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

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THE PUTILOFF WORKS AT ST. PETERSBURG.

THE Putiloff Works, in connection with which there has been so much discussion during the last fortnight owing to their reported absorption by the Krupp Company, are among the oldest established shops in the world, and present another instance of a great engineering company occupying a unique position *vis-à-vis* the Government of its own country. The position of Putiloff is a somewhat curious one, in spite of its national importance, and the fact that the works employ probably more men than any other commercial plant in all Russia. The company cannot be said to possess the same relative status that Armstrongs and Vickers do in England or that Krupp enjoys in Germany, for all these companies make warship construction or the output of war material their main business, and their general engineering trade involves a smaller annual turnover. Possibly the concerns undertaking the most similar class of work, and yet ranking in equal importance, are Cockerills, in Belgium, and Witkowitz, in Austria.

The Putiloff Works are situated some six or seven miles to the south-west from the centre of the city of St. Petersburg. They are built on the water front of one of the many mouths of the Neva River, and cover an extremely extensive site, owing to the fact that the many departments are widely separated from one another. The works were originally established as long ago as 1801, when they were put down by the Russian Government. At this early stage they consisted of little more than an iron foundry employing about seven or eight hundred men, and were chiefly occupied in the manufacture of cannon balls and war material. In this capacity, to which a certain amount of general engineering was gradually added, the plant existed till 1868, when it was purchased by Mr. N. J. Putiloff, who considerably extended the works, and was the first man in Russia to introduce the manufacture of iron rails. In 1873 Mr. Putiloff turned the business into a company, and again increased the works by adding several furnaces for the production of steel by both the Siemens-Martin and Bessemer processes. Mr. Putiloff died in 1885, and the works passed into the hands of a company under the name of the Société des Actionnaires des Usines Putiloff, and this company, as it was then organised, exists at the present time. The output of the works is of an extremely varied nature, and comprises general engineering construction of all kinds, the most important branches consisting of the iron and steel departments, where rail making and plate rolling form a principal part of the work. Shipbuilding was begun in 1890 on a small scale, but at the present time the resources of the shipyard have been very greatly increased, and further extensions are contemplated in the near future. Locomotive construction was commenced in 1893, and two new shops were laid down for this special class of work. Large extensions were made to the forge department in 1898, no less than six vertical and horizontal presses of 1000 tons each being installed in a new shop. The manufacture of artillery was commenced in 1900. During the next few years the Putiloff Works were kept extremely busy, the war with Japan causing a tremendous demand for railway material, the output of which is very large. In 1906 the labour disturbances in Russia, and especially in St. Petersburg, were keenly felt at Putiloff, where the works were practically besieged by the strikers, and had to be occupied by troops to prevent extensive damage being done. Troubles of this nature, however, were soon got over, and at the present day the works are in a flourishing condition, the number of men employed being upwards of 8000, though during periods of exceptional pressure the number has reached a total of between 12,000 and 13,000, a figure that places the establishment probably ahead of any other single commercial works in Russia.

The most important department of the Putiloff Works at the present time is the metallurgical section. There is a Siemens-Martin steel works, which contains no less than twelve furnaces, the total annual output of which exceeds 60,000 tons of forgings and about 6000 tons of castings, the largest of which are about 40 tons weight. Many of these castings are made to the order of outside firms, and not for use in the works. Besides this foundry, there is also a special steel foundry for the production of projectiles, guns, and other articles for which the use of a much more special material is required. The mills are in this section, and contain rolls capable of dealing with an output of plates and rails of all sizes and qualities of a total annual weight of about 80,000 tons. Close to the rolling mills is situated the iron foundry, the output of which is about 12,000 tons per annum, individual castings up to 60 tons having been made. All the briquettes used in the works, to an annual quantity of about 2½ millions, are made in shops attached to the steel works. In the chemical laboratory associated with this department about 1600 analyses are annually carried out, and provision is also made in close conjunction with this laboratory for a metallurgical station for microscopic analyses of metal and for the study of the transformation of the structure of various metals under the influence of different thermal treatments. A tool-tempering shop and a test-house for the physical testing of specimens are also found in the steel works. Under the head, however, of metallurgical work the Putiloff management includes the copper shops, which annually handle some 500 tons of brass and copper, and in which the castings, pipe work, &c. &c., for artillery, locomotives, and railway carriages are made. Altogether there are eleven separate departments in this section of the works.

A second large group is known as the mechanical department, and in this there are four principal sections, the chief of which is the forge, which has an annual output of 15,000 tons, about 1500 of which are in the form of plate and spiral springs, another 1500 consisting of gun barrels. In the boiler shop about 8000 tons a year of boilers and bridges or similar structures are handled. A fine air-compressing plant supplies the power for the pneumatic tools, which are very extensively employed. The largest portion of the mechanical section is perhaps the central machine shops, which consist of three main bays. In this department are machined and erected all the many products of the Putiloff Works in the way of steam engines, pumps, steam turbines, either of the Parsons or Curtis types, Diesel engines, travelling cranes, Temperley transporters and a greater diversity of miscellaneous engineering work than is often seen together in one establishment.

The locomotive department at Putiloff is of a very extensive nature, and comprises five sections, in which all the different stages of locomotive construction are handled. The annual output—nearly all of which is for Russian, Finnish and Siberian railways—attains a figure of about 300 compound locomotives per year, a total which, while not perhaps exceeding that of some of the British or American locomotive building companies, is certainly one that places the Putiloff Works in the front rank of this branch of engineering. The workmanship of this department is of a high order. The railway carriage shops are devoted to the construction of rolling stock and comprise six sections. The output from this department is 300 freight cars and twenty-five passenger cars per month.

The shipyard at Putiloff has recently been considerably extended, and at the present time the construction of two cruisers—the Bootakoff and the Spiridoff—of 7000 tons displacement, and of several destroyers of 1200 tons and 35 knots speed, is being undertaken. The yard itself was only started about 1890, and a few torpedo boats of about 80 tons displacement were built, on the completion of which the yard was closed down till about 1902. In 1906 two destroyers were built to designs by Schichau, and in 1911 a larger vessel, the Novik, which eventually attained about 36 knots on trial, was constructed at the Putiloff yard, the machinery being supplied by the Vulcan Company at Stettin.

The construction of cannon is carried on in four sections of the artillery department. A very large number of field guns and a small number of coast defence weapons have been constructed in these works, which possess a proving ground in close proximity to the shops. A feature of these shops is the very extensive use of electric motors for separately driving even relatively small machines.

In the foregoing it has only been possible to refer shortly to the salient features of each department, but some idea of the magnitude of the establishment may be gathered from the fact that the central station which furnishes current for the entire works contains machinery of an aggregate output of about 15,000 horse-power. The average daily load is about 15,000 kilowatt-hours, of which about 10,000 are for power and 5000 for light.

The offices of the Putiloff Works are of the extensive nature that is so essential to the management of a great business. The individual rooms are spacious and well furnished, and fitted with every modern convenience and comfort. Extensive steam heating is adopted throughout, as well as all the other local protections against a rigorous winter; in summer, ample windows and sun blinds protect the staff from the other extremes of a changeable climate. Attention to the comfort and well-being of the work-men has always been a prominent aim of the directors of the company. There is a hospital attached to the works containing sixty beds, thirty of which are for surgical cases and thirty in the maternity department for the wives of workmen. As many as 600 cases a day have been treated at this hospital, to which a large staff of doctors and nurses is attached. All the equipment is of the latest kind obtainable. The treatment at the hospital is gratuitous, and during sickness a man's family receives three-quarters of his pay; whilst unmarried workmen get a portion of their wages. In the grounds surrounding the works are situated a theatre and a library. There is a school attached to the works wherein both adult workmen and their children can receive instruction. A feature that has few, if any, replicas in other works is a Greek Church erected in the works by contributions from the workmen aided by the company. This church will hold 6000 persons, and cost, with its various interior ornaments, some £50,000. A co-operative supply store, the majority of the members of which consist of workmen, enables everything necessary in the way of food and clothing to be obtained at very low rates. There is a savings bank and mutual aid society for the employees, each of whom pays in about 6 per cent. of his wages, to which the company adds an amount varying from a quarter to the equivalent of the amount paid in by the workman, according to the number of years he has been in the company's service.

It can easily be understood therefore that to allow the control of works of this nature to pass from the control of its Russian directorate into the hands of a large foreign company would have been a most serious matter for the Russian Government. The Paris Press, in commenting on the reported purchase of Putiloff shares by Messrs. Krupp, undoubtedly took an unreasonable view of the situation by using the name of the Schneider Company and its association over artillery work with Putiloff as a peg on which to hang a tale of tribulation regarding French interests in Russia. Had it been the Russian Press which had embarked on a similar crusade in defence of Russian interests, the matter would have been more easily understood. As it is, however, there seems to be no doubt whatever that the Putiloff company will for the time remain in its existing condition as regards ownership, although it is stated at the present time that an arrangement has been arrived at between the representatives of this company, Messrs. Schneider, and two French and Russian banks for a syndicate to be formed between the four, and that an enormous new issue of shares is pending. In this connection, it must never be forgotten—and this is a fact that the history of commercial alliances in Italy, Japan and other countries strongly corroborates—that outside assistance is apt to be dispensed with as soon as it possibly can. It is on such an understanding that the technical assistance proferred by the great British firms in other countries has been given, and a national desire to regain control of national interests is one at which no one can be surprised.

A VISIT TO THE WORKS OF THE LANSTON MONOTYPE CORPORATION.

No. I.

IT is not our intention in the present articles to attempt a full description of the Lanston Monotype Corporation's works at Redhill, nor do we propose to discuss the system of typesetting associated with the company's name, although in both matters our readers would find much of considerable engineering interest. We are going to deal only with a small portion of the typecasting machine, and with that part of the works concerned in its manufacture. But in order that our account may be intelligible to engineers who are unacquainted with recent developments in the art of printing, we may introduce our subject by a few general remarks on the Monotype system.

The distinguishing feature of the Lanston Monotype system is, as the name implies, the fact that each letter or space represents a separate piece of metal. Thus each letter printed on this page is the impression of a separate type, which could be lifted away without

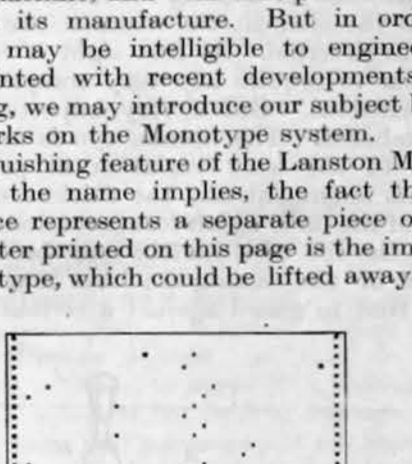

Fig. 1—PUNCHED SLIP

disturbing its neighbours. The Monotype system is thus the opposite of those others, such as the Linotype and Typograph, in which all the letters and spaces in any one line are formed on one piece of metal. Each system has its own advantages. We find it more convenient to use the Monotype system; for the purposes of the daily newspaper rapidity is everything, and, in this country at least, the line unit or "slug" system is very largely favoured.

The Lanston Monotype outfit consists of two distinct machines—a punching or tapping machine and a casting machine. The tapping machine has a keyboard very like that of a typewriter. Instead of printing letters, however, it punches holes in a long roll of paper about 4¼in. wide. A portion of such a roll, as punched for the first line of this article, is shown in Fig. 1. It will be understood that each letter or character or space is represented by a punch hole or group of holes, and that the position of the holes across the width of the paper is the clue to the particular letter represented. The completed roll after punching is taken to the casting machine, wherein it plays much the same part as the record of the pianola. According to the positions of the holes on the roll so certain matrices are presented one after another at the top of a tiny moulding box. Each matrix carries an intaglio of its letter and is held at the top of the moulding box only for a very brief interval. But this interval is quite long enough to allow the liquid type metal, forced into the mould as soon as it is closed by the matrix, to cool and solidify. Immediately thereafter the type is ejected from the mould and is carried over on to the " galley " to take its place in the line of composed type.

Even from such a hurried description as the above the engineer will readily infer that there are many ingenious mechanical details associated with the machines, and that very accurate workmanship is required in their construction. In this series of articles we propose to deal with the methods employed in the manufacture of the matrices for the casting machine. Even though the function of these little parts were less vital than it is to the success of the system, the extraordinary refinement required and attained in their manufacture would more than justify our selection of them for separate treatment.

