THE NYMPH OF FONTAINEBLEAU.
From the Bronze by BENVENUTO CELLINI.

THE ART OF CASTING IN BRONZE.

IN England alone there are many able painters whose names are widely known and whose works are justly popular with all classes. The sculptors, however, who are in any degree known may almost be counted on the fingers, and they are known only in what are usually alluded to as "art circles." For this there is probably a good and sufficient reason. There are few good sculptors because the public does not appreciate sculpture, and, *per contra*, the public takes little interest in sculpture because there are so few good sculptors. Thus cause and effect act and react upon each other. The best men, with rare exceptions, take to painting rather than to sculpture, not so much from any natural impulse to seek expression in colour rather than in form, but because their opportunities for the study of the former are far greater than for that of the latter, and also that the rewards offered by the public to the painter who achieves the highest success in his art are far beyond those that can be hoped for by the successful sculptor. A third- or fourth-rate painter can gain a fair and independent living, whilst a fourth-rate sculptor can hardly earn his salt as a workman in the employment of some more fortunate *confrère*.

All this would seem to point to the conclusion that sculpture is not wanted, or at least not generally in demand; but this is not the case. Sculpture in some form or other exists in every home, and is regarded as a necessary part of the odds and ends that compose our lares and penates. In the houses of the wealthy sculpture takes the form of marble, bronze, or terra-cotta; in the poor man's cottage it is usually represented by the "plaster image" or the china dog—or perhaps the harmless necessary cat, formed with more ingenuity than art out of a snail-shell and a lump of putty.

With very rare exceptions these works are shockingly bad. Indeed the humble dog and cat last mentioned are far less offensive than nine-tenths of the rubbish that is made to do duty as sculpture.

It is strange that wealthy and educated people, who delight to hang their walls with masterpieces of painting, and who have a real appreciation of what is good and beautiful in art, should for a moment tolerate the wretched things that satisfy their natural desire for sculptured form, and which are complacently shown to their artist friends as "my bronzes." If the artist friend is a painter, as is most likely, he simply does not look at them, but turns to the pictures again at once, seeing that there is nothing of merit or interest in the bronzes; but if, as sometimes happens, he is a sculptor, he is

expected to say something about these "works of art," and his heart sinks as he tries to escape with a well-worn commonplace in order to avoid telling his host that the bronzes are abominable, and himself an ignoramus for not knowing it. Yet, after all, how should he know? If you were to ask him how a bronze statue is produced, he would of course tell you it was cast; but beyond that vague fact he could not go. If people more generally understood something of the process whereby bronze statues are produced, I think they would have their eyes opened in some degree to the merits or demerits of their bronzes, and would take a more intelligent interest in sculpture than they did before. With this object in view I propose to give, as well as my limited space will permit, some idea of the *modus operandi*.

The bronze, which is an alloy of copper and tin, is melted in a furnace, and cast or poured into a mould where it solidifies in the process of cooling, and permanently retains every gradation of form which it finds in the hollow mould.

The mould being more fragile than the metal it contains, is then broken up, and its destruction brings to view the bronze cast. This sounds simple enough, but how about the mould? What is a mould made of into which bronze statues can be cast, and how is it made? This is a most important question, and goes to the root of the whole matter.

The mould presupposes a model from which it is made, and of which the mould is only the concave or negative imprint, from which the positive or convex imprint is to be obtained.

Our first concern, then, is with the model. An artist makes this as he would make a model for a statue in marble, usually of clay, sometimes of wax. This is the original design on which he bestows his thought and skill, and to which any excellence in the bronze is ultimately due. If the model is bad in design or execution, the bronze must be at least equally poor. But on the other hand the model may be very fine indeed, and the bronze vile. This is but too often the case. The design indeed cannot be altogether spoiled, but if the various processes connected with bronze founding, which I am about to describe, are not each and all carried out in an artistic spirit and with the highest skill, the result will be a very bad rendering of the original. Many people will be prone to inquire, why, if such is the case, cast the statue at all? Would it not be easier to retain the original model? Undoubtedly it would be so, but unfortunately the sculptor's original thoughts can only be worked out in some plastic material which from its very plasticity is incapable of permanently retaining the form it so readily receives.

