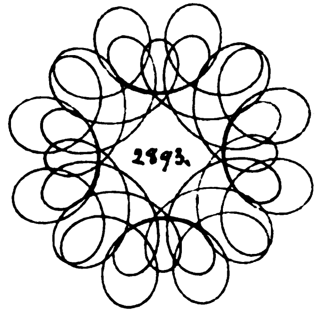
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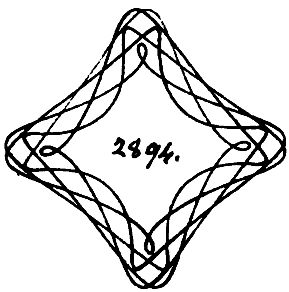
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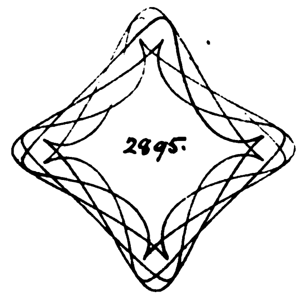
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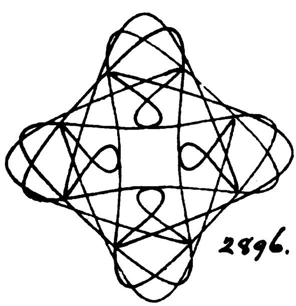
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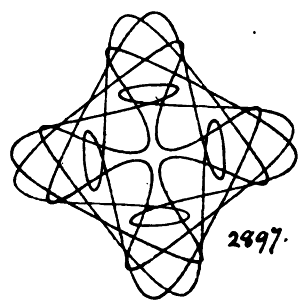
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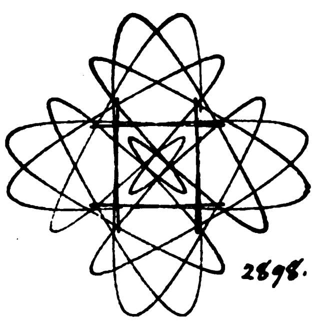
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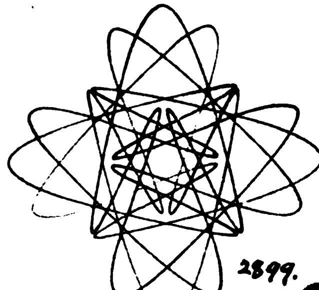
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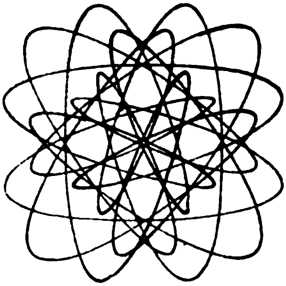

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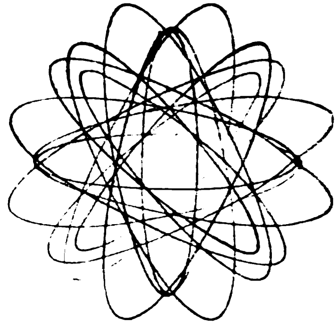

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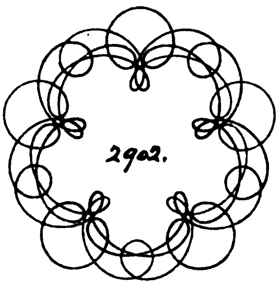

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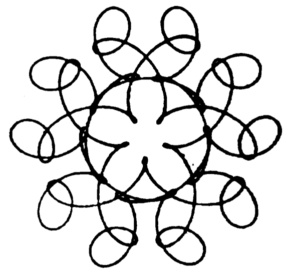

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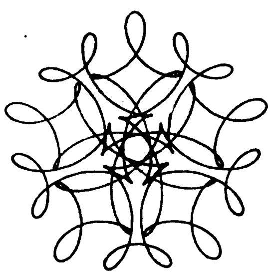

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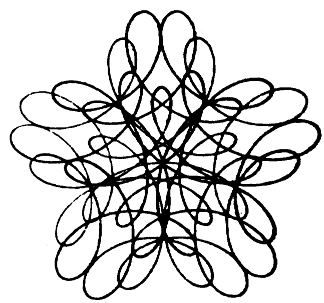

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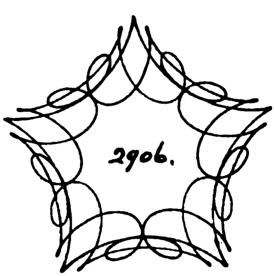

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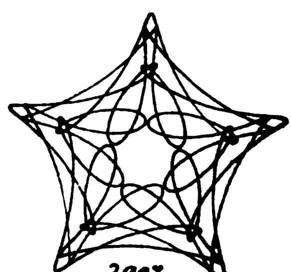

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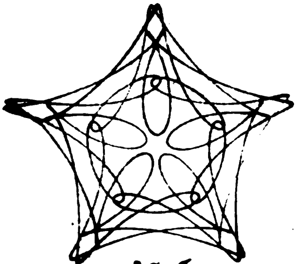

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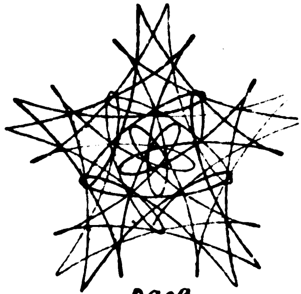

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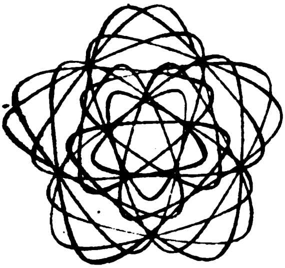

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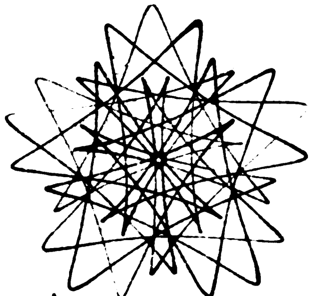

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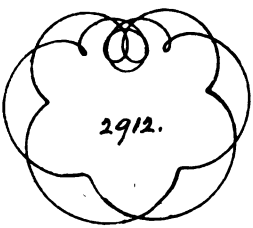

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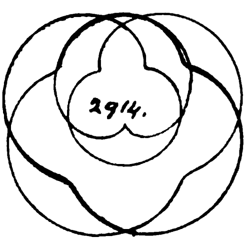

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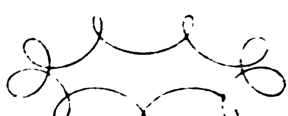

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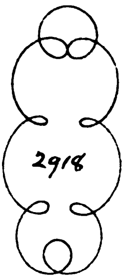
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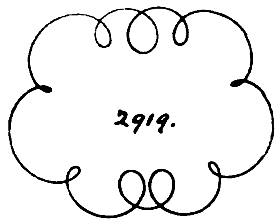
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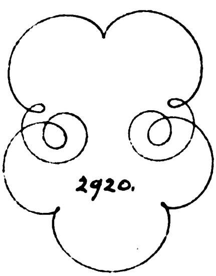
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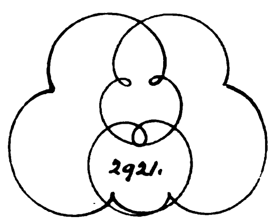
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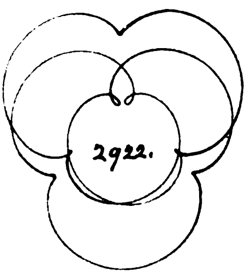
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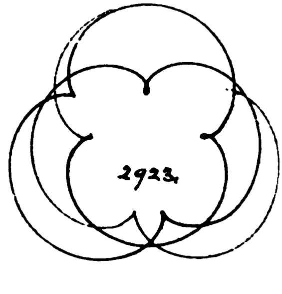
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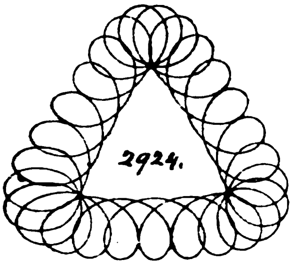

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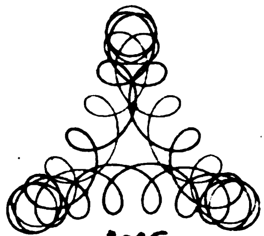

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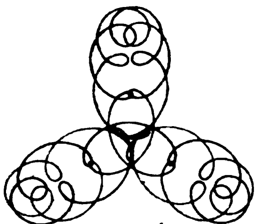

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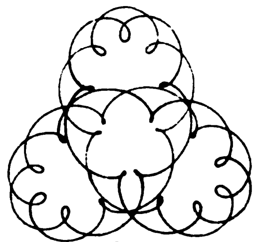

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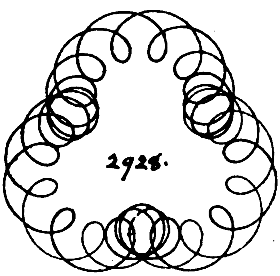

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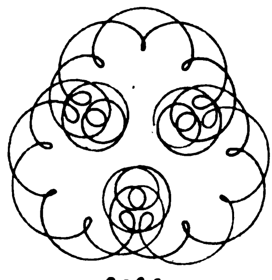

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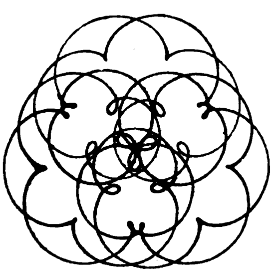

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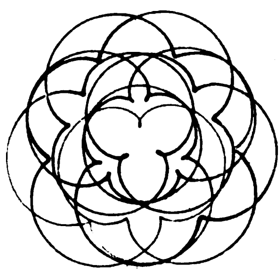

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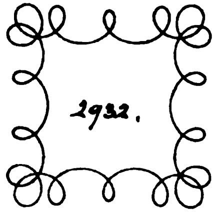

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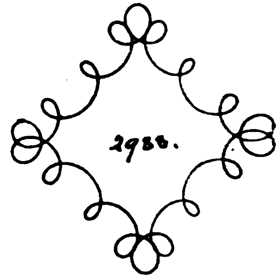

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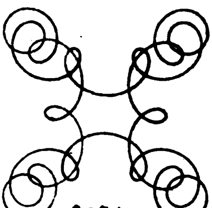

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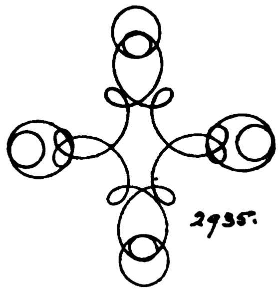

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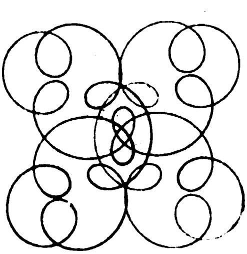

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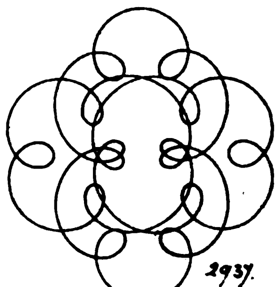

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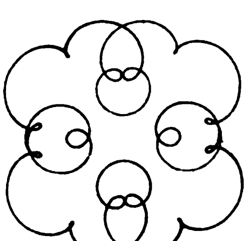

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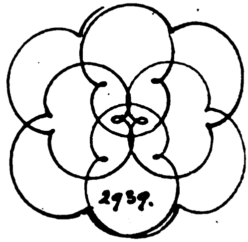

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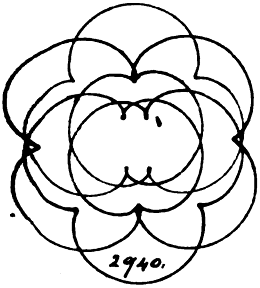

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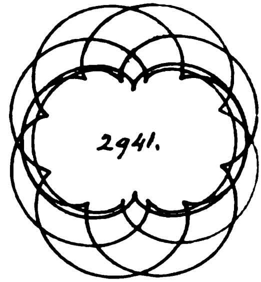

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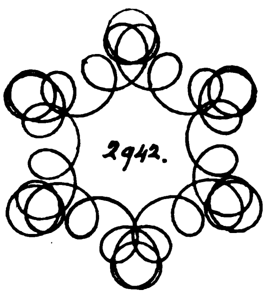

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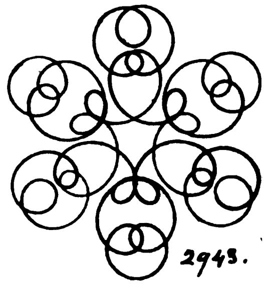

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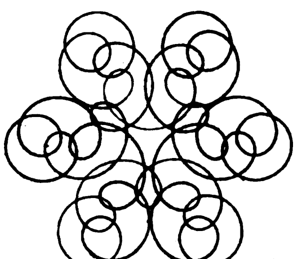

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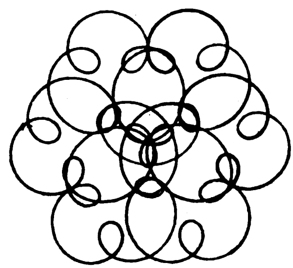

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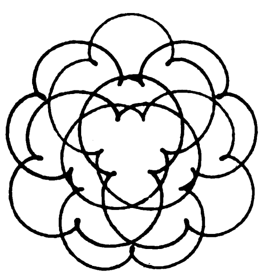

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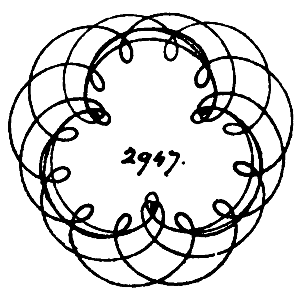

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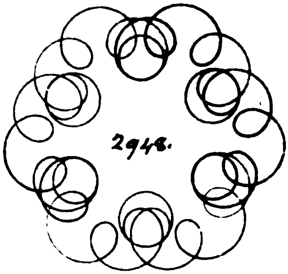

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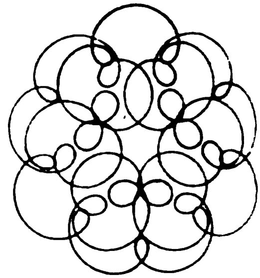

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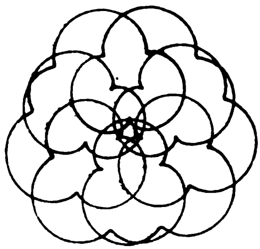

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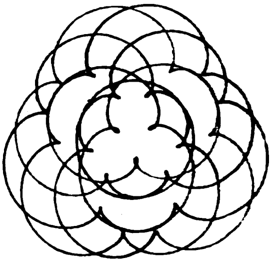

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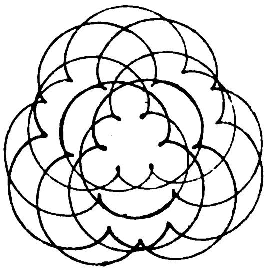

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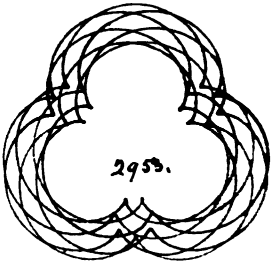

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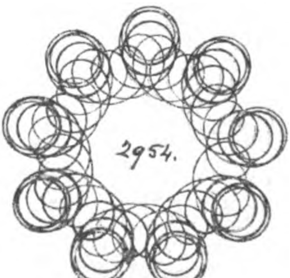

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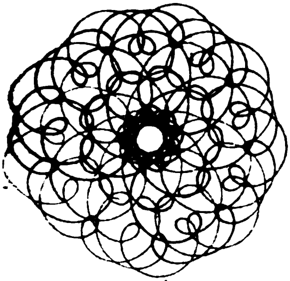

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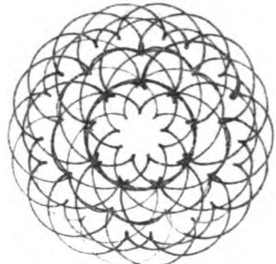

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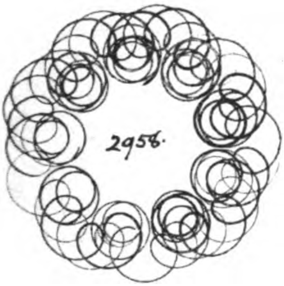

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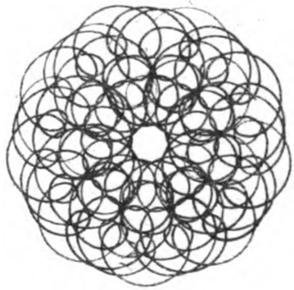

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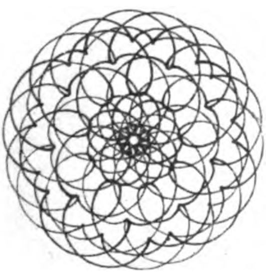

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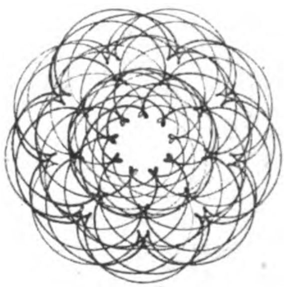

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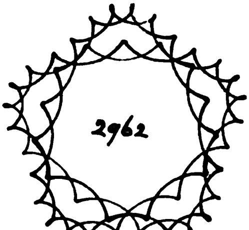

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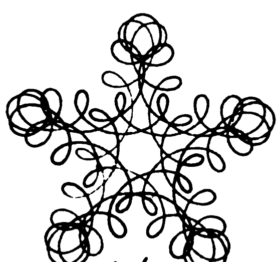

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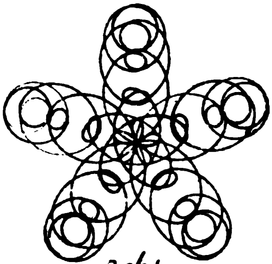

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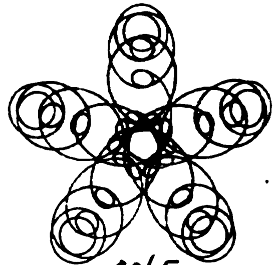

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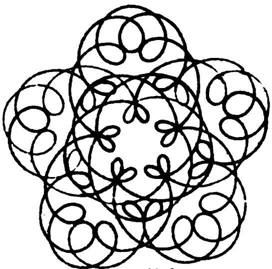

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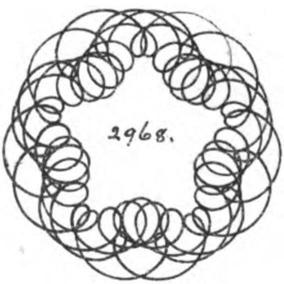

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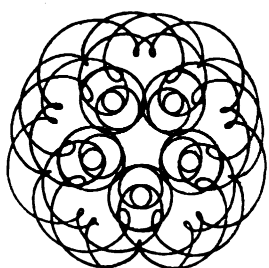

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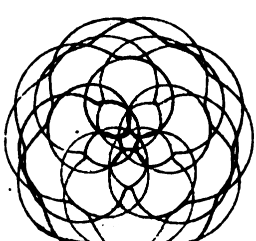

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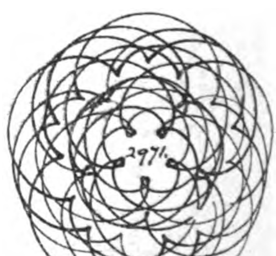

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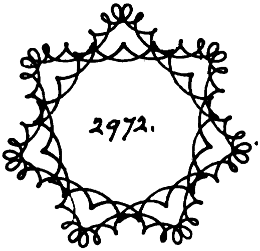

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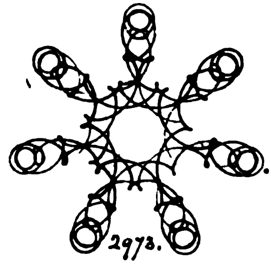

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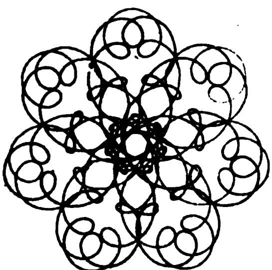

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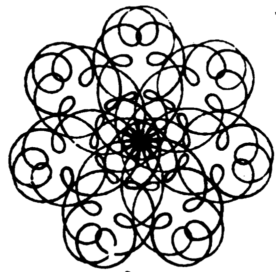

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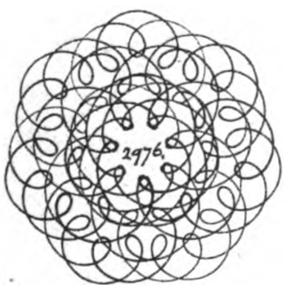

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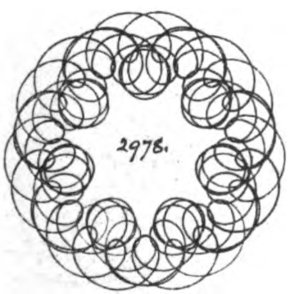

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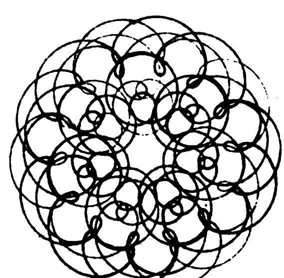

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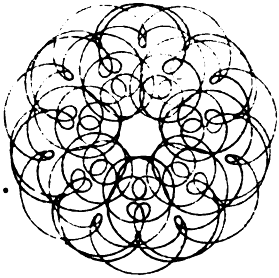

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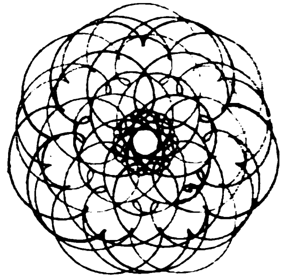

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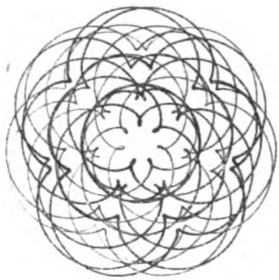

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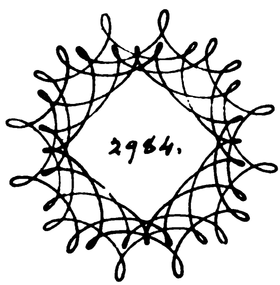

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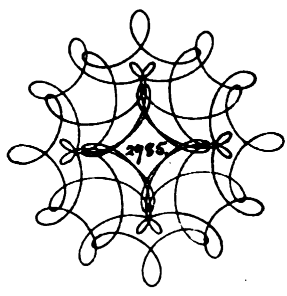

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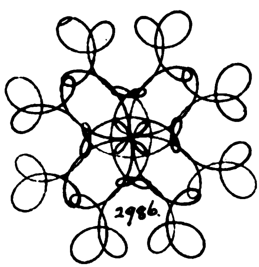

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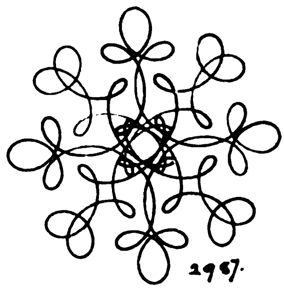

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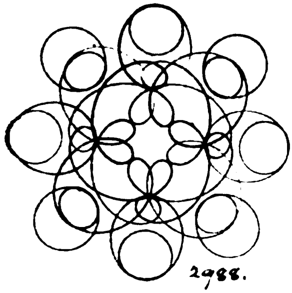

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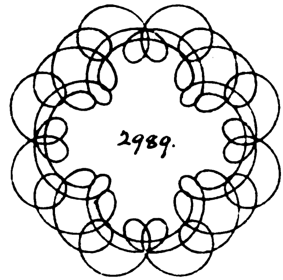

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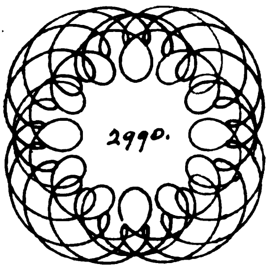

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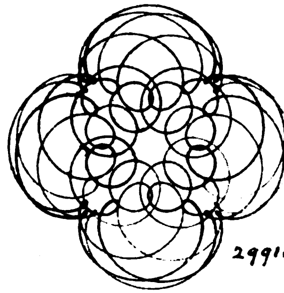

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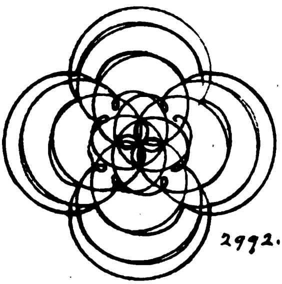

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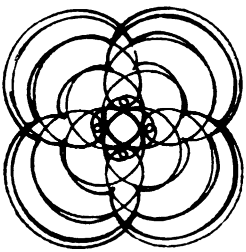

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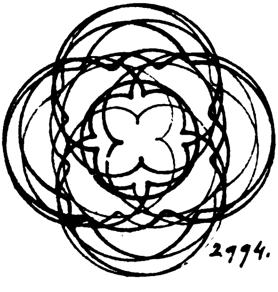

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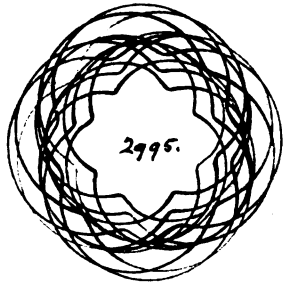

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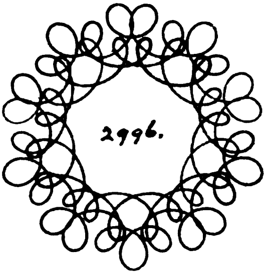
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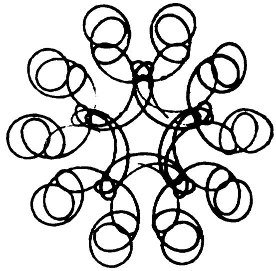
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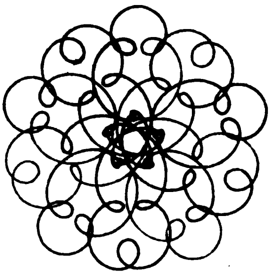
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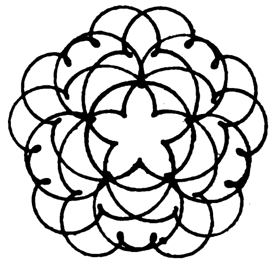
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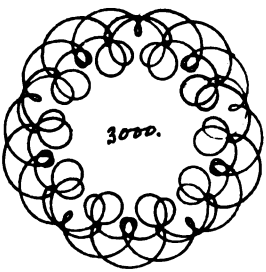
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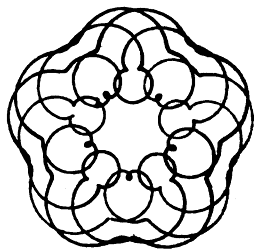
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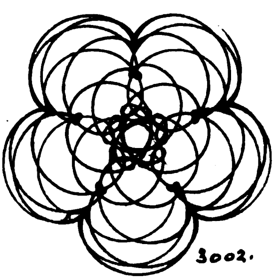
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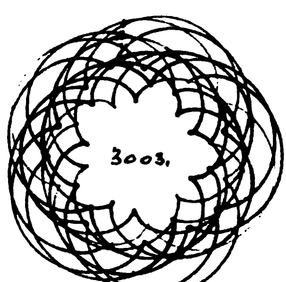
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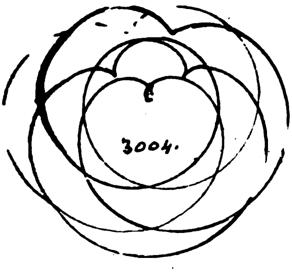

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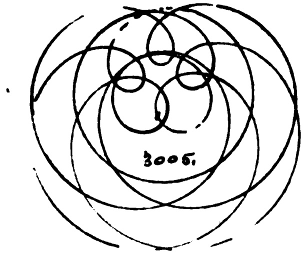

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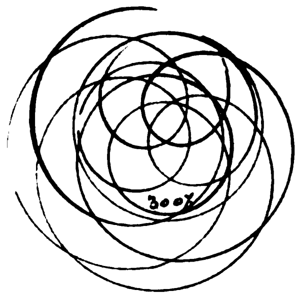

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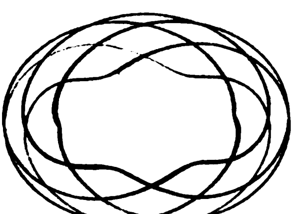

