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THE REPERTORY OF ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c. &c.

VOL. V.

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1796.

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CONTENTS

OF THE

FIFTH VOLUME.

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XIX.

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PLATES

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PLATES

IN THE

FIFTH VOLUME.

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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXV.

I. *Specification of the Patent granted to* THOMAS BURGESS, *of Weymouth-street, Portland-place, in the County of Middlesex, Esq. for a Method whereby to produce a ro[illegible]ry Motion from the Action of an alternate Movement, in any Direction, effected by a Steam-Engine, or any other Machine.*

WITH A PLATE.

Dated June 9, 1789.

TO all to whom these presents shall come, &c. NOW KNOW YE, AND THESE PRESENTS WITNESS, that in compliance with the terms of the said last mentioned proviso, in that behalf expressed,

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preſſed, I the ſaid Thomas Burgeſs have particularly deſcribed and aſcertained, and by theſe preſents do particularly deſcribe and aſcertain, the nature of my ſaid invention, and in what manner the ſame is to be performed, in manner following; that is to ſay, the rotary motion produced from the action of an alternate movement, by the method of my invention, and according to the new principle which I have adopted, is brought about by means of an axis, and a moving collar thereupon, with a pall, palls, or catches, affixed thereto, or connected therewith, and a counterpoiſe acting on the ſame; which apparatus I have invented and put together. The annexed drawing, in perſpective, (ſee Pl. I. Fig. 1.) exhibits an external view of the mechaniſm of my invention, when the alternate movement is effected by a ſteam-engine; where C refers to the collar, upon an axis which receives the rotary motion. The reſt of the perſpective drawing ſerves to ſhew, by way of example, how the apparatus of my invention appears externally, when connected and worked with the lever of a ſteam-engine, *viz.* A the axis; C the ſaid collar; R the chain, rope, or other flexible ſubſtance, applied round or

upon

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upon the collar, and connected with the moving power and counterpoise; W the weight or counterpoise; F the fly. And, for performing my method of rotary motion, when it is to be effected by means of any other machine or moving power than a steam-engine, I diversify the construction and application of my apparatus, in some small degree, according to the sort of machine, mechanism, or acting power, by which the first action thereon is to be effected; nevertheless, the operation always partakes of, and is comprehended within, the same method and principle. I now proceed to explain the internal construction of my apparatus, as suited to this example; and the profile drawing therefore serves to shew the inside of the same apparatus; (which is only externally viewed in the perspective;) in which profile the inside of the said collar C is represented, and a pall or catch marked P is also represented, which moves upon a fixed pin, by which it is hung in a groove or cavity made for its reception in the said collar; and, in the said profile, are represented teeth or notches in the said axis. In the working of the machinery, the said pall or catch falls, by its own gravity, into the

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ſaid teeth or notches in the ſaid axis, when acted upon by the moving power, forcing the axis forwards, together and in union with the collar, and then the pall drops and ſlides back over the teeth or notches, whilſt the collar is in the act of being drawn backwards by the ſaid counterpoiſe. In the perſpective and profile drawings, reſpectively, I have introduced the figures of the lever of a ſteam-engine, the better to ſhew to the eye how and whence my apparatus receives its action, according to that example; and I have introduced a fly upon the axis, to ſhew how and by what power the action is then continued. Thus the rotary motion produced by this method, invented by me upon the principle which I have adopted, being brought about by the action of an alternate movement, continues its conſtant and regular motion and progreſs forwards, notwithſtanding the collar is returned back to its proper place and poſition by the re-action of the counterpoiſe; and thereby the collar is prepared to receive each repetition of the ſtroke or impulſe of the firſt moving power, without impeding the rotary motion of the axis, which axis continues all along in the original rotary motion. In the purſuing

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suing of this my method, and in the construction of the apparatus and performing the operations of this invention, I sometimes use a leather, or other flexible ligature, instead of a chain, or rope. The counterpoise may be effected by a spring, or worm, or by any way that will, by counterpoise and re-action, return the collar to receive the successive action of the first moving power. And I farther add, for describing and ascertaining the nature of my said invention, and the manner in which it is to be performed, the following particular remarks and observations: *viz.* Upon an axis, to which such rotary motion is to be communicated for any purpose, a collar is accurately fitted, so as to turn freely thereupon, and so secured on each side as to prevent its sliding; round which said collar, a chain, rope, or other flexible substance, is wound or placed; one end whereof is carried and made fast to the lever of a steam-engine, or to any other moving power which acts by alternative motion, whether perpendicularly, horizontally, or in any other direction; and by and upon the other end thereof a weight is suspended; or a spring or springs, or other power, is

or

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or are applied thereto, or to the collar, by ſome ſufficient means, according to the nature of the work; which weight, ſpring, or other power, muſt act as a counterpoiſe, to draw the collar back, in the interval between each ſtroke or impulſe of the moving power; and two or more ſuch chains, ropes, or other flexible ſubſtances, may be uſed to produce the ſame effect; each of them being, in ſuch caſe, fixed by one of the ends thereof to the ſaid collar, and the other ends, reſpectively, being aptly connected, one with the moving power, and the other with the counterpoiſe. And to give the effect intended, of turning the axis round by means of the collar ſo acted upon, the pall or catch, palls or catches, or other ſimilar contrivance, is or are placed within or upon, or otherwiſe connected with, the ſaid collar; in ſuch manner that one end or part of every ſuch pall, catch, or other contrivance, may, at each ſucceſſive impulſe of the moving power, moſt readily fall, or be preſſed into, and act upon, teeth or notches, which muſt be for that purpoſe cut in, or fixed upon, the axis; over which ſaid teeth or notches the ſaid palls, catches, or ſuch other

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other contrivances, eaſily and freely ſlide back, when the collar is drawn backwards by the counterpoiſe. Thus, by the ſaid palls, catches, or ſuch other contrivances, upon the teeth or notches, (or by preſſure alone where the reſiſtance is but ſmall,) the axis is forced round with the collar by every alternate ſtroke of the moving power; but the palls, catches, or ſuch other contrivances, being diſengaged from the teeth or notches at the inſtant of ſuch ſtroke of the moving power being completed, the collar is then drawn backwards by the counterpoiſe, and ſo prepared to be acted upon again with the whole force of the moving power in conſtant ſucceſſion, as long as the moving power is at work; the motion of the axis being, during the whole time, continued forward equally and uninterruptedly, by means of a fly or flies thereto aptly annexed or applied, or otherwiſe, as may be found convenient. And the whole may be ſtopped or ſet in motion inſtantly, when the moving power, or counterpoiſe, is in any relative poſition, or at any point, either of the ſtroke or return of the alternate motion, without any jirk or ſhaking; which is a benefit not attained to in any of the methods heretofore em-

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ployed for communicating a rotary from an alternate motion. If it ſhould, in any caſe, be found more convenient to employ an inflexible beam or rod to impel the collar, and therewith the axis, forward, this may be accompliſhed by indenting the rim of the ſaid collar, and alſo one ſide of ſuch beam or rod, with teeth or notches fitted to each other; in which caſe, the weight of ſuch beam or rod may itſelf be made to act as a ſufficient counterpoiſe to bring the collar back, ſo as to be duly acted upon by the next ſucceeding ſtroke; but, in general, a chain, or ſome flexible ſubſtance, applied according to the above deſcription, will anſwer beſt. The application of this rotary motion may be made, with the greateſt advantage, to the turning of any kind of mill-work, for grinding, for rolling, for flatting, or ſlitting, any kinds of metal, and for all other purpoſes to which mills are or can be applied; alſo for working tilt-hammers, or ſtampers, in iron works; and for turning and boring of cannon; as well as for all ſmaller works upon ſimilar principles; and, in ſhort, for every ſpecies of work and manufactory to which mill-work, turners inſtruments, or any form of rotary motion, is, or

hath

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hath been, or can be, applied. It would be endleſs to ſhew every different form of application in the way of example: but that example which I have given, by the drawing and references, ſerves to ſhew the true nature of my invention, and one of the moſt obvious manners in which it is to be performed. From that example, with the above illuſtration, and the whole of my deſcription, I conceive that my method, and the principle thereof, and apparatus adapted for producing the rotary motion, in the way ſpecified, from the action of an alternate movement, is aſcertained; and this my invention is to be uſed, as well in works of the greateſt magnitude, and requiring the mightieſt ſtrength, as in thoſe requiring only moderate ſtrength, and even down to the working a turner's lathe, or the moſt trivial implement. The certain advantages to the public, in this my method, will be found by the eaſe in the performance of it, and the effect it has in its operation; and by reaſon that the mechaniſm may be made and kept in repair at a comparatively ſmall expence, and is worked without any ſhaking or jirking, which is a merit not attained to in, or by means of, any

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of the methods heretofore invented for communicating a rotary motion from an alternate movement. In witneſs whereof, &c.

Explanation of the Figures.

(See Plate I.)

Fig. 1, Perſpective.

A. The axis.
C. The collar.
F. The fly.
L. The lever.
R. The rope.
W. The weight.
The Pall is ſeen only in the profile.

Fig. 2, Profile.

The ſame letters refer to the ſame parts in both figures.

The ſide of the collar is here removed to ſhew the pall P, and its application to the teeth or notches in the axis.

II.

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Fig. 1.

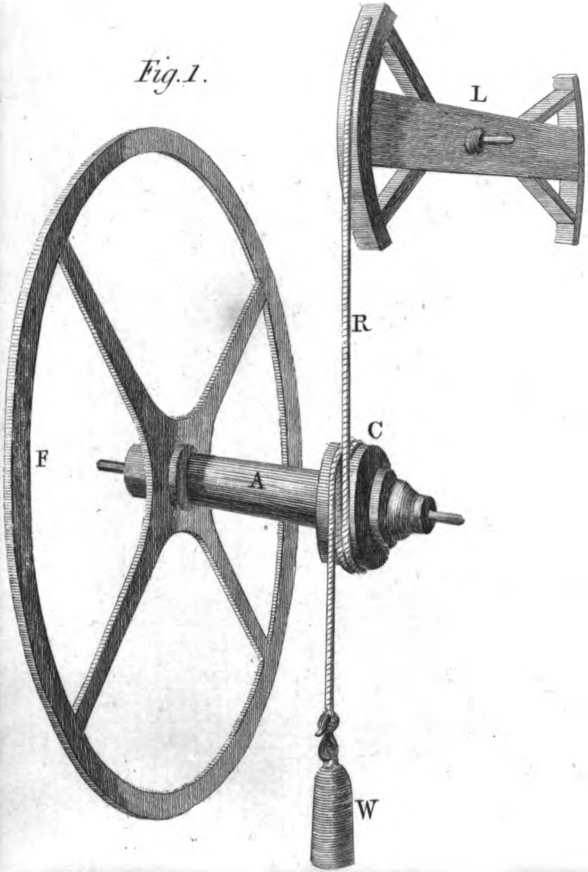
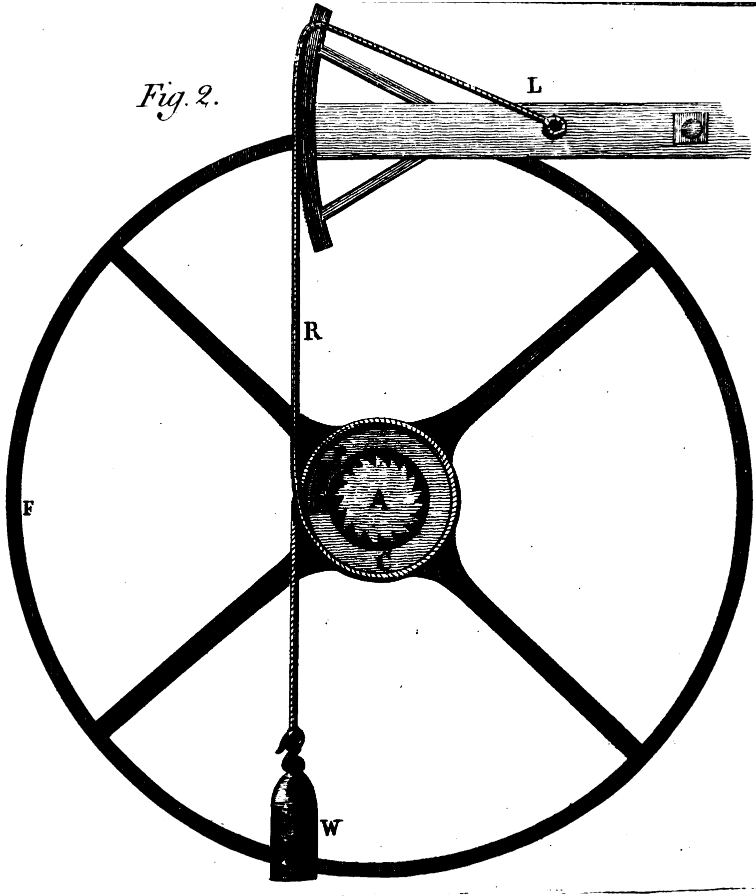


Fig. 2.



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II. *Specification of the Patent granted to Mr.* Joshua Green, *of the Pariſh of Ginſeley, in the County of York; for his Method of conſtructing navigable Canals, without the Uſe or Neceſſity of Locks, whereby moſt of the Objections to, and Inconveniencies ariſing from, Canals are effectually removed.*

Dated June 18, 1793.

TO all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid Joſhua Green do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, the nature and method of my invention is by inclined plane, wheel, balance, veſſels, and levers, of a particular conſtruction. Firſt, Suppoſe a particular riſe, as for inſtance, about thirty feet, which is about equal to the riſe of four common locks; I propoſe to overcome that difficulty, without locks or loſs of water, by inclined planes, &c. Let two principal

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ones be erected, of good ſtone or brick materials, eight or ten times the length of the perpendicular or angle of elevation, the longer the inclined planes the leſs ſtreſs will lie upon the ropes and other machinery hereafter deſcribed; but upon the ſaid inclined planes muſt be laid and fixed a frame of wood, ſuppoſe of half or quarter deal balks, and, to prevent friction as much as may be, the top ſide of ſaid wood ſhould be covered or ſhod with forged or caſt iron. A third inclined plane, about two thirds the length of the other, to be betwixt the other two aforementioned, for an uſe hereafter deſcribed. Secondly, The commercial boats I propoſe to be about thirty or thirty-five feet long, ſeven feet wide, and to draw betwixt four and five feet water, which I apprehend will contain about twenty tons of burden. One veſſel I propoſe to aſcend up one inclined plane, as the other deſcends upon carriages hereafter deſcribed; then it is ſuppoſed that one commercial boat draws up the other, excepting the friction, which will be eaſily overcome by the machinery hereafter deſcribed. Thirdly, I ſhall next deſcribe the carriages, or what I call cradles, to contain

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contain the said commercial boats, which I conceive to be the most difficult part of the apparatus, and also the most ingenious. Then suppose four beams, or half deal balks, joined or framed together for the two sides, of sufficient width for the vessels to slip in and out when in the water; on which account the said frame or carriage is to be open at each end, joined together at the bottom by three or four cross timbers, and good timber knees at each corner and joint, such as boat-builders are accustomed to use. And, that the said boat or vessel may ride as easy as in water, when in the said cradle, the bottom frame is to be corded, like a poor man's bed, with rope about inch diameter, and about one hundred and twenty yards long; the eyes or holes the said rope passes through are to be easy, and as free from friction as possible, that the rope or cord may draw from end to end, then all parts of said rope will have equal bearing: it is also meant that the said cording is to be above the timbers that join the bottom part of said cradles. Four or more strong wheels, either of cast metal, or strong ash plank, about four feet diameter, are to be added to this said

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ſaid cradle-frame; I think the latter, *viz.* aſh plank, is ſafer to truſt to, about nine inches thick at the centre, and about five inches thick at the rim or periphery, the ſole of which rim is to be ſhod with forged or caſt iron. Now comes the difficulty of axleing theſe wheels, conſiſtent with ſtrength and convenience; for, if the axletrees went over the veſſel, it would be inconvenient to the loading, as wool-packs, &c. and if under the veſſel, the burden being ſo much above the centre of gravity would endanger overſetting; alſo axles ſo long would require to be of enormous ſtrength; which difficulties to obviate, I propoſe what I call a falſe rung, beam, or half balk, of timber, well bolted and joined to the upright timbers of each of the outſides of the frame or cradle, but at ſuch diſtance from the ſaid outſide frames as will admit the wheels above deſcribed within the ſaid falſe rung; then each wheel will have its own axis of iron, about three inches diameter, and only eighteen inches long. I recommend that the axles be faſt in the wheels, and turn round with them, which I apprehend will cauſe the machine to move more ſteady. Fourthly, I ſhall next de-

2 ſcribe

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ſcribe the principal lever or regulating wheel, which I propoſe to be twenty feet diameter, with ſhort levers or hand-ſpokes, fixed upon each ſide of the periphery or fellies of ſaid wheel, three feet long, which will be equal to a lever of thirteen feet. The ſaid wheel will hang vertically, being well fixed on the middle or centre of a beam about thirty feet long, and ſay about twenty inches diameter, which muſt at each end, with its gudgeons, reſt upon two ſtrong frames of wood, elevated by their legs to a proper height on each ſide of the upper canal, about thirty feet on the canal. And, if it be thought too long betwixt the two extremities or fulcrums, other two fulcrums may be raiſed on each ſide of the vertical wheel; that part of the beam or axis moving upon theſe fulcrums being ribbed with ſteel ribs, and moving upon braſſes, after the manner of an old-faſhioned windmill. The uſe of this beam or axis is for two pair of ropes to wind or coil upon, faſtened to the carriage or cradle of each boat, the one pair of ropes on the upper ſide of the axis, and the other pair on the under ſide; and, to keep the ſaid ropes parallel, one of the ropes of each pair muſt

be

be ſo fixed by a ſcrew, or ſome other device, as that it can be eaſily lengthened or ſhortened. In my models I have tried with one rope, but could not make it anſwer ſo well as two; I alſo think two ſtronger than one, and ſafer to truſt to; I ſuppoſe the ropes, being made of the beſt hemp, need not be much above inch diameter. The uſe of the lever wheel is to regulate, by either aſſiſting and quickening the motion by the ſhort levers or hand-ſpokes; and, for retarding, a brake may be fixed upon the face or ſide of the ſaid wheel, after the manner of a windmill-brake. Fifthly, The third inclined plane, the uſe of which is to aſſiſt the veſſels going in and out of the upper canal; for, whatever the elevation propoſed to be raiſed at one operation be, four or five feet will be loſt in delivering the veſſel or boat into the upper canal; for, the aſcending veſſel, having arrived at the top of its inclined plane, is landed on to a flat, but rather inclined towards the upper canal, and, to get ſafely launched into the upper canal, it muſt deſcend down an inclined plane into the water at the upper canal; but, to prevent it deſcending too precipitately, a ſingle rope is fixed or hung to the

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the hind part of the cradle, the other end of said rope being coiled and fastened on an axis, on which axis or beam is fixed another lever wheel, but need not be so big as the other already described; from which axis also goes another rope, or couple of ropes, joined to a carriage or vessel with four wheels, at the bottom of the third inclined plane; and, by its ascent up said third inclined plane, it succours or lets down the commercial boat into the upper canal; and, by its descent down said third inclined plane, it assists in getting a commercial vessel out of the upper canal on to the head of its inclined plane; at the same time it is supposed that a commercial boat is coming out of the lower canal; in which lower canal there is no difficulty, for, the carriage or cradle being made specifically heavier than water, the boat when let loose will naturally float out of the carriage, either in the lower canal or upper, being made deeper of water at those places for that purpose. It would be well to have a spare vessel or two ready loaded with water, or any other materials, in case of an alternate course not being kept up by commercial boats. But a more

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ſimple and cheap method (but not ſo expeditious) may be practiſed as follows; ſuppoſe only one inclined plane, as deſcribed in the firſt article, and two lever wheels, as before deſcribed, only the beam or axis need not be above twelve feet long and about fifteen inches diameter, and the inclined plane twelve times the length of the elevation, which will reduce the burden, (ſay twenty-four tons,) to two tons or forty hundred weight; and the lever wheels and hand-ſpokes, being above eighteen times the diameter of the axis, reduce the forty hundred to little more than two hundred, except the friction, which will not amount to one tenth more upon a ſingle machine, if properly executed. Suppoſe the elevation to be overcome be twenty-four feet, then the inclined plane would be two hundred and eighty-eight feet, which would take about ſeventy-two revolutions of the great wheel, which I apprehend the weight or power of three men would work up in about half an hour, but ſuppoſe three-quarters of an hour. I add no more, but, in witneſs whereof, &c.

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III. *Specification of the Patent granted to Mr.* THOMAS CHESTON, *of Birmingham, in the County of Warwick, Plater; for his Invention of making elastic Spring-Buckles, and Spurs, in Gold, Silver, &c. and also in other Metals, or mixed Metals, to be plated with Gold and Silver.*

Dated July 1, 1786.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I the said Thomas Cheston do hereby declare, that my said invention of making elastic spring-buckles, and spurs, in gold, silver, iron, steel, copper, pinchbeck, or other mixed metals, and also in iron, steel, copper, and other metals, or mixed metals, to be plated with gold and silver, is performed in the following manner; that is to say, I take gold, silver, iron, steel, copper, brass, pinchbeck, or any metals, or

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mixed metals; or I take iron, ſteel, copper, braſs, pinchbeck, or any metals, or mixed metals, plated, or to be plated, with gold or ſilver; which I either forge, ſtrike, cut out, roll, file, or grind, into different forms and ſizes, for buckles, ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks; which proceſs is performed by placing the metal on an anvil, die, or ſteady, and by ſtriking it repeatedly with a hammer in my hand; or by a hammer or tool placed between two ſupports ſtanding perpendicular, which is commonly called a ſtamp or preſs; then, by fixing a cord, chain, or fly, or any thing which will force the ſaid hammer up, ſo as to give force to ſtrike or ſqueeze down the ſame ſufficiently to give the form of either buckles, ſpurs, the ſhanks of ſpurs, or ſprings for ſpur-necks; which force or preſſure, being repeated, renders the article elaſtic or ſpringy, if the metal is not ſoftened by fire. I alſo take gold, ſilver, iron, ſteel, copper, pinchbeck, or any metal, or mixed metals, or iron, ſteel, copper, braſs, pinchbeck, or any metal or mixed metals, plated, or to be plated, with gold and

ſilver,

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ſilver, and place them between two round bodies of iron or ſteel, either plain, or on which is ſunk or engraved the forms of buckles, ſpurs, ſhank-parts of ſpurs, or ſprings for ſpur-necks; and, on paſſing the metals through thoſe two round bodies, (which is commonly called rolling,) the forms of buckles, ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks, are given; and, by repeatedly paſſing or ſqueezing the metals or mixed metals, plated or to be plated, through the round bodies above mentioned, or by any other mode of preſſure, the ſame become elaſtic, if not previouſly ſoftened by fire, but ſteel in particular. After I have either forged, flattened, cut out, rolled, ground, or filed it into the forms of buckles, ſpurs, ſhanks of ſpurs, or ſprings for ſpur-necks, I turn the bridge or middle part of the buckle towards the under ſide; and I rivet, ſcrew, or dovetail, or braſe, any ſolid or hollow body, or bridge, on the middle or centre of the buckles, for the purpoſe of affixing or putting to (if neceſſary) a chape and tongue. I then ſet or bend the buckle, (either before or after I have ſo affixed the bridge,) and

alſo

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alſo the ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks, in or near the form they are generally worn in, and put them into an oven, ſtove, or any place heated by fire, till they become red hot, or nearly ſo. I then put them into any ſort of liquid, (but oil, water, turpentine, butter, greaſe, with the addition of ſalt, are found to anſwer the purpoſe beſt,), whereby they become or are made hard. I then temper them, either by blazing the oil, turpentine, butter, or greaſe, which will of courſe hang upon them from the proceſs of hardening, or by any gradual or regular heat; (taking care not to render them too ſoft;) by which means of hardening and tempering, the buckles, ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks, become elaſtic. I alſo take of any of the aforeſaid metals or mixed metals, and either forge, ſtrike, roll, grind, cut out, or file them into the forms of necks of ſpurs, which necks I affix or put to the ſhank or heel part of the ſpur, either by riveting, ſcrewing, or ſoldering, the ſame. I alſo make elaſtic ſprings by any or either of the means aforeſaid, which ſprings I inlay,

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inlay, put to, in, or upon, any parts of the necks or breaſt-parts of ſpurs; and which ſprings receive an elaſtic motion from any preſſure againſt caps or boxes, which I affix to ſpur-necks or breaſt-parts of ſpurs, by means of pins, ſcrews, rivets or dovetails, or by ſoldering; which caps or boxes move upwards, downwards, obliquely, or horizontally, and thereby expoſe the rowel or pricking part of the ſpurs, and, on the preſſure ceaſing, recover their former ſituation by the means of the ſaid elaſtic ſprings; and which caps, or boxes, may be taken off, or put to the necks of ſpurs, at the option of the wearer. In witneſs whereof, &c.

IV.

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IV. *Specification of the Patent granted to Mr.* James Emerson, *of the Parish of Bitton, in the County of Glocester, Brass and Spelter maker; for his Invention of making Brass with Copper and Spelter.*

Dated July 13, 1781.—Term expired.

TO all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said James Emerson do hereby declare, that my said invention of making brass with copper and spelter is performed in manner following; that is to say, I take spelter in ingots, and melt them down in an iron boiler; I then run the melted spelter through a ladle with holes in it fixed over a tub of cold water, by which means the spelter is granulated or sholed, and is then fit for making brass on my plan. I then mix about fifty-four pounds of copper shot, about ten pounds of calcined calamine ground fine, and about one bushel of ground charcoal, together; I then put into a casting-

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castìng-pot a handful of this mixture, and upon it I put about three pounds of the sholed spelter; I then fill up the pot with the said mixture of copper shot, calcined calamine, and ground charcoal. In the same manner I fill eight other pots; so that fifty-four pounds of copper shot, twenty-seven pounds of sholed spelter, about ten pounds of calcined calamine, and about one bushel of ground charcoal, make a charge for one furnace, containing nine pots for making brass on my plan. My chief reason for using this small quantity of calamine in the process, is more for confining the spelter by its weight, than for the sake of the increase arising from it, and I have frequently omitted the calamine in the process. The pots, being so filled, are respectively put into a furnace, and about twelve hours complete the process; and from this charge I have, on an average, eighty-two pounds of pure fine brass, fit for making ingots, or casting plates for making brass battery wire, or brass latten, and my brass so made, as aforesaid, is of superior quality to any brass made from copper and calamine. In witness whereof, &c.

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V. *Description of an improved Printing-Press; invented by Mr.* JOSEPH RIDLEY.

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Forty Guineas was voted to Mr. RIDLEY for this Invention.

THE head of the press is the chief object of this improvement, from which the screw hitherto in general use is taken away, and a perpendicular bar of steel, with a conical end, lodged in a cup on the platen, substituted in its stead. The purchase is obtained by means of a spindle passing through each side of the press, near the bar, to which it is attached by three chains; the two outer ones serving to pull down the bar and platen,

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platen, and the middle one to raiſe or recover them again. To one end of this ſpindle a lever or handle, about two feet long, is fixed, which, by means of the two chains, pulls down the platen with any force required: at the other end of the ſpindle is alſo another lever, with a weight acting as a fly; which weight may be fixed, by means of holes in the lever, at ſuch diſtance from the centre as may be judged neceſſary, according to the work to be done.

Description of the Figures.

(See Plate II, in which Fig. 1 and 2 repreſent a front and ſide view of the preſs, with the ſame letters of reference to both.)

A A. Two ſtrong perpendicular cheeks, joined together by three croſs pieces.

B. The upper croſs-piece, or head-piece; it ſuſtains the preſſure by the two ſtays C C being firmly ſcrewed to the head-piece, and having at the ends two ſlit collars to receive the ſpindle D, which is governed by the lever or handle E, two

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feet long, by which the purchafe is obtained, and which may be affifted, if required, by the other lever F, with a movable weight, on the other fide of the prefs; this weight only becomes ufeful when power and difpatch are the leading objects. A weight of lead, W, hangs by a cord over a pulley fixed on the axis at the bottom of the lever F, ferving to affift the return of the lever when the platen rifes. The fpindle D is made broader in the middle than at the ends; the fpindle and the upright bar G are connected by three chains H H H, two of which afford the pull, and the other reinftates the bar and platen. Of thefe chains, one is bolted by one end to the lower part of the bar, fo as to admit the other two, one on each fide, lengthwife of the bar; and the other end of the chain is brought over the middle of the broad part of the fpindle, and fcrewed through the bottom, fo as to afford an opportunity of adjufting the chain; the two outer chains being, by means of a fwivel, extended wide enough to admit the centre one between them. A ftrong bolt muft pafs through the middle of the fwivel and the upper part of the

bar;

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bar; and, being ſtayed faſt on the back of the bar, by a nut or forelock, the other two ends of the chains muſt be brought under the broad part of the ſpindle, one on each ſide the ſingle chain, and ſcrewed to the bottom, as before mentioned. A notch is made in the middle of the ſpindle, in order to receive the three chains, and thereby obtain a great purchaſe. The upper part of the bar G is incloſed, and works in a collar in the middle of the head-piece B; the middle of the bar paſſes by the ſpindle, to which it is coupled by the aforeſaid chains; and the lower end is conveyed through another collar fixed in the middle of the ſhelf I. The cone at the lower extremity is lodged in a ſteel cup K, ſcrewed on the middle of the platen L. The platen is ſuſpended by four ſprings, branching out from the bar, above the ſhelf I, with a hole at each of their ends, in order to receive the tops of the four pillars MM, on which male ſcrews are cut: the baſes of theſe pillars are fixed on the platen, near the four corners. By nuts, properly applied to the ſcrews above the ſprings, the workmen are enabled to adjuſt the platen ſo that it

comes down parallel to the ſtone, and form of letters laid thereon.

N N N the body or frame of the preſs.

V the lower croſs-piece or main-brace, which acts againſt the head, between which are the ribs O O, the coffin S, and the form of letters; and upon that the paper, tympans T, and friſket U, &c.

The ribs, O O, lie acroſs the main-brace V, and extend beyond the two ends of the frame, to which they are ſtrongly ſcrewed. Two long bars of iron, faſtened to the ribs, bear on them the coffin; to the bottom of which ſix pieces of hollow iron are firmly fixed, well fitted and ground ſmooth, in order to procure an eaſy traverſe, by a gentle motion of the rounce P, fixed on the end of the ſpit Q, on which is put a double pulley R, with two ſtraps made faſt thereto, one at each end; the other ends of the ſtraps are attached one to each end of the coffin S, to convey it with accuracy to the deſired place *. In the coffin is placed a po-

* No work with this preſs requires more than one pull.

liſhed

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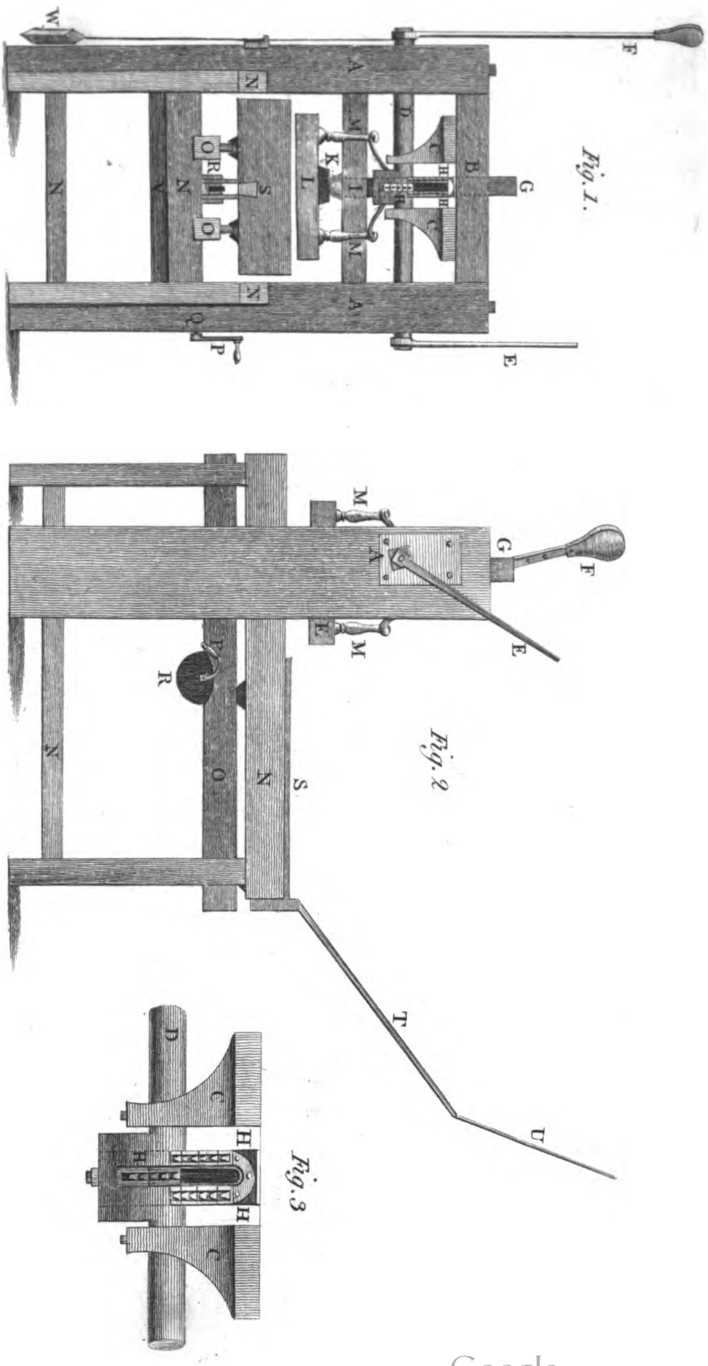

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lifhed ftone, forming a flat furface with the verge of the coffin; it has likewife joined to it, by means of two hinges, the tympan T; which, in performing the work of printing, is, as ufual, firft underlaid with parchment, on that two flannels are laid, over them the upper tympan, with a parchment, as before; then U, a thin frame of iron, the fize of the tympans, called the frifket, on which is faftened a piece of paper, cut out in the form of the pages impofed, in order to keep the fheet in printing clean, and in its proper place.

In order that the ftays C C, the fpindle D, and the chains H H H, with a part of the bar, may be more diftinctly feen, they are fhewn on a larger fcale, at Fig. 3.

VI.

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VI. *Description of a self-moving or sentinel Register; invented by Mr.* William Henry.

WITH A PLATE.

From the Transactions of the American Philosophical Society.

THE machine consists of the following parts.

A. (Plate III. Fig. 1.) A door or common register, applied in the flue of a furnace. The door is fitted in a frame, and made to slide easily up and down.

B. A balance or beam, moving on a centre. Its two arms are of unequal lengths, the longer exceeding the shorter in the proportion of two to one: the extremity of each arm is formed into a segment of a circle, whose radius is equal in length to each respective arm. These segments must be equal to the greatest rise or fall of each end of the balance when in use.

The

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The length of the whole beam or balance muſt be regulated by the ſituation of the regiſter A, and the copper veſſel C, hereafter mentioned.

C. A copper veſſel, about thirteen inches diameter, and ten inches deep, with a double bottom and ſides, which are placed about an inch and a half apart from each other, leaving a ſpace between to contain air. The top or cover is brazed on, and the whole made air-tight. Through the top is inſerted a braſs cock, and alſo a braſs or copper cylinder, open at both ends, about two inches and a quarter in diameter, and two feet long; ſo fixed as to riſe fourteen inches above the top, and to reach near to the bottom of the veſſel.

Through the ſide of the innermoſt veſſel, near the top, are ſome holes made, whereby the air in the cavity between the two bottoms and ſides may communicate with the air in the inſide of the veſſel.

D. A phial, two inches diameter, and ſeven inches deep, corked and ſealed, with a hook fixed in the cork, by which the phial is ſuſpended.

 Theſe

These are the principal parts of the machine, which are to be applied as follows.

From the surface let there be a horizontal flue, of a convenient length.

In the walls of the flue, the frame, in which the register slides, is fixed perpendicularly, so that when the register is down, the flue is closed; when the register is drawn up, the flue is opened; and, the higher it is raised, the more is the passage of the fire enlarged.

To the shorter end of the balance, which is supported on a proper fulcrum, at a convenient height, the register is suspended by a chain and a rod; the chain is just long enough to wind over the segment of the circle, at the end of the beam. The register is made so heavy as to descend by its own weight.

At the distance of two, three, or more, feet from the register, and on the flue of the surface, the copper vessel C is fixed, so as to receive heat from the heat passing through the flue. The end of the longest arm of the balance extends directly over the cylinder fixed in the copper; and to it the phial D is suspended, so as to hang within

the tube, and by ſuch a length of chain and rod as will allow it to be about two or three inches immerſed in the tube, when the balance is in equilibrio. On the ſame end of the beam on which the phial is ſuſpended, a weight is hung, ſufficient, with the weight of the phial, to overbalance the regiſter, and raiſe it, and conſequently open the flue. When the flue is opened to a due degree, the regiſter is held in that ſituation, until ſo much water is poured into the copper, through the cock, as will fill one third of the veſſel; then ſhut the cock, and pour water into the cylinder, until it riſes high enough to float the phial. By pouring water into the cylinder, the air in the veſſel is compreſſed; and, finding no way to eſcape, as the veſſel is air-tight, it reſiſts the water, and prevents its occupying the whole ſpace; and therefore the upper part of the veſſel is apparently empty. The phial is loaded with ſhot, ſo that it will ſwim about one third above the water. When the water riſes in the tube, the phial riſes with it, in which caſe the regiſter A is ſo balanced that it deſcends, and cloſes the flue.

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After this defcription, the principles on which the fentinel regifter acts muft be obvious to every perfon acquainted with the elafticity of the air, and that this elafticity is increafed by heat. For, when the fire in the furnace is increafed, the degree of heat in the flue is alfo increafed; this increafes the elafticity of the air contained between the double bottom and fides of the copper, and confequently of that which occupies the fpace above the water, as there is a communication by means of the holes already defcribed. The elafticity of the air being increafed, it expands, and by its expanfion forces the water up the tube; the water, being raifed, carries the phial with it, whereupon the regifter preponderating defcends, clofes the flue, and, by leffening the draught of the chimney or flue, deadens or checks the fire in the furnace. By this means again the heat in the flue is diminifhed, the air in the cavity becomes cooler, and confequently lefs elaftic; whereupon the water defcends in the tube, and with it the phial to its ftationary point. By the defcent of the phial the regifter is raifed, and opens the flue; by which means it ftands as a fentinel over

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over the fire, and preserves an equal degree of heat.

That this will be the effect of the machine I can attest, having used it for more than a year.

It is submitted to the curious, whether this machine might not be usefully applied; first, to regulate the heat of chymical and alchymical furnaces, where long digestions, and an uniform degree of heat, are required; secondly, in the making of steel, and in burning of Porcelain-ware, in which a due regulation of the fire is of great importance; thirdly, in green or hot houses, and in apartments for hatching chickens according to the Egyptian method. With a little alteration it might be applied to the purpose of opening doors, windows, and other passages, for a draught of air, and thereby preserve a due temperature of the air in hospitals, &c.

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VII. *Account of a Machine for pumping Vessels at Sea, without the Labour of Men.* By Mr. Richard Wells.

WITH A PLATE.

From the Transactions of the American Philosophical Society.

WHEN a vessel at sea springs a leak which cannot be discovered, instead of exhausting the crew with continual working at the pumps, they may form, with very little trouble, a machine to discharge the water, which will work itself, without any assistance from the hands on-board.

Let a spar, or spare top-mast, be cut to the length of eight or ten feet, or more, according to the size of the vessel; mortice four holes through the thickest end, through which run four oars, fixing them tight, exactly in the middle; to the four handles of the oars, nail on four blades, (made of

staves,)

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ſtaves,) the ſize of the other ends, which will form a very good water-wheel, if the oars are ſtrong. Then fix into the oppoſite ends what is commonly called a crank; the iron handle of a grindſtone will ſuit extremely well; if that is not to be had, any ſtrong bar of iron may be bent into that form, wedging it tight, to prevent its twiſting round. Then nail up a new pair of chaps on the fore part of the pump for a new handle to be fixed in, which will point with its outer end to the bow of the veſſel; this handle will be ſhort on the outſide, but as long on the inſide as the diameter of the bore of the pump will admit, in order that the ſpear may be plunged the deeper, and of courſe make the longer ſtroke. The handle muſt be long enough to have a ſlit ſawed up it, ſufficient to admit a ſtave edge-ways, which muſt be faſtened with a ſtrong or iron pin, on which it may work; the lower end of the ſtave muſt be bored, to admit the round end of the crank. Then fix the ſhaft with the oars (or arms) over the gunwale on two crotches; one ſpiked to the gunwale, and the other near the pump; cutting in the ſhaft a circular notch, as well to make it run eaſier,

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easier, by lessening the friction, as to keep the whole steady. A bolt must be fixed in each crotch, close over the shaft, to keep it from rising; as soon as the wheel touches the water, it will turn round, and the crank, by means of the stave fixed on its end, will work the handle of the pump. If the bore be four inches, and the piston or spear moves eighteen inches at a stroke, it will discharge 220 cubic inches of water; and, admitting the arms of the wheel to be six feet from the centre, it will turn round about 146 times in a mile, or 730 times in an hour, when the ship sails five knots, which is equal to nine hogsheads. If the surface of the water in the hold be fifteen feet from the nozzle of the pump, a man can raise in an hour, with common working, about thirty-eight hogsheads; this far exceeds the work performed by the wheel, but the calculation is made on pumps of the common size; I would therefore propose that all vessels should carry larger pumps, the advantage of which will appear from the following table.

A 4-inch

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A 4-inch bore will diſcharge *per* hour, ſailing at the rate of five knots, 9 Hogſheads.

5-inch, - -	14½	ditto.
6-ditto, - -	20¾	ditto.
7-ditto, - -	28¼	ditto.
8-ditto, - -	37	ditto.

Hence we find that a pump of eight inches bore will diſcharge, with the wheel, nearly the ſame quantity that a man commonly raiſes. If both pumps be ſet to work by the crank, double the quantity, or 74 hogſheads will be diſcharged; but if a cog-wheel, of about three feet ten inches, with 51 cogs, be fixed on the end of the ſhaft or axis, and the crank be paſſed through a trundle or lantern wheel, of about two feet diameter, with thirteen rounds, to work with the axis parallel to the deck, and fixed to the pumps, in the manner uſed by brewers and diſtillers, the crank will make about four turns to one revolution of the great wheel, and of courſe deliver 296 hogſheads *per* hour; yet, as the reſiſtance made by the pumps will, in ſome meaſure, impede the motion of the wheel, it will not turn at the rate

of 730 times in an hour; for which ſuppoſe a deduction of one third, which is certainly a great allowance, the quantity then diſcharged *per* hour is about 200 hogſheads, which is more than equal to the conſtant work of five men; thus, if a veſſel, ſailing at the rate of 5 knots, delivers 200 hogſheads *per* hour, equal to five mens work,

6 knots is 240,	-	equal to 6 ditto.
7 knots 280,	- -	equal to 7 ditto.
8 knots 320,	-	equal to 8 ditto.

I am aware of many objections that will be ſuggeſted. In the firſt place it will be ſaid, that pumps of eight inches bore will be too large to be worked by the ſtrength of men, when the wheel cannot be applied. I anſwer, that no more force is required to diſcharge a gallon of water at a ſtroke from an eight-inch bore, than from a four-inch bore; as the ſhort end of the lever or handle to the eight-inch bore, need not be above a quarter part the length of the four-inch, which will give a purchaſe to the ſailor at the long end of the lever, ſufficient to raiſe the piſton or ſpear

a quarter

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a quarter the height of what is required in a four-inch bore; for, a piſton moving three inches in an eight-inch bore, and twelve inches in a four-inch bore, will deliver juſt about the ſame quantity of water. It will be farther objected, that in ſtormy weather, when veſſels generally make the moſt water, the wheel could not be put overboard. I own there is ſome force in this objection, but if a remedy is beneficial in ſome caſes, though not adequate in all, it ought not to be totally rejected. Many leaks happen at ſea in moderate weather; and even thoſe which are occaſioned by damage in a ſtorm often continue when the waves are abated. Sailors are frequently unhappily waſhed overboard, and poſſibly thoſe who may have ſurvived the ſtorm are too few, and too weak, to keep the ſhip clear of water, and perform the other neceſſary duties on-board; in ſuch caſes this machine would be evidently uſeful. It may alſo be urged, that the wind at ſuch time may be ſo much a head, that the ſhip cannot make way enough through the water to work the pumps; to which I reply, that when life is in danger, and death ſtares the affrighted crew in

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the face, the port of deftination is not to be con-fidered, but the veffel muft be fteered for that fhore which beft fuits the working of the pumps, and keeping her above water.

I would therefore propofe, that every veffel fhould not only have pumps of eight-inches bore, but be provided with a fhaft, crank, and proper wheels, which might eafily be ftowed away in little room, as the paddles of the water-wheel may be unfhipped; and the whole may be procured at a fmall expence.

References.

(See Plate III. Fig. 2.)

A. Top-maft, or fhaft of the wheel. B B. Oars or arms of the wheel. C. Crank. D. Pump. E E. Props on the deck, to fupport the fhaft.

VIII.

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Fig. 1.

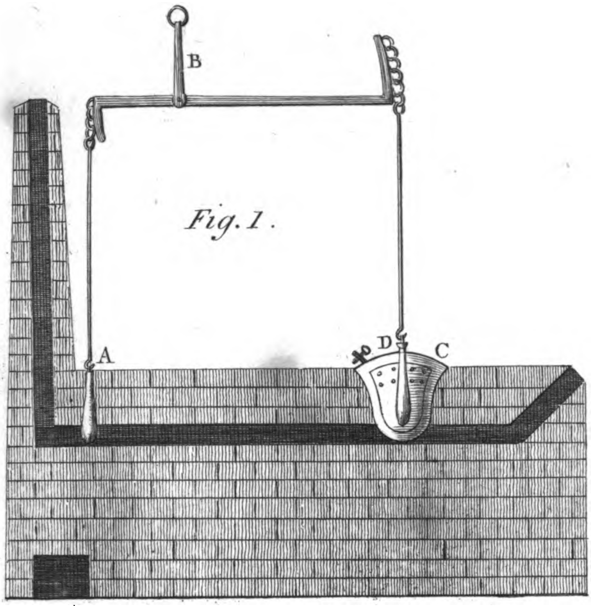
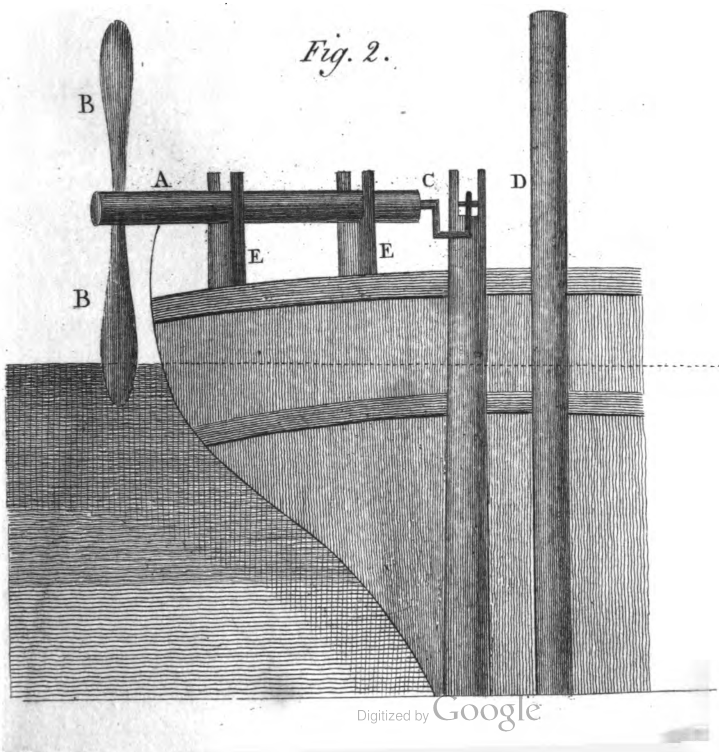


Fig. 2.



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VIII. *Experiments and Obſervations to inveſtigate the Nature of a Kind of Steel, manufactured at Bombay, and there called* Wootz; *with Remarks on the Properties and Compoſition of the different States of Iron. By* GEORGE PEARSON, *M. D. F. R. S.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

§. 1.

DOCTOR Scott, of Bombay, in a letter to Sir Joſeph Banks, P. R. S. acquaints him that he has ſent over ſpecimens of a ſubſtance known by the name of *wootz*; which is conſidered to be a kind of ſteel, and is in high eſteem among the Indians. Dr. Scott mentions ſeveral of its properties, and requeſts that an inquiry may be inſtituted to obtain farther knowledge of its nature. This gentleman alſo ſays, that "wootz admits of a harder temper "than any thing known in that part of India; "that it is employed for covering that part of

"gun-

" gun-locks which the flint ſtrikes; that it is " uſed for cutting iron on a lathe, for cutting " ſtones, for chiſſels, for making files, for ſaws, " and for every purpoſe where exceſſive hardneſs " is neceſſary." Dr. Scott obſerves, that this ſubſtance " cannot bear any thing beyond a very " ſlight red heat, which makes it work very tedi- " ouſly in the hands of ſmiths;" and that " it has " a ſtill greater inconvenience or defect, that " of not being capable of being welded with iron " or ſteel; to which, therefore, it is only joined " by ſcrews and other contrivances." He like-wiſe obſerves, that "when wootz is heated above " a ſlight red heat, part of the maſs ſeems to " run, and the whole is loſt, as if it conſiſted of " metals of different degrees of fuſibility." We learn alſo from Dr. Scott's letter, that " the work- " ing of wootz is ſo difficult, that it is a ſeparate " art from that of forging iron." It will be pro-per alſo to notice his obſervation, that " the " magnetical power, in an imperfect degree, can " be communicated to this ſubſtance."

§. 2.

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§. 2. *Mechanical and obvious Properties.*

The ſpecimens of wootz were in the ſhape of round cakes, of about five inches in diameter, and one thick; each of which weighed ſomewhat more than two pounds. Each cake had been cut almoſt quite through, ſo as to nearly divide it into two equal parts. It was externally of a dull black colour; the ſurface was ſmooth; the cut part was alſo ſmooth; and, excepting a few *pinny* places, and ſmall holes, the texture appeared to be uniform. It felt about as heavy as an equal bulk of iron or ſteel. It was taſteleſs and inodorous. No indentation could be made by blows with a heavy hammer; nor was it broken by blows which, I think, would have broken a like piece of our ſteel. Fire was elicited on colliſion with flint. Under the file, I found wootz much harder than common bar-ſteel not yet hardened; and than Huntſman's caſt-ſteel not yet hardened. It ſeemed to poſſeſs the hardneſs of ſome kinds of crude iron, but did not effectually reſiſt the file, like highly-tempered ſteel, and many ſorts of crude iron: for, although

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the teeth of the file were rapidly worn down and broken, the wootz was alfo reduced to the ftate of filings. The filed furface was of a bright bluifh colour, fhining like hardened fteel; but fome parts were brighter than others, and the moft fhining places feemed to be the hardeft parts. hence perhaps the reafon of the furface being uneven, and a little *pinny*. Notwithftanding this uneven and *pinny* appearance of the filed furface, a polifh was produced, which was, I think, at leaft equal, if not fuperior, in brilliancy and fmoothnefs, to that of any fteel I ever faw. The wootz-filings were attracted by the magnet, like common iron-filings.

A cake of this fubftance being broken in the part nearly cut through, the fracture exhibited the grain and colour of rather open-grained fteel, but it was not nearly fo open as I have conftantly feen the grain of a bar of cement, or blifter fteel. The grain of wootz was moft like that of blifter fteel which has been heated and hammered a little, and alfo like fome kinds of refined crude iron.

The

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The ſpecific gravity of wootz, and of ſeveral ſpecimens of ſteel and iron, was found, by Mr. More and myſelf, to be as follows.

N°. 1.	Wootz, - - -	7,181
N°. 2.	Another ſpecimen of wootz,	7,403
N°. 3.	Ditto, forged, - -	7,647
N°. 4.	Another ſpecimen, forged, -	7,503
N°. 5.	Wootz which had been melted,	7,200
N°. 6.	Wootz which had been quenched while white hot, -	7,166
N°. 7.	Bar-ſteel from Oeregrund iron,	7,313
N°. 8.	Ditto, hammered, - -	7,735
N°. 9.	German-ſteel bar, ſaid to be directly from the ore, - -	7,500
N°. 10.	Ditto, quenched when white hot,	7,370
N°. 11.	Melted ſteel-wire, -	7,500
N°. 12.	Ditto, another parcel, -	7,460
N°. 13.	Piece of hammered Oeregrund ſteel-bar, after quenching when white hot, - -	7,555
N°. 14.	Another parcel of ditto, -	7,570
N°. 15.	Piece of ſame bar hammered, but not hardened by quenching,	7,693

N°. 16.	Piece of ſteel which had been often heated and cooled gradually, - -	7,308
N°. 17.	Huntſman's ſteel hammered,	7,916
N°. 18.	Ditto, another ſpecimen, -	7,826
N°. 19.	Ditto, another ſpecimen, -	7,830
N°. 20.	Ditto, quenched when white hot,	7,771
N°. 21.	Ditto, another ſpecimen ſo quenched, - -	7,765
N°. 22.	Piece of a file quenched while white hot, to produce the appearance called *open grain*,	7,352
N°. 23.	Another ſpecimen of ditto,	7,405
N°. 24.	Piece of ſame file, but not ſo quenched, - -	7,460
N°. 25.	Another ſpecimen of ditto,	7,585
N°. 26.	Piece of very hard ſteel, -	7,260
N°. 27.	Hammered common ſteel, -	7,794
N°. 28.	Another ſpecimen of ditto, and hardened by quenching, -	7,676
N°. 29.	Softeſt and tougheſt hammered iron; from Parkes, an iron merchant, - -	7,716
N°. 30.	Another ſpecimen of ditto, -	7,700

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N°. 31.	Another parcel of ditto, -	7,780
N°. 32.	Another ſpecimen of ditto, -	7,787
N°. 33.	Common hammered iron, -	7,600
N°. 34.	Another ſpecimen of ditto, -	7,450
N°. 35.	Caſt or brittle iron re-melted *,	7,012

§. 3. *Effects of Fire.*

Until the ſubſtance was made red-hot, I could ſcarcely make any impreſſion with a hammer; nor could it be cut through with a chiſel, or wedge, till it was ignited to be of a pale red colour. It had then the peculiar ſmell of iron: it was then malleable, but was much more liable to be cracked and fractured by the hammer than common ſteel; or than, I think, even caſt ſteel. Small and thin pieces are perhaps malleable at lower degrees of fire, but very ſlowly, and not without great care and management. That ingenious ar-

* Bergman ſtates the ſpecific gravities of ſteel and iron as follows: 1, ſteel 7,643.—2, ditto 7,775.—3, ditto 7,727.—4, Ditto 7,784.—5, Ditto indurated 7,693.—6, Wrought iron 7,798.—7, Ditto 7,829.

tiſt Mr. Stodart forged a piece of wootz, at the deſire of Sir Joſeph Banks, for a penknife, at the temperature of ignition in the dark. It received the requiſite temper*. The edge was as fine, and cut as well, as the beſt ſteel knife. Notwithſtanding the difficulty and labour in forging, Mr. Stodart, from this trial, was of opinion that wootz is ſuperior, for many purpoſes, to any ſteel uſed in this country. He thought it would carry a finer, ſtronger, and more durable edge, and point. Hence it might be particularly valuable for lancets, and other chirurgical inſtruments.

