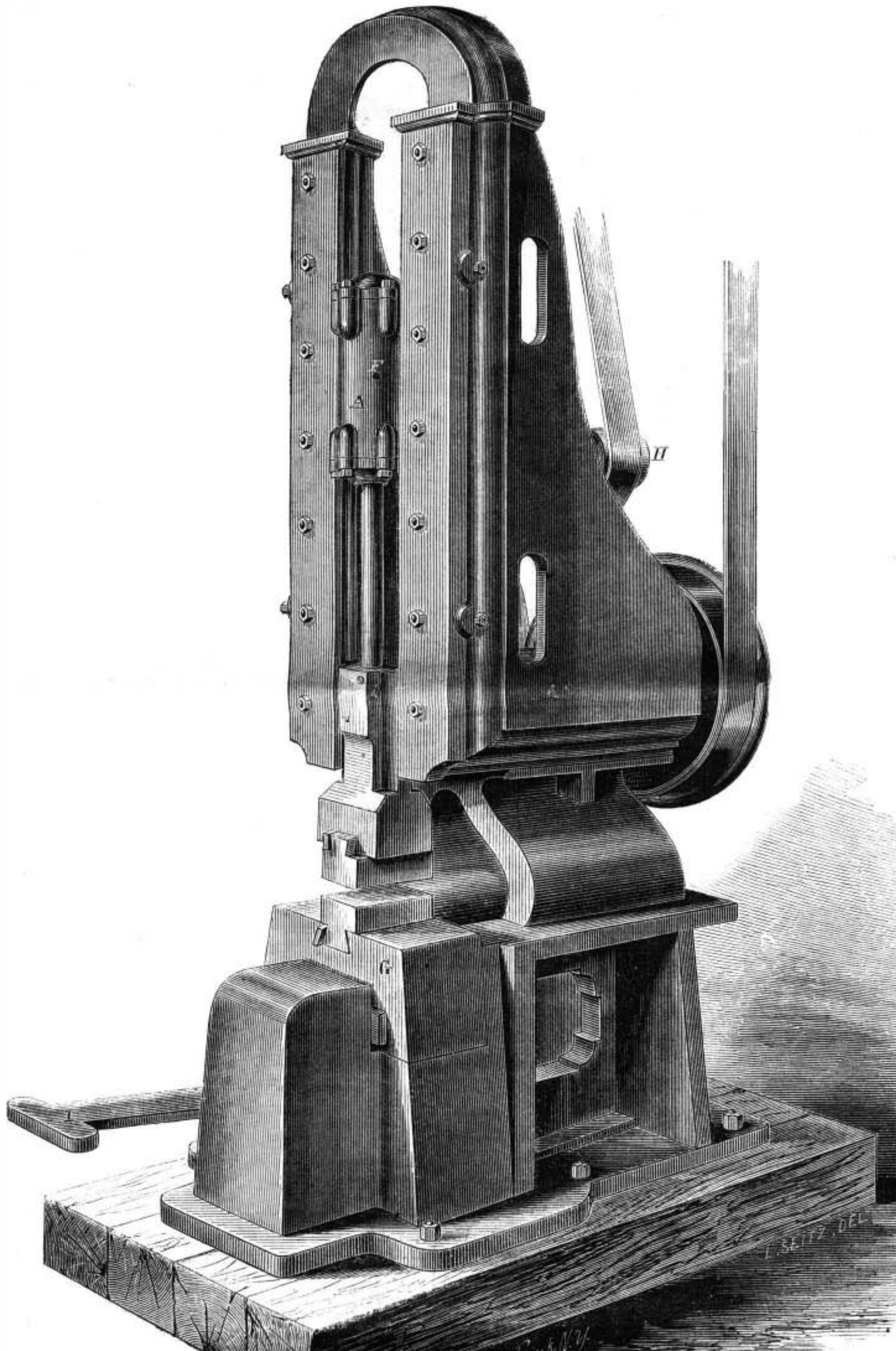
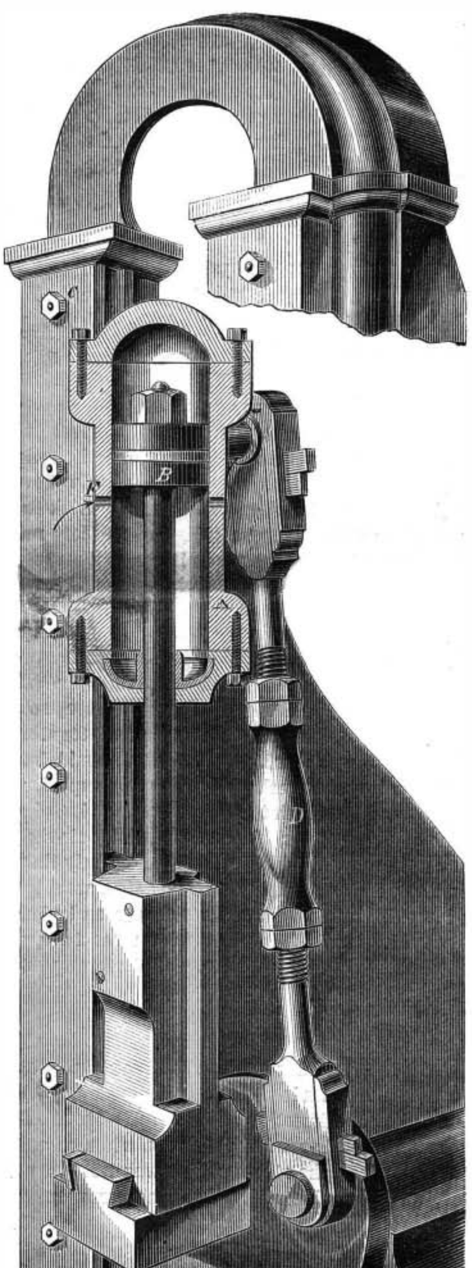
Scientific American.