A typical matrix is represented in Fig. 2. It is a small metal parallelopiped one-fifth of an inch square

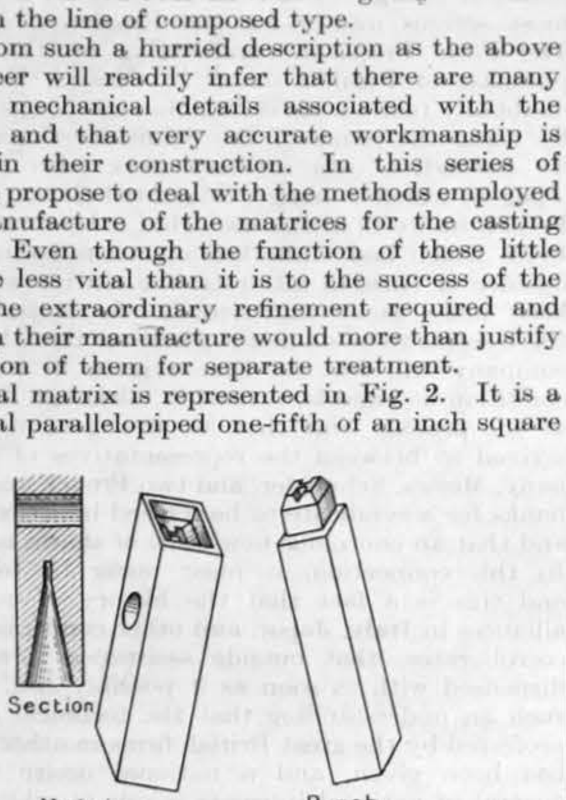

Fig. 2—MATRIX AND PUNCH

and about three-quarters of an inch long. The material of which it is formed is gun-bronze, and is such that it will flow well when pressed cold. At one end the matrix is stamped intaglio with its letter. At the other a cone is bored into it. A conical spike forming part of the mechanism of the casting machine enters this cone and locates the matrix accurately in position at the top of the moulding box. Finally, a parallel hole is bored through the matrix between two of its longer faces. This hole is required in connection with the arrangements made in the casting machine for holding the matrices in their case.

Such is the element the manufacture of which we propose to describe. At first sight it certainly does not appear to require any very complicated process in its formation. But a very important fact must be remembered. The human eye is extraordinarily sensitive to the least variation in print, both as regards its alignment and the thickness, length, and position of the lines which form each individual letter. Further, the life of a matrix may be much shorter than that of the casting machine of which it forms part, so that to guard against a serious interruption

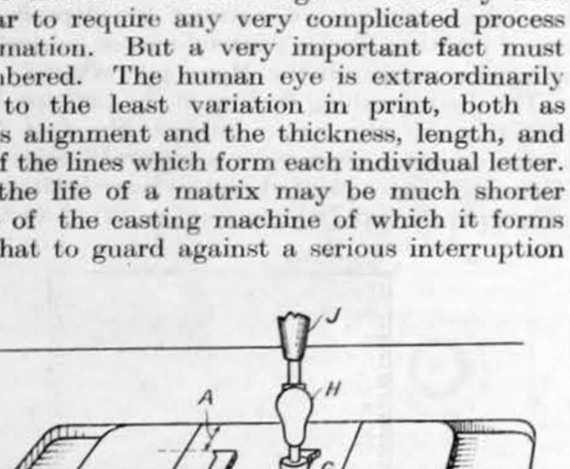

Fig. 3—BASE OF PUNCH ENGRAVING MACHINE

at a critical moment the wise printer always carries a stock of spare matrices. He must therefore have a guarantee that any one of these spare matrices will fit exactly into the place of that which has developed a defect. It thus happens that all the six original faces on the matrix, together with every one of the surfaces subsequently formed on it by machining or stamping, reflect their perfection or their lack of it on the printed page.

Setting aside the difficulty of attaining under commercial conditions the all-round accuracy implied to be requisite in the above, we have next to remark that the slightest suspicion of a burr anywhere on the edges of the matrix might quite easily result in bad printing, if not in a breakdown or jamb. Yet to cut soft metal without the formation of a burr is, except under rare conditions, an achievement of greater difficulty than most of our readers perhaps realise. The removal of one burr nearly always results in the throwing up of another, and so on. The trouble which this apparently trivial circumstance introduces into the manufacture of the Monotype matrices will be appreciated when these articles have been concluded.

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 not, 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 first.

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 copper-coated metal plates, on each of which a separate letter of the alphabet or other character is raised about $\frac{1}{8}$in. from the surface of the plate. An example may be seen in Fig. 3, wherein it is shown in place on the base of the punch engraving machine. It may be explained that these cameos were formerly cut by skilled hand engravers. The process now employed is very largely mechanical and results in a great saving of time and money.

The first step is the production of a pencil sketch of each character required, reproducing on a large scale the formation of the faces of a set of standard type or of other type which are to be copied. The standard or special type are inserted, face upwards, in a suitable holder, and on each one in turn a beam of light from a 2500 candle-power arc lamp is thrown down by a 45 deg. mirror. The beam reflected by

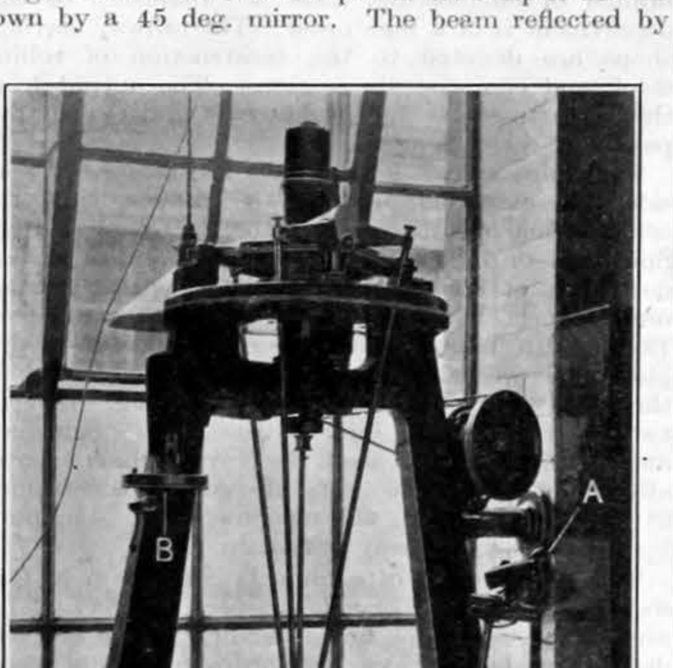

Fig. 4—PUNCH ENGRAVING MACHINE

the face of the type passes up through an unsilvered spot on the mirror and is caught by a 45 deg. prism and reflected on to a vertical drawing board provided with ordinary drawing paper. The magnification obtained is such that the image of a capital letter is 10in. high and others in proportion. The operator, a girl, sketches in the outline of the letter in pencil, using T squares for the purpose where possible and freehand for the curves. The optical process has not reversed the image of the type; that is to say, the pencil sketch shows the letter exactly as it was on the type.

The comparatively rough pencil sketch is then taken in hand by girl tracers for rectification. Irregularities are smoothed out by means of French curves, 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 rectified drawing is next taken to a pantograph 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 $\frac{1}{8}$in. 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 good working temperature. The outline only of the letter is cut on the pantograph, but when the wax has cooled the interior of the letter is lifted out by graving tools, so as to expose the zinc backing. The needle-like tool of the pantograph has, however, thrown up 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.

The waxed plate thus engraved is taken to the electro-plating room, where it is dusted over with powdered graphite. A small border of wax—also dusted with graphite—about $\frac{1}{16}$in. in height, is added around its four edges, when it is ready for the electric bath. In this it is kept for about ten hours until about $\frac{1}{32}$in. of copper has been deposited on the surfaces dusted with graphite. Backing metal—lead or zinc—is then run into the copper shell. The wax melts off the face and leaves a copper plated metal pattern on which the letter, now no longer reversed, is raised in cameo on the surface. The edges of the plate are dressed to a standard size, the distance from the top edge to the top of the letter—that is, the distance marked A in Fig. 3—being carefully gauged, and a small V notch, B in the same figure, cut in the lower edge for locating purposes.

The finished pattern then passes to the punch-engraving room. The punches—see Fig. 2—are made of tool steel, are all $\frac{1}{8}$in. square and are $\frac{7}{8}$in. in length. The machines employed in the work of transferring the letter from the pattern plate to the point of the punch are among the most interesting in the works. An illustration of one of these engraving machines is shown in Fig. 4. On the pattern plate the letter, if a capital, is $2\frac{1}{4}$in. in height. The engraving machine provides means whereby is reproduced on the point of the punch a letter having any height from $\frac{1}{1000}$in. to $\frac{1}{4}$in. At the same time, the letter is reversed so that on the punch it appears exactly as it does on printers' type. We defer further details of the engraving machine until later.

The engraved punch is next taken to the hardening room. Here it is heated up in a salt bath—that is, one containing the chlorides of sodium and barium and other chemicals—the temperature of which is carefully watched by means of a pyrometer. At the right moment the punches are quenched in water. They are then heated up in oil to let down the temper, and are finally allowed to cool either in cold oil or merely in the air.

The tempered punch is even yet far from being finished, and has still to go through the justifying room. Here the first operation consists of polishing the face of the character until a good surface is obtained, and the limbs of the letter assume their proper breadth. The polishing is done by hand, merely by rubbing the punch face over an Arkansas oil stone. As the polishing proceeds the limbs of the letter tend, of course, to become broader, since the upper portions of the flanks are cut on an angle—see Fig. 2. The engraving machine performs its work very accurately, but until the punch reaches the justifying room no facilities are provided for examining the accuracy. Hence, between each polish of the face the punch is examined beneath a microscope, and the breadth of the different lines composing the letter or character measured. The tolerance permitted in these dimensions, it may be interesting to record, is 0·0002in. It is clearly only possible to increase the thickness of the limbs by this polishing process—that is to say, to correct for over-engraving. If the limbs are already too broad, the punch is thrown away. It may be remarked, however, that wear of the engraving machine parts will, in general, result in over, rather than in under, engraving.

When the limbs of the letter have thus been thickened up to their required standard, the position of the character on the punch body is examined under the same microscopic measuring machine. The tolerance allowed here is again only 0·0002in., for, of course, any material error would result on the printed page in an easily detected bad alignment of the letters. With the punch held so that the letter faces the observer, the situation of the character on the body is measured with reference to the top and left-hand edges of the body. If the dimensions involved are excessive, the top and left-hand faces are ground away to the required extent on power-driven emery wheels fitted with a delicate micrometer adjustment. A row of such machines is shown in Fig. 5. The required accuracy having been attained, the two remaining faces of the punch are ground up until the cross section of the body reaches the standard size. It will be understood that if the character is too far out of position one way or another it cannot be justified by grinding the faces in this manner. Under these circumstances the punch is discarded.

The punch is now ready for service and is taken to a store until it is required in the matrix department.

In the matrix department we find in progress an entirely different class of work. It is here that the difficulty of cutting soft metal without the creation of a burr develops into something not far short of a tribulation. It may only be a microscopic burr; still, it is there, and must be removed if the casting machine is to run smoothly and without breakdown. At first sight we may be inclined to wonder why the matrices are not engraved directly instead of being impressed by an engraved punch, the life of which at the best is not very long. The answer is simply that such a direct process for the same number of workpeople would result in a smaller output, and even though it were as efficient, would be rendered impracticable by this difficulty of getting rid of the burrs thrown up by the engraving tool. There is practically no burr left on the steel punch, and what there is, is, since the punch letter is in cameo, easily removed during the subsequent polishing. The softer metal of the matrix is, however, productive of greater burring, and as the letter is in intaglio on it the removal 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 sectioned wire measuring about $\frac{1}{5}$in. by $\frac{1}{5}$in. in cross area. It is impossible to obtain the stock constantly of the required dimensions from the makers, and hence the first operation at the Redhill factory is to pass the material through the power-driven rolling machine shown in Fig. 6. The stock is to be seen in this engraving passing into the machine on the left-hand side. The rolling down reduces the sides of the material almost to the exact size and involves on the average a reduction of 0.005in. The reduced stock, at the other end of the machine, is cut off by a saw to the length required, say, $\frac{7}{8}$in. As the rolling down is carried on continuously the saw blade, while cutting off the stock, travels forward in the same direction and at the same rate as the moving 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 receiver.

