"A Visit to the Works of The Lanston Monotype Corporation"

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THE E N G I N E E R

FER. 20, 1914

THE PUTLITOW WORKS AT ST. PETERSBURG.

The Putlitow Works, in connection with which there has been so much discussion during the last fortnight owing to their reported absorption by the Krupp-Ensinger group, are situated in the picturesque town of Byborze near a number of large department stores. The works employ probably more men than any other commercial plant in all Russia. The company cannot be called a Russian one, for it is of Danzig origin and is largely owned by the great German industrial corporation, Krupp. The position of Putlitow is somewhat curious one, in quite a number of respects. While the works employ a large number of persons, the works have never been a commercial success. A recent strike of the workmen was largely the result of a dispute between the company and the workmen as to what the company considers the proper rate of wages. The dispute was settled by a court decision, but the workmen have been extremely restive, and the company has been unable to induce them to work. The position of Putlitow is such that it is impossible to say whether the company will be able to continue to operate it, or whether it will be forced to close it down.

A second large group is known as the mechanical department, and in this there are four principal making sections: (1) machine tools; (2) machine tools for the production of machine tools; (3) machine tools for the production of machine tools; and (4) machine tools for the production of machine tools.

The company has a large number of employees, including skilled workmen, and the company is able to produce a large number of different products. The company is able to produce a large number of different products, including machine tools, machine tools for the production of machine tools, and machine tools for the production of machine tools.

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The work involved in the manufacture of a matrix may be divided into two parts, namely, the production of a steel punch and the employment of this punch as the means of impressing the letter on the matrix. The life of the steel punch varies in length, but is never very long. It may break or otherwise fail after the first one or two matrices have been punched from it, or it may last for several hundred impressions. Again, although the common run of work in the factory is for letters standardised as to size and character, still numerous requests are received for special characters or for ordinary characters departing in some slight way from the standards. It is, therefore, surprising to find that the punch cutting departments at the Redhill factory are extensive and are kept constantly employed. We will deal with these departments later.

We start in the Type Drawing Room. In this and the immediately succeeding departments the object aimed at is the production of metal patterns for use in the punch engraving machines. These patterns consist of standard or special type of different size, in a suitable holder, and on each is engraved a square of light from a 2500 candle-power lamp is thrown down by a 45 deg. mirror. The beam reflected by the waxed plate thus engraved is taken to the electro-plating room, where it is dusted over with powdered graphite. A small border of copper is also deposited about 0.002in. of copper has been deposited on the surfaces dusted with graphite. Backing metal—lead or copper—then melts off the face and leaves a copper plated metal pattern on which the letter, now no longer reversed, is reversed and engraved. The plate is dressed to a standard size, the distance from the base of the letter to the distance marked A in Fig. 3—is carefully gauged, and a small V notch, B in the same figure, cut in the top corner of the letter.

The finished pattern then passes to the punch-engraving room. The punches—see Fig. 2—are made from steel of a hardness from 50 to 55 H. K. V. in length. The machines employed in the work of punching out the letters of the alphabet are arranged in the point of the punch are among the most interesting in the works. An illustration of one of these engraving machines is given in Fig. 5. The letters are engraved on a large scale, the formation of standard, as well as of special type or of other type which are to be copied. The standard or special type are existing, face upwards, in a suitable holder, and on each is engraved a square of light from a 2500 candle-power lamp is thrown down by a 45 deg. mirror. The beam reflected by the waxed plate thus engraved is taken to the electro-plating room. Here it is heated up in a salt bath—that is, one containing the chlorides of sodium and barium—bichromate of potash, kept at a steady heat, and carefully watched by means of a pyrometer. At the right moment, when the correct light moment, when the correct light moment, the copper plate is taken out of the bath and, as it is taken out, it is struck by a series of blows, which are each made at the precise moment when the plate is at the correct temperature. These blows are made at the rate of 200 per minute and are struck by a hammer 250 lbs. weight, and are each sufficient to knock off enough copper from the plate to make a hole of 0.0002 in. diameter. It is clearly only possible to increase the thickness of the edges by this polishing process—that is to say, to correct for over-engraving. If the letters are already too broad, the punch is thrown away. It may be remarked, however, that wear of the engraving punches is usually slow, in general, if over, rather than in under, engraving. The maxims of the letter becomes the measuring mark in its form, and that all the letters which are exactly as is on the printed page. The comparatively rough pencil sketch is then taken in hand by girl tracers for rectification. Irregularities are rectified on the tracer, and slight adjustments made in the dimensions of the letter where required. The result is an enlarged copy of the standard or special type, with all their little defects suppressed.

The method next taken is a panto- graph reducing machine, whereby it is reproduced one quarter of the original size on to a zinc plate covered with a layer of special wax, about 0.010 thick. The waxed plate, it may be noted, rests, while being engraved, on an electrically heated copper plate just sufficiently warm to preserve the wax at a glassy state working temperature. The outline only of the letter is cut upon the plate, but when the wax-cooled interior of the letter is lifted off by graving tools, so as to expose the zinc backing. The needlelike point of the graving tool is placed upon the wax, which, when touched, cuts a burr on the wax, which burr must be removed before the plate is complete. This is done by running the plate over an electrically heated knife, sunk almost flush into a metal table. The burr is removed in this manner less by actual cutting than by melting it off.

