the Gunpowder a distance of about 5 miles through the most picturesque scenery, which is constantly changing, as the river and the valley through which it runs pursue a very devious course between ranges of precipitous, wooded hills, from where it leaves the open country near Meredith's Ford bridge, which forms the head of the lake. To facilitate operations, a road 10 miles long, about 30 feet wide, and about 10 above the intended level of the lake, has been cut in the sides of the hills on each side, which will no doubt be utilized hereafter as a pleasure drive by the lovers of beautiful scenery.

At the lower end of the site chosen for the lake, two hills jut out into the valley, leaving but a comparatively narrow place, of which advantage is taken to form a dam which will raise the water about twenty feet above the natural level of the river. In one of these hills is the mouth of the tunnel, hereafter referred to, from the side of which a dam will be built having an overfall of 300 feet and a wing of 190 feet, that will extend into the opposite hill. This dam will be of the most substantial character, of heavy stone laid in hydraulic cement. The stone work will be 31 feet high and about 65 at the base, having its foundation on the solid rock; and it is estimated that about 20,000 perches of stone will be required for this part alone. The face of the overfall will be built of large blocks from three to four feet in depth; and to prevent any undermining, an apron is to be cut below the overfall resting four feet below any of the other foundations. The other side of the dam will be protected by a backing of 165 feet of puddle clay, gravel, and riprapping. The parapet walls will rise 12 feet above the overfall, and will be level with the floor of a gate house that is to be erected at the tunnel end of the dam. At the gate house begins the tunnel, which is to carry the water to Lake Montebello. This tunnel is nearly seven miles long—36,510 feet—and is therefore the longest in the country. The bore is circular in shape and is 12 feet in diameter. Over five miles of it will be through hard gneiss, which is being cut with drills driven by manual labor, as the contractors think that, owing to the comparatively small area of the tunnel, the power drills are not economical enough to pay them for the cost of the necessary machinery. A portion of the tunnel is being cut through softer material—a kind of limestone, that crumbles into powder by the force of the explosion when blasted. This part of the tunnel will have to be bricked; but where the gneiss occurs, the brickwork will be dispensed with, except in some localities where there are bad breaks and crevices in the rock, and at the bottoms of the shafts which will, when the tunnel is completed, be arched over with masonry 6 feet thick, to withstand the immense pressure of the loose earth filled in above.

To facilitate the operations in the tunnel, fifteen shafts, from 65 to 300 feet deep, have been sunk, most of which are down to grade; and in some of them considerable work has been done on the tunnel. But owing to the hardness of the rock for the larger portion of the distance, very fast progress cannot be made—only about a running foot of tunnel per shift of 12 hours, or two feet per day, as in tunneling night and day are alike so far as work is concerned, the only light in either case being that obtained from the small lamps attached to the miners' hats. As before stated, the contractors employ manual power for drilling, which, in the hard work, is done by task work—thirteen feet per shift being the miner's task. The holes are bored 30 inches deep, and an eight ounce cartridge of giant powder (nitro-glycerin and sawdust) is used in each hole, at which rate about 7 lbs. of powder, at 40 cents per lb., is used for each running foot of hard rock tunnel, making for the five miles through the gneiss nearly $74,000 for explosives alone, to say nothing of that used in the other portions of the work.

The shafts are from 8 x 17 to 8 x 20 feet inside the timber work, which, when used, adds about 30 inches to the above figures; and as fast as they are completed they are fitted with improved safety cages to prevent accidents from the hoisting mechanism; but they have only the ordinary tipping bucket until the shaft is down to grade. The exhaust from hoisting engines is utilized to create a draught in a pipe, the mouth of which is near the heading, and by this means ventilation is secured in the tunnel.

In the limestone portion of the tunnel, between shafts 1 and 2, the stratum makes an eccentric dip, leaving a "pocket" of mud which, as the miners were working towards it, suddenly ran into the tunnel, overwhelming and suffocating one poor fellow who had been driven by it against the timbers; but the remainder of the workmen managed to escape. In this, as in some other sections, the water forms a great hindrance to operations, a spring being found here which keeps a steam pump of a capacity of 200 gallons a minute constantly at work, while about the same quantity of water percolates through other crevices in the rocky sides of this section of the tunnel and has to be removed by another pump of the same size. The same trouble occurs in other shafts, especially No. 5.