A WEEKLY JOURNAL OF PRACTICAL INFORMATION IN ART, SCIENCE, MECHANICS, CHEMISTRY AND MANUFACTURES.

Vol. XI.---No. 14. (NEW SERIES.) | NEW YORK, OCTOBER 1, 1864. | $3 PER ANNUM (IN ADVANCE.)





HOTCHKISS'S ATMOSPHERIC FORGE HAMMER.

A great improvement has been made of late years in forging light work. Instead of relying upon the hand and eye of some skillful workman, dies have been substituted, and the jobs thus produced have all the accuracy of castings while they are far superior in strength. Many pieces in gun work, which were formerly made of malleable iron, from the supposed impossibility of forging them, are now drawn out from the solid bar at less cost than they could be cast. Drop-presses have been used on this work, as also rapid-working trip-hammers, but these make such a tremendous racket that it is almost impossible to stay in their vicinity.

The hammer illustrated in this connection is, in many respects, superior to the drop or the trip-hammer, for it is under perfect control, can strike a light or a heavy blow, or any number of blows in quick succession. It can forge or draw down work of any description, and for large or small machine, or jobbing shops is an invaluable aid. On gun work it is also indispensable, and the "Starr Arms Company" are now using one in their extensive manufactory at Yonkers, N. Y. With this testimony in its favor we pass to a brief description of its details and operation.

The hammer derives the force of its blow from compressed air. The air is compressed by a cylinder, A, and piston, B, (see Fig. 2.) The cylinder moves in the slides, C, by the action of the connecting rod, D, driven from the face-plate, E, by belting, in the usual manner. There are two small holes, F, in the cylinder, A. Through these the air enters. The whole machinery is carried in a strong iron frame. Now if we suppose the cylinder to ascend, the air will enter through the holes, F, and be compressed as the cylinder goes up. This compression is at the *bottom* of the cylinder and therefore *lifts* the hammer moving in the slides. By the time the hammer is lifted the connecting rod arrives at the top center and commences to descend. The air then enters *above* the piston, and as the cylinder still comes down condenses the volume very highly. This condensed air is the force stored up to make the blow, for so soon as the connecting rod turns the bottom center the confined air expands instantly and thus throws the piston and hammer down with great force. This action is repeated at every revolution, and the hight of the cylinder is altered so as to forge large or small work by lengthening or shortening the connecting rod. The hammer is lifted at the ascending stroke by the compressed air below, as we stated previously, and this also aids the cylinder in compressing the air for the return blow, and it is owing to the rapid action of the two movements that the piston does not fall before it obtains the advantage of the air compressed above it.