Another trick which this apparently trivial circumstance of introducing into the manufacture of the Monotype matrices will be appreciated when these articles have been concluded.

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The matrix is, however, productive of greater benefit and much advantage when the thickness of the burr left by the hypothetical engraving tool would be tedious and difficult.

The material of which the matrices are formed is gun- bronze, 9 of copper to 1 of tin, and is received at the factory in the form of rolls of square-section wire measuring about 1 in. by 1 in. in cross area. It is impossible to obtain the stock constantly of the required dimensions and temper, and hence it is necessary at the Redhill factory to pass the material through the power-driven rolling machine shown in Fig. 6. The stock to be seen in this engraving passing into the machine on the left-hand side. The rolling down reduces the sizes of the material almost to the exact sizes required, and the finished stock is trimmed to size at 0.005-in. The reduced stock, at the other end of the machine, is cut off by a saw to the length required, say, 12 ft. As the rolling down is carried on continually, the saw blade, while cutting off the stock, travels forward in the same direction and at the same rate as the mating material. The matrix blanks are turned out at the rate of 40 per minute and, passing down the pipe A, Fig. 6, are caught in a receptacle below.

The matrix blanks are next taken to a comparatively simple design of machine, which stamps certain designations and reference figures on one of the long sides and chamfers the four edges of each of the square ends. All the operations of this machine are quite automatic. The next process is to bring the blanks more exactly to the size required than is possible by any rolling process, however carefully conducted. The method employed is, it need hardly be said, that of forging, and for this purpose metal wheels charged with diamond dust are used. These wheels, it may be noted, run submerged in a bath of paraffin oil and do not require re-charging otherwise than once a year. The dust employed is made on the premises by pounding black diamonds and grading the product by abrasion. The wheels employed are of soft steel and under the microscope the diamond grains, as the result of merely spreading the dust over the surface and pressing it into the metal, can be seen to be firmly bedded into the surrounding metal just as if each one had been set by a jeweller.

For a reason to be explained later, the blanks are ground on the diameters until they are 0.0005 smaller in cross section than they have to be when finished. Plate-gauges are employed to determine when the correct size has been reached. These gauges are examined and re-made if necessary every morning until the blanks are slightly too large, and then marked with two cross lines at about the middle of their length. The matrix blank has to come to rest somewhere between these cross lines; if it goes farther up it is discarded.

The next step is to bore a small conical hole in one end of the blank by means of a small automatic machine. This cone is the forerunner of the completed cone shown in Fig. 2. The latter cone is, as we have already said, required for locating the matrix in its exact position in the casting machine, and must fit a certain conical spike in the anatomy of that machine without shake. It cannot, therefore, be bored or lathe turned out the blank has a recognition of by the punch, for if it were the pressure involved would be sure to distort it. On the other hand, the cone has to be finished before the matrix goes to the punch press in order that the cone at one end and the mould of the letter at the other may register properly. The difficulty of these contrary requirements is got over by boring a preliminary cone, the apex of which is removed at the centre line of the final cone.

The matrix blank is now ready to receive the impression of its letter from the appropriate punch, the matrix and locates it accurately. The press head carrying the steel punch now descends and impresses the end of the matrix with the image of the letter. The impression is carried as far as it will go—that is to say, until the shoulder of the punch meets the top of the matrix. The press head then rises, the bolster revolves, and a finger pushes the stamped matrix out of the hole in the bolster.

A curious point has here to be noticed. The hole in the bolster is a very exact fit for the matrix blank—that is to say, it is 0.0005 smaller each way than the finished matrix is required. Yet when the matrix is taken out of the bolster after having been stamped it is found to be 0.0005 in larger than the hole, or, in other words, the object of the second grinding is to remove such defects and bring the body to the correct final size. Gauges are again employed to test the accuracy of the process, and as an additional check performed on the matrix blanks are selected at random and examined for fit within a gauge 0.0005 in. square.

The International Conference on Safety of Life at Sea.

For a proper appreciation of what Lord Mersey rightly described as "the great work, which the Inter-

national Conference on Safety of Life at Sea has recently been engaged in perfecting," it is necessary roughly to review the history both of the improvement in the design of passenger steamers and the increased safety of Transatlantic travel on the one hand, and that of national and international attitudes towards steamship companies and the provision of life-saving appliances that the ships of each nation are required to adopt on the other. In recent years there has been a steady tendency on the part of the great Powers in the direction of making the safety regulations for ships international, and the question of the extent of the regulations had already been under discussion prior to the terrible loss of the Titanic in April, 1912, which disaster was really the direct cause of the Conference being convened. That an International Conference should be held to consider and, as far as possible, to agree on a common line of conduct, with respect to the building features affecting the safety of ships and passengers at sea, was the final recommendation of the court of inquiry into the circumstances attending the loss of the Titanic, and, although the convening of such a meeting had originally been suggested by the German Emperor, it was ultimately left by arrangement to the British Government. In the course of last autumn a Delegation of the principal foreign maritime States to meet together with the object of devising means by which greater security could be attained, and of arriving at an agreement as to the application of these means to passenger traffic. The Governments concerned cheerfully responded to this invitation, with the result that the Convention was completed on January 20th this year. It was estimated that the loss of the Titanic two years had elapsed since the sinking of the Titanic before any international agreement on the requisite regulations for the safety of passenger ships. The conference is convened here, before considering the text of the Convention, to recall the attitude of the British Board of Trade on this question.