No sooner has the sculptor finished his model—perhaps the work of years—than it begins to perish, unless he preserves or rather copies it by taking a cast of it in plaster of Paris. This cast is usually all that remains to him, for the plastic clay is of too weak a nature not to be utterly destroyed by the mere process of taking a cast even in plaster.

Plaster of Paris, as everybody knows, is mixed with water into a paste and "plastered" upon any object of which it is desired to obtain an impression. In a few minutes it sets hard, and if it has been properly applied gives a mould or impression so perfect as to leave nothing more to be desired.

This hollow mould can be again filled with plaster, thus faithfully reproducing the original model over which the mould was made. Were it possible to cast bronze into a plaster mould, the process of bronze founding would be far easier than is actually the case. Unluckily plaster, even when it seems to be perfectly dry, still contains a large amount of water which the contact with molten bronze at once converts into vapour, breaking and splitting the mould in all directions. Moulds for bronze must therefore be made of some other material. The usual plan is to make them of loam, which is a sort of sandy earth containing a small portion of clay mixed with it, so that it has a certain power of cohesion even after it has become perfectly dry, and when slightly moist it may be freely compressed into any desired form. When it contains much clay it is too rich for metal casting, as then it shrinks in drying and becomes hardened by the action of heat like the clay that is used for making bricks, or pots and pans. When it is very poor it lacks cohesion when dry, and therefore is only fit for iron castings at most, as from the peculiar nature of iron it can be cast into moulds which are damp, or technically "green."

This cannot be done with fine bronze work which requires the moulds to be quite dry and even rather hot, to produce the best results. Very large moulds may indeed be cast quite cool, as the great bulk of the metal is sufficient to warm the mould to a proper heat without losing its own fluidity.

With small and complicated moulds this is not the case, and they must be quite warm at the time of casting, so as to preclude any chance of the metal being chilled before it has had time to adapt itself to their intricacies.

There are two methods of bronze founding. The one is an art, the other is a trade. The former is very difficult and costly, the latter easier and cheaper, because more certain.

The *art* of bronze founding is not, so far as I am aware, practised at all in this country, and only to a very limited extent on the Continent.

The *trade* on the other hand is carried to a very high point of perfection both in England and abroad, especially in France, from which country we are completely deluged with so-called "art bronzes," which however artistically are about as valuable as chromo-lithographs, or rather less. There are many persons who are so ignorant of painting that it would be easy to palm off on them a chromo-lithograph for an original picture, and the public, are, I am sorry to say, with very few exceptions, so ignorant of sculpture that they do not know the difference between an artistic bronze, and a vile commercial reproduction of the same thing. How shall I explain the difference? An artist sees it clearly in a moment, but to those who have never given the matter a thought it is not so easy to show where the difference lies.

It is the same that exists between engravings, where the one is an artist's proof before letters, and the other a copy struck off from the worn-out plate or a pirated edition surreptitiously published—shall I say?—at Hamburg. The difference in the case of bronzes is perhaps rather harder to detect, because in the case of a statue being reproduced by the commercial, as well as by the artistic process, both may be equally good bronze, whereas the Hamburg piracies are often lithographed.

To make the matter more clear I will suppose that one of the first artists of the day has modelled a statue which is to be cast in bronze. The statue is a seated female figure, half draped. She has bare feet and raised arms. The drapery is full of narrow deep folds designed to show and emphasise the movement of the figure. The statue is cast in plaster as soon as the model in clay is finished, and is handed over to a bronze founder—"art founder" he will probably style himself.