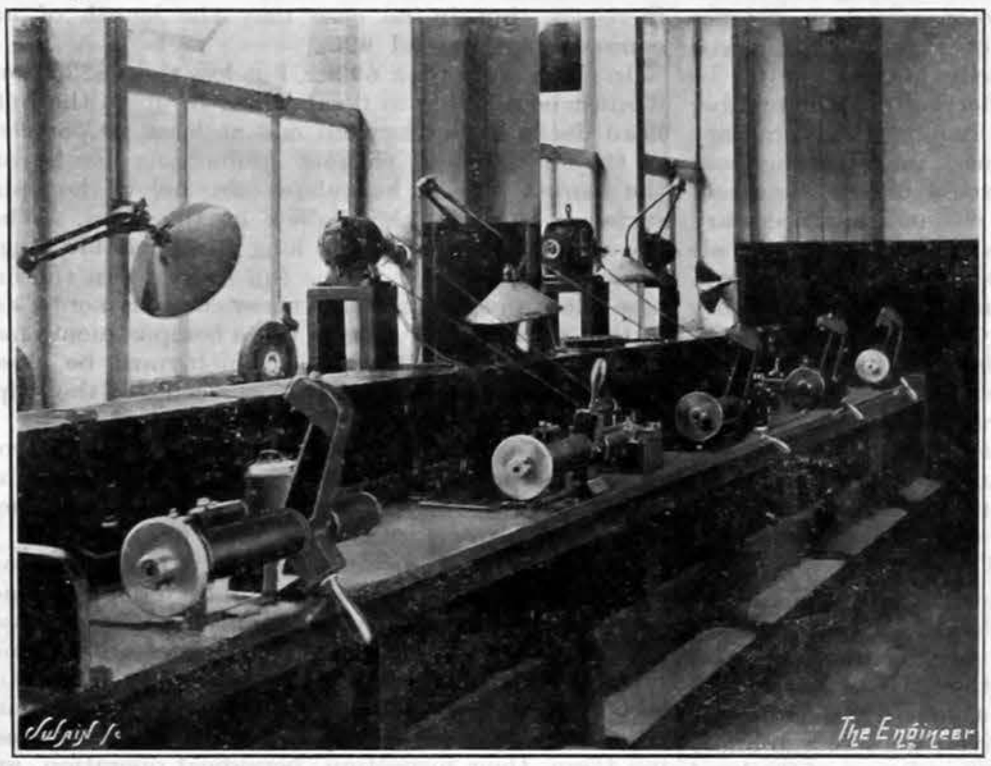

Fig. 5—PUNCH JUSTIFYING-GRINDING MACHINES

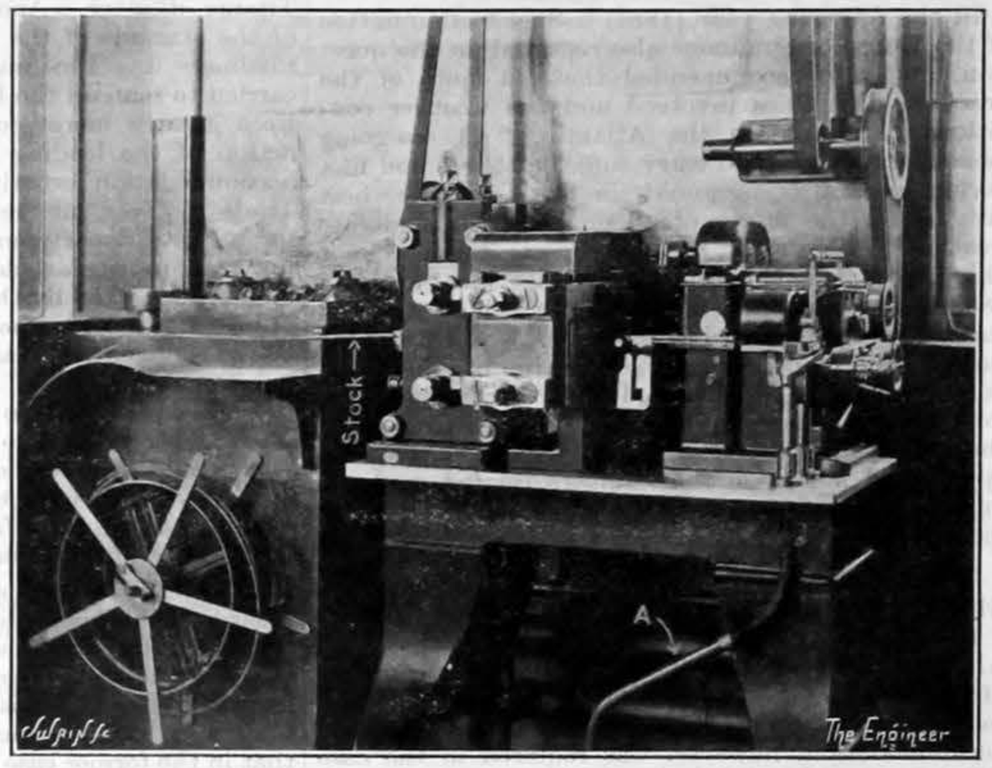

Fig. 6—MATRIX STOCK ROLLING AND CUTTING-OFF MACHINE

The matrix blanks are next taken to a comparatively simple design of machine, which stamps certain designation 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 grinding, 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 oftener than once a year. The dust employed is made on the premises by pounding black diamonds and grading the product by elutriation. 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 in with any flat metallic surface, 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 down on these diamond wheels until they are $\frac{1}{1000}$in. *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. The jaws are very slightly tapered and are marked with two cross lines at about the middle of their length. The matrix blank has to come to rest somewhere within 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 completely until the blank has been impressed by the punch, for if it were the pressure involved would be sure to distort it. On the other hand, the cone must be formed 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 coincides with the centre line of the final cone.

The matrix blank is now ready to receive the impression of its letter from the appropriate punch. This stamping process is conducted in the press illustrated in Fig. 7. The general arrangement of this machine is quite ordinary, but in the special details connected with the feeding-in and extraction of the matrices there are several beautiful mechanical movements. We can, however, only give a rough idea of how the machine works. The matrix blanks with the cone end downwards are arranged in a line on a galley A and are pressed forward by a bar B weighted at C. At given intervals a matrix is carried off from the forward end of the line and pushed across into a square hole in the centre of a bolster D. A conical pin at the foot of this hole enters the cone in 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 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 $\frac{1}{1000}$in. 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 $\frac{1}{1000}$in. larger than the hole, or, in other words, it has now assumed its proper size. The bolster is very solidly constructed, and we believe the theory that the walls of the hole expand under the stamping pressure may be dismissed as untenable. An alternative solution of the mystery may be that the compression of the copper alloy produced by the punch pressure is not wholly permanent, but is in small part elastic and recovers itself to a corresponding amount when the matrix is removed from the constraint of the bolster walls.

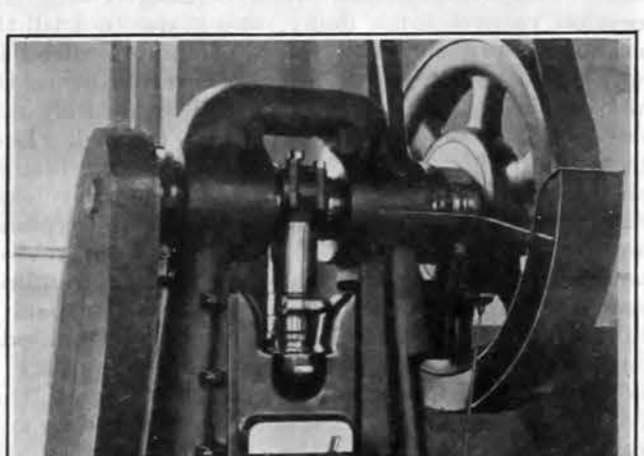

Fig. 7—MATRIX PUNCHING PRESS

A second visit to the diamond lapping machine now follows. The matrix, as a result of the stamping, may be slightly swollen at the letter end and may have other minute irregularities on its four longer faces. 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 at intervals 225 matrices are selected at random and examined for fit within a gauge 3in. 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 International 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 leading 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 to issue invitations to a number of the principal foreign maritime States to meet together with the object of devising means by which greater security could be attained, and of entering into an agreement for 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 must not be thought, however, that nearly two years had elapsed since the sinking of the Titanic before any international agreement on the requisite revision of the safety regulations was reached, and it is convenient here, before considering the text of the Convention, to recall the attitude of the British Board of Trade on the matter.

Up till 1886, a period when the crack vessels of the day were the Aurania, Servia, and Arizona, and the then new Umbria and Etruria, the boat accommodation that was enforced by law was regulated by the Passengers Act of 1855, 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 1886 the Board of Trade appointed a Departmental Committee to inquire into this question of boats and life-saving apparatus, and in its report this committee pointed out that boats would be of little use in saving life—although they might for a time prolong it—unless succour were at hand from other ships or from a near shore. Referring particularly to the North Atlantic trade, the committee said:—

"Considering the number of vessels employed in this trade, and the large number of passengers they carry, and also taking into consideration the stormy resemblance is very similar. In plan the general arrangement of the five turrets, each mounting two 11in. 50-calibre weapons, is the same as before, and is similar to that of the battleships of the "Kaiser" and "Luitpold" classes ordered about the same time. In the case of the latter vessels, however, the shorter length tends to cause crowding, a fact that is considerably accentuated on the main deck by the two extra 6in. guns carried, and we miss the wide arcs of training possessed by the big guns without mutual interference that so distinguish the battle-cruisers. The internal protective construction of the Seidlitz, as well as the armour protection, is exceptionally strong and extensive. The main armour belt extends from 3ft. below the normal water-line to 6ft. above, and is 11in. thick, but tapers off to 6in. at the lower edge. Above this is a thin strake of 9in. armour and another of 8in. The 6in. gun battery is protected by 6in. armour. This belt extends from forward to after turret centres and forms a rectangular citadel with transverse bulkheads at each end 9in. thick. The water-line is belted fore and aft with armour tapering from 5in. to 4in. Both of these remarkable battle-cruisers were built at Hamburg and fitted with steam turbines of the Parsons type. Throughout ship and machinery particular care has been taken with the design and attention to detail.

The growth of the small scouting cruiser in Germany has been equally consistent, though its development, starting perhaps with the Hamburgs—the opposite numbers of the British Amethysts—has continued to lie almost entirely in displacement devoted to increased speed rather than any advance in fighting power. That the later vessels of the type are destined to act with the destroyer flotillas is certain, but they appear to come far more into a category midway between the British Lowestofts and Auroras. In the Supplement are shown the Strasburg and Breslau of the 1909 and 1910 programmes respectively. The Karlsruhe, the first of the pair of light cruisers of this type belonging to the 1911 programme, was only passed into commission last month. All the vessels of this type prior to the Breslau were merely deck-protected cruisers, the last two of which were the Koln and Augsburg, laid down in 1908. The newer vessels, which at the time of their inception were regarded with considerable interest, have a narrow belt—in the Strasburg almost too narrow to be of real use, in view of the fact that it is 3¼in. thick, but in the Karlsruhe it is both deeper and thicker. The whole recent series of these vessels has been used as a class in which to experiment with different forms of steam turbines, and the experiences have frequently proved unlucky, breakdowns having been numerous; considerable forcing has often been used on the trials of this class of ship, and the speeds obtained have, in the ships completed in each of the last four years, generally exceeded 27 knots. Adherence to the 4·1in. gun has been a distinguishing feature of the whole series, and the power of offence against a modern destroyer seems consequently inadequate. Although these vessels are so obviously intended to scout, and to accompany destroyers, they have neither speed to run from, nor strength to fight, one of the British "Town" class cruisers of the same date, though naturally the British "Blonde" and "Fearless" classes would fare badly at the hands of the armoured Karlsruhe. On the whole, the evolution of this type of cruiser seems to have shown less progress than that of the battleships and large cruisers of the same date.