Up till 1886, a period when the crook vessels of the day were the Aurora, Svea, and Arizona, and the then Union, and the letter box in particulars that was enforced by law was regulated by the Passenger Act of 1853, which provided for 216 people as a maximum—that is to say, that a liner such as the above, leaving port with a thousand passengers and a crew of two hundred, needed only to carry boats capable of holding 216 people. In the course of 1866 the Board of Trade appointed a Departmental Committee to inquire into this question of boats and life-saving apparatus, and it was afterwards this committee pointed out that boats would be of little use unless they might for a time prolong life—unless success were at hand from other ships or from a near shore. Referring particularly to the North Atlantic trade, the committee said:

...
resonance is very similar. In plan the general arrangement of the five turrets, each mounting two 11in. 30-calibre weapons, is the same as before, and is similar to the design of the "British India" "Lützow" classes ordered about the same time. In profile and section the length of the ship tends to cause crowding, a fact that is considerably accentuated on the main deck by the two extra funnels on the starboard side of the ship. The height of training possessed by the big guns without mutual interference that so distinguishes the battle-cruiser. The design is a most vigorous one, as well as the armouir protection, is exceptionally strong. The 11in. gun is the highest of the five, being fired from 3ft below the normal water-line to 6ft, above, and is 11in. thick, but tapers off to 6 in. at the lower edge of the gun, then to 4in. of 6in. below, another of 8in. The 6in. gun battery is protected by 6in. armour. This belt extends from forward to aft, both on the top and on the plates of the turrets. The protection of the superstructure and in general neatness of design. As regards work- manship, no criticism whatever can be made; it is generally extremely good. The heart of making one detail serve wherever possible more than one purpose is probably better understood by German designers than by any others. Nearly all the newer vessels are fitted with anti-rolling tanks. Exceptional arrangements are made to facilitate rapid coaling. Where we consider, however, that British vessels are really very superior in the shape of hull, both above and below water. The German armament, above, these German vessels are designed for use in narrow seas rather than oceans, must never be forgotten when attempting to form any reliable idea of their many merits.

A VISIT TO THE WORKS OF THE LANSTON MONOTYPE CORPORATION.

Fig. 8.—MACHINING AND MILLING MACHINES.

It will be perceived that the needle when adjusting the matrix in the jaws has to penetrate the impression line by the punch until its point strikes against the actual face of the letter. Now, the letters of our alphabet were not designed with much science, for by superposing three letters such as X I it will be found that there is no point common to all the characters. This is unfortunate from the point of view of the machinist as he is now dealing with, for it clearly means that the position of the arm when a raised into the adjusting station, Fig. 9, cannot be kept constant for all letters. Means must be provided slightly to vary the position of the arm relatively to the matrix so as to allow the different points of the station may be moved parallel with itself in the vertical and in the horizontal backward and forward. The adjunction of the arm to the matrix in the gear holes, is a thing that is done by mounting the shaft G, Fig. 8, and the two geleys A B on a cradle capable of being pivoted round a position, and the punch B and to the rear of the shaft G. This shaft is indicated in the engraving, the matrix to fall in case of easy. The adjustment of the arm is provided for by means of an adjustable stop against which the arm bears when it rises into position. The accompanying figure is made in this way are, of course, quite small. The greatest required to be made is not sufficient to make a groove, which are cutters, mounted, on the cradle, but the line of the adjustment is, indeed, sufficiently fine to make it desirable to effect them beneath a microscope. In the engraving the light line of vision is reflected through a right angle by a 45 deg. mirror M, provided near its centre with a small glass hole for the passage of the needle. In the operation of this focuses the face of the letter, and when the needle is advanced its point coming into the field of focus appears as a small dot. The arm is adjusted vertically and crosswise until this dot appears somewhere on the centric line of one of the limbs of the character.
During this adjusting process the automatic back-width and forward movement of the needle is, of course, superseded by a hand controlled movement.

The speed at which it is desirable to feed the matrix past the mbling cutters is comparatively slow, and is considerably less than that at which it is desirable and possible to run the machine during the other stages in the cycle of operations. Accordingly, we found embodied in the design an epicyclic speed-reducing gear. During the major portion of the cycle this gear revolves as if it were a solid body, but when the cutters are in action the plate carrying the pair of planet pinions is held stationary by means of a pawl which comes into gear automatically, and the power is transmitted to the arm at a reduced speed.

One of the most interesting parts of the whole mechanism has not so far been mentioned. The forward travel of the needle when it is setting the matrix into its true position in the jaws of the arm is a fixed quantity. Hence, before the machine can be set to work, the impression above that the cutters and their distance apart must be dimensioned and adjusted relatively to the advanced position of the needle in order that they may cut off the required amount of material from each end of the matrix.