The first thing he will do will be to cut off the arms, because it is so much easier to mould them separately. Then he will probably cut off the body at the line of the drapery, then he will likely enough cut off the plinth. All these pieces he will mould and cast separately. They have to be then cleaned up with chisels, punches, and files to remove the lines left on them by the seams of the mould, the latter having been made of many pieces fitted to each other in the same way as piece-moulds are made in plaster. The seams left on plaster casts by these latter are familiar to every one. If there has been deep or intricate under-cutting in any part, as in the hair, the ears, or the drapery, probably this has been quietly filled in by the founder—to the destruction of the artist's work—in order that it may be easier to mould. I know of one instance in particular where a very important national monument was so treated, to the disgust of artists. The nation was none the wiser. All these pieces having been cast and scraped up must now be put together. This is done partly by means of screws and rivets, partly by braising the parts together according to circumstances. These joints have then to be worked over with punches and files in order that the exact line of jointure may be concealed, indeed, it is often requisite to work over several inches on either side to effect this purpose. Sometimes, what between the lines of the mould that have to be removed and the joints that have to be worked over, there is but little left of the touch of the original artist. Besides these evils there is the chance that the proportions may have been considerably altered by the various shrinkages of the metal in different castings, and that the action itself may have been changed by giving the pieces a little too much movement to one side or the other in putting them together. As if all these chances of evil were not enough, there is more of the artist's work to be destroyed by the inevitable jets and vents and by the skin of the mould, which is a sort of scale on the surface of the casting which often obliges the founder to work over the entire surface of the statue. Such is commercial casting. In this country no other kind is practised. Yet there is another method whereby the artist's work can be reproduced with the utmost fidelity, so that every slightest touch of modelling-stick or finger is preserved with all its freshness in the bronze. It was by this art of bronze founding that Lorenzo Ghiberti cast the wonderful bronze doors of the Baptistery at Florence—doors so lovely that Michel Angelo said they were worthy to be the gates of Paradise. All this mar-

vellously intricate work was cast in moulds without seams, and which left no skin on the castings. The artist's touch is shown plainly throughout. The same with the statues on the Church of Or San Michele, the nymphs and tritons of the fountain in the Piazza della Signoria, and the world-famed *Perseus* of Benvenuto Cellini. Florence is in fact the city of bronzes, and it is in Florence that bronze founding has again in modern times arrived at the highest perfection.

When the great revival of art began in Italy and when the first artists of the day were employed in adorning her cities, the commercial bronze founding alone was practised, the most skilled founders being the Maestri d'Artiglieria, or founders of bronze cannon. These men must have been founders of no mean skill, for we find their cannon, as seen in the Bargello and other collections, are often most profusely ornamented with coats of arms, arabesques, and other elaborate designs, the parts near the trunnions and hand pieces being particularly rich in this respect. Yet their work, good as it was, did not come up to the standard of artistic excellence required by the old masters, and we find accordingly that artistic bronzes originated rather from the goldsmith's shop than from the cannon-foundry. The method of casting metal into moulds made without seam, and of a composition which took the finest imprint without leaving a skin on the casting, had been practised by the goldsmiths of Italy from time immemorial. The early Italian artists applied this method to the production of life-sized and even of colossal statues. It was the method employed by Cellini in casting his *Perseus* and was introduced by him into France, where it has had a bare existence until it was extinguished, together with so much else, in the Revolution. In 1819 it was again revived in order to cast the statue of *Henri IV.* that now stands on the Pont Neuf at Paris. This, as far as I know, is the last important work cast in France by this method. In Italy the case is different, and the art has been maintained at a high degree of excellence; and many of the works cast by modern founders can well bear technical comparison with those produced by the artists of the fifteenth and sixteenth centuries.

This process of founding is often called Benvenuto Cellini's process, because he wrote an account of how he used it in casting his *Perseus;* but is more properly known as the "cera perduta," or "lost wax" process, because the melting and consequent destruction of the model which is made of wax forms the leading characteristic.