It is usually customary, and quite incorrect, to consider the development of the modern German navy solely in connection with that of the British fleet. No greater mistake as to the policy of the German Admiralty could possibly be made. Although the German Government laid down twenty-nine battleships and battle-cruisers of an aggregate tonnage exceeding 712,000 between 1905 and 1914, France and Russia between them have laid down during the same period, and exclusive of Black Sea ships, no less than twenty-six similar vessels of about 610,000 tons. It is perfectly true that the rise of the German fleet relative to that of this country has rendered our margin of superiority vastly less than that which, according to the present First Lord of the Admiralty, should be maintained—the present ratio being only 1·4 to 1·0 instead of 1·6 to 1·0—but the German point of view might surely be considered occasionally. Britain is not the German's only thought. It is not, however, the question of relative national strength with which we are now concerned. The exact relative merits in design of German and British vessels—or of those of any two nations for that matter—are not easy to compare; national characteristics and requirements vary so much that there exist very many variables to consider before a fair judgment can be passed. The engravings in the Supplement represent facts and not theories; they show the latest type of German vessel, and for the moment it is the merit of those designs that concern us.

German warships possess certain very definite features. The adherence to the Krupp gun is one; no other nation excepting Austria, and then only in a modified form, adopts this weapon for naval purposes. Very great attention is paid to internal and external protection. The propelling machinery is generally very light compared with that of other nations, the use of cast steel leading to this end. Very low fire-control positions are adopted. As regards details, the greatest care is taken in saving weight and in general neatness of design. As regards workmanship, no criticism whatever can be made; it is generally extremely good. The science 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 is in the shape of hull, both above and below water. The fact that, as we said 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.

No. II.*

In our first article we described operations as far as the punching of the matrix blanks and the subsequent lapping of the longitudinal faces to remove any irregularities developed during the punching process.

The next stage is one of particular interest in view of the ingenuity displayed in the construction of the machine employed in it. The operation in question is simply milling both square ends of the matrix; that is to say, milling the cone end and the small box-like edges left at the other end by the punch. All the matrices must, of course, have the same length, and, further, the depth of the mould of the letter must be the same in them all. Merely to mill both ends of the matrix so that it shall very accurately have a certain standard length is not a particularly difficult operation to perform with modern engineering resources. On the other hand, this milling must be performed in such a way as to leave the depth of the mould at one end equally accurately in agreement with a certain standard, for otherwise the type delivered by the casting machine would vary in height, and those which stood up highest would soon become battered in the printing press. The incidence, then, of these two demands for accuracy renders the milling process now being considered a delicate one to perform under commercial conditions, and requires features in the milling machine employed not met with in ordinary engineering practice.

A row of the milling machines with which we are now dealing is shown in Fig. 8, and in Fig. 9 a portion of their mechanism is represented diagrammatically. In the latter engraving A and B are two inclined galleys. The matrices to be milled are placed as indicated at C in the first galley, and are given a tendency to descend by means of a weighted "pusher" pressing on the topmost member of the set. At its lower end the receiving galley A is closed by a cap D, into which a square sectioned push bar E enters sideways. At given intervals this bar moves over to the right and pushes the lowermost matrix into a square hole in the end of a lever arm F mounted on a shaft G. The bar E is now slightly withdrawn, but not sufficiently so to allow the next matrix in the galley A to fall into the place of that removed. Meanwhile the arm F has risen into the position marked H, in which position a needle advancing from the right through a certain definite distance enters the punch impression on the end of the matrix, and, striking the foot of the letter, adjusts the position of the matrix very accurately in the hole in the arm. The arm now descends to the position marked J, and in doing so traverses the matrix between two end milling cutters K accurately set to the required distance apart. When the milling has been completed the arm rises into its initial position F. The push bar E then advances still farther to the right and ejects the matrix into a square opening in a cap at the end of the delivery galley B. When pushed home the matrix is engaged by a trigger L, and, with all those lying above it in the galley, is moved upwards a space until engaged by a small spring catch. The trigger L then descends to its former position, and the push bar E moving over to its extreme left-hand position allows another unmilled matrix to fall into the cap D.

This description of the mechanism can now be added to, for we have omitted all but the most essential details. It is, for instance, obvious that the arm F cannot be the simple affair we have shown it to be in Fig. 9. When the matrix is being pushed into the square hole, when it is being adjusted therein by the needle and when it is being ejected therefrom at the conclusion of the operations, the fit has to be easy. But when the matrix has been adjusted by the needle and until it has been passed between the milling cutters, the fit has to be tight enough to prevent the least slip. A section of the arm as actually used in the machines is given in Fig. 10, wherein the needle A is shown at work, adjusting the position of the matrix B in the square hole. The lower V of this hole is formed on a sliding piece C, which is pressed upwards by a spring D. The pressure of this spring is sufficient to hold the matrix loosely in the jaws. The lower end of the spring bears against a sliding piece E provided with a roller F, which roller in turn rests against a cam H on the shaft G. When the time comes for the matrix to be locked in the jaws this cam is slightly rotated by means of a link pivoted to it at J. The roller F then moves up against the foot of a pin K on a small piston fixed to which the jaw block C rests.

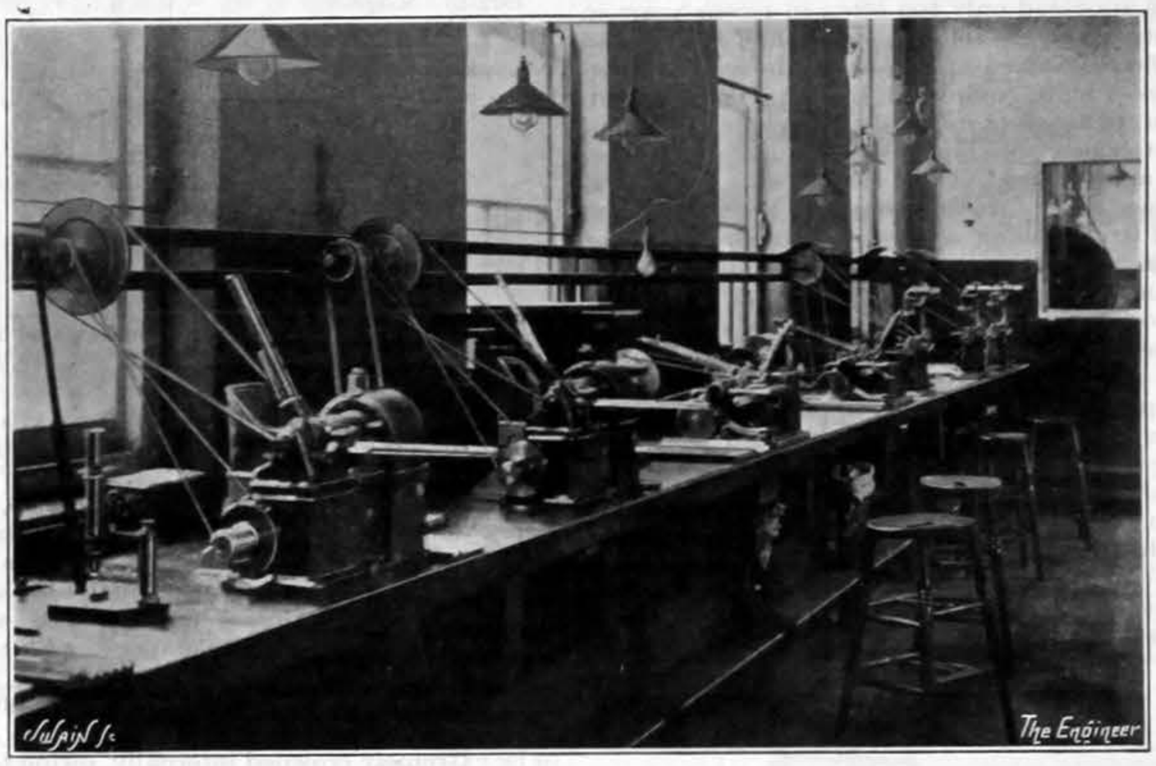

Fig. 8—MATRIX CONING AND MILLING MACHINES

It will be perceived that the needle when adjusting the matrix in the jaws has to penetrate the impression left 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 O 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 machine we are now dealing with, for it clearly means that the position of the arm when raised into the adjusting station H, Fig. 9, cannot be kept constant for all letters. Means must be provided slightly to vary the position of the arm relatively to the needle, so that the matrix in the adjusting station may be moved parallel with itself in the vertical and in the horizontal backward and forward directions. The vertical adjustment is provided for by mounting the shaft G, Fig. 9, and the two galleys A B on a cradle capable of being pivoted round a shaft lying parallel with and to the rear of the shaft G. This shaft is indicated in the engraving. Horizontal backward and forward adjustment of the arm is provided for by means of an adjustable stop against which the arm bears when it rises into the adjusting station H, Fig. 9. The adjustments made in this way are, of course, quite small. The greatest required to be made is not sufficient to make it necessary to shift the position of the milling cutters, which cutters are mounted, not on the cradle, but on the immovable framework of the machine. The adjustments are, indeed, sufficiently fine to make it desirable to effect them beneath a microscope. In Fig. 10 this microscope is indicated at L. The line of vision is reflected through a right angle by a 45 deg. mirror M, provided near its centre with a small hole for the passage of the needle. In use the operator focusses 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 centre line of one of the limbs of the character.

* No. I. appeared February 20th

During this adjusting process the automatic backward 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 milling 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 find 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, as we have indicated above, the position of the cutters and their distance apart must be delicately adjusted relatively to the advanced position of the needle in order that they may mill off the required amount of material from each end of the matrix. The means provided for moving the cutters 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 a way 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 its micrometer 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

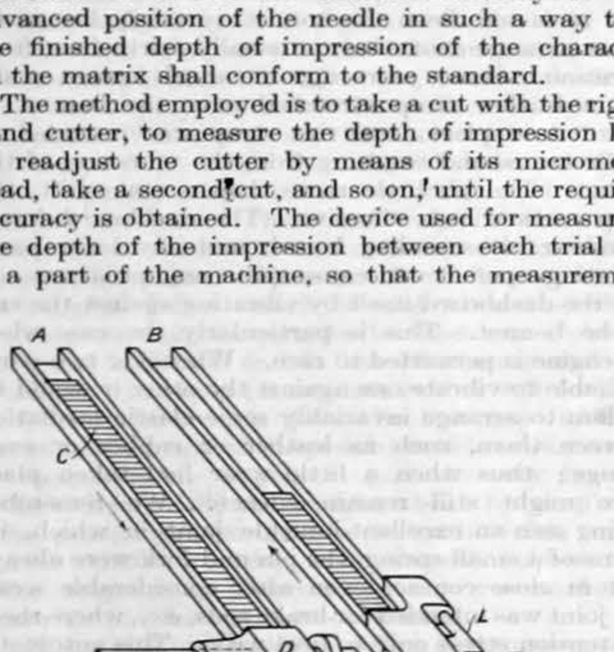

Fig. 9

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 whereby its working can be interrupted 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 dependage D formed on the needle carrier. But on the interruption of the movements the block C is withdrawn by means of a small handle and the needle allowed to move under the action of its spring as far to the left as it will go. A small spring plunger E mounted on the frame of the machine in line with the needle is then advanced by hand. This pushes the matrix, and with it the needle, over to the right until the face of the matrix abuts against a small anvil block F. This 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 microscope.

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 an axis H behind and in line with the needle a metal disc J is mounted inside a casing K. The end of the needle carrier projects through a hole in this casing and a bight in the adjacent portion of 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 non-radial slot at L. A wedge is driven into and secured in this slot so as to swell the metal. The result is that over the quadrant between the bight and the slot the radius of the disc is a gradually increasing one. At the slot the radius is, in actual fact, 0·0007in. larger than it is at the bight. Outside the casing K a plate M, provided with a handle N and a scale P, is mounted on the spindle H. Q 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

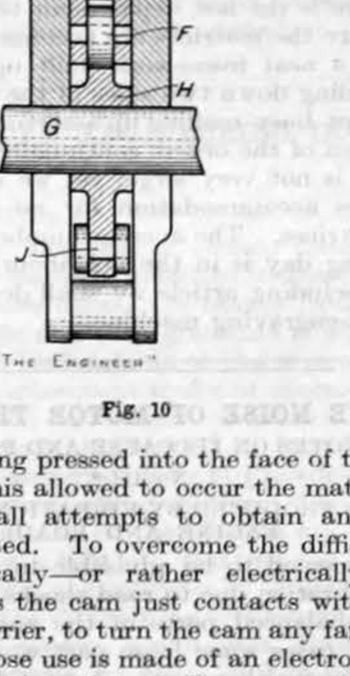

Fig. 10

needle point being pressed into the face of the matrix letter. Were this allowed to occur the matrix would be spoilt and all attempts to obtain an accurate gauging frustrated. To overcome the difficulty it is made mechanically—or rather electrically—impossible, as soon as the cam just contacts with the end of the needle carrier, to turn the cam any farther.