The mechanisms which engage axially are simple enough. Their spindles are enclosed in sleeves threaded externally, which sleeves can be advanced or withdrawn by means of a worm wheel and worm fitted with a micrometer head. The distance between the cutters is measured by a standard end gauge, so that the only difficulty remaining to be overcome is to set the cutters relatively to the advanced position of the needle in such manner that the finished depth of impression of the character on the matrix shall conform to the standard.

The method employed is to take a cut with the right-hand cutter, to measure the depth of impression left, to readjust the cutter by means of the head, take a second cut, and so on, until the required accuracy is obtained. The device used for measuring the depth of the impression between each trial cut is a part of the machine, so that the measurement can be effected without removing the matrix from the arm. In Fig. 11 the details of the device are shown. Means are provided in the power drive of the machine to control the forward movement of the cutters for any length of time just at the instant when the arm A, Fig. 11, carrying the matrix B has risen into the matrix adjusting station. The jaws on the arm have not yet been locked, and ordinarily the needle would be on the point of pushing the matrix into its final position in the jaws. The reciprocation of the needle during the normal working of the machine is effected automatically by a reciprocating cam block C. The jaws of which engage with a dependancy D formed in the sides of the block to hold the block. With the movement of the block C is withdrawn by means of a small handle and the needle allowed to move unscrewed, as the case may be, as far as the block will go. A small spring plunger E mounted on the frame of the machine in line with the needle is then advanced and it pushes the matrix with which it is connected to the needle, over the right of the face of the matrix, and all will return to their initial position. The anvil block is situated just in front of the mirror G, and through a hole in it pass the needle and the line of vision reflected by the mirror into the camera.

Clearly now the position of the needle gives a means of measuring the depth of the impression, for the greater the depth the farther over to the left will the needle carrier be.

On the other hand, if we set the arm a metal disc J is inserted inside a casing K. The end of the needle carrier projects through a hole in this casing and a light in the adjacent part of the matrix is focused on the disc J allows the needle to be reciprocated during the normal working of the machine. The disc is not truly circular. It is really a cam formed in a peculiar way. It is ground circular to begin with and is provided with a mesial slot at L. A wedge is driven into and secured in this slot so as to weld the metal. The result is that over the quadrant between the light and the slot the radius of the disc is a gradually increasing one. At the slot the radius is, in actual fact, 0-00972m, greater than it is at the light. Outside the casing K a plate M, provided with a handle N and a scale P, is mounted on the spindle H. O is a gauge mark on the casing. By the rotation of this plate clockwise until the cam portion of the disc J makes contact with the end of the needle carrier a reading is obtained on the scale P, which reading is a measure of the depth of the impression on the matrix end. Since the leverage involved in these details is considerable and since the area of the needle point is very small, this mechanism as so far described could not possibly be operated commercially without the help of a small driving motor.

In Fig. 11—pawl S, and teeth T on a portion of the periphery of the disc J. The plate M carries an insulated plug U which passes through a slot in the cam disc. A spring attached to this plug passes round an insulated collar on the spindle H and is attached to an insulated plug V fixed to the casing K. From the plug V a wire passes to the electromagnet and thence to a battery. The other terminal of the battery is connected to the arm A carrying the matrix. The spindle H is mounted in insulated bearings. Normally the current is out of the circuit. When, however, the handle N is depressed the plug V makes contact with the opposite and metallic side of the slot in which it is situated. Further rotation now turns the cam disc until contact with the end of the needle carrier is established. When this occurs current leaving the battery flows through the arm A, the matrix, the needle and its carrier, the disc J, the plug U, the spring, the plug V, the coils of the magnet, and back to the battery. The energisation of the magnet results in the attraction of the pawl S, the point of which rises upwards enters between a pair of the teeth T and stops further rotation. The pawl S is in two parts, one part being set half a tooth behind the other, so that should one pawl slide off the crest of a tooth the other will fall into the neighbouring trough. The plate M is provided with two horns. One of these limits the return movement imparted to the plate by the spring pulling on the plug U. The other works in conjunction with a stop which renders it impossible to rotate the plate too far. It will be noticed that after a gauging has been made the circuit is broken at the plug U, which for this reason is furnished with a platinum contact. The circuit is not broken at the needle point, for if this were done the face of the letter would be marked with a small burr.

The needle, after the plate M and with it the disc J are returned to their initial positions, is still projecting forward above the level of the matrix. If the figures were resumed in this state the point of the needle would, of course, be broken off. As soon, however, as the handle controlling the restarting is thrown in the cam block C is automatically returned into engagement with the other plug P. The spring then returns and returns, the arm descends to the cutters, and the ordinary cycle is taken up again.

It is clear that the zero of the scale P should be that position in which the disc J looks when an attempt is made to gauge a matrix which has not been through the punch press. For this purpose a standard blank matrix of steel is employed. The zero can be adjusted by means of two micrometer screws bearing one on each side of the lug X. By the adjustment of these screws the whole casing K and its gear is swung round the point Y and the distance between the spindle H and the end of the needle increased or decreased. From the manner in which the case is adjusted it will be understood that the scale P is not one of uniform intervals and that it has to be divided by calibration. Matrix blanks of steel and recessed at one end to different depths are employed for this calibration. The graduations obtained are quite practicable, and the structure is of the sort used about the inch. Yet each interval corresponds actually to a distance of only 0-0001 in., so that the magnification obtained is 2500 to 1. It is, of course, quite easy to read by eye to the quarter of a division, representing an actual distance of 0-0000256 in., and if such an accuracy as this would imply were required we believe that the machine could be so adjusted that the zero of the scale disc, readily enable it to be obtained under strictly commercial conditions with girl labour. In practice, the accuracy obtained is quite as great as this, and accordingly we find that there is no occasion to read the depth of the impression to more than one thousand.