It will be seen that this hammer is exceedingly simple in its construction; there are no valves about it to get out of order, and the packing is exceedingly durable and easy working. Both that in the piston and in the cylinder head is made of the cup-leathers used in packing hydraulic rams, and they have run for months without leakage or perceptible wear. The dies are fastened in with keys, and the anvil block, G, is adjusted by another key, so that the dies can be set properly without delay. The speed of the hammer is regulated by an idler pulley, H, which can be operated by the treadle, I.

This ingenious and novel hammer is the subject of three patents, bearing date respectively June 14, 1859, July, 1863, and May 3, 1864, which were issued to Bennett Hotchkiss, of New Haven, Conn. For further information address the sole manufacturers, Charles Merrill & Sons, 556 Grand street, New York.

Atmospheric Railways.

Exactly fifty-four years ago, a Mr. Medhurst proposed that a brick tunnel should be built and applied to the conveyance of passengers at speeds never more than dreamt of before. Within the brick tunnel a pair of rails were to be laid, and on these rails a suitable vehicle, very similar in its general arrangements to an ordinary railway carriage, was to travel. The cross section of the brick tube, as proposed, would have been egg-shaped, with the maximum width above. The rails would have rested on projections springing from the side walls near the bottom. To the rear of the carriage a piston, so to speak, formed of boards suitably framed together, would have been affixed. This piston would have nearly fitted the tunnel. Whether any expedients were proposed by which the space between its edges and the brick work could be made partially air-tight, we are not prepared to say. It is not likely that a scheme so perfect in principle as this was, would be found wanting in detail. The carriage and piston thus provided, and put in place within the tube, air was to be forced in behind by means of a large pumping apparatus very similar, we believe, in general design, to the blowing engines at present used at our iron works. The pressure of the air thus pumped in would, it was contended, prove sufficient to propel the carriage with its load of passengers at very high speeds. Mr. Medhurst lived before his time. The scheme never got beyond a model for obvious reasons. In the first place, the steam engine was not yet perfected, and the obtention of the necessary motive power for the blowing machinery was by no means easy. In the second place, people had a very great and perhaps natural antipathy to the idea of being placed within a tube, dark and cheerless, and blown to their destination; and thus a really valuable invention fell to the ground. It is easy, however, to see that Medhurst's was no ordinary mind. In this scheme we have the embodiment of nearly all that constitutes the modern railway—the iron rails, the high speeds, the accommodation for passengers, have a great deal in common with the present system of locomotion, and all this, be it observed, was designed twenty years before the Rainhill trials inaugurated the railway system. After Medhurst came Vallance and Pinkus, gentlemen who proposed certain alterations, the principal idea being involved in the reduction of the size of the tube; the alteration of its position with regard to the carriage, by placing it between the rails and below the floor; and the exhaustion of the air from the space in front of the piston, instead of its compression within the space behind; but this last had already been proposed by Medhurst, who seems to have left scarcely a point overlooked. Messrs. Vallance and Pinkus had no better success than Medhurst, and it remained for Messrs. Clegg and Samuda, years afterwards, to develope the system on a practical scale on the London and Croydon, and Dalkey and Kingstown railways. The atmospheric principle as tried on these lines is now well known to be wholly unsuitable to the demands of an extensive traffic, and, as far as the country is concerned, the vacuum tube and the piston carriage have been banished forever in favor of the locomotive. With the introduction, however, of the underground metropolitan railway system, the old scheme of Medhurst bids fair to be revived. Indeed, there is hardly room to doubt that it is, of all others, the most suitable for the exigencies of this species of traffic. In the pneumatic dispatch we have on a small scale all that Medhurst proposed; and there can be no room to doubt, from the success which has already attended upon the labors of the company known by the same name, that the system can be extended to the conveyance of passengers without any practical difficulty whatever. During the last few months, too, Mr. Rammel, the inventor of the pneumatic dispatch scheme, has been laboring at the Crystal Palace to provide a model line—the first on which regular passengers have been conveyed—which would serve to bring all these advantages fairly before the public.