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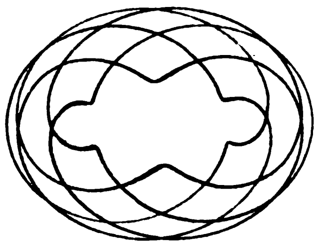

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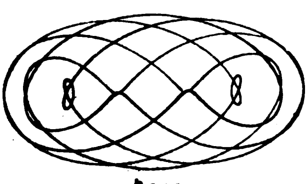

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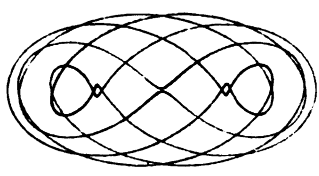

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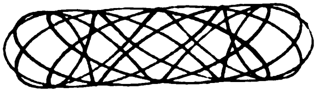

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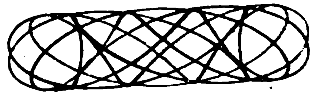

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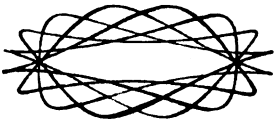

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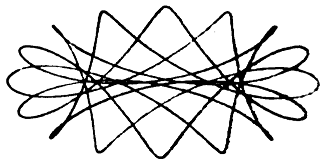

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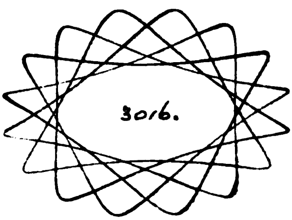

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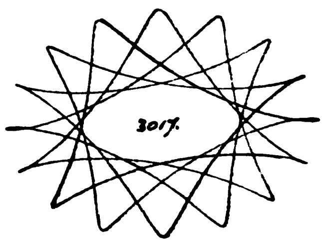

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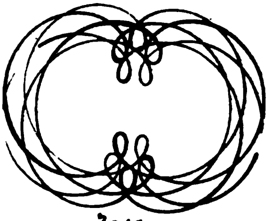

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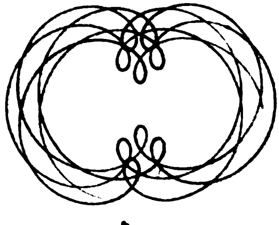

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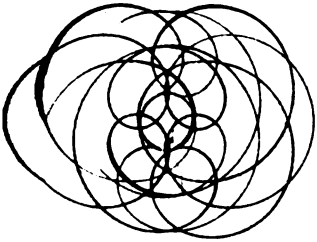

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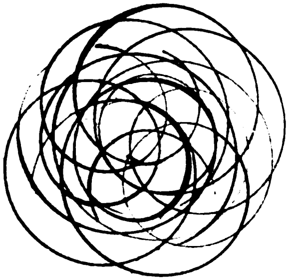

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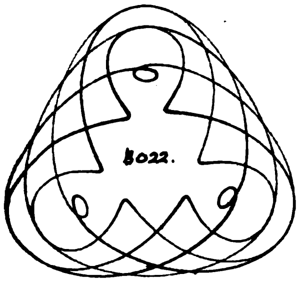

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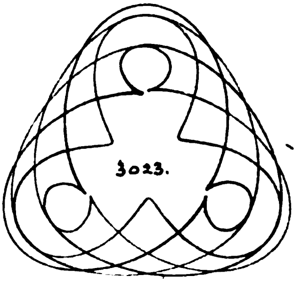

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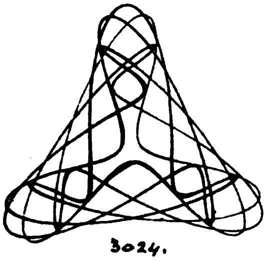

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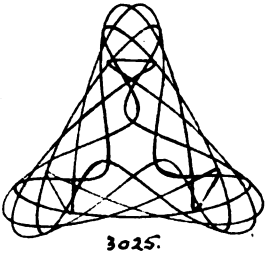

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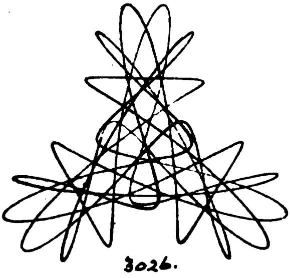

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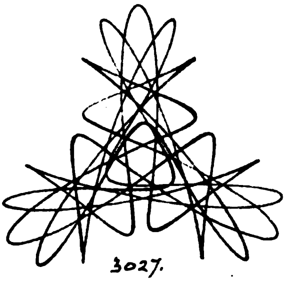

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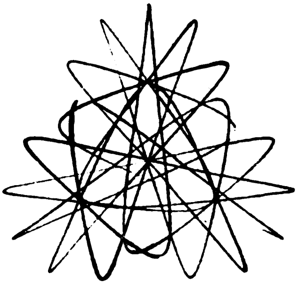

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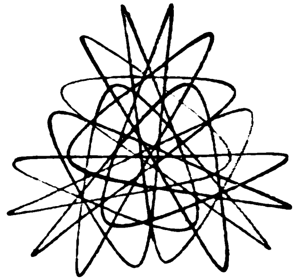

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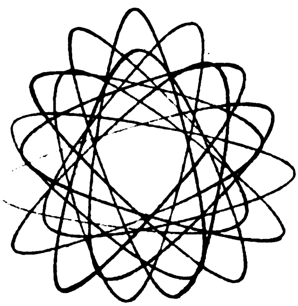

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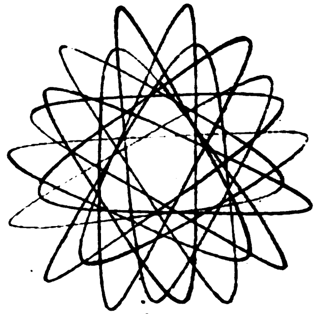

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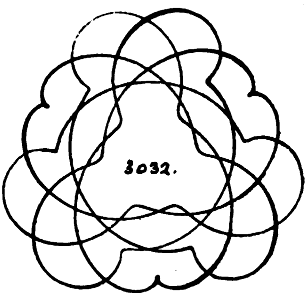

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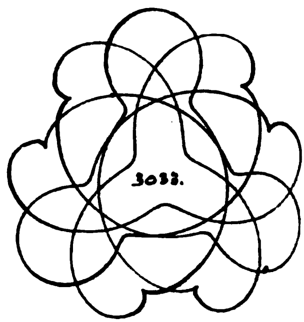

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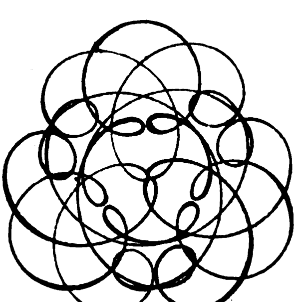

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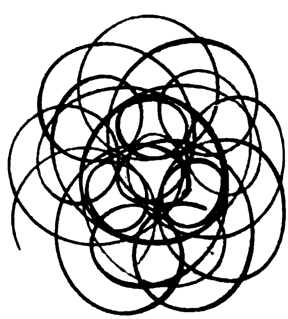

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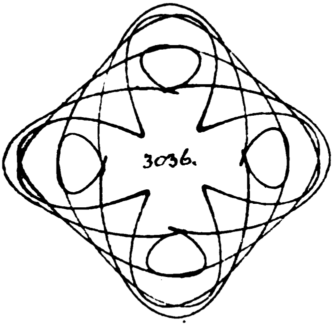

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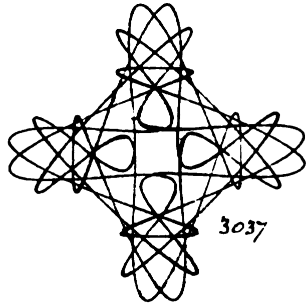

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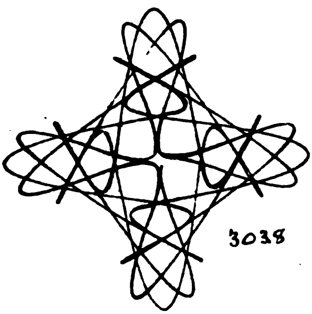

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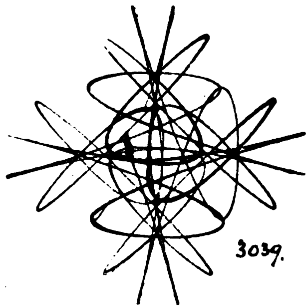

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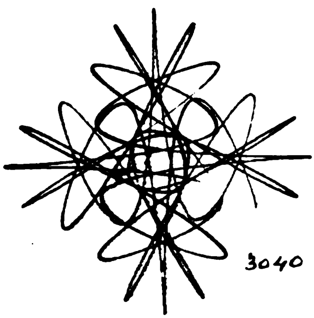

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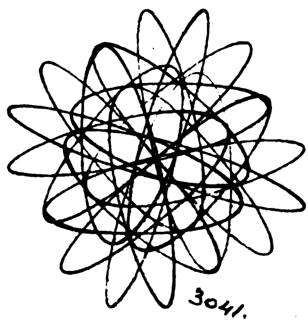

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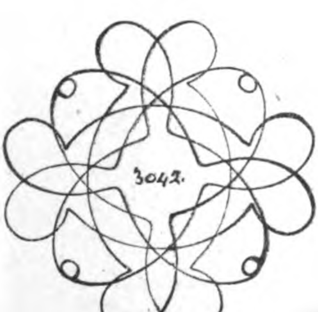

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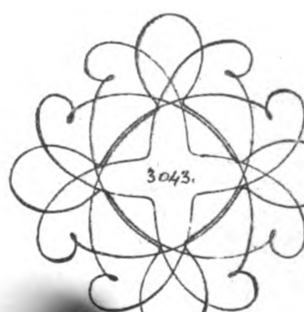

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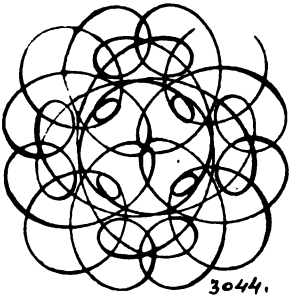
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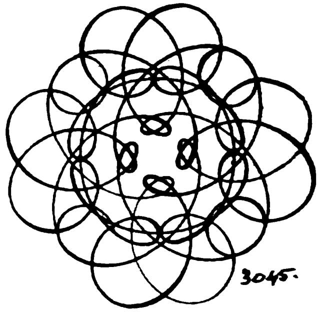
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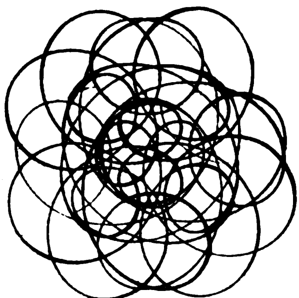
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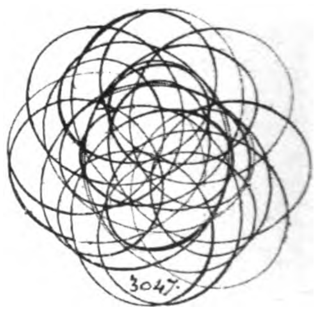
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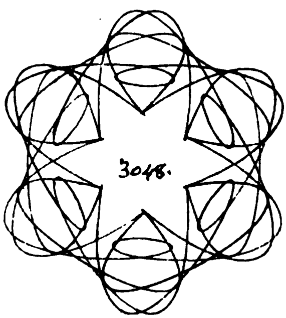
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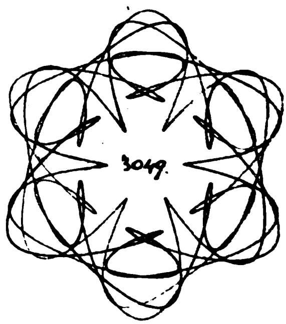
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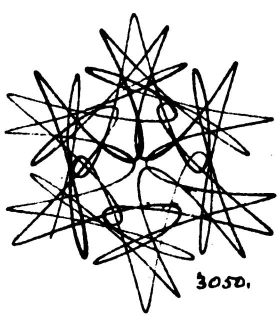
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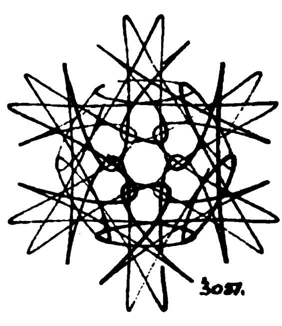
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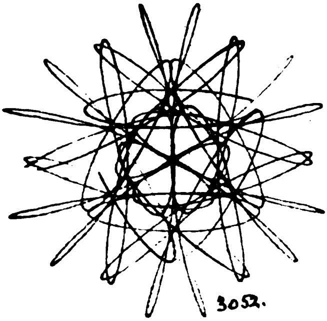

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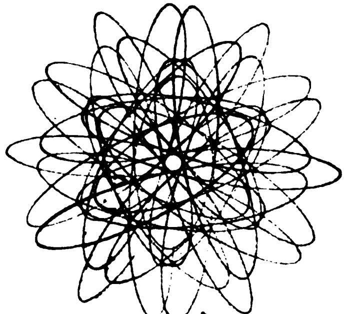

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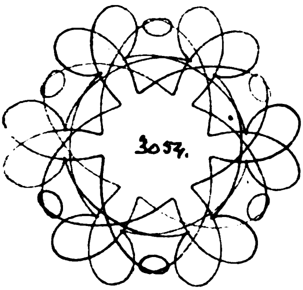

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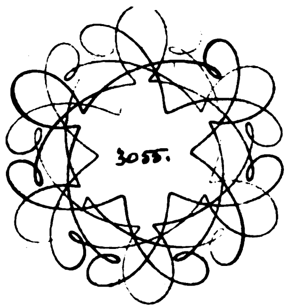

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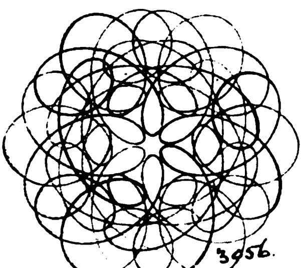

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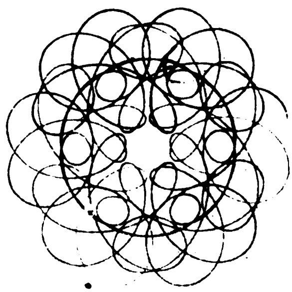

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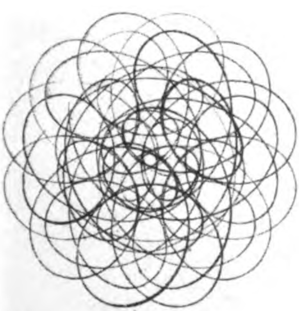

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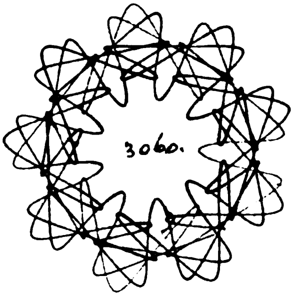

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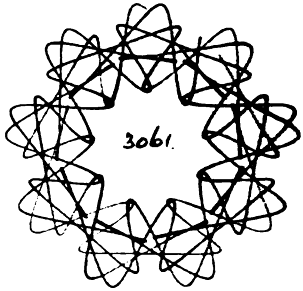

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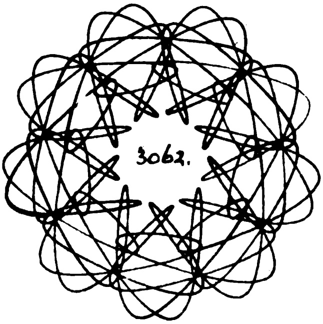

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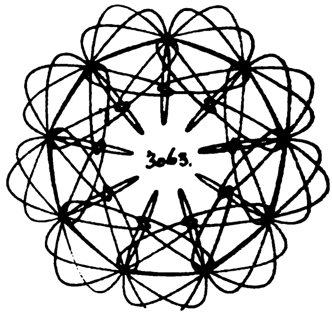

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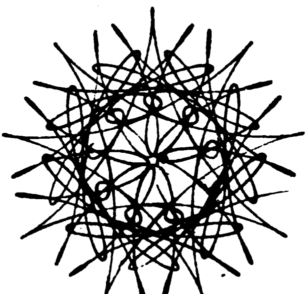

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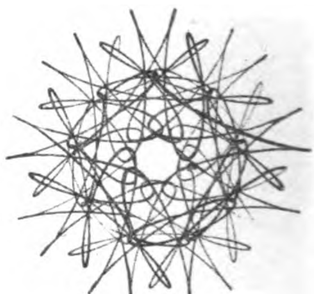

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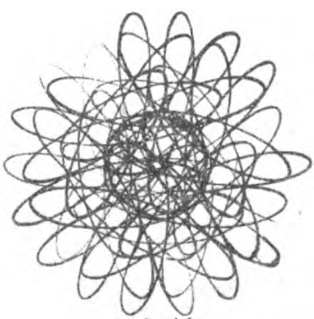

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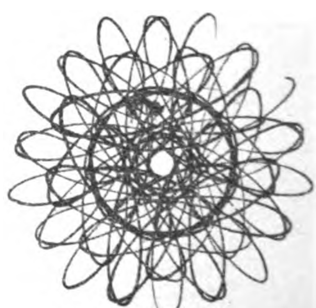

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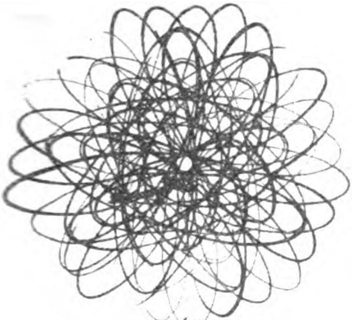

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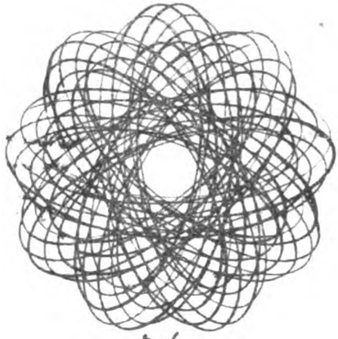

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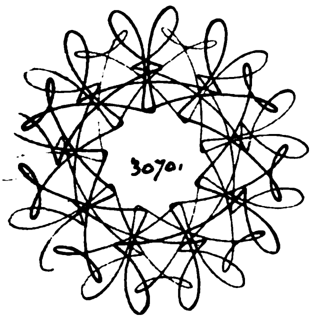

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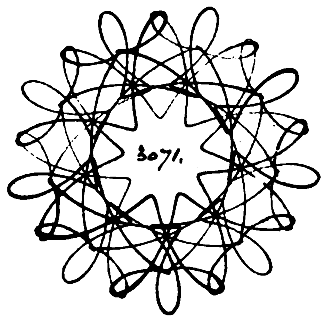

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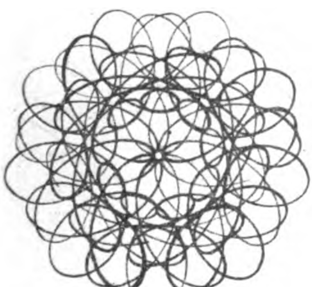

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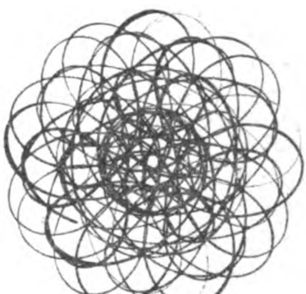

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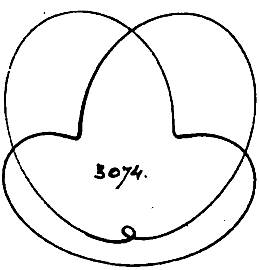

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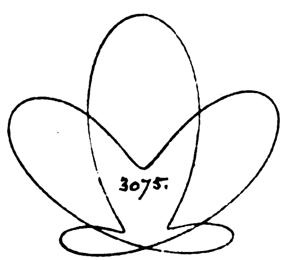

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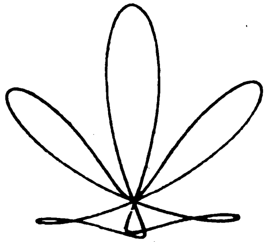

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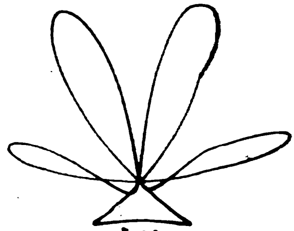

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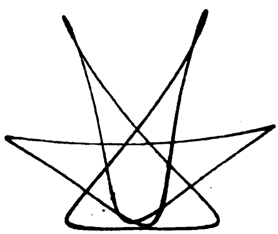

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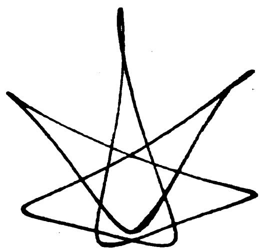

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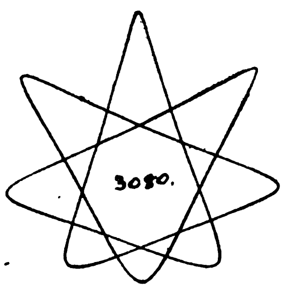

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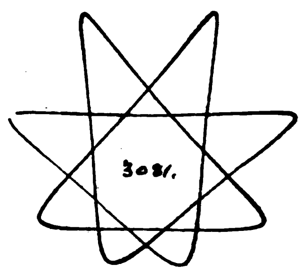

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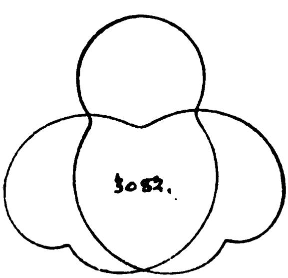

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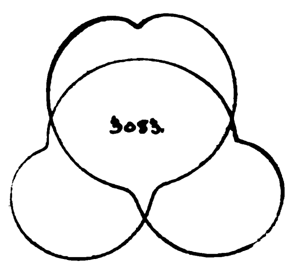

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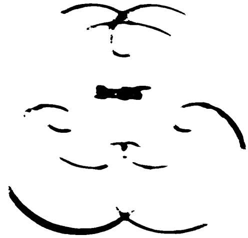

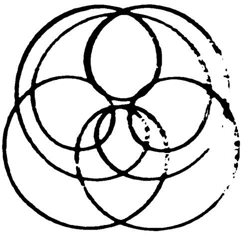

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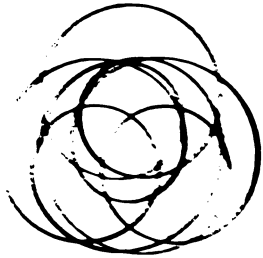

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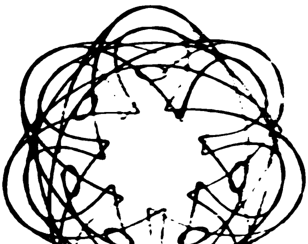

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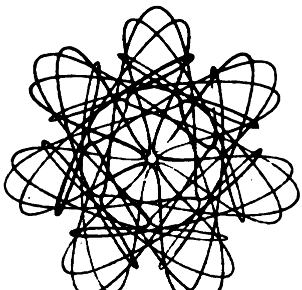

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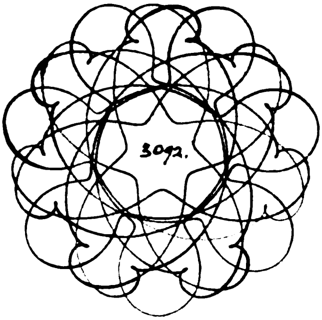

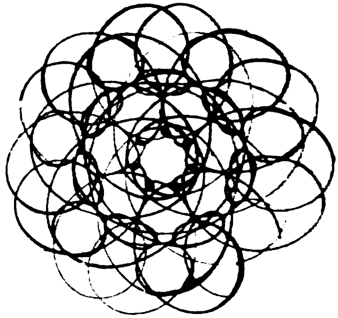

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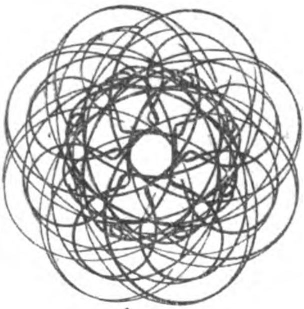

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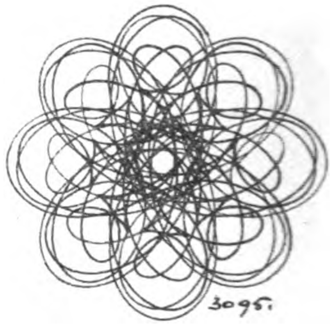

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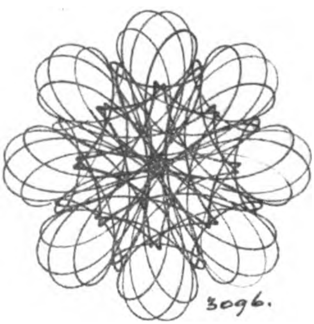

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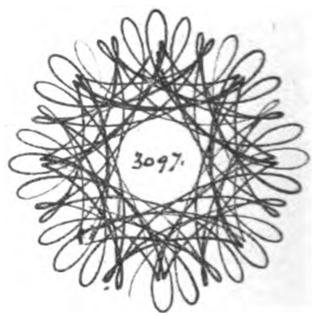

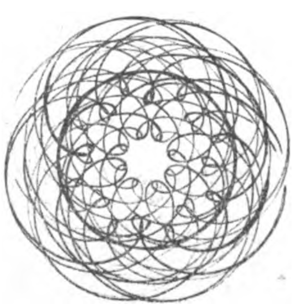

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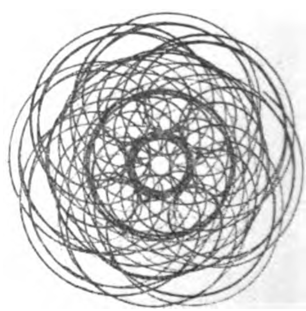

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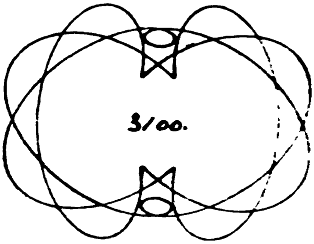

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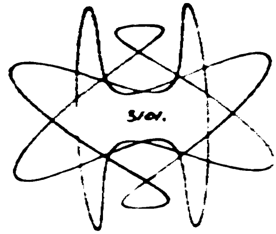

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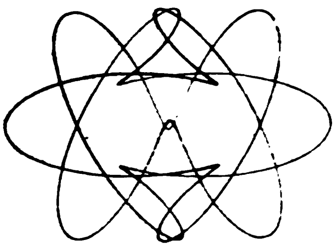

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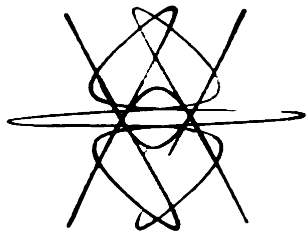

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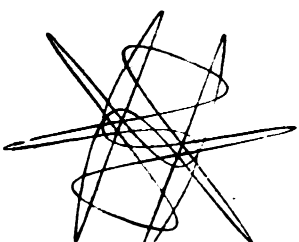

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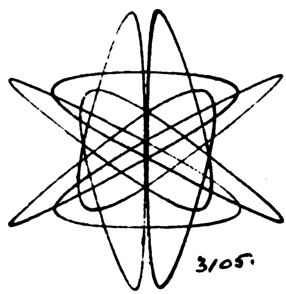

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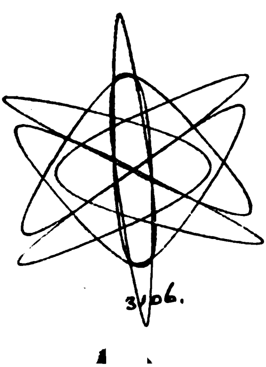

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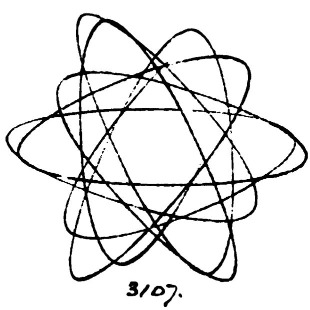

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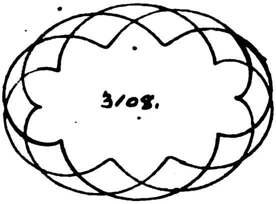