Mr. More got a piece of wootz beat into a thin plate; in this ſtate the texture did not ſeem to be uniform, but appeared to be of different degrees of hardneſs, or kinds. A large piece alſo was forged into a thick bar by Sir Thomas Frankland, Bart.

(*a*) The pieces which had been cut in the ignited ſtate above mentioned had ſmooth ſurfaces, with a few ſmall cavities.

* "At the temperature of 450° of Fahrenheit's ſcale."
Mr. Stodart's letter to Sir Joſeph Banks.

(*b*) The

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(*b*) The ſubſtance made white hot, by the forge, had the glaſſy ſmooth ſurface of iron, in what is termed the welding, or welling *, ſtate. On ſtriking it gently under the hammer, it was cracked in many places: and by a hard blow it was broken into a number of ſmall pieces, as crude iron and caſt ſteel are at this degree of ignition.

(*c*) The ſurfaces of the fractured pieces (§. 3. *b.*) were black and ragged, or, as it is termed, had no grain. Two or three pieces indeed had yellow and reddiſh ſpots; but theſe were merely tinges from the fire, and diſappeared on applying a few drops of muriatic acid.

(*d*) The pieces (§. 3. *c.*) when cold were readily broken. Some of the fractures exhibited a bright, ſilvery, foliated grain, of ſeemingly an homogeneous ſubſtance, as frequently appears on breaking ſteel which has been quenched, when white hot, in cold water; and as alſo appears on breaking ſteel and crude iron which have been repeatedly ignited, and cooled gradually; but many of the fractures of the ſmall pieces were grey, and cloſe grained.

* This term being from the German word *wellen.*

(*e*) A

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(*e*) A piece of the ſubſtance was ignited to whiteneſs, and then quenched in a large bulk of cold water. It was rendered much harder than before, ſo that a good file rubbed off very little. I cannot however, from this experiment, determine whether wootz is ſuſceptible of a greater, or ſo great, a degree of hardneſs as ſome kinds of ſteel uſed by the Engliſh artiſts.

(*f*) The piece (§. 3. *e*.) was ignited in a cloſe veſſel, and let cool in the aſhes of the fuel. It became much leſs hard, but I never could, by annealing, bring down the temper to the degree of any of our ſteels; on which account it is far more difficult to forge. The interior parts of a thick piece of wootz could ſcarcely be ſoftened at all by annealing.

(*g*) A piece of this ſubſtance, about 500 grains in weight, (wrapped in paper, to afford carbon enough to prevent oxidation, without ſuperſaturating the metal with carbon,) was expoſed in a cloſe veſſel, for above an hour, to a pretty conſiderable fire. On cooling, the ſubſtance was found to have retained its form, but it was of a ſlate-blue colour, and many round particles, as large

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large as pins heads, adhered to its ſurface, as if matter had oozed out by melting. The degree of fire, indicated by Wedgwood's pyrometer, was 140°.

A piece of our ſteel, which had been part of a file, was expoſed in a ſimilar manner; but to rather more fire. It retained its form, and its ſurface remained ſmooth.

A piece of crude or caſt iron, by expoſure to this degree of fire, under the circumſtances juſt mentioned, was fuſed: in a temperature of about 120° its ſurface became covered with a number of ſmooth roundiſh maſſes, as if fuſion had begun.

(*b*) 500 grains of wootz were expoſed, as in the former experiment, but to a fiercer fire, in my forge. The temperature was 148°; which is 23° more than Mr. Wedgwood ſtates he could produce in a common ſmith's forge. My forge is movable. The fuel is contained in a pan of caſt iron lined with fire-bricks, as propoſed by Mr. More. The bellows are only of the 22-inch ſize. In this fire the ſubſtance was melted, with the loſs of a few grains in weight. The ſurface was quite ſmooth. It broke under the hammer like caſt ſteel.

ſteel. It received as fine a poliſh as that which had not been melted. Under a lens, the poliſhed ſurface appeared quite uniform and cloſe, with a few pores at equal diſtances. The poliſhed unmelted wootz had ſtill fewer pores, and at unequal diſtances, but with ſeveral fiſſures. Its grain, in the opinion of Mr. Stodart, was like that of caſt ſteel of the beſt quality; conſequently it was uniform, and rather cloſe. Its ſpecific gravity, as already ſtated, was about 7,200.

500 grains of ſteel wire were melted under the circumſtances juſt mentioned. The maſs fractured in the ſame manner, and had the ſame kind of grain, as the wootz which had been melted.

I did not always ſucceed in melting wootz, or ſteel, although the fire denoted by the pyrometer was of the ſame, or a higher, temperature than that in which at other times they were melted. Nor is this reſult difficult to be accounted for by thoſe who conſider the different temperatures in different parts of the ſame fire; even ſuppoſing the inſtrument to invariably indicate the real temperature.

(*i*) Equal

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(*i*) Equal weights, namely, 500 grains, of wootz, of ſteel wire, and of grey pig-iron, were expoſed for half an hour, in the ſame crucible, well covered, to a pretty conſiderable fire. On cooling, the pig-iron was found to have been fuſed, but the other two ſtates of iron had retained their form. The pyrometer was contracted to near the 140th degree.

(*k*) I melted together 500 grains of ſteel wire and 50 grains of grey pig-iron, in a cloſe veſſel, without any addition of carbon. The ſteel ſo alloyed was more brittle than caſt ſteel. Its grain was coarſer, and it had not the uniformity of texture and colour of melted wootz; (§. 3. *b*,) but had more reſemblance to ſome of the fractures of the unmelted wootz. (§. 3. *d*).

§. 4. *Effects of Fire and Oxygen Gaz conjointly.*

A piece of wootz ignited to whiteneſs, being expoſed to a blaſt of air in the charcoal-fire of the forge, emitted ſparks, like thoſe of iron and ſteel in theſe circumſtances: at the ſame time it melted in the ſtate of oxide of iron.

§. 5. *Experiments with diluted Nitrous Acid.*

(*a*) 200 grains of the ſubſtance under examination were firſt digeſted, and afterwards boiled, in three ounce-meaſures of concentrated nitrous acid, mixed with an equal bulk of water. A diſſolution took place, with a diſcharge of nitrous gaz. The mixture, reduced by boiling to half its bulk, was diluted with water, and, while boiling-hot, was filtrated through paper. Excepting a few grains of black matter, the whole mixture paſſed through the filtre. The filtrated liquor, evaporated to dryneſs, afforded a matter, which, after being kept red-hot for two hours, was a light, ſpongy, reddiſh ſubſtance, that weighed 270 grains.

(*b*) 30 grains of the reddiſh ſubſtance, (§. 5. *a.*) digeſted in half an ounce of concentrated acetic acid, on filtration and evaporation to dryneſs, yielded one grain and a half of grey matter, which was aſcertained to be oxide of iron.

(*c*) The blackiſh matter left upon the filtre (§. 5. *a.*) was repeatedly digeſted in diluted nitrous acid. The firſt filtrated liquors afforded, on evaporation,

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poration, a few grains of oxide of iron, and the laſt a very minute quantity of the ſame.

(*d*) 60 grains of the reddiſh matter, (§. 5. *a*,) with a bit of ſugar, were digeſted in diluted nitrous acid. The filtrated liquor, on evaporation to dryneſs, yielded a few grains of a browniſh ſubſtance, which, after many experiments, was found to be oxide of iron. Of theſe it will be ſatisfactory if I mention, that a little of the browniſh ſubſtance, fuſed with the fluxes, by the flame and blowpipe, did not afford a reddiſh or purple glaſs from the exterior or white flame; nor a colourleſs one from the interior blue flame.

Theſe experiments (§. 5. *a*—*d*.) were alſo made on ſteel wire, with the ſame reſults.

(*e*) A few drops of diluted nitrous acid were applied to pieces of poliſhed wootz, ſteel, and iron. The parts of the wootz and ſteel ſo wetted became black, but the iron was made brown.

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§. 6. *Experiments with diluted Sulphuric Acid.*

This acid liquor was made by mixing one meaſure of concentrated ſulphuric acid with three of pure water.

Before I felt any degree of confidence in theſe experiments, with reſpect to the carbon, and the proportions of hydrogen gaz from wootz and water, I repeated them often; but I here think it neceſſary to relate only one experiment.

200 grains of wootz, from the ſurface of which oxide, and all other extraneous matter, had been carefully rubbed off, were put into a retort, with five ounce-meaſures of diluted ſulphuric acid. In the temperature of 55° of the room, in twenty-four hours, about a pint-meaſure of gaz came over, into a jar filled with, and ſtanding over, lime-water; without any diſturbance of its tranſparency, or diminution of the bulk of the gaz. The liquid in the retort became green, and a quantity of black wool-like ſediment appeared upon the undiſſolved wootz.

On

On applying the lamp, the diſſolution went on rapidly, and black matter continued to be ſeparated, and gaz to riſe, till the whole of what ſeemed to be ſoluble in the menſtruum diſappeared. When about three-fourths of the matter were diſſolved, a white ſediment, like the *ſiderite* of Bergman, began to appear, and increaſed as the diſſolution went on.

By ſtanding, ſtill more of this white ſediment fell down; and green cryſtals, apparently thoſe of ſulfate of iron, formed a ſtratum which lay over the white matter. The black matter adhered to the ſides of the retort, it appeared alſo upon the ſurface of the liquid, and ſome of it was depoſited under the white ſediment.

This experiment was alſo made with ſteel wire, and with the tougheſt iron wire.

TO BE CONCLUDED IN OUR NEXT.

IX. *Obſervations on the Uſe of Sithes for reaping Corn, &c. publiſhed by the* Patriotic Society *of* Milan.

WITH A PLATE.

From the Transactions of the ſaid Society.

IT has been a queſtion in agriculture, whether ſithes or ſickles were moſt advantageouſly uſed for reaping corn. All perſons agree that much more work, and with leſs labour, may be done with the ſithe than with the ſickle; but ſome ſay, that the ſaving of time and labour is not ſufficient to compenſate the diſadvantages attending that method.

It is ſaid that the ſithe ſhakes the ear, ſo that many of the grains are loſt; that it lets the corn fall, after cutting it, in a confuſed and ſcattered ſtate, ſo that either much of it is loſt, or a great deal of time is conſumed in gathering it together; that it can only be made uſe of in land which is very

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very even and free from ftones; that it does not leave fufficient length of ftubble in the ground to lay the corn on when cut; that it mixes bad weeds with the corn, the feeds of which are fown the next year; and, laftly, that the ufe of the fithe is prejudicial to the health of the reaper.

Thefe objections, however, are either of no weight, or they are made by thofe who are not acquainted with the good fithes which have been adapted to this purpofe, and with the proper manner of ufing them. With a good fithe, properly managed, the corn, after being cut, remains at firft upright, and then falls very gently upon the rake fixed to the fithe, without any fhake or jolt; or at leaft with lefs than that which it receives when reaped with a fickle. With refpect to the lofs of grain, that proceeds chiefly from the corn being too dry; confequently it fhould be reaped only upon proper days, and proper times of the day, which is much more eafily done with the fithe than with the fickle, becaufe the work is fo much fhorter. The ftalks, kept together by the rake, may be laid upon the ground, or rather againft the corn not yet cut, in fo regular and collected

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collected a ſtate, that thoſe who gather and tie the ſheaves, whether they are women or children, have nothing but their own negligence to accuſe if any thing is left behind. When land is properly ploughed and harrowed, it is ſufficiently even; and, in ſuch as is ſtony, the only precaution neceſſary is to keep the ſithe a little higher in uſing it, that it may not ſtrike againſt the ſtones. If the ſtubble left in the ground be ſhort, the ſtraw which is cut off will be the longer; and the latter is certainly of more value than the former, which only ſerves to incommode the cattle which afterwards go to feed in the field. The graſs will grow more thick, by being cut off near the root; and it is better that the ſeeds of it ſhould be collected from the barn-floor, than that they ſhould fall in the field. The manner of procuring ſeed well cleared from all pernicious weeds, to ſow in the following Autumn, is well known. If the poſture, and manner of uſing the ſickle, be compared with the management of the ſithe, it muſt very clearly appear that the latter is attended with leſs inconvenience, and leſs danger. It is indeed true that the workmen who uſe the ſithe are ſome-

2 times

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times afflicted with diforders of the kidneys, as Duhamel obferves, but that inconvenience arifes from their not keeping themfelves in a proper pofture, of which more will be faid hereafter.

The faving in time and expence is very great indeed. According to Freville, (*Nouveaux Elémens d'Agriculture*, chap. I.) a field, the reaping of which with a fickle cofts, in the neighbourhood of London, thirty-two fhillings, would coft, in the county of York, where reaping is performed with a fithe, only twelve fhillings and fix-pence: and, according to Delifle, (Duhamel, *Elémens d'Agriculture*, §. 4. chap. I.) the fame quantity which, with a fickle, requires one day with two hundred men, (or in that proportion,) with a fithe would require only feventy men, and the fame number of women, or children *. But, fetting calculation afide, a certain argument of the advantage of fithes, in reaping corn, may be drawn from ob-

* The expence of the inftrument cannot be an objection to its ufe, it being very trifling; indeed, except the iron, which cannot coft much, the labourer may make it himfelf.

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ſerving that their uſe is daily increaſing in thoſe countries where they have not yet been generally adopted; and they are never given up when once they have been brought into uſe.

Upon theſe principles the patriotic ſociety was induced to give ſome attention to the uſe of ſithes for reaping; and two ingenious ſmiths, (Joſeph Bolgie of Milan, and Peter Francis Ponti of Deſio,) preſented to the Society two ſithes invented by them for that purpoſe. The Society thought that in Lombardy, where the number of perſons to be procured for the work in queſtion is by no means great, and where there is often danger of injury from hail upon the very day of reaping, great advantages muſt attend the uſe of an inſtrument which, by diminiſhing labour and ſhortening time, would, at leſs expence, more quickly ſecure from danger that harveſt for which the farmer had toiled through the whole year.

The ſociety therefore deputed two of their members, Don Franciſco Molina, and Don Andrea de Carli, to examine into the merit of the ſithes preſented

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presented to them; after proper trials, they were found by no means to answer the proposed end. This failure determined the society to send to those parts in which sithes are made use of for reaping; and, having procured a model of a sithe from Silesia, they caused one to be made of a proper size. It was first tried upon corn, and afterwards upon millet; and, although the first sithe was not accurately made, and the reaper had never before made use of such an instrument, yet it was found that nearly half the usual time was saved, and that the labour and fatigue were much diminished; the corn also was cut without receiving any shock that could be hurtful to it, and fell in an even and regular state, so that it was afterwards easily bound up in compact sheaves.

From these circumstances the society resolved to publish a figure of such an instrument, with a description, and an account of the manner of using it, conceiving it must be convenient and advantageous to farmers. And as another sithe, somewhat different from the first, and generally used

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in Austria, was afterwards presented by Signor de Brambilla, surgeon in the army of his Imperial Majesty, they will, after describing the Silesian sithe, mention in what the Austrian one differed from it; in order that whichever should be found most convenient may be adopted.

The sithe for reaping is so simple an instrument that the figure of it almost renders a description unnecessary. In Fig. 1. (Plate IV.) is shewn the Silesian sithe tried by the Society; the difference between that and the Austrian one we shall mention in our description. The first, or Silesian sithe, differs very little from the sithe we commonly use for mowing grass, except that the blade is rather smaller, like that used in some mountainous parts of our country; to it are added four teeth of wood, parallel to the blade, fixed and secured in a proper manner, and intended to keep the corn together after being cut, so that, instead of its falling in a confused state, the reaper may lay it down in a regular and compact one.

The second, or Austrian sithe, is similar to the former, except that the blade is larger; conse-

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quently the wooden teeth, of which there are five, are longer; the handle alſo is more flat, and rather crooked.

In the firſt, the handle *a b* (ſee Plate IV. Fig. 1.) is two Milaneſe *braſſes* and nine inches and a half in length; the blade *b c* is one *braſs* three inches and a half; the piece of wood in which the teeth are fixed, one *braſs* one inch and a half.

In the ſecond, the handle is two *braſſes* and ſeven inches long; the blade, one *braſs* eleven inches; the piece in which the teeth are fixed, eleven inches and a quarter. The proportions of the other parts may be conceived from the figure.

The difference in the conſtruction of theſe two ſithes makes it requiſite to uſe them in a different manner, but that will be better acquired in practice than by precept. Such of our countrymen as are accuſtomed to the uſe of the common ſithe will very ſoon find out the moſt convenient and advantageous manner of uſing theſe new kinds of

* One hundred Milaneſe *braſſes* are equal to fifty-eight Engliſh yards and a half.

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of ſithe, and of laying down the corn properly when cut.

It ſhould however be obſerved, that in mowing graſs the feet are kept almoſt parallel to each other, whereas in reaping corn they ſhould be kept upon a line, one behind the other, thruſting the right foot forward, and drawing the left towards it. This is neceſſary, becauſe when graſs is mowed it is left to fall juſt where it is cut; but when corn is cut it is to be carried and laid in a proper manner againſt that which is not yet cut, and which is at the left hand of the reaper; and, if the feet were kept parallel to each other, the reaper would be obliged to extend and turn his body in a very inconvenient manner.

POSTSCRIPT.

After having made public theſe obſervations, the ſociety made farther experiments upon the ſubject, in which it was found that when, on account of very wet weather, the ſtalks of the corn are bent down, the wooden teeth of the forementioned ſithes are apt to lay hold of ſome

ears,

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ears, to the ſtalks of which the iron does not reach, and conſequently, not being cut below, they are pulled ſo that the grain is ſcattered. This happens chiefly when the reapers, not being yet ſufficiently accuſtomed to that kind of ſithe, do not know how to adapt it to particular circumſtances; as was the caſe with ſeveral perſons who, in this preſent year, wiſhed to make uſe of it. To remedy this inconvenience, the above mentioned Peter Francis Ponti thought of adding to the common ſithe a *gatherer* or *collector* made of cloth, as may be ſeen at Fig. 2.

a b c is a common ſithe; *c d m l o f n e* is the *gatherer*; which at *c d e* is compoſed of a thin plate of iron, having at its extremity a hollow for receiving the point of the blade. At *e d* are holes for ſewing in the cloth, which is coarſe, light, and of low price; it is alſo fixed to two thick iron wires, of which the upper one is continued to *f*, where it terminates in a hole in the handle; the other is fixed to the back of the blade. The manner of fixing this *gatherer* to the blade of the ſithe will be better underſtood by referring to Fig. 3, which repreſents

represents one of the irons which, by means of a screw, are fastened to the back of the sithe. These irons proceed from, and make part of, the upright irons *m n l o*, which serve to keep the *gatherer* extended.

Although the above mentioned contrivance is very simple, and costs very little, yet Francis Pratesi, beadle of the society, has attempted to render it still more simple, by substituting, in place of the *gatherer*, two iron hoops, shewn in Fig. 2 by dotted lines, marked *b g*, *k i*, with a cross-piece *p* which connects them; saving, in this manner, the cloth, and the plate of iron, used in Ponti's contrivance.

Experiments made with both these instruments have shewn, that the sithe with Ponti's gatherer is preferable in general, as it does not leave an ear of corn behind; and that the alteration proposed by Pratesi is chiefly advantageous when there is no short corn, or other plant, to get between the iron hoops.

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Fig. 3

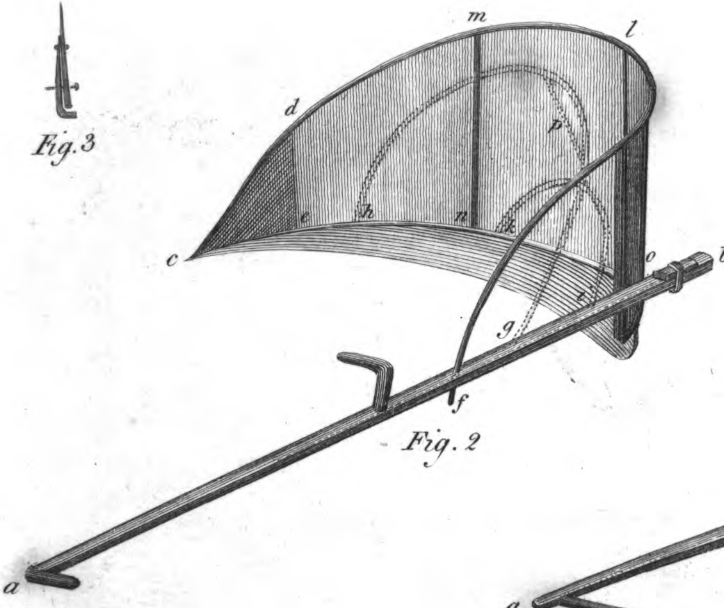

Fig. 2

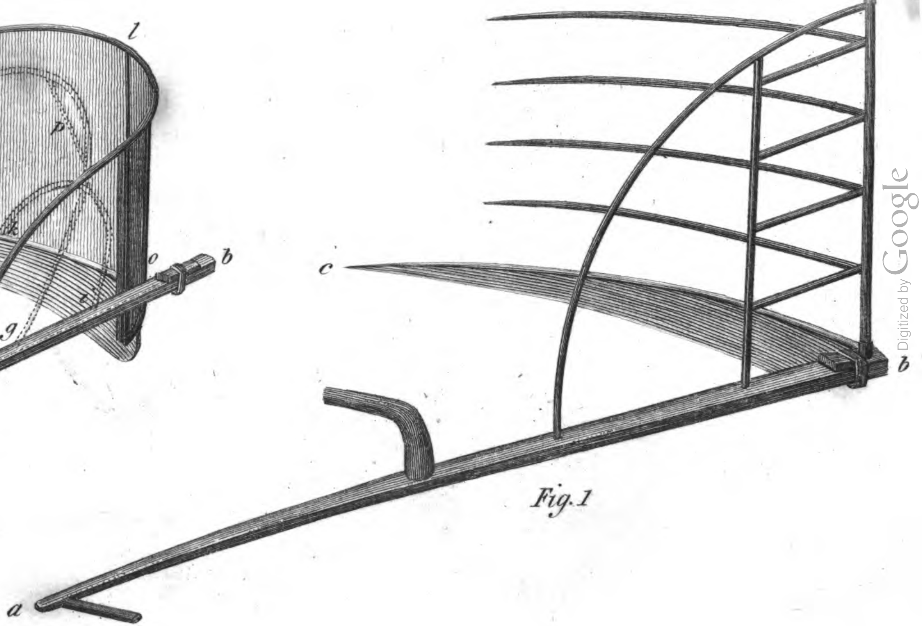

Fig. 1

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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXVI.

X. *Specification of the Patent granted to Mr.* FELTON MATHEW, *of Three-Cranes-Wharf, in the City of London, Merchant; for his Method of completely ſeparating the Beer from Yeaſt, and preſerving the Yeaſt for a great Length of Time, and in any Climate.*

Dated Feb. 22, 1796.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Felton Mathew do hereby

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declare, that my ſaid diſcovery of a method of completely ſeparating the beer from yeaſt, and preſerving the yeaſt for a great length of time, and in any climate, is deſcribed in manner following; that is to ſay, to ſeparate the beer from yeaſt, I uſe a preſs with a lever, the bottom made of ſtout yellow deal, oak, or any other timber fit for the purpoſe, raiſed with ſtrong feet a convenient height from the ground, ſo as to admit the beer to run off into whatever is prepared to receive it. Into the back of it is let a ſtrong piece of timber, or any other fit material, to ſecure one end of the lever, the top of which is ſecured by being well wedged up to a girder, or the joiſts, at the top of the building; in this piece of timber is mortiſed one end of the lever, which is faſtened into this mortiſe with an iron pin, or otherwiſe properly ſecured; the whole well ſecured with iron work. The yeaſt is then put into bags, made of ſail-cloth, or any other ſtrong cloth or material, and carefully tied or ſecured, then placed flat on the preſs; a board is then laid on it, and the lever let down upon it, and weights are then

hung

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hung upon the other end of the lever, by means of hooks, or any other way that may be more convenient for the ſituation of the place; which weights are added as the beer runs from it, ſo as not to burſt the bags, or force the beer out too thick; to prevent this, I find a trough, made the ſize of the bag, with a falſe bottom bored full of holes, (the ſides and ends likewiſe of the trough bored full of holes, this placed on the preſs, and the bag put into it, with a top to come upon the bag, with blocks on it, ſo as to admit the lever to act upon it,) anſwers very well: this may be uſed with a looſe cloth inſtead of a bag, but I think not with ſo much advantage. When a ſufficient weight has been added to the lever, ſo as to completely preſs the beer out, (which may be done by a ſcrew-preſs, if there is not an opportunity of giving ſufficient force to the lever,) the yeaſt that remains in the bags will crumble to pieces, like flour; it muſt then be thinly ſpread upon frames, made with thin canvaſs, hair-cloth, or any other thing that will freely admit the heat to paſs through it, in a room, kiln, or ſtove, or other place where a

regular heat can be kept up to the temperature of from about eighty to ninety degrees; observing to break it finer as it dries, by passing a board, or other fit thing, lightly over it. When completely dry, put it in tight casks, or bottles, so as to exclude the air, or any damp, from it, and it will then keep good for a great length of time, and in any climate. When wanted for use, it may be dissolved in a small quantity of warm wort, or sugar and water, of the temperature of from about eighty to ninety degrees, when it possesses the same quality as fresh liquid yeast. In witness whereof, &c.

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XI. *Specification of the Patent granted to Mr.* JOSEPH SPARROW, *of the Town of Nottingham, Framework-Knitter; for his Method of raiſing, removing, and delivering Earth or Water, by which Rivers, Canals, or Fiſh-Ponds, may be made, or emptied, and alſo of raiſing and removing heavy Weights of Coal, Limeſtone, or other Stones, from and out of any Boat, Barge, or Veſſel, in a navigable River or Canal, and delivering the ſame upon the Wharf or Shore, or into any Waggon, Cart, or other Carriage, with more Facility, and leſs Labour and Expence, than by any Method hitherto known.*

WITH A PLATE.

Dated October 16, 1793.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that the ſaid Joſeph Sparrow, in compliance with the ſaid proviſo, and performance of the condition therein contained, doth hereby deſcribe and aſcertain the nature of his ſaid

said invention, in and by the plan thereof to these presents annexed, and doth hereby declare, that the same consists and is composed of the several particulars, and is to be performed in manner, as herein after is particularly mentioned; that is to say, Fig. 1, A A A A, (Plate V,) the carriage-part of the machine, made of wood; which pieces of wood are fastened together at each end with two strong screws; the said carriage-part runs on the four wheels B B B B, and supports the uprights and the machinery affixed thereon. C C, two upright posts, made of wood, fixed (by tenons and mortises) in the carriage-part A A. D D D D D D, supporters of the upright posts, fixed at the bottom (by tenons and mortises) in the carriage-part A A, and fastened at the top to the upright posts C C, by tenons and mortises. E, a cross beam of wood, fixed at each end thereof into the sides of the upright posts C C, by tenons and mortises. F, a beam, lying over and fastened to the top of the upright posts C C, by tenons and mortises. G, a circular ring of wood, fastened to the upright posts C C; namely, one side thereof six inches from the top of one of the

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the upright poſts, and the other ſide in a declined poſition to the other upright poſt (above the beam E, called the croſs beam) at the letter *a*; the upright poſts dividing the circular ring in two equal halves. H, a piece of wood, affixed at one end into the middle of the beam F, and at the other end into the middle of the circular ring G: there is another piece of wood, in the ſame poſition, on the contrary ſide of the beam F and the circular ring G, to anſwer each other; theſe two pieces of wood are ſtays to the circular ring G. I, an axis, deſcribed in Fig. 4. J J, a beam of wood, called the principal beam or lever, paſſing through the axis I, and turning and balancing upon the pin *b* in the axis I, (ſo as to move under the circular ring G, with the roller P between,) at the centre of the ſaid principal beam or lever; ſuch pin working in two collars or ferrels of iron; one of ſuch collars or ferrels being faſtened or fixed on each outſide of the axis I. K, a ſlot or piece of wood, deſcribed in Fig. 5, fixed at the end of the principal beam or lever, by means of the iron pin C ſhooting through both. This ſlot is fixed, at the end of the principal beam or lever J J, higher or lower, by means

of

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of the different holes *d d d d*, ſo as occaſion (on account of the depth of the river, canal, fiſh-pond, &c.) may require. L, a frame of wood, in which turns the barrel M; which frame is ſcrewed to the top of the principal beam or lever J J. M, a barrel, whereon is wound, by a handle, a rope for raiſing the catch or piece of iron in Fig. 2, marked *g*. N, an upright piece of wood, whereon to faſten the rope *i*, worked by the windlaſs, Fig. 3. O, a piece of wood called the ſtay or ſtrengthener, affixed underneath the centre of the principal beam or lever J J with four ſtrong ſcrews *f f f f*, ſunk into the wood, going through the ſtay and principal beam or lever, and faſtened at the top with nuts; which ſtay paſſes through the axis I, along with the principal beam or lever. P, a ſmall roller of wood, faſtened on the uppermoſt ſide of the principal beam or lever J J, at that part exactly under the circular ring; ſo that, when the principal beam or lever J J is performing its operation, the roller will work on the circular ring, which will prevent friction between the principal beam or lever and circular ring. The dimenſions of Fig. 1 may be as follow; the carriage-part, A A A A, nine feet ſquare

 within.

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within. The wheels, two feet each in diameter. The upright poſts C C, from the ground to the beam F, fifteen feet. The ſpace between the upright poſts, nine feet. The circular ring G, made of oak-wood, ſix inches ſquare, and to be of a diameter ſufficient to paſs through the given points in the upright poſts. The principal beam or lever J J to be forty-five feet long; or the dimenſions may be varied in proportion, according to the uſe to be made of the machine.

Fig. 2. A A. Two upright poſts of wood, to which the trunk B is faſtened by four ſtrong ſcrews *a a a a* in each upright. B, the trunk, for raiſing, removing, and delivering, earth, coals, limeſtone, and other ſtones; to be made of wood, and ſix feet long, four feet broad, and three feet deep, or larger, at diſcretion. C C, two doors at the bottom of the trunk when open; each door to turn on a ſtrong hinge; the two doors open in different directions, when diſcharging or unloading the earth, coals, limeſtone, or other ſtones. D marks the barrel, made of ſolid wood, on which the rope or chain laps round. The ſame rope or chain parts in two directions *b b*, one of

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which is faſtened to one of the doors at the bottom of the trunk, and the other is faſtened to the other door. E is a pulley of iron, faſtened at the top of the upright pieces of wood A A. F, a croſs beam, faſtened to the top of the two upright poſts A A, and hung, by a chain and hook, to the end of the ſlot or piece of wood marked K in Fig. 1. Through the pulley E paſſes a rope, which is faſtened at one end to the catch of iron *g*, at a place marked *e*, and the other end is faſtened to the barrel M in Fig. 1; taking its direction between the two upright pieces of wood C C in Fig. 1, and paſſing under the circular ring G in Fig. 1, and through a pulley that is faſtened to one ſide of the axis I in Fig. 1.

Fig. 3, a windlaſs, the form and principle of which are publicly known; the upright poſts on which the ſame is worked being fixed on the carriage A A A A, four feet ſquare, or larger if the work requires it, with ſupporters, ſhewn in the drawing, and running on four wheels B B B B. This is to work the machine Fig. 1, as after mentioned, and, while performing its office, is to be ſecured in its ſtation by a rope; each end of

which

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which rope, being faſtened to the windlaſs by hooks at each corner E E, is to be tied round a pin of iron, or wooden ſtake, driven into the ground at L.

Fig. 4 ſhews the axis I in Fig. 1, with the centre point of ſteel at the bottom, and ſpindle of iron at the top. A, the vacant ſpace between the ſides of the axis, through which the principal beam or lever JJ, in Fig. 1, paſſes, and the ſame are to be made to fit each other. The centre point turns in a gudgeon of braſs, let into the centre of the croſs beam E; a plate of iron nailed to the croſs piece covering the gudgeon, and in which plate of iron is a hole, through which the centre-point ſhoots into the gudgeon. The ſpindle of iron at the top ſhoots through the centre of the beam F, in an iron ferrel fixed on the uppermoſt ſide of the beam F.

Fig. 5, the movable ſlot or piece of wood K in Fig. 1. A, the vacant ſpace into which the end of the principal beam or lever J J, in Fig. 1, is placed and faſtened.

Fig. 6 deſcribes a trunk to be uſed for raiſing, removing, and delivering water; the upright

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poſts, and the beam at the top of them, as in Fig. 2; and to be fixed to the ſlot K in Fig. 1, ſame as Fig. 2. Between the two upright poſts is a roller R, turning upon iron axles, in ferrels fixed in the ſides of the ſame two upright poſts. The ſides and ends of the trunk to be the ſame as in Fig. 2. In the bottom of the trunk P is an oblong hole S, three feet long and two feet wide; over ſuch hole opens and ſhuts the door A, which turns on a hinge at the end of it; ſuch hinge being fixed, by ſcrews or nails, to a piece of wood (the ſame thickneſs as the door) fixed to the bottom of the trunk by ſcrews. The door to be made larger, by two inches at the ends and ſides, than the hole at the bottom of the trunk; and the bottom of ſuch door to be covered or caſed with leather, to fit water-tight, or as near thereto as may be. On the top of the door is to be affixed a piece of lead Q, of the weight of twelve pounds, or upwards. On the uppermoſt ſide, and at the top, of the ſame door, is faſtened one end of a rope, the other end of which paſſes over the roller R, and then, ſame as in Fig. 1, to the barrel M in Fig. 1; ſeveral yards of rope hanging

over

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over, and beyond, the laſt mentioned barrel M, to be pulled or uſed by the hand.

Fig. 7. T, a lever made of wood, turning on an iron pin U, fixed in the two iron uprights V V. The bottom bar being alſo of iron, turning on a ſwivel of iron W, fixed on a portable ſtand with three legs, made of wood.

The manner in which the machinery is worked. The machinery Fig. 1, together with Fig. 2, hung to the ſlot or piece of wood K, in Fig. 1, by a chain and hook, (for the purpoſe of raiſing, removing, and delivering earth, coals, limeſtone, and other ſtones,) being placed on the bank or ſide of the river, canal, or fiſhpond, the windlaſs, Fig. 3, is to be fixed on the oppoſite ſide of the river, canal, or fiſhpond, or at a convenient diſtance oppoſite the ſide of Fig. 1, and the rope on the barrel of the windlaſs is to be affixed to the top of the upright piece of wood N in Fig. 1. By winding up the rope on the barrel of the windlaſs, the end of the principal beam or lever JJ, with Fig. 2 hanging thereto, is raiſed; and, by looſing or unwinding the ſame rope, the ſaid end of the principal beam or lever, with Fig. 2 hanging thereto,

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thereto, is let down to the boat, barge, or veſſel, river, canal, or fiſhpond, being declined down by means of the circular ring G. Before the end of the principal beam or lever is ſo let down, the rope wound on the barrel M in Fig. 1 is to be looſened, ſo that the catch *g* in Fig. 2 will fall into the teeth of the barrel D in Fig. 2, which, made in the common way, will wind up without being ſtopped by the catch, but the catch will prevent the barrel unwinding the rope which is round it. The rope on the barrel D muſt be wound up, ſo as to ſhut the doors in the bottom of the trunk B in Fig. 2; then the trunk is to be filled with what is intended to be raiſed and removed; then the windlaſs, being worked, will bring down the end of the principal beam or lever, to which the rope is affixed, and raiſe and bring the other end, with the trunk thereto, over the wharf, or ſhore, or any waggon, cart, or carriage there; and the catch g in Fig. 2 being raiſed, by winding up the rope on the barrel M in Fig. 1, (which will then be upon or near the ground,) the rope or chain on the barrel D, in Fig. 2, will be ſet at liberty, and the weight of the contents of

the trunk will preſs open the doors at the bottom of the trunk, and diſcharge ſuch contents upon the wharf or ſhore, or into any waggon, cart, or other carriage there, being underneath the ſaid trunk. This being done, the rope on the barrel M muſt be looſened as before; and, the rope on the barrel of the windlaſs being looſened, the trunk will be returned to the place where it is to be filled. For expedition there may be two parts of Fig. 2, one to be filling whilſt the other is raiſing, removing, and delivering; and, in ſuch caſe, the Fig. 2 may be taken off the hook on the ſlot or piece of wood K in Fig. 1, by the uſe of the movable lever Fig. 7. In uſing the machine for raiſing, removing, and delivering water, the trunk Fig. 6 is to be hung to the ſlot or piece of wood K in Fig. 1, inſtead of the other trunk; the rope on the barrel of the windlaſs, being looſened or unwound, will let the trunk down to the water; and then, on pulling by the hand, the rope paſſing over the roller M in Fig. 1, through the pulley on the ſide of the axis I in Fig. 1, and over the roller R in Fig. 6, and faſtened

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tened to the door at the bottom of the water-trunk, Fig. 6, will raise or open such door of the water-trunk, which will let in the water and fill the trunk; and then, by slackening the rope, the lead upon the door of the water-trunk will close it. Then, by winding the rope upon the windlass, the end of the principal beam or lever, with the water-trunk hanging thereto, will be raised and removed out of the river, canal, or fishpond; when, by pulling the said last mentioned rope, the lid or door at the bottom of the water-trunk is raised and opened, and the water therein let out or discharged; then, by unwinding the rope on the windlass, the water-trunk is let down again to the river, canal, or fishpond, as before. In witness whereof, &c.

XII.

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Fig. 6.

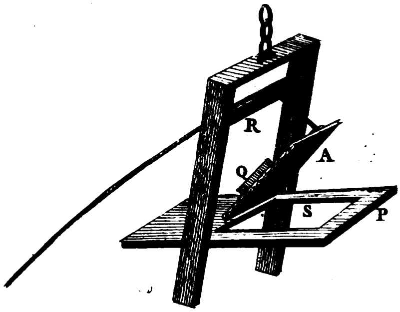
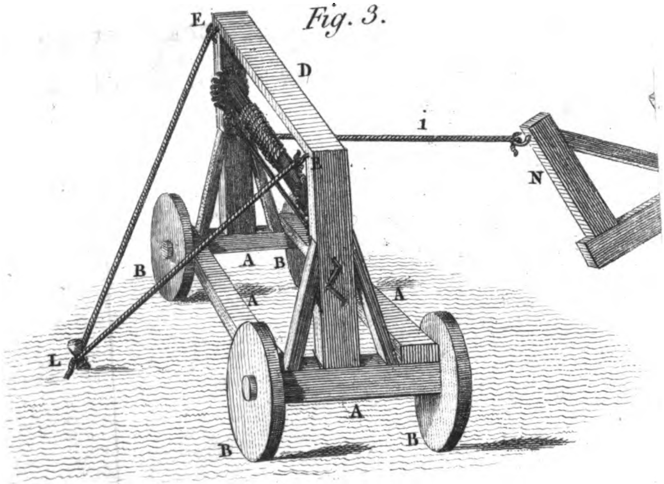


Fig. 3.



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XII. *Specification of the Patent granted to Mr.* JOHN ATKINSON, *of Harrington, near Liverpool, Colour-Manufacturer; for making or manufacturing, from certain Materials, certain Colours or Paints, of a superior Quality to the Colours or Paints hitherto made from the same Materials.*

Dated June 18, 1794.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said John Atkinson, in compliance with and conformity to the said proviso, do hereby particularly describe and ascertain the nature of my said invention as followeth; I do declare that the colours or paints of a superior quality to the colours or paints hitherto made from the same materials, whereof I have invented the making or manufacturing, as before mentioned, (and which materials are herein after mentioned and described,) are respec-

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tively commonly called or known by the names or defcriptions of Venetian red, Spanifh brown, colcothar of vitriol, chocolate purple brown or purple brown, blue purple or dark purple brown, white or mineral white. And, firft, with regard to the making or manufacturing of the faid paint or colour called Venetian red, I do declare, that the material of which the faid Venetian red paint or colour is made, is precipitated ochre, or earth of iron, otherwife called crocus martis or faffron of Mars; and that the fame muft be diluted with water in an iron or other boiler or furnace, and fire or heat applied till the water and ochre boil, or attain a boiling heat; in which ftate it parts with moft of its ferruginous mixtures; and, after ftanding about five minutes, the heterogeneous particles will fall to the bottom of the boiler, and the finer parts muft be taken therefrom, and conveyed into a pan or receiver, or other veffel capable of bearing heat; and fire or heat muft be urged or applied till the whole is fufficiently dry; or the fame may be dried by the fun, or wind. In that ftate it muft

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be removed to a calcining-furnace or oven, commonly called a reverberatory-furnace, where, by the assistance of a bright flame conveyed over the top of it for about eight hours, the colour is changed from a yellow to a bright red colour; in which state it must be drawn from the furnace or oven, and, when cold, must be ground by a mill or machine; regard being had to the colour being duly mixed with water. After which it must be conveyed from the mill or machine, by a plug about twelve inches from the bottom of the tub, into spouts which carry it into fine sieves; whence it must be received into cisterns or vessels which communicate one with another by spouts, or otherwise, by which means the finer particles float into the farther part of the cisterns. I make use of six cisterns in number, but a greater or less number may be used; and in this state, after standing about twenty-four hours, the water is to be drawn from the colour, and then mixed with alabaster and chalk, both finely ground; after which it must be dried. I use for that purpose a drying-loft made with Venetian-blinds, which admit of

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a current of air, and put the colour in earthen dishes, about ten inches wide and four inches deep. The colour is then in the form of a cake, in which state it is saleable; but, when it is ordered in powder, it must be finely ground. And, secondly, with regard to the making or manufacturing of the said paint or colour called Spanish brown, I do declare, that the heterogeneous part of the said precipitated ochre, earth of iron, material or residuum from the boiler, as described in the former process for the making of Venetian red, must be taken to a reverberatory-furnace, where it must be calcined with a strong heat for about six hours, together with a native ochre, commonly called yellow ochre; and at the end of that time its colour will be changed from a yellow to a dark red colour, in which state it is to be taken from the furnace, and, when cold, ground by a mill or machine; regard being had to the colour being duly mixed with water. After which it must be conveyed from the mill or machine, by a plug about twelve inches from the bottom of the tub, into spouts which carry it into sieves; whence it

must

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must be received into cisterns or vessels which communicate one with another by spouts, or otherwise, as described in the process with respect to the making of the Venetian red. And, after the same has stood about twenty-four hours, the water must be drawn from it, and the colour removed to a pan or receiver, or other vessel made of bricks, or other materials, capable of bearing heat; and, after being dried by fire, or otherwise, must be powdered for sale. And, thirdly, with regard to the making or manufacturing of the said paint or colour called colcothar of vitriol, I do declare, that the said precipitated ochre or earth of iron, or material, must be put into a calcining-furnace, commonly called a reverberatory-furnace, and a very strong fire conveyed over the top of it for about sixteen hours, when the same will be changed from a yellow to a bright light purple; and in that state it must be drawn from the furnace, and, when cold, must be ground by a mill or other machine; being duly mixed with water. After which it must be conveyed from the mill or machine, by a plug, into spouts which remove it to

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before mentioned; and, after having ſtood about twenty-four hours, the water muſt be drawn from it, and the colour collected, and dried by fire, or otherwiſe, and powdered for ſale. And, laſtly, with regard to the making or manufacturing of the ſaid paint or colour called white or mineral white, and which is to be made from a certain material called the ore of blende, black jack, or lapis calaminaris; the ſame muſt be firſt calcined, after which it muſt be powdered and mixed with about an eighth part of its weight of powdered charcoal; the whole is then to be put into a jar or pot, with a pipe in the bottom, communicating with a reſervoir ſituated below the bottom of the furnace. The jar or pot, with its contents, are to be placed in a furnace ſimilar to a glaſs-houſe furnace; the jar and reſervoir being firſt duly luted. After which the whole muſt be expoſed to a very ſtrong fire for about five hours, in which time the metallic part of the ore, or zinc, will be collected in the reſervoir. The zinc is to be immerſed in vinegar, and expoſed to a gentle heat for about twelve days, at the end of which

time

time it will be diſſolved, and a white powder will fall down to the bottom, which muſt be collected and dried; after which the ſame muſt be mixed with about a tenth part of its weight of ſulphur, and ſublimed; after which it is to be ground, and conveyed, and received into ciſterns or veſſels which communicate one with another, in like manner, in all reſpects, as deſcribed in the former proceſs; and, after having ſtood about twenty-four hours, the water muſt be drawn from it, and the colour collected, and dried, and then powdered for ſale. In witneſs whereof, &c.

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XIII. *Specification of the Patent granted to Mr.* Robert Golding, *of the Parish of St. Olave, Southwark, Hat-dyer; for his Method of dying, staining, and colouring, Beaver and Beaver-Hats, Green, or any other Colour, &c.*

Dated Jan. 1, 1782.—Term expired.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said Robert Golding do hereby declare, that my said invention of a new method of dying, staining, and colouring, beaver and beaver hats, commonly called felt, or beaver, or stuff hats, green, or any other colour, underneath or on one side only, preserving the natural colour on the other side, is described in the manner following; that is to say, first, the nap of the hat on the side intended to be dyed is to be raised with a card, then boiled in alum and argol;

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argol; and afterwards a thin paſte, made of flour, or clay, ſpread with a painter's brush over every part of the hat not intended to be dyed; then cloſed; or they may be paſted firſt, and then, inſtead of being boiled, muſt be only ſimmered in the ſame liquor. As ſoon as the paſte, in either caſe, is ſpread, plates of copper, or any other metal, or thin boards, nearly of a triangular form, or an inſtrument of the ſame materials, ſhaped like a common funnel, are fixed over and upon the paſte, to prevent the dye coming through, and ſometimes paſted and cloſed together with plates or boards. Then a ſmall plate, with the initials of the dyer's name, is fixed or faſtened to that part of the hat intended for the inſide-crown, which admits ſuch initials being dyed therein at the time the hat is dyed. In this ſtate the hat is put into the dying-liquor, boiling or almoſt boiling, and remains there till the colour propoſed is ſufficiently fixed. It is afterwards taken out, opened, and cleanſed from the paſte; and, if any ſpots have got through, they are removed by being waſhed with a ſmall mop of

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linen rags dipped in a ſtrong alkali infuſed in hot water; but, as a yellow ſpot, or iron-mould, will remain, ſuch ſpots are removed by waſhing them with a ſmall quantity of ſpirit of ſalt, aqua fortis, or vitriol, infuſed in cold water, and run out with a piece of board or ſtamper, made for the purpoſe of making the hats clean from the filth and water, after having been dyed and waſhed as aforeſaid. The compounds made uſe of in dying are, fuſtic, turmeric, ebony, weld, ſafflower, ſaffron, alum, argol, indigo, and vitriol, with chamber-lie, or pearl-aſh, at the option of the dyer, ſometimes all uſed together, ſometimes otherwiſe, according to the intention of the dyer, and to the colour required. In witneſs whereof, &c.

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XIV. *On forming Oak-Trees into Compaſs-Shapes, for the Uſe of Ship-Builders. By Mr.* William Randall, *of Maidſtone, Kent.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

FROM the ſcarcity and very high value of compaſs-ſhape timbers, the enormous waſte in his Majeſty's yards, as well as loſs of time in cutting them out from large trees, when not to be had of a natural growth, excluſive of the delays occaſioned by the want of trees fit for that purpoſe, I have been led to conſider that the ſhape of a tree might be ſo altered, in its early growth, as to ſuit the different purpoſes. From the ineſtimable value of the object, and the extreme length

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of time which muſt elapſe before the full advantages of theſe improvements can be obtained, I was induced to make ſome trials, to prove what was likely to be effected.

By the figures annexed, (ſee Plate VI,) and from ſtrict obſervations on effects inadvertently produced from ſomewhat ſimilar cauſes, I have concluded that the deſign might be accompliſhed; and have taken the liberty of ſubmitting this paper to the ſuperior judgement of the Society, by whom more perfect plans may be formed, &c.

Rules for training Oak-Trees to Compaſs-Shapes, for Naval Purpoſes.

It may not be improper to remark, that moſt of the numerous families of timber-trees either produce their leaves and ſide-ſhoots alternately, or in pairs. In the firſt claſs is the oak, whoſe leading ſhoot frequently takes a reclining direction; yet, in proceſs of time, if it meet with no obſtructions, it becomes erect. Thoſe producing leaves and lateral ſhoots in pairs, as the aſh, maple, &c. ſeldom alter the poſition they firſt take.

It

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It is found necessary, in the common practice of raising trees, (in order to keep them upright,) to leave all the lateral shoots entire, or cut to what are, in the nursery-trade, termed spurs, from some distance below the head, especially on all alternate-leaf trees; for when, by eagerness to accelerate the height of those trees, unskilful persons cut close all the side-shoots, it generally happens that (from the luxuriant growth of the leader, and the weight of its full-extended foliage) a bend in the stem is brought on, which every future shoot assists to increase, until a regular head is formed; which done, the leader will assume an upright direction, and frequently returns to be perpendicular over the root.

These observations are, no doubt, well known to the Society, and to all other persons acquainted with the growth of trees; yet, from every practical rule, and impartial survey of effects inadvertently produced from similar causes, they will be found fully applicable to the present case; namely, to reverse the methods used to obtain straight-stemmed trees, by taking off, twice every year,

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in March and June, all the lateral ſhoots cloſe to the ſtem; beginning when about eight feet high, and continuing till twenty feet, or more. This will cauſe the oak-trees on which it is practiſed to nearly reſemble the form marked Fig. 1; (ſee Plate VI;) after which time, if left to nature, the ſtem will in its regular courſe aſſume, in an advanced age, a form ſomewhat like that marked Fig. 2. This part of the plan might be well adapted to parks, hedge-rows, and open plantations.

The next part may be extended to woods, where underwood is regularly cut every fifteen or twenty years, in many of which are numbers of clean young oaks. Wherever two kindly trees happen to grow ſo near that they can be brought (by pulling down the heads with a ſtick having a hook at one end) to reach each other, a ſtrong branch from each, towards the top, may be gently twiſted, (ſo as not to deſtroy its growing faculties,) and the trees joined together by ſuch twiſt, (as at *a*,) which will keep the ſtems in the poſition ſhewn in Fig. 3. It is, by referring to common

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common causes, to be concluded that each leader will pursue an upright course, which will cause the future appearance to resemble Fig. 4.

In either of the above-mentioned situations, where there are single trees that cannot be brought to join with others of the same kind, and the first plan not approved of, any species of tree might answer the purpose, by cutting it of the height required, and bringing the branch from the oak down to it, then fastening it by a noose, easily made by twisting the branch as before. (See Fig. 5.) In default of a neighbouring tree, a strong stake with a hooked end would endure three or four years, and answer the purpose of confining the tree: (see Fig. 6:) its future growth will be likely to incline upward, and in time to form a shape nearly as Fig. 7. None of these processes are expensive; the two last plans, I find, can be done in ten minutes each tree, and can be only a trifling obstruction to its growth. Their superior advantages will be found in woods, where, at the following fall, or any future period, those that fail to form so de-

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ſirable a ſhape as in the opinion of a judicious wood-reef is neceſſary, may be taken down, with little difference between their value in that ſtate, and that they would have borne had they been left to a natural courſe.

From the age of eight to fourteen years, if free growers, or about the ſame number of feet in height, I find is the moſt convenient time to fix them, according to the different deſigns. The ſpring, before the leaf comes out, I alſo find the beſt ſeaſon for twiſting the branches, or making any reduction of them.

XV.

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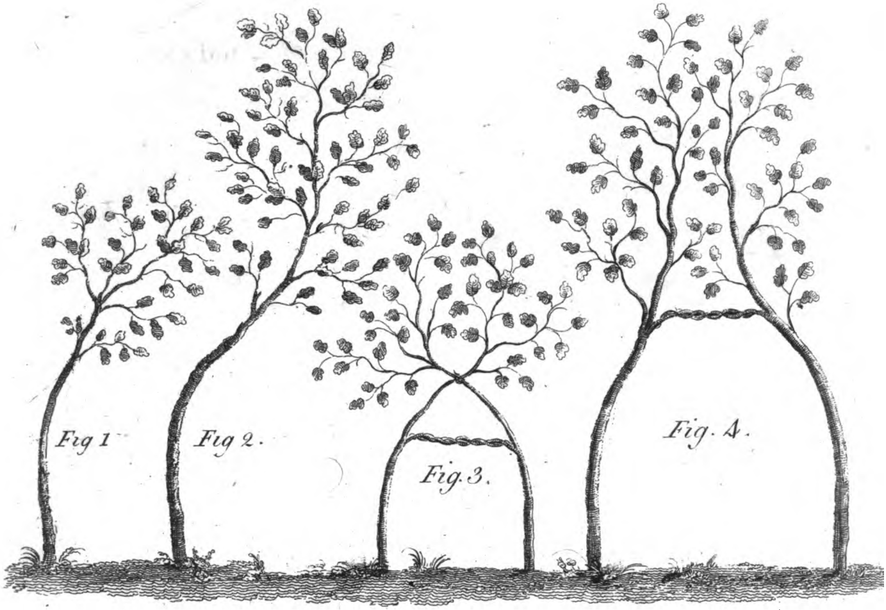

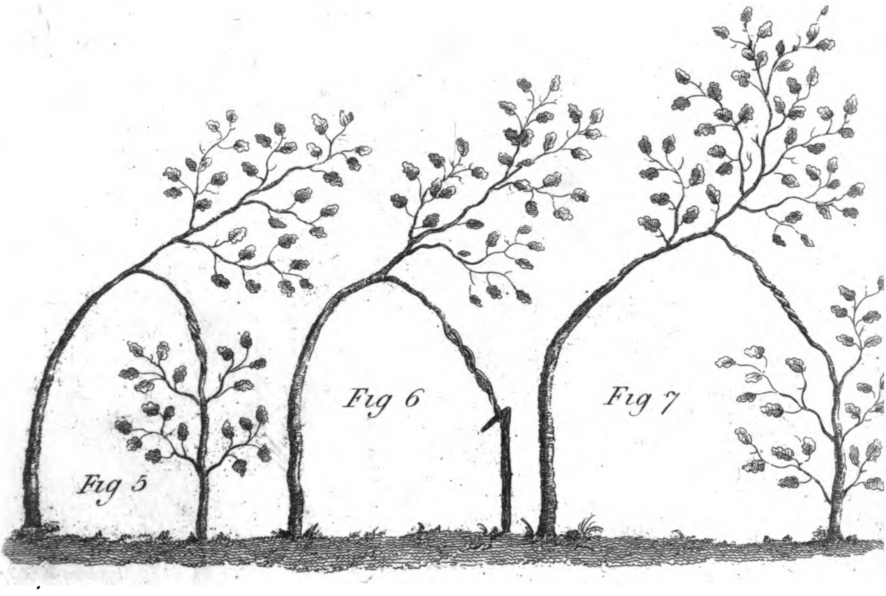

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XV. *Conclusion of Dr.* Pearson's *Experiments and Observations on a Kind of Steel called* Wootz, *&c.*

(from p. 61.)