To make the necessary observations required to properly line and level the tunnel, a straight line has been made over the tops of the hills and through the woods, and three observatories have been erected for this purpose. As an instance of the great care taken by Mr. Martin in this matter, it may be stated that these structures are double, consisting of an inner tower (on which the instruments are placed) protected from atmospheric and other influences by an outer one, entirely detached from the other, on which the engineer stands when making his observations.

At the lower end of the tunnel is to be located a reservoir, to be known as Lake Montebello, which is being formed by damming up a valley admirably suited to the use to which it is being put. The upper and lower ends of the valley, forming the east and west sides of the reservoir, will be closed up with dams of stone and earth, 450 feet wide at the base and 100 feet at the top, with each end imbedded in the hills at the sides, so that the greatest possible strength may be obtained; for this is one of the most critical pieces of construction along the whole line, as these dams will have to sustain the pressure of 600,000,000 gallons of water. The north and south sides of the valley, about 3,500 feet each, will form the other sides of the reservoir, which, when completed, will have the appearance of a natural lake, and will have a superficial area of about 80 acres and a depth of at least 30 feet. The sides will be finished with riprapping, and the top will be surrounded by a fine road $1\frac{1}{2}$ miles long and from 60 to 80 feet wide, divided from the reservoir by a neat and substantial iron fence.

There being a stream running through this valley whose water is too impure to be used, a drainage tunnel, 2,870 feet long and of 9 feet diameter, had to be made to carry it away, which tunnel will also serve to take off the surface drainage, and to empty the reservoir, should it be required. From this reservoir, another tunnel, 2,600 feet in length and 12 feet in diameter, is now in course of construction. This tunnel is cut through soft material, and therefore requires strengthening with brickwork laid in hydraulic cement. Where the tunnel is of the right character, the top arch is three bricks thick and the invert below the spring line two bricks, with a proportionate backing of from 18 to 24 inches above the spring line, built in against the timbers or the rock wall of the tunnel. In the soft places, there is an additional ring of brickwork added, and the backing is proportionately increased. In all cases, the arch is packed over the top with clay well rammed in. The brickwork in this, as in the main and drainage tunnels, requires to be done with the greatest care, as it has to stand not only the outside pressure of the immense weight of material above it, as in railroad tunnels, but also the internal pressure of the water within, which is always searching for weak spots to break through, and it is therefore being done by the day. It is estimated that about 12,000,000 bricks will be used in all the tunnels.

One portion of this tunnel passes beneath a well, the bottom of which is only four feet from the top of the tunnel; and yet the water of the well has not been drained, and it continues to furnish its usual quantity of water, notwithstanding that another well, 300 feet from the tunnel, was almost immediately drained and has now no water whatever.

At the end of this tunnel will be a gate house from which the water will pass into six pipes of 48 inches diameter each, by which it will be conveyed to the city limits, and there connected with the present system of mains for distribution throughout the city.

Along the line of the work have sprung into being several temporary villages for the miners and laborers, showing styles of architecture that one would hardly expect to find so near a great city, varying from the tolerably comfortable offices of the contractors to that of the squalid log huts of the negro laborers on the storage lake, with a single room that is half below ground and half above. Many drinking shops have also been built on the line, or rather as near to it as they can be built (for the engineer will not allow them on the city property), in which the men squander their hard earnings after each pay day, and so unfit themselves for their labor as to cause no small delay to the progress of the work.

Unlike the officials of some other cities that may be named, those of Baltimore appear to have a fashion of completing their public works without exceeding the appropriations for them. This was the case with their city hall, inaugurated a year or two ago, and it appears as if it would be the same with the water works. The whole amount appropriated for this purpose is $4,000,000; but the engineer in charge, who is doing his best to cut down the expenses all he can without depreciating the quality of the work, thinks the whole improvement can be completed at a cost of very little, if any, over $3,000,000. About 1,500 men are employed—common laborers getting $1.25 per day and miners $1.50. It is expected that the whole work will take about three years to finish, and Baltimore will then have a natural flow through the tunnel that will supply it for generations to come with all the water for ordinary purposes that can be used or wasted, as the river at the point tapped is 170 feet above mean tide, and consequently will give water to nearly all the houses in the city, except in the extreme northwest section, for which the water will still have to be pumped into a high service reservoir.