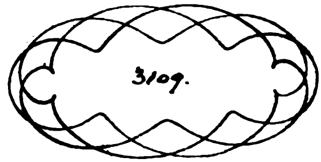

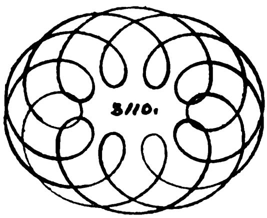

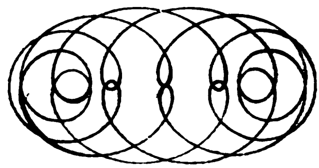

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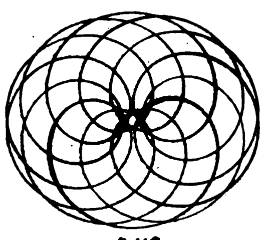

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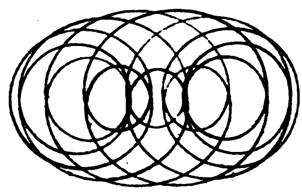

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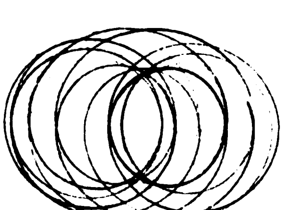

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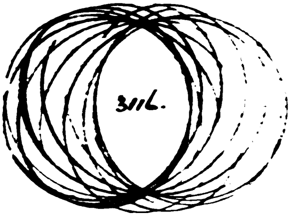

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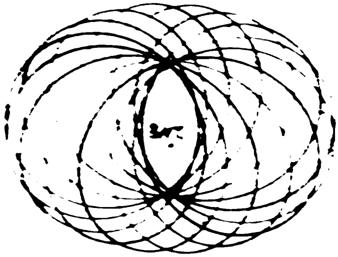

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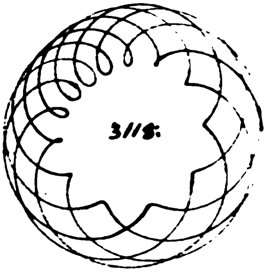

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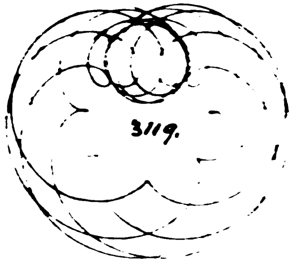

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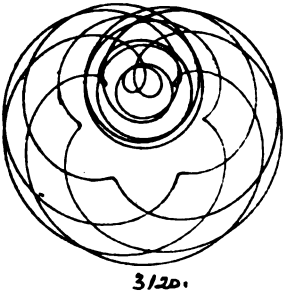

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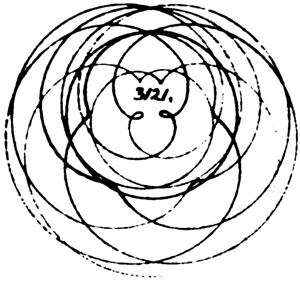

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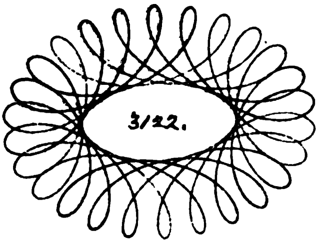

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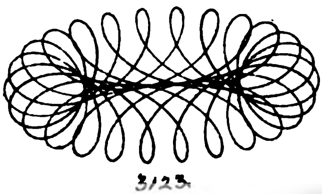

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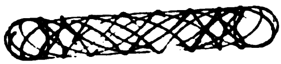

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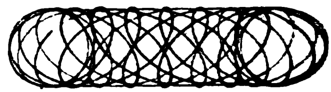

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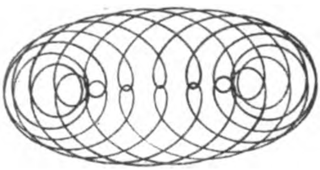

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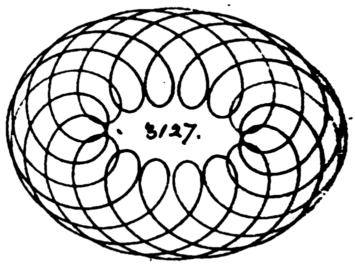

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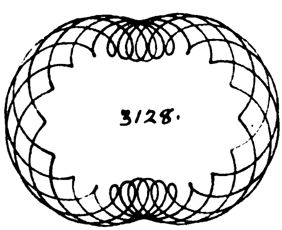

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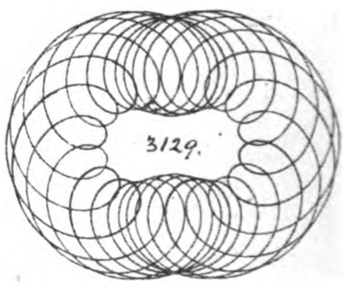

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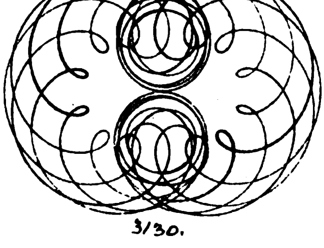

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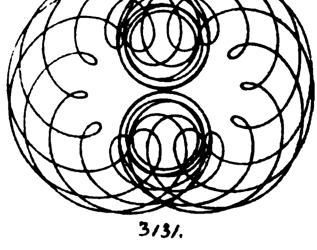

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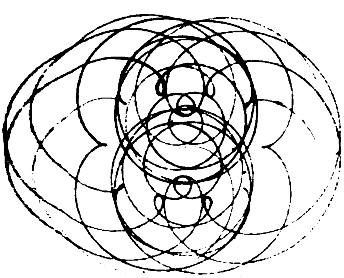

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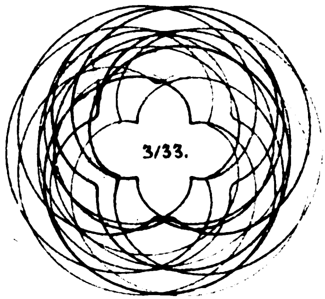

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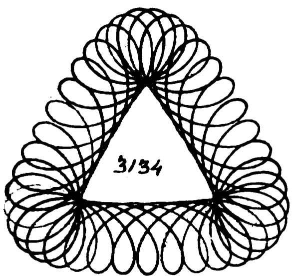

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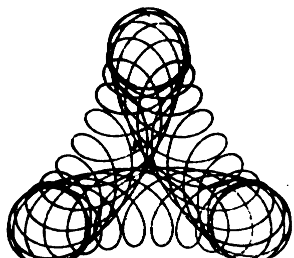

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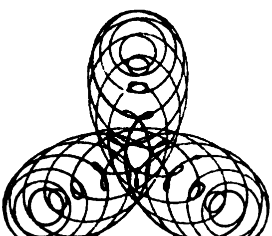

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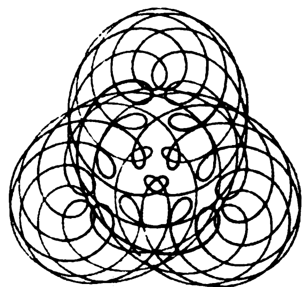

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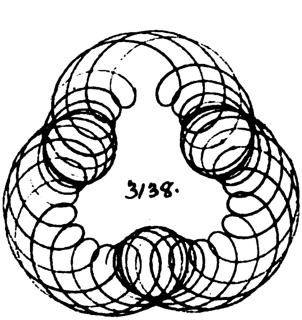

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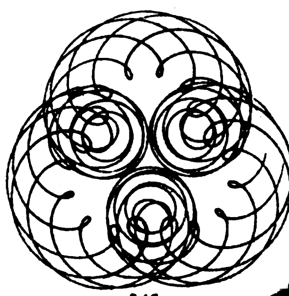

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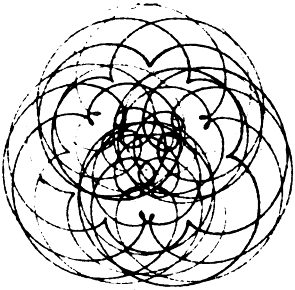

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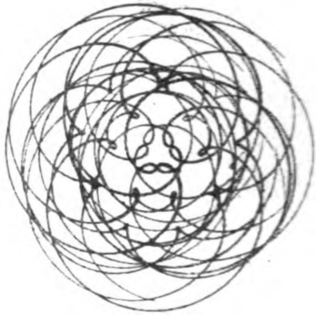

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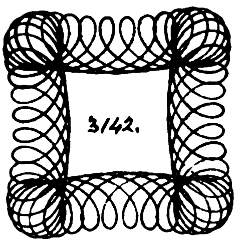

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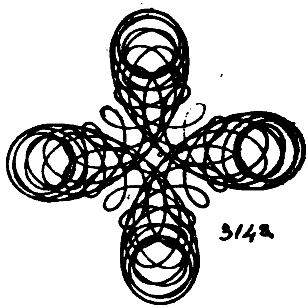

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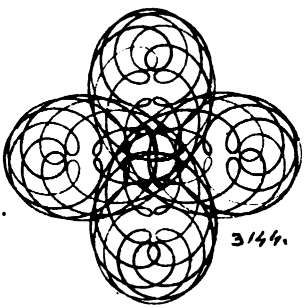

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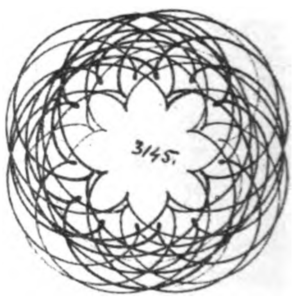

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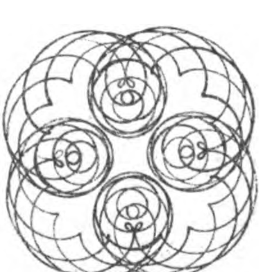

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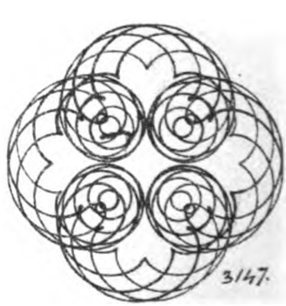

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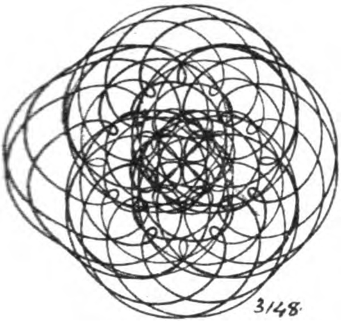

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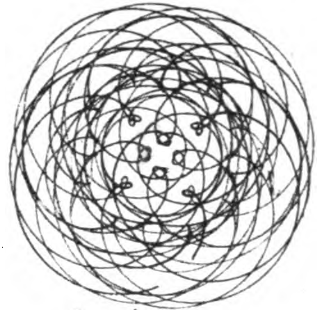

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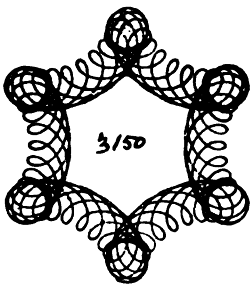

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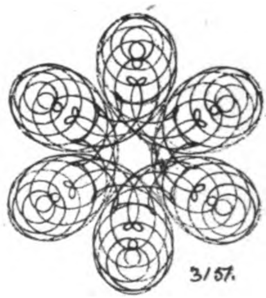

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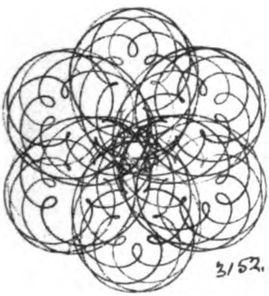

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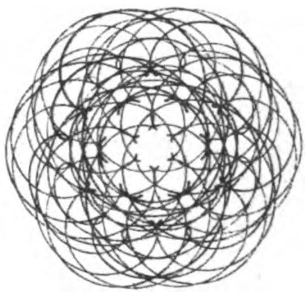

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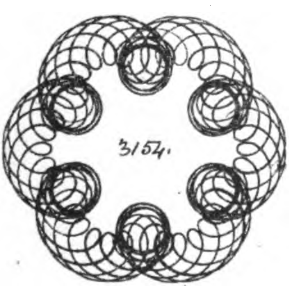

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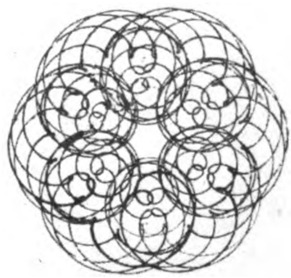

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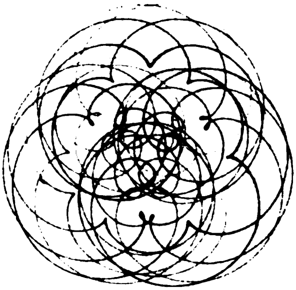

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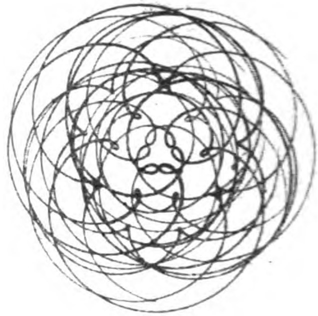

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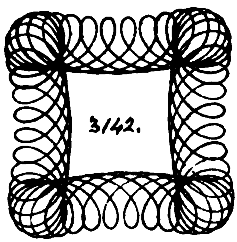

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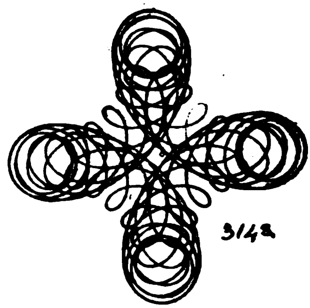

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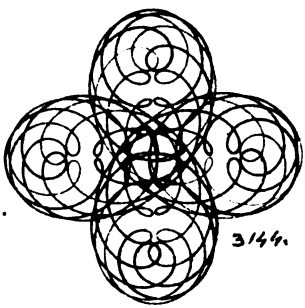

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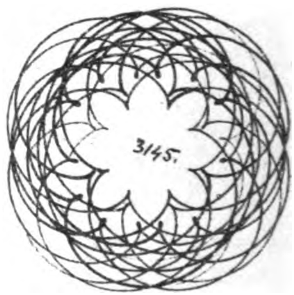

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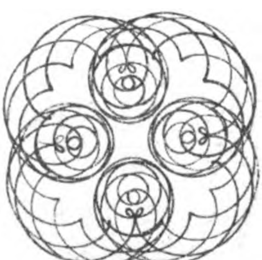

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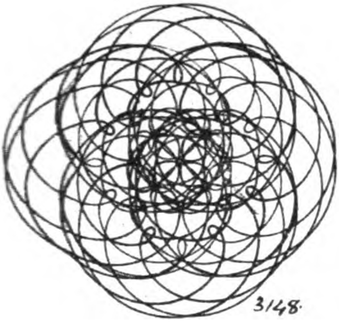

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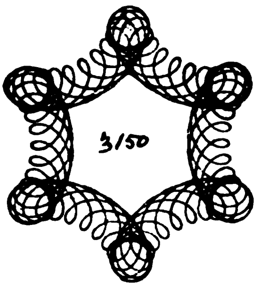

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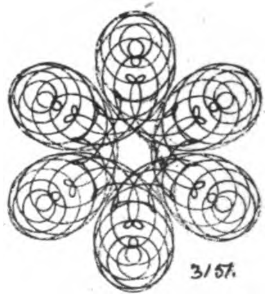

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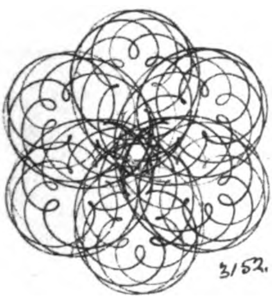

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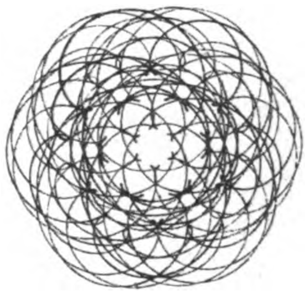

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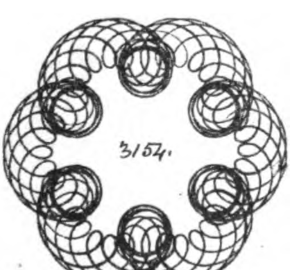

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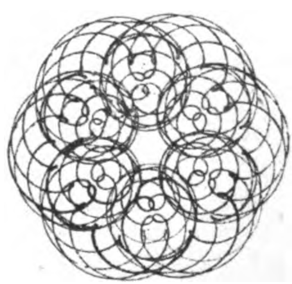

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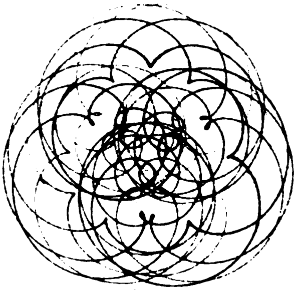

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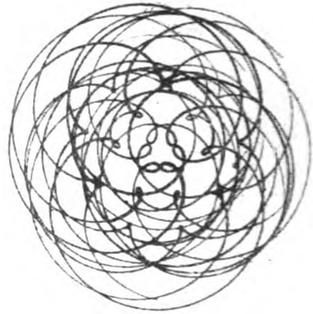

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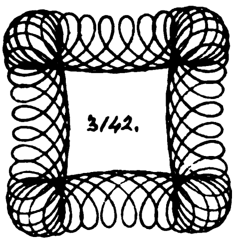

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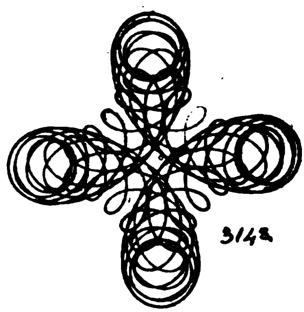

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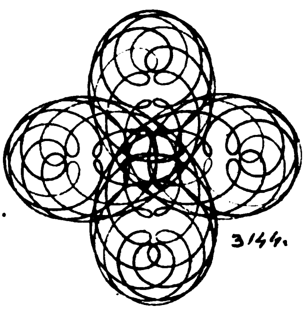

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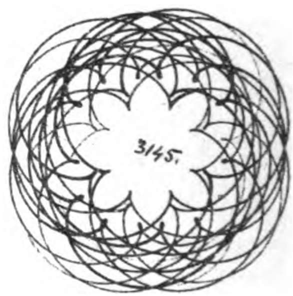

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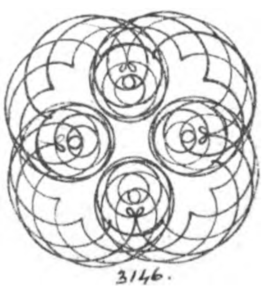

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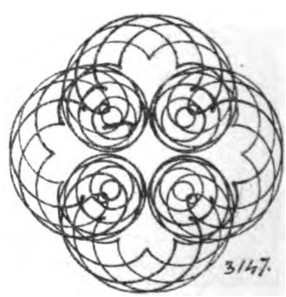

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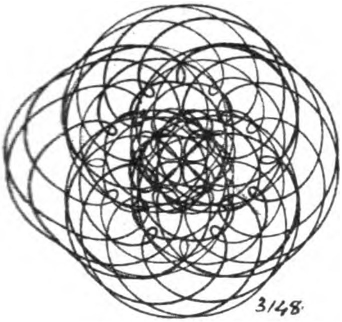

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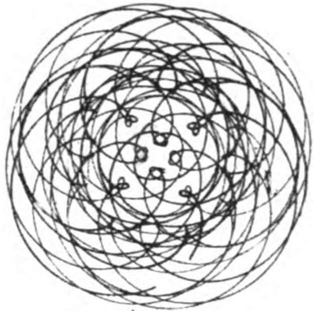

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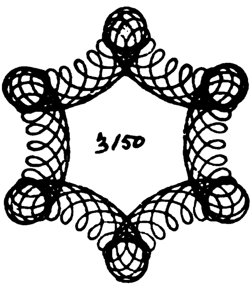

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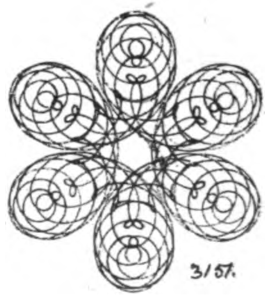

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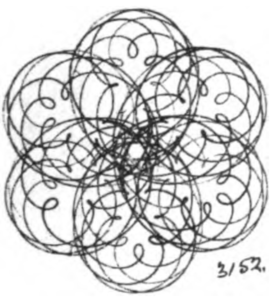

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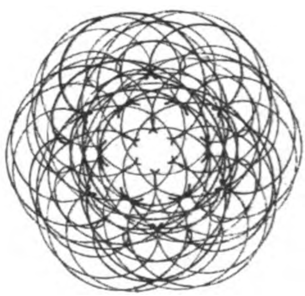

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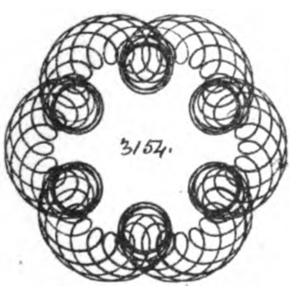

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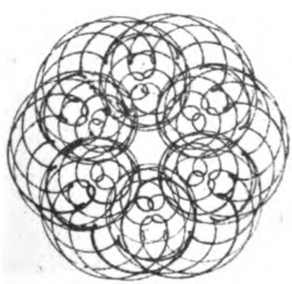

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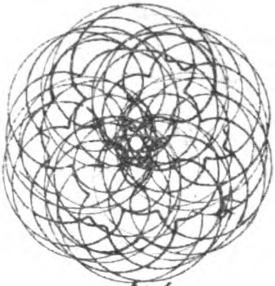

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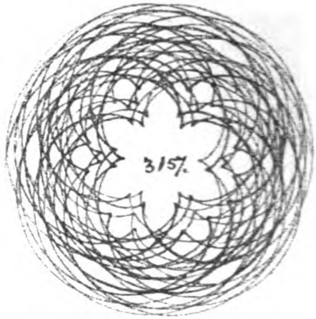

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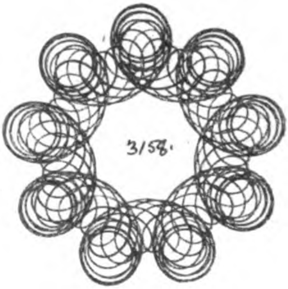

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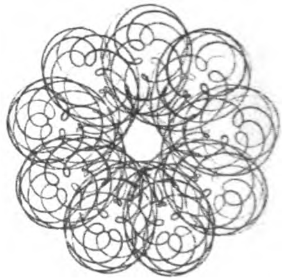

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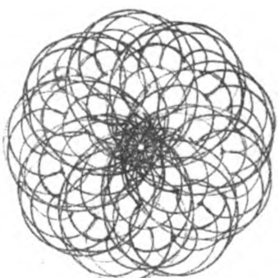

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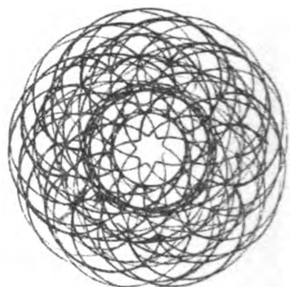

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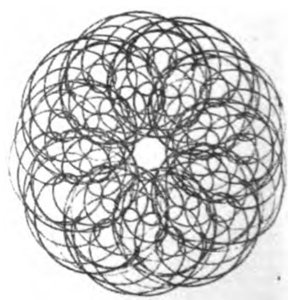

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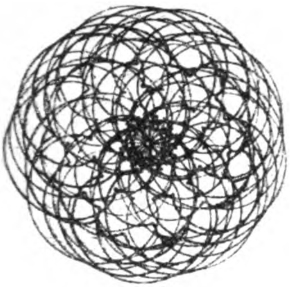

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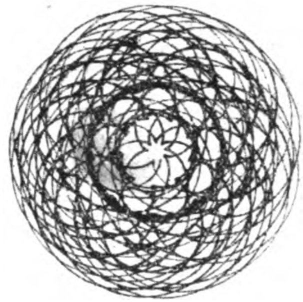

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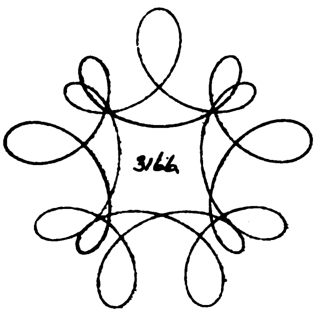

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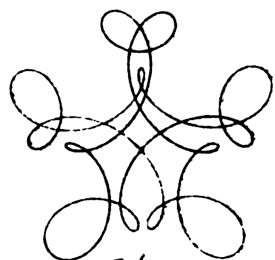

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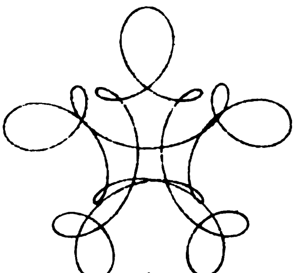

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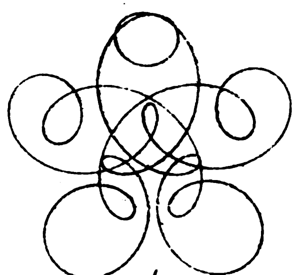

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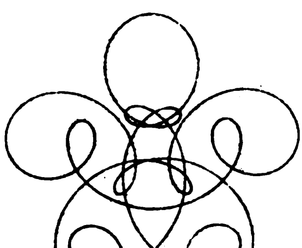

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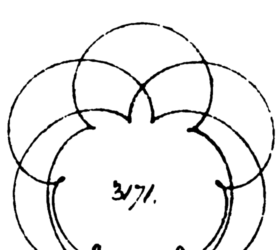

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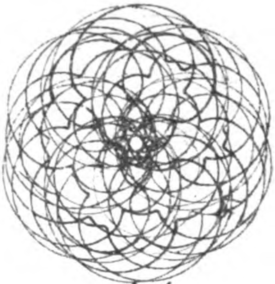

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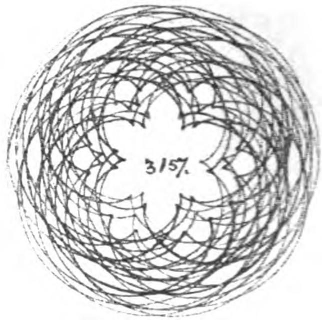

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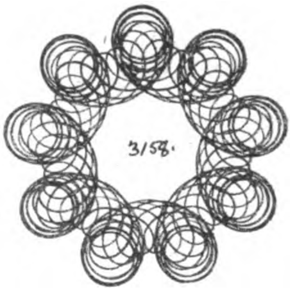

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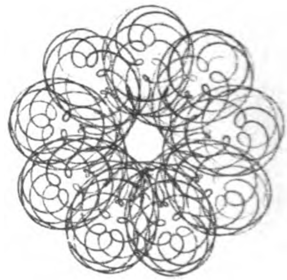

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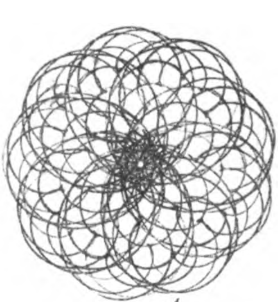

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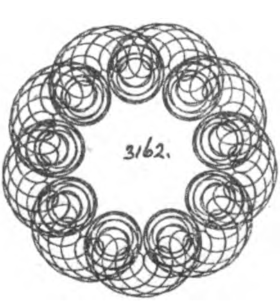

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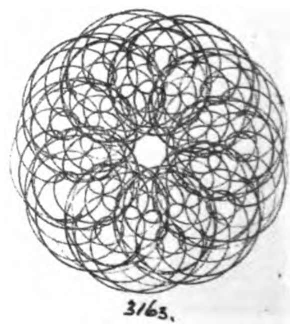

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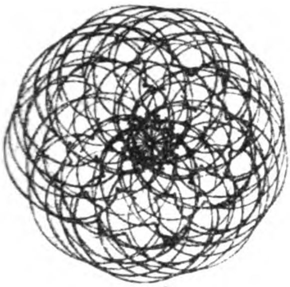

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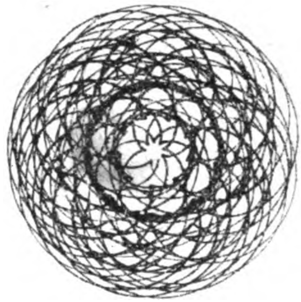