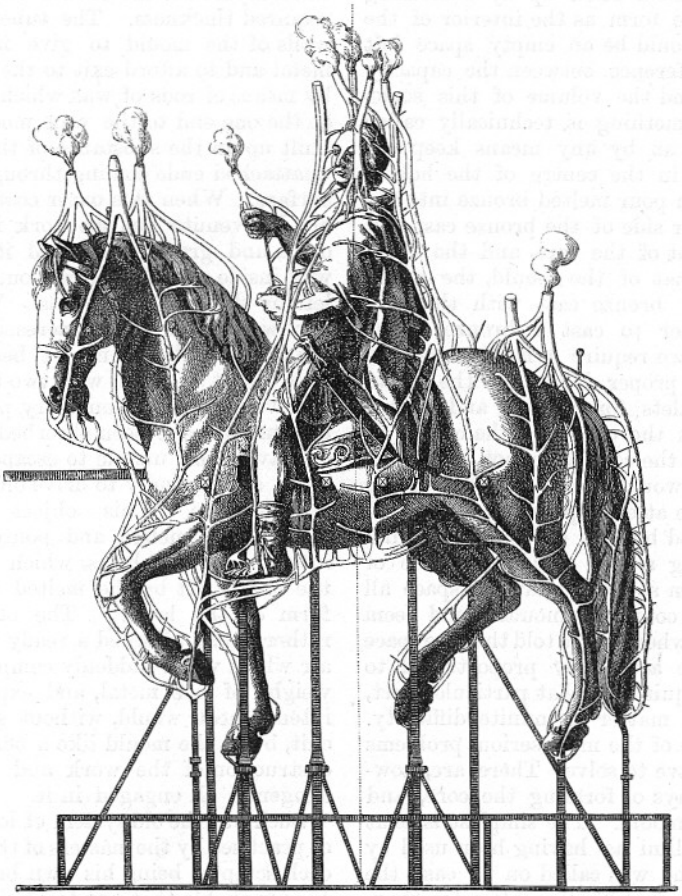
It is obvious that if a plaster statue were to be covered all over with a composition such as we have said must be used in making seamless moulds for metal casting, it would be impossible to take the statue out to make way for the metal without utterly breaking and destroying the mould. The problem is, how to get the model out, and leave the mould absolutely intact. There is but one way, the model must be destroyed. Make it of wax and melt it out. This will leave the empty mould.

The process, however, is not quite so simple as it sounds. In the first place, except for very small statuettes, it would not do to make them solid. They would be too heavy, and would also be needlessly costly. It is the practice therefore to put a core inside, which occupies the greater portion of the space in the mould, merely leaving at the sides a sufficient space for the flow of the metal, and for giving such a thickness to the cast as shall be deemed sufficient for its strength. Here again wax is invaluable. We can with great ease make a hollow wax model of the thickness we require our metal to be, and by moulding it both inside and out we shall have, after melting out the wax, the core left in its proper position in the mould. If then we can succeed in pouring melted bronze into the space between the core and the mould lately occupied by the wax, we shall have an accurate representation of our wax model, reproduced in bronze.

Bronze, or indeed metal casting of all kinds, may be divided into three processes. The first is the melting and mixing of the metal, and running it out of the melting pot or furnace. The second is running it into a mould shaped to receive it, so that when cold it shall have taken the required shape, its exterior surface being a convex imprint of the concave mould into which it was poured. The art of making such castings which were solid throughout is of great antiquity, as is proved by the various bronze implements which are to be found in all our museums; the moulds for these were usually very simple, being made in two halves, and cut in fire-stone with one jet for pouring the metal and one vent for the exit of the air. This method is even now often practised by goldsmiths and others for making castings of very simple forms, bath-brick being the material usually employed for the moulds. The third and most complicated process is that of making a hollow casting. It is