For this purpose use is made of an electromagnet R —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 insulating bearings. Normally the spring pulls the plug U against an insulating fibre piece W screwed to the disc J, so that no current flows. When, however, the handle N is depressed the plug U makes contact with the opposite and metallic side of the slot in which it is situated. Farther 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 so back to the battery. The energisation of the magnet results in the attraction of the pawl S, the point of which rising upwards enters between a pair of the teeth T and stops farther rotation. The pawl S is in two parts, one part being set half a tooth behind the other, so that should one pawl alight on 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 into the impression on the matrix, and if the drive 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 pin D. The needle then advances 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 locks 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 pivot Y and the distance between the spindle H and the end of the needle increased or decreased. From the manner in which the cam J is formed 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 open and, on the average, are about ⅛in. apart. Yet each interval corresponds actually to a distance of only 0·0001 of an inch, 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 0·000025in., and if such an accuracy as this would imply were required we believe that the machine would, merely with somewhat finer teeth on the cam disc, readily enable it to be obtained under strictly commercial conditions with girl labour. In practice, however, the accuracy required is very fine, but is scarcely so great as this, and accordingly we find that there is no occasion to read the depth of the impression more accurately than to within one part in ten thousand.

The manner of setting the machine ready for work

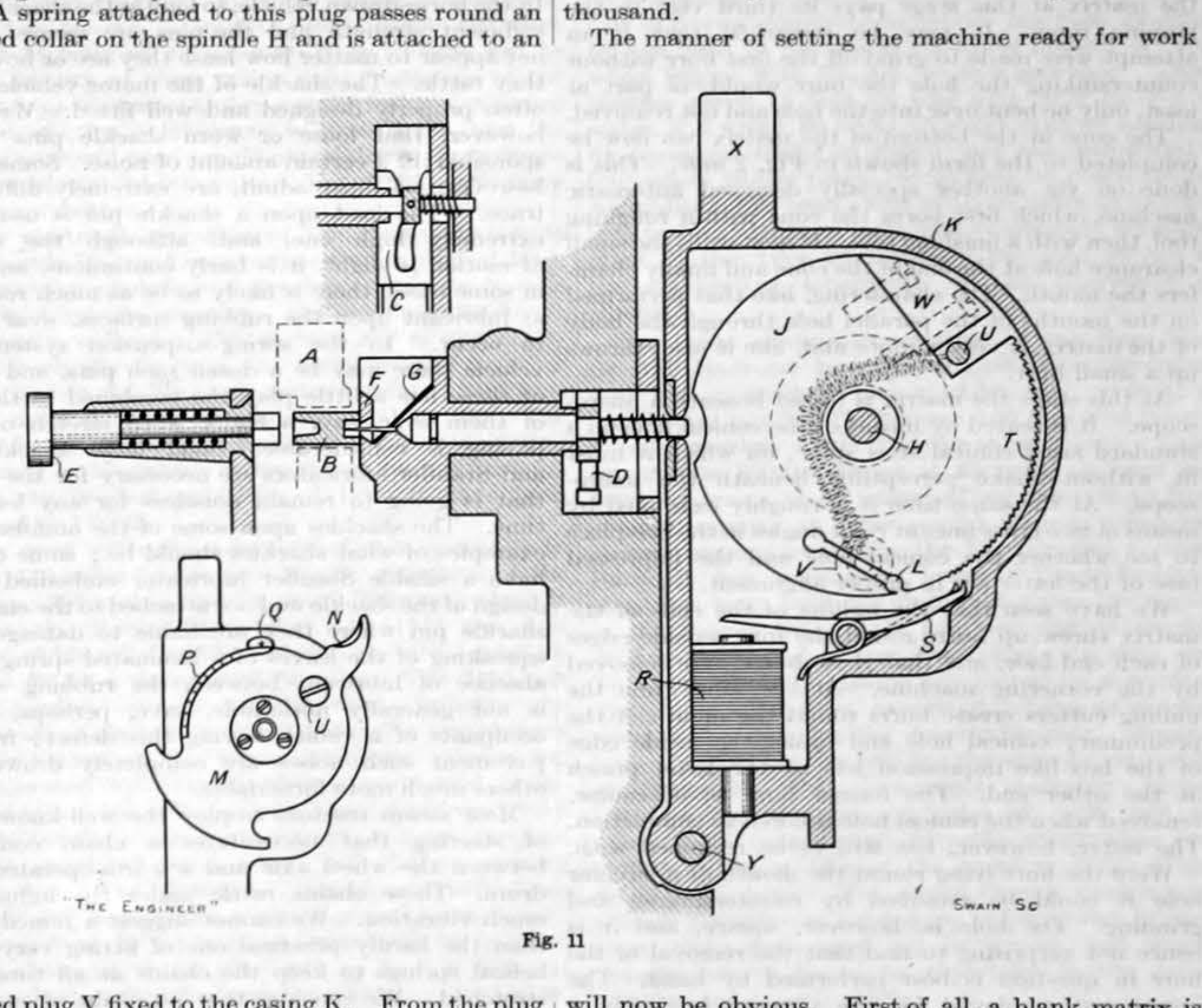

Fig. 11

will now be obvious. First of all, a blank matrix is inserted in the arm and the zero of the scale on the plate M—Fig. 11—checked. The left-hand cutter is then withdrawn quite out of action until the right-hand one has been properly set. Thereafter the left-hand cutter is advanced into its correct position as judged by means of an end gauge held against the face of the other cutter. This work is, of course, done by a skilled mechanic. The girl put in charge subsequently of the machine has merely to feed the receiving galley with a supply of matrices, to remove those collecting on the finished galley, 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 were it not for the fact that the point of the needle and the teeth of the milling cutters are subjected to wear. To guard against inaccuracies from this cause the girl from time to time interrupts the working of the machine and measures the depth of impression on a selected matrix after it has been milled. A little reflection will show that the reading thus obtained will reveal the wear which has taken place on the right-hand cutter, and that it will not show the wear which has taken place on the needle, since the needle is used both to position the matrix and to measure the depth of impression. The wear on the needle can, however, be seen at once by means of a blank steel matrix placed in the jaws of the arm. If the reading on the scale P—Fig. 11—when an attempt is made to measure such a matrix in the usual way is not zero, the needle point has clearly worn by the amount revealed. It is customary to insert such a blank matrix among every galley of matrices fed to the machine and for the operator to watch for it coming into the arm ready to be measured.

With the completion of the milling process described above we see the start of the trouble with burrs. After the stock had been cut off in the machine shown in Fig. 6 *ante* the matrix 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 machine is again made use of at the stage at which we have now arrived and the burrs left by the milling cutters round the same edges removed.

The parallel hole passing through the body of the matrix is then drilled in a specially designed automatic machine. In order to avoid the throwing up of a large burr by the drill as it pierces the last layer of metal it is arranged that two drills shall work simultaneously on the matrix, one on each side, so as to meet somewhere near the centre of the body. Both these drills do not reverse the direction of their travel at the same time. After one has begun to withdraw the other goes on working for a little while longer so as to bore out the hole completely.

The employment of two drills does not, however, obviate all burring, for a drill throws up a burr on the face on which it starts as well as on the face it finally pierces. Hence on both faces of the matrix a small burr is to be found round the mouth of the circular hole. This burr is removed by slightly countersinking the hole, the process being carried out by mechanism forming part of the automatic drilling machine. Unfortunately, one burr is removed in this manner at the expense of throwing up another, for the countersink tool leaves a burr round the outside of its cut. This burr, however, is such that it can be readily removed by grinding, and accordingly the matrix at this stage pays its third visit to the lapping room. It may be remarked that if an attempt were made to grind off the first burr without countersinking the hole the burr would, in part at least, only be bent over into the hole and not removed.

The cone at the bottom of the matrix can now be completed to the form shown in Fig. 2 *ante*. This is done on yet another specially designed automatic machine, which first bores the cone with a roughing tool, then with a finishing tool. It next drills the small clearance hole at the end of the cone and finally chamfers the mouth. The chamfering, like that performed on the mouths of the parallel hole through the body of the matrix, is very minute and, like it also, throws up a small burr.

At this stage the matrix is tested beneath a microscope. It is seated by means of the conical hole on a standard sized conical steel spike, on which it must fit without shake perceptible beneath the microscope. At the same time it is roughly examined by means of two cross lines at right angles in the eye-piece to see whether the conical hole and the impressed face of the letter are in proper alignment.

We have seen that the milling of the ends of the matrix threw up burrs round the four outside edges of each end face, and that these burrs were removed by the cornering machine. At the same time the milling cutters create burrs round the mouth of the preliminary conical hole and round the inside edge of the box-like impression left by the letter punch at the other end. The former burr is, of course, removed when the conical hole is bored to completion. The latter, however, has still to be reckoned with.

Were the burr lying round the mouth of a circular hole it could be removed by countersinking and grinding. The hole is, however, square, and it is hence not surprising to find that the removal of the burr in question is best performed by hand. The instrument employed for the purpose is simply a small scraping tool flexibly suspended at a fixed height from an overhead support with its point downwards. The matrix is stood letter end upwards on the metal base of the device and the scraping tool run round the four inside edges of the impression by hand. The tool is suspended at such a height that its point cannot by accident touch and damage the lower portions of the letter mould.

Here, again, we remove one burr only to throw up another, so that the matrix has a burr at each end, one thrown up by the scraping tool and the other by the tool used to chamfer the mouth of the conical hole. Both these burrs are removed by holding the ends in turn against the side of a revolving cast iron wheel. They cannot be ground off on the diamond lapping machine, for the matrix body has now its precise length. By the use of a cast iron wheel the tool marks, on which are solely relied upon to perform the work, it is ensured that nothing but the burr will be removed.

All the burrs have now been removed and it only remains to examine the matrices finally in several ways. First they are taken to an automatic machine which gauges them in a continuous stream for width and thickness of the body. This machine separates the matrices into three classes, namely, those which are right in size, those which are too big, and those which are too small. A similar automatic machine is then employed to test the length of the bodies. In both instances the toleration allowed is $\pm 0\cdot0001$in. Finally, the matrices are carried to the type drawing room, in which we started our tour of the departments. Here they are examined optically by means of a specially designed electric arc lantern. By means of this an image of the letter end of each matrix is enlarged fifty times and thrown on to an engraved ground glass screen. The edges of the letters must fall on certain prescribed lines on the screen. The limbs must conform in width with certain standard dimensions marked on a scale held by the operator against the ground glass screen. There must be no flaws revealed in the image. The inspection is very thorough, yet with a trained operator it can be made very rapidly.

The store is the last department to which we shall refer. Here the matrices are accommodated in trays sliding in a neat framework built up of angle irons and extending down two sides of the room. A small staff is kept busy making up assortments of matrices in execution of the orders continually being received. The room is not very large, yet we understand that it provides accommodation for no fewer than 27 million matrices. The average number manufactured per working day is in the neighbourhood of 6500.

In a concluding article we shall deal in detail with the punch-engraving machine.

THE NOISE OF MOTOR TRAFFIC.

SOME NOTES ON ITS CAUSE AND PREVENTION.

No. III.*

C.—NOISES PRODUCED BY VIBRATION (DUE TO BOTH ENGINE AND ROAD).

It has seemed to be advisable to treat under one heading vibration due to road shocks, as well as that due to unbalanced parts of the engine, since in a number of cases some loose part would vibrate just as readily from either cause. A great deal more attention is paid now to the design of road spring shackles and shackle pins than was the case a few years back. In the horse-drawn vehicle, so long as the shackles have sufficient strength and the pins are secure, it does not appear to matter how loose they are or how much they rattle. The shackle of the motor vehicle is now often properly designed and well fitted. We fancy, however, that loose or worn shackle pins are responsible for a certain amount of noise. Some noises, however, we must admit, are extremely difficult to trace. The load upon a shackle pin is usually an extremely high one, and, although the amount of motion is slight, it is fairly continuous, and if, as in some cases, there is likely to be as much road dust as lubricant upon the rubbing surfaces, wear is sure to occur. In the spring-suspension system of a vehicle there may be a dozen such pins, and if each of these has a little play the combined rattle of all of them over, say, a badly worn stretch of wood paving is considerable. Good large shackle pins and Stauffer lubricators are necessary for the vehicle that is going to remain noiseless for any length of time. The shackles upon some of the omnibuses are examples of what shackles should be; some of them have a sizable Stauffer lubricator embodied in the design of the shackle and not attached to the end of the shackle pin where they are liable to damage. The squeaking of the leaves of a laminated spring due to absence of lubricant between the rubbing surfaces is not generally noticeable, save, perhaps, to the occupants of a vehicle having this defect; from the pavement such noises are completely drowned by others much more formidable.