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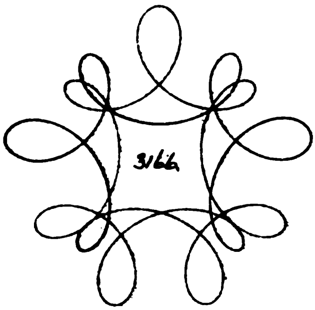

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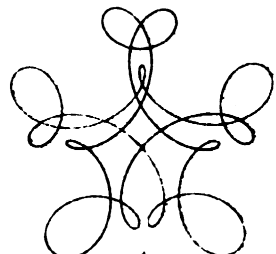

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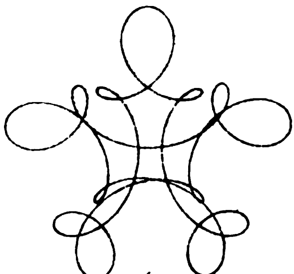

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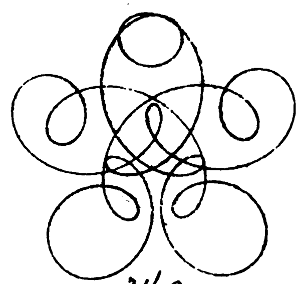

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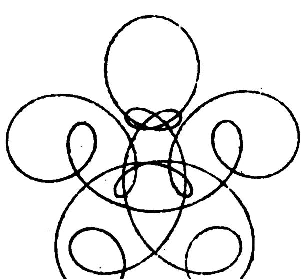

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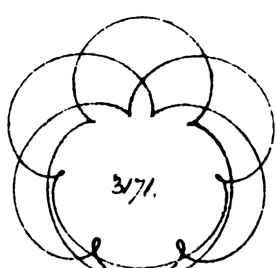

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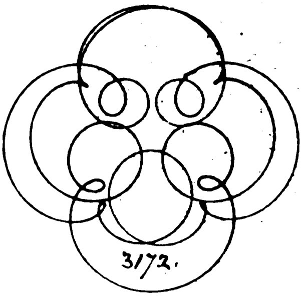

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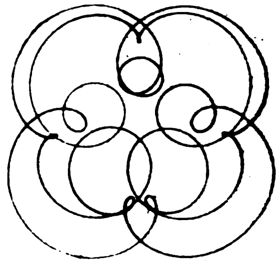

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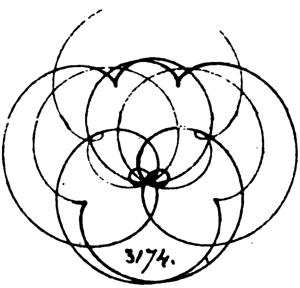

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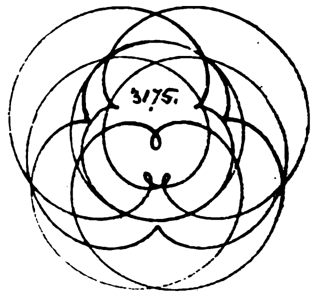

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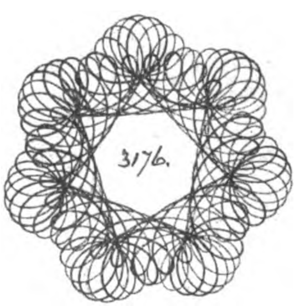

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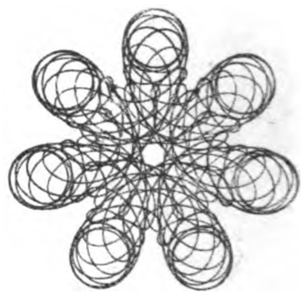

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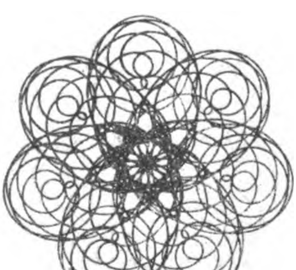

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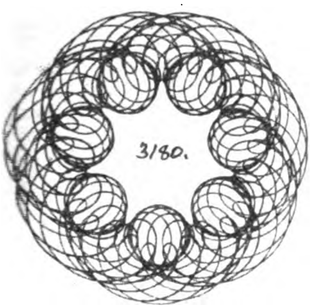

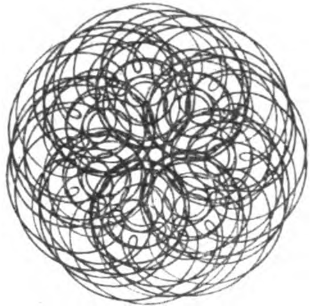

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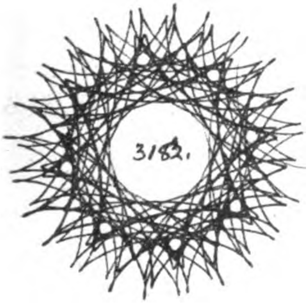

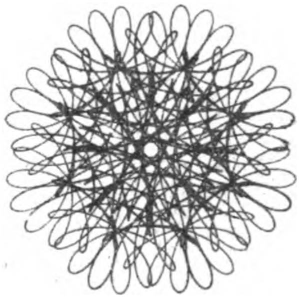

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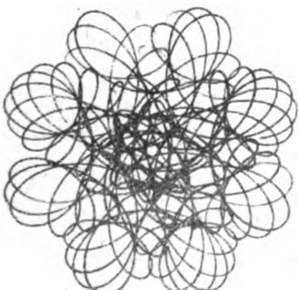

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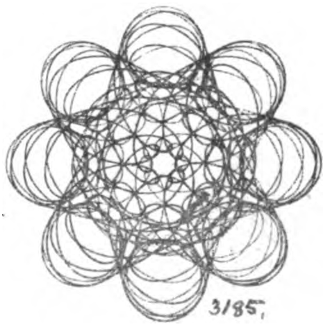

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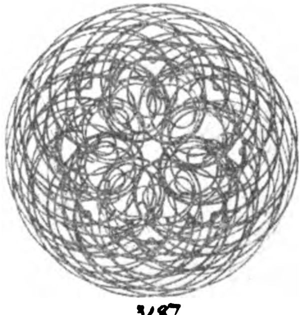

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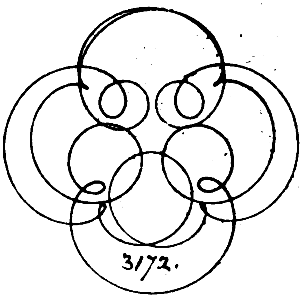
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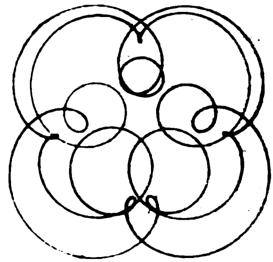
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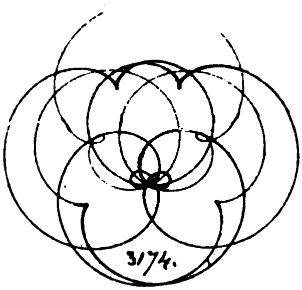
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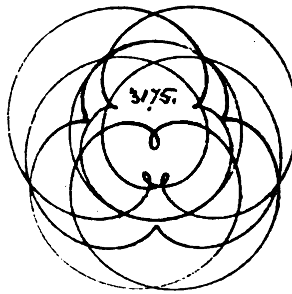
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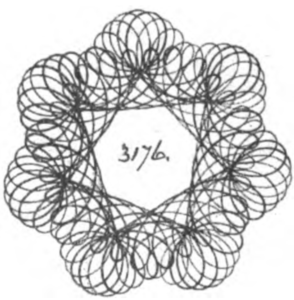
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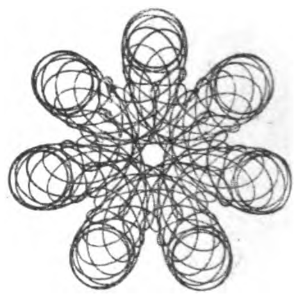
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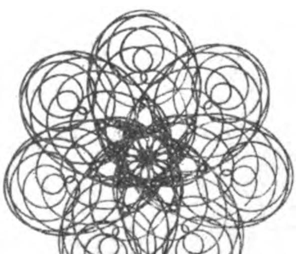
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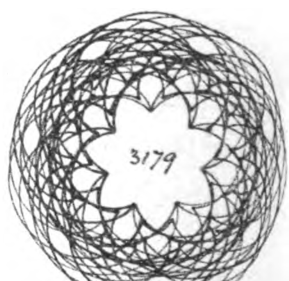
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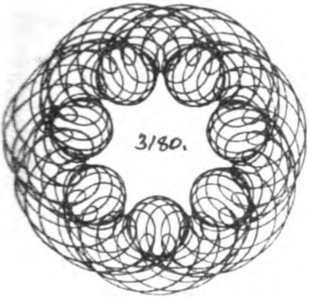

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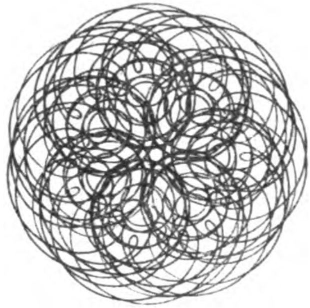

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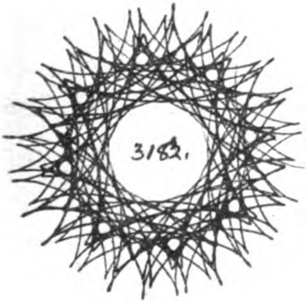

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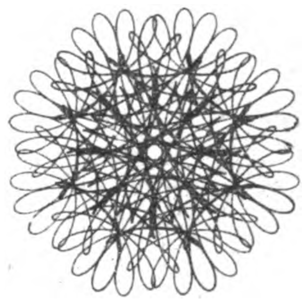

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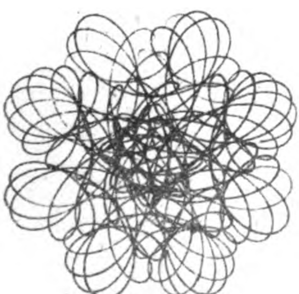

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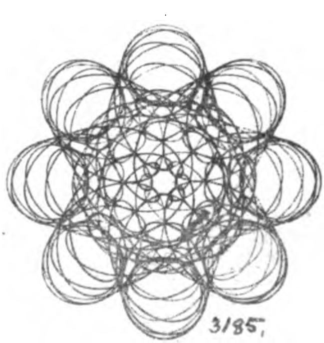

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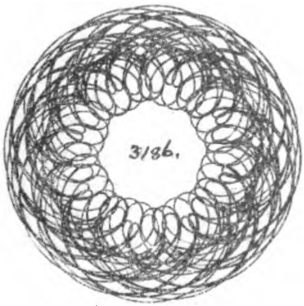

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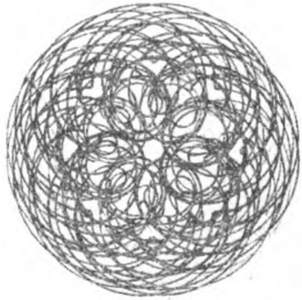

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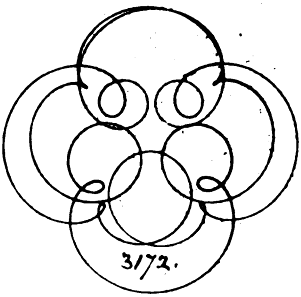
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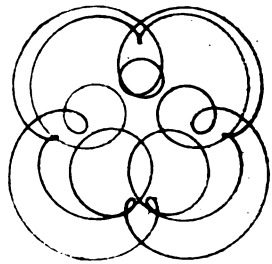
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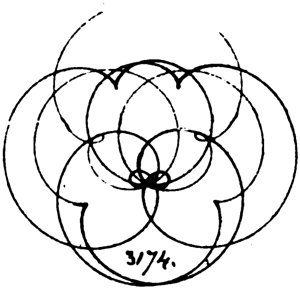
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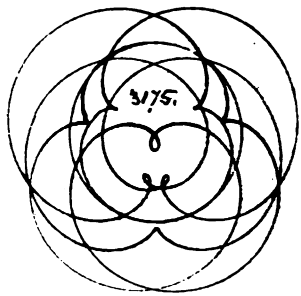
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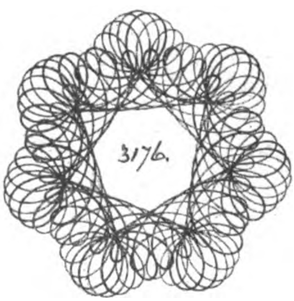
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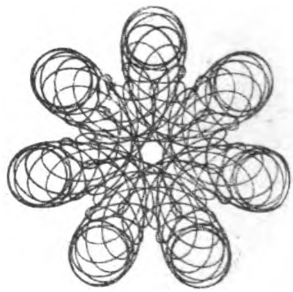
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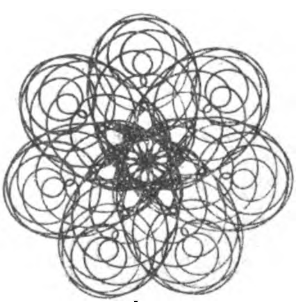
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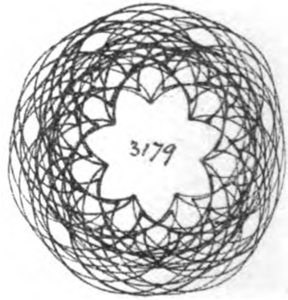
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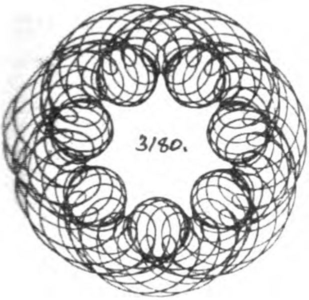

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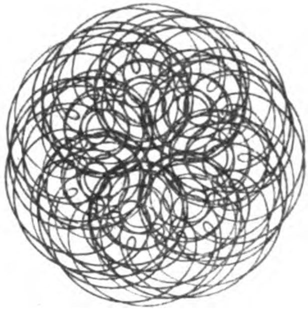

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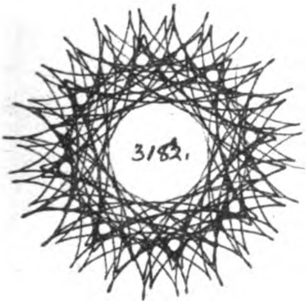

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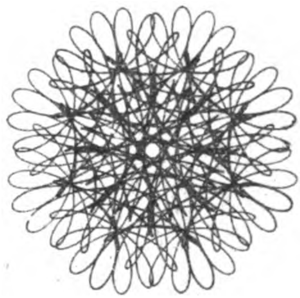

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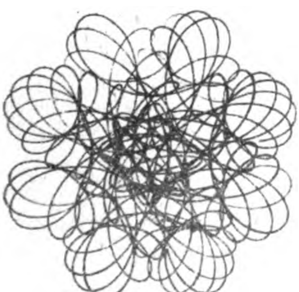

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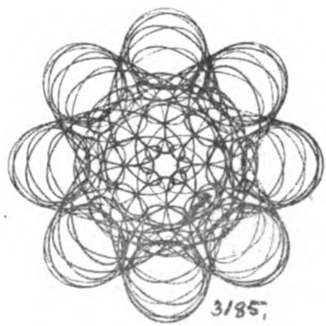

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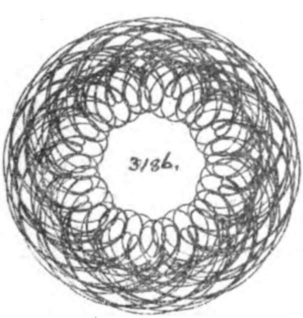

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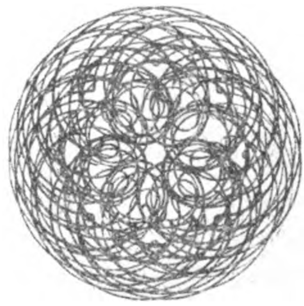

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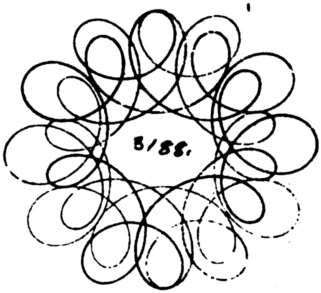

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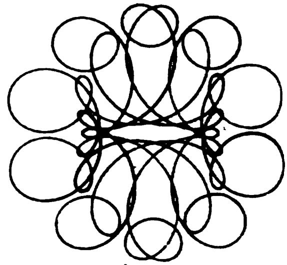

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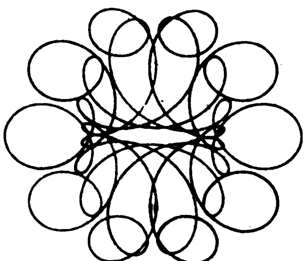

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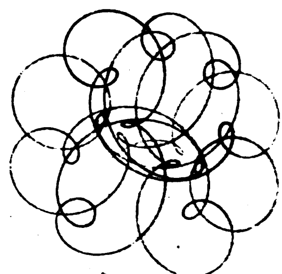

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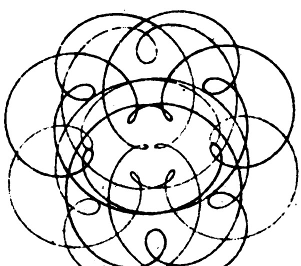

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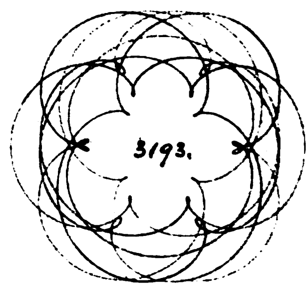

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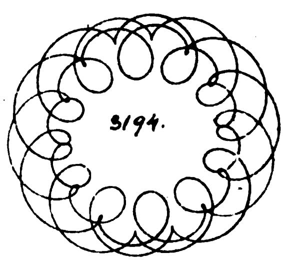

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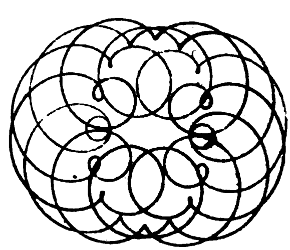

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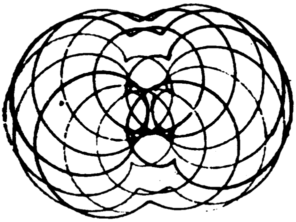

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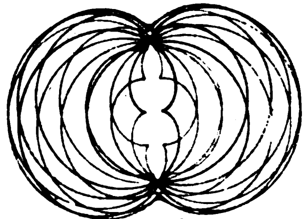

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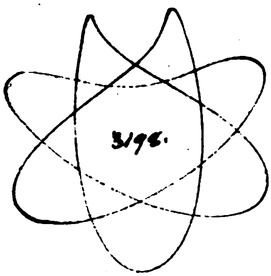

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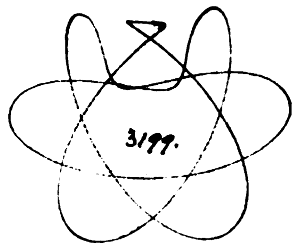

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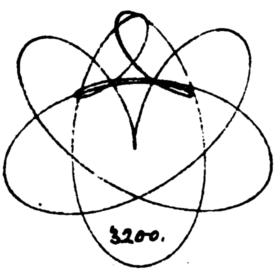

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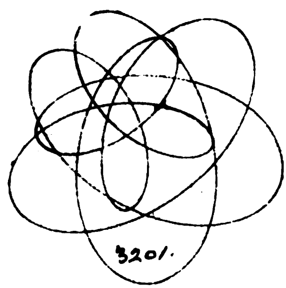

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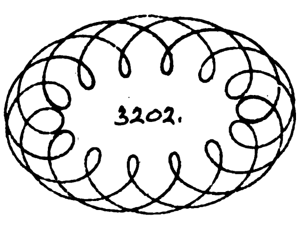

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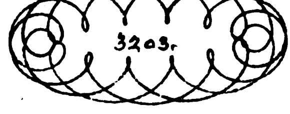

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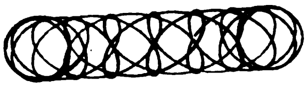

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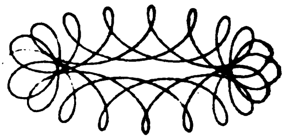

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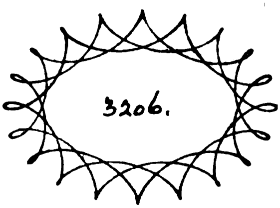

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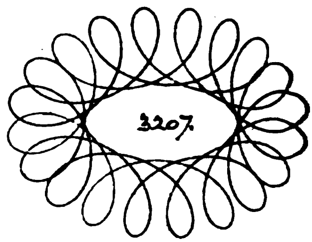

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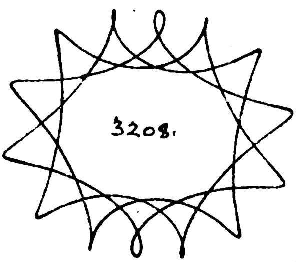

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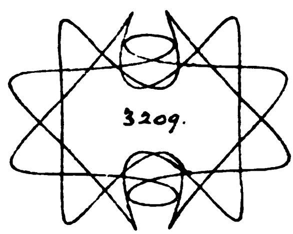

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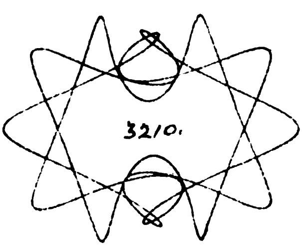

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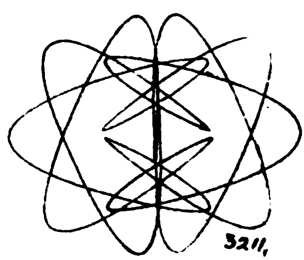

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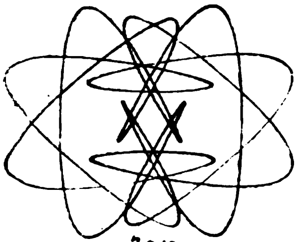

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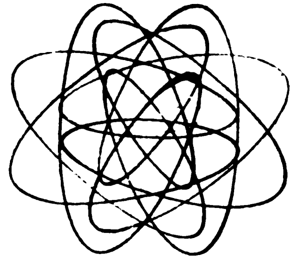

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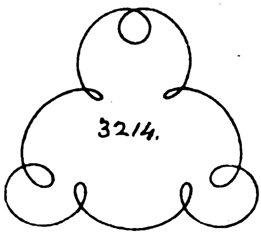

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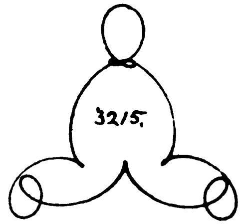

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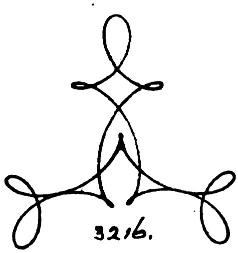

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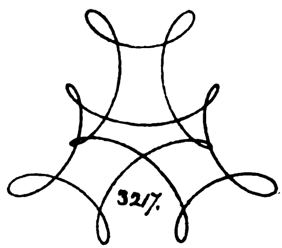

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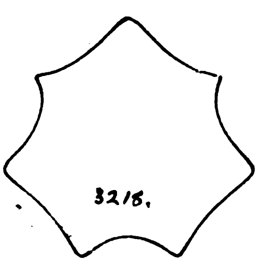

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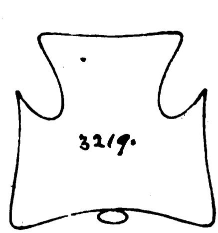

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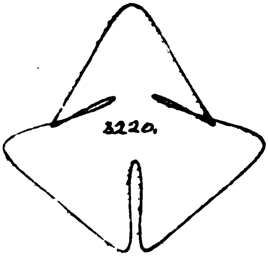

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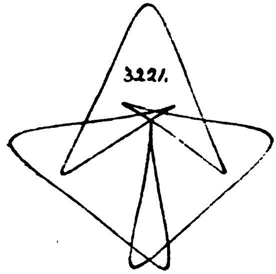

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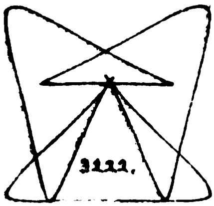

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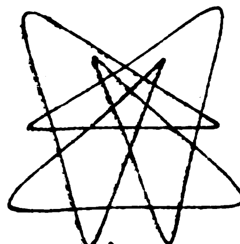

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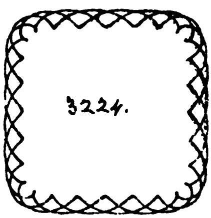

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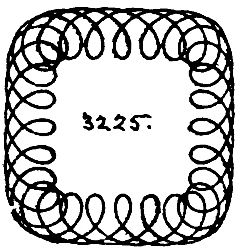

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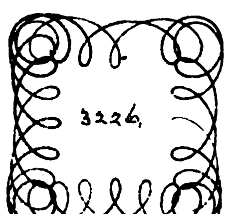

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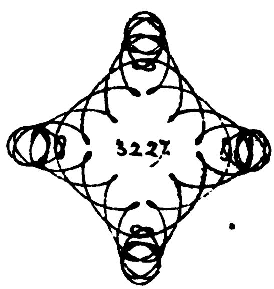

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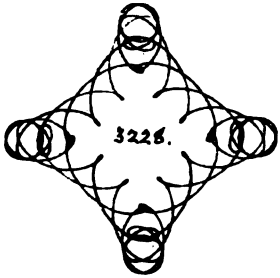

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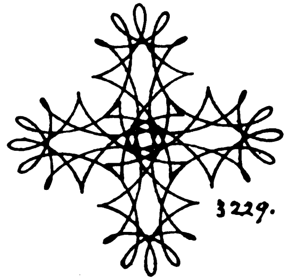

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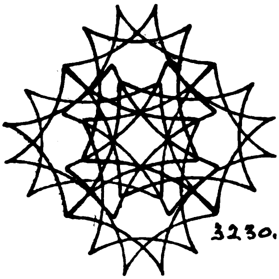

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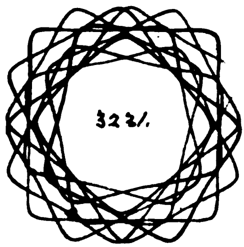

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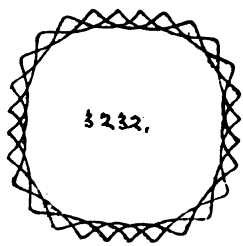

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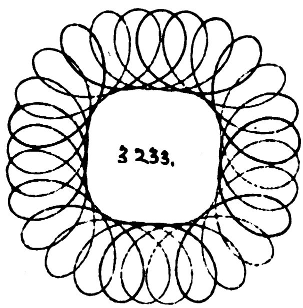

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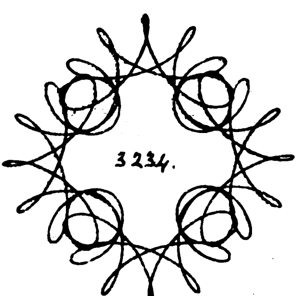

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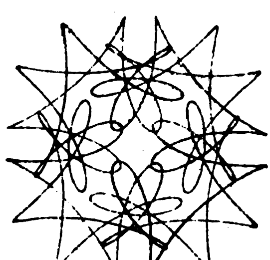

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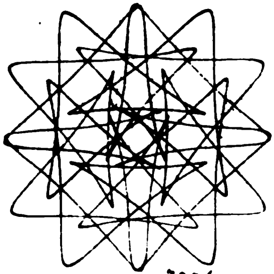

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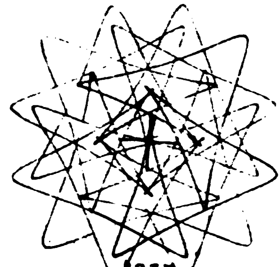

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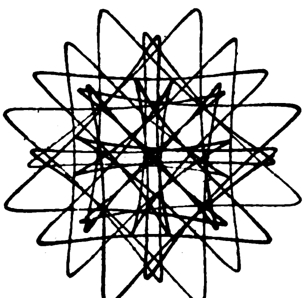