The manner of setting the machine ready for work will now be obvious. First of all, a blank matrix is inserted in the arm and the zero of the scale on the case K is then withdrawn quite out of action until the right-hand one has been properly set. Thereafter the left-hand one is advanced and fixed, and if the zero is judged by means of an end gauge held against the face of the other cutters. This work is, of course, done by a skilled mechanic. The girl put in charge subsequently of the machine has merely to feed the recessed matrices, to turn those on the releasing wheels, to collect those on the collecting lathe, and to adjust the matrix arm vertically and horizontally, as explained above, when a change of letter renders
such a proceeding necessary. Once set correctly the machine could be run continuously without it for the fact that the point of the needle and the teeth of the machine are in the right position. The guard against inaccuracies from this cause the girl from the point of view of the machine and measures the depth of impression on a selected matrix after it has been milled. A little reflection will show that a matrix will reveal the wear which has taken place on the right-hand cutter, and that it will not show the wear on the left-hand cutter. The matrix is used both to position the matrix and to measure the depth of the cavity. The matrix is used to measure such a matrix in the usual way is not zero, the needle point has clearly worn by the amount of the impression of the matrix on the blank surface. Once the matrix is milled, the needle is placed on it and the blank matrix among every galley of matrices fed to the machine until it is sharp enough to go into the arm ready to be used.

With the completion of the milling process described above gives rise to a number of possible trouble with burrs. After the stock had been removed, the matrices in Fig 6 note the blanks were, it will be remembered, taken to a cornering machine wherein the burrs left by the saw were removed by the rounding off of the four corners of each end. The same automatic machinery was used on this process. It is impossible to impossible to make such a matrix in the usual way is not zero, the needle point has clearly worn by the amount of the impression of the matrix on the blank surface. Once the matrix is milled, the needle is placed on it and the blank matrix among every galley of matrices fed to the machine until it is sharp enough to go into the arm ready to be used.

The employment of two drills does not, however, obviate all burring, for a drill throws up a burr on the side opposite to the direction of the rifling after the drill is withdrawn. The burr is produced by the dulling of the matrix end drilled in a new tool break up built and grinded and is returned to the cutting edge of the matrix end. The end of the matrix is then drilled in a specially designed automatic machine wherein the matrix end is pushed against a hardened steel plate, and the cutting edge of the matrix end is sharpened in the same manner in which a file is sharpened.

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A VISIT TO THE WORKS OF THE LANCAST MONOTYPE CORPORATION.

No. III.*

In this, our concluding, article we propose to describe in detail the construction of the punch engraving machine.

This machine—see Fig. 12 (original Fig. 4)—consists of two stout pillars rising from a horizontal base plate and joined solidly together by a cross member near the top. In this cross member a fine-pointed engraving tool is supported, and is rotated by means of a belt driven from the small electric motor. At their very ends the two pillars support a pantograph-like mechanism, which transmits the movement given to it to a punch carrier situated so as to bring the end of the punch directly above the interior of a closed letter such as A, B, C, g, G, O, etc.

Details of the pantograph mechanism are given in Fig. 14. The circular plate A fixed on top of the two inclined columns supports two brackets B in which a frame C, roughly hexagonal in plan, is journaled. At right angles to the brackets B the frame carries two pins D on which a cross bar E provided with four arms F is pivoted. These arms are united by four rods to the cross head below in which the follower spindle is held. The arrangement is thus a gill support. If the follower is moved from left to right the member E turns on the pivots D; if it is moved backward and forward the frame C turns in the brackets B; and if the motion of the follower is compound as it is when a curved letter is being traced out, the frame C and member E will move simultaneously.

At the centre of the member E a boss G carrying a ball is provided with a screwed sleeve H is formed. Over the screwed sleeve a cap J fits loosely. A rod K hangs from the side of the machine below the screw and with a good sliding fit through the hole in the screwed sleeve H and the boss G and terminates in a ball L. It is from this ball that the motion of the gill is transmitted to the holder carrying the punch. The size of the reduction depends upon the exact height of the ball, the lower it is the less the reduction. The adjustment is made by means of a threaded collar M engraved with a scale and working in conjunction with a micrometer N.

If the pins D and the pins in the brackets B are in the same plane—and normally they are—the letter engraved on the punch will be an exactly proportionate reproduction of the letters engraved on the pattern plate. At times, however, requests are received for letters slightly thicker or thinner than, but of the same size as the standard type. Provided the difference is not excessive, it is possible to cut the punches for such letters from the standard pattern. This is accomplished by raising or lowering the pins D above or below their normal position, and therefore bringing the ball L back to its original position. It is clear that by so doing we do not affect the influence of the frame C on the movement of the ball, so that the height of the letter is unaltered. But if we raise the pins D and lower the ball into its original position a given sideways displacement of the follower will produce a greater sideways displacement of the ball than it would do if the pins were not raised. The letter engraved on the punch will therefore be increased in width. To facilitate this adjustment of the pins D micrometer heads are provided.