obvious that if the interior space within a mould were almost filled up by something having the same form as the interior of the mould, there would be an empty space left equal to the difference between the capacity of the mould and the volume of this something. This something is technically called a core. If we can by any means keep the core suspended in the centre of the hollow mould, and then pour melted bronze into the mould, the inner side of the bronze cast will take the imprint of the core, and the outer side will take that of the mould, the result being a hollow bronze cast with the core inside. In order to cast a bronze statue properly, then, we require a mould made in one piece, with proper inlets for the metal and proper outlets for the air, and a core properly held in the centre of the cavity of the mould. If the core were not supported in some way it would touch the walls of the mould and leave at each point of contact no space to be filled by the bronze. The difficulty of poising a core inside a statue of complicated form so as to leave a space all round between core and mould would seem very great, but when we are told that the space so left must be accurately proportioned to the strength required in that particular part, it would seem a matter of infinite difficulty. It is in fact one of the most serious problems an artist can have to solve. There are, however, several ways of forming the core, and fixing it in the mould. The simplest is that described by Cellini as having been used by himself when he was called on to cast the figure of the *Nymph* of Fontainebleau for Francis I. He modelled the figure—a recumbent one about seven feet long—in high relief, with a background of beasts of the chase, hounds, etc., of a somewhat lower relief, in a poor sandy clay or marl. This work, when finished, was carefully dried, shrinking considerably during the process. When quite dry he placed it in a kiln and fired it, burnt it in fact into a terra-cotta, but as it was made of a poor clay it would yield only a very soft porous terra-cotta, and be very friable. This was exactly what he wanted. He then overlaid the whole of the work with an even layer of wax about half an inch thick, or rather less, which brought it back to the original proportions. This layer of wax was then carefully finished in every respect, and was then covered over to a certain thickness with a mixture of bone ash and tripoli powder, ground up with a solution of cow dung and various other ingredients into a smooth paste. This paste being mixed in certain proportions with ordinary founders' loam was then laid on in thick layers till the mould had reached the required thickness. The tubes through the walls of the mould to give ingress to the metal and to afford exit to the air were made by means of rods of wax which were attached at the one end to the wax model, and were built up in the substance of the mould, their unattached ends coming through to the outer surface. When this outer coat or mould was dry Benvenuto put the work into a kiln or oven, and gradually heated it up until the wax inside melted and ran out at the holes left by the melted wax rods. When no more wax would run out he increased the heat of the oven until the mould became red hot. The object of this was two-fold, firstly to remove by combustion every particle of wax that might have been absorbed by the mould, or have been unable to escape through the holes, and secondly to drive off every particle of moisture. This object having been attained, he melted and poured the bronze into one of the holes, which thus entering the cavity left by the melted wax took the form of the latter. The other holes, or rather tubes, afforded a ready escape for the air which when suddenly compressed by the weight of the metal, and expanded by the intense heat, would, without such means of exit, burst the mould like a bomb-shell to the destruction of the work and the imminent danger of all engaged in it.

Such was the old system of lost wax casting as practised by the masters of the Renaissance, each sculptor being his own bronze founder. It is probable that but for Cellini this most interesting process would have been utterly lost in the dark ages which succeeded, but the account given in the charming and instructive though all too meagre treatise on sculpture was sufficient to enable the sculptor Giradon, with the assistance of Balthazar Keller, the founder, to cast successfully the statue of *Louis XIV.* in the year 1699 for the city of Paris. This statue, which was twenty-one feet high, was cast in one piece, as was also the statue of *Louis XV.* by Bouchardon, of which M. Marriette has left us a most minute and interesting account. Both of these statues were entirely successful, but another equestrian statue of *Louis XV.* made by Le Moine for the city of Bordeaux was not so, at first. He had not allowed sufficiently for the enormous pressure exerted on the walls of the mould by the mass of fluid metal. Consequently when the furnace was tapped, although the metal ran quickly into the mould it forced itself a passage through the walls, making a large fissure



LOUIS XV., BY BOUCHARDON, SHOWING DISTRIBUTION OF JETS AND VENTS.