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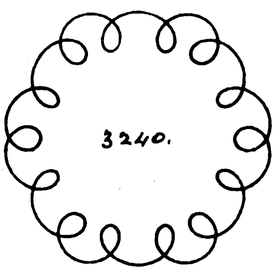

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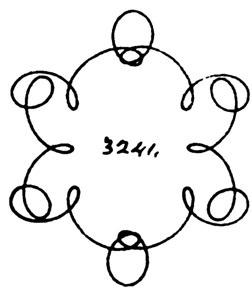

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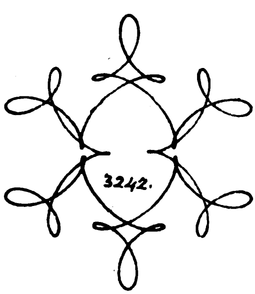

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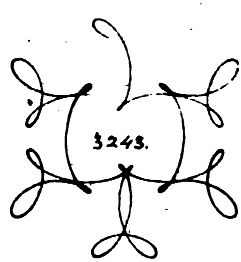

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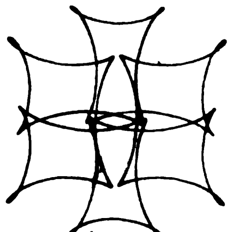

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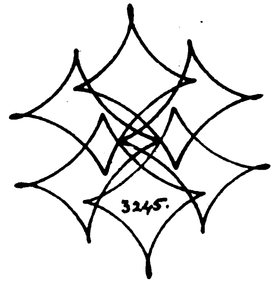

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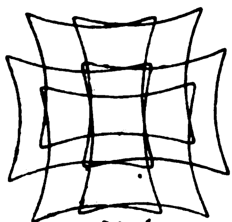

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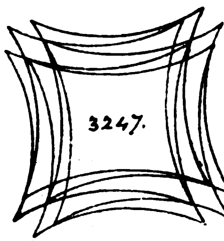

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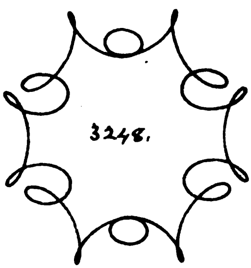

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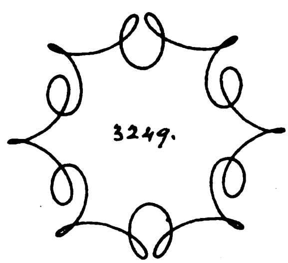

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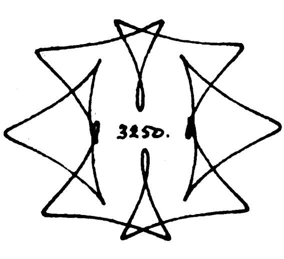

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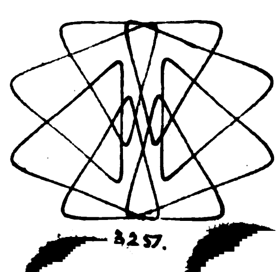

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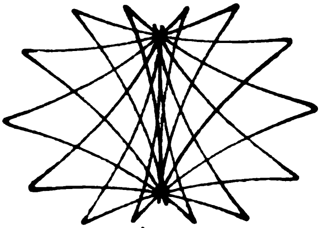
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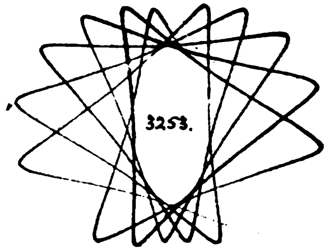
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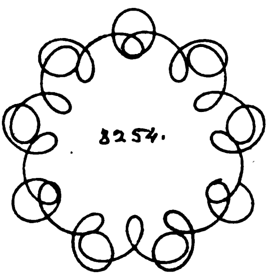
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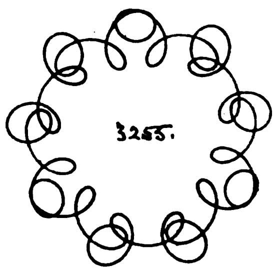
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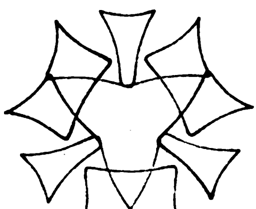
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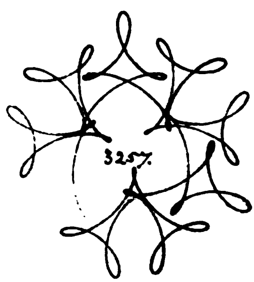
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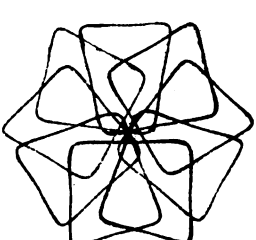
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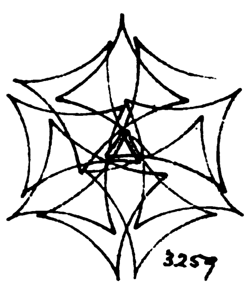
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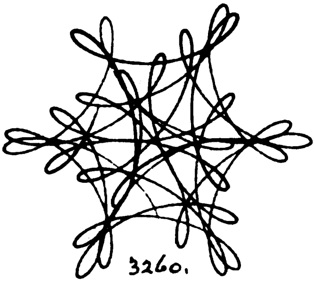

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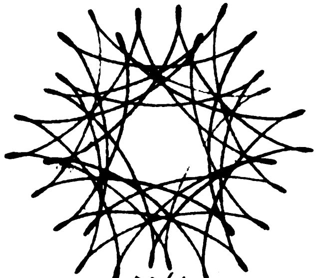

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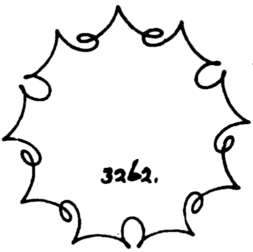

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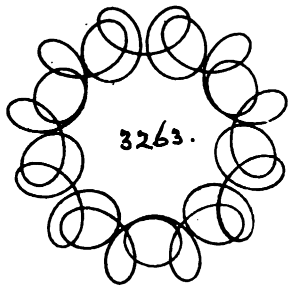

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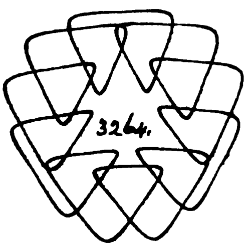

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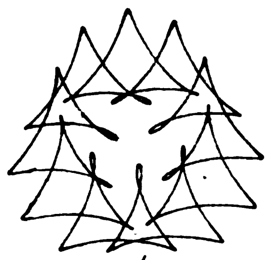

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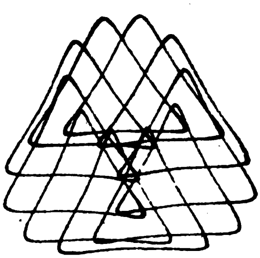

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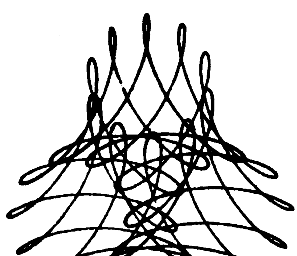

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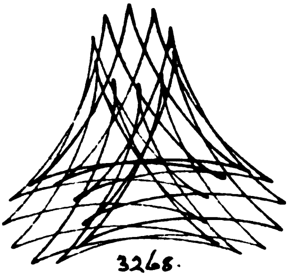

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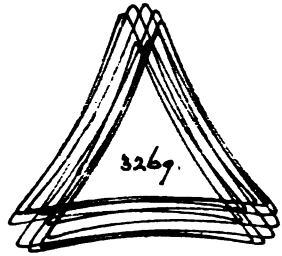

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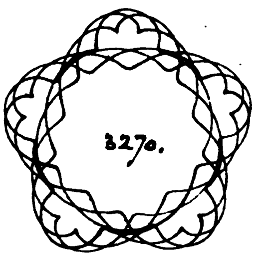

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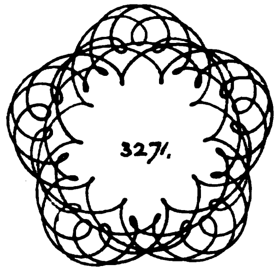

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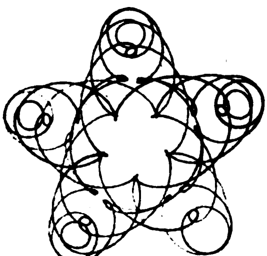

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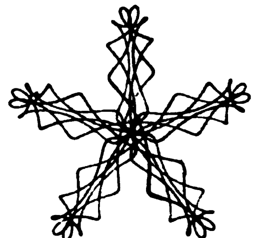

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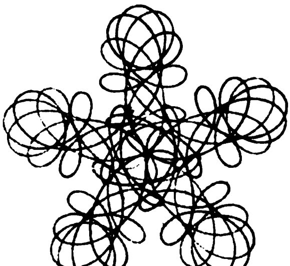

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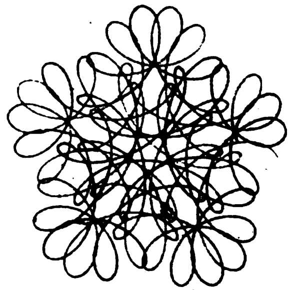

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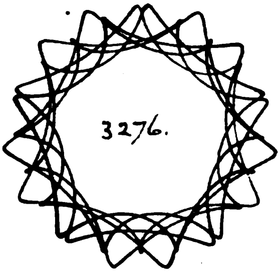
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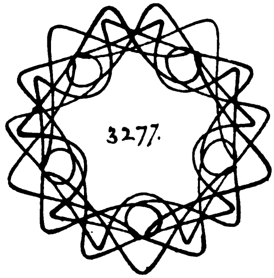
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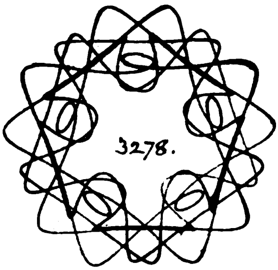
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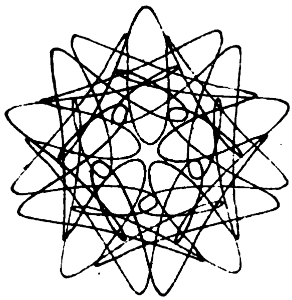
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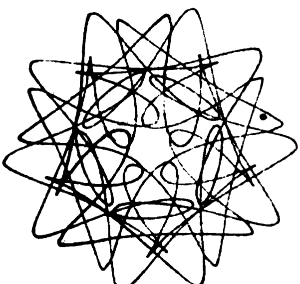
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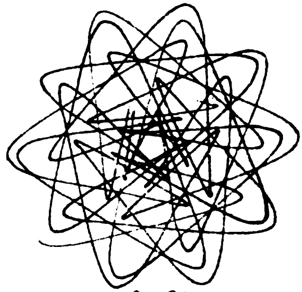
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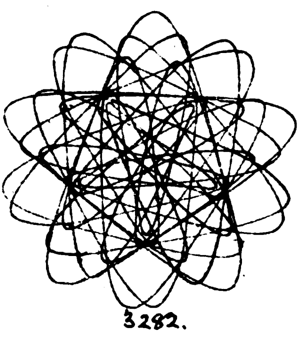
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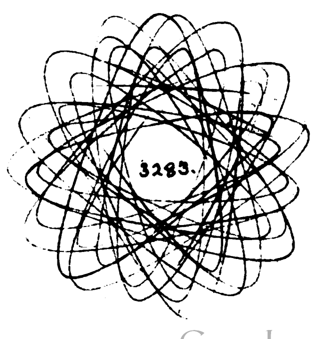
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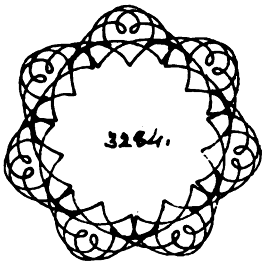

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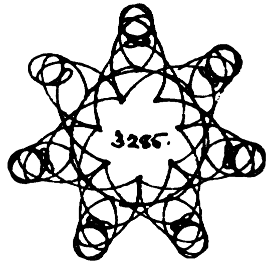

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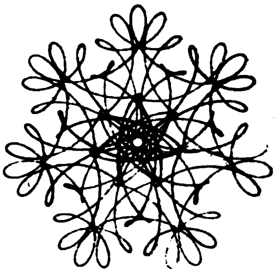

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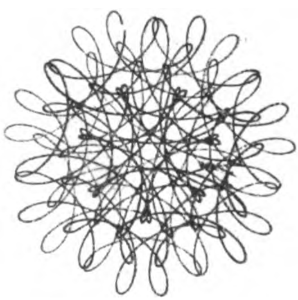

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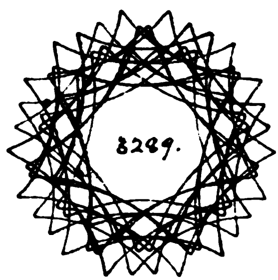

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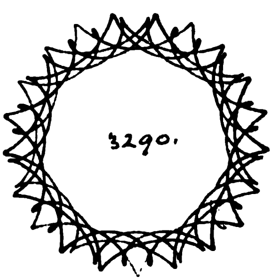

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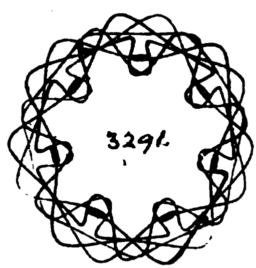

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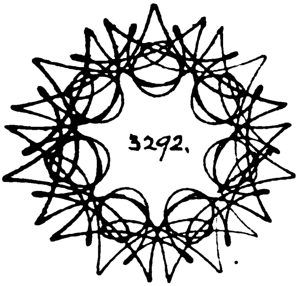

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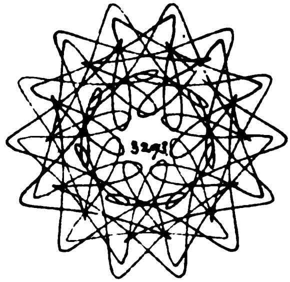

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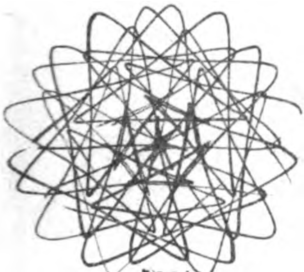

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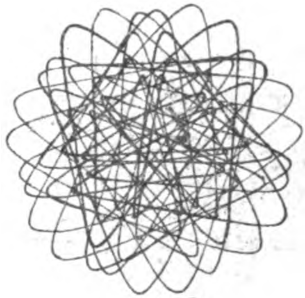

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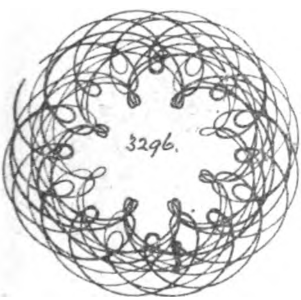

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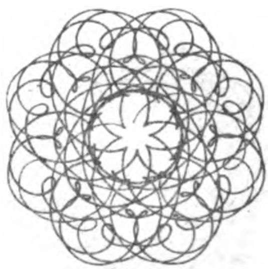

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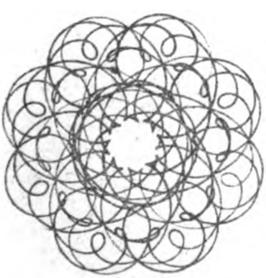

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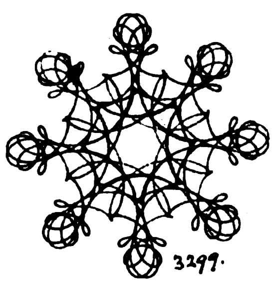

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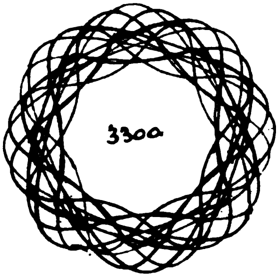

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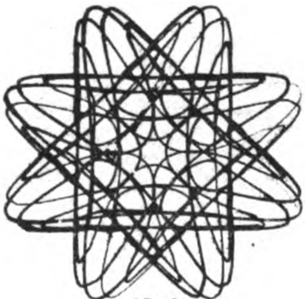

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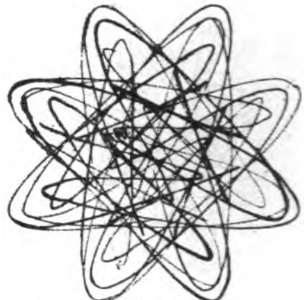

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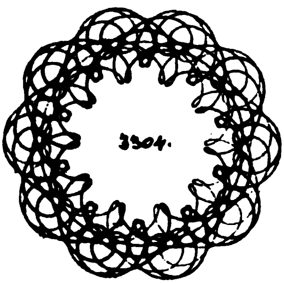

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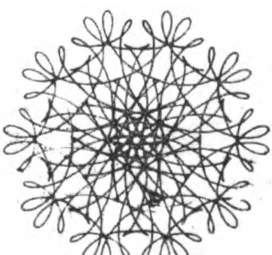

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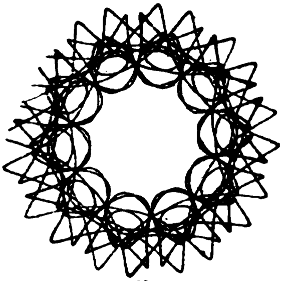

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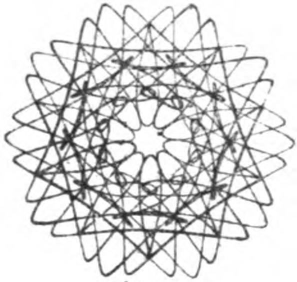

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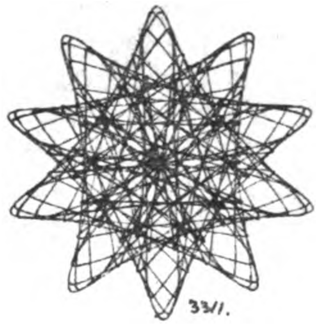

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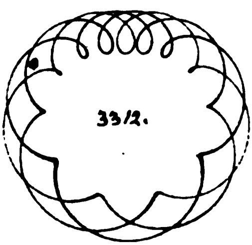

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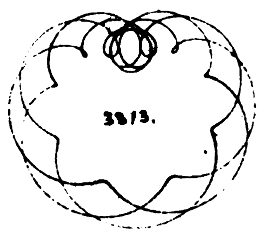

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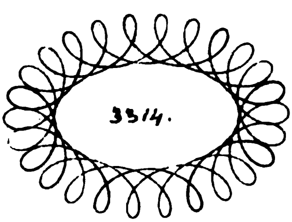

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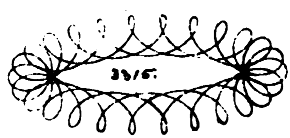

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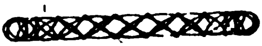

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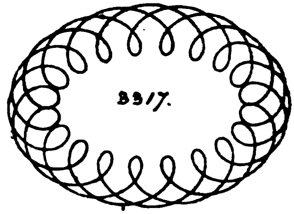

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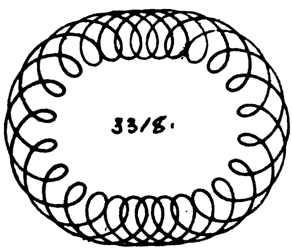

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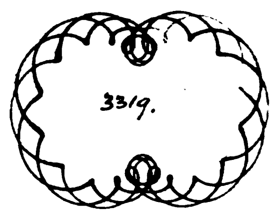

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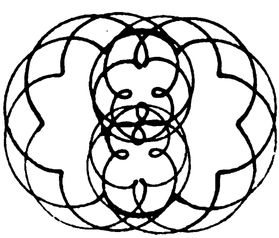

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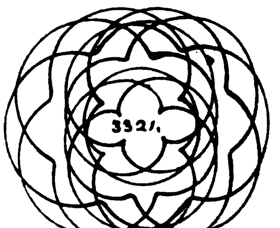

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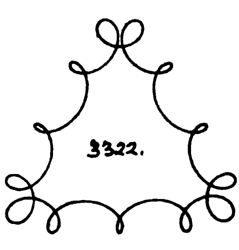

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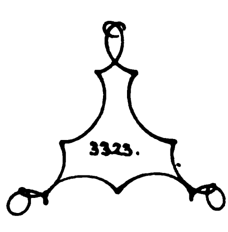

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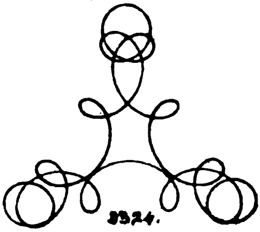
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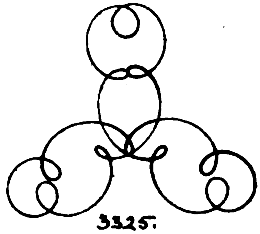
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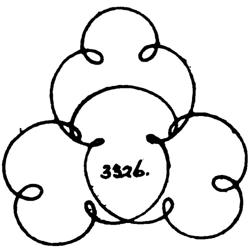
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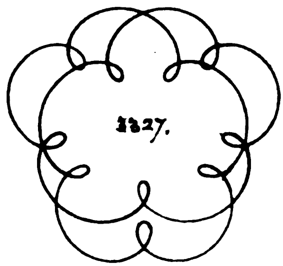
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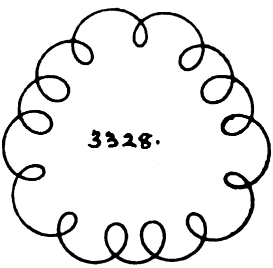
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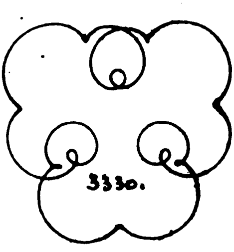
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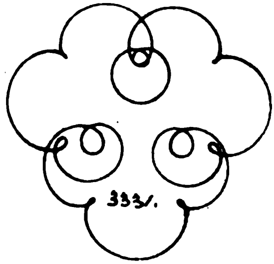
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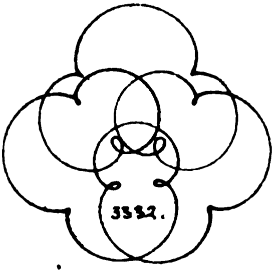

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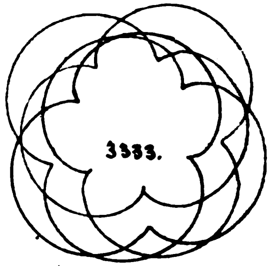

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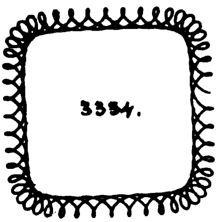

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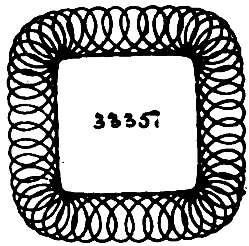

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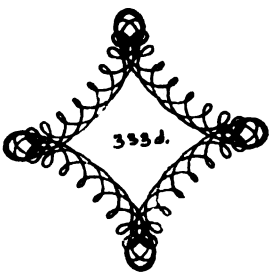

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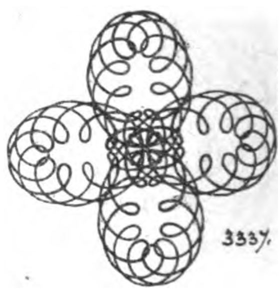

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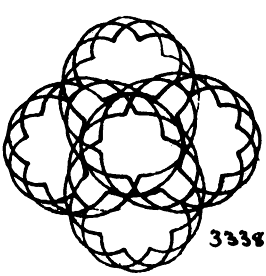

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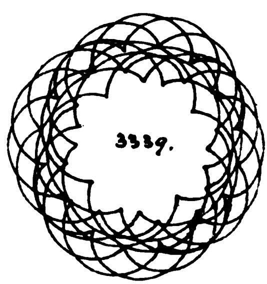

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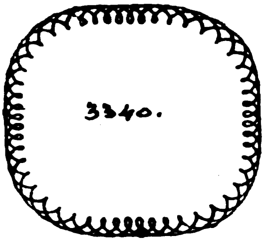

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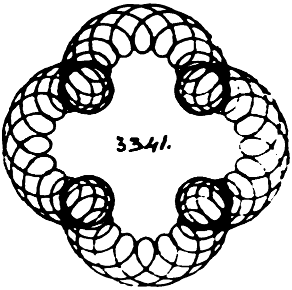

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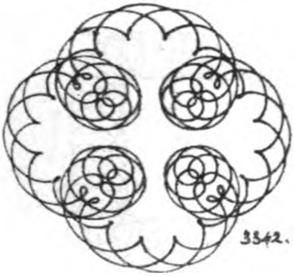

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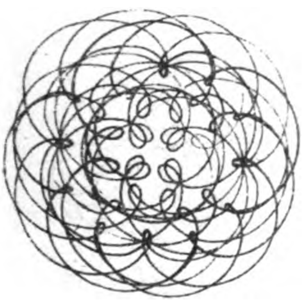

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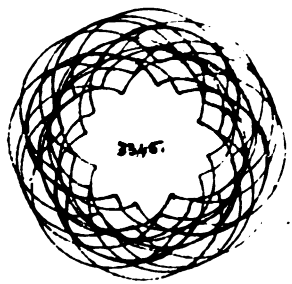

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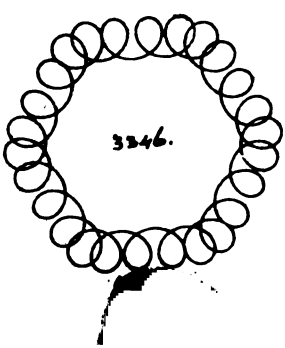

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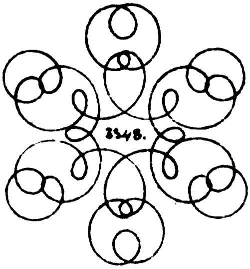
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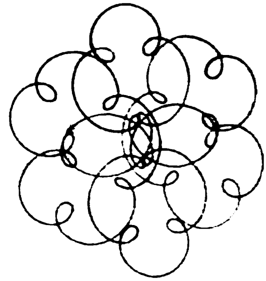
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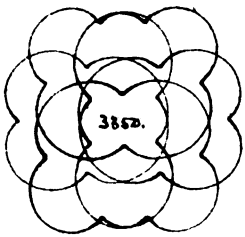
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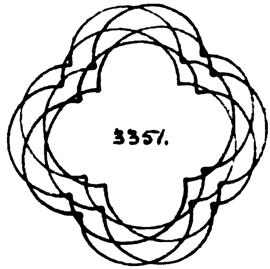
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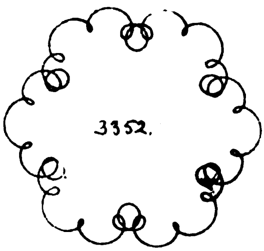
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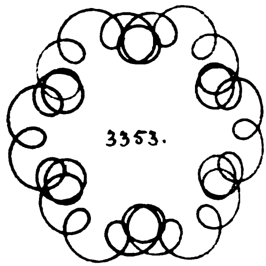
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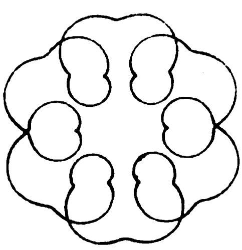
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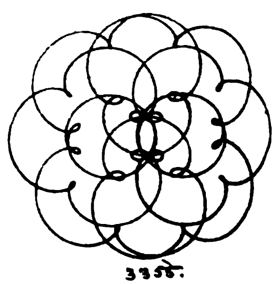
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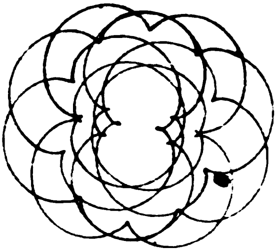

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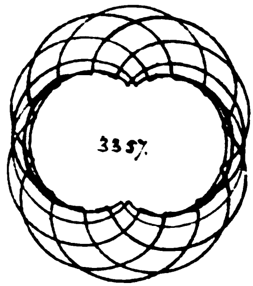

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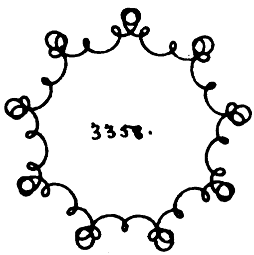