The tube extends from the Sydenham entrance to the armory near Penge-gate—a distance of about a quarter of a mile, and it is, in fact, a simple brick tunnel, nine feet high and eight feet wide—a size that renders it capable of containing an ordinary Great Western Railway carriage. That actually working in the tube at this moment is handsome and commodious. The piston is rendered partially air-tight by the use of a fringe of bristles extending nearly to the brickwork of the tunnel and its floor. A fan 20 feet in diameter is employed to exhaust or to force in air, and perhaps it is impossible to devise any other expedient so well calculated to answer the required purpose. It must be remembered that either a plenum or a vacuum equivalent to ·5 of an inch of mercury is quite sufficient to propel even a heavy train at a high speed on a moderately level line. In the present instance the motive power is supplied by an old locomotive borrowed from one of the railway companies, which is temporarily mounted on brickwork. The tires have been removed from the driving wheels, and these last put the fan in motion by straps.

The line, we have said, is a quarter of a mile long; a very small portion of it, if any, is level, but it has in it a gradient of one in fifteen—an incline which no engineer would construct on an ordinary rail way; and as it is not a level line, so it is not a straight one; for it has curves of only eight chains radius, which are shorter than those usually found in existing railways. The entire distance, 600 yards, is traversed in about 50 seconds, with an atmospheric pressure of but $2\frac{1}{2}$ ounces. The motion is of course easy and pleasant, and the ventilation ample, without being in any way excessive. All the mechanical arrangements are so simple and must be so obvious, we imagine, that it is needless to dwell on them. We feel tolerably certain that the day is not very distant when metropolitan railway traffic can be conducted on this principle with so much success, as far as popular liking goes, that the locomotive will be unknown on underground lines.—*Mechanics' Magazine.*

Small Forge Hammers.

Since the year 1806, when William Deverell, engineer, of Blackfriars-road, specified what was virtually the first crude idea of a hammer to be worked by the direct action of elastic fluids, machinery for forging iron has made vast progress. The steam hammer, under some form, is to be found in nearly every engineering establishment wherein masses of iron of any size, save the very smallest, have to be beaten into shape. The phases under which this machine tool appears, are many and various, and the degree of perfection to which it has been brought is extremely satisfactory. Nevertheless, power hammers do not yet take the place which they ought. This fact is mainly due to a desire to produce machines which can deal with the colossal masses of metal which distinguish the operations of the modern art of working in hot wrought-iron. For centuries past the thews and sinews of the smith have been deemed quite competent to cope with ordinary bars and rods, and plates, to scarf and weld, to cut and punch and shape; and they are deemed so still; but the demand for large forgings, which is quite a thing of yesterday, could not be satisfied by the aid of such means. The old-fashioned helve hammer, although useful enough in its way, is not possessed of that general applicability which is absolutely required. It is probable that the history of this hammer could be easily traced up for a couple of hundred years; yet, until very recently, anchors were forged solely by manual labor, while the furnaces or hearths in which they were heated were blown, not by a fan, but by means of a system of bellows, usually fixed near the roof, and put in action by gangs of men stepping on and off the upper boards, which were raised by a weight and driven down by the men. We hear of such things now with a smile, yet it is by no means certain that succeeding generations may not in turn smile at our proceedings. The toil of the smith is not materially lightened by the steam hammer. That giant has only stepped in so far, to execute a class of work which could not be performed at all without his aid. The working smith, the man who has heretofore beaten out iron into horse-shoes or pruning-hooks, or spades, beats it out still in the old orthodox way, and neither receives, nor expects to receive, any aid from the tool throbbing, perhaps, at his side. In every forge in the kingdom may still be found the smith and his attendant strikers, without whom he cannot get on. Were there no other considerations involved, save those of money, this system would still be found objectionable, because the most costly of all labor is that performed by human muscle and vital energy. It is time that small forge hammers should become so habitual that the duties of the striker might be nearly if not quite dispensed with; but the hammer has yet to be produced which will answer such a purpose, and the sooner it is invented and made, and brought into practical operation, the better for the world and the inventor.