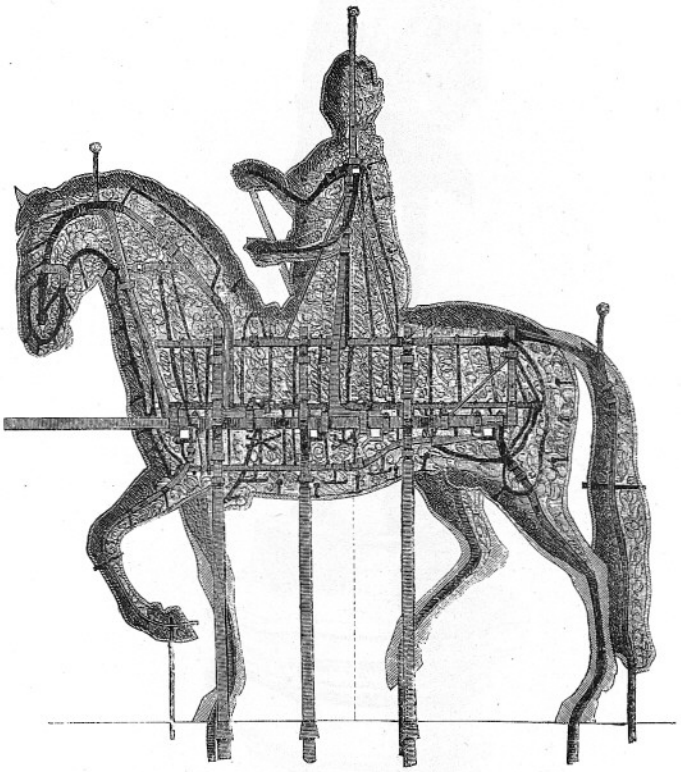
near the upper part of the horse so that only the lower portion was filled. The workmen and all those concerned were in despair, and would have broken up the mould and re-melted the bronze previously to beginning the whole operation of moulding over again. Le Moine, however, with the presence of mind and courage of a true artist, did not despair even then of success. He caused the earth to be removed from the upper part of the mould which had been as usual buried in the earth previous to casting. By this means the fissure through which the bronze had escaped was brought to light, showing plainly the level of the bronze in the interior of the mould. The whole upper portion of the mould was then strengthened and the earth carefully and closely rammed down to a compact mass around it. During these operations, which necessarily took many hours, the furnace was again charged with bronze, and being still very hot from the first charge this metal was soon ready to run; and Le Moine had the satisfaction of seeing his mould fill to the very top and run out at the vents—a sure sign of a successful casting. After sufficient time had been allowed for the metal and mould to become moderately cool, the earth was all dug out, and the mould was broken up—when the statue was found to be perfectly cast, as the heat from the bronze of the second pouring had proved equal to fusing the top part of the first pouring, so that the whole was perfectly united.

These statues were all destroyed during the first revolution in France, and one only, that of *Henri IV.*, has been replaced.

In Italy bronze statues have been more fortunate, and in Venice Verrocchio's noble statue of *Bartolomeo Colleoni* still maintains the proud position of the best equestrian

statue in the world. Venice indeed is rich in monumental horses, her churches are full of them, and the antique bronze horses of St. Mark's are grand examples of equestrian sculpture. They were, however, not cast by the lost wax process. Winckelman, in speaking of them, supposes that they have been all four cast out of one mould, which is simply absurd. It is possible, however, that the same model may have been used with certain alterations, and have been moulded four times. Florence has two splendid equestrian statues of her dukes cast by John of Bologna. Padua has the celebrated statue of *Gattamalata* on his ponderous war-horse, by Donatello, and at Rome the antique statue of *Marcus Aurelius* on the Capitol is well known to all. Other smaller, but perhaps not less excellent works, are to be found by scores all over Italy.