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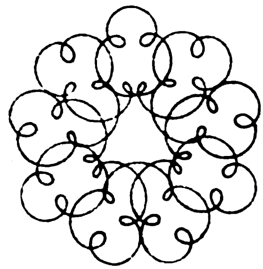

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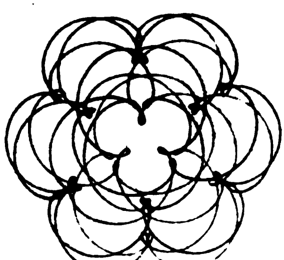

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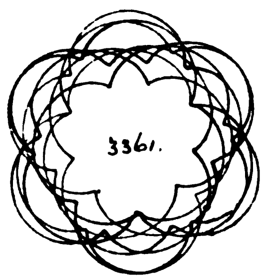

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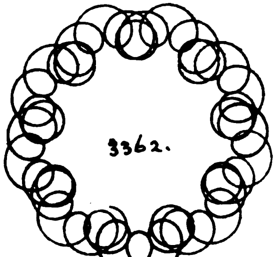

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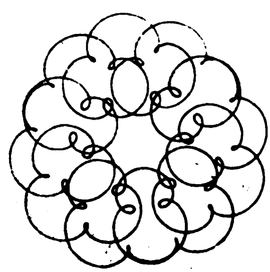

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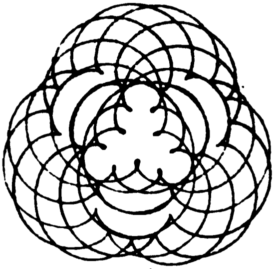

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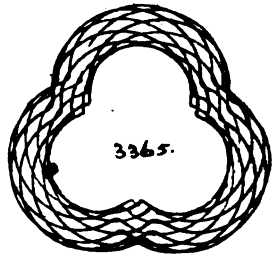

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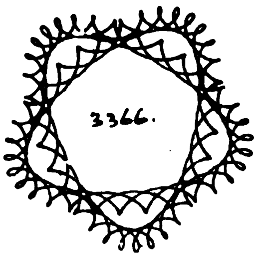

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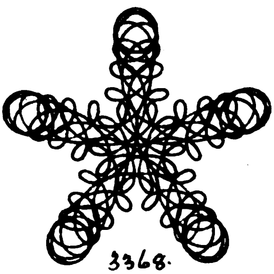

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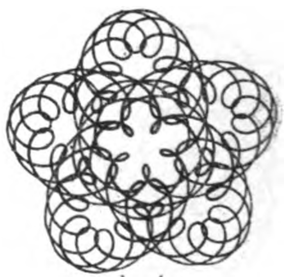

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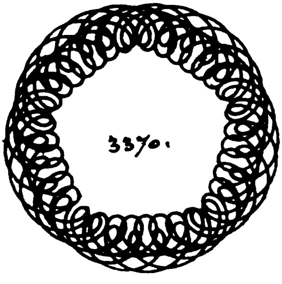

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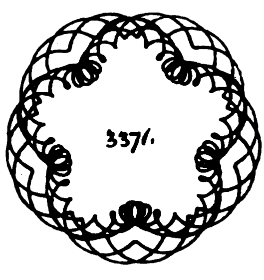

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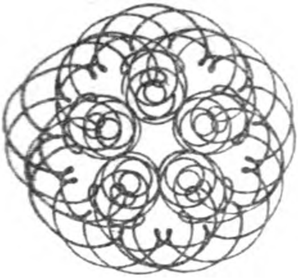

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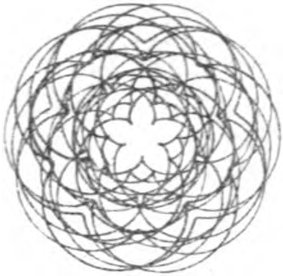

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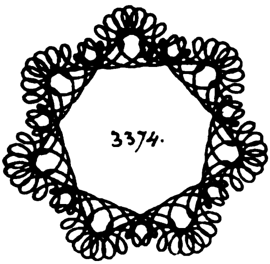

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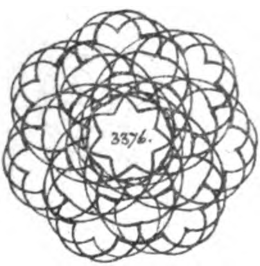

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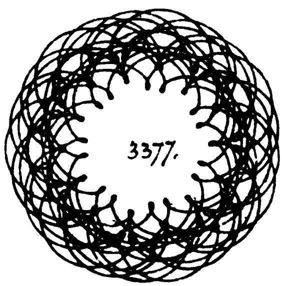

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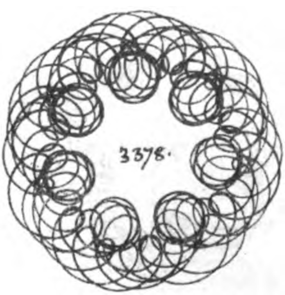

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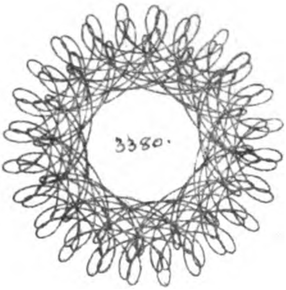

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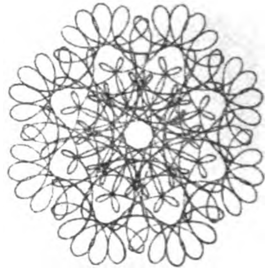

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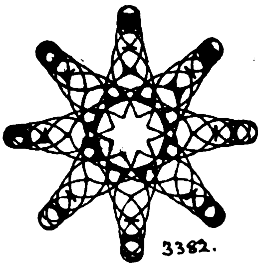

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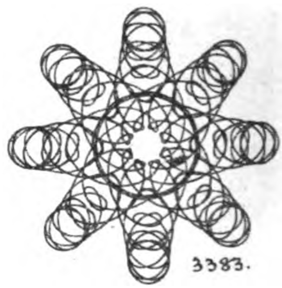

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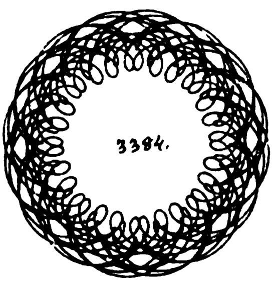

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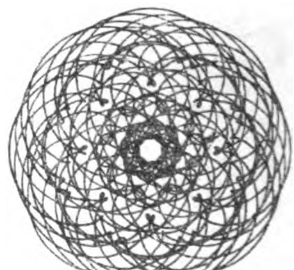

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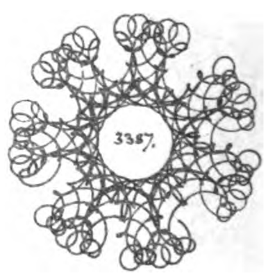

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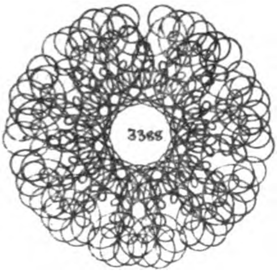

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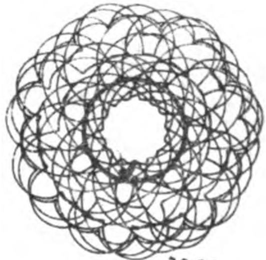

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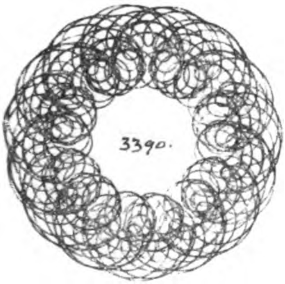

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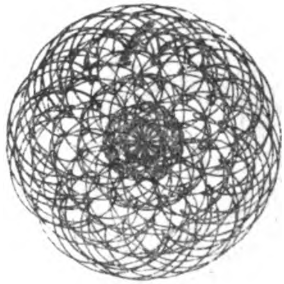

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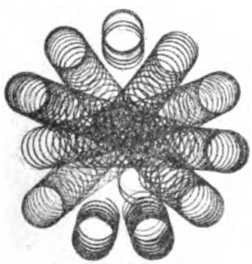

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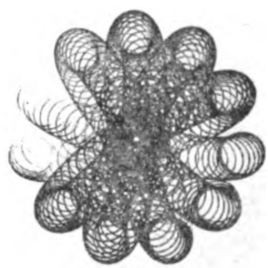

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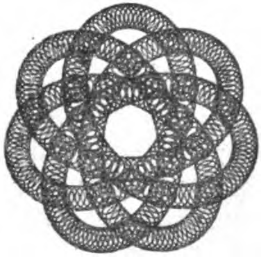

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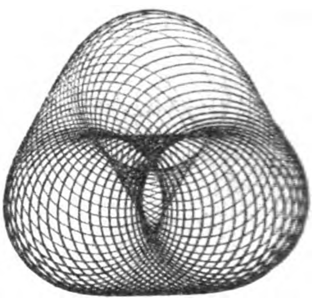

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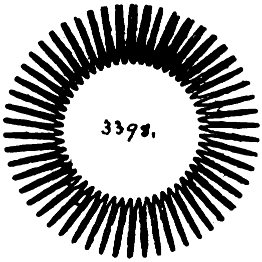

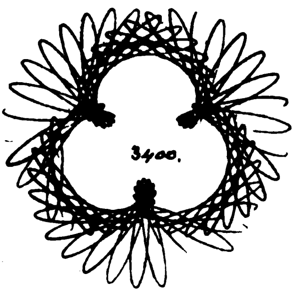

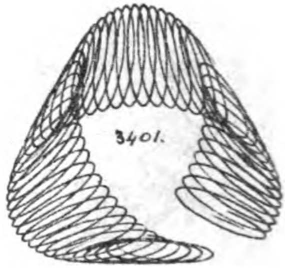

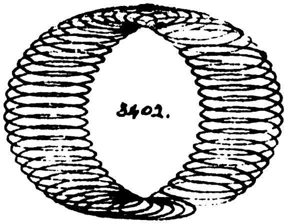

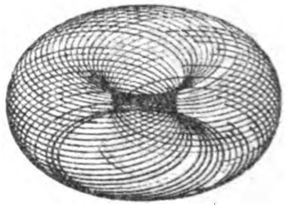

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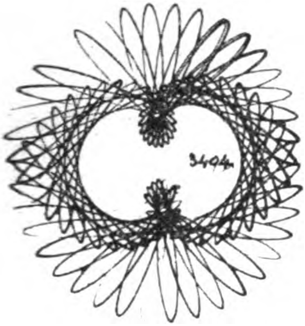

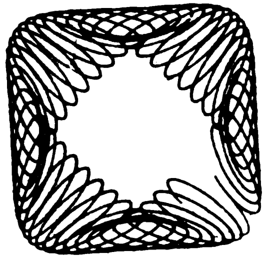

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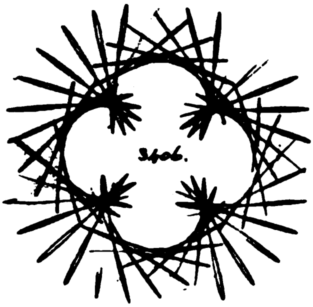

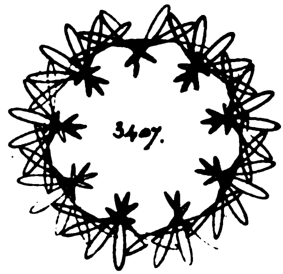

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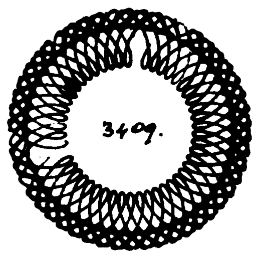

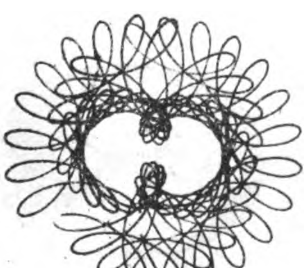

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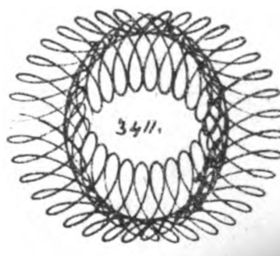

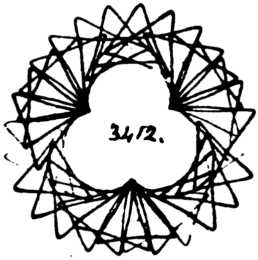

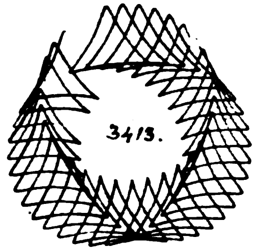

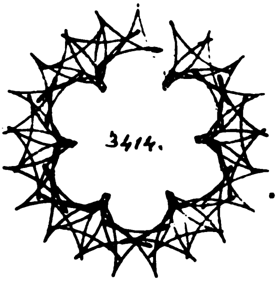

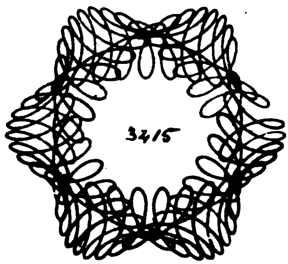

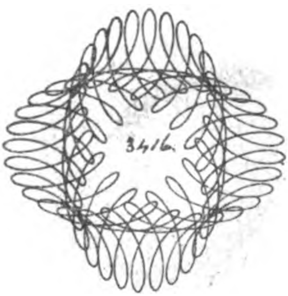

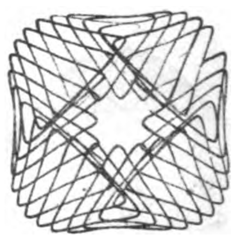

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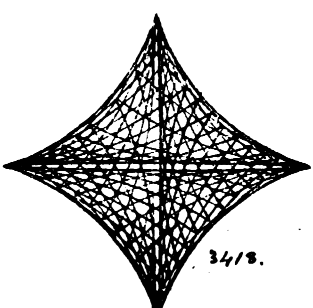

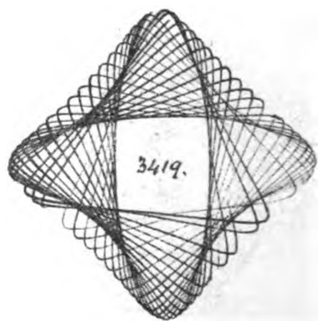

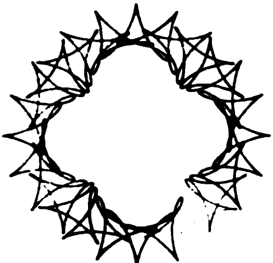

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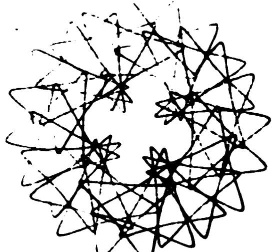

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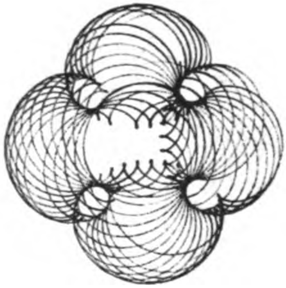

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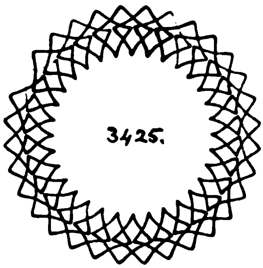

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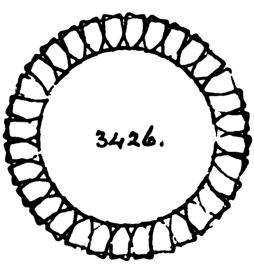

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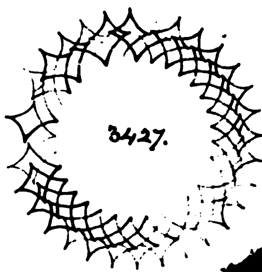

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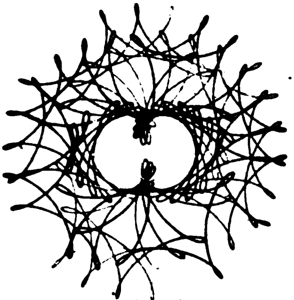

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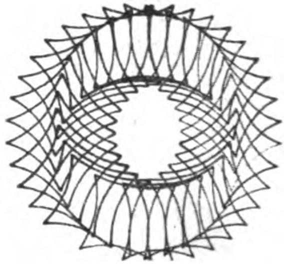

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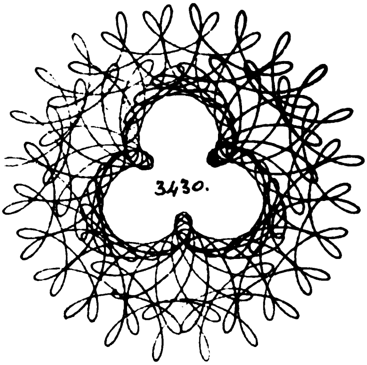

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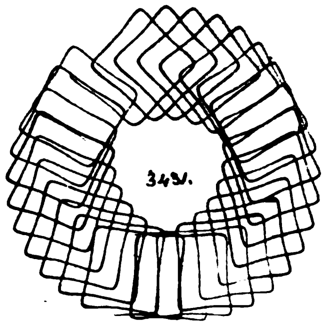

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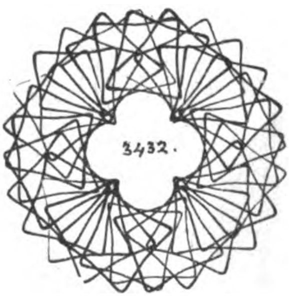

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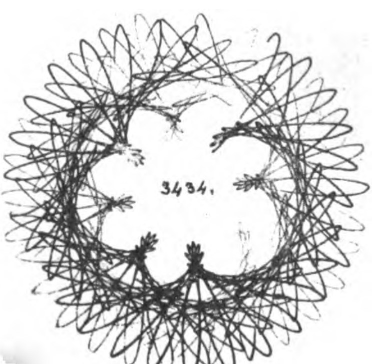

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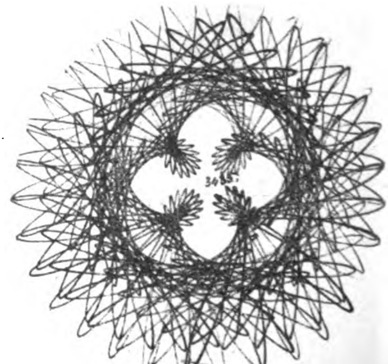

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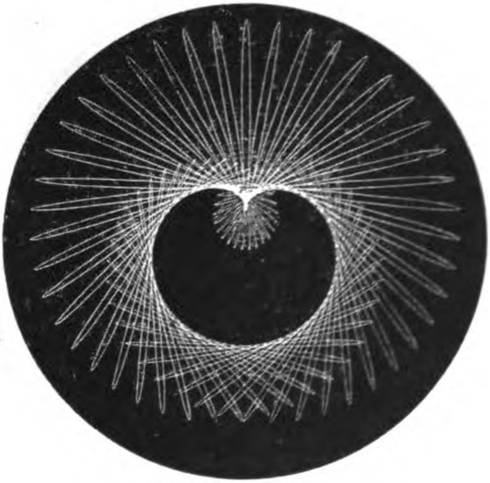

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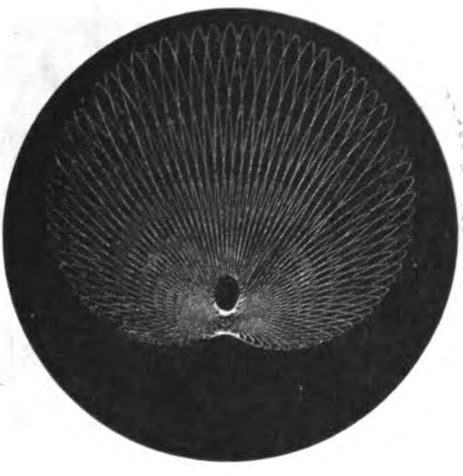

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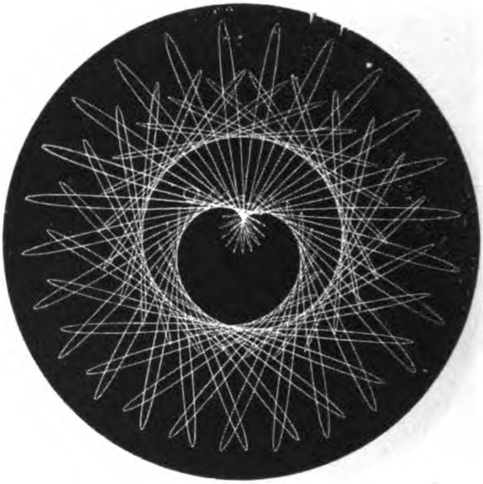

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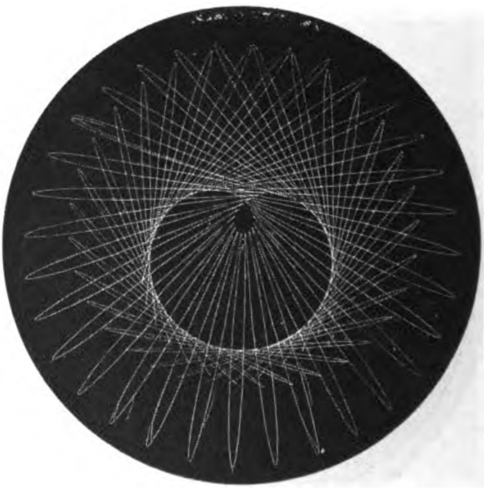

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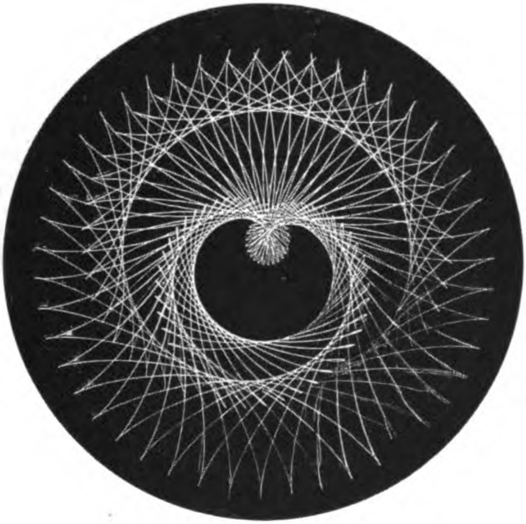

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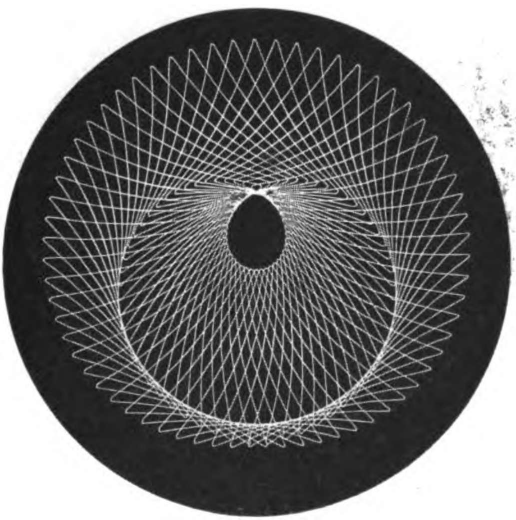

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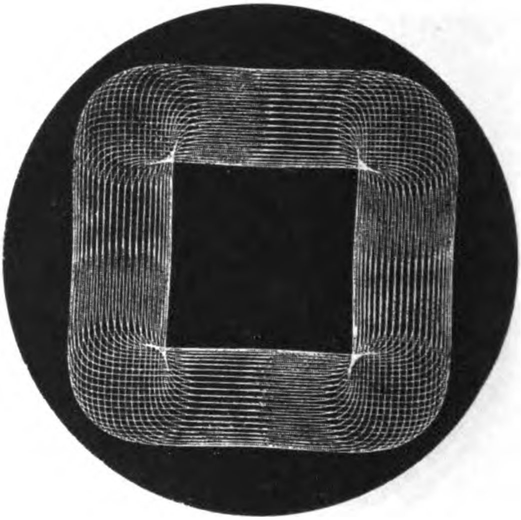

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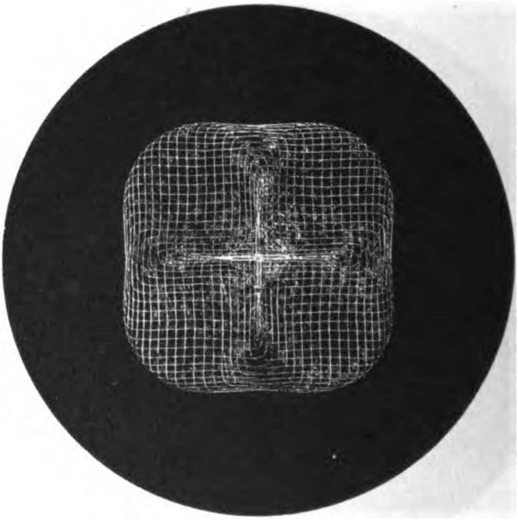

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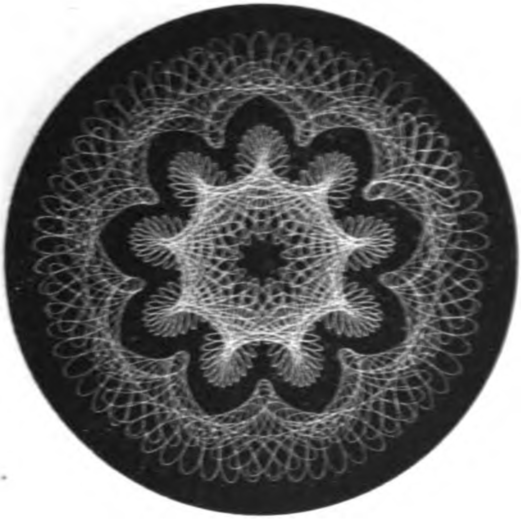

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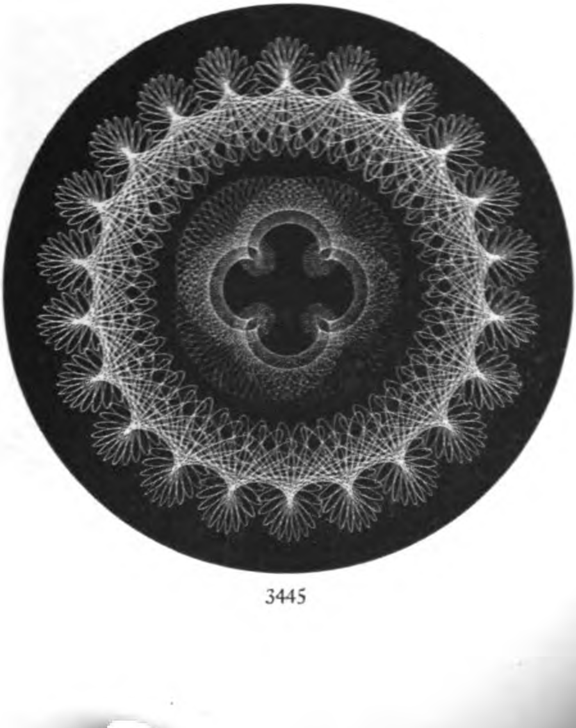

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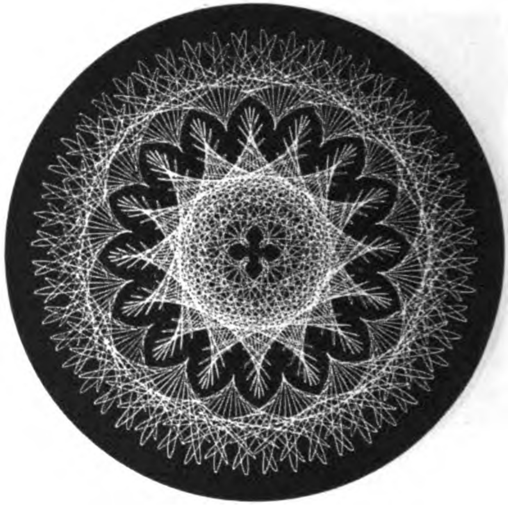