Nothing can be more unsuitable for the execution of work of even moderate dimensions, such as eccentric rods, valve and governor gear, and such like, than a steam hammer capable of doing much heavier work. As a matter of workshop economy, it is always better that tools should be worked nearly or quite up to their full capacity. It is true, however, that a great number of small machines have been brought out from time to time, which are intended to supersede the striker. Ryder's forging machine is one of these, and a very useful and excellent tool it has proved itself for certain classes of work. It is costly in the first instance, however, and it consumes a good deal of power. Compressed air hammers, too, such as Winton and Cowan's, there are in abundance, of small size, and in their way very efficient. Still, none of these things supply exactly the thing wanted; small as they are, they are yet too magnificent for the execution of a great deal of work, too small and unimportant to render their aid indispensable, and yet too large and heavy for one man to perform it unaided. The real want is a steam arm, if we may use the word, which shall do all the hammering comfortably, and which shall be capable of such regulation that it may be said to approach to that discrimination so requisite in a good human striker. It will not do to deliver a series of straight up-and-down blows. The mere weight of the hammer bar must have very little, comparative, to say to the execution of the work, which should be mainly performed by the pressure of steam; and to make such a machine all that it should be, it must be capable of delivering blows at various angles. This might be effected by so fitting the cylinder that it could be swung in a vertical plane through, say 45°, the anvil face marking the center, while the piston rod gave the radius of the curve. By suspending it in blocks moving in curved slots in the frame, such a tool as this, carrying a head of but thirty to fifty pounds weight, with a three or four inch cylinder and an eighteen-inch striker, able to run off three hundred strokes, or thereabouts, per minute, would answer an extremely useful purpose. In order to make it as perfect as possible, however, it is necessary that it should be wholly under the control of the working smith himself. One man should be enough to use it to the best purpose of which it was capable; call in the aid of a second, and he might as well be put to strike at once. There is no great difficulty in this; the smith, once he has got his work on the anvil, seldom requires to hold it there with both hands; one therefore being free, the management of the machine by a single lever, would come quite within his powers; a simple treadle too, might lend its aid under peculiar circumstances. From the varying angles at which the blows could be delivered at pleasure, the use of all kinds of dies and swages would become easy, while the most complex small welds could be shut with an ease and certainty unattainable by the use of any hammer striking only straight up-and-down blows.

As to the power to be employed we are disposed to give the preference to steam without hesitation. No hammer can possibly be made to run at high speed by the aid of gravity alone. In order to use compressed air, a piston and cylinder are requisite, and a certain amount of valve gearing is indispensable; and these things being provided once, the piston may just as well be put in motion by steam, as by the aid of belts and gearing. We do not wish to be understood as generally condemning compressed air hammers; on the contrary, we consider them admirably adapted to certain situations, such as forges at a great distance from a boiler; but, as a rule, we prefer steam. It may perhaps be urged that there is no need for such little hammers as we have just spoken of--that the work which they would perform is too insignificant to require the aid of machinery; but this is not true. It is in the performance of some of the most apparently trivial operations that the aid of machinery has been called in with the greatest advantage; and while hundreds, nay thousands of tuns of small forgings have to be made annually, there will always be a field open for the introduction of the proper modification of the steam hammer to make them.—*Mechanics Magazine.*

DIE ENGRAVING, SINKING AND MULTIPLYING.

BY J. NEWTON, OF THE ROYAL MINT.

It is more than probable that, with the exception of those who may be practically engaged in the above-named arts, very few persons are acquainted with the modern method of preparing dies, whether for the stamping of coins or the striking of medals. The general belief shared, as we have reason to know, by many scientific men, is, that each individual die used for either of these purposes must first be engraved by the skillful hand of an artist, and that therefore, at her Majesty's Mint, where, in addition to the coins of the realm, all our naval and military medals are struck, a numerous staff of engravers is constantly employed in the preparation of new dies. This is a very reasonable supposition ; but as it is also a very erroneous one, it is intended to explain in as popular a way as the subject will admit, the system of die manufacturing as actually carried on at that establishment. It will be found that the processes employed in the conversion of bars of steel as they come from the molds and mills of Sheffield into coining and metal dies are to the full as interesting as those exercised in any other branch of manufacturing and inustrial art.

