CHAPTER XI.

COINING PROCESSES.

DROP-FORGING.

THE process of coining, as has been indicated in earlier chapters, is analogous to drop-forging; or pumping melted metal into a type-mold; or squeezing a piece of soap or clay in the palm of one's hand; or molding a pat of butter. In it we see illustrated the principle of the flow of solids, even more vividly than in the drawing process.

In Fig. 398 is shown, in vertical axial section, a pair of ordinary drop press dies, arranged for drop-forging a small

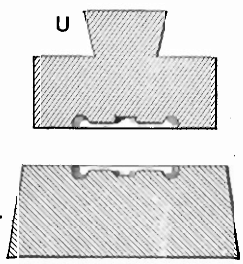

FIG. 398.

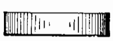
FIG. 399.

FIG. 400.

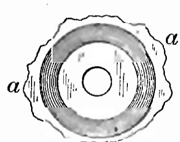

FIG. 401.

hand-wheel, as shown in axial section in Fig. 400 and in top view in Fig. 401. It is possible to do such work as this cold where copper, lead, and other soft metals are used. In practice such dies are more often employed for iron or steel, heated almost to a white heat. In Fig. 399 is shown a blank from which the wheel is made, which may be of any appropriate form. In this case it is merely a round punching, made from flat bar-iron. The process is, of course, simply one of molding, the die L being rigidly secured to the bed of the press and the die U to the ram. The latter descends from a considerable height, and with a force far greater than is usually employed in sheet-metal work.

A distinguishing characteristic of freshly drop-forged products is the irregular little fin, surrounding the work like a halo at *a a*. This is evidently due to the surplus metal creeping out between the dies—the only path of escape open to it. It is true this fin might not occur, but it generally does. Its absence is attainable only by the blank being placed exactly in the right position, remaining there during the blow, and containing exactly the right amount of metal. These fins, as before intimated, are always present in some degree, but are trimmed off afterward in a "trimming-press," in which are mounted dies that are, of course, nothing but ordinary cutting-dies—with the punch hollowed out, as far as practicable, to fit the upper surface of the work. Obviously, by this process such articles only can be made as will deliver freely from the dies, by reason of having considerable taper and no high vertical walls. Extremely irregular contours present no special difficulties.

The practical applications of the art in question are far too numerous to be scheduled here. By it thousands of small tools and parts of machinery, hardware, cutlery, etc., are rapidly made, with the uniformity of punched-out work, but of far better quality as regards smoothness and density. Most of them, moreover, are of rounded-up forms, so to say, which could not be made at all from flat sheet-metal with punching dies. Such forgings are usually better than the best hand-made forgings, as well as vastly cheaper and more uniform. They are often cheaper than castings of like form, and for most purposes a great deal better.

Coining Coins.

The process of coining, as employed for manufacturing medals and metallic money, embodies the same general principles as drop-forging work, but is carried out very differently in detail. Furthermore, the metals used are generally worked cold, and there is much more uniformity in the general design of the product than in the drop-forging art, whose products embrace almost every conceivable kind of article adapted to the processes employed.

In Fig. 402 are shown, in vertical axial section, a pair of coining-dies, *U* and *L*, together with their "collar" *C*, such as are used in the mints of all the principal civilized nations of the earth for stamping the coins of the realm, from so-called "planchets" or "milled" blanks, as shown in axial section

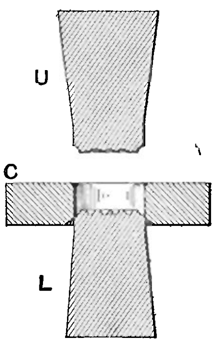

Fig. 402.

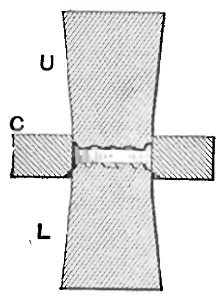

Fig. 403.

in Fig. 406. These dies are shown in open position, ready for the planchet to be fed into them by sliding it over the face of the collar and allowing it to drop into the same and over the lower die. In Fig. 403 the same dies are shown in closed position, as when giving pressure to the embryo coin. In Fig. 404 they are shown when the upper die has risen out of the way and when the lower die has risen in its collar to eject the coin; or, as is often the case with an alternative device in press motions, when the collar has descended for the same purpose, the lower die remaining stationary.

In Fig. 405 is shown, in edge view, a blank as punched by ordinary round cutting dies from a strip of metal of the proper thickness; and in Fig. 408 an enlarged partial section of the same appears. At *a b* are shown, exaggerated, the characteristic rounding on one side and burring on the other incident to all punching operations. These, however, do not signify, as the "milling" machine kindly takes care of them.

In Fig. 406 is shown in section, as before mentioned, and in Fig. 410 in partial section a planchet which has been made from a blank by the "milling process," so called. This consists of rolling the edges in a special machine, the radial com-

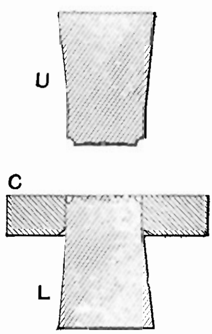

FIG. 404.


FIG. 405.

FIG. 407.


FIG. 406.

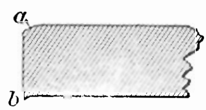

FIG. 408.

pression thus obtained upsetting or thickening them into the form shown, while at the same time the corners are rolled down to a rounded shape, preferably more like *c* than *d*. In Fig. 407 is shown the face of a finished medal which has received upon both sides at once reversed impressions from the respective upper and lower dies employed.