Mr. Martin is assisted by Mr. C. P. Manning, consulting engineer, W. L. Kenley, chief assistant, and seven resident engineers, Messrs. R. B. Hook, W. R. Warfield, C. O. Swan, C. T. Manning, O. H. Balderston, and C. A. Hook, who are named in the order of the work they have in charge, beginning at the storage lake. The contractors, also named in the same order, are Messrs. Condon and Co., Fenton and Allan, Bruce and Patterson, L. B. McCabe and Brother, J. Donohue and Brother, and J. E. Eschback.

From this cursory sketch, some idea of the magnitude of the work in which the city of Baltimore is engaged may be obtained—a work alike honorable to the public spirit of her citizens and the gentlemen engaged in its construction.

THE most valuable part of a man's education is that which he receives from himself.

WHAT IS A TEMPORARY STAR?

On November 24, 1876, Professor Schmidt, Director of the Observatory at Athens, Greece, noticed a new star, of the third magnitude, in the constellation *Cygnus*. The three nights immediately preceding had been cloudy, but the star had not become visible on the night of the 20th. Astronomers throughout the world were at once notified of the discovery, and the object was diligently observed both in Europe and America. Its apparent magnitude very rapidly diminished from the date of its discovery. In a few weeks it became invisible to the naked eye; and in less than three months its light was no greater than that of a star of the ninth or tenth magnitude. Other instances of such phenomena are well known in the records of astronomy. The following catalogue, with the exception of the last two, is given by Humboldt:

No.	Date.		Position.	Duration of visibility.
1.	July,	134 A.B.,	in *Scorpio.*	Doubtful.
2.	Dec.,	123 A.D.,	in *Ophiucus*	"
3.	Dec. 10,	173 "	in *Centaurus*	8 months.
4.	March,	369 "	Doubtful	6 "
5.	April,	386 "	in *Sagittarius*	3 "
6.		389 "	in *Aquila*	3 weeks.
7.	March,	393 "	in *Scorpio*	Doubtful.
8.		827 " (?)	in *Scorpio*	4 months.
9.		945 "	near *Cassiopeia*	Doubtful.
10.	May,	1012 "	in *Aries*	3 months.
11.	July,	1203 "	in *Scorpio*	Doubtful.
12.	Dec.,	1230 "	in *Ophiuchus*	3 months.
13.		1264 "	near *Cassiopeia*	Doubtful.
14.	Nov. 11,	1572 "	in *Cassiopeia*	17 months.
15.		1578 "	Doubtful	Doubtful.
16.	July 1,	1584 "	in *Scorpio*	"
17.	Oct. 10,	1604 "	in *Ophiuchus*	17 months.
18.		1609 "	Doubtful	Doubtful.
19.	June 20,	1670 "	in *Vulpes*	20 months.
20.	April 28,	1848 "	in *Ophiuchus*	Doubtful.
21.	May 12,	1866 "	in *Coronæ Borealis*	"
22.	Nov. 24,	1876 "	in *Cygnus*	"

"It is worthy of especial notice," Sir John Herschel remarks, "that all the stars of this kind on record, of which the places are distinctly indicated, have occurred, without exception, in or close upon the borders of the Milky Way, and that only within the following semicircle, the preceding having offered no example of the kind." The striking fact here noticed indicates the existence of unknown physical conditions in this portion of the heavens, favorable to the production of the phenomena described.

Again, while two or three of the recent temporary stars have remained visible as small telescopic objects of somewhat variable brightness, yet in no case has an outburst occurred in precisely the same locality with a previous one. The supposed identity of the stars of 945, 1264, and 1572, cannot therefore be sustained, and the assumption that "all the temporary stars are simply variable stars" of long period is wholly destitute of support.

CAN THE PHENOMENA BE EXPLAINED WITHOUT THE ASSUMPTION OF AN UNKNOWN CAUSE?

It is a remarkable feature of the binary systems among the fixed stars that the orbits have great eccentricity, the less component in its periastron passage coming into very close proximity to the greater. This approach, in several known instances, is within less than the earth's distance from the sun, and, in at least one case, less than that of Mercury. Among the large and increasing number of known systems whose elements have not been determined there are probably some of still greater eccentricity. If we suppose in such case that the principal star is still in a gaseous condition, and that the radius of its atmosphere is greater than the periastron distance of its companion, the latter will at each return, by plunging through this atmosphere, produce an increased degree of light and heat. Its period will become shorter at each successive return, until it shall be arrested by penetrating the denser strata of the principal star. Its orbital motion will thus be converted into heat and the phenomena of a new or temporary star may be presented to distant spectators. Such collisions as we have supposed must have occurred very frequently in the solar system when the sun's diameter was much greater than at present, as comets of small perihelion distance would be absorbed by the central mass.