The melting of wrought or bar steel, intended for conversion into cast-steel, is effected in small crucibles formed of clay and plumbago, and which are capable of holding about 30 lbs. weight each of the metal to be acted upon. Ten or twelve of these are placed in furnaces very similar to those used in ordinary brass foundries. After the crucibles have been brought by the concentrated action of a coke fire to a white heat, they are charged with pieces of bar steel reduced to a particular degree of softness, and weigh about a pound each. When the crucibles are thus loaded, lids of clay are placed ov them, the furnaces are filled with coke, and the covers of the furnaces are put down. The intense heat thus generated soon reduces the contents of the crucibles to a liquid state, and induces an ebullition of the metal, resembling somewhat the boiling process in the case of ordinary fluids. When the furnaces require feeding with fresh coke, the lids of the crucibles are also removed, and the workmen are enabled to judge as to how far the process is matured. Usually in about three hours the molten metal is ready for "teeming." The subsidence of the ebullition, and the dazzling brilliancy of the metal are proofs of the successful completion of the fiery ordeal, and it is then forthwith poured into ingot molds of the shape and size required. When cold, the resulting ingots are removed, and are in fit condition for the market and the rolling mills or the workshop. Those which are intended for conversion into dies are first elongated into bars, of which we shall have to speak hereafter. Without further preface let us now proceed to deal with the manufacture of cast-steel dies as practiced at her Majesty's Mint. The whole of those which are used there—and in these days of incessant money-making their name is "legion"—are produced within its own walls.

Rectangular bars of the finest cast-steel which Sheffield can furnish, and varying in size in accordance with the respective denominations of coin in the British series alone are used in the Mint. There are two substantial reasons for employing highly refined steel in die making. The first is that the elaborate engraving and fine lines of the artist, as placed on an original die, may be satisfactorily copied, and the second that due resistance may be gained by the perfect homogeneity and toughness of the metal to the rapidly-repeated and heavy thuds of the coining presses. Constant practice has made the officers and workmen of the department excellent judges of the peculiar mechanical and chemical properties which should distinguish the steel they use. They are consequently not very liable to error in selecting it. It is not essential, perhaps, to explain minutely the peculiarities which distinguish good die steel; but it may be said that that which exhibits, when broken or fractured, a moderately fine grain which is of uniform texture, and when polished is free from spot or blemish is the best. Let it be imagined for illustration, that a coinage of florins is required to be struck and issued from the mint, and that the entire duty of engraving, sinking and multiplying a number of dies for the purpose has to be performed. Then, if we succeed in making the operation understood, our readers will have obtained information as to the manufacture of dies generally, for all pass through similar processes. The engraver will have received his instructions from the master of the mint. Let us therefore visit his *atelier* and watch his movements. Having selected with especial care the bar to be first used, tested portions of it with rigorous severity, and thus assured himself of its perfect fitness, the artist will cause it to be sent to the mint. After one end of the bar is heated to redness in an ordinary forge, two pieces are cut off it of the size required. The resulting blocks are then again heated and swaged into round form. It may be suggested that the bars of cast-steel might as well be made round before reaching the hands of the die forgers, and that this would save the labor of hammering the blocks into round shape afterwards. The smith's labor, however, is not labor lost, for it gives a density and tensile strength to the embryo dies which they would not otherwise possess, and hence they are eventually found more durable. It will be well to explain, too, that the blocks are not rounded longitudinally with the bar from which they are cut, but transversely; that is to say, the sides of the bar form the tops and bottoms of the dies, The grain of the steel is thus made to pass across the dies, and not vertically through them. They are thus rendered less liable to splitting while under the press.