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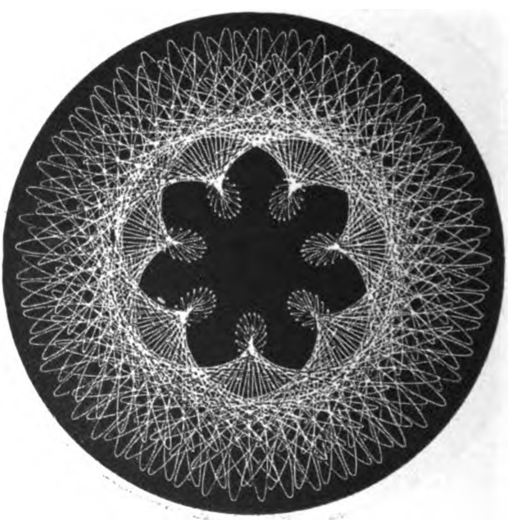

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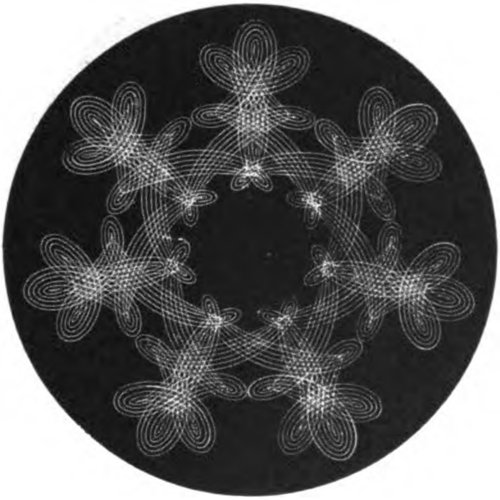

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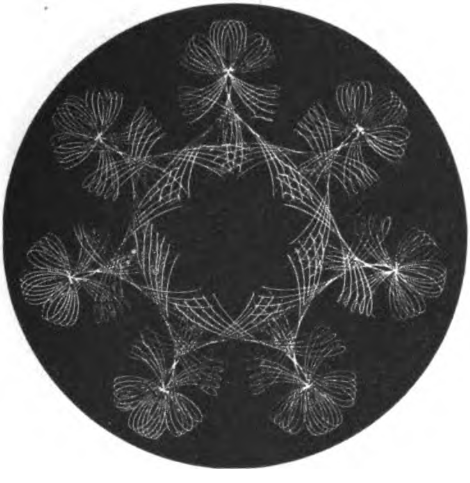

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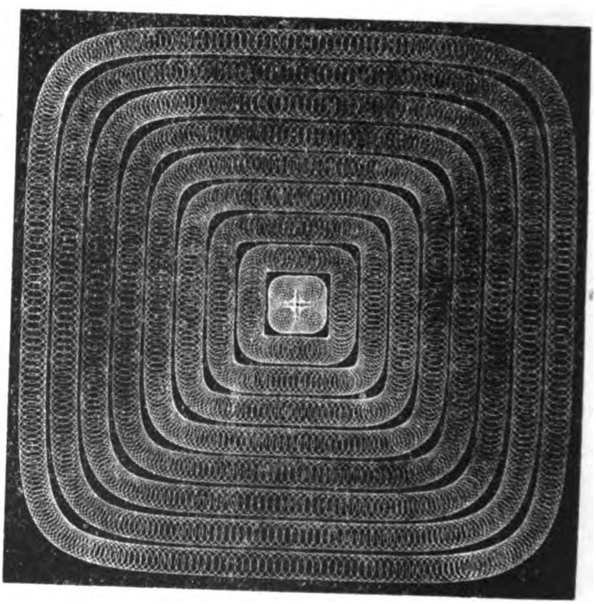

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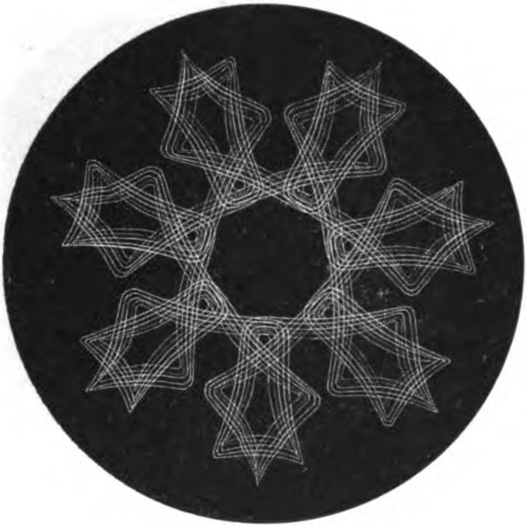

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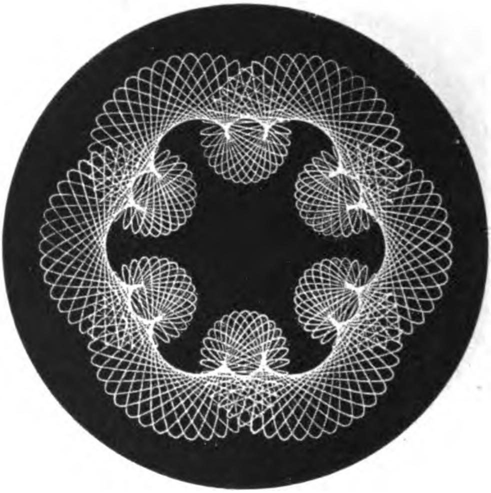

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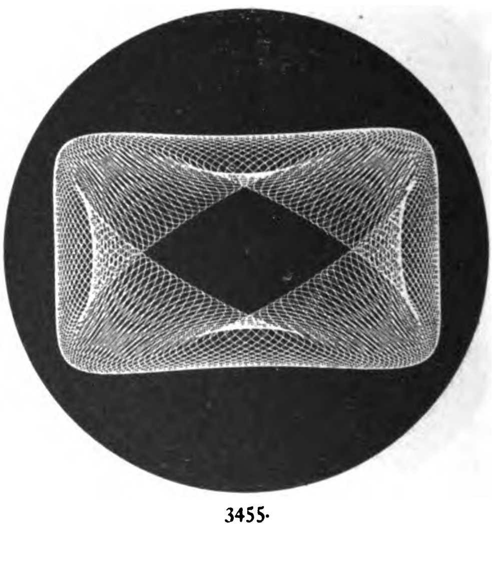

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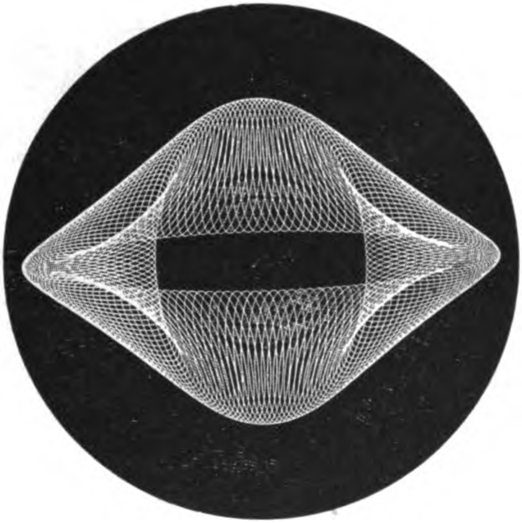

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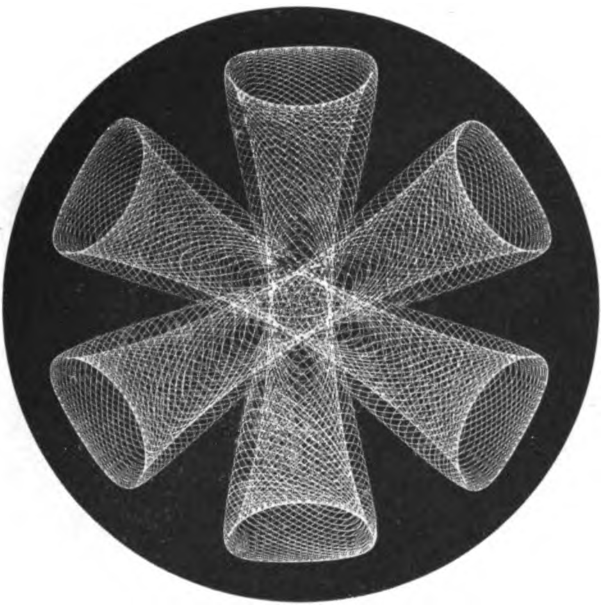

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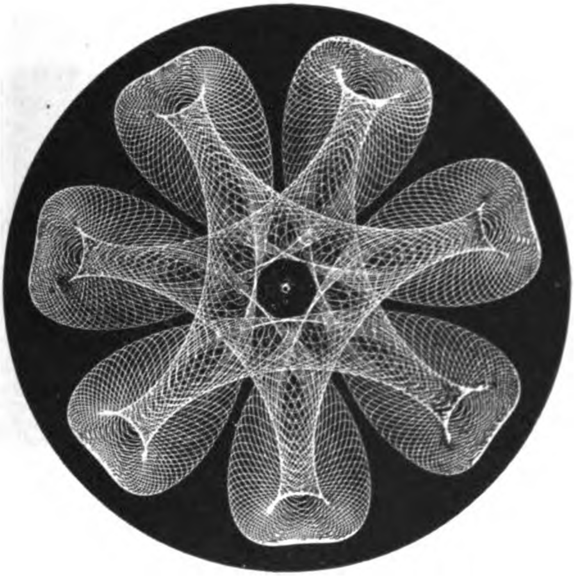

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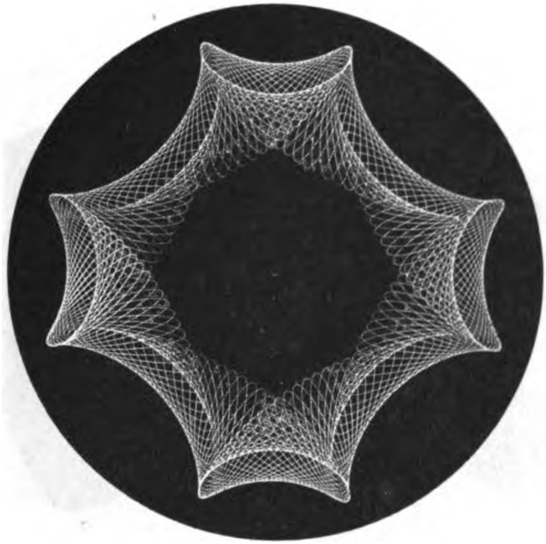

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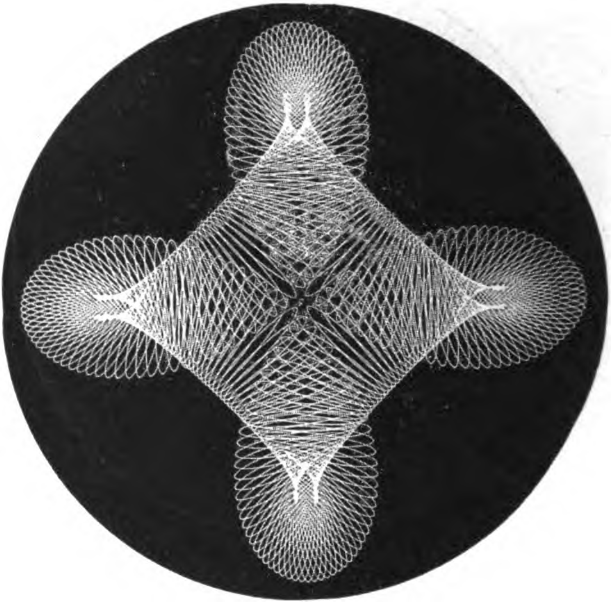

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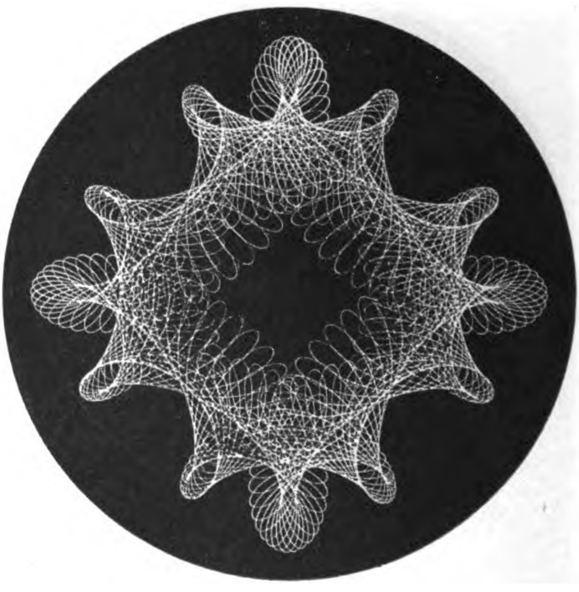

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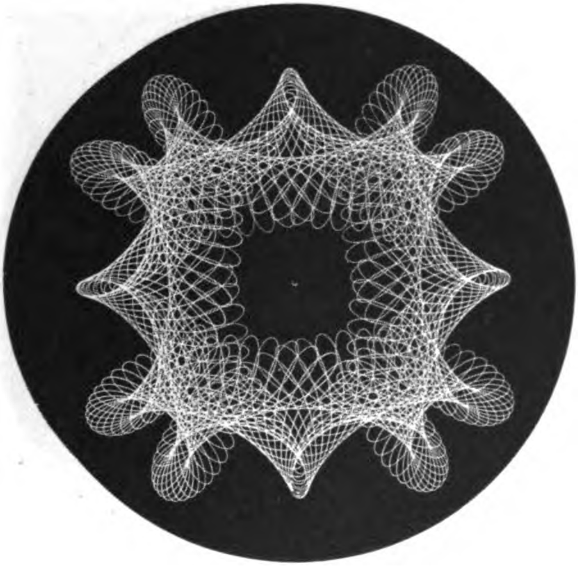

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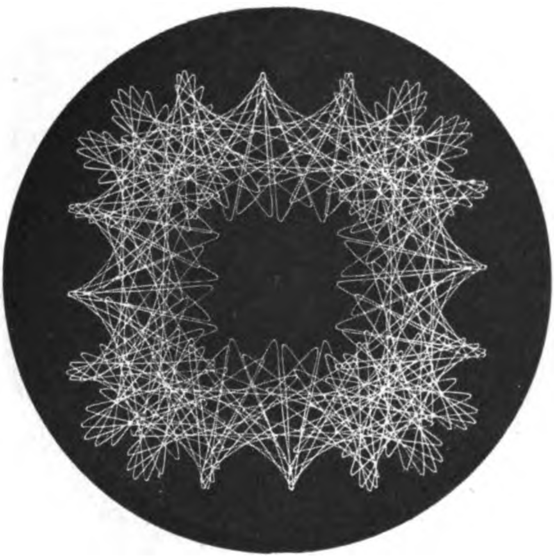

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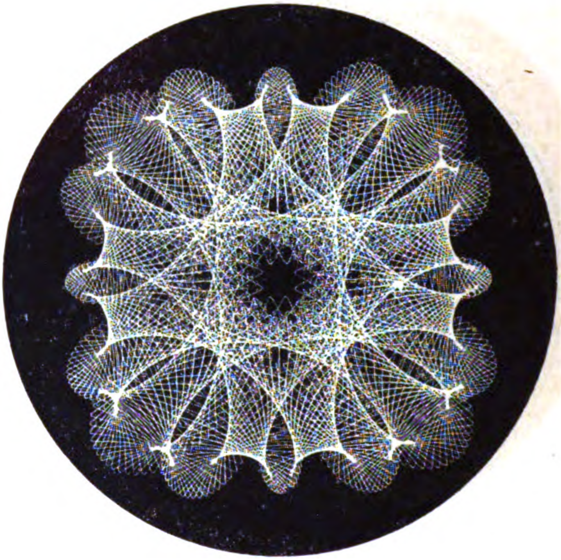

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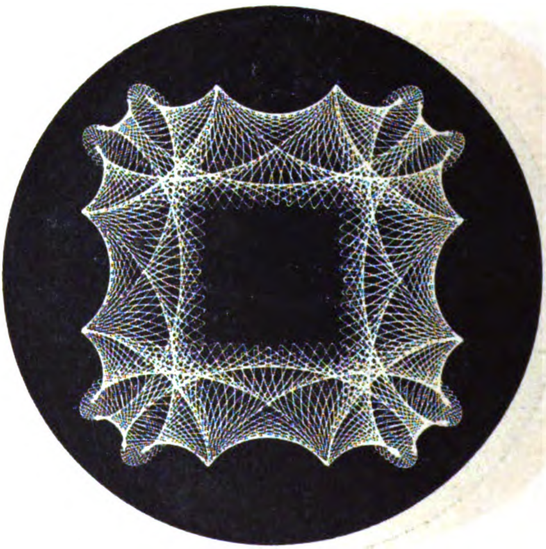

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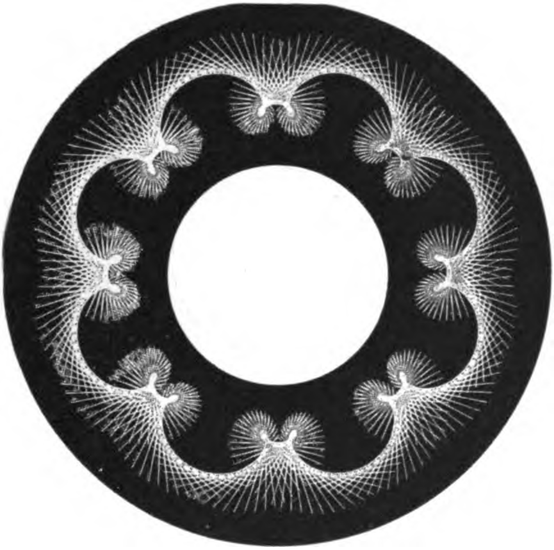

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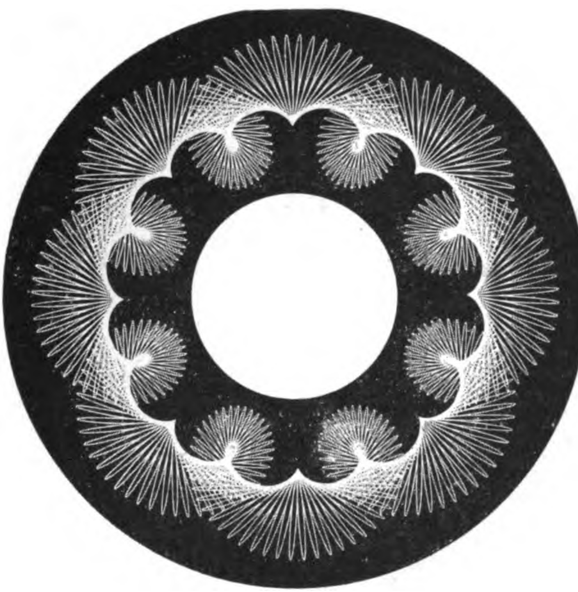

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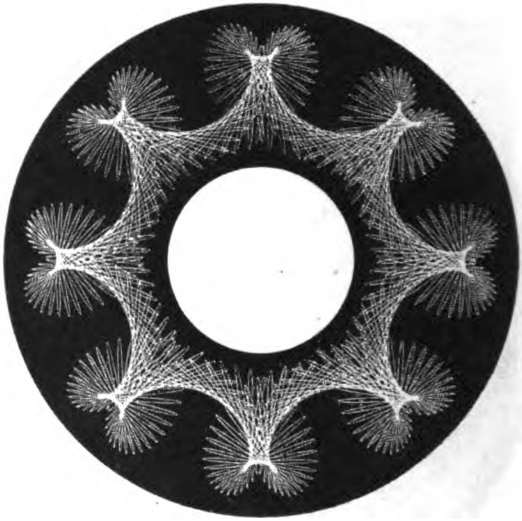

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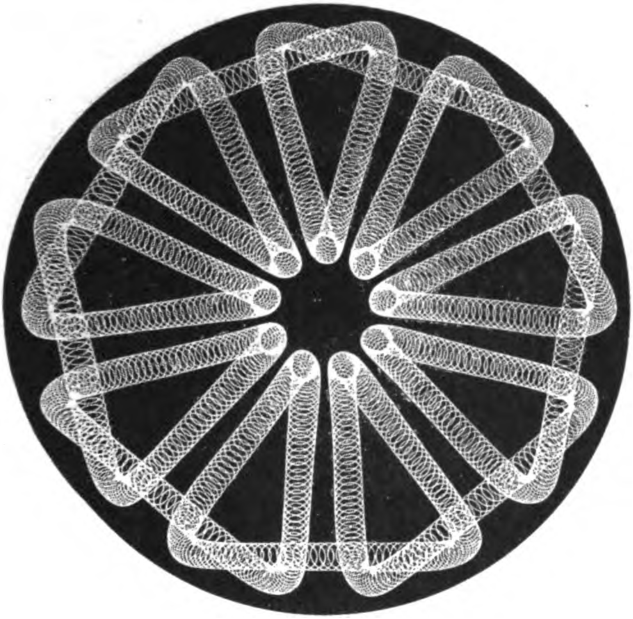

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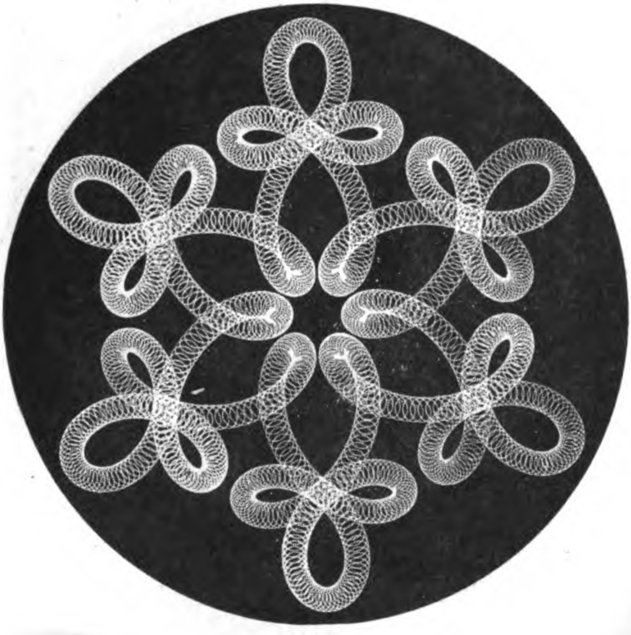

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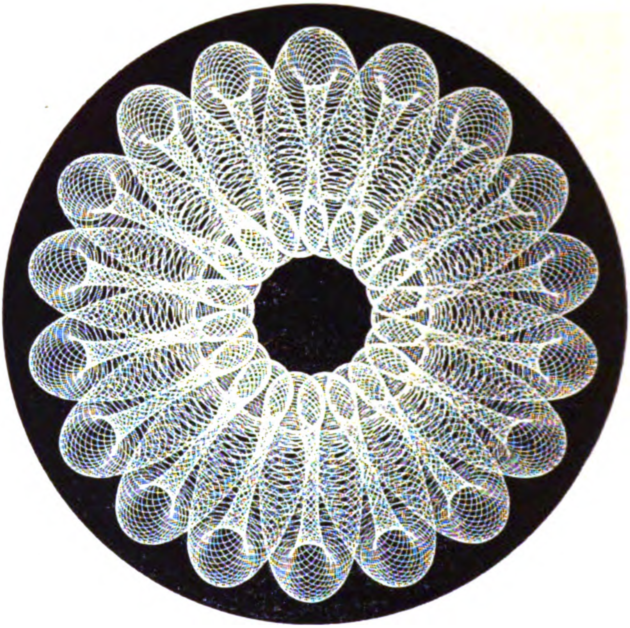

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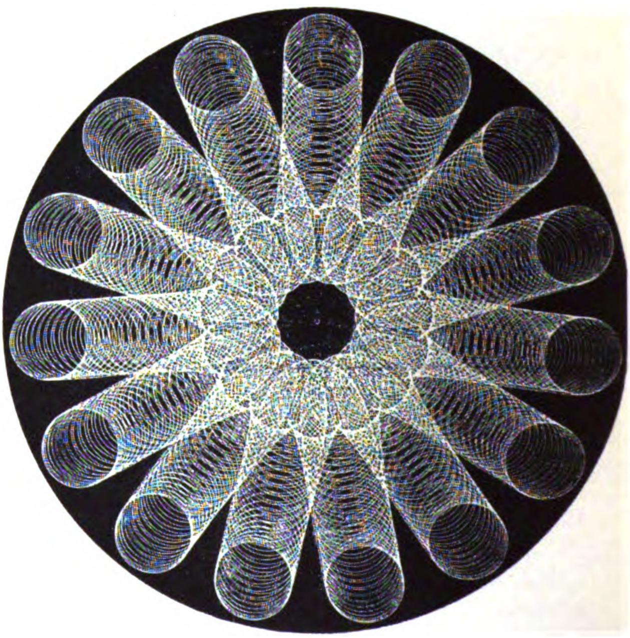

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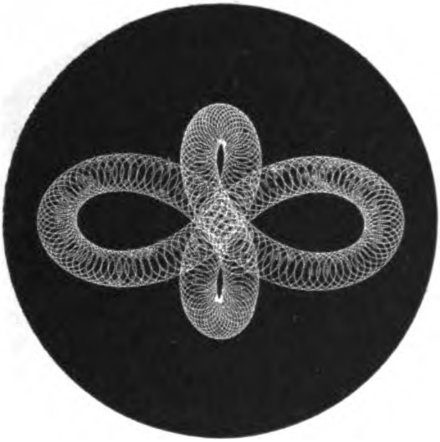

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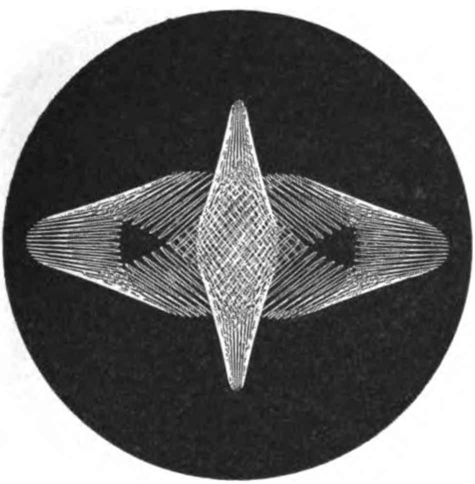

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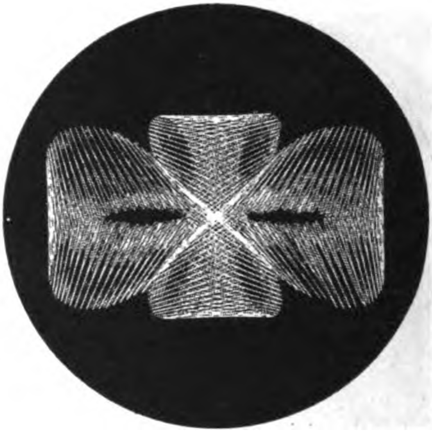

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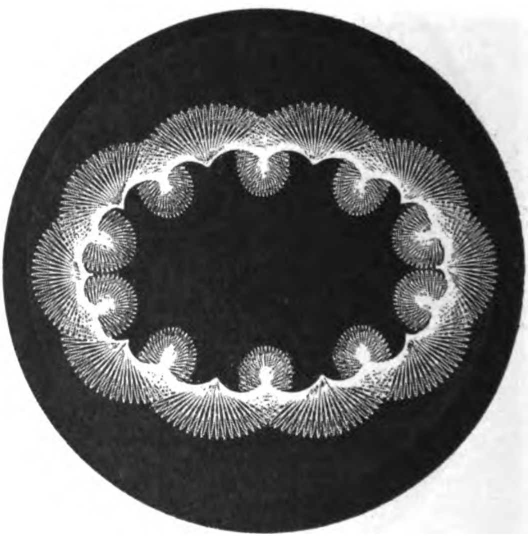

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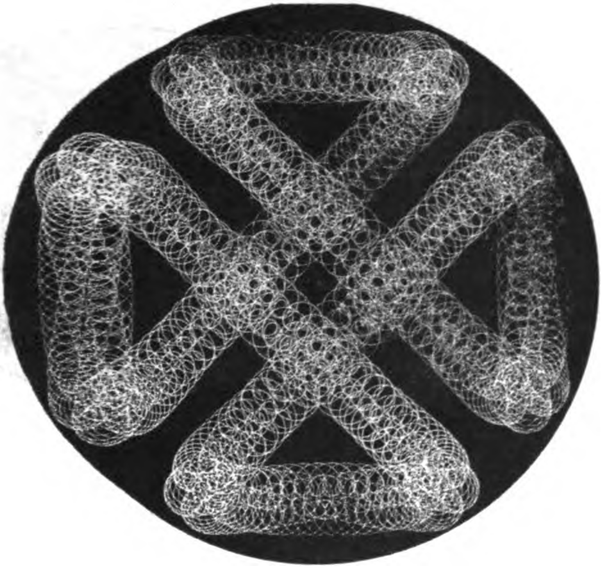