At the present day there are large statue foundries both in Rome and in Florence, where the work is carried out by the lost wax process, in a manner in no way inferior to that of the middle ages. Indeed some of the castings made from natural objects by the late Chev. Clemente Papi are finer and more perfect than anything of the kind previously known. Sig. Papi cast a colossal statue for me, *The Falconer* which was afterwards placed in the Central Park in New York. This was a work of more than ordinary difficulty to the founder, as I wished it to be entirely in one piece, and from the action of the figure and of the falcon, springing with extended wings from the gloved hand, it was a task few would have cared to undertake. Sig. Papi was, however, entirely successful, and the method he adopted was as follows. A carefully made piece-mould of plaster was taken from the original plaster model. This piece-mould was then lined with wax of the exact thickness required for the bronze, varying in this respect as strength or lightness seemed most requisite. The next step was to form the skeleton or framework needed for the support of the core. This is made of iron bars of different thickness,



SECTION OF STATUE OF LOUIS XV., SHOWING INTERNAL IRON WORK AND CORE.

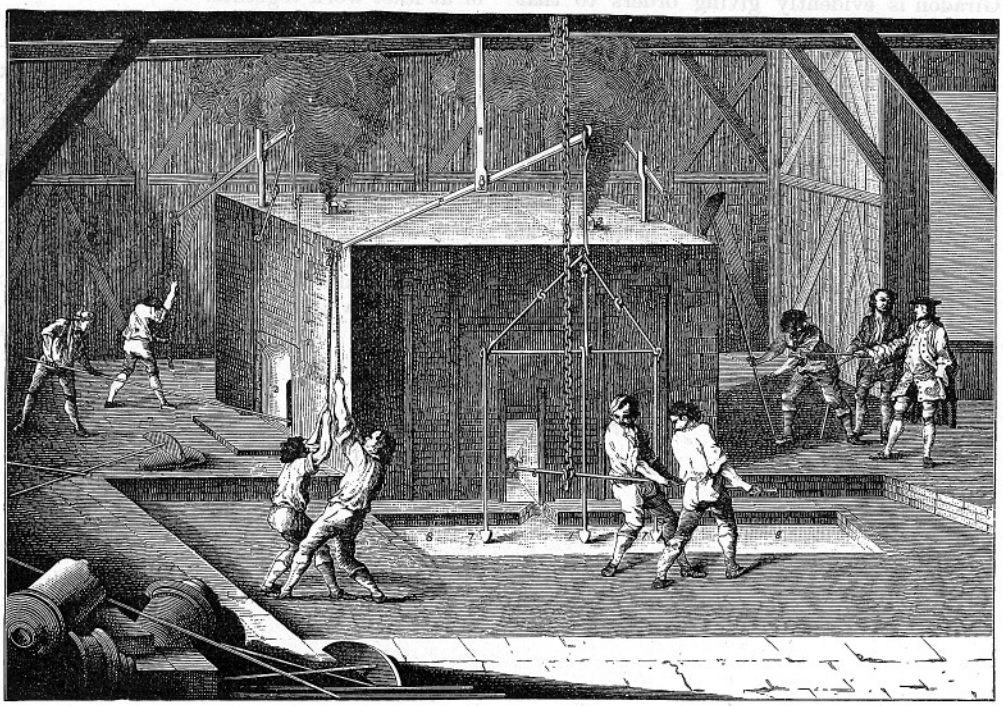
THE FALCONER.