THE phænomena during the diſſolution of ſteel were the ſame as thoſe laſt related, except ſuch as obviouſly aroſe from mechanical differences in the ſubſtances to be diſſolved; in particular, the quantity of inſoluble black matter, of white ſediment, and of green cryſtals, was apparently the ſame. But, with reſpect to the phænomena of the diſſolution of iron, there was one material difference between it and the diſſolution of wootz, and of ſteel, namely, that the liquor was not turbid and black, but clear, with a very ſmall quantity of black matter upon its ſurface. It is, however, proper to ſtate, that ſeemingly the ſame kind and quantity of white ſediment, and green cryſtals, were produced as from the diſſolution of wootz and ſteel.

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I think it of confequence alfo to notice, that the black matter appears in the greateft quantity when about half, or three-fourths, of the matter is diffolved; but after this period, although gaz be feparated in as great quantity as before, the black matter feems to diminifh. Hence I was at firft inclined to conclude, with Mr. Berthollet, that part of this black or carbonaceous matter was diffolved by the gaz, but I think I fhall prove, that no fuch combination takes place; and I now confider it to be moft probable, that the diminution arifes from the diffolution of the laft portions of adhering iron.

With refpect to the quantities and nature of the gaz feparated in this experiment:

I. The quantity of it from each hundred grains of wootz, on trials at different times, was found to be from 78 to 84 ounce-meafures: the mean quantity therefore was 81.

II. The gaz from each hundred grains of fteel wire, after many trials, was found to be from 83 to 86 ounce-meafures; the mean quantity therefore was $84\frac{1}{2}$.

III. The

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III. The gaz from each hundred grains of bright iron wire, by many trials with the ſame and different parcels of wire, was found to be from 86 to 88 ounce-meaſures: the mean quantity therefore was 87.

It is to be underſtood, that when the quantities of the different parcels of gaz were compared with one another, they were meaſured at the ſame temperature, and under the ſame degree of preſſure. It is likewiſe to be underſtood, that whenever the ſolutions of wootz, ſteel, and iron, were made at the ſame time, and under the ſame circumſtances, as far as known, there was uniformly a ſmaller bulk of gaz from wootz than from ſteel, and from ſteel than from iron.

The ſmell of the gaz from the above three ſubſtances was that of hydrogen gaz; but I thought that from wootz had a ſtronger and more offenſive ſmell than that from ſteel, and that from ſteel was more offenſive than that from iron.

I could perceive no difference in the kind of flame, and exploſion, between theſe three parcels of hydrogen gaz: they burned in the ſame manner as common hydrogen gaz from ſulphuric acid, iron, and water.

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Portions of the above gazes, mixed with oxygen gaz, from oxide of manganeſe, were burned in cloſe veſſels, by the electric fire, over lime-water. I could perceive no difference, in the combuſtion, between the gazes from the above different ſubſtances, nor any difference in the gaz from the ſame ſubſtance at different ſtages of the diſſolution. I did not perceive the lime-water to be at all diſturbed in its tranſparency, on my firſt trials; but, in ſubſequent ones, on viewing it more attentively, and in a good light, it was perceived to be very ſlightly turbid. It was equally ſo with all the parcels of gaz.

To ſatisfy myſelf farther, at the time I made theſe experiments, I exploded the mixture of inflammable gaz, obtained by decompounding water with white-hot charcoal of wood, with oxygen gaz; by which the lime-water was rendered quite milky. This inflammable gaz burnt very ſlowly, affording a deep blue lambent flame.

To determine the quantity, and aſcertain the nature, of the undiſſolved black matter in this experiment, I poured the ſolutions, while boiling hot, upon filtres of three folds of paper, and freed the

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the filtres from the adhering ſolutions, by pouring boiling water upon them. The paper was ſtained black, by the ſolutions of wootz and ſteel, as far as the liquid reached; but the paper was only ſtained black at the apex of the cone of the filtre by the ſolution of iron. The quantity of black matter on the filtres, from the two former ſolutions, was apparently ſix or eight times more than from the ſolution of iron; but it adhered too firmly, and was in too ſmall a quantity, to determine the proportion accurately by weight. I eſtimated the quantity of the black matter to be one *per cent.* of the ſteel and wootz, and a proportionally ſmaller quantity from the iron. On account of the very black and turbid appearance during the diſſolution of wootz and ſteel, I was much ſurprized by the ſmallneſs of the quantity of black matter on the filtres; nor could I, by experiment, find that any of it paſſed through the filtres with the ſolutions.

This black matter being ſprinkled upon boiling nitre, a deflagration took place, and a large proportion of reſidue was found, and aſcertained to be oxide of iron. The black matter was therefore

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fore a compound of iron and carbon, or, as ſome chemiſts term it, plumbago; and which, in the new ſyſtem, is denominated a carburet of iron.

I eſtimate the quantity of carbon in wootz and ſteel to be nearly equal; and that quantity to be about one third of a hundredth part, or $\frac{1}{300}$, of the weight of theſe two ſubſtances.

I am, in the next place, to give an account of the ſolutions juſt mentioned of wootz, ſteel, and iron. On ſtanding, it has been obſerved, there was a depoſition of white matter, and formation of green cryſtals in a liquid.

The liquid, being decanted, was examined, and found to be ſulfate of iron, and ſuperabundant diluted ſulphuric acid.

The green cryſtals were obviouſly thoſe of ſulfate of iron.

The white matter I ſuppoſed was the *ſiderite* of Bergman, which is now believed to be phoſphate of iron. I made many experiments to aſcertain its nature; but it is only neceſſary to ſtate, that it readily diſſolved in hot water, and the ſolution afforded nothing but cryſtals of ſulfate of iron. Theſe cryſtals, by diſſolving in a little water, and by boiling

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boiling to leave behind water insufficient for crystalization, yielded, on cooling, a white sediment as before.

This white matter yielded colcothar, (a red oxide of iron,) by applying the flame with the blowpipe. The white matter therefore was not *siderite*, but sulfate of iron, which could not crystalize on account of deficiency of water.

§. 7. *Experiments with Oxide of Wootz, of Steel, and of Iron.*

1200 grains of wootz, dissolved by diluted sulphuric acid, and then precipitated from this acid by potash, yielded a greenish oxide; which, on drying in a stove, became a reddish-brown light powder, weighing 2700 grains; and by ignition it was reduced to 2000 grains.

300 grains of this oxide were made into a paste with linseed-oil; which, being wrapped in paper, was put into a crucible, and exposed for near an hour to a fierce fire in the wind-furnace. On cooling, a cake of metal, weighing 200

grains, was obtained, which had the essential properties of steel. The pyrometer denoted 150° of fire.

The result was the same on treating oxide of steel, and of iron, in the same manner as that of wootz.

Conclusions.

Many of the properties of wootz, related in the preceding experiments and observations, are so generally known to be those of the metallic state of iron, that, but for the sake of order, I should think it superfluous to refer to any of them particularly, to support the conclusion that wootz is at least principally iron. Wootz is proved to be iron by its obvious properties; (§. 2.) by its filings being attracted by the magnet; (§. 2.) by its specific gravity; (§. 2.) by its affording nothing but sulfate of iron, hydrogen gaz, and a trifling residue, on solution in diluted sulphuric acid. (§. 6.)

With regard to the particular state of iron called wootz, I think I cannot explain its nature satis-

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satisfactorily, without first relating the properties, and explaining the interior structure, of the principal different metallic states of iron. I imagine I shall be best able to execute this design, by stating precisely the just meaning of the terms which denote, commonly, the three principal metallic states of iron, namely, *wrought or forged iron*; *steel*; and *cast or raw iron*.

I. *Wrought* or *forged iron* I understand to be that which possesses the following properties.

a. It is malleable and ductile in every temperature; and, the more readily, the higher the temperature.

b. It is susceptible of but little induration (and if pure it is most probably susceptible of none at all) by immersing it, when ignited, in a cold medium, as in water, fat, oil, mercury, &c. Nor is it, on the contrary, susceptible of emollition by igniting, and letting the fire be separated from it very gradually.

c. It cannot be melted without addition; but it may be rendered quite soft by fire, and, in that soft state, it is very tough and malleable.

d. It can easily be reduced to filings.

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e. By being surrounded with carbon for a sufficient length of time, at a due temperature, it becomes steel.

f. It does not become black upon its surface, but equally brown, by being wetted with liquid muriatic, and other acids.

g. By solution in sulphuric, and other acids, it affords a residue of less than [illegible] of its weight of carbon; and, if it could be obtained quite pure, there is no good reason to suppose there would be any residue at all.

II. *Steel* I understand to be that which has the following properties.

a. It is already, or may be rendered, so hard by immersion, when ignited, in a cold medium, as to be unmalleable in the cold; to be brittle, and to perfectly resist the file; also to cut glass, and afford sparks of fire on collision with flint.

b. In its hardened state, it may be rendered softer in various degrees, (so as to be malleable and ductile in the cold,) by ignition and cooling very gradually.

c. It requires upwards of 130° of fire, of the scale of Wedgwood's pyrometer, to melt it.

d. Whether

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d. Whether it has been hardened or not, it is malleable when ignited to certain degrees; but, when ignited to be white, perfectly pure ſteel is ſcarcely malleable.

e. It becomes black on its poliſhed ſurface, by being wetted with acids.

f. Much thinner and more elaſtic plates can be made of it, by hammering, than of iron.

g. The ſpecific gravity of ſteel which has been melted, and hammered, is in general greater than that of forged iron.

h. With the aid of ſulphuric acid, it decompounds a ſmaller quantity of water than an equal weight of forged iron.

i. It decompounds water, in the cold, more ſlowly than forged iron.

k. By repeated ignition in a rather open veſſel, and by hammering, it becomes wrought or forged iron.

l. It affords a reſidue of at leaſt $\frac{1}{100}$ of its weight of carbon, on diſſolution in diluted ſulphuric acid.

m. It is more ſonorous than forged iron.

n. On quenching in cold water, when ignited, it retains about $\frac{2}{3}$ of the extenſion produced by ignition;

ignition; whereas wrought iron, so treated, returns to nearly its former magnitude.

III. By the term *cast* or *raw iron*, I understand that kind of iron which possesses the following properties.

a. It is scarcely malleable at any temperature.

b. It is commonly so hard as to resist, totally or very considerably, the file.

c. It is not susceptible of being hardened or softened, or but in a slight degree, by ignition and cooling.

d. It is very brittle, even after it has been attempted to be softened by ignition and cooling gradually.

e. It is fusible, in a close vessel, at about 130° of Wedgwood's pyrometer.

f. With sulphuric acid it generally decompounds a smaller quantity of water than an equal weight of steel.

g. It decompounds water, in the cold, more slowly than wrought iron.

h. It unites to oxygen of oxygen gaz as slowly, or more slowly, even than steel.

i. By solution in sulphuric and other acids, it leaves a residue, not only of carbon, but of earth; which

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which exceeds the quantity of residue from an equal weight of steel.

k. It is perhaps more sonorous than steel.

With respect to interior structure:

I. Wrought *iron* is to be considered as a simple or undecompounded body; but it has not been hitherto manufactured quite free from carbon, which is to be reckoned an impurity.

The least impure iron, as indicated by properties, is that which possesses the greatest softness, toughness, and strength; but if it be soft, independent of combination, it will of course be of the toughest and strongest quality. To denominate it from properties, I would call it *soft malleable iron:* and from internal structure, it should be called *iron*, or *pure iron*.

The ore from the deep mines of Dannemora produces the purest iron. It is in England called *Oeregrund iron* *. It is almost the only iron manufactured

* Oeregrund is not the name of the country in which the ore of this iron is gotten; or of the place where it is manufactured; but it is the name of a sea-port town, from which the iron of Dannemora was formerly exported.

nufactured which by cementation affords what our artifts reckon good fteel.

II. *Steel* has compofition. It is a compound of iron and carbon, the proportions of which have not been accurately determined, but may be eftimated to be one of carbon, and 300 of iron. I would call this ftate of iron, from external properties, *hard malleable iron*: and from interior ftructure and compofition it may be called, as in the new fyftem, *carburet of iron.*

Steel of the beft imaginable kind is fuch as has not yet been manufactured; or it is that which has the moft extenfive range of degrees of hardnefs or temper; the greateft ftrength, malleability, ductility, and elafticity; which has the greateft compactnefs or fpecific gravity, and which takes the fineft polifh; and laftly, which poffeffes thefe qualities equally in every part. Steel made by cementation, of the beft quality, which has been melted, approximates the neareft to this kind of fteel. Its greateft defect is want of malleability.

III. *Crude* or *raw iron* is a mixture, and has compofition. It confifts of pure iron, united and mixed with other fubftances, fo as to be hard unmalleable

malleable iron: but the ſubſtances with which it is almoſt always mixed and united are three, viz. oxygen, carbon, and earth. I would term this ſtate of iron, on account of external properties, *hard unmalleable iron*; and, on account of ſtructure, *impure iron.*

In this ſtatement of the interior ſtructure of the different ſtates of iron, I have not thought it neceſſary to reckon the impalpable fluids which they contain, in perhaps different proportions; *viz.* light, caloric, electric, and magnetic fluids; for I believe their chemical agency has not been aſcertained.

Iron may alſo contain a much greater quantity of carbon than has been above ſtated to be a conſtituent part of ſteel; and this ſtate of iron is hard, unmalleable, and is not uniform in its texture. It may be called, according to the new nomenclature, *hyper-carburet of iron.* It is liable to be produced by cementing iron in a very high temperature, for a very long time, with a large quantity of carbon; and it is alſo produced by melting iron, or ſteel, with carbon.

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There are innumerable varieties of the first explained state of iron, viz. *wrought iron.* Some of these are familiarly known, and distinguished by names, among artists. Different quantities of carbon, which is here an impurity, are the occasion of these varieties; but, as the carbon is not in sufficient quantity to diminish the toughness, softness, and malleability, to such a degree as to produce the obvious qualities of steel, such varieties are reckoned to be those of wrought iron. The carbon may, however, be in such proportion as to produce a state of iron which, in some degree, possesses the properties both of steel and wrought iron; and which possesses partly the properties of steel, and partly the properties of wrought iron. It is quite arbitrary to call such kinds of iron, steel, or wrought iron.

There are also innumerable varieties of the second state of iron explained, *viz. steel.* Some of these are known, and distinguished by artists. A greater, or smaller, proportion of carbon, than the quantity requisite to saturate the iron, is the cause of these varieties; which are reckoned va-

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rieties of steel, because they possess, in certain degrees, the distinguishing properties of steel.

Besides these varieties of iron and steel, depending upon carbon, there are other varieties, from extraneous substances of a different nature. These are most frequently oxide of iron, or oxygen, and silica; especially in steel from the ore. The presence of phosphoric acid has been shewn to be the occasion of the variety of iron named *cold short*, which is brittle when cold, but not when ignited. And there is another variety, called *red short*, which is malleable when cold, but brittle when ignited; the cause of which is supposed to be arsenic.

Iron and steel may contain an extraneous substance, and yet possess the properties of good, or even of the best, kinds of these metals. This is the case when they contain manganese; as the fine experiments of Professor Gadelin, made under the direction of Bergman, have demonstrated.

Some states of iron are what are called mechanical mixtures of steel and wrought iron. This is, more or less, always the case with *bar steel* made

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by cementation: if the bar be thick, the interior part will be mere iron.

Laſtly: There are different ſorts of ſteel, and of wrought iron, from the difference of mechanical arrangement of their parts. Thus the ſpecific gravity of ſteel, by cementation, may be increaſed by fuſion, or hammering, and its grain altered. I have been told, that it may be hammered, in the cold, till it is ſo brittle that a ſlight ſtroke will break a thick bar. By quenching cloſe-grained hammered ſteel in cold water, when ignited to whiteneſs, its ſpecific gravity is diminiſhed, its grain is opened, and it is rendered much harder.

Theſe diſtinctions will perhaps ſerve to explain the nature of many varieties of the different ſtates of iron, differently named by artizans; namely, *pig-iron*; *charcoal*, and *coal-pig*, or *ſow-iron*; *blue*, *grey*, *white*, *caſt iron*; *ſoft iron*; *tough iron*; *brittle iron*; *hard iron*; *ore ſteel*; *cement ſteel*; *bliſter ſteel*; *ſoft ſteel*; *hard ſteel*; *hammered ſteel*; *caſt ſteel*; *burnt ſteel*; *over-cemented ſteel.*

I ſhall

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I shall next endeavour to shew to which of the above states of iron wootz is to be referred, or to which of them it most approximates.

It appears that wootz is not at all malleable when cold; and when ignited it is difficultly forged, and only in certain degrees of fire. It can be tempered and distempered, but not to a considerable extent of degrees. (§. 3. *e f.*) The range of degrees of fire at which it is forged is of less extent (§. 3. and §. 3. *b.*) than the degrees at which it can be tempered. (§. 3. and §. 3. *e f.*) It vies with the finest steel in its polish. Its specific gravity, which is less than that of hammered iron, is very little diminished by ignition and cooling rapidly. (§. 2. N°. 6.) It melts, but at a higher temperature than crude iron. (§. 3. *b i.*) It is not easily reduced into filings, even after annealing. (§. 3. *f.*) Its polished surface grows black by being wetted with nitrous acid. (§. 5. *e.*) It is not so brittle as raw iron, nor even as steel. (§. 2.) On solution in sulphuric acid and water, it affords about the same quantity of carbon as steel, and rather less hydrogen gaz. (§. 6.)

From

From these and other properties, related in the preceding experiments and observations, it is evident that wootz approaches nearer to the state of steel than of raw iron; although it possesses some properties of this last substance.

With regard to the kind of steel to which wootz is to be referred; it is not of that sort in which there is either an excess or deficiency of carbon, (page 121, line 14, *et seq.*) but it must contain something besides carbon and iron, otherwise it would be common steel. It appears that the solution in nitrous acid, (§. 5.) and in diluted sulphuric acid, (§. 6.) contained only oxide of iron, and a residue of carbonaceous matter, as in common steel. Hence it is obvious to suspect that wootz contains oxygen, either equally united with every part of the mass, or united with a portion of iron to compose oxide, which is diffused throughout the mass. That this is really the ingredient in wootz which distinguishes it from steel, seems to be proved, or at least consists with its properties. For, it accounts for the smaller quantity of hydrogen gaz than was afforded by common steel; (§. 6.) it accounts for the partial fusion; (§. 3. *b.*) it ac-

counts

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counts for the great hardnefs, even on reducing its temper; (§. 3. *f.*) for its little malleability; (§. 3.) and perhaps it is the reafon of the fine edge, and polifh. (§. 2. §. 3.) The experiments (§. 3. *g h.*) confirm this conclufion. The oxide is perhaps not equally diffufed; hence the wootz is not quite uniform in its texture and hardnefs, until it has been remelted. (§. 3. *h.*) The brittlenefs of wootz when white hot (§. 3. *b.*) is a property of caft fteel; and fhews that it contains no veins or particles of wrought iron, and alfo that it has been melted. Common fteel, which is all made by cementation, is very malleable when white hot, only perhaps becaufe it contains iron which has efcaped combination with carbon.

The proportion of oxygen in wootz muft be very fmall, otherwife it would not poffefs fo much ftrength, and break with fo much difficulty, (§. 2.) and much more oxide would have melted out. (§. 3. *g.*) This oozing out of matter is analogous to that which appears on refining raw iron.

Although no account is given by Dr. Scott of the procefs for making wootz, we may, without much

much riſk, conclude that it is made directly from the ore, and conſequently, that it has never been in the ſtate of wrought iron. For, the cake is evidently a maſs which has been fuſed; (§. 2.) and the grain (§. 2.) of the fracture is what I have never ſeen in cement-ſteel, before it is hammered or melted. This opinion conſiſts with the compoſition of wootz; for, it is obvious that a ſmall portion of oxide of iron might eſcape metallization, and be melted with the reſt of the matter. The cakes appear to have been cut almoſt quite through, while white hot, (§. 2.) at the place where wootz is manufactured; and, as it is not probable that it is then plunged in cold water, the great hardneſs of the pieces imported, above that of our ſteel, muſt be imputed to its containing oxide, and conſequently oxygen.

The particular uſes to which wootz may be applied may be inferred from the preceding account of its properties and compoſition; they will alſo be diſcovered by an extenſive trial of it in the innumerable arts which require iron.

XVI.

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XVI. *On the Purification of crude Saltpetre.* *By* M. Baumé.

FROM THE *ANNALES DE CHIMIE.*

THE name of crude ſaltpetre is given to that which is procured by lixiviating the earths which contain it. Potaſh is added to the lie, to decompoſe thoſe ſalts which have an earthy baſis. Crude ſaltpetre is a mixture of nitre with a baſis of fixed alkali; of nitre with an earthy baſis; of three kinds of ſea-ſalt, one with a baſis of mineral alkali, another with a baſis of fixed vegetable alkali, and the third with an earthy baſis; of a ſmall quantity of ſelenite; of a ſmall quantity of earth, in two different ſtates, being partly looſe, and partly diſſolved by thoſe ſalts which form what is called the mother-water; and, laſtly, of a certain quantity of extractive vegetable and animal matter. Sometimes crude ſaltpetre alſo contains a ſmall portion of ſal-ammoniac.

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The object, in the purification of faltpetre, is to feparate from it all foreign fubftances. In the laboratories belonging to government, (which, according to law, are the only places where faltpetre can be purified,) the crude faltpetre undergoes two diffolutions, and two fucceffive cryftalizations. To the firft folution a certain quantity of Flanders glue is added, to clarify the liquor; this is an additional trouble in the operation, and is quite ufelefs in the procefs I am about to propofe. The following is a fhort account of the common method of purifying crude faltpetre.

Five or fix thoufand pounds of crude faltpetre are put into a copper caldron, with about an equal quantity of water. The mixture is heated, and, on account of the fmall quantity of water, the faltpetre is diffolved by help of the heat, in preference to the fea-falt; but fome fea-falt is alfo diffolved; the reft is taken away with a great fkimmer. The falt is put to drain in a bafket, placed over the caldron; and the liquor is then clarified with a pound or two of Flanders glue diffolved in water. A fcum is formed, which contains the loofe earth; this fcum is taken away as it rifes.

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rises. The liquor is then put into large copper vessels, in which it crystalizes. The crystals produced are set to drain; they are impure, as they contain a portion of sea-salt, and also a portion of the mother-water in which they crystalized.

This impure saltpetre is purified by dissolving it again in water, and crystalizing it, as was done before. The crystals arising from the second crystalization are called purified saltpetre, and are used for making gunpowder, &c. The mother-water, from the various crystalizations, is collected together, and is afterwards purified, by itself, by means of potash.

The above is a short view of the manner of refining or purifying saltpetre, as it has been practised for time immemorial. A quantity of mother-water, and of sea-salt, remain, as we have seen, mixed with the saltpetre of the first crystalization. These foreign substances, though in a less proportion, still remain mixed with the saltpetre of the second crystalization; and the liquor separated from the saltpetre of the second crystalization, by being evaporated afresh, forms only

 such

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such saltpetre as is formed by the first crystalization, on account of the mother-water and sea-salt mixed with it.

I do not think it necessary to be more particular respecting this operation, as it is described in almost every book on chymistry; what I have mentioned will serve to bring it into view, so that it may be compared with the process I am going to propose. It is sufficient to remember that, in the old process, the crude saltpetre undergoes two successive dissolutions and crystalizations; and the mother-water is operated upon by itself.

The process I propose is more simple; by it is obtained, without fire, without dissolution, without any clarification, with less labour, less expence, and at one single operation, as much saltpetre, and as pure as that of the second crystalization. The mother-water is collected and purified by itself, as usual; but, as I separate it, and also the sea-salt, at the beginning of the operation, the saltpetre is not accompanied through the whole process (as in the other way) by sub-

stances

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ſtances which do not belong to it, conſequently there is no ſuch impediment to its purification.

I propoſed this method, in the year 1788, to the arſenal. Some experiments were tried, but not properly purſued, becauſe it was thought that my proceſs would cauſe too great a change in the uſual courſe of things; I can, however, aſſert that it requires no changes but ſuch as are ſtrictly œconomical.

I ought to mention, that I made my experiments only upon one hundred ounces of crude ſaltpetre at a time; that quantity is certainly very ſmall, compared with what would be operated upon at once in the large way; but there is no reaſon why my proceſs (which is founded upon the diſpoſition which cold water has to diſſolve the ſea-ſalt, and the mother-water, in preference to the ſaltpetre) may not be practiſed, at once, upon whatever quantity of crude ſaltpetre may be thought neceſſary.

Analyſis

Analysis of one Hundred Ounces of crude Saltpetre.

I took, for my experiments, a crude ſaltpetre upon which the loſs, by the uſual proceſs, was about thirty *per cent.*

I put one hundred ounces of this ſaltpetre into a large glaſs receiver, with ſixteen ounces of cold river-water; I left this mixture in infuſion for the ſpace of half an hour, ſhaking it often. I then put it to drain in a large glaſs funnel, till no more liquor would drop from it; the ſpout of the funnel had a ſmall bundle of ſtraw in it, to retain the ſaltpetre. By this firſt operation I got rid of almoſt all the mother-water, and of a ſmall quantity of the ſea-ſalt.

I put the ſaltpetre again into the ſame glaſs receiver, with a pint of cold river-water; I let this mixture remain for the ſpace of twenty-four hours, taking care to ſhake it often, to facilitate the diſſolution of the ſea-ſalt; at the end of that time, I ſet it to drain as before.

When

When it had thoroughly drained, I mixed it again, for the third time, with another pint of cold river-water; I left this mixture in infusion as before, during twenty-four hours, and then set it to drain. When it had drained, I sprinkled it with cold water several times, that it might be completely washed. The saltpetre had now a beautiful appearance, was very white, and nearly as pure as that which has been twice crystalized.

By the above simple process, without dissolution, I can obtain, whenever I please, saltpetre more pure than it often is after being twice crystalized. But, as the saltpetre which is to be used in making gunpowder ought to be not only very pure, but also intirely free from gravel or small stones, it is necessary that such saltpetre should be purified by dissolution, and that the liquor should be passed through a cloth before it is crystalized. For these reasons it is needless to purify the saltpetre completely by washing.

The saltpetre washed, as above described, and well drained, weighed sixty ounces. I dissolved it, with the assistance of heat, in five pounds of water;

water; and then filtered the liquor. The earth remained upon the filtre; I washed it, and dried it; it then weighed forty-eight grains. By two crystalizations I obtained fifty-one ounces, four *gros*, and nine grains of saltpetre, which was perfectly pure; it scarcely rendered a solution of silver turbid, and was, in short, as good as that which is prepared at the arsenal for the fabrication of the best kind of gunpowder. There remained about eight ounces of liquor, which I mixed with the mother-water, that I might operate upon them together, in the manner I shall hereafter describe.

Thus, from one hundred ounces of crude saltpetre, I obtained nearly three quarters of the original quantity, of very pure saltpetre, by one simple purification.

In the usual way of purifying saltpetre there also remains a great quantity of saltpetre in the first separated mother-waters; which is procured from them afterwards, by operations which perhaps require to be examined. At present I shall not offer any thing new on this head; but shall

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only obſerve that, according to the proceſs I propoſe, the mother-water is ſeparated by the firſt waſhing, and may be treated by itſelf with potaſh, in the common manner. From the water of the ſecond and third waſhings, evaporated together, ſaltpetre of an inferior quality may be obtained.

Crude ſaltpetre, as I have already obſerved, contains a ſmall quantity of earth. This earth is in two different ſtates; a part of it is looſe, and may be ſeparated, almoſt intirely, during the waſhing of the ſaltpetre. For this purpoſe it is ſufficient to take the ſaltpetre out of the veſſel in which it is waſhed, with a ſkimmer, and to put it to drain. The ſolution of the ſaltpetre ſo treated does not grow turbid during its evaporation.

The other part of the earth is kept in ſolution by the mother-water; it ſeparates, by degrees, every time the liquor is evaporated.

TO BE CONCLUDED IN OUR NEXT.

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XVII. *On the Means of preferving thofe who are employed in grinding Colours from the Diforders occafioned by that Employment. By M.* Boulard, *of Lyons, Architect.*

WITH A PLATE.

FROM THE *JOURNAL DE PHYSIQUE.*

It is well known that many fubftances emit exhalations which are dangerous to health; but, if we do not breathe the air with which they are mixed, or if there exifts a wind which carries thofe exhalations away from us, we cannot have any thing to fear from them. If, therefore, the workman who grinds colours does not breathe the air in which they are fituated, or if we can keep up a conftant current of wind, which fhall carry off the vapours arifing from thofe colours, they cannot poffibly do any harm to the workman; it being the air we breathe which ferves as a vehicle to convey thefe noxious vapours

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vapours into our bodies. Theſe principles are certain and inconteſtible.

To produce the ſalutary effects above mentioned, I ſurround the table A, (Plate VII,) and the ſtone on which the colours are ground B, with a caſe CC; this caſe is open at top *, and is ſo much larger in its dimenſions than the ſtone, as to leave a ſmall interval, of about $\frac{1}{16}$ of an inch, all round it; the upper edge of the caſe is nearly on a level with the ſurface of the ſtone. Through one of the ſides of the caſe paſſes a pipe D, which has a communication with the external air, by going through the floor, or one of the walls. About ſix inches above the ſtone is a kind of hollow pyramid E, formed of four glazed frames, which are ſo wide as to extend about three inches beyond the edge of the ſtone. The pyramid is terminated by an iron pipe or funnel F, which communicates with a furnace G, which draws in its air from the bottom, and finiſhes at top in a pipe, which ſerves as a chimney. When a fire is lighted in the furnace, the air contained under

* In the plate one of the ſides is taken away, to ſhew the internal conſtruction.

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the pyramid will aſcend; this air will ſoon be re-placed by the external air, which, paſſing through the caſe, will keep conſtantly riſing all round the ſtone, (by the interval between it and the caſe,) and thence into the pyramid. This current, being once eſtabliſhed, will confine, as much as poſſible, the vapours ariſing from the colours, and will convey them away, ſo that the workman will be no longer expoſed to their dangerous effects.

This ſimple contrivance appears to me unobjectionable, as it preſents no obſtacle to the labour of the workman, who may ſee his work through the glazed frame, and may ſcrape together his colour as often as he thinks proper. If the ſtone ſhould be too large, ſo that the pyramid is in the way of his arms, he may leſſen that inconvenience by walking round the ſtone as he works.

In order that the furnace may produce its effects properly, the doors of it muſt be cloſe ſhut, and the room in which this contrivance is placed muſt be only of a middling ſize, and well cloſed. The ſmall quantity of air which will come in, through

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through the interstices of the doors and windows, will do no harm; on the contrary, as it will be drawn under the pyramid, it will carry off those vapours which the workman, by the motion of his arm, may have caused to escape.

I have tried the effect of the contrivance I propose; and found that, by means of as much charcoal as served me to fill the furnace twice, I could grind verdegris, (a colour which furnishes themost dangerous vapours, and the most offensive smell,) for the space of three hours, without the smallest inconvenience. Several very delicate persons, who came into the room during the operation, assured me that they did not perceive any disagreeable smell, and that the contrivance appeared to them to answer the end proposed in the most complete manner.

I afterwards made the following experiment. To render the current of air which rises around the grinding-stone perceptible, I put into the wooden case, under the stone, a chafing-dish with a small fire in it, on which I threw some powdered sugar. A thick smoke arose round the stone; and was perceived to pass rapidly into the

pyramid,

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pyramid, being drawn that way by the current of air which paſſed through the furnace. This current of air and ſmoke was ſo rapid, that I could by no means alter its courſe, or direct it to the outſide of the pyramid.

The ſucceſs of the forementioned experiments convinced me of the advantages of this contrivance. In the firſt place, it is very ſimple, and defends the workman from danger, without making any alteration in the uſual manner of grinding colours; it alſo carries off the dangerous vapours without rendering the work more difficult, the workman (as was before obſerved) being able to ſcrape the colours together, as often, and as eaſily, as in the common way of working. Secondly, this contrivance may, at a very ſmall expence, be adopted by all perſons who grind colours; the expence of grinding them will be very little increaſed by it, as a ſmall quantity of charcoal is ſufficient; and the expence of that might be diminiſhed, or taken away, by making the furnace ſerve alſo for other uſes. It might be uſed for the purpoſe of boiling oils to mix with colours, and the workman who is employed in grinding

could,

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could, at the ſame time, attend to the oils which are to be boiled.

I muſt obſerve, that if the furnace is to be uſed for theſe various operations, it ſhould be placed near the ground; it will not, on that account, act with leſs effect on the pyramid, provided the pipe of communication, proceeding from it, is bent in a proper manner.

I ſee but one reaſonable objection to what I have here propoſed. It may be ſaid, that in ſummer the furnace may occaſion a degree of heat in the room which may be very diſagreeable; or (admitting that not to happen) the furnace may not occaſion ſo ſtrong a current of air at that ſeaſon of the year as at others.

The firſt part of this objection I conſider as abſolutely void of foundation; a very ſmall quantity of fuel ſerves to keep up the fire, the heat from which is mild and temperate, and much leſs than that in which many workmen are obliged to perform their reſpective operations. But, were it greater, an increaſe of heat would ſurely be leſs dangerous than the vapours ariſing from many colours.

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With respect to the current of air in summer, I have reason to think it would always be sufficient to produce the desired effect. If it should not, I propose to employ, instead of the furnace, two pair of single bellows, of a middling size, which a child might work by means of a beam or lever. These bellows should be placed opposite each other, and near the floor; their lower parts should be firmly fixed, and motionless, and their upper parts should be moved by rods connected with the lever. The tube of the pyramid should be divided into two branches, which branches should communicate with the bellows; the nozles of which should be larger than usual. Thus the air, loaded with the vapours from the colours, might be driven into a chimney, or any other place where it might be dispersed without danger.

Instead of the bellows, a ventilator, or any other means of occasioning a draught of air, might be used. The object required being only to produce a current of air, round the grinding-stone, that may be capable of carrying off the dangerous effluvia arising from the colours.

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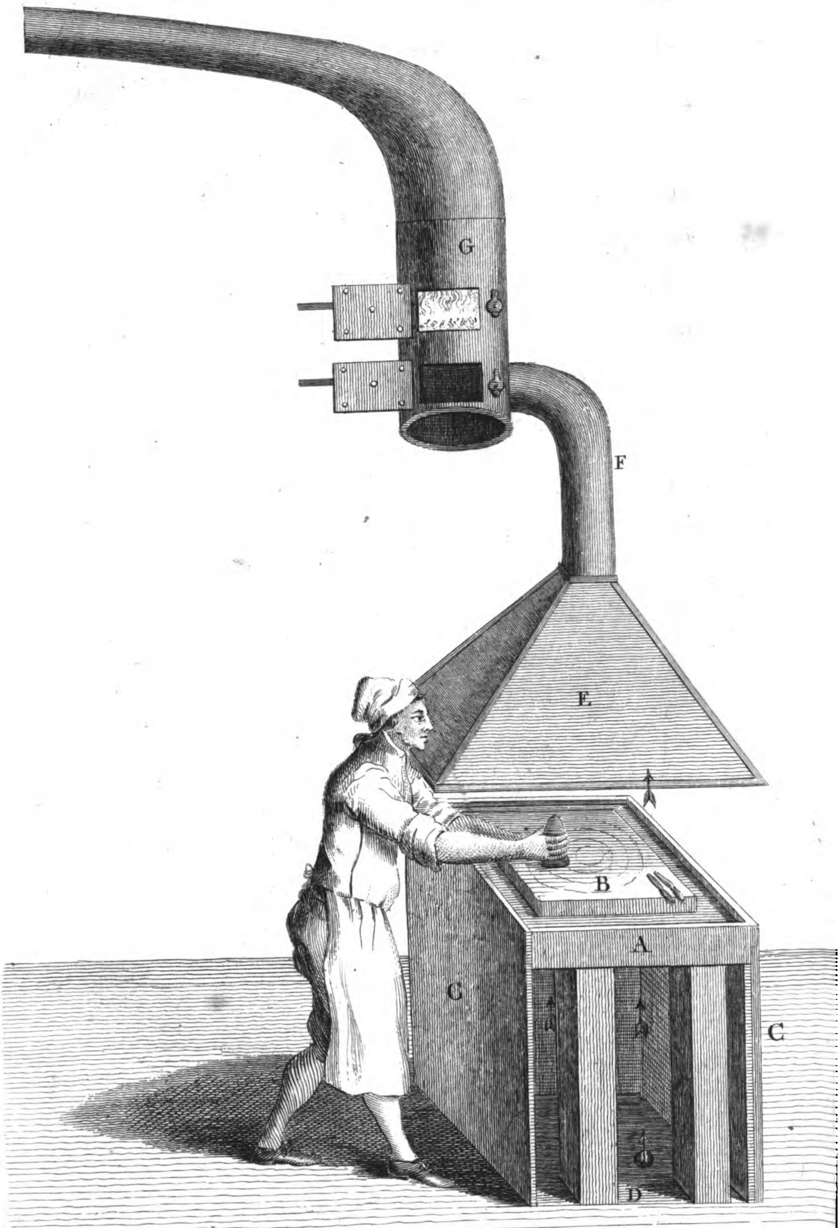

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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXVII.

XVIII. *Specification of the Patent granted to Mr.* WILLIAM NICHOLSON, *of New North-ſtreet, Red Lion-Square; for a Machine or Inſtrument for printing on Paper, Linen, Cotton, Woollen, and other Articles, in a more neat, cheap, and accurate Manner, than is effected by the Machines now in Uſe.*

WITH THREE PLATES.

Dated April 29, 1790.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid

 proviſo,

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proviso, I the said William Nicholson do hereby declare, that my said invention is described in the plan hereunto annexed, and the description thereof hereunder written, and in manner following; that is to say, my invention consists in three parts or particulars; namely, first, the manner or method of making, preparing, or placing, the original model, models, casts, types, engravings, carvings, or sculptures from which the impression is to be made. Secondly, in applying the ink, or colouring-matter, to such models, casts, types, engravings, carvings, or sculptures. And, thirdly, in taking off the impression, or transferring the ink, or colouring-matter, from such models, casts, types, engravings, carvings, or sculptures, to the paper, cloth, or other material upon which it is intended it should remain.

I. In the first place then, I not only avail myself of all the methods of making, preparing, and placing, the original models, casts, types, engravings, carvings, or sculptures which have hitherto been known or used in printing, and do myself make use of them in conjunction with my newly-invented method of applying the ink, or colouring-

colouring-matter, to ſuch original models, caſts, types, engravings, carvings, or ſculptures, and alſo with my newly-invented method of taking off the impreſſions, but I do likewiſe make, put together, and arrange them in a new manner, as occaſion may require; that is to ſay,

II. I make my moulds, punches, and matrices, for caſting letters, in the ſame manner, and with the ſame materials, as other letter-founders do, excepting that, inſtead of leaving a ſpace in the mould for the ſtem of one letter only, I leave ſpaces for two, three, or more letters, to be caſt at one pouring of the metal; and at the lower extremity of each of thoſe ſpaces (which communicate by a common groove at top) I place a matrix, or piece of copper with the letter punched upon its face in the uſual way. And moreover, I bring the ſtem of my letters to a due form and finiſh, not only by rubbing it upon a ſtone, and ſcraping it when arranged in the finiſhing-ſtick, but likewiſe by ſcraping it, on one or more ſides, in a finiſhing-ſtick whoſe hollowed part is leſs deep at the inner than the outer ſide. I call that ſide of the groove which is neareſt the face of the diſpoſed

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letter, the outer ſide; and the purpoſe accompliſhed by this method of ſcraping is, that of rendering the tail of the letter gradually ſmaller the more remote it is, or farther from the face. Such letter may be firmly impoſed upon a cylindrical ſurface, in the ſame manner as common letter is impoſed upon a flat ſtone. I ſpecify and affirm that the above deſcribed methods of caſting two or more letters at once, and of chamfering or ſloping their tails, are parts of my new invention.

III. I impoſe or diſpoſe my letter for printing in the common manner, to be uſed in conjunction with my newly-invented improvements. And I likewiſe impoſe it in frames or chaſes adapted to the ſurface of a cylinder of wood, or metal, and faſten it to the ſaid ſurface by ſcrews, or wedges, or in grooves, or by other methods well known to workmen; and this impoſing letter upon a cylinder I ſtate and affirm to be part of my new invention.

IV. I cut, carve, engrave, chaſe, caſt, model or make, (in the uſual manner of performing thoſe operations,) blocks, forms, plates, types, or originals,

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ginals, to be ufed for printing, either of wood, metal, or other materials; and thefe I ufe in conjunction with my other newly-invented improvements. I likewife, for other kinds of work, do faften with glue, cement, fcrews, wedges, or by other known methods, fuch blocks, forms, plates, types, or originals, as aforefaid, to the furface of a cylinder. I likewife, for other kinds of work, do cut, carve, engrave, chafe, caft, model or make, blocks, forms, plates, types, or originals, as aforefaid, of a cylindrical form, of wood, metal, or other materials. And I ftate and affirm that this difpofition of blocks, forms, plates, types, or originals, upon a cylinder, and alfo that the cutting, carving, engraving, chafing and cafting, modelling or making, blocks, plates, types, or originals, of a cylindrical form, as aforefaid, are parts of my new invention.

V. In the fecond place, I diftribute or apply the ink, or colouring-matter, upon the furface, or in the interftices, of the blocks, forms, plates, types, or originals aforefaid, by caufing the furface of a cylinder, fmeared or wetted with the colouring-matter, to roll over, or fucceffively

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apply itſelf to, the ſurfaces of the ſaid blocks, forms, plates, types, or originals, of whatever figure or conſtruction ſuch blocks, forms, plates, types, or originals, may be. Or elſe I cauſe the ſaid blocks, forms, plates, types, or originals, ſucceſſively to apply themſelves to the ſaid cylinder. I call the ſaid ſmeared or wetted cylinder, the colouring-cylinder. Its ſurface is covered with leather, or the dreſſed ſkins which printers call pelts, or elſe it is covered with woollen, or linen, or cotton cloth. When the colour to be uſed is thin, as in calico-printing, and in almoſt every caſe, the covering is ſupported by a firm elaſtic ſtuffing, conſiſting of hair, or wool, or woollen cloth wrapped one or more folds round the cylinder. When the covering conſiſts of woollen cloth, the ſtuffing muſt be defended by leather; or oilſkin, to prevent its imbibing too much colour, and by that means loſing its elaſticity. It is abſolutely neceſſary that the colouring-matter be evenly diſtributed over the ſurface of the cylinder; for this purpoſe, when the colour is thick and ſtiff, as in letter-preſs printing, I apply two, three, or more ſmall cylinders,

called

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called diſtributing-rollers, longitudinally againſt the colouring-cylinders, ſo that they may be turned by the motion of the latter; and the effect of this application is, that every lump or maſs of colour which may be redundant, or irregularly placed upon the face of the colouring-cylinder, will be preſſed, ſpread, and partly taken up, and carried by the ſmall rollers to the other parts of the colouring-cylinder; ſo that this laſt will very ſpeedily acquire and preſerve an even face of colour. But if the colouring-matter be thinner, I do not apply more than one or two of theſe diſtributing-rollers; and, if it be very thin, I apply an even blunt edge of metal, or wood, or other material, or a ſtraight bruſh, or both of theſe laſt, againſt the colouring-cylinder, for the purpoſe of rendering its colour uniform.

VI. When I apply colour to an engraved plate, or cylinder, or apply the colour through the interſtices of a perforated pattern, or cylinder, as in the manufacturing of ſome kinds of paper-hangings and floor-cloths, I uſe a cylinder entirely covered with hair or briſtles, in the manner of a bruſh.

VII. The

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VII. The whole of the manipulations or practices described in the two preceding paragraphs (numbers V. and VI.) are parts of my new invention.

VIII. In the third place, I perform all my impressions by the action of a cylinder, or cylindrical surface; that is to say, I cause the paper, or cloth, or other material intended to be printed upon, (and previously damped if necessary,) to pass between two cylinders, or segments of cylinders, in equal motion; one of which has the block, form, plate, assemblage of types, or originals, attached to, or forming part of, its surface, and the other is faced with cloth or leather, and serves to press the paper, cloth, or other material, as aforesaid, so as to take off an impression of the colour previously applied. Or otherwise, I cause the block, form, plate, assemblage of types, or originals, previously coloured, to pass in close and successive pressure or contact with the paper, or cloth, or other material, wrapped round a cylinder with woollen. Or otherwise, I cause the last mentioned cylinder, with the paper, or cloth, or other material wrapped round it, to roll along the face of the block, form, plate, assemblage

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aſſemblage of types, or originals, previouſly coloured. Or otherwiſe, I cauſe a cylinder having the block, form, plate, aſſemblage of types, or originals, attached to, or forming part of, its ſurface, to roll along the ſurface of the paper, cloth, or other material intended to be printed, and previouſly ſpread out upon an even plane covered with cloth or leather; the ſaid cylinder being ſupplied with colour by means of a colouring cylinder herein before deſcribed, and herein after more particularly to be noticed.

IX. The foregoing deſcription ſhews the nature of my invention; which may be applied to a great variety of uſes, and conſtructed or put together in a great variety of forms. Its uſes conſiſt in the printing of books in general, the printing of paper-hangings, floor-cloths, cottons, linens, woollens, ſilks, ribands, laces, leather, ſkin, and every other flexible material whatever. And its form or conſtruction, being no eſſential part of the invention, may without difficulty be obtained and carried into effect, by any workman poſſeſſed of common ſkill and ability. Neverthe-leſs, as there may be ſome artiſts of ſuch a mode-

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rate capacity as to find the foregoing inſtructions not ſufficient to enable them to conſtruct my machines, I ſhall proceed to exhibit drawings, and deſcribe ſeveral methods of conſtructing them. But, at the ſame time, I think it pertinent to take notice, that as the following conſtructions cannot be excluſively claimed by me by virtue of his Majeſty's letters patent granted unto me, excepting ſo far as the ſame include or contain my new improvements and inventions, ſo, on the other hand, I do not exhibit the ſame as the only practicable methods of carrying my invention into effect, but I claim the general and univerſal application of the principles diſcovered and brought into practice by me, as before deſcribed; and do here proceed to exhibit and deſcribe certain ſpecific applications of thoſe principles, chiefly from a conviction that it is my duty to render this preſent ſpecification clear and intelligible by every means in my power. And moreover, ſince in the following applications or particular methods there are, and may be found, ſeveral contrivances reſulting from a conſiderable ſhare of deliberation, labour, and expence, and tending to facilitate the practice

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practice of my ſaid inventions, I do not by any means hereby exclude the following deſcriptions and drawings from my preſent ſpecification; for I do not conſider them as being merely illuſtrative of the general principles herein before deſcribed and explained, but do hereby aſſert and maintain, that all and every parts and part of the machines herein after deſcribed, which have not hitherto been uſed as parts of ſome other machine, or in combination directed to the accompliſhment of the like purpoſe of printing, are ſtated and claimed by me as parts of my ſaid invention; for the excluſive enjoyment of which, as well as of every other part of the ſaid invention hereby ſpecified by me, I claim all protection and every advantage which, by his Majeſty's letters patent, I may lawfully be entitled to.

Explanation of the annexed Drawings.

(See Plates VIII, IX, and X.)

Fig. 1 (Plate VIII.) repreſents a printing-preſs, more eſpecially applicable to the printing of ſheets of paper, or books. A and E repreſent two cylin-

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ders, running or turning in a ſtrong frame of wood, or metal, or both. The cylinder A is faced with woollen cloth, and is capable of being preſſed with more or leſs force upon H I, by means of the lever M. H I is a long table, which is capable of moving endways, backwards and forwards, upon the rollers E and K. The roller A acts upon this table by means of a cog-wheel, or by ſtraps, ſo as to draw it backwards and forwards by the motion of its handle L. The table is kept in the ſame line by grooves on its ſides, which contain the cylinder A. D is a chaſe, containing letter ſet up and impoſed. B is a box, containing a colouring-roller, with its diſtributing-rollers C C; it is ſupported by the arm N. O is a cylinder faced with leather, and lying acroſs an ink-block; this cylinder is fixed by the middle to a bended lever movable on the joint Q.

The action. When D, or the letter, is drawn beneath the cylinder B, it receives ink; and when it has paſſed into the poſition R, a workman places, or turns down a tympan with paper upon it; (this tympan differs in no reſpect from the uſual one, except that its hinge opens ſideways;) it then proceeds

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proceeds to pafs under the cylinder A, which preffes it fucceffively through its whole furface. On the other fide, at S, the workman takes off the paper, and leaves the tympan up. This motion caufes the cylinder B to revolve continually, and confequently renders its inked furface very uniform, by the action of its diftributing-rollers C C; and, when the table has paffed to its extreme diftance in the direction now fpoken of, the arm G touches the lever P, and raifes the cylinder O off the ink-block, by which means it dabs againft one of the diftributing-rollers, and gives it a fmall quantity of ink. The returning motion of the table carries the letter again under the roller B, which again inks it, and the procefs of printing another fheet goes on as before. N. B. The table in this drawing is not quite long enough in its dimenfions, compared with the inking-roller.

Fig. 2 is another printing-prefs; in this, B is the inking-roller; A is a cylinder, having the letter impofed upon its furface; and E is a cylinder, having its uniform furface covered with woollen cloth; thefe three cylinders are connected, either by cogs or ftraps at the edges of

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of each. The machine is uniformly turned in one direction by the handle L. The workman applies a sheet of paper to the surface of E, where it is retained, either by points in the usual manner, or by the apparatus to be described in treating of Fig. 4. The paper passes between E and A, and receives an impression; after which the workman takes it off, and applies another sheet; and in the mean time the letter on the surface of A passes round against the surface of B, and receives ink during the rotation of B. The distributing-rollers CC do their office as in the machine Fig 1; and once in every revolution the tail F, affixed to B, raises the inking-piece G, so as to cause it to touch one of the distributing-rollers, and supply it with ink. In this way therefore the repeated printing of sheet after sheet goes on.

Fig. 3 is a printing-press, more particularly adapted to print cottons, silks, paper-hangings, or other articles which run of a considerable length. A is a cylinder covered with woollen cloth, or other soft substance. The web or piece of cotton, or other goods, is passed round this cylinder, from the carrying-roller F to the receiving-

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ving-rollers G H; which are connected by a piece of linen, woollen, or hair-cloth, in the manner of a jack-towel sewed round them; the rotation of this towel carries away the printed stuff or goods, and deposits them at I. K L is a movable box, containing three rollers, which move against each other in rotation. The lowest roller C revolves in a mass of colour, contained in a trough or vessel in the bottom part of the box K L; the surface of this colour is represented by the line M N. The next roller B is stuffed and covered, as described in paragraph V. The pressure of B against C prevents the cylinder B from receiving too much colour. D is the carved or cut cylinder mentioned in paragraph IV. or any other of the cylindrical contrivances there mentioned; it receives colour, during the rotation, from the roller B, and impresses it upon the web as it passes round the cylinder A; in this way the constant and effectual action of the machine is sufficiently obvious. It must be observed, that the cylinders A D B and G are connected together by cog-wheels, straps, or other well-known equivalent contrivances; so that the handle P drives

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drives the whole, without their neceſſarily depending on any adheſion or friction at their ſurfaces. The preſſure of B againſt D is governed by an adjuſtment of the axis of D, whoſe ſockets are capable of a ſmall motion; and the preſſure of D againſt A is governed by the poſition of the whole box K L. There are many other well-known ways of thus communicating the motions, and of regulating the preſſures; but as they are in general uſe in mills, and other rotary machines of various kinds, I do not conſider it to be neceſſary, in this place, to ſay more than that I alſo uſe them in the conſtruction of my new machines. When it is required to print more than one colour upon a piece, I cauſe it to paſs two or more times through the machine; or, in thoſe caſes where the materials are liable to change their dimenſions, I apply, at one and the ſame time, two or more ſuch boxes as K L, with their reſpective cylinders, ſo that the pattern-cylinder of each may make its impreſſion upon the web or material to be printed on. In this operation I am particularly careful to adjuſt the reſpective pattern-cylinders to each other, by trials on a waſte

piece

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piece of the material, before I proceed to operate upon goods for sale; and in this way a variety of colours are impressed at one and the same time.

Fig. 4 (Pl. IX.) is a printing-press, chiefly of use for books and papers. 1 2 3 4 represents a long table, with ledges on each side; so that the two cylinders A and B can run backwards and forwards without any side shake. In one of these ledges is placed a strip or plate of metal cut into teeth, which lock into correspondent teeth in each cylinder; by which means the two cylinders roll along, without the possibility of changing the relative positions of their surfaces at any determinate part of the table. This may also be effected by straps, and may indeed be accomplished, with tolerable accuracy, by the mere rolling of the cylinders on the smooth or flat ledges without any provision. A is the printing-cylinder, covered with woollen cloth, and B is the inking-cylinder, with its distributing-rollers. The table may be divided into four compartments, marked with a thicker bounding-line than the rest, and numbered 1 2 3 4. At 1 is placed a sheet of paper;

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at 2 is the form or chafe, containing letter fet and impofed; at 3 is an apparatus for receiving the printed fheet; and 4 is employed in no other ufe than as a place of ftanding for the carriage E, after it has paffed through one operation, and when it takes ink at F. Its action is as follows: the carriage is thruft forward by the workman, and as the roller A paffes over the fpace numbered 1, it takes up the fheet of paper previoufly laid there, while the roller B runs over the form and inks the letter. The fheet of paper, being wrapped round the cylinder A, is preffed againft the form as that cylinder proceeds, and confequently it receives an impreffion. When A arrives at the fpace numbered 3, it lets go the fheet of paper, while the prominent part of the carriage, G, ftrikes the lever P, and raifes the inking-piece, which applies itfelf againft one of the diftributing-rollers. In this manner therefore the cylinder A returns empty, and the cylinder B inked, and in the mean time the workman places another fheet of paper ready in the fpace numbered 1. Thus it is that the operation proceeds in the printing of one fheet after another.

4 The

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The preceding defcription is not incumbered with an account of the apparatus by which the paper is taken up and laid down. This may be done in feveral ways: Figs. 9 and 10 reprefent one of the methods. D E is a lever, moving on the centre pin C, and having its end D preffed upwards by the action of the fpring G. The fhoulder which contains the pin C is fixed in another piece F, which is inferted in a groove in the furface of the cylinder A; (Fig. 4;) fo that it is capable of moving in and out, in a direction parallel to the axis of that cylinder. As that cylinder proceeds, it meets a pin in the table; which, (letter P, Fig. 9,) acting on the inclined plane at the other end of the lever, throws the whole inwards, in the pofition reprefented in Fig. 10; in which cafe the extremity D fhoots inwards, and applies itfelf againft the fide of the cylinder.

In Fig. 11 is a reprefentation of part of the table; the dotted fquare reprefents a fheet of paper, and the four fmall fhaded fquares denote holes in the board, with pins ftanding befide them. When the lever D E (Fig. 10) fhoots forward, it is fitu-

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ated in one of thefe holes, and advances under the edge of the paper, which confequently it preffes and retains againft the cylinder with its extremity D. Nothing more remains to be faid refpecting the taking up, but that the cylinder is provided with two pair of thefe clafps or levers, which are fo fixed as to correfpond with the four holes reprefented in Fig. 11. It will be eafy to underftand how the paper is depofited in the compartment N°. 3. (Fig. 4.) A pin P, (Fig. 10,) rifing out of the platform or table, acts againft a pin E, projecting fideways out of the lever, and muft of courfe draw the flider and its lever to the original pofition; the paper confequently will be let go, and its difengagement is rendered certain by an apparatus fixed in the compartment numbered 3, (Fig. 4,) of exactly the fame kind as that upon the cylinder, and which, by the action of a pin duly placed in the furface of the cylinder A, takes the paper from the cylinder in precifely the fame manner as that cylinder originally took it up in the compartment numbered 1. (Fig. 4.)