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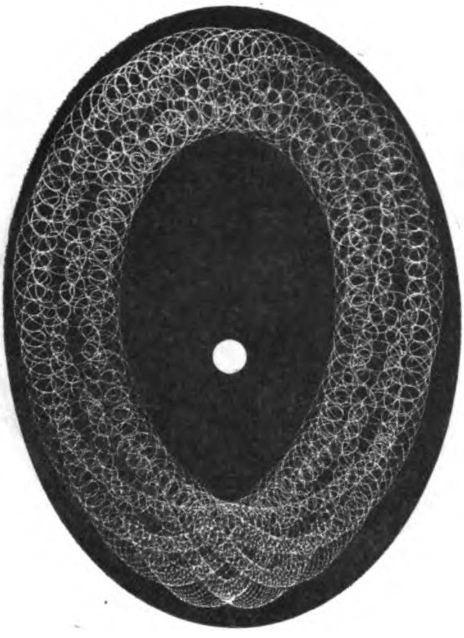

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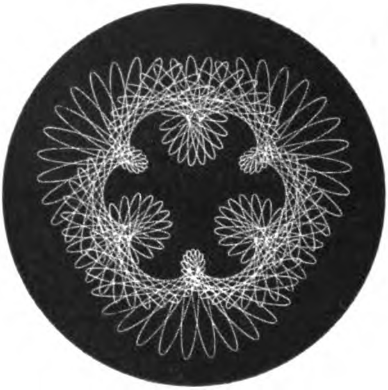

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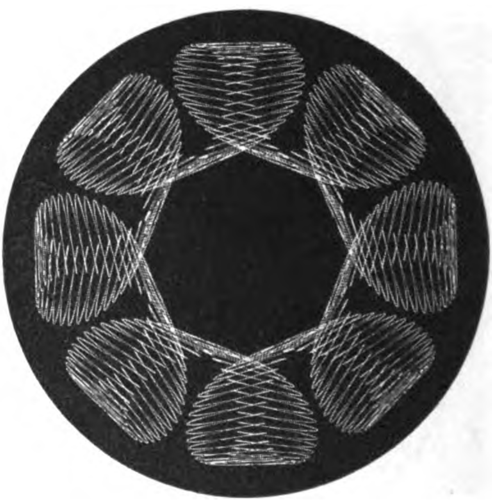

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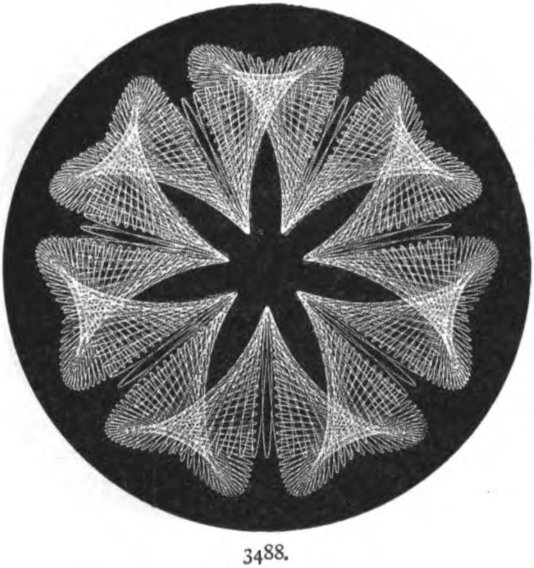

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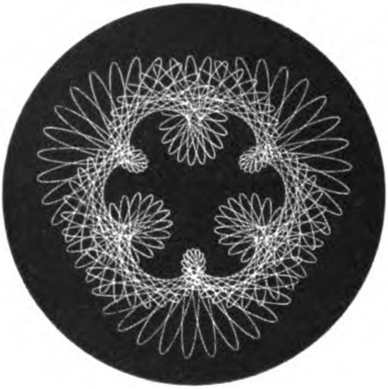

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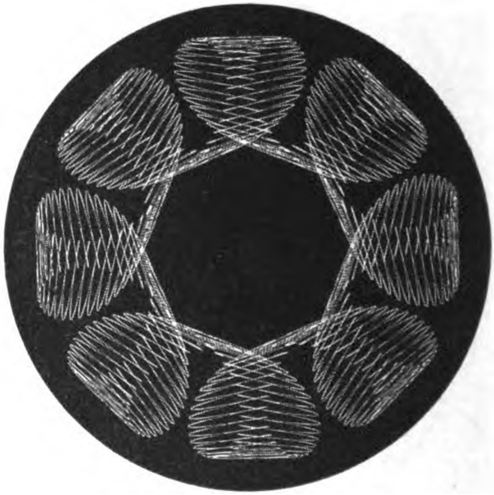

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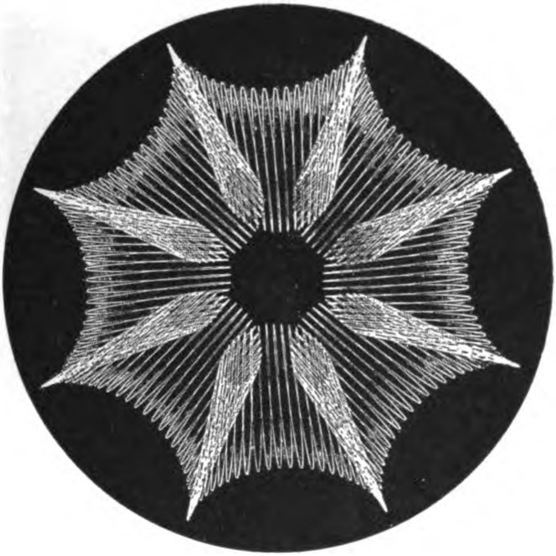

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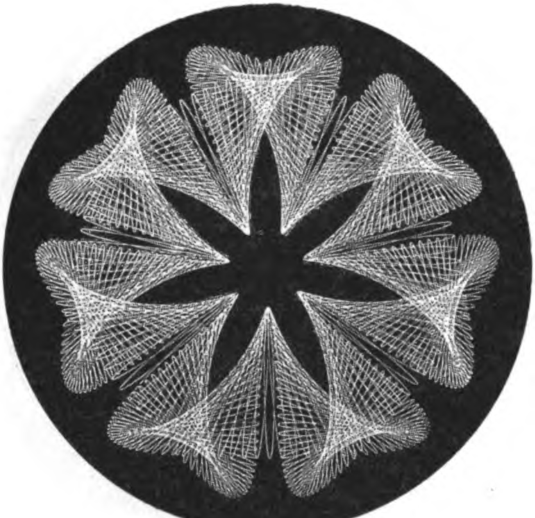

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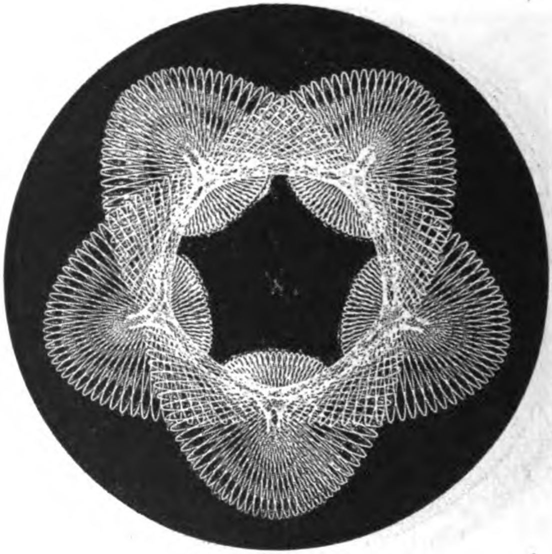

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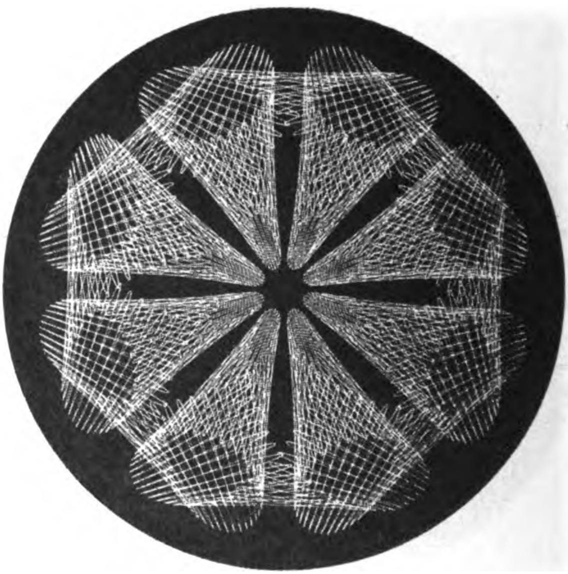

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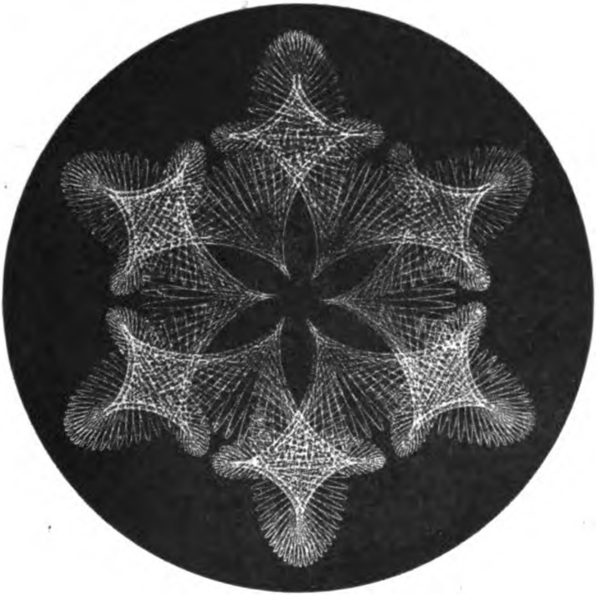

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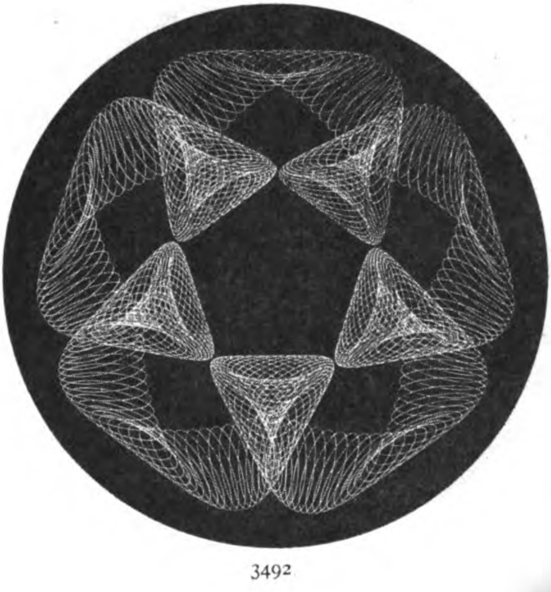

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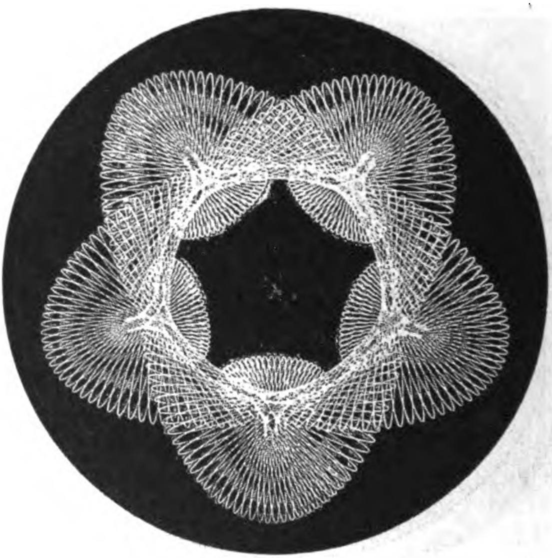

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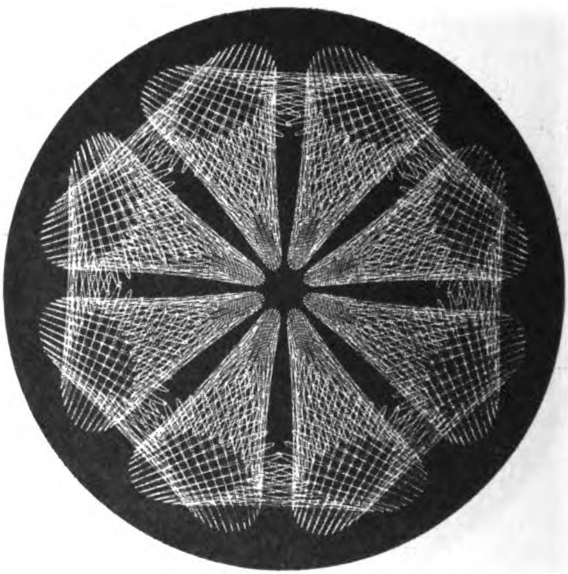

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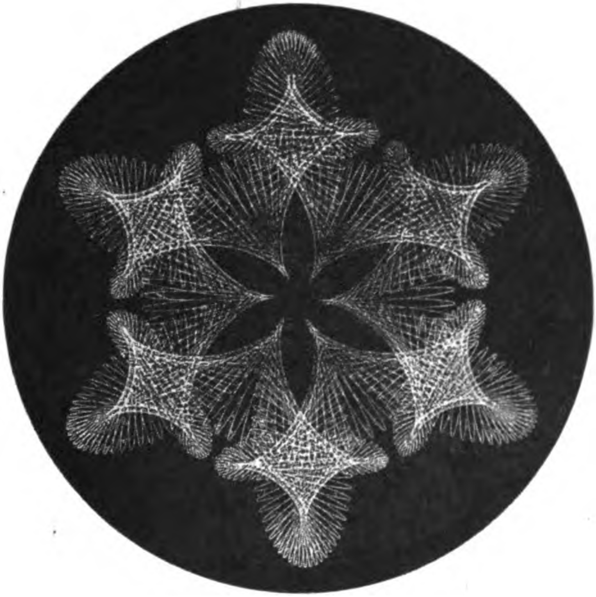

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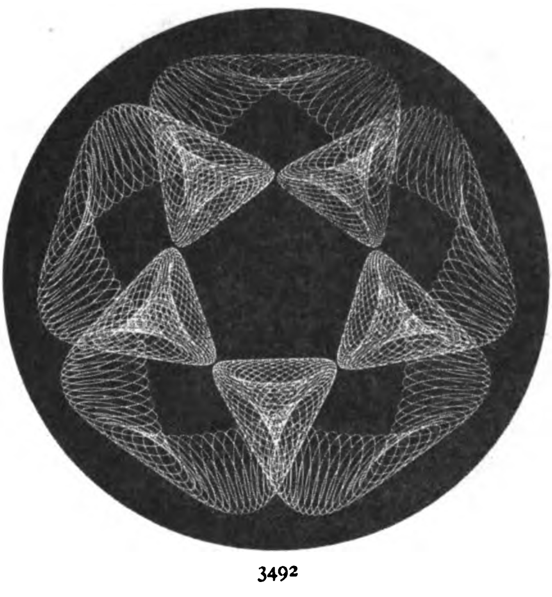

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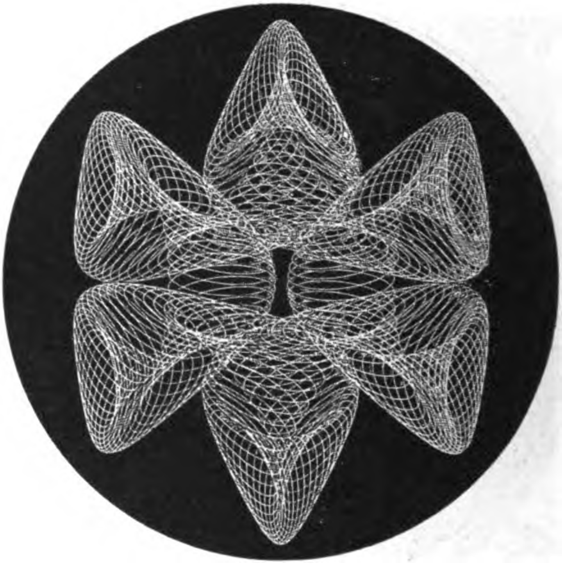

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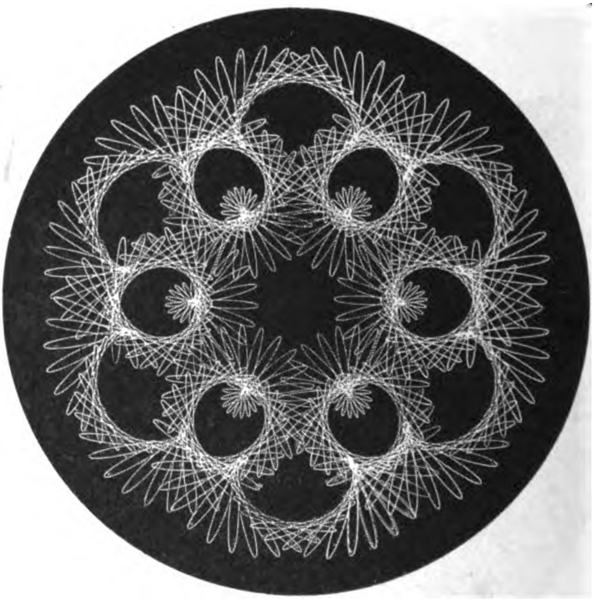

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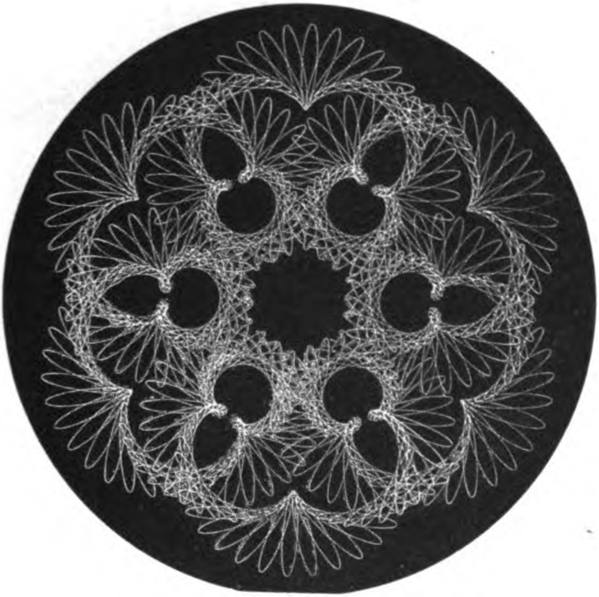

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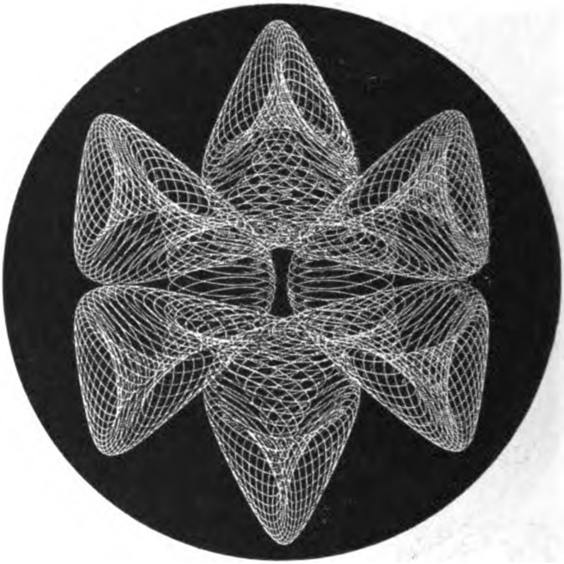

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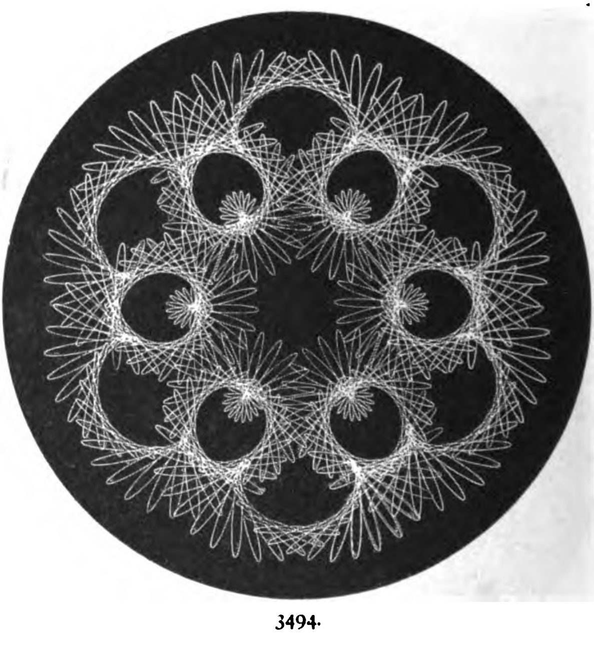

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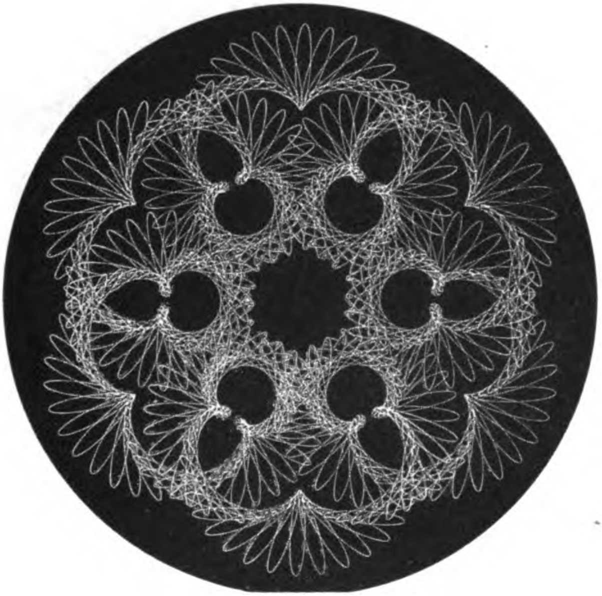

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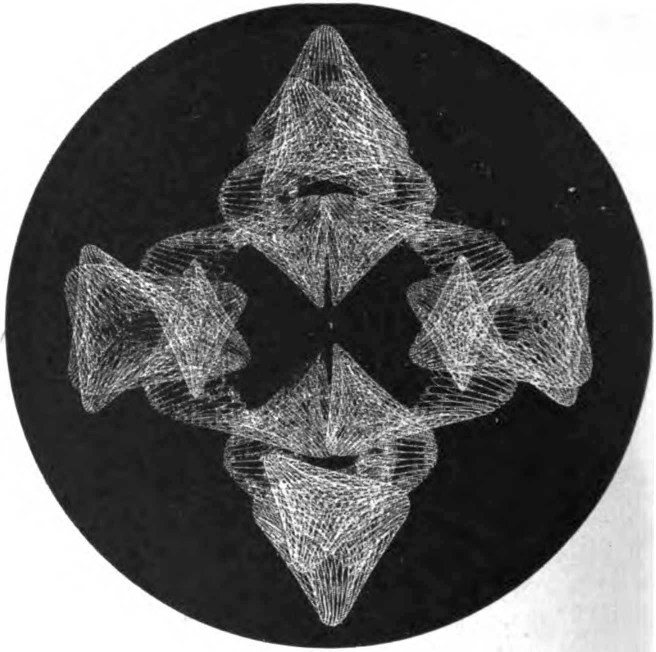

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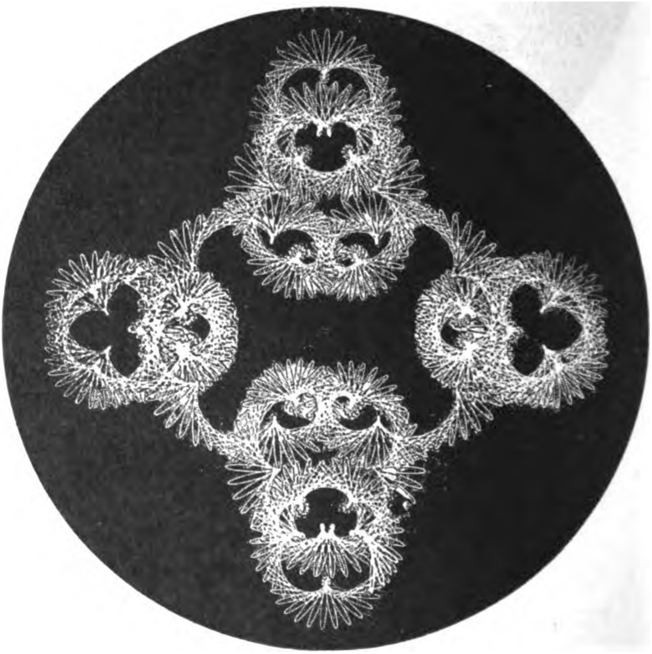

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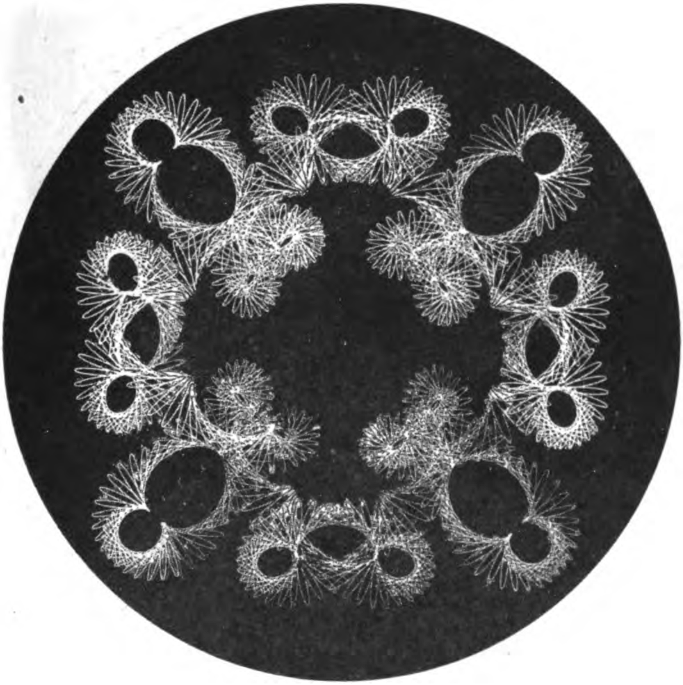

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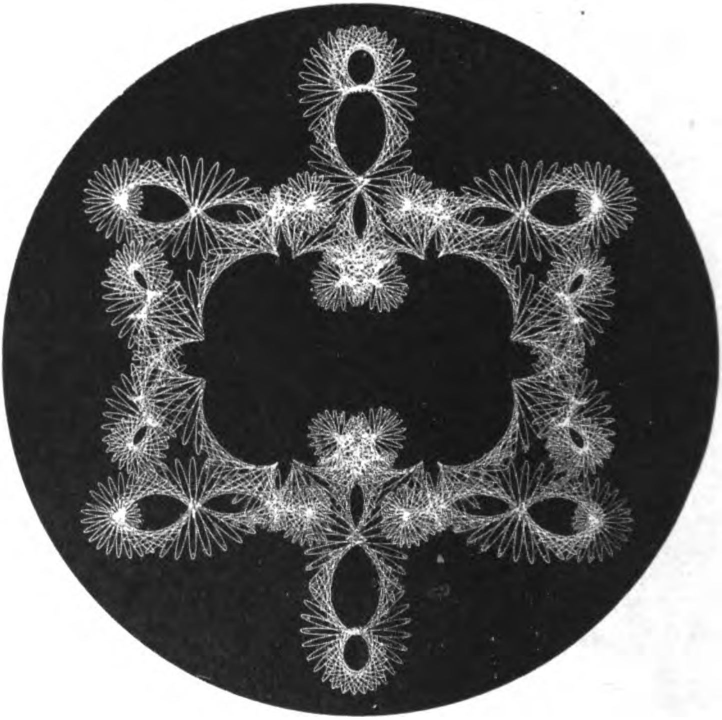

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