It is of interest to note that when the first machine was constructed, the frame C was found to deflect when loaded by 0.025 in. as measured at the centre. This caused the pivots in the brackets B to work unevenly, and, further, resulted in slight errors in the proportionality of the patterns. Subsequently the frame were loaded with a weight equal to that ultimately to be borne by them, and when thus loaded the holes for the pivot pins were bored.

The connection between the ball L and the punch holder has now to be described. The ball as shown in detail in Fig. 14 is embraced in a two-part socket, the base portion of which is countersunk to allow for the play of the ball rod. The socket is a good sliding fit inside a short tubular casing Q, carried on two plates R, S, sliding on the circular top A and forming practically an Oldham coupling. The parts A Q E and S are shown in section in Fig. 15. The lower plate E carries two keys T sliding in keyways cut in the upper surface of the top A. At right angles to the line of three keyways, the upper plate E carries a pair of keys U sliding in keyways cut in the upper surface of the lower plate S. On the underside of the top A a third plate V is arranged to slide freely in all directions. The whole system is held together by a member W pinned to the underside of the tube-like casing Q. The holes in the plates H and V just fit the outside diameter of the member W, but the holes in the plate S and the top A are somewhat larger. The lower surface of the member W is formed with a slot X for the reception of the punch holder. H, now, the follower be given a movement from back to front of the machine the thrust of the ball L will cause the plate R and with it the member W and the plate V to move forward on the keys U, the plate S meanwhile remaining stationary. Should the motion of the follower be purely sideways the whole system comprising the plates R S and V and the member W will move sideways on the keys T. A compound motion of the follower results clearly in a similar compound motion of the member W.

The question as to whether or not this mechanism gives a mathematically accurate reproduction need not be debated here. Those who desire to investigate it should note that the stylus over which the followers fit ends in a sphere, and that the corresponding sockets in the followers are hemispheres.

* No. II. appended February 28th, 1914.
holder consists of a semi-dovetail metal wedge provided with a handle and recessed as indicated on the underside. At the centre of the recess a small steel bush pierced with a square hole is let in flush. This hole exactly fits the punch blank, and if wear takes place the bush is readily removed. At the top of the square hole in the bush is a tiny coiled spring, which bears against the end of the punch blank. The gauge shown on the right of Fig. 16 is used to set the punch at the right height relatively to the under face of the holder, and while the gauge is still in position a set screw on the axis of the holder and penetrating the square hole in the bush is tightened up. The punch is thus set and held very accurately in its correct position in the holder.

The holder is then inserted in the slot X.—Fig. 15—until it is brought up against a stop Y. A simple catch, not shown in the engraving, engages in a hole in the side of the tool holder and prevents all movement. The workmen operate on these parts, as indeed on all other parts of this machine, with exquisite beauty. The slightest shake would, of course, upset the accuracy of the whole process.

The engraving tool and its "quill" are shown in Fig. 17. The body A of the quill is a cylinder formed with a race B at its lower end. The body fits into a suitable bearing in the cross bar between the two main columns of the machine and is held up by a catch fitting into the race B. The tool C is formed of tool steel wire 0.056 in. in diameter, ground as indicated in the enlarged view, on four faces. The form of the tool point shown is only approximately accurate. In reality each tool is ground to a shape composed of three flat portions joined by two circularly curved portions. At its end the tool comes to a point as fine as that of a needle. This tool is held in a collet chuck formed on the end of a spindle D, which is rotatable inside the body A. At its lower end the spindle carries a two-armed driver E designed to engage inside the driving pulley F. This driving pulley 540 revolutions per minute. A brass fly G surrounds it and catches the cuttings.

Let us now suppose that a capital letter I has to be cut. Using a standard pattern plate, a large diameter follower, and a square-nosed roughing tool such as shown at A—Fig. 18— the operator cuts the nose of the punch blank until it assumes something like the form shown at B in the same figure. The cameo thus formed has perpendicular flanks. Its shape in plan results from the use of a large diameter follower as indicated in sketch C, Fig. 16. The roughing tool is now removed and the finishing tool shown in Fig. 19 inserted in its place. The first cut is taken with a fairly large diametered follower—say, that shown at A, Fig. 19, and with such succeeding cut the size of the follower is progressively increased until we arrive at cone B, say, which is equal to or less in radius than the smallest radius involved in the outline of the letter.

A little reflection will show that this explanation of the method of working is far from complete. Imagine that instead of the engraving tool shown in Fig. 19 a tiny milling cutter is in use. The path along which the centre of this milling cutter moves is an exact reproduction of the line along which the centre of the follower is caused to travel. If, then, the diameter of the follower bears to the diameter of the milling cutter the same ratio as the height, say, of the pattern letter bears to the height of the letter on the punch, then on the first cut our punch will be completely engraved except at the re-entrant angles. In these we will obviously have a radius equal to one half of the radius of the milling cutter. When, therefore, we take the second cut with the next smallest size of follower we merely reduce the diameter of the milling cutter by one half of the total. For if we did not we would fail to get a smaller radius in the re-entrant angles, and, further, as we would have brought the centre of the milling cutter inwards, we would undercut the letter on its already finished flanks.