Figs.

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Figs. 5, 6, and 7, (Pl. X.) represent a simpler apparatus for accomplishing the same purpose. If A *a* B *b* (Fig. 7) be supposed to represent a thick plate of metal of a circular form, with two pins A and B proceeding sideways or perpendicularly out of its plane, and diametrically opposite to each other, and G another pin proceeding in the direction of that plane, then it is obvious that any force applied to the pin A, so as to press it into the position *a*, (by turning the plate on its axis or centre X,) will at the same time cause the pin G to acquire the position *g*; and, on the other hand, when B is at *b*, or the dotted representation of the side-pin, if any pressure be applied to restore its original position at B, the pin *g* will return back to G. Now the figures 5 and 6 exhibit an apparatus of this kind, applied to the cylinder A; and that cylinder, by rolling over the pins P and *p*, properly fixed in the table to re-act upon the apparatus, will cause its prominent part G, either to apply to the cylinder and clasp the paper, or to rise up and let it go. The compartment numbered 3 (Fig. 4) must of course have an apparatus of the same kind, to be acted

upon

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upon by pins from A, in order that it may take the paper from that cylinder.

There is one other circumſtance belonging to this machine which remains to be explained. When the carriage E (Fig. 4) goes out in the direction of the numbers 1 2 3 4, both rollers, A and B, preſs the form of letter in their paſſage; but in their return back again the roller A, having no paper upon it, would itſelf become ſoiled, by taking a faint impreſſion from the letter, if it were not prevented from touching it: the manner of effecting this may be underſtood from Fig. 12. The apparatus there repreſented is fixed upon the outſide of the carriage E, near the lower corner, in the vicinity of the roller A; the whole of this projects ſideways beyond the ledge of the table, except the ſmall truck or wheel B. The irregularly-triangular piece, which is ſhaded by the ſtroke of the pen, carries this wheel, and alſo a catch movable on the axis or pin E. The whole piece is movable on the pin A, which connects it to the carriage. C D, or the part which is ſhaded by dotting, is a detent which ſerves to hold the piece down in a certain poſition. It may be

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be obſerved, that both the detent and the tri-angular piece are furniſhed each with a claw, which holds in one direction, but trips or yields in the other, like the jacks of a harpſicord, or reſembling certain pieces uſed in clock and watch making, as is clearly repreſented in the drawing. Theſe claws over-hang the ſide of the table, and their effect is as follows. There is a pin C (Fig. 4) between the compartments of the table numbered 2 and 3, but which is marked F in Fig. 12, where G H repreſents the table. In the outward run of the carriage theſe claws ſtrike that pin, but with no other effect than that they yield for an inſtant, and as inſtantly reſume their original poſition by the action of their reſpective ſlender back-ſprings. When the carriage returns, the claw of the detent indeed ſtrikes the pin, but with as little effect as before, becauſe its de-rangement is inſtantly removed by the action of the back-ſpring of the detent itſelf; but, when the claw of the triangular piece takes the pin, the whole piece is made to revolve on its axis or pin A, the wheel B is forced down, ſo as to lift that end of the carriage, and the detent, catching

on

on the piece at C, prevents the former poſition from being recovered. The conſequence of this is, that the carriage runs upon the truck B, (and its correſpondent truck on the oppoſite ſide,) inſtead of the cylinder A, which is too much raiſed to take the letter, and ſoil itſelf; but, as ſoon as the end of the carriage has paſſed clear of the letter, another pin R (Fig. 4.) takes the claw of the detent, and draws it off the triangular piece; at which inſtant the cylinder A ſubſides to its uſual place, and performs its functions as before. This laſt pin R does not affect the claw of the triangular piece, becauſe it is placed too low; and the claw of the detent is made the longeſt, on purpoſe that it may ſtrike this pin.

Fig. 8 repreſents an inſtrument for printing floor-cloths, paper-hangings, and the like, with ſtiff paint and a bruſh. D is a copper or metallic cylinder fixed in a frame A, like a garden-roller; its carved part is thin, and is cut through in various places, according to the deſired pattern. A ſtrong axis paſſes through the cylinder, and its extremities are firmly attached to the frame A. To this axis is fixed a veſſel or box of the ſame kind,

kind, and anſwering the ſame purpoſe, as the box K L in Fig. 3. It carries a cylinder P, which revolves in the colour; another cylinder E, which revolves in contact with P; and a third cylinder B, whoſe exterior ſurface is covered with hair, after the manner of a bruſh, and revolves in contact with E. This cylinder B is adjuſted by its axis, in ſuch a manner that its bruſh-part ſweeps in the perforated parts of the metallic cylinder D. The circle C repreſents a cog-wheel, fixed concentric to the cylinder D, and revolving with it; this wheel takes another wheel concentric to, and fixed to, B: hence the action is as follows. When the metallic cylinder is wheeled or rolled along any ſurface, its cog-wheel C drives the bruſh B in the contrary direction; and this bruſh-cylinder, being connected by cogs or otherwiſe with E and P, cauſes thoſe alſo to revolve and ſupply it with colour. As the ſucceſſive openings of the cylinder D, therefore, come in contact with the ground, the ſeveral parts of the bruſh will traverſe the uncovered part of that ground, and paint the pattern upon it. The wheel G, being kept lightly on the ground, ſerves to determine

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the line of contact, that it shall be the part opposite to B, and no other.

Lastly, I must take notice, that in these and every other of my machines, as well as in every machine whatever, the power may be wind, water, steam, animal strength, or any other natural change capable of producing motion; and that the mechanism by which such powers may be applied to produce a regular unceasing, or an intermittent, motion, as circumstances may require, may be used with these machines, though I have held it totally unnecessary either to specify or annex those methods. The materials, the adjustments, the fittings, and that degree of accuracy necessary to the perfection of every machine, have likewise made no part of my specification, because every workman must know that no mechanism can be completed without a due attention to these well-known particulars. In witness whereof, &c.

XIX.

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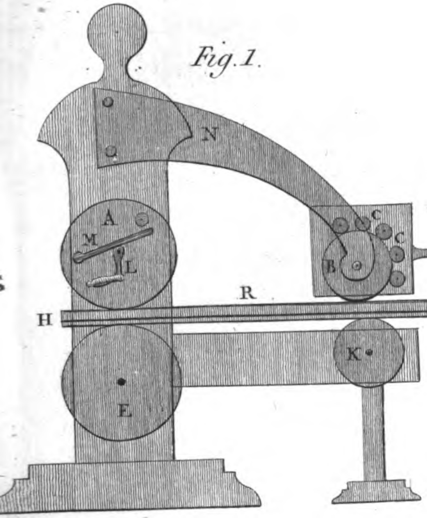


Fig. 1.

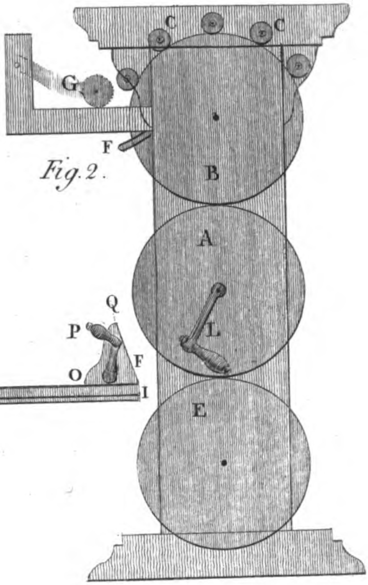
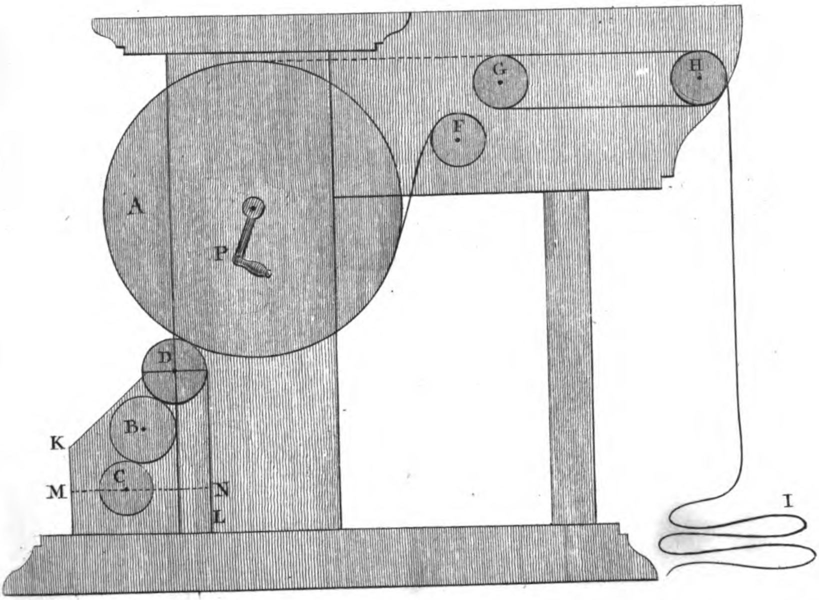


Fig. 2.

Fig. 3.



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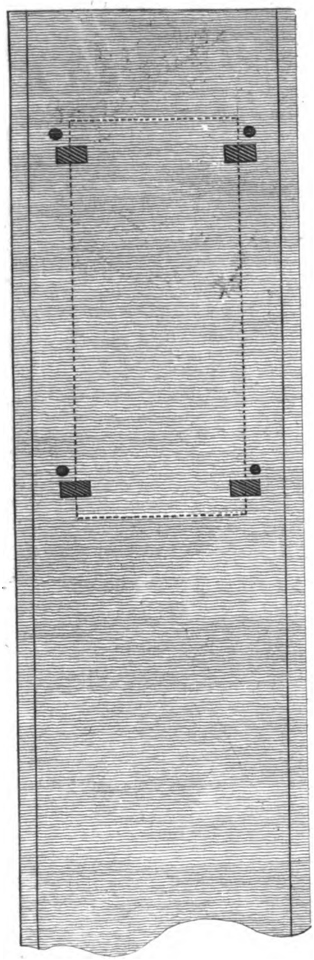

Fig. 11.

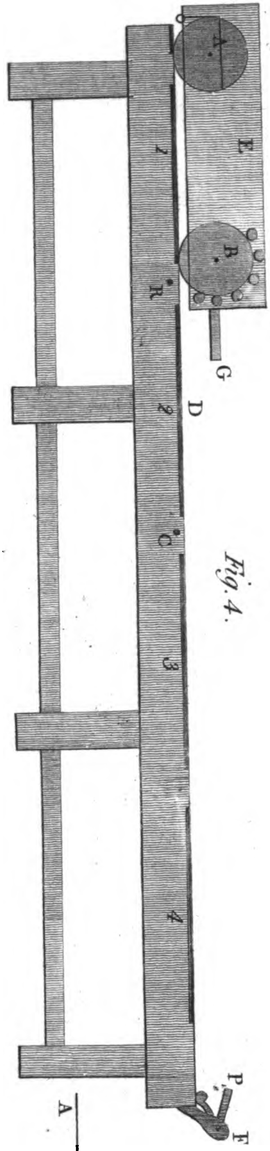

Fig. 4.

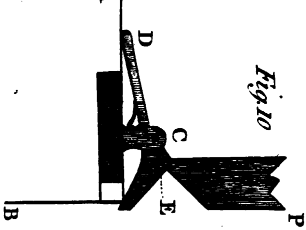

Fig. 10

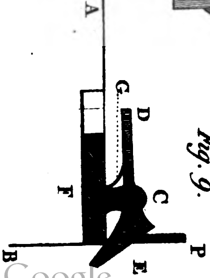

Fig. 9.

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Fig. 5.

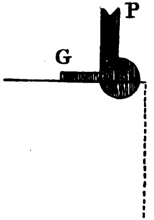


Fig. 6.

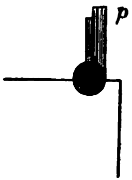


Fig. 7.

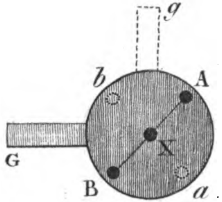


Fig. 8.

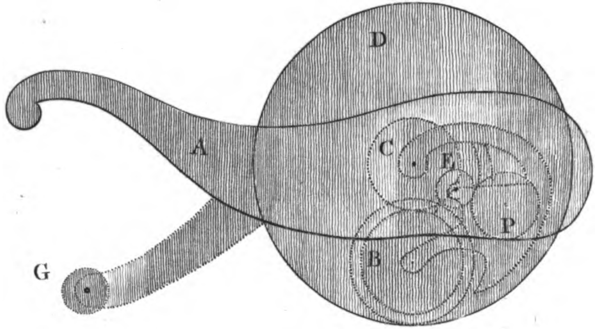
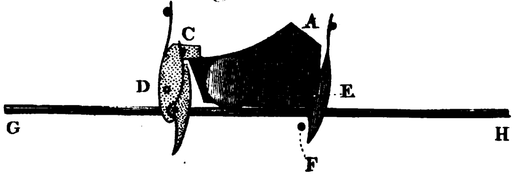


Fig. 12.



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XIX. *Specification of the Patent granted to Mr.* RICHARD TILLYER BLUNT; *for his new-invented Composition to be used instead of Yeast.*

Dated October 30, 1787.

TO all to whom these presents shall come, &c. Now KNOW YE that, in compliance with the said proviso, I the said Richard Tillyer Blunt do hereby declare, that my said new invention is composed and made in manner following; that is to say, to make a yeast-gallon of the above composition to be used as yeast, such yeast-gallon containing, and to contain, eight beer-quarts, boil in common water eight pounds of potatoes, as for eating; bruise them perfectly smooth, and mix with them, whilst warm, two ounces of honey, or any other sweet, and one quart (being the eighth part of a gallon of yeast) of common

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yeast. And, for making bread, mix three beer-pints of the above composition with a bushel of flour, using warm water in making the bread; the water to be warmer in winter than in summer; and the composition to be used in a few hours after it is made; and as soon as the sponge (the mixture of the composition with the flour) begins to fall the first time, the bread should be made and put in the oven. In witness whereof, &c.

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XX. *Specification of the Patent granted to Mr.* JOHN GRIMSHAW, *of Strines-Hall, in the County of Derby, Calico-Printer; for his Invention or Discovery of certain vegetable Substances, in particular States of Preparation, to be used in clearing or bleaching printed, painted, stained, or dyed Cloths, &c.*

Dated Feb. 17, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in pursuance of, and compliance with, the said recited proviso, I the said John Grimshaw do hereby declare, that the nature of my said invention or discovery is as follows. The vegetable substances, in particular states of preparation, to be used in clearing or bleaching, or assisting to clear or bleach, printed, painted, stained, or dyed cloths, or other materials, consisting of, or manufactured from, linen, cotton, hemp, silk, or wool, or any two or more of them, and other printed, painted, stained, or dyed goods,

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goods, manufactured or produced from animal or vegetable materials, or both, consist of the grains either of barley, wheat, oats, rye, or other corn, which remain after such barley, wheat, oats, rye, or other corn, has been made into malt, or brought into a sweet state; and either brewed, for the purpose of making ale, beer, or other malt liquor, or used for the purpose of distillation. Such grains, in all cases, to be brought into a sour state, either by keeping the same without mixture until they become sour, or by mixing the same, either with sour beer, or with alegar, or vinegar, or with cream of tartar, or with any other acid, in order to render the same sour.

Manner of using the sour grains. The manner of using such sour grains is, by putting three or four bushels, or a greater or less quantity, of the same, either into a copper or other pan or vessel, containing either two hundred gallons, or more or less, of water or other liquid, and either in a boiling or hot state, and putting four, or more or fewer, pieces of such printed, painted, stained, or dyed cloths, or other materials or goods, into such mixture, and continuing the same in such mixture

ture either for five or ten minutes, or a greater or less length of time. This operation may be performed in a copper pan, exactly similar to those which are used by calico-printers, for the purpose of clearing their printed calicoes, cottons, and linens, with bran; and it renders the use of bran unnecessary. The operation may be greatly expedited by working the pieces quickly out of and into the mixture, by means of a winch or reel, placed across the top of the pan or vessel above the mixture, over which winch or reel each of the pieces may be made to pass. The winch or reel may be turned quickly round, either by the hand of a man, or any other power. The manner in which I generally exercise my invention or discovery is as follows; I take any quantity of common brewhouse-grains, such as remain after ale or beer has been brewed in the common way from barley-malt, and put them close together into a vessel, tub, cask, or cistern, for the purpose of turning them sour. In hot weather they will become sour in about six days; in cold weather they will become sour in about eight days. When the grains are sour, I put two, three, or four

Winchester

Winchester bushels of them into a common-sized calico-printer's dying copper pan, nearly full of boiling water. Into this mixture I put four pieces, containing about twenty-one or twenty-eight yards each in length, of printed calicoes, cottons, or linens, and work them quickly out of and into the mixture, by turning them over a winch or reel, as before described, placed over and across the pan. I continue this operation from five to ten minutes, during which time I let the mixture gently boil. I then take out the pieces and wash them immediately, either in hot water or cold water, and afterwards treat them in the same manner as is usually done with printed goods by calico-printers, when such printed goods have been cleared with bran. After I have used this mixture for clearing twelve or sixteen pieces, I put one additional bushel of such sour grains as last mentioned into the pan, and fill the pan up with additional water; when it boils, I repeat the operation with other printed calicoes, cottons, and linens, as before. In witness whereof, &c.

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XXI. *Specification of the Patent granted to Mr.* JOHN WORTH, *of Diss, in the County of Norfolk, Chemist; for a Preparation or Cement for the Purpose of preserving his Majesty's and other Ships and Vessels from Worms, &c. and for various Purposes in Agriculture and Commerce.*

Dated May 28, 1771.—Term expired.

TO all to whom these presents shall come, &c. Now KNOW YE that, in compliance with the said proviso, I the said John Worth do hereby declare, that my said invention of a preparation or cement for the purpose of preserving his Majesty's and other ships and vessels from worms, &c. by the paying of their sides and bottoms, and for various purposes in agriculture and commerce, for preserving buildings, &c. made of wood, from the weather, is to be performed in the following manner; that is to say, take of powdered or small pieces of rosin fourteen pounds, sand sifted and

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washed clean from dirt, or loam, twenty-eight pounds, red lead three pounds and a half, oil one pound and three-fourths; melt the rosin over a moderate fire, put the sand and lead in by degrees, then put in your oil; when they are boiling keep them constantly stirring till cold, that you may have an uniform mass. Take of this mass or cement such quantity as may suit your purpose, broke into small pieces, and to every twelve pounds put in a bare half pound of oil. When melted, apply it to what you design, either by pouring it on, or using it with a brush, while boiling hot. It is to be observed that your oil, to be added to the cement, must be of that sort which chemists call fat oil; and that more or less must be used as you want the composition to be harder or softer. This will be of a reddish colour; for the white, and green, I use cerufs, and verdegris, in the same proportion as the minium or red-lead. In witness whereof, &c.

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XXII. *Description of a Machine for cutting Files.* *By* B. O.

WITH A PLATE.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

AAAA, (Plate XI,) a bench, made of well-feasoned oak, and the face of it planed very fmooth.

BBBBB, the feet of the bench, which fhould be fubftantial.

CCCC, the carriage on which the files are laid, which moves along the face of the bench AAAA, parallel to its fides, and carries the files gradually under the edge of the cutter or chifel HH, while the teeth are cut: this carriage is made to move by a contrivance fomewhat fimilar to that which carries the log againft the

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saw of a saw-mill, as will be more particularly described.

DDD are three iron rods, inserted into the ends of the carriage CCCC, and passing through holes in the studs EEE, which are screwed firmly against the ends of the bench AAAA, for directing the course of the carriage CCCC parallel to the sides of the said bench.

FF, two upright pillars, mortised firmly into the bench AAAA, nearly equidistant from each end thereof, near the edge, and directly opposite to each other.

G, the lever or arm, which carries the cutter HH, (fixed by the screw I,) and works on the centres of two screws KK, which are fixed into the two pillars FF, in a direction right across the bench AAAA. By tightening or loosening these screws, the arm which carries the chisel may be made to work more or less steady.

L is the regulating-screw, by means of which the files may be made coarser or finer; this screw works in a stud M, which is screwed firmly upon the top of the pillar F. The lower end of the

ſcrew L bears againſt the upper part of the arm G, and limits the height to which it can riſe.

N, a ſteel ſpring, one end of which is ſcrewed to the other pillar F, and the other end preſſes againſt the pillar O, which is fixed upon the arm G; by its preſſure, it forces the ſaid arm upwards, until it meets with the regulating-ſcrew L.

P is an arm with a claw at one end, marked 6, the other end is fixed by a joint into the end of the ſtud or pillar O; and, by the motion of the arm G, is made to move the ratch-wheel Q. This ratch-wheel is fixed upon an axis, which carries a ſmall trundle-head or pinion R, on the oppoſite end; this takes into a piece S S, which is indented with teeth, and ſcrewed firmly againſt one ſide of the carriage C C C C; by means of this piece the carriage has motion communicated to it.

T is a clamp, for faſtening one end of the file Z Z in the place or bed on which it is to be cut.

V is another clamp or dog, at the oppoſite end, which works by a joint W, firmly fixed into the carriage C C C C.

Y, a

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Y, a bridge, likewife fcrewed into the carriage, through which the fcrew X paffes, and preffes with its lower end againft the upper fide of the clamp V; under which clamp the other end of the file ZZ is placed, and held firmly in its place while it is cutting, by the preffure of the faid clamp or dog V.

7 7 7 7 is a bed of lead, which is let into a cavity formed in the body of the carriage, fomething broader and longer than the largeft-fized files; the upper face of this bed of lead is formed varioufly, fo as to fit the different kinds of files which may be required.

2 2, two catches, which take into the teeth of the ratch-wheel Q, to prevent a recoil of its motion.

3 3 is a bridge to fupport one end of the axis 4, of the ratch-wheel Q.

5, a ftud to fupport the other end of the axis of the ratch-wheel Q.

When the file or files are laid in their place, the machine muft be regulated to cut them of the due degree of finenefs by means of the re-gulating-

gulating-ſcrew L; which, by ſcrewing farther through the arm M, will make the files finer, and, *vice verſa*, by unſcrewing it a little, will make them coarſer; for, the arm G will, by that means, have liberty to riſe the higher, which will occaſion the arm P, with the claw, to move farther along the periphery of the ratch-wheel, and conſequently communicate a more extenſive motion to the carriage CCCC, and make the files coarſer.

When the machine is thus adjuſted, a blind man may cut a file with more exactneſs than can be done in the uſual method with the keeneſt ſight; for, by ſtriking with a hammer on the head of the cutter or chiſel H H, all the movements are ſet at work; and, by repeating the ſtroke with the hammer, the files on one ſide will at length be cut; then they muſt be turned, and the operation repeated, for cutting the other ſide. It is needleſs to enlarge much on the utility or extent of this machine; for, on an examination, it will appear to perſons of but indifferent mechanical ſkill, that it may be made to work by water

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water as readily as by hand, to cut coarſe or fine, large or ſmall, files, or any number at a time; but it may be more particularly uſeful for cutting very fine ſmall files for watchmakers, as they may be executed by this machine with the greateſt equality and nicety imaginable. As to the materials and dimenſions of the ſeveral parts of this machine, I ſhall leave that to the judgement and ſkill of the artiſt who may have occaſion to make one, only obſerving that the whole ſhould be capable of bearing a good deal of violence.

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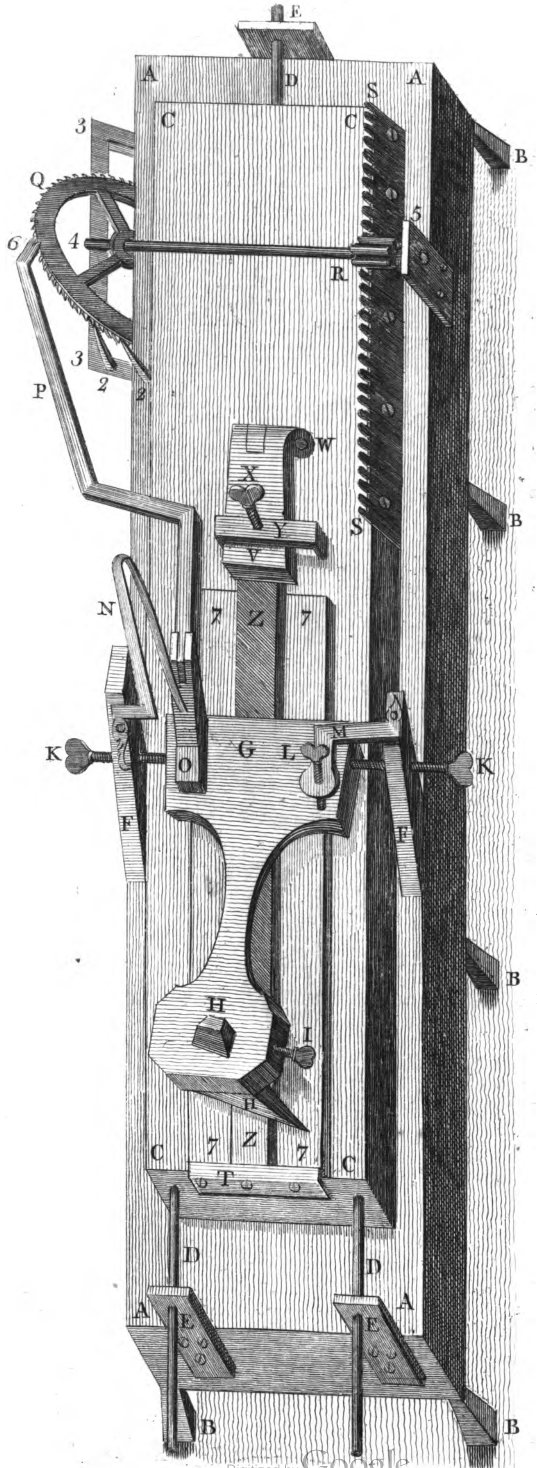

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XXIII. *On the Conversion of animal Substances into a fatty Matter much resembling Spermaceti.* By George Smith Gibbes, *B. A.*

From the Transactions of the Royal Society of London.

In a paper which the Royal Society have done me the honour of inserting in the last volume of their transactions, I related some experiments on the decomposition of animal muscle *. I regret that it has not been in my power to pursue these inquiries with the attention the subject seems to demand. I beg leave, however, to present the few additional facts contained in this paper, not by any means as a full investigation of the subject, but as serving to excite the attention of those who

* For these experiments see our second volume, page 105.

have more opportunities, and are better qualified, to purſue ſuch inquiries.

I mentioned, in my former paper, that the ſubſtance procured, either by means of water, or the nitrous acid, appeared to me to have preciſely the ſame external characters; but, I have obſerved ſince, that there is a difference between that which I obtain from quadrupeds, and that which is procured from the human ſubject: the former ſeems not diſpoſed to cryſtalize, while the latter aſſumes a very beautiful and regular cryſtaline appearance.

The matter which I procured from human muſcle was melted, into which I plunged a very ſenſible thermometer, which ſoon roſe to 160°; it began congealing at 112°, and became ſo ſolid at 110°, that the thermometer could not eaſily be taken out.

I took ſome of the ſpermaceti of the ſhops, and under the ſame circumſtances I plunged the ſame thermometer into it. It ſoon roſe to 170°; a pellicle was formed at the top of it when at 117°; and it became ſo ſolid at 114°, that the thermometer could not eaſily be taken out.

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I dissolved a piece of the substance, which I had formed by means of water and the nitrous acid, in boiling spirit of wine; on cooling this mixture, a great quantity of this waxy matter was separated in the form of beautiful flakes. I could not procure large crystals, but the flakes assumed a crystaline appearance.

I put into an earthen retort some of this waxy matter, to which I added some finely-powdered charcoal; on applying a pretty strong fire, a small quantity of an oily fluid came over, which concreted on cooling; after which came over a prodigious quantity of thick white vapours, which were very suffocating and offensive.

I had a copper retort made, for the purpose of trying some experiments on this matter. I put a small quantity into it, and placed it on a common fire; there came over first a limpid fluid like water, without much smell; on the addition of more heat, there came over an oily fluid, which soon coagulated of a firmer consistence than when put in, and was coloured of a beautiful green by the copper; this last circumstance proves that it contained no ammonia.

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Having procured some very pure quicksilver, I took a glass, which contained about ten pounds of that fluid, with which I filled it; I inverted it in a bason, which contained the same fluid; I introduced a small piece of lean meat, and also a small quantity of water. At the end of about six weeks, so great a quantity of gas was disengaged as nearly to occupy the whole of the vessel; the meat had assumed a white appearance.

Since I mentioned my former experiments on the cow which I had submitted to the action of running water, I have observed a few facts relating to the changes which took place. This cow was placed in a situation where the water could come twice every day, as before described; over it some loose earth was thrown. After it had remained some time in this place, I used frequently to push a stick through this earth to the cow; every time this was done there came up a prodigious quantity of air, after I had suffered it to remain quiet for a short time. Since I put the cow in this situation, I have had two horses and another cow placed under the same circumstances; in all

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all of them this diſengagement of air takes place; this air is extremely offenſive.

In the former cow the whole muſcular part ſeemed changed; and from the ſubſtance formed I have procured a very large quantity of a waxy ſubſtance, by means of the nitrous acid. Though the nitrous acid takes off the greateſt part of the fœtor from the ſubſtance thus formed, yet it gives it a yellow colour, which is with difficulty removed, and a peculiar ſmell, evidently ſimilar to the ſmell of the acid employed, which mere waſhing, and the addition of alkalies, will not intirely remove.

My father, who has been indefatigable in his attempts to whiten this ſubſtance, finds that the following proceſs will make it very pure, and very beautiful, though not ſo white as the ſpermaceti of the ſhops. The cow which had lain in the water for a year and an half was taken up, and we found that the whole muſcular part was perfectly changed into a white matter; this was broken into ſmall pieces, and was expoſed to the action of the ſun and air for a conſiderable

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able length of time. By these means it lost a great deal of its smell, and seemed to acquire a firmer consistence. The appearance of this substance was somewhat singular; for, on breaking it, we found little filaments running in every direction, exactly similar to the cellular substance between the muscular fibres. These pieces were then beaten to a fine powder, and on this powder was poured some diluted nitrous acid. After the acid had been on it for about an hour, a froth was formed at the top; the acid was then poured off, and the substance was repeatedly washed; it was then melted in hot water, and when it concreted it was of a very beautiful straw-colour, without the least offensive smell; on the contrary, it had the agreeable smell of the best spermaceti. May not this substance be applied as an article of commerce? great quantities of it may be obtained. It burns with a fine flame; and dead animals, which at present are of little or no use, may be changed into it. I am very sorry it has not been in my power to ascertain the precise quantity which may be obtained from

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a given quantity of fleſh; but, from what I have obtained, I can ſay that it would be very conſiderable. The running-water carries off a great deal of it, but that might be obviated by the addition of ſtrainers. Moreover, that which is carried off by the water is the pureſt, and I always take care to get as much as poſſible of it, becauſe I find it gives me leſs trouble in purifying it. The water over the animals, and for ſome diſtance round them, is covered with a very beautiful pellicle, which is white in general; ſometimes it refracts the ſun's rays, producing the priſmatic colours.

Fiſh may be alſo changed; and I recollect having ſeen in ſome old author, whoſe name I cannot recollect, a paſſage in which he mentions a circumſtance where ſomething of this kind happened in a whale. He ſays, that after this fiſh has been putrifying on the ſhore ſome time, the people have a ſecret by which they can procure and purify lumps, which they find to be ſimilar to the ſpermaceti which they get in the uſual way.

I have

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I have heard, from many people, obſervations which they had made where this ſubſtance had been formed, and which they could not account for; but, as the circumſtances were the ſame as thoſe before mentioned, I ſhall forbear giving additional trouble.

On ſeeing a body opened ſome time ago, where there was a great collection of water in the cavity of the thorax, I obſerved that the ſurface of the lungs was covered with a whitiſh cruſt. I remarked to a friend, that I thought this cruſt was owing to ſome combinations which had taken place between the lungs, or pleura, and the ſerous fluid effuſed, ſimilar to what I had obſerved between fleſh and water; or that the ſerous fluid had acted on the coagulable matter, and had produced a ſimilar change.

Dr. Cleghorn mentions a circumſtance, which in ſome meaſure ſeems to agree with the obſervation then made. As the fact is a curious one, I ſhall ſubjoin the following extract. He is ſpeaking of abſceſſes formed in the lungs. "Theſe "abſceſſes had ſometimes emptied themſelves "into

"into the cavity of the thorax, so that the lungs "floated in purulent serum; their external membrane, and likewise the pleura, being greatly "thickened, and converted as it were into a "white crust, like melted tallow grown cold." In a note he says, "I am now doubtful if this "crust was the pleura and external coat of the "lungs, changed from a natural state by soaking "in a purulent fluid, and if it was not altogether a preternatural substance, formed by fluids "deposited on those membranes, and compacted "together by the motion of the lungs."

Much has been said by many authors on the subject of secretion. It was at one time supposed that it depended on some peculiar property of the living principle; and it was thought impossible to form any secretion but through the medium of secreting organs. M. Fourcroy has, however, contradicted this by the experiments where he forms bile.

Spermaceti is an animal substance, secreted in a particular species of whale; and the substance which is formed in the foregoing experiments, as

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far as I can judge, agrees with it in every particular.

M. Fourcroy says, that M. Poulletier de la Salle found a crystalized inflammable substance, similar to spermaceti, in biliary calculi.

May not the suety matter in steatomatous tumours arise from something of this kind?

By attending to the various secretions of the body, by examining their composition in the healthy and morbid states of the system, may we not expect to derive great advantage, particularly when accurate experiments are applied towards the relief of disease?

Some excuse may, perhaps, seem necessary for the little attention which has been paid to accuracy in the results of the different experiments; particularly so, as the analysis of every part of the animal body, except the bones, is at present so incomplete; but I hope that the time necessary for my medical pursuits, and the want of a complete chemical apparatus, will not render the simple facts I have here related less useful.

I have

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I have not attempted to account for the various phænomena which appear in the experiments, becauſe the facts ſeem too few to admit of any general concluſion.

If the above experiments ſhould appear to the Society worthy of their attention, the application of my former experiments, and the reſults of ſome which I hope to make, on ſome animals that are placed under different circumſtances favourable to their decompoſition, ſhall be the baſis of a future paper.

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XXIV. *Conclusion of M.* Baumé's *Memoir on the Purification of crude Saltpetre.*

(from p. 137.)

On the Mother-water resulting from the Operation before described.

THIS mother-water contains the same substances as the crude saltpetre, but in different proportions. The pure saltpetre does not amount to above half the weight of the other saline substances. The whole of the sea-salt is collected in it, and almost all the earth. In the usual way, the mother-water is treated with potash, which decomposes the salts with an earthy basis, and forms saltpetre and muriat of potash. As it was my intention to examine this mother-water analytically, in order to discover what it contained, I operated upon some of it without potash; another part I treated with potash, that it might serve

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ferve by way of comparifon; of that I fhall fpeak hereafter.

I fhall not defcribe, in a particular manner, the various and fucceffive evaporations, cryftalizations, and feparations of fea-falt; fuch defcriptions of the fame operation, many times repeated, would be as tedious in the recital, as the operations were troublefome and tirefome to perform. I fhall only fay, that, as this mother-water was very turbid, I filtered it, to feparate the loofe earth; and then put the liquor to evaporate. It foon furnifhed fea-falt, which I feparated as it was produced. When the liquor was fufficiently evaporated, I filtered it, and fet it by to cryftalize. It produced faltpetre of a reddifh colour, in which there was a mixture of a fmall quantity of fea-falt. I put this faltpetre to drain in a funnel, and fprinkled over it a fmall quantity of cold water, which took away the reddifh colour, and diffolved the fea-falt.

I repeated the evaporation, the feparation of fea-falt, the filtration, the cryftalization, and the fprinkling cold water upon the cryftals, (to take away the colour, and diffolve the fea-falt

which had cryſtalized with the ſaltpetre,) until the remaining liquor would furniſh no more cryſtals. Of this liquor there was about a pint; which I mixed with a pint of rectified ſpirit of wine, and expoſed the mixture to the cold. After ſome days, there formed, at the bottom of the veſſel, an ounce and a half of ſalt; which conſiſted of ſaltpetre and ſea-ſalt, the proportion of the latter being ſmalleſt.

I ſeparated theſe two ſalts from each other, and evaporated the ſpirit of wine, to procure the mother-water; of which there then remained fourteen ounces.

The whole quantity of pure ſaltpetre obtained from the mother-water, treated as above deſcribed, was eighteen ounces, ſeven grains.

To avoid repetitions, I will deſcribe in the following part how I ſeparated the ſaltpetre from the ſea-ſalt.

Reſults

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Results from the forementioned Operations.

	ounces.	gros.	grains.	ounces.	gros.	grains.
Saltpetre obtained from the first operation, -	51	4	9			
Ditto obtained from the mother-water,	18	0	7	69	6	16
Ditto mixed with a very small quantity of sea-salt, -	0	2	0			
Sea-salt, -	13	6	54			
Ditto mixed with a small quantity of saltpetre,	0	2	36	14	1	18
Earth, in the whole,			-	0	4	53
Mother-water,		-	-	14	0	0
				98	4	15
Loss,	-	-	-	1	3	57
				100	0	0

Analysis

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Analysis of one Hundred Ounces of the same crude Saltpetre as was used in the former Experiment, the mother-water being treated with fixed Alkali.

To complete my work, it was necessary that I should examine the crude saltpetre by analysis, and that I should treat the mother-water with fixed alkali, that I might know how much the quantity of saltpetre was increased by the said alkali.

I began by washing one hundred ounces of crude saltpetre, in the manner already described. By this means I separated that part of the saltpetre (about three fourths) which did not require any alkaline salt. This I purified as before, and obtained from it fifty-one ounces and three *gros* of perfectly pure, and very dry, saltpetre. I washed the earth which remained upon the filter, and dried it; it weighed fifty-eight grains. There remained about eight ounces of mother-water, which I mixed with that I had obtained by washing.

I first

I first filtered the mother-water, to collect the loose earth; this I washed, and dried. It weighed one *gros*, twenty-four grains; which, added to that I had separated from the washed saltpetre, amounted all together to two *gros*, ten grains, of loose earth. The rest of the earth is kept in solution by the mother-water.

I then heated the liquor, and added, by degrees, some dry and very pure fixed alkali, till I reached the point of saturation. It required, for that purpose, four ounces, two *gros*, and sixty grains. The earth of the neutral salts with an earthy basis was now precipitated. I filtered the liquor; it passed through the filter of a yellow colour. I washed the earth which remained upon the filter, till it was quite free from saline particles, and then dried it: it weighed two ounces, five *gros*, and fifty-two grains.

I united all the liquors, and evaporated them, till about a quart remained; during this evaporation a great deal of sea-salt was precipitated. This salt I collected into a funnel, (the neck of which had a small bundle of straw in it,) that it might

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drain. The liquor, being ſet to cryſtalize, furniſhed a quantity of ſaltpetre of a reddiſh colour, mixed with ſea-ſalt. I put it to drain in a funnel, and waſhed it, by paſſing cold water over it, which took away the colour, and diſſolved the ſea-ſalt.

I repeated theſe evaporations and cryſtalizations ſeveral times, filtering the liquor each time, and waſhing the ſalt after every cryſtalization, to deprive it of colour, and to diſſolve the ſea-ſalt. I alſo took away the ſea-ſalt, as it was ſeparated by evaporation. At laſt there remained two *gros* of extractive mother-water.

I afterwards ſeparated from the ſea-ſalt the ſaltpetre which it had retained.

Reſults,

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Results.

	ounces.	gros.	grains.	ounces.	gros.	grains.
Saltpetre obtained from the first operation, -	51	3	0	72	6	4
Ditto obtained from the mother-water, -	21	3	4			
Loose earth,	-	-	-	0	2	10
Sea-salt, -	-	-	-	19	5	60
Extractive mother-water,			-	0	2	0
				93	0	2
Loss, -	-	-	-	6	7	70
				100	0	0

Remarks.

By means of the washing which the crude saltpetre undergoes, in the beginning of the foregoing process, it is freed from most of the foreign sub-

ſtances; but there remains, as was ſaid before, a ſmall quantity of earth. This could not occaſion any embarraſſment in operating in the large way; it would attach itſelf to the ſides of the caldrons.

If the mixture of alkaline ſalt and mother-water is made without heat, the earthy precipitate (as in the preparation of lakes) takes up the greateſt part of the colouring-matter; but a portion of the earth is diſſolved by the fixed air which is diſengaged during the ſaturation, and appears again as ſoon as the liquor is heated in the ſmalleſt degree. If, on the contrary, the ſaturation is made with the aſſiſtance of heat, leſs of the colouring-matter is ſeparated, and the liquor does not become turbid till towards the end of the evaporation. It would be proper, in operations upon a large ſcale, to filter the liquors into caſks, after the precipitates are formed in them, and even a ſhort time only before the evaporation of them is completed, and they are about to be ſet to cryſtalize.

The ſea-ſalt taken from the mother-water, during the evaporations, is mixed with ſaltpetre. Theſe

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These two salts must be separated, that the weight of each may be known. Their separation is accomplished by their different solubility in cold or hot water. Saltpetre dissolves in hot water more readily than sea-salt; and sea-salt dissolves more readily in cold water.

The sea-salt impregnated with saltpetre is to be put into a silver saucepan, adding thereto a small quantity of water, little more than sufficient to cover the salt. The mixture is then to be heated, and the saltpetre will be dissolved in preference to the sea-salt; after which the liquor is to be decanted. This operation may be repeated ten or fifteen times, or more, until the sea-salt remaining in the saucepan contains no more saltpetre. This may be determined by drying a little of the sea-salt, and throwing it upon burning coals: if it shews any disposition to melt, the washing it with water, in the manner just described, must be continued.

The liquor from the sea-salt, though loaded with saltpetre, still contains a portion of sea-salt also. It must be evaporated, and operated upon afresh,

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afresh, in the manner already described. By these means, with patience and address, we may at least separate these salts from each other; without which it is impossible to obtain a perfect analysis.

The sea-salt in the crude saltpetre is found (as we have already said) in three different states, But I have also observed a fourth state, which has very singular properties; and which I at first thought was oxygenated sea-salt, but it does not detonate like that salt, when thrown upon live coals. I found abundance of this kind of sea-salt in the mother-water treated with potash; it shews itself when the evaporation is nearly completed.

The following are the properties of this salt. It is much more soluble than either of the sea-salts with an alkaline basis; (I could not observe the form of its crystals, as the manner in which I obtained it is not favourable to crystalization;) it sinks and bubbles upon live coals without melting; it leaves upon the coals a neutral salt, which has a cold taste like the fusible salt of urine; concentrated vitriolic acid sets free from it, with great effer-

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effervescence, a ſtrong ſmell of oxygenated marine acid, or of aqua regis; the vapours produced have a reddiſh caſt.

In another ſimilar operation I had remaining about two ounces of thick brown mother-water, which contained a great deal of this ſalt, and alſo a ſmall quantity of ſaltpetre, which it was impoſſible to ſeparate by cryſtalization. I dried a very ſmall portion of this mother-water in a ſilver ſaucepan, in hopes of deſtroying the extractive part by heat; but, when the matter had acquired a certain degree of dryneſs, it ſuddenly inflamed, and jumped out of the ſaucepan, more than ſix feet high, with a ſtrong exploſion. A ſmall quantity of matter which remained in the ſaucepan appeared to be fixed alkali.

The analyſis of this ſaltpetre with alkaline ſalt exhibits products which differ ſo much from thoſe of that made without it, as to deſerve conſideration. This difference, however, is only in the products of the mother-water. The quantity of ſaltpetre I obtained from the firſt operation was nearly the ſame in both experiments.

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The mother-water, treated with four ounces, two *gros*, and sixty grains, of alkaline salt, yielded eight ounces, six *gros*, and thirty-two grains more of saline substances than that treated without alkaline salt; of which, three ounces, two *gros*, and sixty-nine grains, were saltpetre; and five ounces, four *gros*, and fifty-two grains, were sea-salt. It is obvious that this increase is owing to the decomposition of the salts with an earthy basis. As it is supposed that as great a quantity of alkali, (in weight,) as of dry acid, enters into the composition of saltpetre, and of sea-salt, a certain portion of the alkali was employed in producing the increase of the saltpetre obtained; and the rest of the alkali, which was the greatest part thereof, was employed in decomposing the calcareous sea-salt, and in forming muriat of potash; which being a salt of no value, this part of the alkali is intirely lost. It would therefore be of great advantage to discover a method by which the calcareous sea-salt might be separated from the mother-water, before the alkali is added; as, in that

case,

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case, all the alkali made uſe of would form ſalt-petre only.

I have diſcovered a method of doing this, and mean to make it the ſubject of a paper which I am now preparing to write. I alſo hope to be able, in conſequence of this diſcovery, to eſtabliſh a method of analyſing crude ſaltpetre, which ſhall be free from the inconveniences attending that commonly made uſe of.

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XXV. *On the Action of the Fluor-acid upon siliceous Earth, and on the Application of that Property to engraving upon Glass.* By M. de PUYMAURIN.

From the Memoirs of the ACADEMY of SCIENCES, &c. of TOULOUSE.

THE fluor-acid is procured from a saline stone, known by the name of fusible spar, fluor-spar, false amethyst, &c. Chemists were ignorant of the nature of this mineral, and confounded it with the selenitic spar; but miners, in consequence of their practice, distinguished it therefrom, by its useful property of serving as a flux to the most refractory ores.

Marggraf was the first who examined fusible spar, and selenitic spar. He soon determined their different characters; and, having remarked that a mixture of fusible spar with vitriolic acid corroded

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corroded the glass of which retorts were made, and that a particular kind of earth was volatilized with the acid made use of, he considered the property of being volatilized by acids as the essential character of the fluor-spar.

Priestley, who sought for aeriform fluids in every substance, first observed, that an acid gas was disengaged in the distillation of this spar with vitriolic acid, which communicated to water, as soon as it came into contact with it, a strong degree of acidity, and covered the surface of the water with a stony crust. At the first discovery of this new being, he could not attribute the acidity of the water to any thing but its combination with the vitriolic acid, partly volatilized by phlogiston, and partly saturated by a portion of the earth of the spar, which precipitated itself as soon as it came into contact with the water.

It was reserved for a man as learned as he was modest, and one whose every work contains a discovery, to find in a stony, insipid, and indissoluble, substance, a most penetrating acid, which easily mixes with water, and which alone

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possesses, in an eminent degree, the remarkable property of dissolving siliceous earth.

Scheele, in 1771, presented to the Academy of Stockholm the result of his experiments upon fusible spar. He discovered the acid of its basis, and assigned it the rank it was entitled to among the mineral acids. He continued a labour as new as interesting, and thereby corrected those errors which the singular circumstances attending his experiments at first led him into. Being attacked at the same time, in two different manners, by Messieurs Monnet and Boullanger, he refuted their systems, and settled the different degrees of affinity of his new acid to various substances. Lastly, in the year 1786, already on the brink of the grave, he victoriously replied to M. Achard, and shewed us how we might in future obtain the fluor-acid pure, and without any mixture.

I had already made many experiments upon the decomposition of glass by means of the fluor-acid, when I read, in the new *Encyclopédie Méthodique*, the experiments of Messieurs Wiegleb and Bucholz upon the same subject. From that time I considered mine as useless, and I shall therefore only

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only mention the loſs of weight ſuffered by the various ſmall glaſs retorts I made uſe of. I found in the receiver (in the form of a jelly which had the appearance of chalcedony) the quartzoſe earth which had been ſeparated from the glaſs of the retorts; each of which had contained two ounces of ſulphuric acid, and one ounce of fluor-ſpar.

	First Retort.			Second Retort.			Third Retort.			Fourth Retort.		
	oz.	*gros.*	grs.	oz.	*gros.*	grs.	oz.	*gros.*	grs.	oz.	*gros.*	grs.
Weight before the diſtillation,	1	7	5	1	3	36	1	2	7	1	3	54
Weight afterwards, -	1	5	35	1	2	0	1	1	23	1	2	36
Loſs of weight,	0	1	42	0	1	36	0	0	56	0	1	18

Two other retorts, of the ſame ſize, were expoſed to a more violent fire. Not only the interior ſurface of the upper part of them was corroded, but the inferior part was in holes, and ſo much damaged, that I could not exactly compute how much they had loſt in weight.

When the fluor-acid is obtained from a mixture of fluor-ſpar and vitriolic acid in a naked fire, and in a glaſs retort, it is rendered impure in

in two different ways. It is ſaturated with ſiliceous earth, which it holds in ſolution, and it is mixed with ſulphuric and ſulphureous acids. The preſence of theſe is immediately ſhewn by the acetite of Barytes. To obtain the fluor-acid pure, we muſt follow Scheele's proceſs; that is to ſay, we muſt diſtil the mixture in a retort made of lead, or of tin, and cover the inſide of the receiver with a coat of wax.

The diſtillation of a mixture of four ounces of fluor-ſpar and twelve ounces of ſulphuric acid, in that way, is ſufficient to render acid eight ounces of water. The acetite of Barytes does not then diſcover any mixture of ſulphuric acid, though the acid obtained by the diſtillation is ſtrong enough to diſſolve calcareous earth with efferveſcence *. It alſo changes vegetable colours, but does not deſtroy them. Having let ſome drops of this acid fall upon a pair of ſilk ſtockings, of a blue grey colour, yellow ſpots were formed, which diſappeared merely by waſhing. It muſt not,

* This acid muſt be kept in flint-glaſs bottles, coated internally with a mixture of wax and oil.

however,

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however, be thought that the acid, when obtained this way, is quite pure: it is mixed with a ſmall quantity of oxide of lead, or of tin, according to the retort made uſe of. I have precipitated the metal by volatile alkali, and reduced it into its original form of lead, or tin.

I diſtilled in a ſmall retort of lead, in a water-bath, two ounces of vitriolic acid and half an ounce of fluor-ſpar.

The retort weighed eleven ounces eight *gros*. In the firſt diſtillation, it loſt one *gros* and a half; in the ſecond, one *gros*; and, in the third, fifty-eight grains. The acid obtained was whitiſh, and had a ſtrong ſmell of liver of ſulphur. The fluor-acid alone cannot diſſolve tin, or lead; but, during the diſtillation, the ſuperabundant ſulphuric acid diſſolves theſe metals. Being deprived of its oxygene, it forms an earthy hepar with the calcareous earth of the ſpar; while the fluor-acid diſſolves, and takes up, the metallic calx or oxide.

In this diſtillation we muſt never exceed the heat of boiling water, becauſe the ſulphuric and ſulphureous acids would, in that caſe, paſs into the receiver with the fluor-acid.

 Having

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Having been able, by this procefs, to procure the fluor-acid intirely deprived of fulphuric and fulphureous acids, I fubmitted various fubftances, fome metallic and fome filiceous, to its action; and am perfuaded that the difference obferved by fome chemifts, in the refults of fimilar experiments, arofe only from the different quality of the acid made ufe of.

I put into two phials an equal quantity of fluor-acid and filings of iron. The acid put into the firft phial had been obtained by diftillation in a glafs retort, and, if mixed with acetite of Barytes, would reftore the Barytes. The acid of the fecond phial had been made according to Scheele's procefs, before defcribed.

TO BE CONCLUDED IN OUR NEXT.

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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XXVIII.

XXVI. *Specification of the Patent granted to Mr.* JOSEPH BRAMAH, *of Piccadilly, in the County of Middlesex; for his Invention of Locks upon a new Construction.*

WITH TWO PLATES.

Dated April 3, 1784.