Most steam tractors employ the well-known form of steering that necessitates a chain connection between the wheel axle and a worm-operated chain drum. These chains rattle under the influence of much vibration. We cannot suggest a remedy other than the hardly practical one of fitting very strong helical springs to keep the chains at all times fully stretched. We consider that no chain of such type as that to which we have just referred should enter into the construction of a vehicle—either motor or horse-drawn—that is intended for town use. Chains consist of a number of small loosely fitting pieces, and if it were for some reason desirable to make a simple device automatically to produce noise under the influence of road vibration, probably a chain would be the best kind of device to use. In the horse-drawn vehicle, such as used by carriers and others, the horses' hoofs, the iron tires of the wheels and several loose chains vie with one another in the direction of causing clamour.

* No. II. appeared February 20th.

It will have been gathered from remarks already made that we have no very high opinion of the bonnet as a means for suppressing engine noise; indeed, we believe that in many cases if the bonnet were to be left in the garage it would be better for the silent running of the vehicle. However, the bonnet is necessary to satisfy the æsthetic sense and to protect the engine parts from wet, so that it must be made to serve these purposes as silently as possible. The bonnet is usually of light gauge material, so that it can be lifted without difficulty, but our belief is that the fact of employing light material would not be objectionable if there were no nominally flat surfaces to vibrate. The loud noise that can be made by pressing upon a slightly buckled or dished plate is familiar to all, and, since no part of a bonnet can be considered to be perfectly flat, under vibrating influences these parts constantly become buckled, first inwardly and then outwardly; the actual movement is, of course, very slight indeed, but if such a movement takes place it might well be responsible for a good deal of noise. Possibly, if the sides of bonnets were dished or corrugated, the whole construction would be improved so much in rigidity as not to vibrate.

The bonnet usually depends for its support upon the radiator and dashboard, and the former, in particular, cannot be attached to the chassis in a very firm manner, owing to an essential allowance for expansion. There must necessarily, therefore, be some difficulty in fitting the bonnet between the two parts in such a way as not to vibrate and rattle. Leather has been very helpful here, and this, together with some kind of spring catch that is commonly used to fasten down the bonnet, certainly has given us an arrangement that is usually fairly free from vibration. Some years ago a car of foreign make had a leather strap stretched over the bonnet to secure it in place, and this strap was intended to muffle any sound resulting from the vibration of the bonnet. Though little more than a makeshift, the strap method was effective. The dashboard forms an admirable sounding board, and any loose parts vibrating upon it can cause quite an uproar, as can also the dashboard itself by vibrating against the end of the bonnet. This is particularly the case when the engine is permitted to race. Whenever two parts are liable to vibrate one against the other it would be wisdom to arrange invariably some elastic insulation between them, such as leather or rubber or even springs; thus when a little wear had taken place there might still remain silence. We remember having seen an excellent knuckle joint in which, by means of a small spring, the pin and fork were always kept in close contact even after considerable wear. The joint was intended for brake rods, &c., where there is a tension stress only to deal with. This automatic adjusting system might also be introduced into other small parts which are, owing to their inaccessible position, liable to wear, and consequently to rattle. The volume of noise made by the rattling of small parts, the vibrating of rods against fixtures, side play in small bearings, &c., is not great, but such noises ought to be taken into account since they must evidently become more formidable as soon as the major noises already referred to are diminished, or even eliminated.

The guards and casings used over the gears of tractors and similar vehicles are composed of quite light material, and after a few years upon the road such guards are liable to become loose or partially disjointed. The loose parts set in vibration one against the other can make a very objectionable quantity of noise. Cast guards, cast merely for the purpose of resisting vibration and not for reasons of strength, might prove to be more lasting and satisfactory from the point of view of those who aim at securing quiet thoroughfares.

Vehicles that carry boards indicating their destination, or advertisement boards, ought to have them fixed in such a manner that they would be not only secure when the vehicles were first started upon the road, but would remain secure. These boards and signs sometimes rattle considerably, but can be easily rendered quiet by a light pressure of the hand against them. Perhaps spring washers or similar contrivances might be brought into requisition with advantage. It is frequently such removable kinds of attachments which receive so little consideration with a view to making them snug and secure that cause much disagreeable clatter. In the case of steam tractors there is usually a number of loose articles of various descriptions such as tools, lamps, &c., that rattle and shake in an abominable fashion, and one can hardly wonder that such is the case, seeing that drivers have no incentive to suppress the noises caused by the vibration of such miscellaneous gear.

D.—NOISES PRODUCED BY WHEEL CONTACT WITH ROAD.

Save for the fact that no very great number of motor vehicles is provided with iron tires, this form of tire could, we believe, be pronounced the most prolific motor noise-maker upon the road, though actually the degree of sound produced depends largely upon the kind of road material and the condition of the surface of that material. A heavy iron-tired vehicle progressing quite slowly over granite setts creates a din that no user of the streets ought to be expected to endure, whereas the same vehicle running over a stretch of newly laid macadam

A VISIT TO THE WORKS OF THE LANSTON 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 drive from a 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

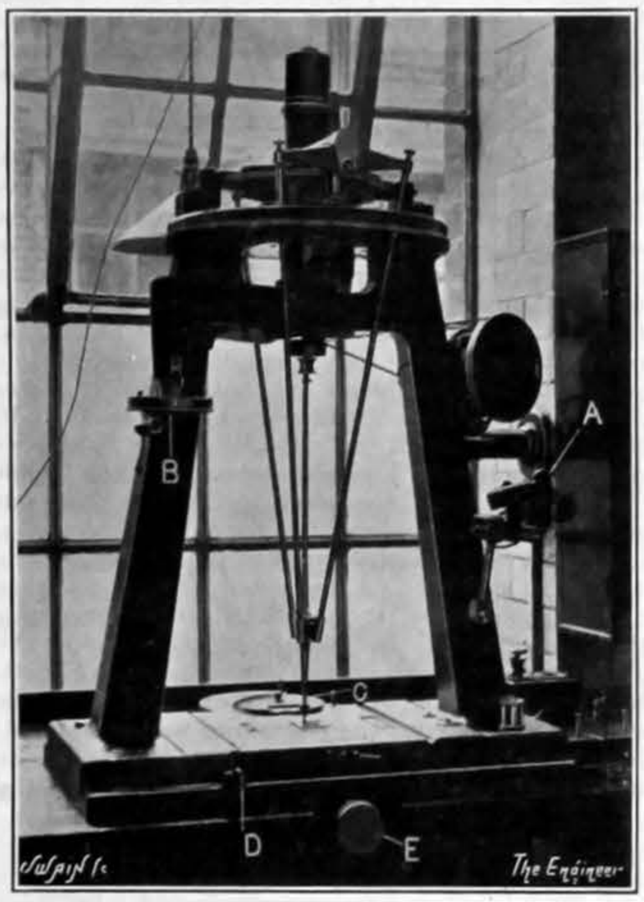

Fig. 12—PUNCH ENGRAVING MACHINE

upwardly pointing engraving tool. The required motion is given to the pantograph by four rods depending from it, and uniting near the base of the machine in a cross head. In this cross head is fixed a spindle which carries a "follower" at its lower end. This follower is guided by hand round the edges of the letter raised on the pattern plate, which pattern plate is clamped to the base of the machine between the two columns. As the follower is moved round the pattern letter the punch up above is moved in a reduced ratio against the revolving engraving tool, and with each successive cut acquires a more and more perfect image of the pattern.

A detailed view of the base plate is given in Fig. 13 (original Fig. 3). The pattern is held between

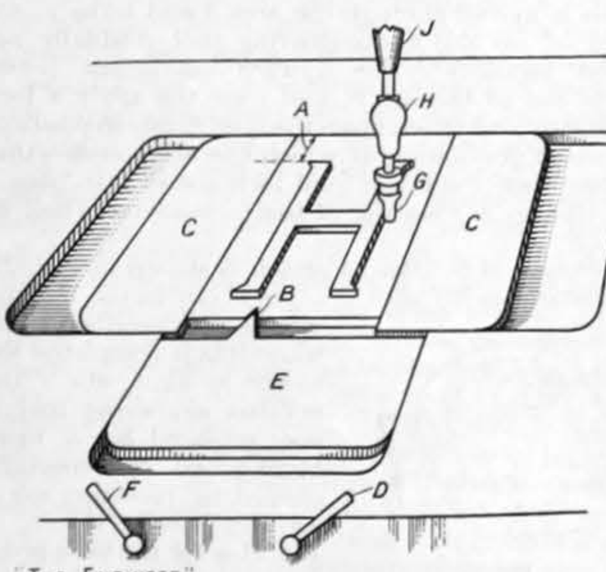

Fig. 13—BASE OF PUNCH ENGRAVING MACHINE

two side plates C clamped by means of a handle D. It is held top and bottom by the edge of the shallow recess, in which it lies, and by a V point formed on a plate E. The latter plate is clamped by the handle F. A view of the follower is also given in this figure. The follower proper G may be described as a steel thimble fitting without shake over the end of a short spindle. This spindle is supplied with a small pear-shaped wooden handle H and passing upwards is supported in the end J of a hollow spindle. This spindle in turn is held in the cross head joining the ends of the four rods connected to the pantograph. The spindle on which the pear-shaped handle and the follower are carried is constantly pressed downwards by a spring inside the hollow member J. It can thus be lifted up sufficiently to carry the follower into the interior of a closed letter such as A, B, e, g, O, &c.

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 gimbal 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 solidly with it a screwed sleeve H is formed. Over the screwed sleeve a cap J fits loosely. A rod K hung from the top of this cap passes downwards 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 gimbals 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 reduction of the letter on the pattern plate. At times, however, requests are received for letters slightly thicker or thinner than, but of the same

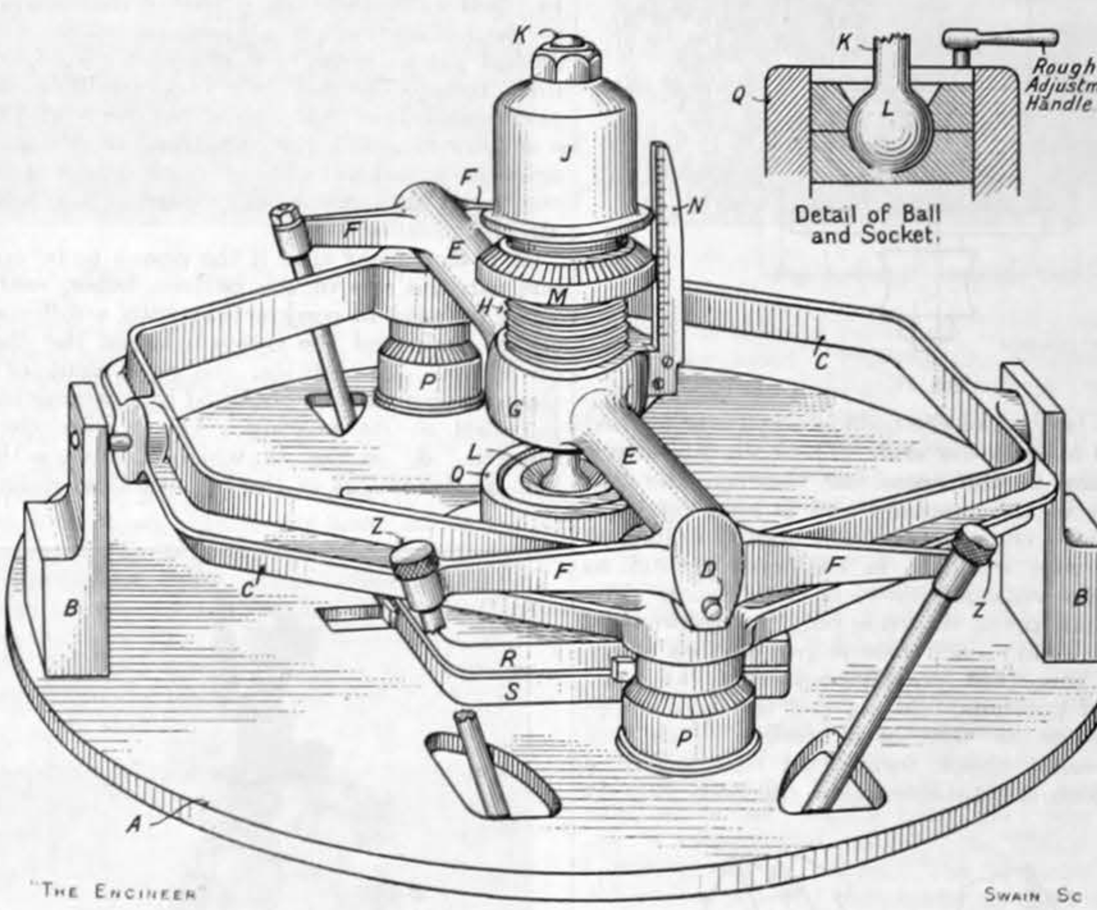

Fig. 14—PANTOGRAPH MECHANISM

height as the standard type. Provided the difference required is not excessive, it is possible to cut the punches for such letters from the standard patterns. This is accomplished by raising or lowering the pins D above or below their normal position, and thereafter 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 P 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 0.025in. as measured at the centre. This caused the pivots in the brackets B to work uneasily, and, further, resulted in slight errors in the proportionality of the reduction. Subsequently, the frames 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 upper 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 R and S are shown in section in Fig. 15. The lower plate S carries two keys T sliding in keyways cut in the upper surface of the top A. At right angles to the line of these keyways, the upper plate R 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 R and V just fit the outside diameter of the member W, but the holes in the plate S and the top A are somewhat