The two rounded blocks are next annealed to the fullest extent possible, and this is done by placing them in a wrought-iron pot, covering them with animal charcoal and depositing the whole for twenty-four hours in an oven heated by coke; they are afterwards withdrawn, removed from the pot, and allowed to cool gradually. Next they are taken to the lathe and one end of each is turned. That which is intended to become the "matrix" die (of which more anon) is made perfectly flat and smooth, and it is upon this prepared surface that the artists' talent will have to be first expended. The second block, turned slightly conical, and which is destined to become the "puncheon" may be put out of view *pro tem*. The engraver addresses himself to the work of etching in upon the matrix block his approved design, say of the obverse for the florin. Assured of having put in his outlines correctly, the work of engraving fairly commences, and only those who have witnessed the operation of die cutting can realize the amount of patience and skill necessary for its successful completion. After many weeks of close and constant application the design in intaglio will probably be finished, repeated impressions in clay and soft metal being taken *ad interim* by the artist as tests of the accuracy of his work. Innumerable touchings and re-touchings, with the graver, are indispensable to the minute realization of the design, but it at last satisfactorily appears on the surface of the softened steel. The letters to form the legend and the date are stamped in by aid of punches, and the matrix or first die is engraven. A very important and, to the engraver, an anxious operation follows. It is that of hardening the matrix. In its present annealed condition it is practically useless, and therefore the risk must be run of exposing a very beautiful work of art in quick succession to the tender mercies of the antagonistic elements fire and water. There is no escaping this, however; and the artist, if a nervous man, may tremble for the result. His only hope lies in the excessive care with which the work is done, and the excellence of the cast-steel of which the die is composed. The preservation unmarred of the delicate lines and tracery which have cost him so many hours and so much exertion is naturally a great consideration. To insure this, as far as possible, the engraved face of the die is covered by a mask composed of some fixed oil, thickened to the consistency of a paste by the addition of animal charcoal finely powdered. This Ethiopian-like compound is spread over the surface of the engraving to which it closely adheres, filling all interstices.

As an extra precaution an iron ring is usually made to encompass tightly the matrix before hardening, so as to lessen the risk of fracture. In this condition it is deposited with its face downwards in a pot or crucible and buried once more in animal charcoal, that is to say burnt leather, horn, etc. The crucible and its precious contents are placed now in a furnace, the whole being heated to redness. After submission to this saturation of fire, if the term be admissible, for about an hour the pot is withdrawn and the matrix, taken out of it by means of a pair of tongs, is instantly and *sans ceremonie* plunged into a cold-water bath. The bath is sufficiently capacious to contain as much water as will prevent the latter becoming sensibly warm by the immersion of the red-hot die. Held firmly by the workman's tongs, the matrix is swayed too and fro rapidly in the water until it ceases to splutter and hiss at its rough treatment. Should no unusual or singing sound proceed from it while in the bath, the probability is that the expansion induced by the fire and the sudden contraction caused by the cold water have not injured the die, and the engraver may take heart again, for his work is safe and sound. If, on the contrary, it sings the die will be found to have cracked in the process of hardening and his work will have to be done over again. For the reasons previously given such a disastrous result seldom happens at the Royal Mint.

Allowing that all has proved favorable, the coating which protects the engraved surface is removed, and the matrix is forwarded to the polisher, who, by pressing its "table" or face carefully against a flat disk of iron running rapidly in a lathe, and upon which a film of flower emery and oil has been spread, soon produces a mirror-like polish. Tempering is the next operation, for at present the steel is much too hard for its purpose, and this is effected by putting the matrix into water to be gradually heated to the boiling point or by placing it on a red-hot plate of iron. In either case the work is done when the die, after a series of chameleon-like changes of color, assumes that of pale straw. At this juncture, therefore, it is again plunged into cold water, and the obverse matrix is ready for use. Arrangements of a precisely similar character throughout are observed in the production of the reverse matrix, and thus the first and more important stage in the manufacture of coining dies is passed.

It is time that we turned to the second block of steel, namely, that intended for the "puncheon." This has been annealed and turned, not flat, but flatly conical, on the surface to be decorated. Both it and the matrix are thus made ready for a massive and powerful stamping press, with a coarse triple-threaded screw of some 6 inches in diameter passed