TO all to whom these presents shall come, &c. Now KNOW YE that, in compliance with the said proviso, and in pursuance of the said statute, I the said Joseph Bramah do hereby declare, that my said invention is composed and made in man-

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ner following; that is to ſay, the principle of all locks hitherto known, or in public uſe, is too well underſtood to require any particular deſcription here; yet it may not be improper to obſerve on what ideas their ſecurity was always founded, and likewiſe how far ſuch principle may tend to render them perfect or effectual; by which may be obtained ſome comparative information, neceſſary to ſhew or explain the advantages and ſuperior utility of this my ſaid invention. The means hitherto adopted for the ſecurity of all locks are, the inſerting or fixing, between the key-hole and the bolt, a greater or a leſs number of wheels or wards; which ſaid wheels or wards may be croſſed or interwoven, in ſuch a manner as to render the communication between the key-hole and the bolt as irregular and crooked as poſſible, in order to prevent the ſaid bolt from being moved by any counterfeit application when the key is abſent; the bit of which ſaid key is ſo cut or ſhaped as to form a complete tally with the ſaid wheels and wards, and is thereby capable of producing the required effect, when applied for the purpoſe of moving the bolt. Now the inſufficiency of this method

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method of rendering locks a perfect security is as follows: *viz.* notwithstanding the said wheels and wards may be variously placed and disposed, yet they cannot by any means become sufficient to answer the intended purpose, owing to their being always left fixed in the lock. Their form and disposition can be easily obtained by impression; so that, notwithstanding they may prevent the use or effect of picklocks, yet the making a perfect or skeleton key is always extremely practicable. And farther, the variations capable of being made in the disposition of the said wheels or wards, and the form of the key's bit, are not sufficient to produce the required number of locks, without having great quantities exactly alike, and their keys capable of opening each other reciprocally; from which they become a very imperfect security, as any ill-disposed person may, by furnishing himself with a number of old keys, be enabled to open almost all the common locks in the kingdom, with as little difficulty as if he had in his possession the key belonging to each lock. To remedy these objections, by discovering some principle or method whereby the success of pick-

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locks, falſe keys, and all other counterfeit means of opening locks, may be infallibly prevented, has been the ultimate deſign of my ſaid invention, and may be effected in manner following; *viz.* inſtead of introducing (for the ſecurity of the bolt and other movable parts of the lock) a number of wards and wheels, I have found out and invented much more ſimple and effectual means of rendering the ſaid bolt and other parts entirely immovable, without the abſolute application of the real key; by thoſe ſaid means, the effects of picklocks, the practicability of obtaining the form of the key, and the having a number of the ſaid keys alike, are entirely avoided, by having a greater or leſs number of movable parts, ſuch as levers, ſliders, &c. adapted and placed in the lock, ſo as to require each of them a ſeparate and diſtinct change in their ſituation and poſition, before the bolt, and other parts of the lock on which its ſafety depends, can be ſet at liberty or moved. Theſe ſaid levers, ſliders, or other movables, by the aſſiſtance of an elaſtic, gravitating, or other power, have the property of maintaining, or reſtoring, their given poſition or ſituation,

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tion, after it may have been destroyed by any forcible application for that purpose. From this said property, the said levers, sliders, or other movables, are rendered capable of receiving (as it were) any impression or required change in their position or situation, correspondent to the cause which produces such said change, and are also thereby always restored to their former state, or resting situation, when the said cause is withdrawn; so that the opening these my said invented locks is as difficult as it would be to determine what kind of impression had been made in any fluid, when the cause of such said impression was wholly unknown; or to determine the separate magnitudes of any given number of unequal substances, without being permitted to see them; or to counterfeit the tally of a banker's check, without having either part in possession. The form of these said levers, sliders, or other movables, and also the manner of fixing them in the lock, may be varied without end, without altering or losing any of the intended properties or advantages, as the principal merits and efficacy of my said invention do no ways depend thereon, but entirely depend on the

the ſaid levers, ſliders, and other movable parts, being ſo fixed or diſpoſed as to prevent the bolt, or other parts of the lock on which its ſafety depends, from being moved, without the ſaid levers, ſliders, or other movables, firſt receiving each of them a ſeparate and diſtinct change in their poſition or ſituation, by a key or other contrivance for that purpoſe; which, being puſhed or preſſed in a progreſſive direction, without revolution, againſt ſome part of each of the ſaid levers, ſliders, &c. occaſions them to change their poſitions, in manner exactly correſpondent to the part of the key ſo applied. And the ſaid part, being formed with a number of irregular ſurfaces, equal to the number of levers, ſliders, &c. againſt which it is puſhed or preſſed, cauſes them to move at different times, and to different diſtances from their original ſituation. And the ſaid key, by having a ſtop, or ſome mark whereby to limit or determine the length of its puſh againſt the ſaid levers, ſliders, &c. puts a period to each of their motions, notwithſtanding they are at liberty to move farther, but are prevented by the reſiſtance of a ſpring, gravity, or other power,

6 always

always endeavouring to reſtore them to their original ſituation. So that the motion of each lever, &c. ſeparately, depends on the height or depth of that ſurface of the key againſt which it falls. So that a perfect tally is formed, ſimilar to any impreſſion made in a ſoft body by the forcible application of any harder one; which ſaid hard body repreſents the eſſential part of the key, and may be of any determinate ſhape, formed by rule or by accident; and the moving the bolt, or other parts of the lock whereby it may be opened, entirely depends on the poſitive motion of the ſaid levers, ſliders, &c. as any one of them would, by being puſhed the leaſt degree too much or too little, entirely prevent the bolt, &c. from being moved, or ſet at liberty. And, as the whole of the ſaid levers, ſliders, &c. are reſtored to their reſting ſituation when the key is withdrawn, by the properties or powers above mentioned, the ſaid tally or impreſſion is then totally deſtroyed, and conſequently the opening of the lock is then left wholly dependent on chance, whilſt the ſaid key is abſent, as there is no rule whatever, nor imagination founded on certainty, that may in the leaſt degree

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degree tend to aſſiſt in diſcovering the required poſition or ſituation of each or any of the ſaid levers, ſliders, or other movables, whereby the form of the key, or the part of the ſaid key neceſſary to the opening of the lock, might be aſcertained. Now, admitting that no lock on this ſaid principle can be picked, or the form of the key obtained, their farther ſecurity then depends on the number of different keys that may be made without having any two of them alike, which number I truſt will appear indeterminate from the following demonſtration; *viz.* let us ſuppoſe the number of levers, ſliders, or other movables by which the lock is kept ſhut, to conſiſt of twelve, all of which muſt receive a different and diſtinct change in their poſition or ſituation by the application of the key, and each of them likewiſe capable of receiving more or leſs than its due, either of which would be ſufficient to prevent the intended effect; it remains therefore to eſtimate the number producible, which may thus be attempted, *viz.* let the denominations of thoſe levers, &c. be repreſented by twelve arithmetical progreſſionals, we find that the ultimate number

of

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of changes that may be made in their place or situation is 479,001500, and by adding one more to that number of levers, &c. they would then be capable of receiving a number of changes equal to 6227,019500, and so on progressively, by the addition of others in like manner, to infinity. From this it appears that one lock, consisting of thirteen of the said levers, sliders, or other movable parts, may (by changing their places only, without any difference in motion or size) be made to require the said immense number of keys, by which the said lock could only be opened under all its variations; wherefore it likewise appears that the said number of locks may be made, consisting of the same parts, without the smallest difference whatsoever, and, by varying the places of such said parts, would require each of them a separate key, and not one out of the whole number above mentioned be capable of opening any lock, except that particular lock to which it belongs. Now it must be observed, that the number of different locks above stated is produced by thirteen movables, (to wit,) levers, sliders, &c. which, having all a distinct difference in their re-

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quired motions, determines their denominations or names, without any relation being had to the ſeparate value or poſitive motion of each, which ſaid motion may be given at diſcretion; ſo that it plainly appears that the number producible from a like number of levers &c. is far from terminating here, as their motions, and the difference in proportion one to another, may be varied without end, and are to be added to the former; it is therefore very obvious, from this demonſtration, that a much leſs number of the ſaid levers, ſliders, or other movables, will be found ſufficient to produce any required number of the ſaid locks, without having any of their keys to paſs each other. Theſe ſaid levers, ſliders, or other movables above mentioned, may be adapted and applied to all ſorts of diſcretionary faſtenings whatever, ſuch as bolts, bars, turn-buckles, &c. The figures or drawings hereunder written, or hereunto annexed, together with the demonſtration or deſcription therewith given, will more fully ſhew the true nature and intent of this my ſaid invention, In witneſs whereof, &c.

Before

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Before I refer to the drawings, I think it proper to obſerve, that the art of conſtructing locks wholly depends on ſome method or means, ſo adapted or contrived as to be rendered capable of admitting or preventing, at diſcretion, the motion of ſome faſtening, ſuch as bolt, bar, or other movable part; which may be made of iron, braſs, wood, or other materials ſufficient for the purpoſe. I therefore flatter myſelf that the drawing, Fig. 1, (Plate XII,) will be fully ſufficient to ſhew the true nature and deſign of this my invention. G repreſents a ſliding bar or bolt, in the frame K, that hath cut in its edge ſix notches of any proper depth. In theſe notches are placed ſix ſliders or ſmall bars A B C D E F, that are ſunk into the bottom of each notch, ſo that the motion of the bar or bolt G is thereby totally prevented, till theſe ſliders are moved ſome way or other to give it liberty; which muſt be done from their ends at I I, as no other part of them is meant to be expoſed for the purpoſe of moving them; which ends at I I always have an equal projection when the bar G is ſet faſt. Now we will ſuppoſe each of theſe ſliders capable of being

pushed upwards towards A B &c. to any determined distance, and, when each of them has exactly received its due motion, the bar G is set at liberty, so as to slide backwards and forwards as required. Now, in order to determine the separate and distinct motion that shall be given to each, we will suppose the part H to be made; which part serves to represent a key, and the ends 1 2 3 4 5 6 are cut of different lengths, either by rule or by chance, so that, when pushed against the ends of the sliders at I I, they will cause each of them to be slided up at different times, and to different distances, from I I, in a form exactly correspondent to the ends of the part H. When they have thus received their correspondent position, and their ends at I I form a complete tally with the part H, by making a notch in each slider at 1 2 3 &c. in a line with the bar G, the said bar will then have liberty to be slided backwards and forwards without obstruction; and, when brought into its original situation, and the part H withdrawn, the sliders A B C &c. will then fall down into their notches, and fasten it as usual; and their ends at I I will be restored per-

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fectly even as before, and not the least trace left of the position required in them to set the bar G at liberty; it depends therefore entirely on chance, when the part H, or key, is absent. (See specification.) The construction of the Fig. 1 is thus adapted for the more easy conveying the true ideas of this invention. These sliders A B C &c. may also be made so as to have their required motion or position given them, without the use of H, by having sundry changeable marks graduated on the edge, or other part of each of them exposed for that purpose, as at O O; certain of which are to be brought in contact, or in a line, before the notches 1 2 3 &c. will be opposite to each other, or the bar G moved; and the said marks or graduations required may be distinguished by figures, characters, &c. and the secret will serve as a key to such as are in possession thereof. (For the changes producible in this number of sliders, or other movables, see specification).

Fig. 2 is meant only to represent in what manner sliders may most conveniently be applied in locks of all sorts. A is a frame or barrel that moves the bolt by its turning, in which barrel or frame are

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are fixed eight, or any other number of fliders. B is a thin plate fixed in the lock, through which the barrel or frame A paffes, and is prevented from turning for the purpofe of moving the bolt, by the projecting parts of the fliders that move in the fixed plate B, till the notches in each of them are, by the application of the correfpondent part of the key, pufhed into contact, or in a line with the plate A. At the end of each flider, in the cylindrical parts C C C &c. is fixed a fpiral fpring, which always reftores them after the key is withdrawn, fimilar to A B C &c. by their own gravity, in Fig. 1.

Fig. 3 reprefents a method of fixing any number of levers for the fecurity of the part that moves the bolt, which part is B, and is fixed to the levers C C &c. as in the fection. A A A is the plate, and other fixed parts of the lock. D is the drill-pin, on which the key is applied. *e* is the fpring that reftores the levers, after having been preffed down by the key. The notches in the head of each lever are made by the rules already defcribed. An endlefs variety of other modes may be adopted, of placing levers, fliders,

or other movable parts, in order to effect the above purposes, without in the least degree deviating from, or losing any of the essential properties arising from, the ideas of this invention. A, Fig. 4, (Plate XIII,) represents a lock that locks on both sides. B is the bolt. C is the lower plate, in which the projecting part of the sliders moves, for the purpose of securing the bolt; *e e* &c. are the sliders. D is the barrel or frame, represented in Fig. 2, in which the sliders are fixed. F F &c. are the cylindrical parts in which the spiral springs act. G is the key-hole, which is bored through the centre of D, as shewn in the section; into which hole the edges of the sliders project, in order that the end of the key may fall against them when pushed forward in the hole G. H is a part joined to the barrel or frame D, and acts as a key's bit to move the bolt, when D is turned round for that purpose. I is the section, where the barrels, sliders, &c. are marked the same as in the plan. K K is the key from both sides, on which there is a small stump at L, that falls into a notch or slit in the barrel D, in order that D may be turned round with the key, for the

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the purpose of moving the bolt; and also, by its turning under the cap M, the key is prevented from being pushed out by the springs whilst it is revolving to move the bolt. The end of the key is formed with different surfaces, which gives the sliders different motions, (see specification,) and brings the notches in the sliders, when pushed down to its stop, exactly in a line with the cover plate C; which notches, being the size of the thickness of the said plate, permit the barrel D to make a revolution, if required; and it appears from this section, that as the sliders *e e* &c. may each of them be pushed as far as the bottom of the slit or groove *n n*, in which they move, the whole of the notches in the sliders are liable to be pushed too far as well as too little, both of which would prevent the barrel D from being turned, or the bolt B from being moved.

XXVII.

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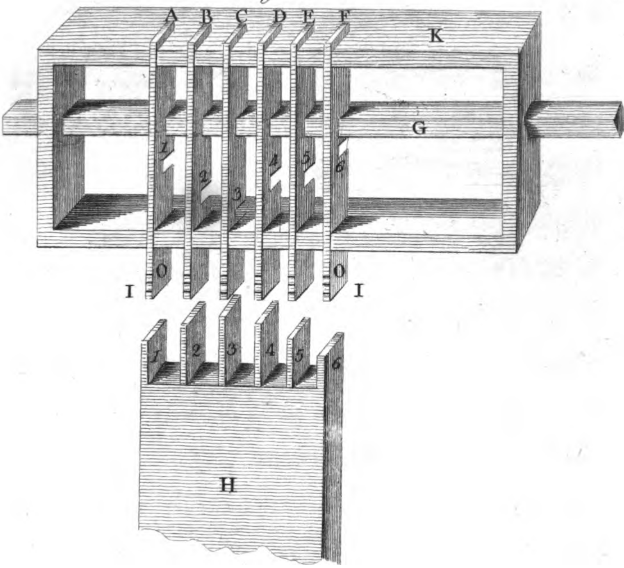
Fig. 1.



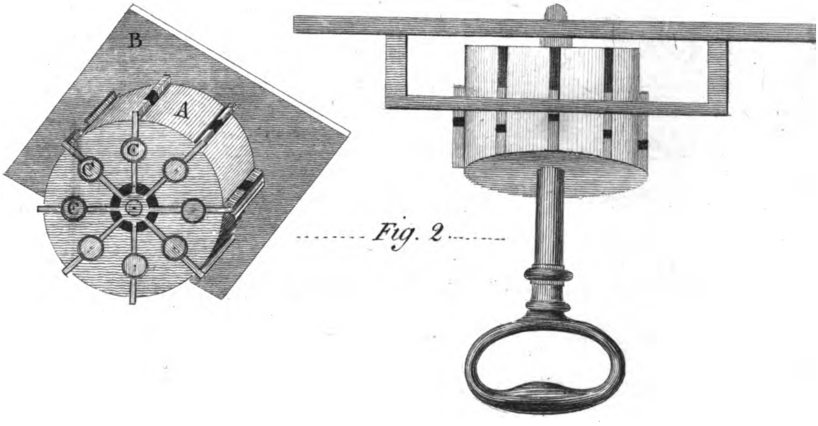


Fig. 2

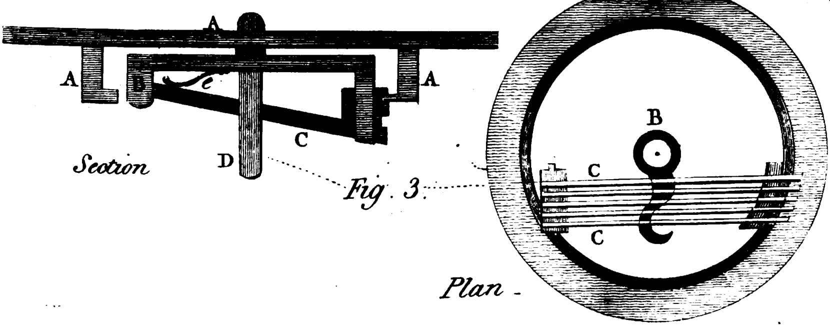


Fig. 3.

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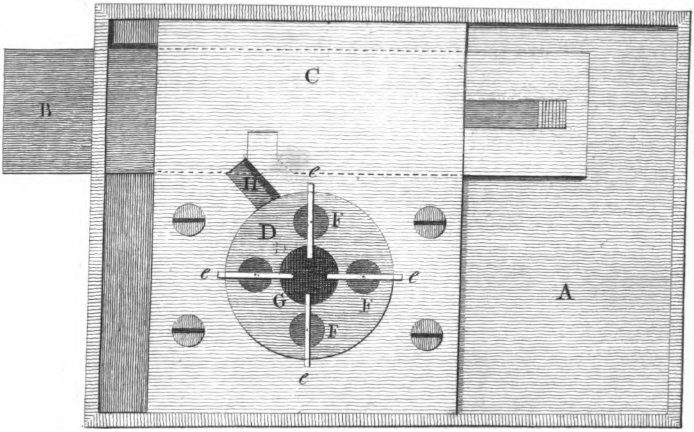
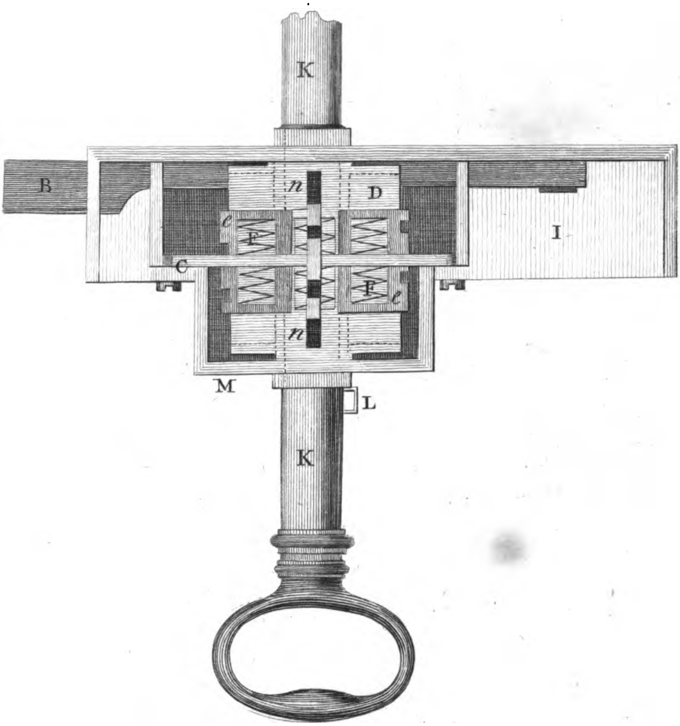


Fig. 4



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XXVII. *Specification of the Patent granted to Mr.* SAMUEL BIRNIE, *of the City of Glasgow, Refiner of Lead; for his Method of preparing and restoring the Calx of Lead, after being used in extracting the mineral Alkali from common Salt, by which means a great Quantity of mineral Alkali may be extracted to Advantage from common Salt.*

Dated August 12, 1788.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I the said Samuel Birnie do hereby declare, that the method I have invented for preparing a calx of lead, for extracting the mineral alkali from common salt, or other purposes, consists in extracting the silver from the lead by the following process; *viz.* the lead is put into a calcining furnace, and calcined with a moderate heat, until it is all or most of it converted into a calx. The calx is then to be melted, without addition, either in the same or in another furnace; when the calx becomes fluid, the silver, and what lead may be still in a metallic state, will sink to the bottom,

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bottom, and be thus ſeparated from the calx. By repeating in this manner the calcination and melting, all the lead will thus be converted into a calx, and the ſilver obtained at laſt pure. Or the ſilver may be purified from the laſt portion of lead by the common proceſs of cupellation or refining. Or, in place of again calcining by itſelf the metal got by the firſt melting of the calx, it may be calcined with a quantity of freſh lead, and the calx melted as formerly; and this proceſs may be repeated at pleaſure; the ſilver being purified at laſt, as above directed. Or the calx, prepared as above, may firſt be uſed in extracting the alkali from common ſalt, and afterwards melted to extract the ſilver. And the method I have invented of reſtoring or reducing again into lead the above calx, litharge, minium, or any other calx of lead, which has been uſed in extracting the mineral alkali from common ſalt, or which has by any method whatever been combined with the marine acid, conſiſts in adding to the above calx a ſubſtance or ſubſtances which have a ſtrong attraction for the marine acid; by which means the acid is prevented from volatilizing and carrying off with it, in the proceſs of reduction, a conſiderable

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derable portion of the metal, which it always does when the calx is reduced, according to the common method, without any other addition than an inflammable ſubſtance; this is done in the following manner, *viz.* to ſixteen parts, by weight, of the above calx add one part of lime, or a greater or a leſs proportion; they may be mixed either before or after they are put into the reducing furnace; the reduction is then to be performed in the uſual and common method in practice, by adding to the above mixture, pit-coal, charcoal, or any other convenient inflammable ſubſtance. Or, in place of lime, chalk may be uſed, common limeſtone, the ſhells of fiſh, or any calcareous, abſorbent, or other ſubſtance, capable of ſeparating, with the aſſiſtance of heat and an inflammable ſubſtance, the marine acid from the calx of lead. The lime, or other calcareous or abſorbent ſubſtances uſed in the reduction, will form, with the marine acid, a marine ſalt with an earthy baſis; which may be obtained from the ſlag which remains after the reduction, by adding water to it, decanting or drawing off the clear liquor, and then evaporating it to dryneſs. In witneſs whereof, &c.

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XXVIII. *Specification of the Patent granted to Mr.* ROBERTSON BUCHANAN, *Engineer, and Overseer or Manager of the Cotton-Mills of Rothsay, in the Isle of Bute, Scotland; for his Invention of a Pump for raising Water in various Situations, but more particularly on-board Ships; and which may be occasionally converted into an Engine for extinguishing Fire, &c.*

WITH A PLATE.

Dated March 8, 1796.

TO all to whom these presents shall come, &c. Now KNOW YE, that I the said Robertson Buchanan, in pursuance of and compliance with the said proviso, in the said letters patent contained, and the purport and true intent and meaning thereof, and of his Majesty's said most gracious intentions, do by this instrument in writing, under my hand and seal duly executed, describe and ascertain the nature of my said invention, and in what manner the same

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ſame is to be performed, as follows; that is to ſay, this pump, like the common pump, acts by the preſſure of the atmoſphere; but differs from it in ſome particulars hereafter expreſſed, and has the following advantages. Firſt, the water is diſcharged from this pump through two valves; the one called the inner valve, ſituated on the bore of the ſuction-piece, through which the water on raiſing up the piſton firſt paſſes, and thence is communicated, by means of an aperture in the ſide of the pipe, to the ſecond or outer valve, which is placed at the bottom of the ciſtern, whence it paſſes into the ſpout. Secondly, the outer valve is not only within the command of a perſon's hand, and may be at all times cleared, but is made ſo as to afford a communication to clear the inner valve. Thirdly, theſe valves, not being confined to any particular dimenſions, are made large enough to admit any body or ſubſtance through them that is capable of paſſing through the ſuction-piece; and, being placed near to each other, and in an inclined poſition, gravel, dirt, or other things, cannot eaſily lodge in the pump, and the water is thus reſiſted or wire-

drawn

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drawn as little as poſſible in paſſing through the valves; and the pump is thus alſo made not liable to choke, or to have any unneceſſary tear and wear of its parts; but the valves may alſo be placed horizontally, or in any other poſition, when circumſtances require it. Fourthly, from the ſize and ſituation of the valves, they may be at all times eaſily taken out, ſo that they may without difficulty be readily repaired or renewed. Fifthly, this pump may be occaſionally uſed as an engine for extinguiſhing fire.

Theſe are the advantages which diſtinguiſh this pump, but the following inſtructions in regard to its conſtruction will more fully explain its nature and principle; though the principle of the invention, in the particulars above mentioned, may be obtained by various modes of conſtruction, provided the arrangement and diſpoſition of its parts here mentioned are preſerved.

This pump in its body and parts is made of wood, copper, caſt iron, or any other metal or material ſuited to ſuch purpoſes, or partly of wood and partly of metal, but metal is recommended for the parts above deck on-board ſhips; and

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and it is varied in form and dimenſions, as ſituation and circumſtances require. The valves beſt ſuited to the purpoſes of this pump are of the kind called clack-valves. Their apertures are made of any form or ſhape, and of any dimenſions; but the elliptical form is the beſt, becauſe it has been found that, where the apertures are of this ſhape, the valves loſe leſs water at each ſhutting than when the apertures are of a circular form; and the apertures ought to be made as large as the bore of the ſuction-piece, becauſe where the apertures of the valves are of the ſame dimenſions with the bore of the ſuction-piece, the water will be thereby leſs reſiſted or wire-drawn in paſſing through the valves. The valves may be made of any metal, but braſs is recommended as leaſt liable to ruſt.

A flat piece of leather is fixed on the under part of the lid, to render it elaſtic. The lid of each of the valves turns upon two pivots, which have freedom in their ſockets to riſe a little upwards, that any ſmall ſubſtance which happens to intervene near the hinge may not prevent the lid from lying cloſe to the box. The bore of the

lower or ſuction-piece may be made of any ſhape and dimenſions, but, for the reaſon above mentioned, it is beſt made of the ſame ſhape and dimenſions with the aperture of the valves. For the purpoſe of allowing a more eaſy paſſage to the water, and for the better diſcharge of oblong pieces of wood and other things which may be brought up along with the water, the bore of the ſuction or lower pipe ſhould, when the inner valve is inclined, receive a bended or curved form as it approaches the inner valve, ſo as to make its ultimate direction nearly at right angles to the inclined poſition of the inner valve. From the loweſt extremity to the ſuction or lower pipe, a reticulated grate, extending ſome feet upwards on the outſide of the pipe, leaving a vacant ſpace between the outſide of the pipe and the inſide of the grate, may be fixed with advantage, in ſituations where there is any danger that large quantities of dirt, chips, gravel, or ſuch like ſubſtances may lodge in the well, and choke the lower extremity of the pipe; for, where this grate is ſo placed, although the lower extremity of it ſhould be choaked, the water will find a free paſſage,

through

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through the openings of the grate above the dirt, gravel, or other substances so lodging, to the lower extremity of the pipe. The inner valve is placed below the piston; that is, as near the lower extremity of its stroke as the nature of the thing will admit, and is fixed by a rest or rabbet, made in the periphery of the bore, or by any other means most convenient; and, when the pump is made of wood, it is introduced to its place by an aperture in the side of the pipe, to allow the water a passage to the outer valve. The outer valve is, in this case, fixed in a frame or piece of wood which covers this aperture, to which the outer valve is placed opposite. The frame or piece of wood containing the outer valve is enclosed by a cistern, with or without a movable lid, for the purpose of keeping water above the outer valve when the pump is in action; and the water is discharged from the cistern by a spout, placed at a height sufficient to keep the outer valve covered with water when the pump is in action. A triangular piece of wood is fastened on each side of the inside of the cistern, to secure or hold the

 frame

frame or piece of wood containing the outer valve; and the triangular pieces of wood are kept tight by interpofing tar, tallow, or any other fimilar fubftance. Thefe triangular pieces of wood are eafily removed as occafion may require; and the frame or piece of wood containing the outer valve may be taken off, when the inner valve is in need of repair, or when a more free accefs is wanted to it than the aperture of the outer valve admits of. The above is the mode of fixing the outer valve, when the pump is made of wood; and, when made of wood, the working-barrel fhould be lined with brafs, to leffen friction. But, when the pump is made of copper, caft iron, or other metal, lining the working-barrel with brafs is unneceffary; and the outer valve is fixed in the fide of the pipe, without being contained in a movable frame or piece of wood, and the triangular pieces of wood mentioned above are unneceffary; but, in order to introduce the inner valve, and afterwards to get at it, when in need of repair, the barrel is faftened immediately above the valves by means of a flanch. For the purpofe of letting

fuch

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ſuch part of the air eſcape (which is collected in what is called fetching the water) as does not find its way through the outer valve, a ſmall air-valve is placed, either in the piſton, or between the lower extremity of its ſtroke and the inner valve; but it is placed in the piſton with beſt effect, for the purpoſe of letting up a little water to aſſiſt in keeping the piſton air-tight. This air-valve, however, is not abſolutely neceſſary in either ſituation; for, the piſton may be made ſo pliant as to allow the remainder of the air ſo collected to eſcape around its circumference; and, in all caſes where the water is to be raiſed only a little height, this air-valve is unneceſſary. Motion may be given to this machine by means of the common brake, or by what are commonly called bell-ropes, or by ropes led horizontally from a bended lever, or by any other method practiſed in working the common pump, which it reſembles, except in the particulars above ſtated. In order to render this pump occaſionally uſeful as an engine for the purpoſe of extinguiſhing fire, it is only neceſſary to make the piſton air-tight in deſcending as well

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as in aſcending, and to fix to the ciſtern an air-veſſel communicating with pipes, in ſuch manner that the ciſtern is made air-tight in every part, excepting where it communicates with the air-veſſel. No particular method of rendering the piſton air-tight is eſſential to this pump; all or moſt of the methods in common uſe may therefore be applied to it. The air-veſſel may, without any inconvenience, remain fixed to the ciſtern at all times, which will be an advantage, as the pump can thus, when neceſſary, be inſtantly applied to the extinguiſhing of fire. For the more fully underſtanding the conſtruction of this machine, both in its operation as a pump, and as an engine for extinguiſhing fire, drawings are annexed, (ſee Plate XIV,) having references to the different parts, the paper containing which drawings is ſigned by me as relating thereto. In witneſs whereof, &c.

Ex-

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Explanation of the Figures.

(See Plate XIV.)

Fig. 1 is a vertical ſection of the pump, in which the ſuction-piece is only ſo far delineated as is neceſſary for illuſtration.

A is part of the ſuction-piece.

B the inner valve.

C the outer valve.

D the barrel.

E the piſton.

F the ciſtern.

G the ſpout.

a the air-valve in the piſton.

H the air-veſſel.

I the ajutage-pipe.

K a colander, which is neceſſary when the water is mixed with any extraneous matter, to prevent the ajutage-pipe from being choked.

b a ſcrew for ſecuring down the air-valve, when the piſton is wanted air-tight in deſcending.

Fig. 2 is a plan of the pump, wherein the ſame parts are marked by the ſame letters as in Fig. 1.

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The dotted lines in Fig. 2 reprefent a plan of the fuction-piece.

Figs. 3 and 4 are a front view and fection of the ftopple commonly ufed for plugging up the fpout, when the water is to be difcharged by the ajutage-pipe. This ftopple is covered on the edge with leather, or fome foft material, and is made with a bevel inwards, fo that, when admitted by its oval form within the ciftern, it prefents its lefs furface outwards, and is preffed tight by the water in the ciftern.

N. B. Thefe drawings reprefent the pump as it was made of metal, with every part executed in the manner that was moft convenient; and they give fo clear an idea of the conftruction of the pump, as to render any farther defcription in words unneceffary.

XXIX.

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Fig. 1.

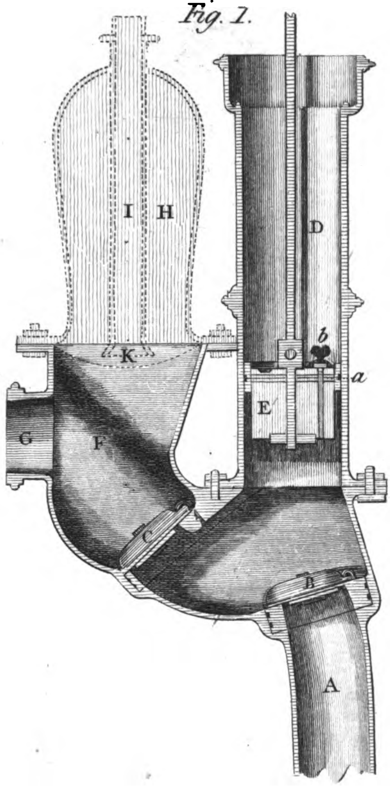


Fig. 2.

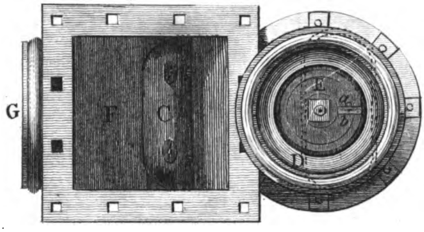


Fig. 3.

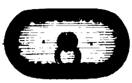
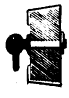


Fig. 4.



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XXIX. *Specification of the Patent granted to Mr.* RICHARD DEARMAN, *of Birmingham, in the County of Warwick, Ironmaſter; for making Mills for grinding Malt, and various other Articles, in the ſame Manner thoſe Articles are ground in what are commonly called Steel-Mills.*

Dated March 22, 1779.—Term expired.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Richard Dearman do hereby declare, that my ſaid invention of an intire new method of making mills for grinding malt, wheat, barley, beans, peaſe, groats, rice, Indian corn, coffee, pepper, ſeeds, drugs, and all kinds of ſpice, in the ſame manner thoſe articles are ground in what are commonly called ſteel-mills, is deſcribed in the manner following; that is to ſay, to form the grinding-parts of the mills, or

or what is called the inside and outside thereof, melt iron in a furnace or crucible, and cast the same in moulds of a suitable shape and size for the different purposes for which they may be intended. Then, to soften them, in order to file the teeth to a proper edge, neal them in a gradual heat until that be effected; afterwards harden the grinding-parts of the mill with hoofs, horns, or bones of animals, or charcoal pounded or ground small, or common soot mixed with kelp, or common or marine salt laid on with grounds or lees of malt-liquor, or other acid or glutinous matter. Heat them in a furnace, muffle, or open fire, and plunge them in water. In witness whereof, &c.

XXX.

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XXX. *Defcription of a Method of preventing Injury to the Health of the Workmen employed in preparing White Lead. By Mr.* ARCHER WARD, *of Derby White-Lead Works.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal of the Society was voted to Mr. WARD for this Invention.

IN order to explain, as well as I can, the advantage that will accrue to the workmen by adopting my invention, in preference to the common mode of preparing white lead, I will firft ftate what the common mode is. When blue lead is in part corroded in the ftacks, by an acid raifed by a confiderable degree of heat, brought on by horfe-litter, the corroded and

uncorroded lead are taken from the ſtacks to a room called the engine-loft, where a pair of iron rollers is fixed with a ſcreen under them. The lead in this ſtate is paſſed through the rollers and ſcreen; from the motion of theſe rollers and ſcreen, by which the white lead is ſeparated from the uncorroded or blue lead, together with the moving the lead in order to its being paſſed through them, a very conſiderable quantity of fine duſty white lead is raiſed, which almoſt covers the workmen thus employed, and is very pernicious to them. And not only in this part of the proceſs are they liable to be thus injured, but they are again expoſed to the duſty lead, by removing the blue lead from the ſcreen-houſe to the furnace, as there ſtill remains a quantity of the fine particles of white lead, which of courſe riſes in removing it; and alſo, in removing the white lead from under the ſcreen to the grinding-tub, a quantity of the duſt ariſes, which is very detrimental to the people ſo employed.

My invention removes all theſe difficulties reſpecting the dry duſty white lead, ſo very injuri-

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ous to the health of the working people; and confifts of a veffel, as fhewn in Plate XV, Fig. 1, twelve feet long, fix feet wide, and three feet ten inches deep. In this veffel is fixed a pair of brafs rollers in a frame, one roller above the other. The centre of the rollers is about ten inches below the top of the veffel; and, one inch lower, is a covering of oak boards or riddles, an inch thick, fixed in the infide of the veffel, in a groove, fo as to be taken out occafionally: thefe boards are bored, with a centre-bit, as full of holes as may be, without danger of breaking into each other; the fize of thefe holes is, in the machine at large, about five-eighths of an inch diameter. This being done, the veffel is filled with water, about three inches above the oak boards or riddles; the lower brafs roller is now under water, and about half of the upper roller is under water alfo. Thus the lead coming from the ftacks is put through the brafs rollers in water, and, by raking the lead with a copper rake over the oak boards or riddles, the white lead paffes through the riddles, and the blue lead remains above; which, being taken out,

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is thrown upon an inclined plane of ftrong laths to drain, where it remains about twelve hours, when the blue lead is ready for the furnace to be remelted; by this means no dufty white lead can rife in any part to the work-people. No fuch plan as this (although long defired) has, to my knowledge, been put in execution, fo as to anfwer all the purpofes above ftated. It may be afked, why the lead in the common mode is not made wet before it is paffed through the rollers and fcreen. Should this be done, the lead would be a pafte on the rollers and fcreen, and the white lead prevented feparating from the blue lead, which is abfolutely neceffary in the preparation of white lead.

Explanation of the Figures.

(See Plate XV.)

Fig. 1, A, an inclined plane of wood, on which the white and blue lead is placed immediately from the ftacks, and thus introduced between the brafs rollers B B.

C C, the veffel containing water.

D D D,

D D D, the pierced oak boards or riddles, which, by being made to slide in grooves in the sides of the vessel C C, may occasionally be taken out by removing the wooden bar *e e*.

E, a handle or winch, which, in the machine at large, may be a wheel communicating to mill-work, and thus turn the rollers B B.

F, a pinion, fixed on the gudgeon of the upper roller, and communicating with a similar pinion on the arbor of the lower roller, keeping both of them in motion by the turn of the handle. As it is necessary that the upper roller should be at liberty to rise or fall, in order to give a due degree of pressure to the lead in passing between the rollers, two weights G G, with proper stems to them, (as shewn more at large in Fig. 2,) are placed over the gudgeons of the upper roller, thereby keeping a due degree of pressure; and, if any piece of the lead should be thicker than usual, admitting the roller to give way to it, and thereby preventing any injury to the machinery.

H, a notch in one side of the wooden vessel, serving to regulate the depth of the water on the riddles D D D.

The

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The foregoing defcription is accompanied by two certificates; one from Mr. Samuel Walker Parker, ftating that many tons of white lead have been made, in the manner above defcribed, at the manufactory at Iflington belonging to Walker, Ward, and Co. and that, fince Mr. Ward's plan was adopted, no other method has been ufed. The other certificate is from Mr. H. Browne, of Irongate, Derby; who fays that he thinks the foregoing invention a very valuable improvement in preparing white lead, and that the quality of the lead is not in the leaft injured by it.

XXXI.

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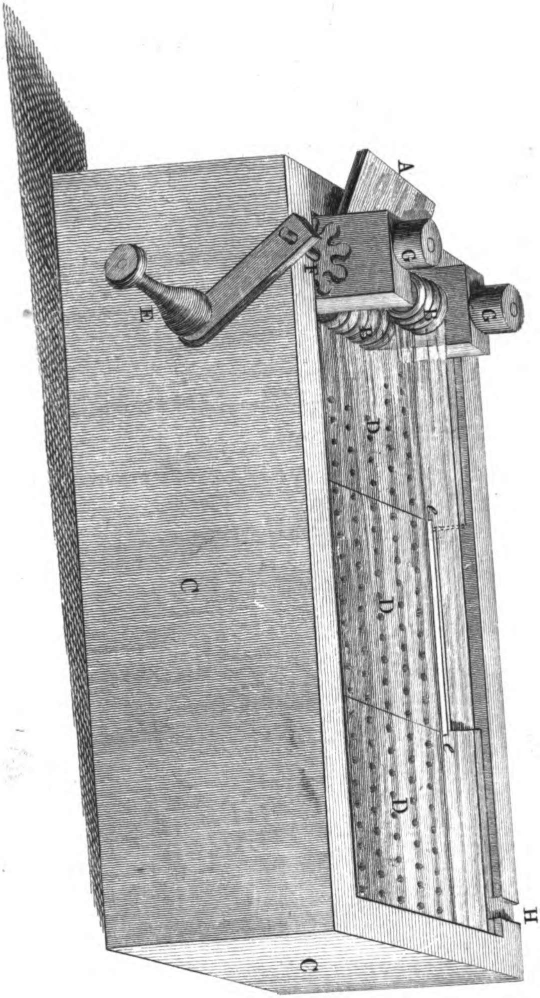

Fig. 1.

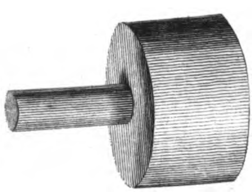

Fig. 2.

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XXXI. *Experiments on the alkaline Subſtances uſed in bleaching, and on the Colouring-Matter of Linen-Yarn. By* RICHARD KIRWAN, *Eſq. F. R. S. and M. R. I. A.*

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

SECTION I.

BLEACHING being one of thoſe arts which conſiſt in ſcarce any thing elſe than a particular application of ſome of the general principles of chymiſtry, it might be expected that the knowledge of the inſtruments it employs would keep pace with the progreſs and improvements of that ſcience to which it is ſubordinate, and ſo much the more as the nature of alkaline ſubſtances in general, which are its proper inſtruments, has been in great meaſure explained by the celebrated Doctor Black upwards of thirty years ago; yet

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yet it has ſo happened that, on a late occaſion, when a ſcarcity of theſe ſaline ſubſtances, imported from foreign countries, unhappily prevailed in this kingdom, it was ſeriouſly queſtioned whether their place could be ſupplied by materials manufactured at home. In the courſe of this diſcuſſion it evidently appeared, from the contradictory teſtimonies of many of the principal bleachers, that, however they might excel in that art, when well provided with the inſtruments they employ, they were but little acquainted with the general agency of the inſtruments themſelves, and their reſpective powers, or even with the moſt advantageous and œconomical method of employing them. To elucidate theſe points, by an analyſis of ſome of the different ſubſtances employed by bleachers, and by giving a ſure method of diſtinguiſhing the relative powers of every ſaline ſubſtance they may uſe, together with an account of the beſt method of obtaining them, as well as of adapting them to the purpoſe of bleaching, is the object of this paper. This taſk, which I have impoſed upon myſelf ſolely with a view to the utility

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utility of the public, requires no ingenuity, and might have been long ago well executed by many others, if chymiſtry, which has ſo many votaries of the higheſt rank in the moſt civilized parts of Europe, had been more known and cultivated in this country, which perhaps of all others ſtands moſt in need of its aſſiſtance.

SECTION II.

Barilha. Of this ſubſtance there are ſeveral ſorts, made of different plants *, but the beſt is that formed near Alicant, at a diſtance from the ſea, by the combuſtion of a plant called by the inhabitants *barilha*, and deſcribed by Juſſieu, in the Memoirs of the Academy of Paris for 1717, under the name of *Kali Hiſpanicum ſupinum annuum, ſedi foliis brevibus*. It is called by Linnæus *Salſola ſativa*, and ſhould carefully be diſtinguiſhed from the various ſpecies of *Salicornia*, and of *Chænopo-*

* See Colonel Conyngham's letter: report of the committee of the houſe of Commons in Ireland, 1788, p. 87.

dium, which yield an alkali, but leſs pure than the *Salſola*. Theſe plants, being dried to the ſame degree as hay, are burned in pits, nearly as kelp is with us; the aſhes and ſalt run into a greyiſh blue maſs, which is the barilha *. The beſt ſort is here called *ſweet barilha*.

The ſweet barilha which I examined was preſented to me by Mr. Byrne, an eminent merchant of this city. It was of a bluiſh colour, covered over with a ſaline powder, exceedingly hard, and had a ſmart alkaline taſte. When broken, it looked black in the fractured part, and viſibly contained pretty large pieces of charcoal.

To find the proportion of fixed air in this ſubſtance, having reduced a quantity of it to fine powder, I poured on an ounce of it a ſufficient quantity of marine acid, and found it to loſe, by the action of this acid, 80 grains of its weight; conſequently one pound troy of this ſubſtance contains 960 grains of fixed air, (mixed with a

* It is called by the French *ſoude*, being employed in ſoldering metals.

little

little that had an hepatic ſmell,) that is, exactly $\frac{1}{6}$ of its weight. Other parcels contained ſomewhat more, and others ſomewhat leſs.

As this ſubſtance evidently contained ſome parts that were ſoluble in water, and ſome that were inſoluble therein, to diſcover the weight of each, I poured on one pound of it, reduced to fine powder, thirteen pounds of water moderately hot, ſucceſſively; this water had previouſly been boiled and filtered, and contained no other impurity than a ſlight trace of common ſalt. This quantity of water was neceſſary to exhauſt all the ſoluble matter in the barilha.

The ſolutions were taken in ſix different portions; none of them betrayed the ſmalleſt mark of ſulphur, of which I was aſſured, by trying them with the nitrous ſolution of ſilver; nor did the Pruſſian alkali diſcover any veſtige of iron.

By eighteen ſucceſſive evaporations and cryſtalizations, I obtained 4881 grains of ſaline matter, the different ſpecies of which I ſhall preſently mention, and 2903 of inſoluble matter.

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It may at firſt ſight appear extraordinary, that the ſaline matter and the inſoluble part ſhould weigh more than the pound of barilha that ſeemed to afford them; for, this amounts only to 5760 grains, and the two former weighed 7784 grains; but, it ſhould be conſidered that theſe products were obtained, not from the barilha alone, but from the barilha and the water in which the ſalts were diſſolved, whoſe cryſtals retained a great quantity of it; and alſo from the air to which the ſolutions were expoſed, and which they abſorbed in large proportion.

As the quantity of the inſoluble matter was ſubject to no ſuch deceptive appearance, I began by examining the weight of that; for this, being ſubtracted from 5760 grains, neceſſarily determined the true weight of the ſaline part; and, as the ſtate in which the ſaline part exiſts in barilha depends, in ſome meaſure, on the earths and charcoal with which it is united, as well as the moſt advantageous method of uſing it, I examined the nature and quantity of theſe very minutely.

Having

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Having therefore dried the insoluble matter for a considerable time in a low heat, until it appeared as dry as the barilha itself, and having found its weight in that state to amount to 2903 grains, or 6,04791 ounces, I took one ounce of it, and, drying it in a heat little below redness, found it to lose 38 grains of moisture.

Another ounce of the same residuum, being treated with dilute marine acid, lost 125,5 grains of its weight, and this loss expresses the quantity of fixed air contained in it.

Another ounce, being calcined in a white heat for about one hour, lost 200 grains of its weight; on repeating this experiment, I found the loss amount to 199 grains.

Lastly, on the 281 grains, which remained after this experiment, I poured dilute marine acid, and found the quantity of fixed air to be 106 grains.

Hence I deduce the weights of the several substances dissipated by the calcination of an ounce of the insoluble residuum of the barilha:

First. The weight of the fixed air lost was 125,5 —106=18,5 grains.

Secondly.

Secondly. The loss of moisture was 38 grains.

Thirdly. The loss of the fixed air and moisture amounted together to 56,5 grains. This, deducted from the entire loss, that is from 199 grains, gives the loss arising from the combustion of the charcoal, and consequently its quantity, 199—56,5 = 142,5 grains.

I next proceeded to examine the fixed incombustible part that remained after the above calcination. On 279 grains of this, which remained after the calcination of an ounce of the insoluble part, I poured a quantity of distilled vinegar, whose specific gravity, in the temperature of 62°, was 1,008, and digested that residuum therein for sixteen hours, in a heat little more than 100°. After edulcoration and desiccation, I found the weight of what remained undissolved to amount to 63 grains. Upon this experiment I reasoned thus: 281 grains of a residuum of this sort contained 106 grains of fixed air, therefore the 279 grains subjected to the vinegar in this experiment must have contained 105,24, which were dissipated by the action of the acid;

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there remained therefore of mere earth only 173,76; but, of these, 63 escaped the action of the acid, therefore there were dissolved 110,76; and, as distilled vinegar can act only on calcareous and muriatic earth, (the barytic being not expected,) the 110,76 that were dissolved must have consisted of either or both of these, and the undissolved 63 grains must have been argillaceous, or siliceous.

To determine the first point, I distilled, in a glass retort, the acetous solution, which was very voluminous, until no more than about four pints remained. During the distillation some earth was deposited, which, when dried in a red heat, amounted to 4 grains; this I re-dissolved, and, finding it precipitable by caustic volatile alkali, judged it to be magnesia. I then took as much of the acetous solution as amounted to $\frac{1}{6}$ of the whole, and, pouring caustic volatile alkali upon it, obtained nearly 3 grains, or more exactly 2,83 grains, of magnesia precipitated by the alkali. Whence I concluded the whole solution to contain 17 grains, to which adding the 4 grains deposited,

posited, we have the entire quantity of magnesia dissolved by the vinegar = 21 grains, and consequently the remainder of 110,76 grains, namely, 89,76, must have been calcareous earth.

I also examined the quantity of this earth in another manner: to the $\frac{5}{6}$ of the acetous solution that remained, I added gradually vitriolic acid, whose specific gravity was 1,463, as long as any precipitation appeared to take place; then, pouring off the vinegar, I edulcorated the residuum, and, having dried it, found it to weigh 240 grains, and consequently, if the whole acetous solution had been used, the resulting selenite would have weighed 288 grains; now 100 grains of selenite contain 32 of calcareous earth, therefore 288 grains contain 92,16 grains, which differs inconsiderably from the former determination.

Lastly. The 63 grains which eluded the action of the acetous acid, being digested in spirit of salt, left a residuum of 41,3 grains, which therefore was siliceous; the remainder, not being precipitable by the vitriolic acid, was consequently argillaceous earth; hence the quantities of

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of these ingredients in 480 grains of the insoluble part of barilha were found to be,

	Grains.		Grains.
Fixed air, - -	125,5	And in the whole insoluble part,	759
Water, - -	38		229,82
Charcoal, - -	142,5		861,82
Calcareous earth, -	89,76		542,86
Muriatic ditto, (magnesia,)	21		127
Argillaceous ditto, -	21,7		131,23
Siliceous ditto, -	41,3		249,58
	479,76		2901,31
Error - -	,24	Error -	1,69
	480,00		2903,00

I now return to the soluble part of the barilha, which necessarily amounted only to 2857 grains, as 5760—2903=2857.

In the first place, I obtained 4213 grains of pure crystalized mineral alkali, but these crystals are known to contain but $\frac{1}{5}$ of real alkaline substance,

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the remainder of their weight being fixed air, and water of cryſtalization; therefore one pound of barilha contains but 842 grains of pure real alkali.

Beſides this, I alſo obtained 127 grains of a mixture of mineral alkali and common ſalt, which I could not eaſily ſeparate; and 346 grains of a mixture of vegetable and mineral alkali, with a ſmall proportion of extractive matter, and ſome digeſtive ſalt, as I believe: this maſs conſtantly attracted moiſture. I weighed it hot and dry, but forgot to examine the portion of fixed air it contained; it could not be leſs, nor much more, than 28 *per cent.* and therefore this maſs contained about 250 grains of mere alkali.

Theſe ſolutions, and particularly the laſt portions, afforded alſo 125 grains of Glauber's ſalt, and 70 of common ſalt; but the Glauber's ſalt at leaſt did not exiſt in a cryſtalized form in the barilha; and, as 100 grains of it are reduced to 42, by expelling the water of cryſtalization, no more than 58 grains of it can be deemed to have preexiſted in the barilha.

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Theſe ſolutions alſo depoſited 20 grains of earth.

Hence the weights of the different ingredients contained in one pound of ſweet barilha are as follow :

Fixed air, - -	960	
Charcoal, - - -	861,82	
Calcareous earth, - -	542,86	
Muriatic ditto, - -	127	1050,67 (Calcareous to Siliceous)
Argillaceous ditto, -	131,23	
Siliceous ditto, - -	249,58	
Mineral alkali, pure, -	842	
Ditto, impure, - -	250	1219 (Mineral alkali, pure, to Ditto, mixed with common ſalt)
Ditto, mixed with common ſalt, - - -	127	
Glauber's ſalt, - -	125	
Common ſalt, - -	70	
Earth depoſited, -	20	
	4306,49	
Water, -	1453,51	
Total, -	5760,00	

Hence we ſee, that the alkaline part of barilha is nearly in a cauſtic ſtate; for, the entire pound of barilha contained but 960 grains of fixed air, and, of this quantity, we have ſeen that 759 were contained in the earthy part; therefore only 201 grains were contained in the ſaline part. Now 960 grains of this (and the mere alkaline part did not certainly amount to leſs) require for their ſaturation at leaſt 700 of fixed air, therefore they wanted at leaſt $\frac{2}{3}$ of the quantity requiſite to ſaturate them. Hence bleachers ſhould not uſe boiling water to extract the ſaline ſubſtance of barilha; for the alkaline part, being in a cauſtic ſtate, diſſolves part of the coaly matter with which it is united, which ſullies the ſolution, gives it a dark hue, and afterwards is depoſited on the linen, and cannot be ſeparated by acids.

SECTION III.

Of Dantzic pearl-aſh. This ſalt was alſo ſent to me by Mr. Byrne. It is exceeding white, and, if not expoſed to the air, very hard, and poſſeſſes an alkaline taſte.

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The quantity of fixed air and earth contained in different parcels of this ſubſtance is variable; in ſome ounces I found the quantity of fixed air to amount to 100 grains, in others to 115; and therefore, at a medium, it may be rated at 107,5 grains, or 1290 grains in one pound Troy. The earth remaining after the ſolution of one pound amounted to 20 grains.

One ounce of this ſubſtance, gradually heated to redneſs, and kept in that heat for three quarters of an hour, loſt 70 grains of its weight; and, being then diſſolved in ſpirit of ſalt, loſt 72 grains; therefore the quantity of moiſture in one ounce of this ſubſtance was $70 - \overline{107{,}5 - 72} = 34{,}5$ grains, or 414 in one pound.

Again, after ten evaporations, I procured from one pound of this ſubſtance 505 grains of vitriolated tartar, the laſt portions of which appeared, by the teſt of the nitrous ſolution of ſilver, to contain ſome digeſtive ſalt; and alſo 36 grains of this laſt, containing a portion of vitriolated tartar: about 38 grains of earth were depoſited during the evaporations. The remainder of the pound, after all theſe deductions, muſt have con-

ſiſted of mere alkali. Hence the ingredients in a pound muſt have been nearly in the following quantities:

Fixed air, - -	1290	
Moiſture, - -	414	
Vitriolated tartar, -	505	
Digeſtive ſalt and ditto,	36	
Earth, - - -	38	
	2283	5760
Mere alkali, -	3477	2283
	5760	3477

Diſguſted by the tedioufneſs of theſe experiments, and recollecting that the alkaline part of theſe ſalts was that alone with which bleachers had any concern, I bethought myſelf of an eaſy practical method of diſcovering the preſence of this principle, and determining its quantity in all ſubſtances in which it exiſts, either uncombined, or combined only with fixed air, or ſulphur.

TO BE CONTINUED IN OUR NEXT.

XXXII.

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XXXII. *Conclusion of M. de* PUYMAURIN'S *Memoir on the Action of the Fluor-acid upon siliceous Earth, &c.*

(FROM P. 216.)

THE iron-filings in the first phial were partly dissolved, and the solution furnished vitriol of iron: in the second phial, the liquor was only covered with a ferruginous crust, of a reddish colour. The two phials were then exposed to a strong heat, and the fluor-acid was volatilized in the form of a vapour, which was sharp and penetrating. The residuum of the first phial retained a styptic taste, while that of the second had the colour of *crocus martis*, and was insipid to the taste.

The same thing was found to take place with respect to calx of copper, precipitated from blue vitriol by fixed alkali, and also with respect

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to lead, and tin, when these substances were exposed to the action of the two different kinds of fluor-acid.

I put a small piece of a diamond into the fluor-acid, in a glass vessel, and heated the vessel two or three times in a sand-heat; after the diamond had been four or five days in the acid it disappeared, and nothing could be observed in its place but some small shining particles, which rolled about at the bottom of the vessel, if it was at all agitated. This experiment appeared to me so singular, that I thought it right to repeat it upon two other diamonds: these two did not appear to suffer the smallest alteration. I know not what was the cause of the dissolution, or rather of the extreme division, of the first diamond; but, if I had not repeated my experiment, I should have supposed that the fluor-acid was a menstruum for diamonds, as well as for glass. I exposed various gems, and other siliceous substances, to the action of this acid; but, as such an enquiry demands numerous experiments and observations, conducted with great care and assiduity, in order

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to be able to depend upon the reſults, I ſhall relate only ſome detached experiments, until the action of the fluor-acid upon gems and ſtones ſhall be determined with accuracy. It is by no means indifferent in what veſſels the pieces of ſtone or gems to be examined are placed. The glaſs veſſels I at firſt made uſe of were not ſo proper for the purpoſe as I wiſhed. The great affinity of the acid with the quartzoſe earth of ſuch veſſels prevents its action upon the ſubſtances put into it. The internal ſurface of the veſſels is corroded; a grey gelatinous ſubſtance covers the pieces of ſtone, &c. and they are little or not at all acted upon by the acid.

Veſſels of box wood, although varniſhed, could not reſiſt the gentle heat neceſſary to haſten the action of the acid; which ſoon penetrated through their pores, in ſuch a manner that it was neceſſary to procure veſſels of another kind.

Veſſels of tin had all the advantages I wiſhed; but we muſt apply heat very gradually, becauſe the acid becomes volatile with a very gentle heat, and the veſſels, when empty, are apt to melt.

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It is alſo neceſſary to be very particular reſpecting the purity of the fluor-acid; if it is mixed with ſulphuric acid, this laſt attacks and calcines the metal of the veſſels, and the fluor-acid then exerts its action upon theſe calces or oxides, and becomes loaded with them.

If we ſhould be able, as I hope we ſhall, to analyſe gems and other ſtony ſubſtances in a new way, by means of the fluor-acid, we muſt always deduct from the products the Pruſſian blue or pruſſiate of iron, which the fluor-acid always contains, and alſo the calx or oxide of tin, or of lead, which it may have taken up during the diſtillation.

I expoſed the following ſubſtances in tin veſſels, with a ſufficient quantity of fluor-acid to cover them, to a moderate heat, for the ſpace of two days.