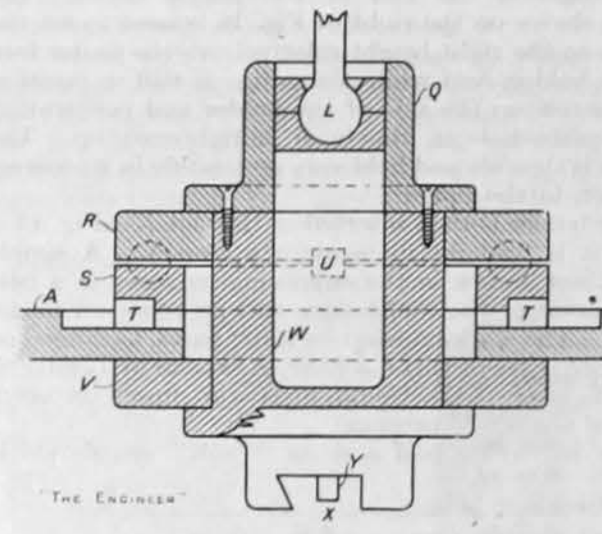

Fig. 15

larger. The lower surface of the member W is formed with a slot X for the reception of the punch holder.

If, 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 steady. 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

Fig. 16

having their centres in the plane of the upper surface of the pattern letter. Excepting those followers which are too small to permit of this ball-and-socket joint, the mechanism, we believe, does give a mathematically accurate reproduction. The accuracy of the mechanism, then, is exact except at a re-entrant angle, and here the discrepancies introduced are of no account, even when the accuracy required of the machine extends, as it actually does, to the ten-thousandth part of an inch.

In Fig. 16 a view of the punch holder, which fits into the slot X shown in Fig. 15, is given. The

* No. II. appeared February 27th, 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 side 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 workmanship on these parts, as indeed on all other parts of this machine, is extremely beautiful. The slightest shake would, of course, upset the accuracy of the whole process.

The engraving tool and its "quill" are shown in

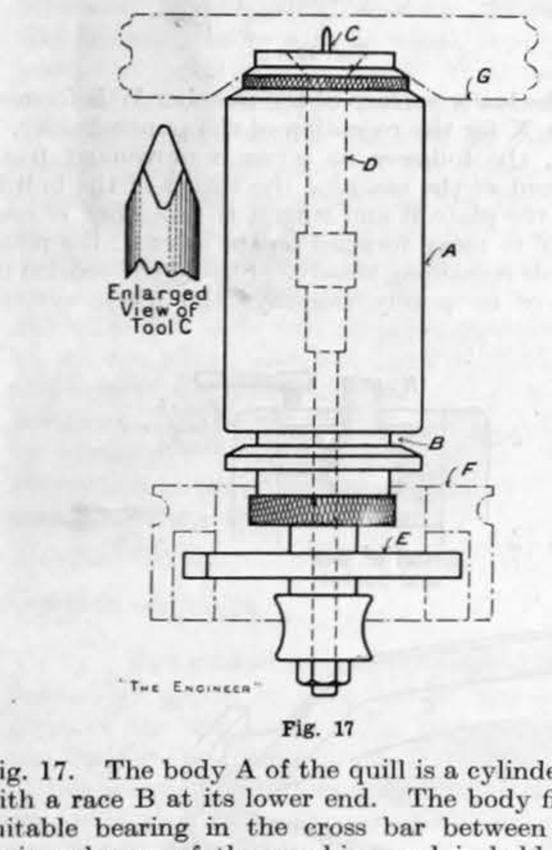

Fig. 17

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 0.055in. 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 face 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

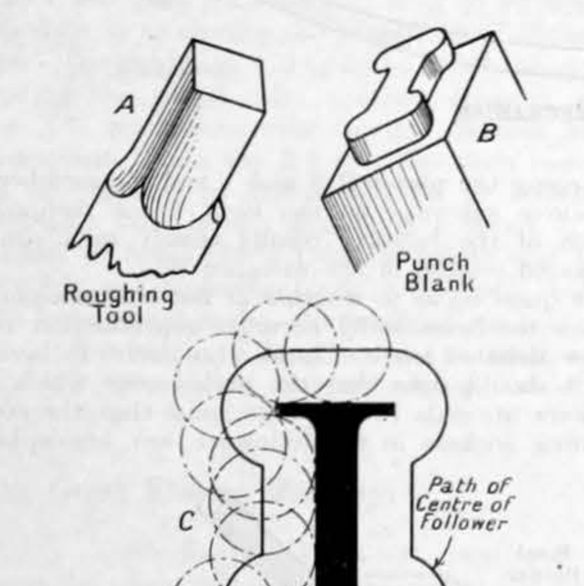

Fig. 18

its lower end the spindle carries a two-armed driver E designed to engage inside the driving pulley F. This driving pulley, it will be understood, is a fixture on the cross bar of the machine frame; the entire quill can be withdrawn for inspection through it. By arranging matters in this way the side pull of the belt is taken entirely by the pulley. None of it is transmitted to the quill. The speed of the tool is 5000 revolutions per minute. A brass tray 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 each succeeding cut the size of the follower is progressively decreased until we arrive at one, 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 path 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

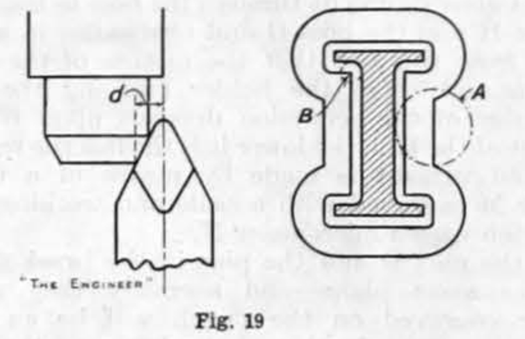

Fig. 19

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 that of the milling cutter. When, therefore, we take the second cut with the next smallest size of follower we must reduce the diameter of the milling cutter proportionately. For if we did not we would fail to get a smaller radius in the re-entrant angles, and, further, since 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 *n*th 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 *n*. 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 distance is the equivalent of the radius of the hypothetical milling cutter.

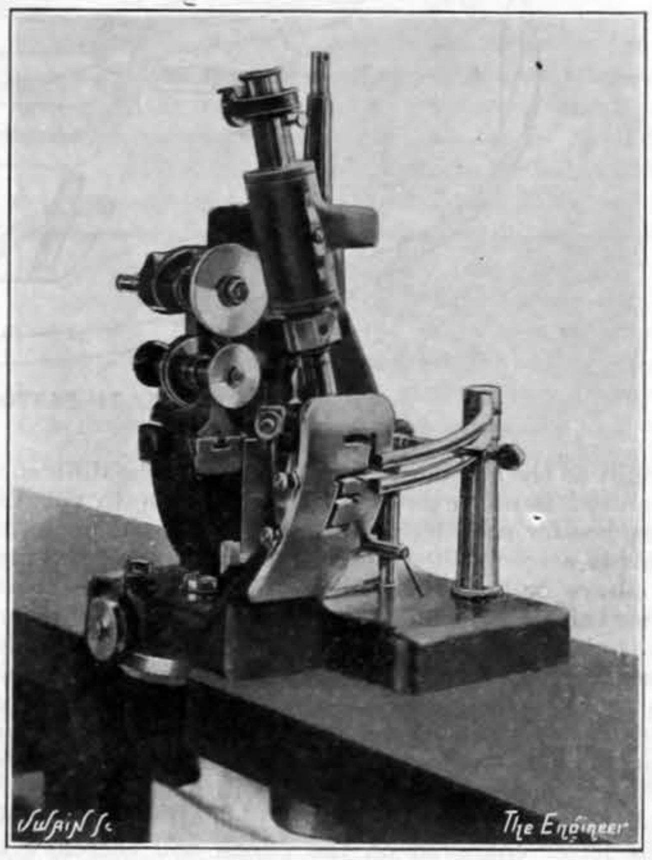

Fig. 20—TOOL GRINDING MACHINE

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 0·012in. in diameter, and when it is in use the engraving tool is cutting practically by its very point. 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 attached at A—Fig. 12—to the standard of the engraving machine. If it is seen still to be sharp it is taken for granted that the punch has been cut correctly.

The means employed to lower the engraving tool with each change of follower consist of a micrometer wheel marked B in Fig. 12, controlling the vertical position of the "quill," Fig. 17, through a lever and screw and nut. One revolution of the micrometer wheel moves the tool up 0·05in. Each follower is marked with a certain figure, and in practice all that is required of the operator is to set the micrometer wheel to the same figure as shown on the follower in use for the moment. The various followers are carried on a circular plate C, Fig. 12, at the back of the base, so that the operator is compelled to carry the punch blank well clear of the engraving tool before changing her followers. The micrometer wheel is set to its proper value before the new follower is lifted off the circular plate.

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—see Fig. 13—is movable vertically against the downward 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 cutting the outside edge of the letter. If, then, having finished the outside of the letter, we carried the follower straight away into the inside of the pattern letter, we would in the first place cut a groove across the face of the letter, and, secondly, would probably break the point of the tool by setting it to cut the interior of the letter straight away to the full depth. How these difficulties are overcome will be understood by examining the handle D, Fig. 12. A diagrammatic detail view is given in Fig. 21. When the handle is over at the extreme right 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

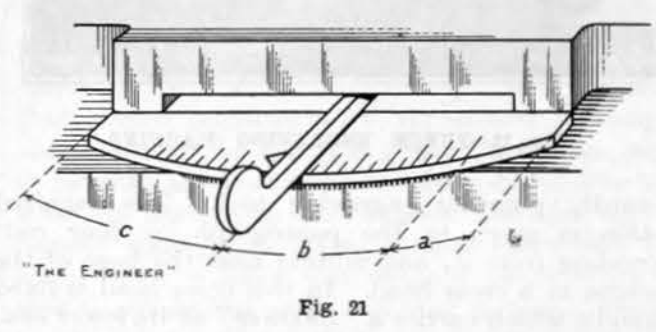

Fig. 21

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 arrangement 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. With the handle carried to 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 down from the blank. As the handle is moved through the arcs *a* and *b* the motor is started up and the engraving tool gradually advanced upwards. The upward movement ceases at the end of the arc *b*, and over the arc *c* a lock comes into play which holds the quill firmly in position. The exact graduation at which the arc *b* ends—that is to say, at which the quill lock comes into play—is settled by the setting of the micrometer wheel 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 now replaced by a more blunt-nosed one specially shaped for recessing work. As the handle shown in Fig. 21 is for the time being in its extreme right-hand

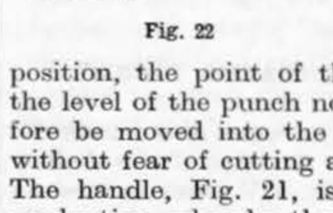

Fig. 22

position, the point of the tool is somewhere below the level of the punch nose. The follower can therefore be moved into the centre of the pattern letter without fear of cutting across the face of the punch. The handle, Fig. 21, is next brought to the zero graduation, whereby the motor is started up and 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 and round about inside the pattern letter. 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 prevent ink adhering inside it when transferred to the type of the casting machine; it cannot be made too deep, however, or otherwise the punch and the type would be weak. But whatever depth is required, the micrometer wheel B, Fig. 12, is set to the appropriate graduation before the "countering" begins. This, as we have said, determines the point at which the quill lock comes into action, and therefore the depth to which the recess is cut.