"The circumstance," says Humboldt, "that almost all these new stars burst forth at once with extreme brilliancy, as stars of the first magnitude, and even with still stronger scintillation, and that they do not appear, at least to the naked eye, to increase gradually in brightness is, in my opinion, a singular peculiarity, and one well deserving of consideration."* The fact here stated is in manifest harmony with the theory above proposed. It is worthy of note, moreover, that the part of the heavens in which the outbursts have occurred is rich in double stars and sidereal clusters.

Bloomington, Ind. DANIEL KIRKWOOD.

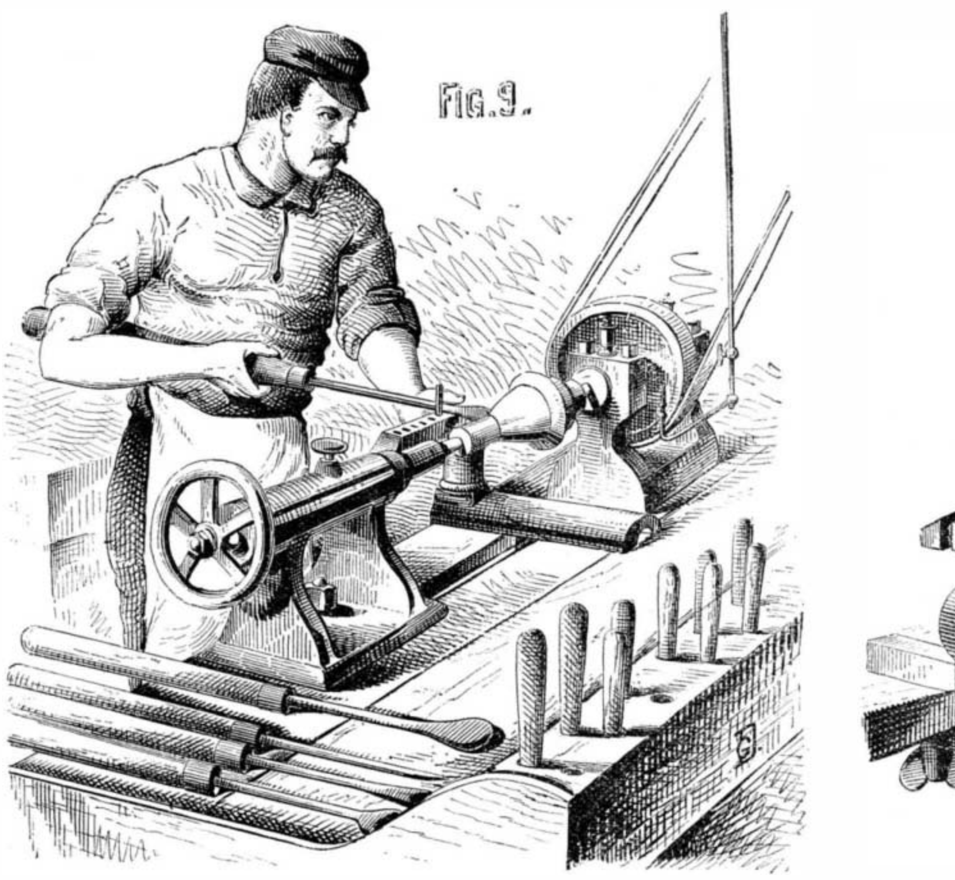
A Simple Fire Escape.

J. R. M. writes to suggest that a piece of stout canvas, about 20 feet square, with hand loops all around it, could be held in the hands of a few men under the windows of a burning house. Persons could then jump from the windows with safety, especially if the handles were attached to the canvas with rubber or wire springs, which would give elasticity to the canvas, and break the fall of the person jumping from the window.

* "Cosmos," vol. III., page 218.

THE MANUFACTURE OF SILVERWARE.