A cryſ-

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	Weighing.	Weighed after the operation.	Loſs of weight.
A cryſtal of Brazilian topaz,	24 grains	22 grains	2 grains
A topaz cut, -	2	2	0
An amethyſt, -	3	3	0
An opal, -	4	2½	1½
The kind of jaſper called blood-ſtone, -	8½	7	1½
Red jaſper, -	5½	4½	1
Striped agate,	6	5	1
True aventurine, but of inferior quality, -	4½	3	1½
Coarſe agate, uſed for gun-flints,	7	5½	1½
Two pieces of feld-ſpar,	18	12½	5½
Hyacinth, -	6½	5½	1
Peruvian emerald,	12	10	2
Green ſchorl,	8	7½	0½
Rock cryſtal *,	3½	3½	0

* This cryſtal loſt its poliſh in the acid.

 The

The Brazilian topaz, the Emerald, and the Hyacinth, did not lose their polish, and their angles only seemed to have been attacked.

The opal lost its polish and water; its surface became rough, so that it appeared like a clouded opaque crystal. The striped agate lost its transparency, and its fine red colour. The aventurine appeared only like a piece of a grey pebble, and its brilliant particles had entirely disappeared. The blood-stone suffered the greatest change; the beautiful broad red spots, from which it takes its name, were changed into spots of a brownish red colour; the dark green was changed into a greyash colour; and the hardness of the stone was so diminished that it might be scraped with a knife. It had also become very brittle; when broke, the broken part appeared of a dark brownish green colour *.

The feld-spar had evidently been acted upon; it appeared to be covered with a white powder, but still preserved its semitransparency.

* Since these experiments were made, I have engraved various characters upon blood-stone, and upon agate, by means of the fluor-acid.

Green

Green schorl, tourmalin, and black schorl, seem to be very little affected by this acid.

A small hexaedral crystal lost its polish, but did not decrease in weight. A piece of phosphoric glass, of the most complete transparency, suffered no loss, either of polish or weight.

Four small garnets lost a portion of their weight, and became of a beautiful dark rose-colour; their outer surface having been taken off by the acid.

The zeolite of Feroe was dissolved by the fluor-acid, and formed a jelly with it, as with other acids.

The blue lava of Mount Vesuvius, which has the appearance of lapis lazuli, and of which snuff-boxes are made at Naples, was dissolved with effervescence; the residuum was a black spongy mass.

The silky asbestos of Corsica lost its suppleness, and became hard and brittle.

Black mica lost its brilliancy and its elasticity; being dried, it acquired a dark grey colour, and became very brittle. Gypsum from Montmartre,

and

and ſand-ſtone from Fontainebleau, were completely diſſolved.

It may be obſerved, from the experiments above deſcribed, that the fluor-acid acts moſt readily upon ſiliceous ſtones; but I believe that its action is increaſed by their being of a mixed nature, becauſe the ſiliceous earth is then more minutely divided: for that reaſon it acts more readily upon glaſs than upon rock-cryſtal. The ſiliceous earth in glaſs is divided by fuſion, and by its mixture with alkaline ſubſtances; and conſequently preſents a multitude of ſurfaces to the action of the acid, which ſoon deſtroys it; reducing it into a light powder, of a ſhining white colour, and which may be again fuſed by being mixed with an alkali.

This effect of the fluor-acid was at firſt denied, but the corroſion of the glaſs of retorts put the matter out of doubt. Macquer conſidered this as the effect of the fluor-acid in the gaſeous or aeriform ſtate. I ſaw in M. Fourcroy's laboratory a piece of glaſs, which had loſt its poliſh, and was corroded, by the gas which exhaled from a retort in which was left the reſiduum of a diſtillation

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lation of fluor-acid. Being surprised at this singular and expeditious effect of that acid, I thought it right to try whether I could not produce a similar effect by means of the fluor-acid combined with water. My experiment succeeded, and I convinced myself that the fluor-acid had almost as much action upon glass as aqua fortis and other acids have upon copper, or other metals.

I had now only to go one step farther, in order to make some advantage of this property of the fluor-acid, and to render it useful to the arts. Imitating the process of engravers upon copper with aqua fortis, I covered a piece of glass with a coat of wax, and, having drawn some figures upon it, I applied fluor-acid over the whole, and exposed it to the sun. I observed soon afterwards that the lines which I had drawn were covered with a white powder, arising from the dissolution of the glass. After four or five hours I took off the coat of wax, and cleaned the glass. I then found, with the greatest satisfaction, that my conjectures were true, and I was thereby assured that a skilful engraver

graver might, by means of the fluor-acid, engrave upon the hardeſt glaſs, in the ſame manner as he can engrave upon copper with aqua fortis.

But though the reſult of my firſt trial was ſuch as to encourage me to proceed, I could not help remarking that the lines of the engraved figure were of unequal thickneſs, and full of irregularities. As I was ignorant even of the firſt principles of engraving, I could not hope to be able to bring this diſcovery to perfection; but I thought it right that I ſhould endeavour to remove thoſe cauſes to which the inferiority of my work was owing.

The coat of wax had been laid on too thick, which had prevented me from giving to the outlines of my drawing the delicacy they ought to have had; and the action of the fluor-acid had rendered them thicker in thoſe parts where the coating was not evenly laid on.

I ſoon found that it would be neceſſary to make uſe of a varniſh which ſhould be ſufficiently thin to admit of ſhading, and performing other delicate parts of engraving; and at the ſame time ſo

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ſtrong that, when applied evenly upon the glaſs, it ſhould not be taken off, or deſtroyed, by the action of the acid.

The difficulty of applying a ſubſtance of that kind upon the ſurface of glaſs, makes this part of the operation very troubleſome. The ſtrong varniſh uſed by engravers was found to anſwer pretty well, but the ſmalleſt negligence in applying it renders it apt to ſcale, and to be penetrated by the acid. The glaſs then becomes dull, the lines are rough, and conſequently the engraving is imperfect. I think therefore that, to bring engraving upon glaſs to its higheſt perfection, it will be neceſſary to diſcover a new kind of varniſh, which ſhall have the properties requiſite for the purpoſe. I tried, with tolerable ſucceſs, the ſtrong varniſh of the engravers, deſcribed in the *Encyclopédie*, and which is compoſed of equal quantities of drying oil and maſtic in tears *. But it

* Being of opinion that oils acquire their drying quality merely from their acidification by the oxygene of the metallic calces with which they are boiled, and red precipitate appearing to me the moſt convenient calx for trying the truth of

it is very difficult to apply it evenly; and it is very long in drying, eſpecially in winter, as it requires to be expoſed to a pretty ſtrong heat, in order to deprive it of its pitchy quality.

I ſhall not give a tedious account of all the trials I made, but ſhall only mention thoſe which appeared to me moſt uſeful.

Before the varniſh is applied, the glaſs muſt be thoroughly cleaned, and heated until the hand can hardly be borne upon it. The varniſh is then to be applied lightly over the glaſs, and laid ſmooth by dabbing it with ſmall balls of ſilk ſtuffed with cotton. It is then to be expoſed to

of my conjecture, I put into a retort two ounces of that ſubſtance, with a certain quantity of common linſeed-oil. I adapted a pneumatic apparatus to the retort, and applied heat to it. Some bubbles of fixed air ſoon paſſed over; upon the fire being increaſed, the air was diſengaged with ſo much rapidity, and ſuch a noiſe was heard in the retort, that, fearing it would burſt, I thought it beſt to unlute it, and to let it cool gradually. I found the next morning, that the mercury was revived, and lay, in the form of ſmall globules, at the bottom of the retort. The oil had acquired a fine red colour, had a very diſagreeable ſmell, and was become very drying. I uſed this oil in making my varniſh.

the ſmoke of ſmall wax-candles, as is done by the engravers with reſpect to copper plates, when they make uſe of aqua fortis.

When the varniſh is very dry, and its ſurface very even, the figure intended to be engraved is to be traced in it. But, the dark colour of the glaſs not ſhewing the lines, as copper does, the engraver cannot ſee what he does, unleſs he holds the glaſs up to the light. As this ſituation would neceſſarily render his work difficult and troubleſome, I have contrived a table, the upper part of which may be raiſed in form of a deſk, and conſequently make the taſk of the engraver more eaſy. In the middle of this table a pane of glaſs is fitted; upon it the engraver places the varniſhed glaſs on which the engraving is to be made. This glaſs having light thus thrown upon it, the lines made by the engraver's tool become viſible, and conſequently he can not only work with greater eaſe, but can judge of the effects his work will produce.

Artiſts alone can give to this invention the extent and perfection which it is capable of recei-

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ving. But it may not be amiſs to inform them of the precautions which are neceſſary, to prevent their loſing, in an inſtant, the fruits of a tedious and tireſome operation.

It is neceſſary, Firſt, to be well acquainted with the quality of the glaſs made uſe of. Secondly, to aſcertain the ſtrength and purity of the fluor-acid. Thirdly, to attend to the temperature of the atmoſphere.

Bohemian glaſs is not of an equal quality in all its parts; the ſubſtances of which it is compoſed have not undergone a ſufficient fuſion to be well mixed. The fluor-acid acts upon it unequally; the lines engraved upon it are rough, and have not a good appearance, except when viewed on that ſide of the glaſs which is oppoſite to the engraving. Engliſh glaſs, in the compoſition of which a great quantity of calx of lead enters, is eaſily acted upon by the acid; but the leaſt defect in the varniſh lets the acid penetrate; the calx of lead is firſt acted upon, and its ſolution gives a diſagreeable tinge to the glaſs. Plate-glaſs is the ſubſtance which the acid acts beſt upon; the ſiliceous earth is there ſo prepared by the heat it has ſuffered,

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ſuffered, that the acid meets with it in the ſtate moſt proper for its action.

That plate-glaſs which has a white reflection, not a green one, muſt be choſen. The glaſs uſed for ſmall looking-glaſſes ſeems to me to merit the preference. The lines of the engravings made upon it are equal in depth, and have no irregularities.

It is neceſſary to know the degree of purity of the acid made uſe of. I always uſe fluor-acid which has been diſtilled in a leaden retort, according to the method I have already deſcribed. That which is diſtilled in a glaſs-retort (being mixed with ſulphuric acid, and ſaturated with the ſiliceous earth of the retort) is leſs ſtrong, and leſs equal in its action.

If, when Reaumur's thermometer ſtands at ſixteen degrees in the ſhade, and the weather is clear and ſerene, a piece of plate-glaſs, varniſhed, traced, and covered with the acid, is expoſed to the ſun, the engraving is completed in five or ſix hours; this is known by a white powder, which covers the lines drawn upon the glaſs. In winter

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winter the glaſs is but ſlightly attacked in four days, and the operation would never be finiſhed if the action of the acid were not aſſiſted by a moderate and regulated heat, ſuch as that of an oven, or a ſtove. The glaſs muſt not be heated by applying heat under it, becauſe the varniſh thereby becomes ſoft, and ſcales off; the acid conſequently penetrates to all parts, and the glaſs is made rough, without any regular figure being produced.

We may engrave on glaſs either in relief or otherwiſe. If it is propoſed to engrave in relief, the varniſh which covers the ground on which the figures are traced muſt be taken off with a ſcraper; the fluor-acid muſt then be applied, and ſpread evenly with a ſmall bruſh. If the action of the acid is aſſiſted by the heat of the ſun, the glaſs ſoon becomes covered with a white pellicle; which is to be taken off, and freſh acid applied, until the ground is thought to be ſo much deepened that the figures have a ſufficient relief. When it is propoſed to take the poliſh from certain parts of glaſs, the ſame operation may be practiſed.

To

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To engrave in the common way, the glafs muft have a border of engravers wax put round it, and, in all other refpects, we muft proceed as is ufual in engraving with aqua fortis.

In order to judge of the ftate of the engraving, a corner of the glafs muft be expofed, and examined. If the operation appear to be finifhed, the acid is to be poured off, and the fame acid may fometimes be employed more than once. The glafs is to be drained, then wafhed two or three times with clean water, to take away the fuperabundant acid, and afterwards dried. The varnifh may be taken off with a coarfe cloth, dipped in fpirit of wine, and the glafs may be cleaned with chalk finely powdered.

M. Fourcroy, in his Elements of Chemiftry, fays that the fluor-acid has not been put to any ufe, but that its property of diffolving filiceous earth will render it very ufeful. I have fulfilled a part of the predictions of this able chemift, by applying this acid to engraving upon glafs. It may eafily be rendered of fervice to philofophy, by employing it for taking the polifh from plate-

glafs,

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glaſs, and from the inſtruments uſed as eudiometers; alſo for graduating thoſe inſtruments to which hitherto ſcales of box-wood, or of copper, (which are always uncertain,) have been adapted. Perhaps hereafter thick plates of glaſs may be uſed for engraving prints, maps, &c. They may be made thick enough to reſiſt the preſs, and would have the advantage of not being liable to wear; conſequently all the impreſſions would be of equal ſtrength, and the plates might be delivered to poſterity without any danger of their being deſtroyed or even damaged by ruſt.

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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XXIX.

XXXIII. *Specification of the Patent granted to Mr.* JOHN PEPPER, *of Newcastle under Line, Builder and Architect; for his Invention of a certain Kiln, for the Purpose of drying Malt, or other Grain.*

WITH TWO PLATES.

Dated June 9, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I the said John Pepper do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed,

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is deſcribed and aſcertained in the plans hereunto annexed, and the following deſcription: that is to ſay; Fig. 1 (Plate XVI) is the ground plan, ſuppoſed to be twenty feet ſquare, but, if required larger or ſmaller, by following the ſame proportion, may be made agreeable to any ſize or ſituation. The dark-ſhaded walls riſe four feet high, to put the reflector upon, over the fire, and alſo what the ſide-arches ſtand upon, the brick piers that carry the ſpark-ſtone, and bearers that the tiles lie upon. Letter A, firegrate, lies nine inches below the bottom edge of the reflector. B, bottom edge of the reflector. CCCC, brick pillars, nine inches ſquare, that carry the ſpark-ſtone. DDDDDD, brick pillars, nine inches ſquare, that carry the bearers for the floor-tiles to lie upon. E ſhews the bottom of the ſide-arches on each ſide of the kiln. F ſhews the ſpace between the fire-place and the ſide-arches, for the man to go round to clean the kiln. G, the wall on each ſide the kiln, that the ſide-arches ſtand upon.

Fig. 2. Section. G ſhews the ſection of the wall which the ſide-arches ſtand upon. H, door to go

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to the fire-place. I, the reflector of caft iron that covers the fire. K, fmall door in the reflector, to feed the fire. L L, the ears of the reflector, that the iron pipes are fitted upon, which convey the fmoke &c. from the reflector, round the kiln, to the chimney. M, what is commonly called the fpark-ftone; it prevents the kiln from being too hot in the middle, and affifts in fpreading the heat to the outfides. N, bearers of caft iron, or wood, that carry the kiln-floor. O O fhew the ends of the ribs that carry the tiles. P, the kiln-tiles that the malt lies upon. Q, the fteam-pipe that conveys the fteam from the malt. C C, brick pillars, nine inches fquare, that carry the fpark-ftone. D D, brick pillars, nine inches fquare, that carry the bearers for the floor-tiles to lie upon. E E fhew the arches on each fide the kiln. U U fhew the fituation of the pipes under the floor.

Fig. 3. (Plate XVII.) Plan of the kiln-floor, fhews the ribs that the kiln-tiles lie upon. O O the caft iron or wood-ribs that the tiles lie upon. N N, the bearers that carry the ribs. D D fhew the

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tops of the brick pillars that carry the bearers, &c. B, the reflector that covers the fire, of caſt iron, about an inch thick, hollow, and on a ſemicircular plan, as ſhewn in the drawings. R R, the iron pipes that convey the ſmoke and heat from the reflector, round the kiln, to the chimney, which lies about three feet under the kiln-floor, and about the ſame diſtance from the ſide-walls, which are ſupported by iron ſtays from the ſide-arches. S S ſhew the ends of the iron pipes that go into the chimney. T T, regiſters to regulate the draught and heat.

N. B. The pillars, bearers, &c. that belong to the ſame thing, are marked with the ſame letters in all the figures. In witneſs whereof, &c.

XXXIV.

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Fig. 1 Ground Plan.

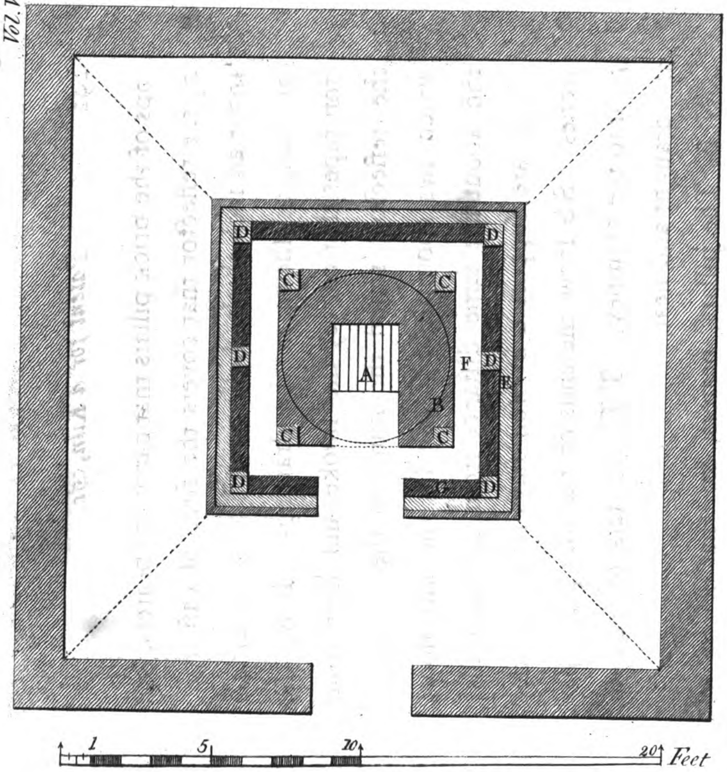
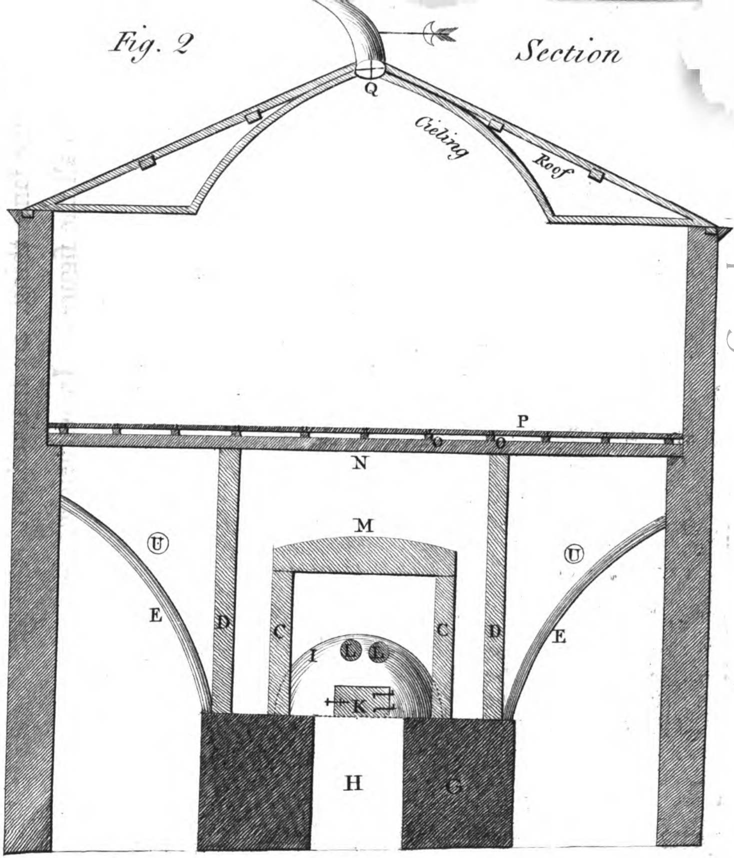


Fig. 2 Section



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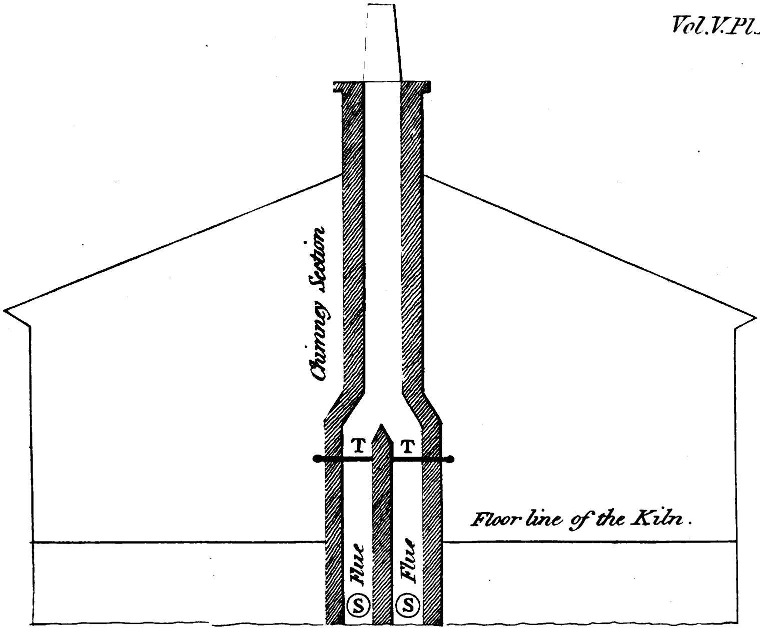

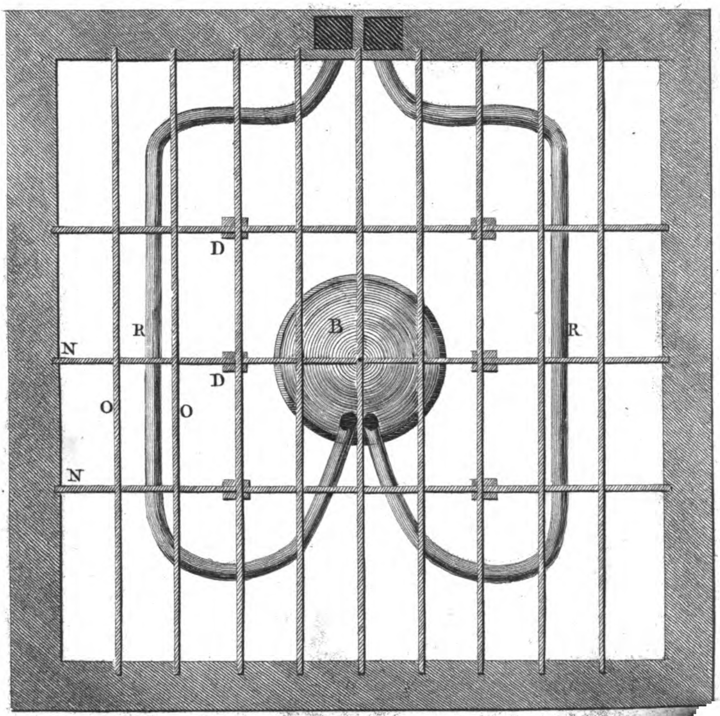

Fig. 3. Plan of the Kiln Floor.

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XXXIV. *Specification of the Patent granted to* Samuel Bentham, *of Dover-ſtreet, in the County of Middleſex, Eſq.; for his Invention of a new Method of planing Wood.*

Dated Nov. 26, 1791.

To all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid Samuel Bentham do hereby declare, that my ſaid invention is deſcribed in manner following: that is to ſay; the eſſence of the preſent invention, reſpecting the planing of wood, conſiſts in the having diveſted that operation of the quantity of ſkill and attention at preſent neceſſary, in ſuch ſort that brute force may be employed in it; by brute force I mean not only the ſtrength of animals, but the force of inanimate agents, ſuch as wind, water, ſteam, &c. and even that of men, when employed in ſuch a way as requires nothing of ſkill or dexterity on the part of the

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the perſon who exerts it; by this means, machinery may take place of human ſkill in this operation, to as perfect a degree as in any of the manufactures on which invention has been employed, ſo much to the honour and advantage of this country. Hence ariſe three capital advantages: Firſt; the quantity of force employed, and thence the quantity of work done at a time, may be increaſed at pleaſure. Secondly; even the force of men may be exerted in this way to a greater advantage than while confined, as in the preſent practice, to a particular mode, by the neceſſity of care and dexterity. Thirdly; the labour not only of the aukward and unpractiſed, but of the blind and the lame, may be called in, and a value given to it, little if at all ſhort of what that of the moſt ſkilful and experienced artiſt bears at preſent. The invention, as thus ſtated, is, properly ſpeaking, the invention not of a mode but of a principle; the modes in which that principle may be employed, and the ſpecies of work to the performance of which it may be applied in different circumſtances, with different degrees of advantage, are innumerable. To fulfil the conditions

preſcribed

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prefcribed by law, the beft and indeed only courfe I can purfue is, therefore, to give fuch a general, and in a manner exhauftive view of the extent of the principle, of the manner of applying it, and of the forts of work to which it may be applied, as to enable the public at large, upon the expiration of my term, to reap the benefit of the invention in its fulleft extent, by fuch directions and inftructions of a general nature, as, in each of the many different forts of work in which it may be employed, may put an intelligent workman in the way of making ufe of the principle to the moft advantage. Drawings are not given, as they would tend rather to confine the direction to a particular mode; whereas words may ferve to convey the inftructions in the moft general way, and with a latitude that will adapt itfelf to whatever variety of circumftances may prefent themfelves, and the better enable the artift to purfue the invention through all its branches. In the common mode of planing a ftraight board, for example, the workman, befides exerting the force neceffary to move the inftrument along, and overcome the refiftance he finds oppofed to him, has a num-

a number of other points to attend to. Firſt; he has to adjuſt his tool to the board in a proper manner for beginning the ſtroke. Secondly; he has to employ exertion to keep the inſtrument down, ſo as to prevent its paſſing over without cutting. Thirdly; he has exertion to employ again to raiſe it upon its return, in order to ſave the cutting edge from being injured. Fourthly; he has to guide it ſideways, to prevent its ſlipping off. Fifthly; as the board is broader than his plane, he has to examine from time to time if the middle of the board correſponds with the edges, and to take as much care not to cut away too much from ſuch parts, as to cut away enough from others. Sixthly; in many caſes, having had to mark it at the edges, he has from time to time to obſerve theſe marks, and to take care that his ſtrokes conform to them. Upon my principle, all theſe points are accompliſhed by machinery, in manner following: to begin with the ſimpleſt caſe, *viz.* when the board to be planed is already of the form required, and nothing more is wanted than that degree of ſmoothing which a plane will give, when drawn over the board with the ſole

reſting

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reſting thereon. Here the board may be laid on the bench in the uſual way, but the plane for this purpoſe muſt be made in the firſt place as broad, at leaſt, as the board, and muſt be capable of cutting the whole breadth of the board at once. Secondly; the ſides of the plane, which I call the cheeks, and which are neceſſarily of a ſubſtance ſufficient for the ſtrength of the plane, may extend below the ſole ſufficiently to ſerve as guides to the plane, on each ſide, in its courſe along the board, and ſhould cover ſo much of the breadth of the iron, if there be any, as does not cut; ſo that ſhavings may be taken from cheek to cheek, in ſuch manner as not to be impeded by their breadth in their paſſage out of the mouth. For making the ſtroke, the plane may be kept down by its own weight, or by being loaded as required; the force neceſſary for this purpoſe being greater or leſs, according to the breadth of the board and other circumſtances; but, though mere weight may ſerve to inſure the continuation of its cutting, when once it has been properly applied, yet, for guiding it upon the firſt application to the end of the board, at the commencement of the

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ſtroke, and upon the quitting the board, at the concluſion of the ſtroke, particular precautions or contrivances are neceſſary. The bench, it is evident, muſt be at each end as much longer than the board as to afford a reſting place for the plane, at which places it will reſt upon its cheeks. From this ſituation it will have to riſe at the commencement of the ſtroke, for the ſole to mount upon the board, and it will fall down again, in the ſame manner, upon theſe cheeks, at the concluſion of the ſtroke; the nearer therefore the depth of theſe cheeks is to the thickneſs of the board, the leſs the plane will have to riſe and fall. But, as there muſt always be ſome difference between the two levels, or the iron would not take hold, the ſole of the plane at each end muſt be rounded off, or ſloped up, to enable it to ſlide on and off the board. But this would not do without ſome farther contrivance; whatever were the preſſure employed for keeping the plane to its work, during the continuance of the ſtroke, that ſame degree of preſſure would not do at the commencement or concluſion of it. At the commencement, the fore end muſt be preſſed down hardeſt, that in

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in rising it may be made to assume the direction in which it is to cut; so, at the conclusion of the stroke, the pressure must be augmented at the hinder end, lest, by the dropping or tilting down of the fore end, the iron should be raised from the board before it had reached the end of it. This variation in the pressure may be insured by a weight resting upon the plane, but made capable of traversing from end to end, and shaped in such a manner as not to disturb the passage of the shavings. An obstacle connected with the bench, in such manner as for the movable weight to be carried against it by the plane, while the plane itself passes clear of it, will, by causing the weight to slide accordingly, secure the preponderancy of the part required at each of these points. While the plane is off the board, fillets or battens may guide it, or secure it from lateral deviation. If the board being finished at one stroke is thereupon removed, the plane may be thereupon drawn back without obstacle or difficulty; but, if a fresh stroke is to be given, a contrivance is necessary to save the cutting edge from being injured in dragging back on the board; for this purpose, the

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ſole of the plane muſt be lifted up, ſo as to be clear of the board, and the plane in its paſſage back muſt find ſome other ſupport. Amongſt the variety of means, by any of which this effect may be produced, as ſimple a one perhaps as any is as follows. From the upper ſurface of the plane project a bar of wood, or metal, anſwering the purpoſe of a handle, to which the moving force is to be applied; let this handle be connected with the plane, by a pin paſſing through it in a direction tranſverſe to the plane, ſo as to form an axis round which the handle may play, in the manner of a lever, for a ſmall determinate diſtance, in a direction parallel to the length of the plane. The upper (which it may be convenient to make the longer) end of this handle being ſhaped in the manner the moſt convenient for its connection with the moving power; the lower end is forked, or otherwiſe adapted to receive one or more rollers, which, when the handle is erect, extend before the ſole of the plane, and thereby clear it of the wood. In this way, when the moving force draws the plane forward, the handle, by the play it was allowed to have round its axis,

is

is made to incline forward, whereby the rollers attached to it are raiſed, in ſuch manner as to leave the ſole of the plane free to drop down upon the work: as ſoon as the moving force acts upon the handle, in a manner to draw the plane back again, it becomes erect, and the rollers are thereby preſſed down below the ſole of the plane, ſo as to receive the weight of it during its return, leaving the ſole and the iron clear of the work. It is true, if there be but one handle of this ſort, then, according as the rollers are nearer to the one or the other end of the plane, the oppoſite end will ſtill bear a part of the weight; but the edge of the ſole being of courſe ſmooth, and rounded off, this ſlight bearing will not be productive of any inconvenience; and, if you fix another roller at this end, juſt even with the ſole, this ſecond roller will take off ſo much of the weight as was left by the firſt. Theſe rollers will of courſe be ſo contrived and diſpoſed as not to damage the work, eſpecially where it is of any of the nicer kinds hereinafter ſpoken of. So much for the moſt ſimple caſe, but in others farther contrivances will be neceſſary. The accuracy of planing depends, even

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even in the preſent mode, in ſome meaſure upon the bench: in this new mode, an attention to the conſtruction of that implement is particularly eſſential. For the caſe when the board winds, ſo as to afford no ſurface on which it would lie firm on an ordinary bench, a compound bench may be employed, conſiſting of a middle part and two ſides; the middle part ſerves for the ſupport of the board or piece to be planed, and is capable of being lowered or raiſed at pleaſure; the ſides are made to ſeparate and cloſe horizontally, ſo as to receive between them, and keep ſteady, a piece of any breadth. For this purpoſe they are furniſhed with one or more rows of flat teeth, which, without being long enough to damage the board, are numerous enough (in conjunction with a common ſtop or bench hook) to keep it to its poſition, in ſpite of the weight of the plane, and the tendency which the action of the ſtroke will ſometimes have to draw the plane and board together. The piece being thus fixed, with ſuch part as you think proper to cut off projecting above the ſides of the bench, the plane, being ſet to work, will cut away till its cheeks come down ſo as to touch

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these bench ſides; which, being out of winding, in reſpect of each other, will inſure the ſame regularity to the ſurface of the piece between them. When one ſurface has been thus planed out of winding, ſo as to lie flat on the bench, the piece may be planed to a parallel thickneſs on an ordinary bench, *viz.* by only making the cheeks of the plane to riſe and fall, and adjuſting them to the thickneſs which is to be taken off. But here it is neceſſary to obſerve, that in planing of boards not very thick, even after the plane-iron has been ſtopped by the cheeks from getting down to this board, the board may at one part of it ſpring up to the iron; and the iron, having thus once got hold of it, may not part with it until it has reduced it below the intended thickneſs to which the cheeks were adapted. To obviate this accident, recourſe muſt be had in ſuch a caſe to the ſort of compound or compreſſing bench above mentioned; and, in caſe of very thin boards, where, though you keep down the edges in manner above mentioned, the middle may notwithſtanding be apt to riſe, there may be heavy rollers, or rollers loaded with weights, let through the ſides of the plane, as near the iron as may be,

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and on one or both ſides of it. In this manner, without any great additional conſumption of moving force, the board, however thin, may be effectually kept down flat upon the bench. When the two ſides of a board are brought into parallelism, as before, in order to bring either of the edges to a ſquare with them, all you have to do is to ſteady it by compreſſion between the ſides of the bench, as in the former caſe, leaving as much above them as you ſee occaſion to cut away; only here, as the ſides of the boards are finiſhed, to ſave them from being indented, you muſt give the teeth of the bench ſides ſome thing by way of a ſheath to bite upon; and one edge of the board, being thus ſquared and ſmoothed, will as before ſerve as a baſis, which, by reſting on the middle part of the bench, will inſure paralleliſm to the oppoſite edge. The ſame ſort of bench affords an eaſy means of tapering the piece to any degree of taper, and that as well lengthways as croſſways, in the manner of weather-boarding. Raiſe one end of the middle part of the bench, you taper the piece at that end: raiſe one of the ſides of the bench, you taper the piece at that ſide: having raiſed the mid-

dle

dle part of the bench at one end, raiſe the two ſides to any one and the ſame angle, but one of them higher than the other, you may thus taper the board in both ways at once. So, inſtead of letting the plane bring itſelf down, as it works, to the piece to be planed, *viz.* by riſing leſs and leſs after each ſhaving has been taken off, you may make the piece bring itſelf to the plane. To do this, raiſe the middle part of the bench on which the piece reſts, leaving the poſition of the ſides unaltered. But, where the ſides are employed to keep the piece faſt, as in the caſe of thin ſtuff before mentioned, falſe ſides without them muſt be added, for the plane to run upon; which falſe ſides remain fixed, while all the reſt of the bench is raiſed up: or, what will be eaſier, letting the reſt of the bench remain fixed, lower theſe falſe ſides. This manner of working will admit of the plane's being perfectly confined in all directions, except that of the horizontal or other line, in which it is worked in ſuch manner that all the above mentioned contrivances for ſetting and keeping the plane to its work, and ſaving the edge from injury, are ſuperſeded. A yet remaining way

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of producing the ſame effect is, by making the plane ſo as to drop, after each ſhaving, between its cheeks. Any of theſe parallel riſings and droppings may be effected by two or more ſcrews, ſo connected as to be all turned at once. By a proper configuration of the bench, the ſurface of the work may be made to receive curved forms, and thoſe of a very complex nature. In a tranſverſe direction, ſuch forms are already given to the work in the ordinary way of planing; for inſtance, by moulding-planes. In longitudinal direction alſo, the work may now be curved, by giving a correſpondent curvature to the bench ſides; and, by a combination of theſe two ſources of curvature, it is eaſy to ſee that curves of a very complex and ſeemingly irregular nature may be produced. By means of a double motion, another more complicated, but perhaps for ſome caſes an uſeful plane may be made, very much extended in breadth, and of different curvatures at different parts of that breadth; and this, by being made to move tranſverſely, at the ſame time that it is drawn along longitudinally, may preſent to different parts of the work different curvatures at dif-

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ferent periods of its courſe. Barrel-ſtaves, blades of oars, and ſeveral other articles may be worked, and perhaps with advantage, in this manner. So much with regard to the planing a ſingle ſurface at a time; but, where your board or other piece is of ſubſtance enough to admit of your confining it in ſuch manner as to come at more than one ſurface, you may eaſily connect planes together, or compound your plane, ſo as for it to apply itſelf to either or both edges at the ſame time, as to one ſide. In the caſe of a ſingle edge, one means of confining to its work the plane belonging to that edge is, by giving to the plane-iron of the plane belonging to the ſide a diagonal direction, as is ſometimes done in rabbet-planes; or you may confine the plane at the edge, or a plane at each edge, by ſprings or guides. In this manner, edges of boards may receive any moulding, or be rabbetted, or tongued and grooved, at the ſame time that the ſide is planed. Hitherto I have ſpoken only of taking a ſingle ſhaving at a time from each ſurface, though it be the whole breadth of the piece; but irons may be ſo diſpoſed in the plane, one behind and lower than another, as to take off as many ſhavings in thickneſs as you

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pleafe; and, the piece being fixed, and the laft and lowermoft iron adjufted to the cheeks of the plane at the proper height, to carry off the whole thicknefs required, and fo finifh the planing. In this way, if before the laft iron you have provided irons enough to take off the thicknefs, the plane, if it has completed its courfe, cannot but have done its bufinefs. In this manner, fo you apply force enough, you may perform almoft any planing-work at one ftroke, though it embrace feveral furfaces at once. You may difpofe irons enough, one after the other, to cut the piece through; and, if you make them narrow enough, flitting or plowing may, in this manner, take the place of fawing. But here it is evident that the difficulty of attaining fufficient accuracy will increafe with the depth; the thinner too the irons, that is the narrower the flit, the weaker they will be, and the more liable to bend or break: the thicker the irons, the greater will be the refiftance to be overcome, and the greater the wafte of wood, which, in fome inftances, may be a material object. Minute inftructions and dimenfions cannot here be given, fince thefe muft

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be adapted to the nature of the wood. The above inconveniences may be obviated, in ſome degree, by applying a ſlitting-plane of this ſort to each of the two oppoſite ſides, ſo as for the two planes to meet in the middle at the concluſion of the ſtroke; by which means each will have but half the depth to cut which a ſingle one would have; but, in making of ſuch many-ironed planes, a great deal of accuracy is neceſſary, and if any one of the irons is damaged, or choaks, the operation fails. A better way may be, to employ a number of ſeparate planes, connected ſo as to follow one another, but ſo that each may be preſſed down to the work ſeparately, by its own weight, or otherwiſe: in this way, though choaking were to take place, the bad effect of it may be avoided; for, if any one of ſuch a chain of planes gets choaked, it will only riſe, and paſs over without effect. A depth of ſhaving, correſpondent to this choaked plane, will indeed fail of having been taken, and a correſpondent failure will of courſe take place in the whole depth carried away, in compariſon of what was intended to be carried away, ſo that ſo much of the work will remain undone, requiring a freſh ſtroke; but againſt this inconvenience ſufficient ſecurity may

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may be provided, by only adding a few ſupernumerary planes, over and above the number which, in the event of their not any of them choaking, would be ſufficient; in this caſe, if none of the planes which come before the ſupernumerary ones choak, the ſupernumerary ones will paſs over without effect. As to the mode of connection between the links of ſuch a chain of planes, as ſimple a one as any may be by an oblong frame, the ſides of it furniſhed with perpendicular ſlits, to receive pins projecting from the ſides of each of the planes; the length of the ſlit ſufficient to leave the pins at liberty to play up and down, at the extent of the whole thickneſs which the whole chain of planes is intended to plane away. In the thickneſs of ſhaving which theſe different planes are ſet to take off, there may be ſome difference; the foremoſt ones being ſet the rankeſt, for the ſake of riddance; the hinder ones the leſs rank, for the ſake of ſmoothneſs; but each of them prevented by its cheeks from cutting below the total depth intended. To ſave the length of plane otherwiſe neceſſary to take off the whole thickneſs at a time, the whole breadth of a board may

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be planed into grooves and ridges, and those ridges immediately taken off in the following manner: divide the breadth of your plane-iron into teeth, say about one eighth of an inch wide, with intervals equal in width to the width of the teeth; this makes a set of channels of that width, with ridges between them of equal width. To bring these channels to the depth required, say a quarter of an inch, I put four such irons, one behind and below the other, each taking a shaving off a sixteenth of an inch. To cut away the intermediate ridges behind the last of these toothed irons, I use a set of square pins, running in and reaching to the bottom of these channels; a pin following each tooth, and the whole of them fitted into an iron frame, placed underneath the sole of the plane. Each pin at its base, where it runs along the bottom of the channel, is terminated in, and stands as it were on, a horizontal cutter or tooth, shaped like the blade of a bricklayer's trowel, being broader than the channel by a full sixteenth of an inch on each side. Each of these trowels cuts through half of the adjacent ridge on each side; so that, between the trowel on the left hand

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hand of it, and that on the right hand, each ridge is cut away, as it were, at its root. This ſort of plane, however, can hardly be made to ſuch nicety, but that a ſhaving or two of an ordinary plane-iron will be neceſſary to ſmooth the work. The uſe of this ſort of plane is moſt conſpicuous in the caſe of croſs-grained wood, to which it would otherwiſe be neceſſary to uſe double irons; becauſe double irons, taking ſo much thinner ſhavings than ſingle irons, muſt be in proportionably greater number to do the buſineſs: a number which, where the thickneſs to be taken away is conſiderable, may be ſo great as to render the length of the plane not only expenſive, but cumberſome and inconvenient. Hitherto I have conſidered the plane alone as moving, the piece of wood to be planed remaining fixed; but planing may equally be performed by moving the piece, the plane remaining fixed; or even were both to move. The expedient of making the piece move, while the plane is fixed, may, beſides being applicable in caſes where the piece is very ſmall or ſhort, be particularly uſeful where the plane is ſo conſtructed as to embrace the piece on

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all ſides, whether it have cutters on all ſides or not. In this mode, which ſeems to bear reſemblance to wire-drawing in metal, ſeveral ſorts of work, ſuch as the planing of tree-nails for ſhips, the fluting of pillars, and the forming of rails and baluſters, might be performed, and perhaps to ſome advantage; but there are other configurations given to wood, in the inſtance of which the plane is at preſent either not uſed at all, or uſed in ſuch a way as to perform the buſineſs but imperfectly, in ſpite of all the ſkill and dexterity which can be applied to it. Tenons are ſometimes, for example, planed; mortiſes are not, but are made in a manner in which accuracy depends altogether upon ſkill and dexterity. Both theſe, as alſo all other forms which wood is made to receive for the purpoſe of junction and connexion, may be produced, in this way of planing, upon this ſame principle. As to tenons, at the end of a bench let a plane with cheeks, but no wood before the cutting iron, be ſo diſpoſed as to move in a channel longitudinally ſtraight, and lying flat on the bench, the depth of the cheeks determining the height at which it moves; then, if any

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ſtraight piece to which a tenon is to be formed at the end, (a door-rail for example,) be confined ſtraight and flat on the bench, the depth of the ſhoulder being already cut by a ſaw or other tool, ſuch a plane may be made to cut off, ſhaving after ſhaving, the whole depth of the ſhoulder quite home to the ſawkerf. When the tenon is thus worked down to the proper depth on one ſide, the other may be turned, and treated in the ſame manner. If the tenon were already roughed out by ſawing, or otherwiſe, ſo as not to require more than one ſtroke of the plane, no riſing or lowering of either plane or piece would be neceſſary at each ſhaving. By putting two cutters, the one for the upper the other for the lower ſide, and, if wanted, one for each edge, the whole tenon may be finiſhed at a ſtroke; and, by an alteration in the breadth of, and diſtances between, theſe cutters, tenons of different ſizes may be finiſhed. It is ſcarce neceſſary to obſerve that, againſt croſs-grained wood, double irons, and other precautions againſt the tearing up of the grain, may be employed here, as in other caſes. Neither, in caſes where the extent of the motion required is thus ſhort,

ſhort, is it neceſſary that there ſhould be cheeks running upon the bench, if the ſtock, or part uſually made of wood, be made to move in the required direction, by being confined within a piece projecting upwards from the end of the bench to the ſame ſtock. Inſtead of theſe cutters, which are calculated to embrace the outſide of tenons, other irons may be adapted proper to finiſh the inſide of mortices, and that either at all the ſides, or at any leſs number of the ſides at a time. For this purpoſe, the greater part of the wood muſt already have been got out of the mortiſe, either by boring, for inſtance, or otherwiſe. The piece in which the mortiſe is to be cut will be laid horizontally acroſs the bench, confined by proper ſtops to receive in the requiſite parts the action of the tool. The cutting out ſcores and dovetails may of courſe be performed in the ſame manner; the former being only a ſpecies of right-angled, the other of acute-angled mortiſe, each wanting one of the four ſides. To theſe operations I give the name of planing, as well as to any of the above; the cutting-inſtrument being employed and governed by guides, as well in reſpect

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of the depth to which it is ſet to cut, as in point of direction. With reſpect to the choice of the moving power for all theſe ſeveral operations, and the manner of applying it, nothing need here be ſaid. The choice between wind, water, ſteam, animal ſtrength, and ſo forth, is a conſideration of œconomy, depending on particular circumſtances. In the production of the alternate motion, like that of ordinary planing, if the ſtrength of man is employed in what I have termed a brute way, it may be aſſiſted by declivity, or by adventitious weight; by a man's having to puſh down hill as he makes the ſtroke, and conſequently draw up hill as the plane is brought back free; or by drawing up over a pulley, on the return of the plane, a weight which, being faſtened to the plane, aſſiſts him as it works; or farther force may be produced by a man or men drawing, in any manner, a rope faſtened to the plane, for inſtance, winding it over a barrel by a winch. Having ſhewn that channels in the bench may be made to guide the plane, and that planes ſo guided will do the work, the determining the plane to move along the guides, whatever be the direction

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direction of them, is a business within the competency of any intelligent mechanic, who I think cannot now be much at a loss for means of executing the details of any of the species of work above mentioned. In point of œconomy, how far machines thus complicated may, in particular instances, and under particular circumstances, give an advantage in comparison of each other, or of the present mode of working by hand, is a matter of calculation foreign to the present purpose. In witness whereof, &c.

XXXV.

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XXXV. *Specification of the Patent granted to* William Murray, *Esq.* *(commonly called Lord William Murray;) for his Invention and Discovery of extracting Starch from Horse-Chesnuts, by a new and simple Method, at present unknown to any one but himself.*

Dated March 8, 1796.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said William Murray, Esq. (commonly called Lord William Murray,) do hereby particularly describe the nature of my said invention, and how it is to be performed, which is in manner following: that is to say; I first take the horse-chesnuts out of the outward green prickly husks, and then, either by hand, with a knife or other tool, or else with a mill adapted for that purpose, I very carefully pare off the brown rind; being particular not to leave the smallest speck, and to intirely eradicate the sprout or

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or growth. I next take the nuts, and raſp, grate, or grind them fine into water, either by hand, or by a mill adapted for that purpoſe. The pulp, which is thereby formed in this water, I waſh as clean as poſſible, through a coarſe horſe-hair ſieve; this I again waſh through a finer ſieve, and then again through a ſtill finer, conſtantly adding clean water, to prevent any ſtarch adhering to the pulp. The laſt proceſs is, to put it with a large quantity of water (about four gallons to a pound of ſtarch) through a fine gauze, muſlin, or lawn, ſo as intirely to clear it of all bran, or other impurities. As ſoon as it ſettles, pour off the water; then mix it up with clean water, repeating this operation till it no longer imparts any green, yellow, or other colour to the water. Then drain it off till nearly dry, and ſet it to bake, either in the uſual mode of baking ſtarch, or elſe ſpread out before a briſk fire; being very attentive to ſtir it frequently, to prevent its horning; that is to ſay, turning to a paſte or jelly, which, on being dried, turns hard like horn. The whole proceſs ſhould be conducted as quickly as poſſible. In witneſs whereof, &c.

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XXXVI. *Specification of the Patent granted to Mr.* ALEXANDER MABYN BAYLEY, *of the Parish of St. Martin in the Fields, Middlesex; for his Invention of a Machine for making fresh Water from Sea-Water, or from Brine-Springs, without boiling; and for making Salt from Sea Water, or from Brine-Springs, with much less boiling than in the common Way.*

Dated July 9, 1777.—Term expired.

TO all to whom these presents shall come, &c. Now KNOW YE that, in compliance with the said proviso, I the said Alexander Mabyn Bayley do hereby declare, that my said invention of a machine for making fresh water from sea-water, or brine-springs, without boiling, which will be pure element, without any spirit of salt, bitumen, or heterogenous matter, and for making salt from sea-water, or from brine-springs, upon a new and particular construction, is to be performed in manner following: to wit; this machine consists of five parts, *viz.* First; a large pair of bellows

bellows on a ſtrong frame. Secondly; an iron ſtove with a tube or pipe, which conveys the air from the bellows through the fire, into a dodecagon frame or barrel. Thirdly; an iron pan with a groove or channel on its upper edge, to receive the cover or condenſer, and with a pipe at the bottom of it, to draw off the ſalt-water when needful. Fourthly; the dodecagon frame or barrel, covered with flannel, or coarſe canvas, which revolves on two concave cylinders; the one to convey the hot air from the ſtove into the dodecagon frame or barrel, the other to let out the air occaſionally. Fifthly; the cover or condenſer with a groove or channel on its inſide, to convey off the freſh water; on its outſide is a pipe which communicates to the groove or channel aforeſaid; the upper part of it has a conic roof, and is a reſervoir of ſalt-water to ſupply the pan when wanted. This machine may be worked by hand, horſe, wind, or water. In witneſs whereof, &c.

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XXXVII. *Description of a Loom on a new Construction, for weaving slight Silks. By Mr.* Samuel Sholl, *of New Turville-street, Bethnal Green.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The Silver Medal and Thirty Guineas were given to Mr. Sholl for this Invention.

HAVING been employed more than twelve years past in the weaving of silk, I have had occasion to observe several considerable inconveniences to which this manufacture is subject. To the removal of these, my attention has been for a long while directed; and I have at length succeeded in the construction of a model, which is entirely new, the utility of which I now beg leave humbly to submit to the critical examination

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tion of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The ſeveral advantages of this invention are as follow:

1. It is not liable to unſquare; and yet, on any neceſſary occaſion, it may be more eaſily removed than the old loom.

2. In the conſtruction of it, more than thirty feet of wood are ſaved.

3. It is much ſooner removed, in caſe of fire, or any other ſudden occurrence.

4. It has a very great advantage, with reſpect to admitting light to the workmen.

5. In caſe of removal, it may be carried up ſome ſtairs which the old loom cannot paſs.

6. If room ſhould be wanted for any temporary purpoſe, the work may be laid aſide without injury.

7. It may ſet up in ſloping garrets, which will not admit of the old loom.

8. As the cane-roll poſts are fixed to the floor by ſcrews, the porry may be made of any length, by only ſcrewing the cane-roll poſts nearer or farther from the breaſt-roll.

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9. The gibbet is formed in the loom; and therefore the trouble of fixing it is prevented.

10. There is an advantage in the bridge of the battons, which was formerly nailed to the block; but in this loom iron pins are put in the block, and partly go through the bridge, fastened with glue, so that the silk cannot be injured, as used often to be the case.

11. The battons rise as the work rises, and keep more true.

12. The manner of fitting to the work obviates inconveniences, and prevents the injury attending the workmen in old looms.

13. As some landlords do not care to let their houses to weavers, on account of their breaking the walls, that inconvenience is also removed.

In order to render this improvement the more acceptable, it is so contrived as to preserve in use the most valuable part of the old materials, such as rolls, battons, counter-meshes, &c.

With a model less perfect than that I now offer, I have ascertained, by near two years experience, and on one of the nicest works in the trade,

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trade, the advantages above recited; and to my employers I have given great ſatisfaction.

Explanation of the Figure.

(See Plate XVIII.)

A A. The ſills.
B B. The breaſt-roll poſts.
C. The cut-tree.
D D. The uprights.
E. The burdown.
F F. The battons.
G. The reeds.
H. The harneſs.
I. The breaſt-roll.
K. The cheeſe.
L. The gibbet.
M. The treadles.
N. The tumblers.
O. Short counter-meſhes.
P. Long counter-meſhes.
Q. The porry.
R R. The cane-roll poſts.
S. The cane-roll.

T. The

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T. The weight-bar and weight.

U U. Counter-weights.

W. The breaking rod.

X X. Crofs rods.

In the introduction to the foregoing defcription it is faid, that it appears, from the evidence of feveral gentlemen converfant in the branch of filk-weaving to which this loom is particularly adapted, that the advantages of this conftruction are; the gaining light; a power of fhortening the porry occafionally, fo as to fuit any kind of work; being more portable, and having the gibbet firmly fixed; alfo a diminution of price, which, compared with the old loom, is as five pounds (the price of a loom on the old conftruction) to three pounds ten fhillings, (the price of one of thofe contrived by Mr. Sholl;) and that, as the proportion of light work is, to ftrong work, as nine to one, this fort of loom promifes to be of very confiderable advantage, particularly in making modes, or other black work.

XXXVIII.

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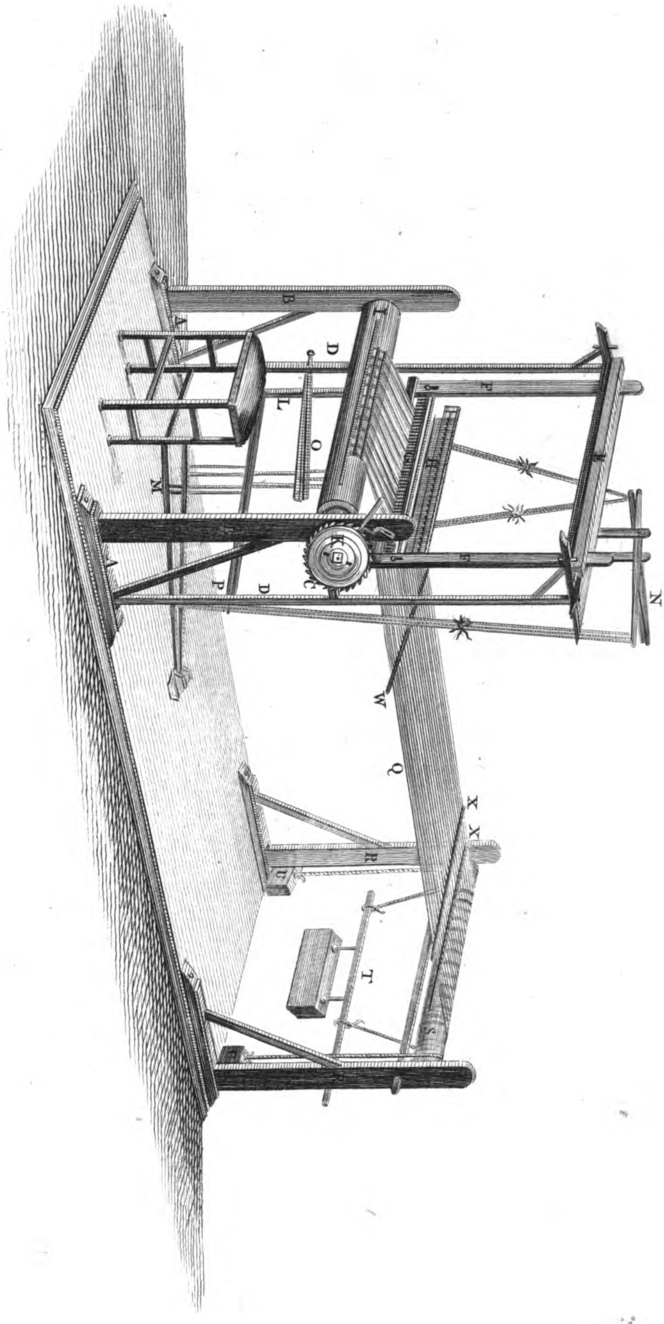

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XXXVIII. *On welding Cast Steel. By Sir* Thomas Frankland, *Bart. F. R. S.*

From the Transactions of the Royal Society of London.