It is thus clear that if the punch to be cut is to be one sixtieth the size of the pattern letter, each follower must be used in conjunction with a different milling cutter such that the ratios between the diameters is always 1⁄6. In practice, the equivalent of changing the milling cutters is obtained by lowering the engraving tool in its bearing. This varies the distance marked "d" in Fig. 19, which is equal to the radius of the hypotenuse of the milling cutter.

Fig. 19-TOOL GRINDING MACHINE

There are, of course, some letters, such as A, e, v, z, &c., in which the re-entrant angles are sharp and not rounded off with a fillet. In such cases the range of followers used extends down to smaller sizes than in the case of the letter I, which we have used for our example. The last follower employed is, in fact, little more than 0.921 in. in diameter, and when it is taken off the punch will be cut down by 0.056 in. in every part. It may be noticed that the employment of a pointed engraving tool of the kind shown in our illustrations not only provides a means of changing the cutting radius, but forms the letter with inclined flanks, exactly as required for purposes of strength both in the punch and in the type produced in the casting machine. As will readily be understood, the grinding of the engraving tool has to be performed with extreme accuracy. Special machines—one of which is illustrated in Fig. 20—have been designed for the purpose. We can say nothing more about them here than that the shape of the tool is generated by the agency of cam guides, and that the operator

examines and measures the point of the tool between each cut under a microscope. After a punch has been engraved the tool is again examined beneath a microscope and cut at A—Fig. 12—to the standard of the engraving machine. It is if seen still to be sharp it is taken for granted that the punch has been cut to a satisfactory degree of finish.

The means employed to lower the engraving tool with each change of follower are the same as described in the description of the operating wheel marked B in Fig. 12, controlling the vertical position of the "quill," Fig. 17, through a lever and controlling the movement of the follower wheel moves the tool up 0.05in. Each follower is marked with a certain figure, and in practice all that is done is to move the operating wheel to the figure of the follower wheel to the same figure as shown on the follower wheel. Then the required number of followers is carried on a circular plate C, Fig. 12, at the back of the base, so that the operator is compelled to carry of the punch blank wall clear of the engraving tool before changing her followers. The micrometer wheel is set to its proper value before the new follower is fitted on the circular plate C, Fig. 12.

The engraving of a closed letter, say, O, presents certain difficulties and necessitates certain additional features in the mechanism of the machine. We have seen that the spindle on which the follower is mounted—say, a—Fig. 18—is movable axially by means of an upward pressure of a spring. It is therefore an easy matter to carry the follower over the face of the pattern letter into its interior. But it must be remembered that during this movement the engraving tool remains at the same height as that at which it was set for the previous cut. If, then, having finished the outside of the letter, we carried the follower through the interior, the bottom side of the pattern letter, we would in the first place cut a groove across the face of the letter, and, secondly, we would cut away the outer half of the length of the letter. It is therefore necessary to cut the inner part of the letter first. How these difficulties are overcome will best be understood by referring to the handle D, Fig. 12. A diagrammatic detail view is given in Fig. 21.

When the handle is over at the extreme right end it is against the electric motor driving the engraving tool is cut out. While the handle is being moved through the distance marked "a" the motor is gradually started up, and at the end of this movement it has acquired its full speed. The switch is, however, a mechanical one, as well as an electrical. It is, in fact, connected up to the "quill" by a lever and spring in such a way that when the handle is at the zero graduation the point of the engraving tool is just touching the surface of the punch blank. As soon as the left of the zero position, the tool is moved upwards into the metal. To the right of the zero mark the tool is withdrawn downwards into the metal, and the handle is moved through the areas a and b and so on until the cut is completed. The upward movement ceases at the end of the area b, and over the area c a lock screwed by means of a handle which passes into the interior of the punch letter. The exact graduation at which the arc b ends—that is, at which the quill lock comes into play—is determined by the setting of the arc shown B, Fig. 12.

A section of a letter O punch is shown in Fig. 22. The outer edge of such a letter is cut in the manner we have described, and when this is completed the motor is shut off. The pointed engraving tool is then withdrawn, and a new one of a more blunt-nosed one specially shaped for finishing work. As the handle shown in Fig. 21 is for the time being in the right-hand position, the point of the tool is somewhere below the level of the punch nose. The follower can therefore be dropped back into the punch blank without fear of cutting across the face of the punch. The handle, Fig. 21, is next brought to the zero graduation, whereby the follower is dropped into the tool simultaneously raised until its point is just touching the punch nose. Very gradually the handle is pushed over to the left, and during this process the operator moves the follower backwards and forwards, up and down until the pattern letter is reached. By the time the handle reaches the end of the arc b, Fig. 21, a plane recessed surface bounded by perpendicular sides has been formed in the interior of the punch letter. The best depth of this recess is settled by experience. It has to be sufficiently deep to accommodate the engraving inside it when transferred to the type of the casting machine; it cannot be made too deep, however, or...
12 knots; we fancy, too, that it was a good deal less than the launching speed of the Aquitania, though on this point we have no definite figures. Another feature was the entire absence of any smoking or soot on the ways—again a contrast to the Aquitania. Whether this was due to the slower speed, to a lower pressure per square foot on the ways, to the lower temperature of the atmosphere so that the tallow did not squeeze out so easily, or what, we cannot say, and anyway the evidence is of little importance; but the result gave the impression of foresight and forethought and of the safety and certainty of the launching operation, which was pleasant to experience. Everything went off without a hitch, and the great ship was brought