There are certain industries which grade so insensibly into the fine arts that, in referring to those who follow them, one scarcely knows whether to use the terms workmen or artists. The manufacture of jewelry is one of these callings, that of silverware is another. The casual looker-on, seeing men with metal tools and hammers in their hands, bending over their benches, working at some dull-looking metal, instinctively regards them as mere manual laborers engaged upon no arduous task; but if he glances over their shoulders, and sees the ductile metal under their manipulation assume the most exquisite shapes, if he witnesses work produced not only of marvelous delicacy, but bearing the imprint of genius in every detail, the simple tools and begrimed garb of the workers are noticed no longer, and a feeling of genuine admiration comes uppermost in the mind capable of appreciating true artistic skill. Silver working has its prosaic side; for, despite beautiful ornamentation, forks and spoons are the commonest of every-day articles, and teapots, as teapots, are not conducive to lofty reflections. But on the other hand, such homely objects tend to make the industry what it is—art-workmanship, or to render it a link between the ideal and the actual, a means of adaptation of the airy conceptions of the artist to forms of utility. The manufacture of silverware may be divided into two parts: first, such as relates to the production of forks, spoons, and like small objects of definite form; and secondly, that relating to the making of hollow ware, which includes vessels of every description, whether for use or ornament. We propose in the following article to trace the various processes as practised at the largest establishment devoted to such work in the country—that of the well known firm of Tiffany & Co., of this city.



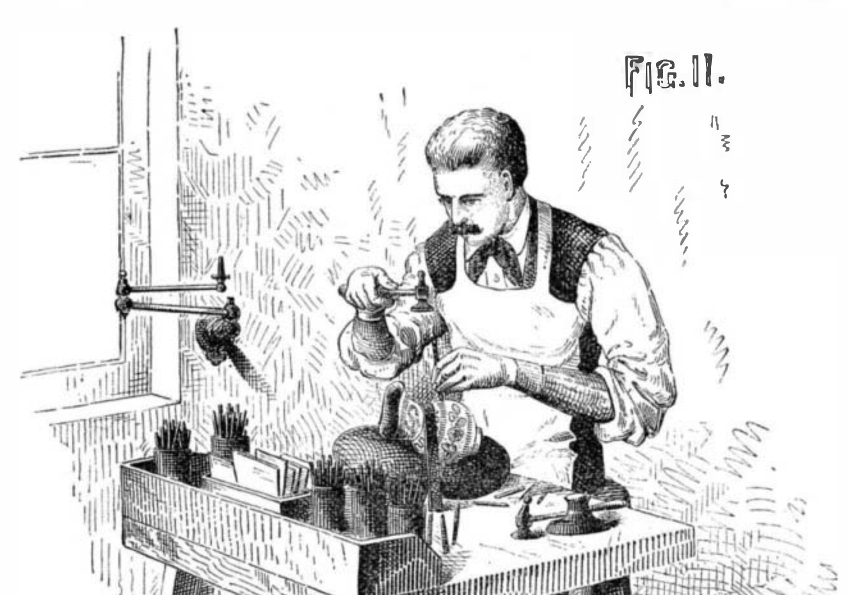
THE SPINNER AT WORK.

REPOUSSE WORK.—SNARLING.

The silver, to fit it for use, is alloyed with copper in the proportion of 0·075 copper to 0·925 of silver. The metal, on its reception at the factory, is weighed and tested to determine its standard quality, and is then sent to the melting hearth to be run into ingots of proper size. The operation of melting is represented in Fig. 1. (See front page.) The charge in each crucible is from 400 to 450 ozs., which, on becoming fused, is poured into either a skillet mold or else run into bars. The skillet is an ingot about 10 inches long by 6 inches broad, and 1½ inches thick, and is used for making the plates subsequently spun into hollow ware. The bars from which spoons, etc., are produced are some 20 inches in length, 1¼ inches in width, and ¾ inch thick. As in these two forms of the metal are the starting points respectively of the two departments of the manufacture above noted, we shall trace the operations upon each separately, beginning with

THE MAKING OF FORKS AND SPOONS.