THE uniting of ſteel to iron by welding is a well-known practice; in ſome caſes for the purpoſe of ſaving ſteel, in others to render work leſs liable to break, by giving the ſteel a back, or ſupport, of a tougher material.

Ever ſince the invention of *caſt ſteel,* (or bar ſteel refined by fuſion,) it has generally been ſuppoſed impoſſible to weld it, either to common ſteel, or iron; and naturally, for the deſcription in Watſon's Chemical Eſſays (vol. IV. p. 148) is juſt, that in a welding heat it "runs away under the "hammer like ſand." How far the Sheffield artiſts, who ſtamp much low-priced work with the title

title of caſt ſteel, practiſe the welding it, I am ignorant; but, though I have inquired of many ſmiths and cutlers in different parts of the kingdom, I have not yet found the workman who profeſſed himſelf able to accompliſh it. If, therefore, I ſhould deſcribe a ſimple proceſs for the purpoſe, I may be of uſe to the very many who are incredulous on the ſubject.

If any one has made the diſcovery on principle, he has reaſoned thus: caſt ſteel in a welding heat is too ſoft to bear being hammered, but is there no lower degree of heat in which it may be ſoft enough to unite with iron, yet without hazard of running under the hammer? a few experiments decided the queſtion; for the fact is, that caſt ſteel in a *white heat*, and iron in a *welding heat*, unite completely.

It muſt not be denied that conſiderable nicety is required in giving a proper heat to the ſteel; for, on applying it to the iron, it receives an increaſe of heat, and will ſometimes run on that increaſe, though it would have borne the hammer in that ſtate in which it was taken from the fire.

I need

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I need ſcarcely obſerve, that when this proceſs is intended, the ſteel and iron muſt be heated ſeparately, and the union of the parts propoſed to be joined effected at a ſingle heat. In caſe of a conſiderable length of work being required, a ſuitable thickneſs muſt be united, and afterwards drawn out, as is practiſed in forging reap-hooks, &c.

The ſteels, on which my experiments have been made, are Walker's of Rotherham, and Huntſman's, between which I can diſcover no difference; and, though there may be ſome trifling variation in the flux uſed for melting, they are probably the ſame in eſſentials.

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XXXIX. *Continuation of Mr.* KIRWAN's *Experiments on the alkaline Substances used in bleaching, &c.*

(FROM P. 270.)

SECTION IV.

TO discover whether any quantity of fixed alkali worth attention exists in any saline compound, dissolve one ounce of it in boiling water, and into this solution let fall a drop of a solution of corrosive sublimate; this will be converted into a brick-colour, if an alkali be present; or into a brick-colour mixed with yellow, if the substance tried contains lime.

But the substances used by bleachers being always impregnated with an alkali, the above trial is in general superfluous, except for the purpose of detecting lime. The quantity of alkali is therefore what they should chiefly be solicitous to determine, and for this purpose;

First,

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First. Procure a quantity of alum, suppose one pound, reduce it to powder, wash it with cold water, then put it into a tea-pot, and pour on it three or four times its weight of boiling water.

Secondly. Weigh an ounce of the ash or alkaline substance to be tried, powder it, and put it into a Florence flask, with one pound of pure water, (common water, boiled for a quarter of an hour, and afterwards filtered through paper, will answer,) if the substance to be examined be of the nature of barilha, or pot-ash; or half a pound of water, if it contain but little earthy matter, as pearl-ash. Let them boil for a quarter of an hour; when cool, let the solution be filtered into another Florence flask.

Thirdly. This being done, gradually pour the solution of alum, hot, into the alkaline solution, also heated; a precipitation will immediately appear; shake them well together, and let the effervescence, if any, cease before more of the aluminous solution be added. Continue the addition of the alum until the mixed liquor, when clear, turns syrup of violets, or paper tinged blue by radishes, or by litmus, red; then pour the

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liquor and precipitate on a paper filter placed in a glaſs funnel; the precipitated earth will remain on the filter. Pour on this a pound, or more, of hot water gradually until it paſſes taſteleſs; take up the filter, and let the earth dry in it, until it ſeparates eaſily. Then put the earth into a cup of Staffordſhire ware, place it on hot ſand, and dry the earth until it ceaſes to ſtick to glaſs, or iron; then pound it, and reduce it to powder, in the cup, with a glaſs peſtle, and keep it a quarter of an hour in a heat of from 470° to 500°.

Fourthly. The earth being thus dried, throw it into a Florence flaſk, and weigh it; then put about one ounce of ſpirit of ſalt into another flaſk, and place this in the ſame ſcale as the earth, and counterbalance both in the oppoſite ſcale. This being done, pour the ſpirit of ſalt gradually into the flaſk that contains the earth, and, when all effervеſcence is over, (if there be any,) blow into the flaſk, and obſerve what weight muſt be added to the ſcale containing the flaſks to reſtore the equilibrium. Subtract this weight from that of the earth; the remainder is a weight exactly *proportioned* to the weight of mere alkali, of that particular

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ticular ſpecies which is contained in one ounce of the ſubſtance examined; all beſides is ſuperfluous matter.

I have ſaid that alkalies of the *ſame ſpecies* may thus be directly compared, becauſe alkalies of *different ſpecies* cannot, but require the intervention of another proportion; and the reaſon is, becauſe *equal* quantities of alkalies of different ſpecies precipitate *unequal* quantities of earth of alum. Thus, 100 parts, by weight, of mere *vegetable* alkali precipitate 78 of earth of alum; but 100 parts of *mineral* alkali precipitate 170,8 of that earth. Therefore the precipitation of 78 parts of earth of alum, by the vegetable alkali, denotes as much of this, as the precipitation of 170,8 of that earth, by the mineral alkali, denotes of the mineral alkali. Hence the quantities of alkali in all the different ſpecies of pot-aſhes, pearl-aſhes, weed or wood aſhes, may be immediately compared by the above teſt, as they all contain the vegetable alkali; and the different kinds of kelp, or kelps manufactured in different places, and the different ſorts of barilha, may thus be compared, becauſe they all contain the

mineral

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mineral alkali; but kelps and pot-aſhes, as they contain different ſorts of alkali, can only be compared together by means of the proportion above indicated.

The application of this teſt is founded on the following principles:

Firſt. That a hot ſolution of a free alkali, or of an alkali combined only with fixed air, or ſulphur, can hold no *terreno or metallico neutral* ſalt in ſolution; though it may *alkalino-neutral* ſalts, or quick lime, if the alkali be free from fixed air.

Secondly. That earth of alum cannot be precipitated, either totally or partially, by the hot ſolutions of any *alkalino-neutral* ſalt; and therefore, that its precipitation is always due to the preſence of a free alkali, or at leaſt of an alkali combined only with fixed air, or ſulphur, to whoſe quantity it is always proportional. It is true that quick lime will alſo decompoſe alum; but the preſence of quick lime is eaſily diſcovered, by the addition of a few drops of any mild alkaline ſolution, and by the ſame means as eaſily ſeparated.

Thirdly. That if the earth of alum takes up fixed air, (which would encreaſe its weight,) this

air

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air will be ſeparated by the heat employed in drying it, or at leaſt by the ſpirit of ſalt poured upon it, and ſo may alſo another heterogeneity which will hereafter be mentioned.

I can ſee but one inaccuracy attending this teſt, and that of little moment; it is this, if the alkali contain ſulphur, this will alſo be precipitated with the earth of alum, and increaſe its weight. The limits of this inaccuracy, at leaſt in common caſes, ſcarcely reach 2 or 3 grains, as we ſhall preſently find.

Sulphur is eaſily detected in any alkaline ſolution, by ſaturating it with an acid; hepatic air is generally developed, and the liquor becomes troubled.

Not only the proportion, but alſo the *abſolute* weight, of alkali in different alkaline ſubſtances, or aſhes, may be found by this teſt, as will appear by the following experiments.

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SECTION V.

Of the Quantity of mere Alkali in different alkaline Subſtances, as exhibited by the aluminous Teſt.

Cryſtalized ſoda. I begin with this, as being the pureſt mineral alkaline ſubſtance, in a dry form, produced by art. Though it contains only $\frac{1}{5}$ of its weight of real alkali, (the remainder being water and fixed air,) yet, the proportion of alkali being invariably the ſame, it is the fitteſt for a ſtandard with which other ſubſtances, containing the ſame ſort of alkali, may be compared. I found that as much of this ſubſtance as would contain 480 grains of mere alkali would precipitate 725 grains of earth of alum, dried, and treated as already mentioned; and conſequently, that 480 grains of *mere* mineral alkali precipitate 725 of earth of alum.

Note. That in this and all the ſubſequent experiments, a little more earth of alum is precipitated than is mentioned, becauſe a little always remains in the filtering-paper, and cannot be had

out

out of it; and I have reaſon to think, by weighing the paper before and after, that this quantity amounts to 3 or 4 grains; but, as this defect is the ſame in all caſes, it does not invalidate the compariſon.

Sweet barilha. The ſolution of one ounce of barilha precipitated 174 grains of earth of alum; therefore, ſince 725 grains of earth of alum require for their precipitation 480 of mere mineral alkali, 174 grains of that earth require 115,2 of mere mineral alkali; and conſequently, one ounce of barilha contains but 115,2 of mere alkali; and one pound of barilha ſhould contain 1382,4 grains. This quantity exceeds, by about $\frac{1}{8}$, the quantity I found by direct analyſis; but poſſibly one pound may contain more than another, for it could ſcarcely happen that I ſhould commit a miſtake of that magnitude.

I muſt not here omit an odd appearance that occurred in this experiment. The earth of alum, in drying, acquired a bluiſh colour; and, when ſpirit of ſalt was poured on it, to diſengage the fixed air it might contain, the blue colour was more developed, and ſome blue particles floated

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in the liquor. This ſeems to proceed from the tinging matter of Pruſſian blue, which has been found in barilha: the weight of this I have not examined, but it could not exceed one or two grains.

Cunnamara kelp. This was manufactured by Mr. Martin Mealy, and ſent to me by Mr. Francis French, an eminent merchant in this city. It is a hard porous black ſubſtance, mixed with white and grey ſpots; its ſmell ſulphureous, and its taſte mixed, being that of common ſalt and alkali. One ounce of it, diſſolved in marine acid, loſt 24 grains of its weight, which eſcaped in an aërial form: this air was hepatic.

Another ounce, diſſolved in boiling water, left an inſoluble reſidue; which, being heated in a crucible to redneſs, weighed 165 grains: this reſidue efferveſced with acids, and ſeemed for the moſt part calcareous.

The ſolution, by the teſt of the nitrous ſolution of ſilver, evidently contained ſulphur; and the Pruſſian alkali gave manifeſt ſigns of iron.

This ſolution precipitated 25 grains of earth of alum, and therefore contained 16,5 grains of

mere

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mere alkali. During the precipitation of the earth of alum, much hepatic air was emitted, and the earth was sullied by the sulphur, though only a few grains of this can be presumed to be mixed with it.

To find the quantity of sulphur in this kelp, I dissolved two ounces of it in pure water, and saturated the solution with marine acid. The liquor became turbid; and, partly by filtration, and partly by spontaneous deposition, (for some of the sulphur passed through the filter,) I obtained 8 grains of sulphur; which gives 4 grains for each ounce, besides what exhaled in hepatic air.

In order to estimate the quantity of sulphur which a given quantity of mineral alkali is capable of containing, I dissolved 400 grains of crystalized mineral alkali in six times its weight of water; (this quantity of the crystals contained 80 grains of mere alkali;) to this I added 80 grains of sulphur, and boiled them for half an hour. Only 60 grains of sulphur were dissolved, by which I found that this alkali can take up nearly $\frac{3}{4}$ of its weight of sulphur, in the moist way; I say *nearly*, as some earth remained with the undissolved sul-

phur. With this saturated liver of sulphur I precipitated a solution of alum, and found the precipitate to amount to 130 grains. Now 80 grains of mere mineral alkali can precipitate only 120,8 grains of earth of alum; therefore 9 grains of the above precipitate were sulphur. Yet this small proportion of sulphur was very visible in the earth of alum, when heated to 500 degrees, by its strong yellow colour; therefore, in the precipitation of the earth of alum by kelp, in which no sulphur was visible, the proportion was incomparably smaller, and no deduction need be made on that account.

There are three methods of desulphurating kelp, or any other alkalino-sulphureous compound. The first is, by calcining it in an open fire, by exposing it to a rapid blast of air; and for this a very ingenious contrivance was devised by Mr. William Dean; the only inconvenience attending it is, that much of the sulphur will be converted into vitriolic acid, and thus combine with the alkali. The second is, by saturating it with a vegetable acid, and afterwards calcining it; by which means the vegetable acid will be decomposed:

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composed: if this method could be cheaply executed it would be the best. The third is, by saturating a solution of kelp with fixed air: this I have endeavoured to effect, by putting a solution of two ounces of kelp into Dr. Nooth's machine for impregnating water with fixed air. The liquor soon became turbid, and emitted a strong hepatic smell; after the sulphur had subsided I drew off the liquor, and with one half of it precipitated a solution of alum. No hepatic smell was now perceptable, and the precipitate amounted to 40 grains. I dare not say that this great increase of power in the alkali was intirely owing to the desulphuration, but some part undoubtedly was; yet the quantity of the sulphur I could collect was very inconsiderable, and mixed with coal-dust. Kelp may also be desulphurated by nitre, as shall hereafter be shewn. According to Dr. Watson, 30 ounces of kelp afforded him 12 ounces of crystalized mineral alkali; consequently 1 ounce would afford ,4 of an ounce, that is 192 grains; of which $\frac{1}{5}$, that is =38 grains, must have been mere alkali. His kelp might have been better than that I used, but it is impossible

that

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that his alkali was pure; as mineral alkali, when mixed with ſuch a quantity of common ſalt as is in kelp, can never be thoroughly ſeparated from it, but by proceſſes which he certainly did not uſe; namely, by precipitating a ſolution of ſilver in ſpirit of nitre, eſtimating the quantity of *luna cornea*, and afterwards decompoſing the cubic nitre; or, by ſaturating the alkali with diſtilled vinegar, and diſſolving the neutral ſalt thus formed in ſpirit of wine, which leaves the common ſalt behind.

Strangford Kelp. This was ſent to me by Mr. Braughhall. It was much more denſe, leſs porous, and in appearance approached more to that of a vitrified maſs than Cunnamara kelp; it was at leaſt equally ſulphureous. The ſolution of one ounce of it precipitated only 9 grains of earth of alum; and this earth was much more diſcoloured than that precipitated by Cunnamara kelp.

The inſoluble reſiduum of an ounce amounted to 174 grains.

Vegetable alkali. I found that 480 grains of the pureſt and drieſt ſalt of tartar (making allowance for the quantity of fixed air it contained) precipitated 331,5 grains of earth of alum.

Dantzic

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Dantzic pearl-ash. The ſolution of one ounce of this ſalt precipitated, in one experiment, 200 grains of earth of alum; and in another 220 grains; at a medium, 210 grains. Then, if 331,5 grains of this precipitate require 480 grains of mere vegetable alkali, 210 grains of this precipitate require 304; therefore, at a medium, an ounce of this ſubſtance contains 304 grains of mere alkali; and a pound contains 3648. By my analyſis it contained 3477 grains; the difference is 171 grains.

We may now determine which of two or more ſaline ſubſtances, one poſſeſſing the mineral, the other the vegetable alkali, is beſt in its kind; for, that ſubſtance is beſt in its kind which approaches moſt to its proper ſtandard; 725, that is, the precipitation of 725 grains of alum, being the ſtandard of the goodneſs of an ounce of a ſubſtance containing the mineral alkali; and 331,5 being the ſtandard of the richneſs of an ounce of a ſubſtance containing the vegetable alkali. Thus, if we compare barilha and Dantzic pearl-aſh, as the ſtandard of barilha is to the quantity of earth of alum an ounce of it precipitates, ſo is the ſtandard of

Dantzic ſalt to the quantity an ounce of it precipitates: or, 725 : 174 :: 331,5 : 79,5. By which we ſee, that an ounce of Dantzic ſalt that would precipitate 79,5 grains of earth of alum, would be as good in its kind as an ounce of barilha that precipitates 174. Therefore, ſince an ounce of Dantzic ſalt precipitates 210, it is richer in its kind by the difference between 79,5 and 210.

With reſpect to antacid powers, the mineral alkali is ſtronger than an equal quantity of the vegetable; that is, will ſaturate more acid, nearly in the proportion of 48 to 22; yet it attracts acids leſs, that is, with leſs force and activity, ſince the vegetable will take them from the mineral alkali. But, if the quantities of real alkali be unequal, we may compare their antacid powers in this manner: as the precipitate by an ounce of a ſubſtance containing the mineral alkali is to 48, ſo is the precipitate by an ounce of a ſubſtance containing the vegetable alkali to a number expreſſing its comparative antacid power: thus, with reſpect to barilha and Dantzic ſalt, as 174 : 48 :: 210 : 58 nearly; therefore, the antacid power of Dantzic ſalt is greater than that of barilha, when

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when taken in equal quantities, in the ratio of 58 to 48.

Cashup. The beſt ſort, namely, that marked with the croſs arrows, is of a bluiſh grey colour, exceeding hard, and of a ſemi-vitrified appearance; its ſmell ſulphureous; its taſte ſcarcely alkaline, and it does not attract the moiſture of the air. With marine acid, one ounce of it afforded 31 grains of hepatic air. When diſſolved in water, the reſiduum of an ounce was 357 grains of a grey earth, that appeared to be calcareous for the moſt part: the ſolution itſelf was of a yellow colour, and ſtrongly ſulphureous. With the ſolution of alum it did not effervеſce ſtrongly, until a good deal was added: the precipitate was of a dirty white, and amounted to 66 grains, of which two appeared to be ſulphur. Hence its quantity of vegetable alkali is nearly 93 grains *per* ounce.

Mr. Clarke's refined aſh. This I obtained from Mr. Clarke himſelf. It is of a yellowiſh-white colour, with greeniſh ſpots; many pieces are externally white, and internally green; it is moderately hard, of a very ſharp taſte, and effervеſces with acids.

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An ounce of this ſubſtance, diſſolved in twelve ounces of boiling water, did not effervesce with acids, but precipitated the ſolution of corroſive ſublimate yellow and red, as lime-water does, and left a reſiduum of 17 grains, which was evidently calcareous. A ſolution of two ounces of this ſubſtance, being impregnated with fixed air in Doctor Nooth's machine, depoſited 5 grains of mild calcareous earth; but a ſolution made in three or four times its weight of water, or without the aſſiſtance of heat, contained no lime, and effervesced ſlightly with acids: when this ſalt has been ſome time expoſed to the air, its ſolution contains no lime.

A ſolution of one ounce of this ſalt precipitated 89 grains of earth of alum, and therefore contained 129 grains of mere vegetable alkali, to which if we add 17 grains of inſoluble earth, we ſhall find that the remainder of the ounce, namely, 334 grains, conſiſted of neutral ſalts, namely, digeſtive ſalt, and perhaps vitriolated tartar, in ſmall quantity. To prove the exiſtence of theſe, I ſaturated an ounce of the ſolution of this refined aſh with the nitrous acid, and then dropped into

it

it the nitrous solution of silver; this latter was immediately precipitated in a curdy form, which, as the alkaline part was saturated, could proceed only from the marine acid contained in the digestive salt.

In the report of the committee of the house of commons, dated April, 1788, Mr. Clarke delivers an account of his method of manufacturing this salt. He mixes five parts of weed or wood ashes with one part of quick lime, and suffers them to lie together in a heap, for six, nine, or twelve months; then extracts a ley from them, which he evaporates to dryness. By suffering the lime and ashes to stand together for so many months, he imagines that the common salt contained in the ashes is decomposed, and the quantity of alkali thus increased; but, though it is possible to decompose common salt by quick lime, as Mr. Scheele has shewn, yet this decomposition is effected by a very different management; and if, in the first part of Mr. Clarke's process, such a decomposition were obtained, a recomposition would speedily be effected in the second part of his process. For, supposing the

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marine acid to quit its alkaline baſis and unite to the lime, yet, when the alkaline ſalt and marine ſelenite are both drawn off into the ley, the alkali immediately decompoſes the marine ſelenite, and reunites to its acid, according to the well-known laws of chemical affinity; ſo that, by this long *maceration*, (as he calls it,) no advantage whatever is gained. However, Mr. Clarke's ſalt is undoubtedly a valuable preparation for the purpoſe of bleaching, but may be obtained in a ſpace of time incomparably ſhorter than he requires.

The neutral ſalts, contained in the ſolution of Mr. Clarke's refined aſh, do not proceed from any error in his proceſs, but from the bad quality of the aſhes he employs.

Common Iriſh weed-aſhes. I obtained a parcel of theſe aſhes from Mr. Clarke; they were of a looſe texture, dark grey colour, and ſalt taſte, mixed with charcoal, brick-duſt, and other impurities. I choſe the cleaneſt, and ſifted them. One ounce of them loſt, by gentle drying, 47 grains, and, in a red heat, 72 grains more.

Twelve ounces of the undried aſhes, being lixiviated, left a reſiduum which, when dried,

2 weighed

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weighed 4214 grains. The solution was reddish, and replete with extractive matter; it afforded a large quantity of digestive salt, some vitriolated tartar, and very little alkali.

Two ounces of the same ashes, being gently heated to a slight degree of redness, lost 186 grains of their weight. One ounce of this calcined ash, being boiled in six ounces of water, left a residuum of 344 grains, and consequently contained 136 grains of saline matter; but, of this saline matter, only 22,4 grains were pure alkali, for the solution precipitated only 15,5 grains of earth of alum; an hepatic smell was perceived during the precipitation of the alum, and the earth was of a dirty colour.

TO BE CONCLUDED IN OUR NEXT.

XL.

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XL. *On the Means of making Bread from Rice alone.*

From the *Journal des Sciences, des Lettres, et des Arts.*

THE art of making bread from rice, though much ſpoken of, ſeems to be very little known. In Chomel's dictionary it is ſaid that bread may be made of rice, but there is no account of the means by which it is to be done. The book called *La Maiſon Ruſtique* goes rather farther; for, it informs us that this kind of bread is made by mixing together the flour of rye and that of rice. The firſt of theſe books therefore may be conſidered as ſaying nothing, ſince it is abſolutely impoſſible to make bread of the flour of rice (which is harſh and dry, like ſand or aſhes) by treating it in the manner in which wheat-flour is treated. The manner of uſing rice-flour deſcribed in the ſecond book, is but an uncertain remedy in caſe of want; for, if we have no rye, we cannot, according to that book, make uſe of rice-flour for making

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making bread, becauſe an equal quantity of rye-flour is ſaid to be neceſſary for that purpoſe; and conſequently, in countries where no rye is grown, it would be impoſſible to make bread of rice, however great the want of bread might be.

I therefore think it my duty to ſupply that information which is wanting in the two books above mentioned, by deſcribing a method by which excellent bread may be made from rice alone, which method I learned from the natives of America.

The firſt thing to be done to the rice is, to reduce it into flour: this may be done by grinding it in a mill, or, if we have not a mill, it may be done in the following manner. Let a certain quantity of water be heated in a ſaucepan or caldron; when the water is near boiling, let the rice we mean to reduce into flour be thrown into it: the veſſel is then to be taken off the fire, and the rice left to ſoak till the next morning. It will then be found at the bottom of the water, which is to be poured off, and the rice put to drain upon a table placed in an inclined poſition. When it is dry, it muſt be beat to powder, and paſſed through the fineſt ſieve that can be procured.

When

When we have brought the rice into flour, we muſt take as much of it as may be thought neceſſary, and put it into the kneading-trough in which bread is generally made. At the ſame time we muſt heat ſome water in a ſaucepan or other veſſel, and, having thrown into it ſome handfuls of rice, we muſt let them boil together for ſome time: the quantity of rice muſt be ſuch as to render the water very thick and glutinous. When this glutinous matter is a little cooled, it muſt be poured upon the rice-flour, and the whole muſt be well kneaded together, adding thereto a little ſalt, and a proper quantity of leaven. We are then to cover the dough with warm cloths, and to let it ſtand that it may riſe. During the fermentation, this paſte (which, when kneaded, muſt have ſuch a proportion of flour as to render it pretty firm) becomes ſo ſoft and liquid that it ſeems impoſſible it ſhould be formed into bread: it is now to be treated as follows.

While the dough is riſing, the oven muſt be heated; and, when it is of a proper degree of heat, we muſt take a ſtew-pan of tin, or copper tinned, to which is fixed a handle of ſufficient length to reach to the end of the oven. A little water

water muſt be put into this ſtew-pan, which muſt then be filled with the fermented paſte, and covered with cabbage or any other large leaves, or with a ſheet of paper. When this is done, the ſtew-pan is to be put into the oven, and puſhed forward to the part where it is intended the bread ſhall be baked; it muſt then be quickly turned upſide down. The heat of the oven acts upon the paſte in ſuch a way as to prevent its ſpreading, and keeps it in the form the ſtew-pan has given it.

In this manner pure rice-bread may be made; it comes out of the oven of a fine yellow colour, like paſtry which has yolk of eggs over it. It is as agreeable to the taſte as to the ſight; and may be made uſe of, like wheat-bread, to put into broth, &c. I muſt, however, obſerve that it loſes its goodneſs very much as it becomes ſtale.

It may be here remarked, that the manner in which Indian corn is uſed in France, for making bread, can only produce (and does in fact produce) very bad dough, and of courſe very bad bread. To employ it advantageouſly, it ſhould be treated like rice, and it may then be uſed, not only for making bread, but alſo for paſtry.

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XLI. *Description of a movable Table, for the Use of Engravers; invented by the Abbé* Joseph Longhi, *of Monza.*

WITH A PLATE.

From the Transactions of the Patriotic Society of Milan.

A Gold Medal was given to the Abbé Longhi for this Invention.

THE art of engraving upon copper, which was at first invented to multiply and preserve copies of the best pictures of the most able painters, and portraits of the most famous men, and which has ever since its invention been much esteemed, is at present in such repute in every civilized nation, that its productions are become of great consequence, even when considered as an article of commerce; and, when this art is followed by young men who have both an inclination and a genius

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genius for it, what advantage may it not produce to their country, and to society in general? But it often happens, as history testifies, that those artists who apply themselves the most assiduously to it fall early victims to their assiduity, so that their first essays become their last works. I myself remember, with great concern, several who have been taken from this world by a death more or less premature. Considering what could be the cause of this evil, as it was by no means difficult to discover, I found it to proceed from the very hurtful attitude in which the engraver is placed while he is at work; for, in engraving a plate, even of a middling size, if the plate be placed horizontally upon a cushion, as is usual, it is impossible to perform the work without a very injurious curvature of the body; which, by being repeated as often as is necessary in the course of the operation, lays the foundation of those complaints which so often prove fatal to artists. It is however certain that, besides this cause, many others may have contributed to those disorders which have deprived us of many excellent engravers, but the most evident cause is in

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the art itself. Wherefore, instead of being surprised at their unhappy fate, I cannot help considering those who have lived to an advanced age as wonderful instances; a very strong constitution, (which, however, is seldom the lot of those who have great talents,) taking exercise, less assiduity in their labour, and a power of performing their work without carrying their eyes very near it, may have exempted them from the common fate of their fellow-artists.

Instead of trusting to these infrequent examples, I thought I should do a more useful thing by contriving such a table, for the use of engravers, as is here described. My intention was that those artists should be able to work, either standing or sitting, without bending the body; for that reason I began by placing the copper-plate upon a desk. It was then necessary to be able to turn it about as occasion required: for this purpose, a pivot or axis in the centre, upon which it might revolve, would suffice; but I soon found that, upon one centre, it would not be possible to execute properly the various lines, in so many different directions as would be required.

It

It became therefore alſo neceſſary that the board, upon which the plate was to be fixed, ſhould have a great number of holes underneath, by which it might be put upon the axis or pivot in any part, as occaſion might require; and as theſe holes, if made of a circular form, would perhaps not be all exactly of the ſame ſize, (either from the difficulty of making them ſo originally, or from ſome of them being oftener made uſe of than others,) which conſequently would take from the machine that ſteadineſs which the artiſt always finds eſſential to his work, I thought it would be better to make them ſquare, and, of courſe, to make that part of the axis which fits into them ſquare alſo. Below this ſquare part, the axis is round, and turns in a ſocket, ſo that there is no danger of its becoming either too looſe or too tight. In this manner I had a table made, and I find it to anſwer the purpoſe for which it was intended in the moſt complete manner. Indeed I find it much more commodious for engraving than any other method; for, when it is neceſſary to engrave in the corner of a plate, if we turn the plate upon a cuſhion, and ſupport it with

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with the left hand, (as is the usual way,) that hand finds it difficult, from the weight of the plate, to keep it quite motionless; and the smallest motion in the plate renders it impossible to perform the work properly, consequently that part of the plate is worse executed than the rest: but, upon my table, where the plate is fixed upon a pivot or axis, and supported by a projecting part under it, the left hand has much less to do, and the plate always turns round parallel to what it rests upon.

Thus I have given an account of the motives which induced me to contrive this table, and of the manner in which I have executed it. It has been approved by Signor de Vangelisty, professor of engraving at Milan, (who, upon seeing it, immediately made trial of it,) and by the Imperial Academy of Vienna; I therefore take the liberty to present the foregoing account of it to the Patriotic Society, with a figure of it, trusting it will be found not less useful to artists than to the art itself.

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Description of the Figures.

(See Plate XIX.)

Fig. 1. represents the whole machine, as it is used.

A. Copper-plate on which the engraving is to be made.

a a a a a a a a. Screws by which the plate is affixed to the movable board B.

B. The upper or movable part of the table. It consists of a thin plank, to the bottom of which is united the iron plate represented in Fig. 3.

C. The under-board, which is made to rise and fall at pleasure, in the manner of a desk, by means of a pair of hinges; in the middle of it is a pretty thick axis.

D. The foot by which the desk is supported at any required height.

E. The frame of the table.

Fig. 2. The under-board or desk.

F. A circle of iron, through the middle of which protrudes that part of the axis marked H. (In Fig. 4.)

G,

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G. A larger circle of iron, of the ſame height as the circle F; it ſerves for the movable board B to reſt upon, as it is turned round.

Fig. 3. The movable board B, with the iron plate fixed to it. The ſquare holes in this plate muſt exactly fit that part of the axis which protrudes; and the plate itſelf muſt project ſo much from the board, as to take in the ſaid part of the axis conveniently.

Fig. 4. The axis, upon a larger ſcale than the other figures, and out of its ſocket.

H. The ſquare protruding part, which fits into the holes of the iron plate.

I. A round part, of the ſame ſize and height as the hole in the circle F, (in Fig. 2,) in which it turns.

K. A larger round part, which turns under the circle F, and is by it kept in its place.

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Fig. 1

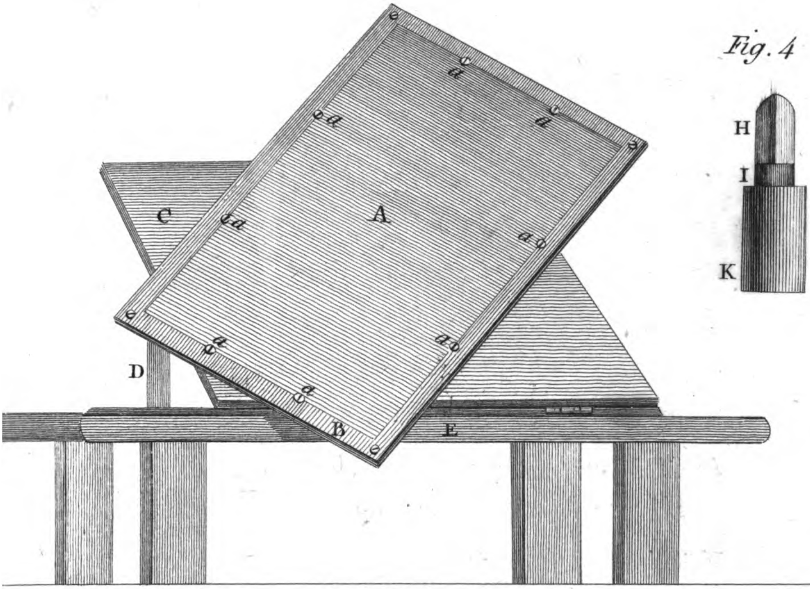


Fig. 4

Fig. 2

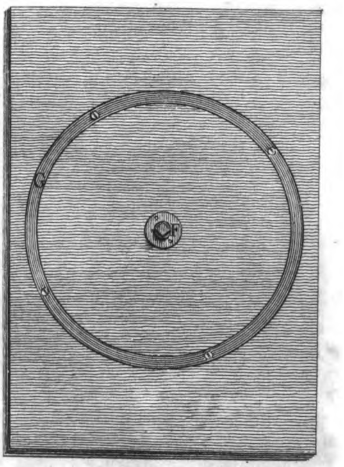
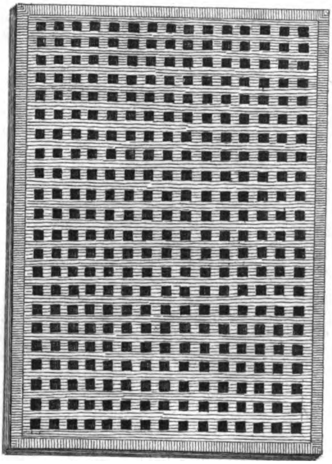


Fig. 3



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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XXX.

XLII. *Specification of the Patent granted to* ROWLAND BURDON, *of Harley-ſtreet, Cavendiſh-ſquare, in the County of Middleſex, and of Caſtle Eden, in the County of Durham, Eſq. M. P. for his Invention of a certain Mode or Manner of making, uniting, and applying, caſt-iron Blocks to be ſubſtituted in Lieu of Keyſtones, in the Conſtruction of Arches.*

WITH A PLATE.

Dated September 18, 1795.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid

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provifo, I the faid Rowland Burdon do hereby declare, that my invention confifts in applying iron, or other metallic compofitions, to the purpofe of conftructing arches, upon the fame principle as ftone is now employed, by a fubdivifion into blocks eafily portable, anfwering to the keyftones of a common arch, which, being brought to bear on each other, gives them all the firmnefs of the folid ftone arch; whilft, by the great vacuities in the blocks, and their refpective diftances in their lateral pofition, the arch becomes infinitely lighter than that of ftone; and, by the tenacity of the metal, the parts are fo intimately connected, that the accurate calculation of the extrados and intrados, fo neceffary in ftone arches of magnitude, is rendered of much lefs confequence. Fig. 1. (Plate XX.) reprefents a block of caft iron, 5 feet in depth from A to A, and 4 inches in thicknefs; having three arms B, B, B, and making a part of a circle or ellipfis: the middle arm is 2 feet in length from B to C, and the other two are in proportion. On each fide of the arms are grooves, (¾ of an inch deep, and 3 inches broad,) for the purpofe of receiving malleable or bar iron; and in each arm

are

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are two bolt-holes. D (Fig. 2.) represents two of these blocks placed together, and the joints confined to their respective positions by the bar-iron on each side of the arms, as at E, E, E; which, with other similar blocks, so united and bearing upon each other, become a rib. Fig. 3. and F, F, Fig. 2. are hollow tubes, 6 feet long, and 4 inches in diameter, having shoulders at each end, with holes answering to those of the blocks. G is a block of another rib, connected with the former by the tubes F, F, placed horizontally. Through the holes in the shoulders and arms of the block, and bar-iron, are bolts, (fastened with cotterels or forelocks,) as at H, H, H, H. The blocks being united with each other in ribs, and the ribs connected, and supported laterally, by the tubes, as above described, the whole becomes one mass, having the property of key-stones cramped together. The blocks and tubes above specified are those intended to be used in the construction of the arch of the bridge, now erecting by me, across the river Wear, at Wear-mouth, near Sunderland, in the county of Durham. The arch is a segment of a circle, whose

 chord

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chord or ſpan is 236 feet; its verſed ſine or height 34 feet; and its breadth 32 feet, conſiſting of ſix ribs: but the ſizes of the blocks, tubes, and other parts, with the number of ribs and arms in the blocks, muſt be ſuited to the dimenſions, form, and uſe, of the arch. In witneſs whereof, &c.

The preceding Patent appearing to us to be very intereſting, as exhibiting a new Principle in the Conſtruction of Iron Arches, we truſt the following Account of the firſt Bridge wherein that Principle has been adopted, (with a View thereof, Plate XXI.) *with which, at our Requeſt, Mr.* BURDON *has favoured us, will not be unacceptable to our Readers.*

From the encreaſing population and trade of Sunderland and the two Wearmouths, the ancient ferry, which was almoſt in the centre of the harbour, was become very inſufficient, and unſafe; inſomuch that frequent inſtances occurred of the loſs

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Fig. 1.

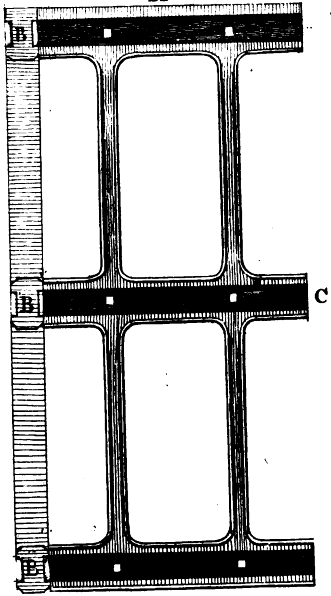
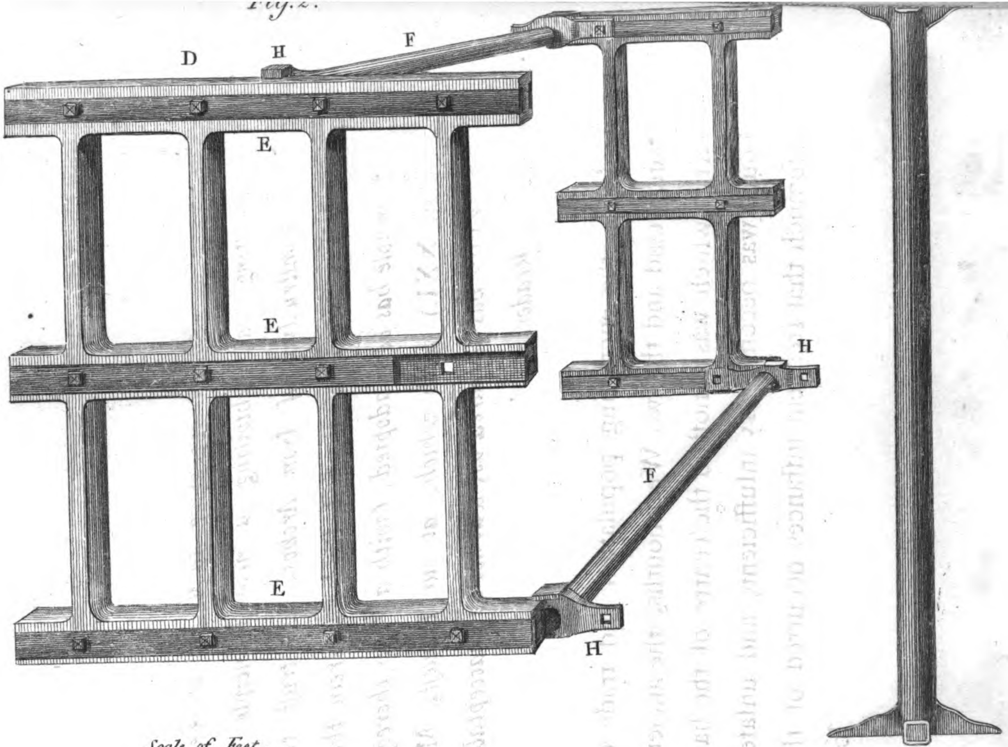
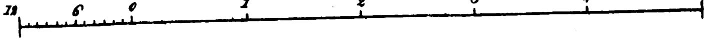


Fig. 2.





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loſs of lives, independent of the conſtant delay and diſappointment occaſioned to all deſcriptions of people.

Under theſe circumſtances, Mr. Burdon, who had previouſly procured a turnpike-road from Stockton to Sunderland, was early in expreſſing his wiſhes for the accommodation of a bridge acroſs the Wear, as near Sunderland as poſſible. Being returned to Parliament by the county of Durham, in the year 1790, he began to move in the buſineſs during the enſuing year, and an act of Parliament for a bridge was, with ſome difficulty, obtained in 1792. At firſt a ſtone bridge was propoſed, of 200 feet ſpan, and 80 feet to the crown of the arch; but, the plan, with the eſtimate, being referred to perſons of ſkill, the extent of expence appeared beyond all reaſonable bounds; and, upon ſearching for foundations, none were to be found within the limits of the ſpace covered by the tide, which flowed between rocky ſhores, diſtant from each other, in the narroweſt part, about 240 feet. Another difficulty alſo aroſe from the ſituation being ſo near the mouth of the river, and perpetually occupied

cupied by the craft of the coal, lime, and other trades, which could not admit even a momentary interruption. From the attempts at conſtructing bridges of iron by the Coalbrook-Dale Company, and alſo by Thomas Paine, Mr. Burdon, though he diſapproved of their principles, conceived the idea of making uſe of that metal; adhering however to the ancient conſtruction of bridges, by the ſubdiviſion of the parts of the arch, in the manner of key-ſtones; and taking advantage of the ductility and tenacity of iron, to produce an arch of that metal, at leaſt fifteen times lighter than a correſponding arch of ſtone, and capable of being put together upon an ordinary ſcaffold, inſtead of an accurate centre, in an infinitely leſs ſpace of time.

After having cauſed an experimental rib to be be caſt, and ſet up, by Meſſrs. Walkers of Rotheram, under the direction of Mr. Thomas Wilſon, Mr. Burdon brought forward a propoſal, to the town of Sunderland, and the county, of conſtructing a bridge, on his principles, over the Wear, between the Wearmouths, immediately adjoining to Sunderland and its harbour. His pro-

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propofition was adopted; and the foundation-ftone was laid on the North fide, on September 24, 1793. To the fuperintendance of the execution of the work, Mr. Thomas Wilfon of Sunderland was appointed, through whofe indefatigable zeal the bridge was rendered paffable, and opened for the accommodation of the public, in the prefence of a vaft concourfe of people, on Auguft 9, 1796. The arch is a fegment of a large circle; its fpan is 236 feet; the height from low water to the fpring of the arch is about 60 feet; and the verfed fine 34; producing fo flat an arch, that fhips of 200 or 300 tons may pafs under it, with equal facility, within fifty feet on either fide of its centre; having 94 feet clear at low water, and abundant depth in the mid-ftream. The bridge confifts of 6 ribs, at 5 feet diftance from each other: the fpandrils are compofed of caft-iron circles. The 6 ribs were put together, over the river, in the fhort fpace of 10 days. The fuperftructure is of timber, planked over to fupport the carriage-road, which is compofed of marle, limeftone, and gravel, with a cement of tar and chalk immediately upon the planks, to preferve

them.

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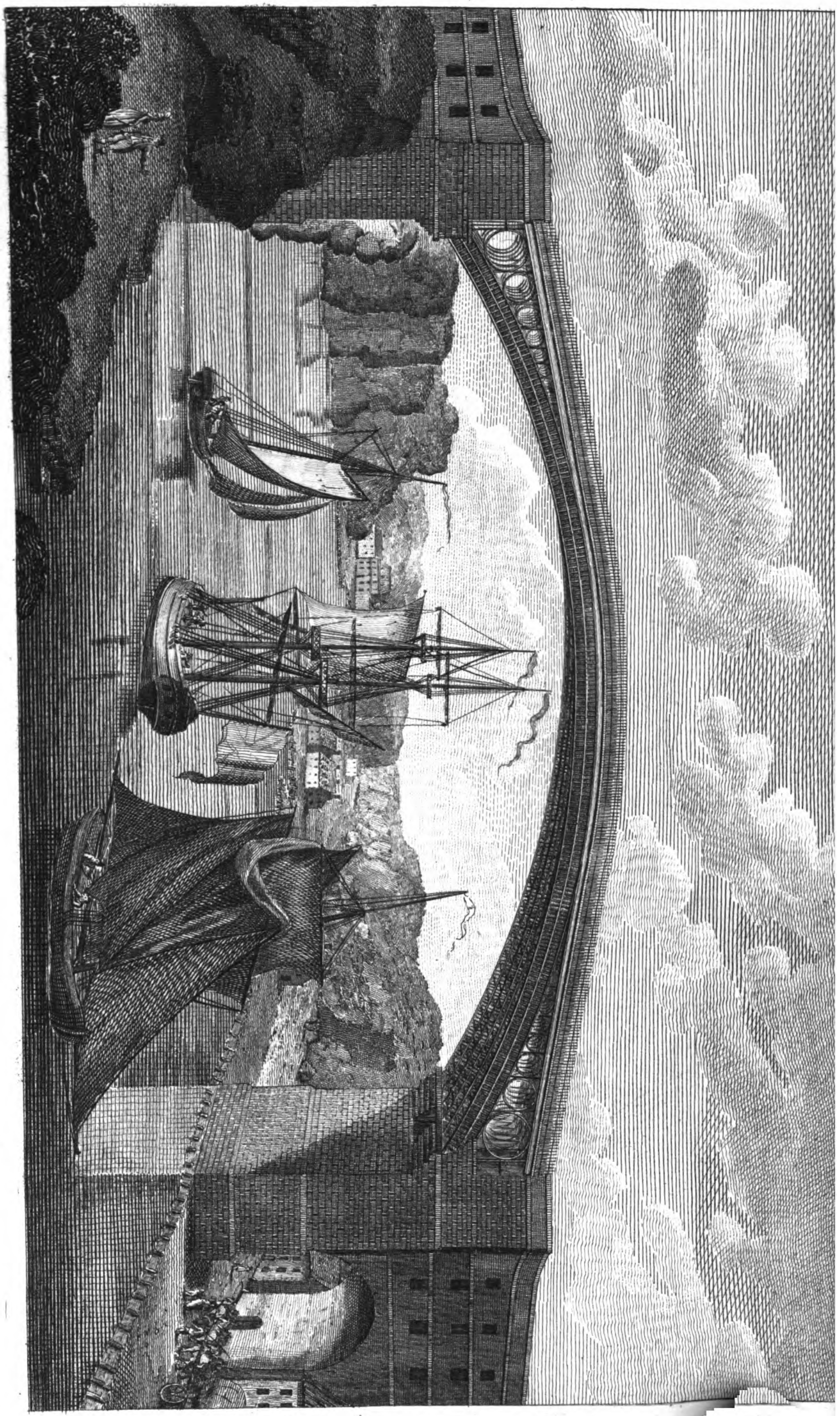
them. The whole width of the bridge is 32 fe
and, on each ſide, is a footway of ſubſtantial fla
having an iron paliſade, with lamp-poſts of tim
at intervals. The weight of the arch is calcula
to exceed 900 tons, of which 260 tons are ir
Of 28 parts of the iron, 23 are caſt, and 5 a
wrought iron.

The expence of conſtructing the bridge w
amount to above £.26,000, of which £.4,000 w
ſubſcribed by different gentlemen, and the remai
der by Mr. Burdon. The tolls, which are the ſam
as thoſe of the ancient ferry, are ſubjected, by th
act, to pay £.5 *per Cent.* on the capital, if equ
thereto; and all accumulations beyond that a
to go to diſcharge the capital.



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XLIII. *Specification of the Patent granted to Mr.* Elias Carpenter, *of the Neckinger, in the Parish of St. Mary Magdalen, Bermondsey; for his Invention of a Method of bleaching Paper in the Water-Leaf or Sheet, and sizing it, without drying; whereby the Manufacture of it will be improved, by shortening its Process, lessening its Expence, and considerably increasing its Value.*

Dated Nov. 19, 1795.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said Elias Carpenter do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, is hereinafter particularly described and ascertained: that is to say; I provide a stout deal box or case, which must be perfectly closed, capable of confining water or steam; the cover on the top

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I make to let into a groove, the dimenſions of which muſt be regulated by the ſize of the paper intended to be bleached in it. One I have made for fool's-cap paper is three feet four inches ſquare, and three feet nine inches deep, with a hole cut in one ſide, near the top, to receive the neck of a retort. In this caſe I put a falſe bottom of deal, bored full of holes; which ſaid bottom, including the feet on which it ſtands, takes up a ſpace of about five inches. I have alſo four deal frames made to fit into the ſaid box or caſe, with two croſs bars in each, diſtant about fifteen inches from each end, leaving a ſpace in the centre of about four or five inches: theſe frames have feet which make their height about ten inches. The firſt of theſe frames ſtands on the falſe bottom; the ſecond on the firſt; the third on the ſecond; and the fourth on the third. I then put into the ſaid box or caſe, under the falſe bottom, a proportion of a certain liquid which I ſhall hereafter deſcribe; the uſe of which liquid is for the preſervation of the health of the operator. In my frames I have a groove cut in the inſide of each end, and another facing each end in the croſs

bars;

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bars; these grooves receive the end of the laths on which the paper hangs. Much difficulty arose in finding a contrivance for hanging the paper on. Lines, on account of their being so close, were particularly inconvenient and tedious; and those which would be moderate in price gave a stain to the paper. Wood was subject to the same complaint, and, being cut so thin as was necessary, twisted and warped in all forms; and all metal would rust or corrode in the operation. Nothing therefore appearing so convenient and cheap as glass, I procured from some glaziers the cuttings of sash-squares, in large quantities of strips, from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch broad, and about fifteen inches long. Thus provided, I took my paper, when pressed in the packs in its wet state, and, laying one of the strips of glass in the middle of the pack, I turned about four sheets over on it, and placed it edgeways in a groove of one of the frames; then a second the same way, placing it quite close to the first: thus I proceeded until the frame was filled. In like manner I proceeded with the remaining frames, placing them in the box or case as before described, (making it in the

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whole to contain about five reams,) the cover of which I place on, and either close it with pipe-clay, or strips of paper pasted on, which latter I prefer, as the most cleanly. I then lute the neck of a glass retort in the hole of the box or case before mentioned, containing manganese, sea-salt, and vitriolic acid; the proportions of which I have frequently varied, without discovering any very great difference in their effects; but have generally found equal quantities of manganese and sea-salt, and about $\frac{5}{6}$ of their weight of the vitriolic acid, have answered best. The manganese and salt must be well mixed together, and put into the retort; then the vitriolic acid must be mixed with an equal quantity of water impregnated with the fumes of burning sulphur, and put to the other ingredients: these mixtures after standing a short time require a moderate heat, which I have, from repeated experiments, found most conveniently communicated by boiling water. The paper, after having been exposed about eight or ten hours to the vapour or steam arising from this preparation, will be found sufficiently whitened, and may be taken from the box or case, and sized

 with

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with the following ſize: that is to ſay; take one hundred weight of pieces of ſkins of which ſize is uſually made, and, after boiling it to a due conſiſtence, and ſtraining it, mix with it the following ingredients; *viz.* fourteen pounds weight of alum, ſeven pounds of calcined vitriol, and one pound of gum arabic: this quantity will make ſize enough for about fifty reams of fool's-cap paper; then preſs it, and finiſh in the uſual way. This proceſs will anſwer extremely well for a rag that is devoid of ſheaves, and wants only a brightneſs of colour; but, where the rag is of a coarſe bad quality, abounding with ſheaves, it will require the following previous preparation; *viz.* I prepare a lixivium from equal quantities of pearl-aſh and quick lime freſh from the kiln, in the proportion of about four pounds to each hundred weight of the article; I pour on water, by degrees, until the lime is ſlacked, and mix them well together, then pour on a large quantity of water, ſtirring it well ſeveral times; after which I ſuffer it to ſtand until the ſolution is clear, which I draw off, adding more water to the reſiduum, until all the ſalts of the aſhes are entirely diſſolved;

then

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then I draw off the clear and mix it with the former, and, if not ſufficient for the purpoſe, I add more water to the ſolution. With this lixivium I either macerate my rag, or boil it, as its ſtate and condition may require; the firſt of which I prefer, as the moſt cleanly, as well as the moſt economical, but the latter is the moſt expeditious and effectual; and, when working a cloſe-wrought rag, made of a hard twiſted thread, and abounding with ſheaves, it will be found neceſſary to paſs it through a waſhing-engine, to open it, and give the lixivium and bleaching principle free acceſs to its internal parts. After it hath been thus macerated, or boiled, until the ſheaves are extirpated, which will take a longer or ſhorter time, according to the quality and texture of the rag, it is then either to be preſſed, or ſtand in ſome convenient receptacle to drain away the ſuperfluous water, and then put into the box or caſe prepared for bleaching the paper, or any other box, cheſt, or caſe made of wood, of any ſhape, or dimenſions, only obſerving it is perfectly tight. I have uſed frequently, for this purpoſe, caſes three feet ſquare, and about two feet three inches deep.