The motor is next shut off, the roughing tool taken out and the fine-pointed engraving tool put back in place. With the follower still in the interior of the pattern letter the handle, Fig. 21, is moved over to its extreme left-hand position. This starts the motor, raises the tool until its point is just touching the recessed surface and locks the quill in position. The bevelling of the inside edge of the letter is now proceeded with just as it is done on the outside edge.

Two means of adjusting the working of the machine not already referred to may be mentioned in conclusion. The handle E, Fig. 12, operates a small slide on which the clamping details shown in Fig. 13 are fixed. By means of it the position of the pattern letter from back to front of the base plate can be varied and a corresponding change produced in the position of the letter on the punch nose. The accuracy of the copying mechanism requires that the centre of the follower when in the middle of the base plate should be exactly below the centre of the ball L, Fig. 14. To permit of a slight adjustment in this direction—a thousandth of an inch or so is all that is required in view of the accuracy of the workmanship attained in the construction of the machine—the two front tubes joining the pantograph link work with the cross head holding the follower spindle each contain a piano wire inside them. One end of this wire is fixed to the cross head, and the other to the milled head Z, Fig. 14. By the tightening or slackening of the wires the tubes are slightly stressed and the required amount of strain produced.

Our description of this machine probably conveys the idea that its construction is somewhat complicated. No doubt, it is so; but, on the other hand, the process of working it is simple and very largely automatic. We understand, indeed, that a girl can be taught to use it in a few hours' time. The number of punches produced per day of nine hours varies largely with the particular characters being engraved. It is, for instance, easier to produce a letter I than a letter B. But, on the average, we are informed, forty to fifty punches per day is the normal output and eighty about the maximum. Of the machines we have described, eight are kept more or less constantly at work.

In conclusion, we have to express our best thanks to Mr. F. H. Pierpont, who invented and designed this and all the other extremely ingenious machines we have mentioned in the course of these articles, and to his assistants and foremen, who all united in giving us every facility to gather the information contained in this account of the manufacturing processes under their charge.

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 the job is complete, you are furnished 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 completed their ocean giant the Olympic. On a half sheet of note-paper, it is said, was written the order for the Britannic, which was launched from Queen's Island on Thursday, Feb. 26th. Generally speaking, owing to the nature of the instructions given, the Britannic does not differ greatly from her predecessors, and such differences as there are, are to a large extent due to the lessons learnt from the grim tragedy of the Titanic; indeed, it is worthy of note that every possible improvement suggested by that tragedy has been embodied in the new ship, even when it hampered or altered work already begun. The similarity between the two ships is so great, and we dealt so fully with the Olympic just before her completion—see THE ENGINEER, March 3rd, 1911—that we shall not go over the old ground, but shall simply confine ourselves to noting the differences between the two; thus the combination will give a correct and full description of the latest ship.

Before dealing with the vessel herself we should perhaps give a few particulars of the actual launch. We are informed that the total launching weight was 24,800 tons, actually slightly less than that of the Olympic, and the Britannic was found to float at a draught of 15ft. $4\frac{1}{2}$in. forward and 20ft. 7in. aft; the load recorded on the trigger was stated to be 560 tons. The most remarkable feature of the launch was, to our minds, the exceedingly slow speed at which the vessel moved for the greater part of the length of the ways—she appeared almost as if she would stop; this is to a certain extent borne out by records taken, which showed that the time occupied was 81 seconds, and that her maximum speed was only $9\frac{1}{2}$ knots, and though the declivity of the ways—$\frac{3}{8}$in. in 1ft. forward and $\frac{1}{2}$in. aft—was the same in each case, considerably slower than that of either the Olympic or Titanic, when the speed was over 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 of 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 it is of little importance; but the result gave the impression of fore-knowledge and forethought and of the safety and certainty of the launching operations which was pleasant to experience. Everything went off without a hitch, and the great ship was brought up a little beyond the end of the ways. The Harland and Wolff yard is, unfortunately, not so well arranged from a spectacular 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 peep-show purposes, so we have no right to complain. As the solution of an engineering problem of transferring a mass of 24,800 tons safely from the land to the water the launch was a triumphant success.

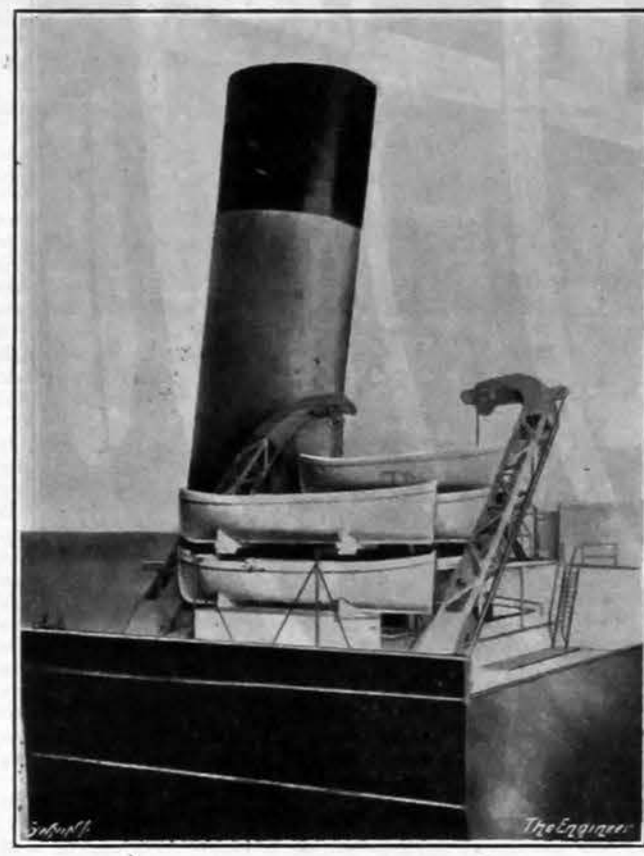

Fig. 1—NEST OF BOATS AND DAVITS

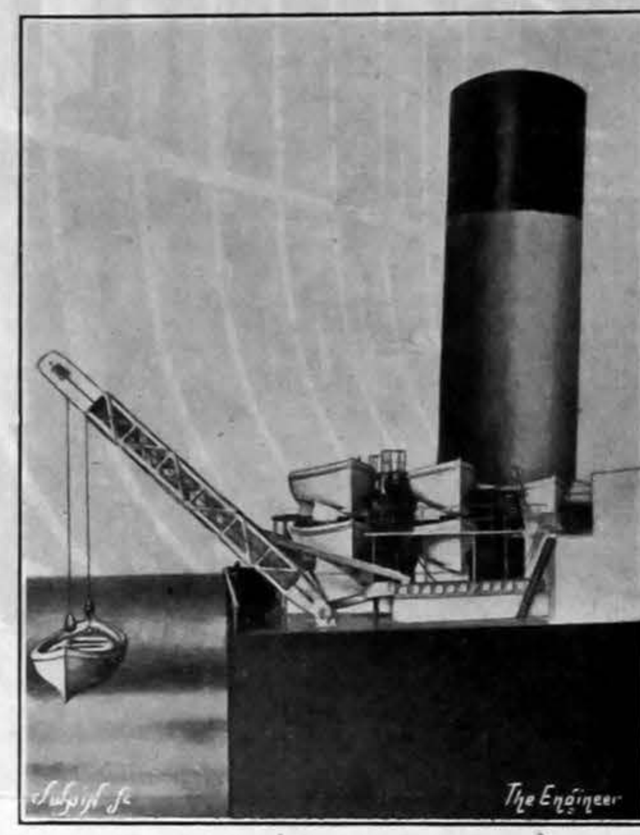

Fig. 2—BOAT SWUNG OUT

The most important 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 unsinkable. The arrangement is practically the same as that which was fitted to the Olympic after her completion, 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 94ft. wide. It is to this increase in beam that the rise in gross tonnage to 50,000 is chiefly due. This, again, reacts on the machinery, the total indicated horse-power in the new boat being 50,000, in order to maintain the steady sea speed of 21 knots. Each of the reciprocating engines gives 16,000 indicated horse-power instead of 15,000, while the turbine has been increased in size till the drum is 12ft. 6in. in diameter, the blading varying in length from 16in. to $26\frac{1}{2}$in., and the output is now 18,000 shaft 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 bladed, 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 blading of the old form was scrapped and the new ideas introduced. The respective revolutions of the engines and turbines are now 77 and 170 per minute. It may here be 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.

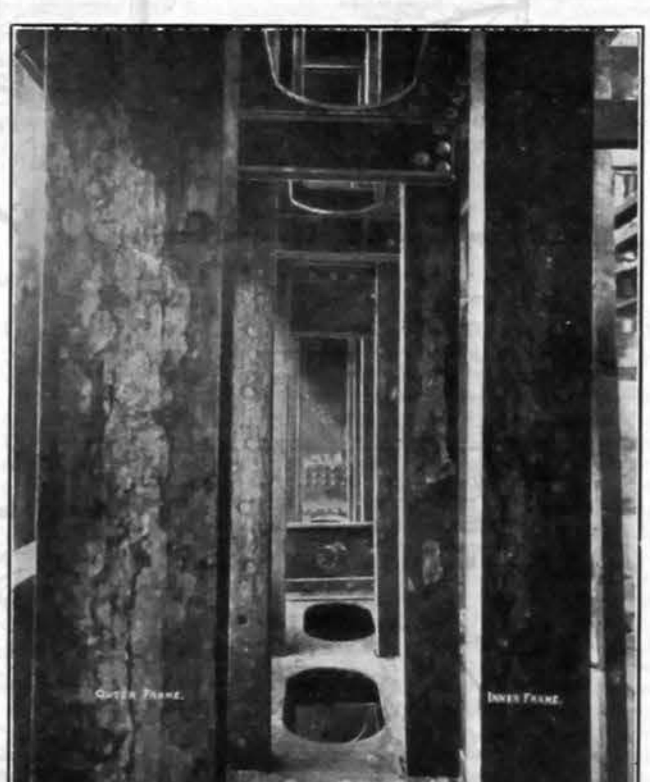

Fig. 3—SPACE BETWEEN INNER AND OUTER PLATING

There are otherwise but few alterations in the main engines, 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 is made use of in the turbine, the change is obviously in the direction of improvement. We only noticed one other alteration, or rather addition, to the main engines, and that a minute one, namely, the fitting of light steel splash plates in between the branched legs of the columns 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 whole of the oil which the greaser aims at that point actually reaches the pin and so gets thrown about instead of the greater part finding its way direct into the bilges as with the usual method. It is curious that no such complete protection was to be seen on steam engines except on those naval jobs fitted with full forced lubrication, before the advent of the motor, though it will probably be said that motor practice has had nothing to do with this. At the same time the motor has legitimatised all sorts of things that were at one time looked at askance by the steam marine engineer. Similar plates are also fitted right round the eccentrics, but these are portable in order to facilitate overhaul. Whether the system of lubrication adopted for the thrust collars can fairly be called "forced" we should not like to argue, but it certainly has a good head behind it, though the pumps are only used for carrying the oil into tanks right at the top of the engine-room, from which, and not from the pumps, the head is obtained. It is a nice point.

The boilers, of course, have had to undergo some change in order to deal with the increased horse-power, and though the number has been kept the same as before—twenty-four double-ended and five single-ended—the lengths have been increased so that the former are now 21ft. by 15ft. 9in. and the latter 11ft. 9in. by 15ft. 9in. mean, while the total heating surface is 150,958 square feet and the grate area 3466 square feet. One other change in the boiler-rooms is to be noticed, namely, that instead of ash ejectors, Stone's ash expellers are used, though the difference in nomenclature does not indicate the difference in operation. Ejectors eject the ashes overboard above the water line through a curved pipe, whereas expellers expel them under water through a straight pipe. In the latter arrangement the shoot