The bar of silver alloy above mentioned is placed between heavy rolls (Fig. 2, front page) and flattened out to ¼ inch in thickness. Ponderous shears then cut it into suitable lengths for the individual articles to be produced; and then rolling in a transverse direction flattens that portion which is to form the bowl of the spoon or tines of the fork, until at such part the width is about 2½ inches. The blank, as it is termed, is now of the shape of A (Fig. 3, front page). It is then placed in dies in a drop press; and on the fall of the hammer, it emerges in the shape shown at B in the same figure. Next follows the rolling; and this involves the use of one of the most expensive machines employed. The outlay is incurred in the manufacture of the steel rolls, a pair of which is shown in Fig. 4 (see front page). On a single pair may be cut stamps for seven different articles. Thus we found the necessary patterns for dessert, table, tea, salt, and mustard spoons, besides those for large and small forks, on the two rolls represented, which, though quite small in size, cost about a thousand dollars to engrave. The designs are cut directly upon the cylindrical surface, and the metal is subsequently case-hardened. In operating the machine, the rolls are set in motion, and the workman inserts blanks for the articles desired, as the respective dies rotate in front of him. As the metal enters the rolls, it is caught by the deep notches made beside the pattern, and is thus prevented from slipping. On emerging, a spoon blank appears as in Fig. 5 (see front page). The pattern is perfectly stamped; but the bowl is flat, and around the spoon now outlined is a large amount of superfluous metal, which is clipped off by hand shears, the pieces falling into a locked box. Then the blank is carried to a file wheel, which removes all the material close up to the edge of the pattern; and if a fork is being made, a rotary file cuts the spaces between the tines.



REPOUSSE WORK.—CHASING.

The next operation is forming the bowls of spoons or the curved portions of other objects. This is done under the drop press by steel stamps, which force the portions to be curved into matrices made of tin. This metal is used because it is softer than the silver alloy, and yields to the raised portion of the ornamentation on the under side of the object as the blow is delivered. If the matrix were of steel, the ornament would, of course, be flattened out. The operation of drop pressing is shown in Fig. 6 (see front page). At A, a tin die for a spoon is separately exhibited.

The proper curve to the handle of the spoon is imparted by setting with a wooden mallet. Then follows smooth filing and weighing of the objects previous to their polishing. As a rule, about one third the metal in the original piece cut from the bar remains in the spoon; and during the various operations detailed, the absolute waste of material rarely exceeds 3 per cent. Nothing further is necessary but the buffing and polishing, which is done on wheels rotating at about 2,000 revolutions per minute, oil and sand being first used and then ordinary rouge powder. Fig. 7 (see front page) represents the polishing room. Meanwhile the elegant boxes, satin-lined and Russia-leather-covered, are being prepared from copper models of the objects which they are to contain; and in these receptacles, the gracefully shaped articles, dazzling in their fresh polish, repose in the salesrooms of the iron palace on Union Square.

We may now retrace our steps back to the murky basement where the silver is melted and rolled, and thence follow the skillets in their final manufacture into hollow ware.

THE MANUFACTURE OF SILVER HOLLOW WARE.

Each skillet is passed some twenty times through the heavy 24 inch face rolls before mentioned (Fig. 2, front page), until it is reduced to a thickness indicated by 26 wire gauge (Brown and Sharpe's). Meanwhile the designers have produced detail drawings of the object to be manufactured, a pitcher, for example, of the form shown in Fig. 8 (front page). With the plate before him, a workman marks on the silver the lines laid down in the drawing, and, following them, rapidly cuts out the object. Our pitcher is now an assemblage of disks. Two, which answer to the upper and lower hemispheres of the lower portion; another forms the cover, and still another is to be made into the slightly flared straight intermediate portion. Then there are two narrow strips from which the ornamental bands are to be made. The decorative object on the cover and the handle are not provided for; but these we shall refer to further on.

The materials which are to be rendered concave are sent to a spinner, who has before him the drawing and a wooden pattern of the shape of the desired bowl. He pinches a disk in the fixed center screw of his lathe between two flat surfaces of wood, one of which is the wooden pattern. A burnisher resting against a pin in the lathe rest is now applied near the center of the metal, and the latter is gradually but rapidly bent or arranged until it fits close against the curved face of the block. The spinner at his work is represented in Fig. 9. The disks which are to form the upper part of the pitcher, globe, and also the cover, are treated in a similar manner, and the square-shaped pieces are flared by a similar process. While this is in progress, the narrow strips which are to form the ornamental bands are passed between engraved rolls, which impress upon them a suitable pattern. Their ends are soldered together, and they are bent around formers which give them the requisite flaring shape. Now the various parts of the pitcher being completed, nothing remains but to solder them neatly together, and the vessel assumes its desired form.

The handle and ornament for the cover, having been moulded in wax, and clay moulds prepared, are cast, an operation of the greatest delicacy, inasmuch as there is an immense amount of intricate undercutting work to look after. The moulds are made in fragments of every possible shape, and all are numbered so that they can be readily put together. At this stage, the handle and cover being affixed, our pitcher