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deep. The noxious vapour which iſſued from the bleaching-caſes immediately on their being opened, having made ſeveral of the people employed therein extremely ill, and having experienced the pernicious effects of it ſeverely myſelf, I turned my attention to a preventive; and, conſidering the attractions of all alkalies with acids, I diſcovered, after trying various means, that the lixivium which we have always at hand anſwered the purpoſe fully. When I have put it in too ſtrong, or in too great a quantity, its effects have been curious: in ſeveral of thoſe trials, after putting in my lixivium of various ſtrengths and quantities, laying on my falſe bottom, and throwing in the article thereon, to the amount of at leaſt one hundred weight and a quarter in each caſe, I have found on opening, after ſtanding the uſual time of eight or ten hours, the caſe which had the weakeſt portion of the lixivium well done throughout; where it was a little ſtronger, one ſmall ſpot in the centre had the colour untouched; and, where it was ſtrongeſt, one large globular form in the middle, of about eighteen inches diameter,

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meter, was as full of colour as when put in; while all round, top, bottom, and ſides, particularly the bottom, was purely white. This I attributed to the powerful attraction of the lixivium, drawing the gaz down at the ſides and corners, where it would find an eaſier paſſage than in the centre, where it lay in a more ſolid body. One gallon of the ſecond running of the lixivium will be generally found a proper quantity for every hundred weight, to draw the bleaching power into the pulp, and render the proceſs ſafe and pleaſant to the operator. It may be ſuppoſed much of the gaz muſt be waſted in the lixivium: if put in injudiciouſly it will, but, if in a proper quantity, the ſame charge will bleach much more effectually than without it; being ſo volatile that it is difficult to confine it. I have ſeen the finer and more ſubtile parts penetrate through the neck of a ſtone retort of conſiderable thickneſs, which is ſoon rendered porous by repeated uſe; and, as ſoon as the caſe was opened, great quantities would fly off, and, if the people employed did not fly from it for a time, they would experience a trembling

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trembling of the limbs, fick head-ach, painful fenfation at the ftomach and throat, and a wheefing cough, as if afflicted with a violent afthma; all of which are removed by the application of the lixivium. As the gaz decompofes all the fubftances found in the pores of wood, to the deftruction of the wood, and continual decreafe of the bleaching power, it will be neceffary to line the cafe with fome kind of cement that will repel it: I have lined my box or cafe with a thick coat of white paint, which hath anfwered tolerably well. When I have thus prepared my box or cafe with the lixivium and falfe bottom, I fill it with the article to bleach; having clofed the cover, I fix the retort with the chemical mixtures heretofore mentioned. The precife charge to each of thefe retorts cannot be affixed, but muft be regulated by the article to be bleached, which the judgement and ingenuity of the operator muft determine; for inftance, that charge which might with fafety be employed on a ftrong coarfe rag would injure the texture of a fine or tender one; and that charge which would be fufficient

 for

for a fine rag would be ineffectual for a very coarse one. A few careful experiments will furnish a diligent person with more instructions and knowledge on those particulars than all that can be written; I have however generally found, that less than two pounds weight of vitriolic acid, to each hundred weight of rag or pulp, hath been insufficient for the finest, and that more than five pounds weight was mischievous to the coarsest, having a tendency to take out strength as well as colour. The heat communicated to these retorts is by boiling water, as before mentioned, being neither accompanied with the dirt, the expence, or labour, of sand-heats, and much more uniform in its effects. Many circumstances may happen to make separate cases and fire produce different shades, therefore, instead of many cases, I intend having only one, equal in dimensions to all I propose bleaching at a time; with retorts in proportion; with a trough of some convenient substance, to hold the body of the retorts in boiling water; and with a cover to confine in the steam; by which means the heat will be retained, and the

cold

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cold air kept from checking the aſcent of the gaz when it becomes weak. A caſe of about twelve feet long, three feet deep, and twenty-eight inches wide, with about four retorts, would bleach from ſix to eight hundred weight at a time. After the article hath been expoſed to the action of the gaz for eight or ten hours, it may be taken out of the caſes; and, if entirely freed from ſheaves, it may be made into paper; but, if any ſheaves remain, it muſt be again ſubmitted to a ſecond maceration, or boiling, and made into paper; then finiſhed from the packs in the water-leaf or ſheet, as before particularized. In witneſs whereof, &c.

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XLIV. *Specification of the Patent granted to Mr.* JAMES STUARD, *of the Pariſh of St. Anne, Middleſex; for his Invention of an Anchor on a new Conſtruction, for Ships and Veſſels, which is much ſuperior to thoſe now in Uſe.*

WITH A PLATE.

Dated Feb. 4, 1796.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that I the ſaid James Stuard, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, and declare that the ſame is to be performed in manner following: that is to ſay; whereas, the uppermoſt fluke of a common anchor, which has two, is dangerous to ſhips and veſſels which may happen to ground by it, and alſo frequently occaſions the anchor to be tripped, by the cable taking hold of it on the ſhip's ſwinging, to the

hazard

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hazard of the ſhip's going on ſhore, or occaſioning damage, by driving foul of other ſhips or veſſels. To obviate ſuch conſequences I would have but one fluke; and, that the anchor may be ſure to fall the right way, with the fluke downward, I would have the ſhank very ſhort; whereby, when ſuſpended by the cable, it will cant the moſt, and when it has hold in the ground the ſhip will ride ſafer; as a long ſhank has more power to looſen and break the ground, and is more likely to be bent or broken from its hold. The form of the ſhank and arm of the anchor to be as AA, Fig. 1. (Plate XXII.) in the annexed drawing; and, that they may be ſtronger than if made ſeparately and ſhot together, I would have the bars which compoſe them in one length; ſo that there be no ſhoot or joining in the whole length of the ſhank and arm. The hole B is to receive the ring for the cable, and the hole C for the ſtock. Or, the ſhank may be made without the hole C, and the hole B made octagonal; or, if round, I would have a ſmall projection on the ſtock, and a ſmall cavity on one ſide of the hole B to receive it, to prevent the ſhank's turning; and, inſtead of a ring for the cable, to have a

 ſhackle,

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shackle, through which, and the shank at B, the stock must pass; and, that the shackle may not fall too low, have a stop on each side, at the upper end of the shank. The palm to be in shape as D D, Fig. 1. and as Fig. 2. made either entirely of cast iron, or a cast-iron shell filled with lead; that being of much more specific gravity than iron. The back of the palm to be formed either as the convex lines, or the strait lines making angles at the centre, or the concave lines. The stock to be composed of a wrought-iron bolt, as A, Fig. 3. covered with cast iron, B B. Also to have a small shackle, or two plates with a small bolt between them, as E E, Fig. 1. on the bend of the shank and arm, for the buoy-rope to be made fast to; or a long circular bolt passed through the plates, and fastened to each corner of the palm. In witness whereof, &c.

XLV.

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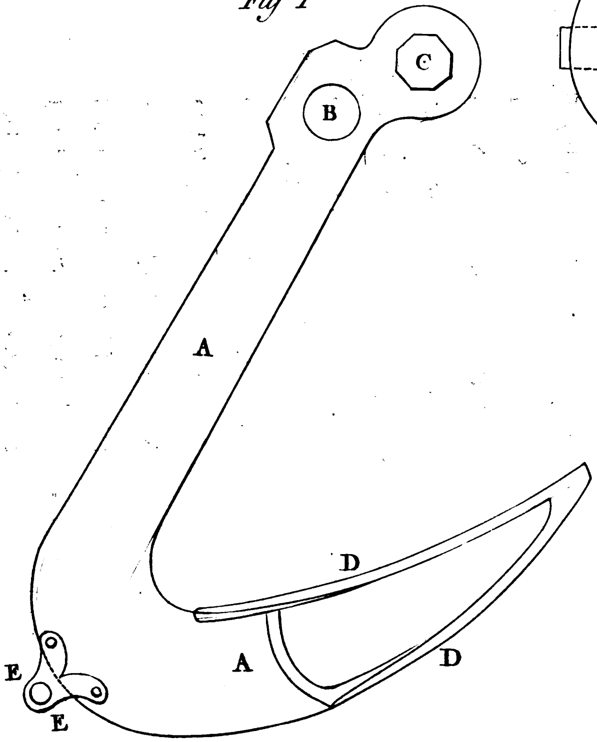
Fig 1



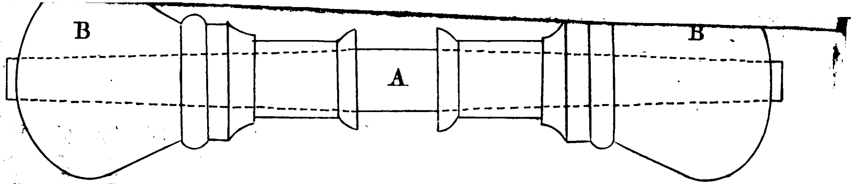
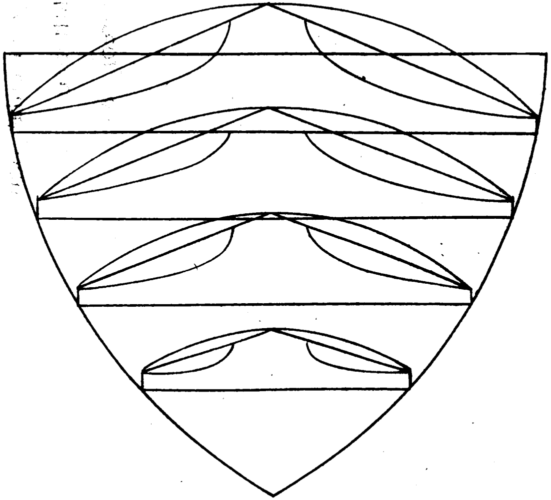


Fig 2



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XLV. *Specification of the Patent granted to Mr.* JACOB LEVY, *of Garden-court, in the Pariſh of St. Botolph, Aldgate; for his Invention of the Art of making Semolina from Wheat.*

Dated July 5, 1780.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Jacob Levy do hereby declare, that my ſaid invention of the art of making from wheat, the growth of this kingdom, ſemolina, from which vermicelli and macaroni are manufactured, equal in quality and goodneſs to that imported from Italy, is deſcribed in manner following: that is to ſay; the wheat is ground in a flour-mill, and the flour ſeparated from the middlings; the ſaid middlings are dreſſed in a bolting-mill, in four different ſorts, and then ſifted through parchment ſieves, till all the bran and pollard is ſeparated from them. In witneſs whereof, &c.

XLVI.

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XLVI. *Observations on the raising and dressing of Hemp.* *By* Edward Antill, *Esq.*

From the Transactions of the American Philosophical Society.

WHOEVER would raise hemp properly, and to advantage, should set aside two pieces of ground, of such dimensions each as he shall be able to cultivate every year, and sow the one, while he is manuring and preparing the other for the succeeding year's crop; the higher and drier the ground the better, provided it be well dunged, and made strong and mellow. The ground should not be too sloping, lest the good soil be washed away with hard rains; if it droops toward the South, so that it may have the full influence of the sun, it will be an advantage; low, rich, warm, dry grounds will also produce good hemp; but wet land, though ever so rich, will by no means do. The ground being prepared, and made

very

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very mellow, I now come to that part which must be particularly and exactly attended to, since the success of the crop greatly depends upon it. Some time in May, the ground, being moist and in a vegetating state, but by no means wet, must be well ploughed, the furrows must be close and even, and the soil must lie light and mellow; it must then be sown very even, with two bushels of seed upon one acre. A man with an iron-tooth harrow follows the sower, and harrows in the seed, with two horses, without any balks; for, the less the ground is trampled the better. If harrowing one way be not sufficient to cover the seed, though it would be best if that could be done, it must be cross-harrowed. The ground being moist, as I said before, but by no means so wet as to clod, which would ruin the crop, the seed will all start and come up together, which is a sure sign of a good crop, and nothing after that, but too much wet, will hurt it; for, hemp thus come up bids defiance to weeds and grass of every kind. Its growth is so quick, and it so effectually shades the ground, that nothing below can rise, or shew its head; and it so preserves all the moisture below, that, the

hotter and drier the weather, the faster it grows. Whereas, if the seed be sown when the ground is dry, the seed that lies deepest, where the moisture is, will come up first, and these plants will shade and starve those that come up after; by which means the first comers will be too large, and the last will be much too small, so that the crop will be greatly damaged every way: so much depends upon this one circumstance, of sowing the seed when the ground is moist, and fit to receive it. The crop, thus rightly managed, will stand as thick as very good wheat, and be from four to six feet high, according to the strength of the ground, and the stems will not be thicker than a good wheat straw; by this means the hemp will be finer, it will yield the greater quantity, and it may be plucked from the ground, like flax, which will be a great saving. But, if it be sown thin, that is, one bushel to an acre, which is the common practice, it grows large; the hemp is harsh and coarse, and then it must be cut with hooks, which occasions great waste; for, four or five inches above the ground is left by way

of

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of ſtubble, which contains the beſt and heavieſt part of the hemp.

When the hemp has got its growth, and is fit to be plucked, which you will know by the under leaves of the carle or male hemp turning yellow and falling off, the ſooner it is pulled the better. It muſt then be bound up with ſtraw bands, in ſingle-band ſheaves, rather ſmall than large, and each ſheaf muſt be bound in two places; and, the ſooner it is carried to the water, to rot, the better. Water-rotted hemp, if it be rightly managed, is every way better than that which is rotted on the ground; there is leſs waſte in it, when it comes to be dreſſed; it looks brighter and fairer to the eye; it is eſteemed to be ſtronger and more durable, and it always fetches a better price; beſides, it is much ſooner done, and it is rotted more even and alike, and with greater certainty and exactneſs. Many people in America are acquainted with the method of rotting hemp in water; but, as many more are not yet acquainted with it, I ſhall, for their information, ſet down the method of doing it. Hemp may be

rotted in stagnated or standing water, such as ponds, pools, or broad deep ditches; and, in such water, it is generally four or five days and nights in rotting, and sometimes longer, according to the heat or coolness of the weather. It may also be rotted in running water, as in a brook or river; and, in such water, three or four days and nights are sufficient, according to the weather. To know whether the hemp is rotted enough, in either case, take a middling handful out of the middle row, and try with both your hands to snap it asunder; if it break easy, it is rotted enough; but, if it yet appear pretty strong, it is not, and must lie longer, till it breaks with ease; then it must be taken out, and dried as soon as possible. In handling the sheaves, take hold of the bands, and set them upright against a fence, if one be near, or lay them down upon the grass, for the water to drain off; then unbind them carefully, open and spread them, that they may dry thoroughly; then bind them up again, and house them in a dry tight place. The reason of handling the hemp in this careful manner is, that, when it is well rotted, whilst it is wet the lint

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comes off with the least touch; therefore, if it be handled roughly, or if, while it is wet, it be thrown into a cart, and carried to a distance to be unbound and dried, it will be greatly hurt, and the owner will receive great damage; but, when it is dry it may be handled with safety.

If the hemp be rotted in a brook or running water, the sheaves must be laid across the stream; for, if they be laid down lengthways with the stream, the current of the water will wash away the lint, and ruin the hemp: it must be laid down heads and points, two, four, or six thick, according to the depth of the water, and the quantity of hemp. If the bottom of the river be sand, gravel, or mud, three good strong stakes must be driven down at each end, above and below, and three long strong poles must be laid on the hemp, and fastened well to the stakes, in such manner as to force down the hemp under water, where it is to remain till it is rotted enough; though, if a muddy stream could be avoided, it would be best, because it is apt to foul and stain the hemp. If the bottom of the stream be rocky or stony, so that stakes cannot be driven down to secure the

hemp

hemp under water, and prevent its floating away, then a rough wall must be made at the lower end of the hemp, and along the side, to keep it in; and strong poles or rails must be laid upon the top of the hemp, and pretty heavy stones upon them, so as to sink the hemp under water, where it must lie till it is rotted enough.

What hemp is intended for seed, should be sown on a piece of ground by itself, which must be made very rich and strong. It must be sown in ridges six feet wide; and the seed must be of the largest and best sort, and sown very thin, at the rate of a peck upon an acre, or rather six quarts; for, the thinner it is sown the more it branches, and the more seed it bears. It should be sown some time about the middle of April, and then the seed will not be ripe till some time after the other hemp is done with. If you have no convenient place to sow your seed-hemp by itself, then sow a border, of six feet wide, along the North and West sides of your hemp-field. The reason for sowing your seed-hemp in such narrow ridges or borders is, that when the carle or male hemp is ripe, and has shed its farina on the fimble or female

hemp,

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hemp, (by which the seed is impregnated,) and the leaves of the carle hemp fall off, and the stem grows yellow, you may easily step in along the sides, and pull up the carle without hurting the female, which now begins to branch out, and looks of a deep green colour, and very flourishing; and, when the seeds begin to ripen, which is known by their falling out of their sockets, you may, all along both sides, bend down the plants, and shake out the seed upon a cloth laid on the ground; for, as they ripen, they scatter upon being shaken by a hard wind, or otherwise. Then it must be watched, and the fowls and yellow-birds kept from it, for they are immoderately fond of the seed. As the first ripe seeds are the fullest and best, they are worthy of some pains to save them; and the best way to do that is, to bend down the plants all along, on each side of the border or ridge, as is said above, and shake them over a cloth spread on the ground to receive the seed. If one side of the plant be rooted out of the ground, by forcing it down to shake out the seed, there will be no damage, the seed that remains will ripen notwithstanding; and the plant must

muſt be thus ſhaken every two or three days, till all the ſeeds are ripe, and thus ſaved. This way is much better than pulling up the plants by the roots, and ſhaking them on a barn-floor, and then ſetting them up againſt a fence on the ſide of the barn, for the ſeed to ripen, ſhaking them again morning and evening on the barn-floor; for, by this method, which is the common practice, one third of the ſeed at leaſt never comes to maturity.

It is well known to every farmer, that, in the three bread-colonies at leaſt, the ſpring and ſummer ſeaſons are of late years become very dry; ſo that a crop of flax is become very precarious, ſcarcely one year in ſeven producing a good one. This is a conſtant complaint in the mouth of every huſbandman: now, hemp does not require half the rain that flax does; this is a circumſtance that is well worth the notice and attention of every farmer; and therefore, by his raiſing hemp in the manner before directed, and by preparing it in the beſt manner for ſpinning and weaving into good cloth, he can with greater certainty ſupply all the neceſſary uſes of his family; and, by ſel-

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ling the overplus, he can purchase such things as his wife and daughters may think convenient on extraordinary occasions. This, however, need not hinder him from raising some flax every year: but I think that it is more for his interest to fix his chief dependence upon his crop of hemp, as that is more sure, and every way more profitable, the general run of seasons considered.

I shall now endeavour to instruct the husbandman in a few easy rules for preparing his hemp, which he has raised and managed in the manner before directed.

The best preparation of hemp, for the manufacturing of cloth, is to render it as soft and as fine as possible, without lessening its strength; and the easiest and cheapest way of doing this is certainly the best. This is to be found out by a variety of trials and experiments; but, till a better way is discovered, with which I should be greatly pleased, take the following method, which is the best I have yet been able to discover.

If you have a large wide kettle, that will take in your hemp at full length, it will be the better; but, if your kettle be small, then you must

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double your hemp, but without twiſting; only the ſmall ends of every hand muſt be twiſted a little, to keep them whole and from entangling. Then, firſt of all, lay ſome ſmooth ſticks at the bottom of the kettle, ſo as to lie acroſs one another, three or four layers, according to the ſize and depth of your kettle: this is to keep the hemp from touching the liquor. Then pour ſome ley of middling ſtrength, half as ſtrong as what you make ſoap of, gently into the kettle, not ſo much as to riſe up to the top of the ſticks, they being kept down to the bottom. Then lay in the hemp, each layer croſſing the other, ſo that the ſteam may riſe up through the whole body of hemp; which done, cover your kettle as cloſe as you can, and hang it over a very gentle fire, and keep it ſimmering or ſtewing, but not boiling, ſo as to raiſe a good ſteam for ſix or eight hours. Then take it off, and let it ſtand covered till it is cool enough to handle. Then take out the hemp, and wring it very carefully, as dry as you well can, and hang it up out of the way of the wind, either in your garret or your barn, ſhutting the doors; there let it remain, turning it now and then, till

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till it is perfectly dry. Then pack it up in ſome cloſe dry place till you want to uſe it; but you will do well to viſit it now and then, leſt any part might be damp and rot. You muſt know that wind and air weaken and rot hemp, flax, and thread, very much. Then, at your leiſure, twiſt up ſome of the hands, as many as you intend for preſent uſe, as hard as you can, and, with a round ſmooth hand-beetle, on a ſmooth ſtone, beat and pound each hand by itſelf all over very well, turning it round from ſide to ſide, till every part be very well bruiſed. You muſt then untwiſt it, and hatchel it, firſt through a coarſe, and then through a fine hatchel; and remember, that hatcheling muſt be performed in the ſame manner as a man would comb a fine head of hair; he begins at the end below, and, as that diſentangles, he riſes higher, till at laſt he reaches up to the crown of the head. The firſt tow makes good ropes for the uſe of the plantation; the ſecond tow makes very good coarſe ſheeting; and the hemp itſelf will make excellent linen. The ſame method of ſteaming ſoftens flax very much.

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XLVII. *Conclusion of Mr.* Kirwan's *Experiments on the alkaline Substances used in bleaching, &c.*

(from p. 349.)

I TRIED also another sort of ashes, which I had from a chandler; they were of a whiter colour, and cleaner. The solution of an ounce of them, in six ounces of water, precipitated only 5,5 grains of earth of alum, and therefore contained but 8 grains of mere alkali.

There is a remarkable circumstance attending these ashes, namely, that if they be much calcined they seem to lose their alkaline properties, and the solution no longer precipitates that of corrosive sublimate reddish, as alkalies not thoroughly aërated do. What this circumstance depends on, I have not as yet examined, but am almost certain it proceeds from the presence of common salt, as fixed alkalies and common salt melt very easily, and thus unite to the earths.

To

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To eſtimate the goodneſs of different aſhes, ſome have recommended the uſe of an hydrometer, whereby to diſcover the ſtrength of ſolutions of equal weights of theſe aſhes in equal quantities of water; but, as this inſtrument is equally affected by the preſence of neutral ſalts as of alkali, it becomes uſeleſs.

Table of the Quantity of mere Alkali in one hundred avoirdupois Pounds of the following Subſtances, by the aluminous Teſt.

One hundred Pounds,	Mineral Alkali.	
Cryſtalized ſoda, - -	20	lbs.
Sweet barilha, - -	24	
Mealy's Cunnamara kelp, -	3,457	
Ditto deſulphurated by fixed air,	4,457	
Strangford kelp, - -	1,25	
One hundred Pounds,	**Vegetable Alkali.**	
Dantzic pearl-aſh, - -	63,33	lbs.
Clarke's refined aſh, -	26,875	
Caſhup, - - -	19,376	
Common raw Iriſh weed-aſh, -	1,666	
Ditto ſlightly calcined, -	4,666	

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SECTION VI.

Of the beſt Manner of procuring alkaline Salts.

Of the Method of procuring mineral Alkali. Firſt. Mineral alkali may be procured more or leſs pure from the combuſtion of the various ſpecies of kali, or *Salſola* of Linnæus, or from that of the different ſpecies of *Salicornia* and *Chœnopodium* of the ſame author. The compounds thus formed are called *barilhas* or *ſoudes.*

The cultivation of the *Salicornia* may be ſeen in the fifth volume of the *Mémoires des Savants étrangers.* A French acre (1,261 Engliſh) produces one ton of this weed; and this ton, when burned, produces but 100 weight of barilha, and this of a kind inferior to ſweet barilha. A ſmall quantity of this alkali is alſo contained in kelp. I am inclined to think that much of the alkali is loſt by its union with the earthy parts, during the fuſion effected in the common manner of fabricating this ſubſtance; and therefore the proceſs ſuggeſted

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gested by M. Cadet may be useful. He advises a trench, two feet deep, seven feet long, and eighteen inches broad, to be made, lined with clay mixed with sand, and over this, iron bars, two inches distant from each other, to be laid; upon which a wall 2,5 feet high is to be constructed, of limestone, if possible; over the bars the dry sea-weed is to be laid, and set fire to; the ashes will fall into the trench, and when it is full the fire is discontinued *. I believe also that washing the sea-weed in fresh water, to carry off the sea-salt that adheres to it, would be useful.

To desulphurate kelp, the Abbé Mazeas recommends projecting on it, while in a red heat, $\frac{1}{3}$ of its weight of nitre; but this process seems too expensive to be practised in the great.

Secondly. This alkali is found native in Egypt, and in several parts of the Russian empire, and perhaps may be cheaply imported.

Thirdly. Common salt may be decomposed, after Mr. Turner's method, by trituration with

* Mémoires de l'Académie des Sciences de Paris, 1767.

litharge. As the calx of lead here employed is afterwards converted into a yellow pigment, this method is very beneficial.

I have alſo contrived another proceſs for decompoſing common ſalt. The particulars of my experiment were as follow.

Firſt. I rendered the common ſalt pure, by adding to its ſolution a ſolution of mineral alkali, until all the earthy matter was depoſited.

Secondly. To a ſolution of three ounces of this purified ſalt, in nine ounces of water, I gradually added a ſaturate ſolution of 4,75 ounces of ſugar of lead, both hot, until the ſolution of lead ſcarcely excited any whiteneſs in that of the common ſalt. After one night's reſt, part of the ſugar of lead cryſtalized in the bottom of the veſſel; by which it is plain that too much of it had been uſed: theſe cryſtals weighed 240 grains. The ſupernatant liquor I again evaporated to nearly $\frac{2}{3}$, and after two days obtained large pellicles of acetous ſoda, which I ſeparated: they weighed 325 grains. To the reſiduum, which ſtill had a ſweetiſh taſte, I added a ſolution of mineral alkali, until no far-

ther

ther precipitation appeared; a very ſmall quantity of the alkali was ſufficient for this purpoſe. I then evaporated the remainder nearly to dryneſs, and afterwards heated it in a crucible to redneſs. In this heat it inflamed, and, when calcined nearly to whiteneſs, I took it out, diſſolved it in twelve ounces of water, filtered it, and, on adding a hot ſolution of alum, obtained a precipitate which, when dried, weighed 169 grains, and indicated the quantity of pure alkali to be 112 grains nearly. In this proceſs nothing is loſt, for the lead may be either revived or turned into a pigment.

Laſtly. Glauber's ſalt may afford the mineral alkali, but moſt eaſily in the form of liver of ſulphur: I endeavoured to decompoſe it by the above proceſs, but the quantity of alkali obtained from a large quantity of it was very inconſiderable.

Of the vegetable alkali. It is univerſally known that this alkali may be extracted, in a greater or leſs quantity, by lixiviation, from the aſhes of almoſt all vegetables; and it is *now* well eſtabliſh-

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ed that it pre-exiſts in vegetables before combuſtion; not indeed in a ſeparate uncombined ſtate, but united partly with the vitriolic or marine acids, and ſometimes the nitrous, but generally, and for the greater part, with a vegetable acid, or oil, with which it forms eſſential ſalts, as they are termed. Theſe vegetable acids and oils are decompoſed during combuſtion, and thus the alkaline part is ſet free; but the vitriolic acid, by contact with inflamed matter, is converted into ſulphur; part of which unites to the free alkali, which protects it from combuſtion, and thus forms what is called *liver of ſulphur*; a product found in moſt aſhes, eſpecially when the air has not had free acceſs to them during combuſtion.

As alkaline ſalts are of great importance in ſeveral arts, the proportion of aſhes afforded by different vegetables, and that of alkali by the aſhes of each ſort of vegetable, has of late been accurately attended to: I ſhall here preſent the beſt authenticated reſults of the experiments made with this view.

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One thousand pounds of the following vegetables, perfectly dry, and burned in a clean chimney and open fire, afforded the quantity of ashes, and saline matter, exhibited in the annexed tables.

One thousand Pounds	Pounds of Ashes.	Pounds of Salt.	
Stalks of Turkey-wheat or maize, -	88,6	17,5	
Ditto of sunflower,	57,2	20	
Vine branches, -	34	5,5	
Box, - -	29	2,26	
Sallow, - -	28	2,85	
Elm, - -	23,5	3,9	
Oak, - -	13,5	1,5	
Aspin, - -	12,2	0,74	
Beech, - -	5,8	1,27	
Fir, - -	3,4	0,45	
Fern cut in August,	36,46	4,25	Home.
Wormwood, -	97,44	73	Wiegleb.
Fumitory, -	219	79	Id.

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Table of the saline Products from one thousand Pounds of the Ashes of the following Vegetables.

	Saline Products.
Stalks of Turkey wheat or maize, -	198 lbs.
Ditto of sunflower,	349
Vine branches, -	162,6
Elm, - -	166
P[illegible] - -	78
[illegible]ow, - -	102
Oak, - -	111
Aspin, - -	61
Beech, - -	219
Fir, - -	132
Fern cut in August,	116, or 125 according to Wildenheim.
Wormwood, -	748
Fumitory, - -	360
Heath, - -	115 Wildenheim.

Hence we see that, in general, weeds yield much more ashes, and their ashes much more salt, than woods; and that consequently, as to

 salts

salts of the vegetable alkali kind, such as pot-ash, pearl-ash, cashup, &c. neither America, Trieste, nor the northern countries, possess any advantage over us.

Secondly; that, of all weeds, fumitory produces most salt, and next to it wormwood; but, if we attend only to the quantity of salt in a given weight of ashes, the ashes of wormwood contain most. *Trifolium fibrinum* (Buck-bean) also produces more ashes and salt than fern.

Most of the experiments on woods were made in France, by order of government, under the inspection of the overseers of the saltpetre-works; yet are to be read with caution by those that attend to the quantity of alkali with respect to bleachers; for, as vitriolated tartar (a salt useless to bleachers) is as serviceable to the makers of saltpetre as alkaline salts, they have constantly confounded one with the other; but the experiments made on weeds were instituted by persons who carefully discriminated these salts. 100 grains of the salt of wormwood contain but six of vitriolated tartar, and 100 grains of the salt of fumitory contain 15. All alkaline salts, unless mixed with

lime,

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lime, contain also $\frac{1}{7}$ at least of fixed air; which produces no other effect in bleaching than that of restraining their activity.

SECTION VII.

Of the Process of obtaining Pot and Pearl Ash.

First. The weeds should be cut just before they seed; then spread, well dried, and gathered clean.

Secondly. They should be burned within doors on a grate, and the ashes laid in a chest as fast as they are produced. If any charcoal be visible, it should be picked out, and thrown back into the fire. If the weeds are moist, much coal will be found. A close smothered fire, which has been recommended by some, is very prejudicial.

Thirdly. They should be lixiviated with twelve times their weight of boiling water. A drop of the solution of corrosive sublimate will immediately discover when the water ceases to take up any more alkali. The earthy matter that remains is said to be a good manure for clayey grounds.

Fourthly.

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Fourthly. The ley thus formed should be evaporated to dryneſs in iron pans; two or three at leaſt of theſe ſhould be uſed, and the ley, as faſt as it is concentrated, paſſed from one to the other: thus, much time is ſaved, as weak leys evaporate more quickly than the ſtronger. The ſalt thus procured is of a dark colour, and contains much extractive matter; and, being formed in iron pots, is called *pot-aſh*.

Fifthly. This ſalt ſhould then be carried to a reverberatory furnace, in which the extractive matter is burned off, and much of the water diſſipated; hence it generally loſes from 10 to 15 *per cent.* of its weight. Particular care ſhould be taken that it do not melt, as the extractive matter would not be thoroughly conſumed, and the alkali would form ſuch an union with the earthy parts as could not eaſily be diſſolved. I add this caution, as Dr. Lewis and Mr. Doſſie have inadvertently directed the contrary. This ſalt, thus refined, is called pearl-aſh, and muſt be the ſame as Dantzic pearl-aſh *.

* The French call the refined aſh *potaſſe*, and the unrefined *ſalin*.

For

For the moſt œconomical conſtruction of a laboratory and furnaces for the above operations, I refer to the deſcription given in a French tract, called *L'Art de fabriquer le Salin & la Potaſſe*; and ſhall only add, that if the ſalt were extracted by a fire ſupported by vegetables, whoſe aſhes might afterwards be employed, no inconſiderable advantage would be gained. Pearl-aſh is frequently tinged green, or blue; this colour it acquires during fuſion, not from any union of the ſalt with phlogiſton, as was formerly ſuppoſed, but by reaſon of the manganeſe contained in the aſhes of almoſt all vegetables, as Mr. Scheele has ſhewn. When it is calcined without melting, it is as perfectly white as Dantzic pearl-aſh.

SECTION VIII.

Of the colouring Matter of linen Yarn, and its Solvents.

Having, through the obliging attention of Mr. Arbuthnot, procured a ſufficient quantity of alkaline ley ſaturated with this colouring-matter, or, as the workmen call it, *killed*, and which they are

in

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in the habit of throwing away, I found it to be a turbid liquor, of a reddiſh brown colour, a peculiar taſte, and ſtrong ſmell, affording no ſign either of acidity or alkaleſcence. On five quarts of this liquor, I poured two ounces of weak marine acid; there was no effervеſcence, but a copious depoſition inſtantly took place, of a greyiſh green colour, and the liquor freed from this depoſit was of the colour of red amber.

The next day I drew off the liquor with a ſyphon, and poured two quarts of pure water on the depoſited matter, and, having agitated the whole, ſuffered this matter again to ſubſide, drew off the water, and added two quarts more; this liquor gave manifeſt ſigns of acidity, and continued ſomewhat reddiſh. Preſuming that, after the addition of ſo much water, this acidity could not proceed from the ſmall quantity of marine acid I had uſed, more eſpecially as the liquor originally contained an alkali, in the ſaturation of which the greater part of the acid muſt have been employed, I began to ſuſpect that this ley contained an acid of its own, which was diſengaged and ſeparated from the alkali by the marine acid, as the

more powerful of the two; and hence I reſerved the two quarts of liquor laſt added, for ſubſequent experiments.

After repeated effuſions of cold water, when the characters of acidity were ſcarcely any longer perceptible, I threw the depoſited matter on a filter, and ſuffered it to dry for ſome time; it was then of a dark greeniſh colour, and ſomewhat clammy, like moiſt clay. I took a ſmall portion of it, and added to it ſixty times its weight of boiling water, but not a particle of it was diſſolved. The remainder I dried in a ſand heat; it then aſſumed a ſhining black colour, became more brittle, but internally remained of a greeniſh yellow, and weighed 1½ ounce.

By treating eight quarts more of the ſaturated ley in the ſame manner, I obtained a farther quantity of the greeniſh depoſit; on which I made the following experiments.

Firſt. Having digeſted a portion of it in rectified ſpirit of wine, it communicated to it a reddiſh hue, and was in a great meaſure diſſolved; but, by the affuſion of diſtilled water, the ſolution became milky, and a white depoſit was gradually formed:

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formed: the black matter diſſolved in the ſame manner.

Secondly. Neither the green nor the black matter was ſoluble in oil of turpentine, or linſeed oil, by a long continued digeſtion.

Thirdly. The black matter, being placed on a red-hot iron, burned with a yellow flame and a black ſmoke, leaving a coaly reſiduum.

Fourthly. The green matter, being put into the vitriolic, marine, and nitrous acids, communicated a browniſh tinge to the two former, and a greeniſh to the latter, but did not ſeem in the leaſt diminiſhed.

Hence it appears, that the matter extracted by alkalies from linen-yarn is a peculiar ſort of *reſin*, different from pure reſins only by its inſolubility in eſſential oils, and in this reſpect reſembling lacs. I now proceeded to examine the power of the different alkalies on this ſubſtance. 8 grains of it being digeſted in a ſolution of cryſtalized mineral alkali, ſaturated in the temperature of 60°, inſtantly communicated to the ſolution a dark brown colour: two meaſures (each of which would contain eleven penny-weights of water)

 did

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did not intirely dissolve this substance. Two measures of the mild vegetable alkali dissolved the whole.

One measure of caustic mineral alkali, whose specific gravity was 1,053, dissolved nearly the whole, leaving only a white residuum.

One measure of caustic vegetable alkali, whose specific gravity was 1,039, dissolved the whole.

One measure of liver of sulphur, whose specific gravity was 1,170, dissolved the whole.

One measure of caustic volatile alkali dissolved also a portion of this matter.

Though these experiments were fully sufficient to resolve my own doubts, yet, to render still more satisfaction to bleachers, I repeated them with the salts they generally use, and also with soap.

I therefore dissolved one ounce of sweet barilha, Dantzic pearl-ash, Cunnamara kelp, cashup, and Clarke's pearl-ash, each in six ounces of pure water; and putting, in one ounce-measure of each solution, 8 grains of the green colouring-matter, set them to digest in a heat of

about

about 180°, for 3½ hours. At the end of this time I found that

The Dantzic salt dissolved more than the barilha.

The kelp as much as the Dantzic salt.

The cashup, and Clarke's ash, dissolved the whole.

Hence, I added half an ounce more of the solutions of Dantzic salt, barilha, and kelp; the Dantzic salt, and the kelp, then dissolved the whole; but, of the solution of barilha, two ounces were requisite to perform this effect.

I also dissolved half an ounce of Windsor soap in eighteen ounces of water. The solution was turbid, and could not be rendered transparent, except when it was near boiling, and then it was very unmanageable; for, when boiled, it spouted three feet high out of the bottle. Three ounces of this solution were requisite to dissolve eight grains of the colouring-matter.

Now, to compare the powers of these different solvents, we must remark, that as an ounce of barilha contains 115 grains of mere alkali, the solution of it being made in six ounces of water, each

each ounce of the ſolution muſt contain the fixth part of 115, that is 19 grains; and, in the ſame manner it will be found, that an ounce of the ſolution of Dantzic ſalt contains 50 grains of mere alkali; that of Cunnamara kelp 2,8 grains; that of caſhup 15; and that of Clarke's aſh 21.

Therefore 4,2 grains of ſaline ſubſtance of kelp performed the ſame effect,

As 75 of that of Dantzic ſalt,
38 of that of barilha,
15 of that of caſhup,
21 of that of Clarke's aſh,
213 of ſoap.

I alſo tried the power of lime-water, but found that three ounces of the ſtrongeſt diſſolved very little of the colouring-matter, as ſhould be naturally expected; for, the three ounces did not contain above three grains of lime, nor did the mixture of ſulphur render it more active.

From the foregoing experiments we may now deduce the following practical propoſitions.

Firſt. Liver of ſulphur is, of all alkaline compounds, the ſtrongeſt ſolvent of the colouring-matter; next to this the cauſtic vegetable, and after this

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this the cauſtic mineral alkali; the mild vegetable, and the mild mineral alkali occupy the laſt place. Sulphur, it is ſaid, leaves a ſtain in linen; but, if liver of ſulphur be uſed in the beginning, that is to ſay, in bleaching the yarn, the ſtain will probably be removed by the purer alkalies afterwards uſed. Hence, the ſolutions of kelp, caſhup, and markoſt, are advantageouſly uſed in the firſt proceſſes of bleaching, for which Dantzic ſalt and ſweet barilha are leſs fit; but ſix tons of kelp will be neceſſary to produce the ſame effect as one ton of caſhup; yet, as the former is manufactured at home, it deſerves the preference.

Secondly. As the alkali manufactured from inland weeds is more powerful than the mineral, Mr. Clarke's is more powerful, or may be rendered ſo, than any imported. It is already ſufficiently cauſtic, and may be converted into liver of ſulphur, only by adding $\frac{1}{20}$ of its weight of ſulphur to it when boiling; and thus it is fitted for the firſt proceſſes of bleaching. In its primitive ſtate it is fit for the ſecond proceſs; and, by rendering it milder, which may be effected by burning half a buſhel of charcoal in a pan, in the

ſame

ſame room in which its ſolution ſtands, it will be adapted to the laſt proceſſes, in which a leſs active alkali is required.

Thirdly. Mr. Clarke's ſalt, converted into liver of ſulphur, is preferable to kelp, becauſe this latter, by the preſent manner of manufacturing it, holds charcoal in ſolution; this coaly matter it depoſits on the yarn, and thus leaves a black tinge; whereas Mr. Clarke's is free from this contamination, to ſay nothing of the far greater quantity of alkali it contains, which is ſuch that one ton of it is nearly equal to eight tons of kelp. Hence it clearly follows, that the linen manufacture ſtands in no ſort of need of foreign ſalts or aſhes, for the proceſſes of bleaching.

The chief defect in Mr. Clarke's manipulation is, the loſs of time during what he calls the *maceration* of aſhes and quick lime; by barely moiſtening them, the ſame effect may be produced, in nine hours, as he expects from their maceration during nine months; and much more lime is uſed than is neceſſary.

Dantzic pearl-aſh contains much more alkali than Clarke's; this muſt proceed from the ſupe-

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rior quality of the ashes from which it is extracted. Those I received from Mr. Clarke were exceeding bad; nor do I believe that any crude ashes can be advantageously used in bleaching. But, if some persons, in the different manufacturing counties, would allot a few acres to the culture of wormwood and fumitory, I believe their own advantage, as well as that of the public, would thereby be considerably promoted. An acre will, I suppose, scarcely produce less than four tons of the dry weeds; each ton will afford nearly 200 weight of ashes, and each ton of wormwood-ashes will give nearly 1500 weight of unrefined salt, or 1300 of the refined.

The alkali, manufactured after the manner I have indicated in the seventh section, may not be sufficiently caustic for the earlier operations of bleaching; but, by the addition of half a pound of quick lime to every hundred of the salt, or of ten pounds for every ton, it will be rendered sufficiently sharp. There is no danger that any of the lime will remain in the ley; but, if any should, it will be immediately discovered, and deposited, by the addition of a little of the unmixed ley.

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XLVIII. *Enquiry into the comparative Intensity of the Heat produced by the Combustion of Charcoal, and charred Turf.* By *M.* SAGE.

From the MEMOIRS of the ACADEMY of SCIENCES of PARIS.

TURF reduced into the ſtate of coal, or charred, is capable of maintaining a livelier and ſtronger heat, and one of longer duration, than charcoal. This is ſhewn in the following experiments; but, to char the turf, by any means except by diſtillation, is a difficult operation; for, when it is done by ſtifling, as is practiſed in making charcoal, a kind of pyrophorus only is obtained. This pyrophorus is produced by the decompoſition of the ſelenite which is in the turf; the vitriolic acid of which combines with the phlogiſton of the coal, and forms ſulphur; which,

2 being

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being united with the earth of the ſelenite, conſtitutes pyrophorus.

When turf is charred in the beſt manner, it always contains a portion of earthy liver of ſulphur, which is decompoſed during the combuſtion of the turf. This decompoſed liver of ſulphur blackens and ruſts copper, tarniſhes ſilver, and ruſts iron; and, at the beginning of the combuſtion, even of the beſt charred turf, there is diſengaged a remarkable hepatic ſmell.

The comparative examination of the intenſity of the heat produced by burning charcoal, and charred turf, proves, that the heat of the latter is nearly in the proportion of three to one.

I had two round furnaces of ſix inches diameter, the fire-place of which was four inches and a half in height, and the aſh-hole four inches. I filled one of theſe furnaces with charcoal, and the other with charred turf; and then kindled them, by putting a live coal upon the top. I let both theſe burn, without ſtirring; and placed over them two ſmall bars of iron, upon which I put two ſaucepans of copper tinned, each of which contained three pints of water: the diameter

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meter of the ſaucepans was ſix inches and four lines, their height two inches and nine lines, and their thickneſs one line.

The charcoal-fire cauſed four ſaucepans of water to boil in fifty minutes.

The firſt boiled at the end of			14 minutes.
The ſecond	-	-	11
The third	-	-	12
The fourth	-	-	13

The charcoal burned without any flame, and did not alter the colour of the ſaucepans.

Charred turf, made by ſtifling, at firſt emitted a fetid ſmell, to which ſucceeded a briſk flame, without any ſmell. This turf cauſed eleven ſaucepans of water to boil in one hour and fifty minutes *.

The firſt boiled at the end of			13 minutes.
The ſecond	-	-	7

* Either this or ſome of the following portions of time muſt be wrong; as, when added together, they produce only one hour and forty-three minutes.

The

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The third	-	-	6 minutes.
The fourth	-	-	5
The fifth	-	-	6
The fixth	-	-	7
The feventh	-	-	$7\frac{1}{2}$
The eighth	-	-	$7\frac{1}{2}$
The ninth	-	-	10
The tenth	-	-	15
The eleventh	-	-	19

The charred turf made by diftillation kindled more flowly, and emitted a lefs difagreeable fmell; its flame was not fo brifk. It caufed eleven faucepans of water to boil in two hours, fix minutes and a half *.

The firft boiled at the end of 33 minutes.			
The fecond	-	-	12

* Here is another error; the following numbers amount to two hours, fixteen minutes and a half.

We cannot help alfo remarking, that although the author, in the firft paragraph, fpeaks of diftillation as the beft way to procure good charred turf, yet, according to his experiments, that which was made by ftifling was fuperior, in its power of producing heat, to that made by diftillation.

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The third	-	-	8 minutes
The fourth	-	-	8
The fifth	-	-	7½
The ſixth	-	-	7
The ſeventh	-	-	7
The eighth	-	-	8
The ninth	-	-	10
The tenth	-	-	15
The eleventh	-	-	21

One pound and a half of charred turf, which ſerved for theſe experiments, was not conſumed in leſs than four hours; it left five ounces of reddiſh aſhes, which contained calcareous earth, ſelenite, argillaceous earth, and a ſmall quantity of liver of ſulphur.

One pound and three ounces of charcoal was conſumed in two hours, and left five drachms of alkaline aſhes.

The charred turf produces more heat than charcoal during its combuſtion, becauſe, as it waſtes leſs, it contributes to the decompoſition of a greater quantity of air; and conſequently the heat it occaſions is greater, and of longer duration.

XLIX.

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XLIX. *On the Means of watering Kitchen-Gardens, &c. upon a large Scale. By M.* SYLVESTRE, *Member of the Academy of Dijon, &c.*

WITH A PLATE.

FROM THE *JOURNAL DE PHYSIQUE.*

THE attention which nature beſtows on the vegetables ſhe produces is ſufficient for the wants of thoſe which grow ſpontaneouſly; but almoſt all the vegetables of our kitchen-gardens are either exotic, or are too tough to ſerve for our food in their natural ſtate; they require the care of the gardener, to enable them to reſiſt the enemies which prey upon them, and to overcome the unfitneſs of the ſoil into which they have been tranſplanted, and become proper for the food of man, or other animals. Tilling the earth, manuring it, and watering it, are the moſt efficacious means of producing theſe effects. The two firſt

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first of these are treated of so fully, in various works on agriculture, that I shall not say any thing respecting them. The last has been less considered by theorists; and those who have written on that subject seem to have moved in a narrow circle. The small number of their works presents always the same facts, and the same methods; of which they know only three different ones, *viz.* irrigation or watering by trenches; making use of a watering-pot; and sprinkling by means of a brush, or similar instrument. As the last method is only applicable to pots, or boxes of plants, I shall not take any farther notice of it; the other two methods are the only ones which merit our attention. It would be difficult to determine when watering by trenches was first thought of; we know that the Egyptians, the Greeks, and the Romans made a constant use of it. It was for them that Archimedes invented the screw which bears his name; it was for them that men who seem to have thought nothing of time and expence, but to have considered only the durability of their works, constructed those immense reservoirs, and those surprising aqueducts, which never

fail

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fail to impreſs our minds with wonder and admiration. The Chineſe are the only people who, in our time, have conſidered nature upon ſo large a ſcale as the ancients; and have, in conſequence, interſected their country with canals which carry plenty to every part of it. To their precautions in this reſpect are owing thoſe rice-fields which, without inconvenience, they can increaſe to any extent; while apprehenſions of their being prejudicial to health prevent us from cultivating the uſeful grain they produce.

Many authors have treated profeſſedly of the rules to be followed in making theſe canals for irrigation. Vitruvius was the firſt who did ſo; and, ſince that time, Belidor, Lecke, and M. Bertrand, have given to the public the reſult of their experience. They all agree, that the meadow which is to be watered in this manner muſt be in the neighbourhood of a river, or pond, that can furniſh a ſufficient quantity of water; that it muſt have a declivity of about eight or ten inches in one hundred fathoms; and a canal in the middle, which is to be conſidered as the main ſtream, and is to ſupply the ſmall branches or trenches,

which in soft soils should be carried to the distance of about thirty feet, and in hard ones to the distance of about fifty feet. These canals, if made in the best manner, should be paved, or lined with clay.

In the Annals of Agriculture for the year 1786, M. Desmarets mentions a method of watering, which he saw practised with success in Champagne, in a meadow which had a very small degree of inclination, and in the middle of which flowed a pretty large rivulet. Sluices were constructed on the rivulet, at from one hundred and fifty to two hundred fathoms distance; and by stopping the stream, it was made to overflow and discharge its water successively into the space between the sluices: thus every part of the meadow was watered in a short time. The various methods which are followed with advantage in the Milanese, in Piedmont, in Flanders, in Switzerland, in the low countries, and in many parts of France, particularly Dauphiny, Roussillon, and Provence, are attended with some difficulties. It is to be considered, first, that the situation of the ground, and that of the water, must be such as to favour the operation. Secondly,

that,

that, to bear the expence of constructing and keeping in repair the canals, sluices, &c. there must be a coalition of a certain number of persons, through whose grounds the canals are to be conducted. Thirdly; that the loss of ground is pretty considerable. Fourthly; (and this consideration is of consequence,) that much depends upon the manner in which the water is given to the plants; many gardeners having remarked that it is not sufficient that the roots of plants should be watered, but that water should also be thrown on their leaves, which imbibe it with great eagerness, and are thus cleared from the dust which choaks up their pores.

The use of watering-pots is not attended with the above mentioned inconveniences, but it has others which are of no less importance; particularly the great labour of filling the watering-pots, and carrying them to the spot where they are to be used. It is perhaps owing to this difficulty, which renders the labour and expence of watering very great, that kitchen-gardens are so little cultivated in our country. John Leoke, who has

written a very good dissertation on watering, has computed that, in order to water properly a garden consisting of twenty beds, (each bed being supposed to be twenty feet long and three wide,) one thousand seven hundred and fifty pots of water, each containing the fifth part of a common watering-pot, would be required; and that we should consequently be obliged to fill one watering-pot more than three hundred times: a degree of labour which appears impracticable, particularly when it is considered that the water must be drawn or pumped up from a well, or taken up, by dipping, from a river. As a remedy for these inconveniences, he proposes that only a quarter part of the ground shall be watered on one day, which part is to have the full quantity of water. He says, that when all the ground has been watered in this manner, we may rest for four days: thus each part will be watered once in eight days, which, he thinks, will be sufficient in the most dry seasons. It is evident that this method is very defective; as it drowns the plants one day, and leaves them in want of water the following

seven,

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ſeven. The moſt experienced gardeners agree, that watering ſhould be performed in an equal manner, and repeated regularly; otherwiſe they think it better not to water at all.

These conſiderations led me to conſider what means might be ſubſtituted to thoſe already in uſe; and the firſt idea that preſented itſelf to my mind was, to make uſe of an engine; but, as that method cannot be adopted with advantage, except where the reſervoir of water is higher than the ground to be watered, I thought it would be better to contrive means for carrying about the ground ſuch a quantity of water as would render it ſeldom neceſſary to return to the place where it is procured. The diſtance between the wheels of carriages making it difficult to employ them in gardens, I tried a carriage with a ſingle wheel, and found that ſuch an one, which would only require walks of eighteen inches in breadth, would ſupport a caſk of a proper ſize; by means of which beds of ten or twelve feet wide might eaſily be watered. This carriage might be drawn by a mule, or an aſs, and one

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one man (whose business it would be to guide the animal, to support the carriage in places where it might be liable to be overset, and to open and shut the cocks when necessary,) would thus be able to water a great space of ground in a short time.

Many persons have suggested, that making use of only one wheel to the carriage would cause too great a degree of friction, and that it would be impossible to turn the carriage, without taking up a large space of ground for that purpose. This last inconvenience would not take place, if the beds and walks of a garden were originally formed with a view to the use of such a machine; it might however be found convenient to form the carriage with two broad wheels, which should have only an interval of two inches between them; this would facilitate the going of the machine, and would not require above six inches more width in the walks. Another objection, not less important, has been made respecting the fluctuation of the water as it goes along. The usual practice of water-carriers pointed out to me the remedy for this;

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this; and I propose to have a number of planks united by bands of leather, which shall be fixed in the inside of the cask, on a level with its greatest diameter; and which, swimming upon the surface of the water, shall rise and fall with it.

It has been thought, that it would be advantageous to keep the water parallel to the axis of the cask, (whether the carriage went up hill or down,) that the weight might never be too much increased either forwards or backwards. This difficulty it appears impossible to remove, without rendering the machine rather complicate. Of various methods which have occurred to me, the most simple is, to support the fore part of the cask in a firm manner, and to let the hind part rest in a semi-circle formed of several bands of iron, which, by means of a sort of rack, (to be moved by a handle, at the will of the conductor,) might be so managed as to keep the water always in a line with the axis of the cask. This might be done with great exactness, by the help of a level, provided those who conduct the great operations of agriculture could attend to such minutiæ.

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The figures in Plate XXIII. ſhew the various ways in which ſuch a machine may be uſed, according to the different purpoſes for which it is required.

In Fig. 1. the pipes for watering, which terminate in what are called *roſes*, are all on one ſide of the caſk. The man who conducts the machine is ſuppoſed to be going to ſhut the cock.

In Fig. 2. the watering-pipes are placed behind the caſk. The machine has two wheels, to render it more convenient for turning.

In Fig. 3, a long leathern pipe, terminating in a roſe, is fixed to the caſk, inſtead of the uſual watering-pipes. The man holds the leathern pipe in one hand, and with the other directs the roſe, ſo as to throw the water wherever he wiſhes it ſhould fall.

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Fig.1

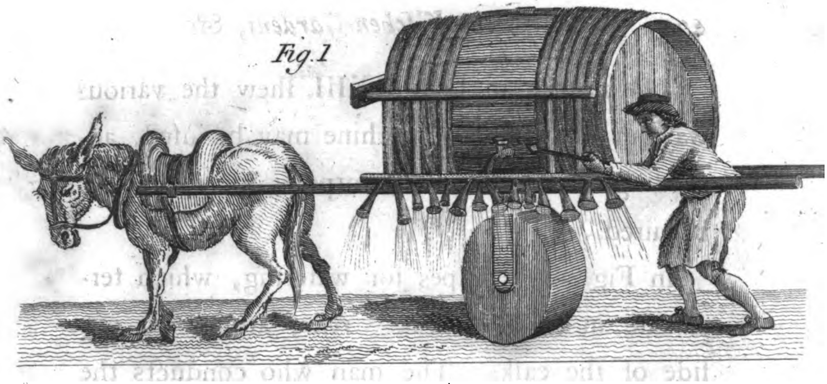


Fig.2

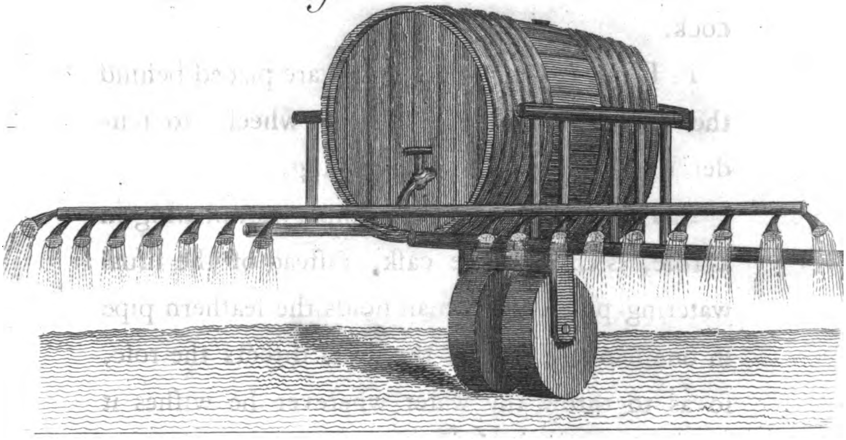
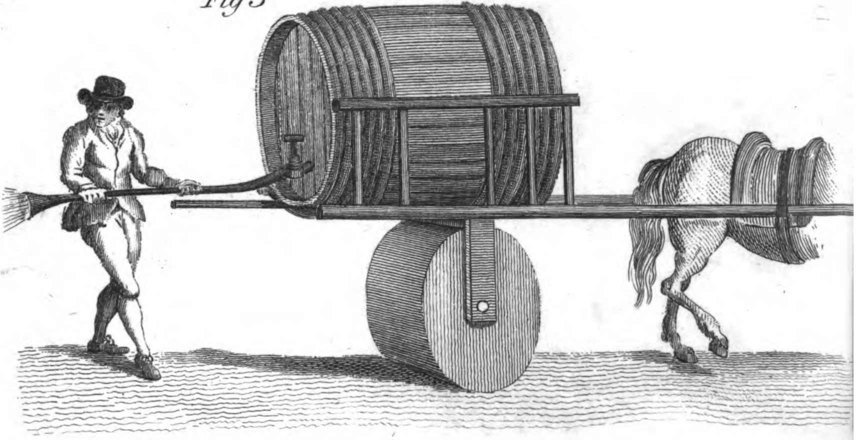


Fig 3



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INDEX

TO THE

FIFTH VOLUME.

A

Car-

Digitized by Google

Pearson,

Digitized by Google

Digitized by Google

W *Ward*,

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W

Y

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