By G. SIMONDS, *cast by the late* CHEV. PAPI, *of Florence.*

twisted and bent into the proper curves, and bound together with screw clamps also of iron. For this work a good smith is required, and careful supervision on the part of artist and founder. Some idea of the complicated nature of such work may be obtained from the illustration, which represents the framework used by Bouchardon for his statue of *Louis XV.*

The iron framework being finished the mould is next to be put together around it. We have now, first the plaster mould, next the wax lining of the mould, and inside this we have an iron skeleton destined to support the core. This core is made of a composition of plaster and brickdust mixed together in certain proportions and poured into the cavity of the mould through apertures made for that pur-

pose. The core now fills the entire cavity between the wax lining of the mould and the iron skeleton. The mould must now be taken to pieces, and the wax statue with the core inside it is exposed to view. This is the time for the artist to retouch his model and finish it with the greatest care, for on its perfection depends the beauty of the bronze. In the case of *The Falconer* the wax cast made by the Chev. Papi was so sharp and accurate that a very few days were sufficient for all that I found necessary to do to it, and I was equally astonished and delighted with the skilful way in which this colossal statue of wax was poised, with raised arm and falcon just taking flight, barely touching the glove with its two feet—the expanded wings measuring nearly five feet from tip to tip—and all supported by the irons of the core in the interior of the statue, no exterior support whatever being employed. The founder's next care is the disposal of the jets and vents. These are often both numerous and complicated, as it is necessary that the bronze should have free and rapid access to all parts of the mould, and that there should be no *culs-de-sacs* left in which air might be confined to the exclusion of the metal. These having been properly made, the process of forming the mould and firing it is precisely the same as that which I have said was employed by Cellini for the *Nymph* of Fontainebleau—indeed there is in the whole process but one radical difference, namely, the construction of the core. In the one case it was made of a material at least as strong as that of the mould itself; the reason for this is obvious. The work being in relief, not in the round, it had no core proper, that being in reality the back portion of the mould itself. Plaster and brickdust could not therefore have been safely used. Where the core is entirely surrounded by the metal, strength is not needed; on the contrary, the core should yield somewhat to the pressure of the metal, which contracts in cooling. This quality of compressibility, without which the core would burst the bronze, is technically called *pouff*, and is obtained by the plaster being partially burned and the water of crystallisation driven off in the process of firing the mould. This leaves the core very spongy and weak, and incapable of resisting the enormous pressure exerted upon it by



GIRADON'S FOUNDRY IN PARIS, 1699.
From an old Engraving.

the contraction of the cooling metal. The metal itself is melted in furnaces which are almost identically the same as those used in the middle ages, of which Cellini has left us an excellent description.

The accompanying illustration shows M. Giradon preparing to tap the furnace for casting the statue of Louis XIV. The side doors of the furnace are raised by levers, and the assistants are making ready with their long bars, called "rastelli," to sweep the liquid metal towards the opening, and to check the exit of any dirt or dross that might have formed on the surface. M. Giradon is evidently giving orders to that effect. Two other men are raising, by means of a sort of crane, three iron spindles which end in plugs closing the mouths of the jets. Two more men are engaged in placing in position the "perrier," or ram, slung at the end of a long chain, with which, at the proper moment the spiggot is to be driven in, and the charge of the furnace, in this case no less than 83,752 pounds of metal, allowed to escape like a river of fire into the square reservoir or "écheno," and thence through the jets into the cavity of the mould which is buried in the earth beneath. This casting was perfectly successful.

The foundry, which was built by the city of Paris, and consisted of a series of most perfect studios and workshops, as well as courtyard and dwelling-house, was placed by the city at the disposal of artists engaged on important national works; and was thus occupied by Giradon, Bouchardon, Le Moine, and others. It was used for the last time in 1817, and has since been pulled down and the materials sold by auction.

In Belgium there is already a society for *cise perdue* casting, but the bronzes which they have exhibited in this country are not all that can be desired. It is useless to adopt this method unless artist and founder are one, or at least work together.

Having now concluded this necessarily short and imperfect account of a little understood branch of sculpture, I can only hope that those who have had the patience to follow me will find their reward in a somewhat fuller appreciation of whatever they may be fortunate enough to find of the good and beautiful in bronze work, either at home or abroad. The subject is one on which volumes might be written, but these would be too technical for the object I had in view, and would only weary the amateur, for whose sole benefit these pages are written.

GEORGE SIMONDS.