order to maintain the steady sea speed of 21 knots. Each of the reciprocating engines gives 18,000 indicated horse-power, and the triple expansion engine gives 15,000 horse-power. This turbine provides a practical example of the fact that questions of expense are not allowed to stand in the way of everything being of the very best in Harland and Wolff White Star ships. Experience in some of the bigger turbine engined ships has shown that, as originally blazoned, the question of expansion has not been fully met, and only recently have improved methods suggested themselves. Directly these were found to be a success all work done on the

FIG. 1—BERTH OF BOATS AND DAVIDS

up a little beyond the end of the ways. The Harland and Wolff yard is, unfortunately, not so well arranged from a spectator point of view as the Clydebank yard, and for that reason the launch lost somewhat in spectacular interest as compared with that of the Aquitania; but a great ship is not launched for spectacular purposes, so we have no right to complain. As the solution of an engineering problem of trans- ferring a mass of 24,800 tons safely from the land to the water the launch was a triumphal success.

The most interesting innovation which has been introduced into this ship is, we think, the wonderful double-skin arrangement—mentioned in our article last week—designed to make her as nearly as possible unbreakable. The arrangement is basically the same as that which was fitted to the Olympic after her collision, and a stupendous work that must have been. In the case of a new ship it is naturally a far less difficult piece of work. In order to make the outer compartments as large as possible so as to allow of thorough inspection, cleaning, and painting, and in order to interfere as little as possible with the cabin and engine-room arrangements, 18in. has been added to the beam of the new ship, so that she is now slightly over 14ft. wide. It is to this increase in beam that the rise in gross tonnage to 20,000 is chiefly due. This, again, reacts on the machinery, the total indicated horse-power in the new boat being 50,000, in

FIG. 2—BOAT SWUNG OUT

blading of the old form was scrapped and the new form introduced. The respective revolutions of the engines and turbines are now 77 and 170 per minute. It may have been added that the wing propellers are each three-bladed and 23ft. 9in. in diameter, manganese bronze blades being bolted to a steel boss, while the centre propeller is solid and 16ft. 6in. diameter with four blades.

There are otherwise but few alterations in the main plans, the general outlines remaining the same as in the Olympic, except that two piston valves are now fitted on each of the low-pressure cylinders instead of the original slide valves; as these valves impose so very much less work on the valve gear and as any leakage that might get past them, in the case of the turbine, the change is obviously in the direction of improvement. We only noticed one other alteration, or rather addition, to the main engine, and that a minute one, namely, the fitting of light steel splasher plates in between the branched legs of the column abreast of the cranks, in order to prevent oil being splashed about the foot-plates, and fitted with doors to enable the parts to be felt. Perhaps they have been found to be necessary partly on account of the telescopic tubes which supply oil from an almost stationary box to the bottom ends, so that the sides of the oil which the greater airmass at that point actually reaches the pin-ends and goes far beyond instead of the greater part finding its way direct into the bilges as with the usual method. It is curious that no such alteration was to be seen on steam engines, except on those naval jobs fitted with full forced lubrication, before the advent of the motor, though no one has ever said that the pump cannot do the work or that there has been nothing to do with it. At the same time the motor has brought a new and far more useful use at one time looked at askance by the steam marine engine. Similar plates are also fitted right round the excentri- cial pin-ends, though with no such purpose, in order to hard-over hull. Whether the system of lubrication adopted—thrust collars can fairly be called forced— gosting should not like to comment, but this good head behind it, though the pumps are only used for carrying the oil into tanks right at the bottom, and for the purpose of the engine-room, from which, and not from the bearings, the head is obtained. It is a nice point.

Dimensions of the above-mentioned alterations are very largely in accordance with the general rule of change in order to deal with the increased horse-power, and though the number has been kept the same as before, the speed has increased quite considerably. The speed has been increased from 19 to 21, and the number of revolutions from 150 to 180 per minute. The total area of the pumps is 1918,365 square feet and the grate area 14,696 square feet. One other change in the boiler-room is to be noticed, namely, that instead of ash-ecokers, Stone's ash expellers are used, though the difference in numerals does not indicate the difference in operation. Ejectors act the ashes overboard through the water line through a curved pipe, whereas expellers expel these through a straight pipe. In the latter arrangement the shoot

R.M.S. BRITANNIC.

When you have done your utmost and spared neither skill nor trouble nor money in turning out the very best that you are capable of, it is very difficult to do anything much better or different when, as soon as this job is complete, you are faced with instructions, "Do another one like it, but better if you can;" and that is just the situation which faced Messrs. Harland and Wolff when they had launched their ocean giant the Olympic. A half sheet of newsprint is too small to contain the story of all the improvements which we have mentioned in the course of these articles, and text cannot do justice and foreword, who all united in giving us every facility for gathering the full information concerning this in the account of the manufacturing processes under their charge.

M.E. M.N.I