In some cases a coin or medal is "reeded," or fluted upon the edges, as is the case with our American silver and gold coins, the so-called reeding consisting of a number of fine teeth, or cogs, running parallel with the axis of the coin. These are formed by fluting the internal surface of the collar *C*, which is usually made very slightly conical, to facilitate easy deliverance.

It is evident that in this kind of work, as well as in drop-forging, there is a tendency to produce unwelcome fins, should there be a surplus of metal to the slightest degree. These fins of course tend to form as at *e* and *f*, Fig. 409, in the only place available for the metal to escape, which is in the joints between the dies and collar. Manifestly they must be avoided, and great care is therefore taken, for mechanical as well as financial reasons, that the weight, and consequently the approximate mass, of metal in all the planchets shall be uniform, at least to within a very small limit of error. Even with this accuracy of bulk there would sometimes be minute fins, especially as the dies cannot be depended upon to always come exactly the right distance apart, were an attempt made to produce perfectly sharp corners at *c* and *d*. For this rea-

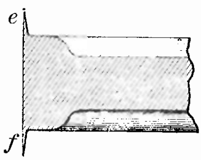

FIG. 409.

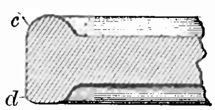

FIG. 410.

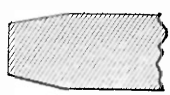

FIG. 411.

son, as well as for convenience and beauty in the coin, these corners are rounded, an attempt being made to leave them of nearly as great a radius of curvature as was given to them by the milling process. This, of course, can only be done by not pressing the planchet hard enough in the middle to make the edge flow out violently and force itself into the interstices of the mold, as in Fig. 409. Fortunately, with the metals ordinarily used, this can be done successfully, and yet a sufficiently deep, sharp, cameo impression obtained upon each face of the coin. The changing conditions above referred to, however—viz., some slight difference in bulk, a non-uniform descent of the upper die owing to springiness in the machinery, and certain trifling variations in the density of the metal—cause a different amount of edgeward flow. Conse quently upon some coins, and upon one face more than the other of some certain coin, and perhaps at certain places around the edge of a given coin-face, the metal will flow outwardly scarcely at all, thus leaving a considerably rounded corner at *c*. At other times and places the circumstances mentioned will cause a greater flow edgeward, with the result of a much sharper corner, as shown at *d*. The constant effort of the coiner, however, is to prevent *d* from ever becoming entirely sharp. A casual examination of any new coin will show, without a magnifying-glass, these inaccuracies as to the relative sharpness of corners, even in different places upon the same coin.

Within a short time past, and since the production of aluminum has been so wonderfully cheapened, it has become fashionable to coin this metal into medals of all imaginable designs, and all degrees of beauty and ugliness. Some of the makers of these have attempted an excessively deep cameo effect. The metal, however, has proved itself too prone to flow wheresoever it listeth, with the practical result of a finned edge like Fig. 409, the metal near the periphery not proving itself to be a sufficiently strong hoop to hold in against the radial flow outward started by the central expanding forces. The makers, who attempted but a small production, dressed the obnoxious fins off in a lathe, which, of course, was a slow and wasteful process. In one case these difficulties were brought to the attention of the writer, who suggested the use of a planchet made thinner around its edge instead of thicker, and also considerably tapered off, as in Fig. 411. Such a shape is easily made in a pair of special dies after cutting the blank; or in the sheet, before cutting the same, by compressing dies set in a gang with the cutting die, on the "successive" plan, so as to produce the blanks at one operation.

This form of planchet proved successful, as the surplus flow from the center was, by the time the impressions were made, none too great to properly fill the edges of the mold—by which term is meant the group formed by the dies and collar, closed as in Fig. 403. In general, as the flow can be outward easier than inward, there should always be thickness enough in the middle to suit the particular coin being made.

RIVETING.

Riveting is really a coining process, inasmuch as the metal is caused to flow from the old shape of the rivet-body (usually cylindrical) to a new and different shape of larger diameter, forming the head, which is approximately conical or hemispherical. The body also is oftentimes upset, that it may closely fill the hole, and thus a coining-flow is set up throughout the structure. Sometimes the metal is hot and sometimes cold. In any case the details of riveting are too well known to need further description herein. It should be mentioned, however, that there is in modern practice a tendency to more and more substitute a single press-stroke for the numerous hammer-blows formerly so much used, especially in hot work, as boiler-riveting, etc.

COMPRESSING PLASTIC SUBSTANCES.

In Fig. 412 is shown a pair of dies and a collar, such as is used for making the ordinary medicinal tablets, or disk-shaped pills, shown in Fig. 413. These work precisely upon the same

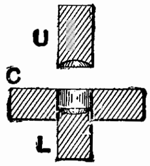

FIG. 412.


FIG. 413.

principle as do the dies in a coining-press, and are sometimes made of other shapes than round, such as square, triangular, etc. The material in this case is usually a dry powder which adheres by compression. Any fins that may occur are so fragile as to rub off in handling, and are not noticed.

Soap-presses also work upon precisely the same principles above described, and all the cake-soap in common use is simply the product of coining the crude pieces of irregular shape, which are usually placed in the lower die by hand.

The same process is sometimes used for compressing cakes of salt and other materials, usually in the form of rectangular bricks. The ordinary brick press of commerce is another illustration of a coining apparatus, the dies or molds being usually set in gangs of several together in a row. That form of brick press which uses dry powdered clay is almost as elaborately built as is a smaller coining press, but is, of course, relatively immense in its proportions and strength, as very great pressure is required to properly compact the clay.

TUBE-SQUIRTING.

An interesting modification of coining proper is seen in the process of making from soft metal (cold) the thin-walled, thick-ended, collapsible tubes used for painters' colors, toilet-pastes, and a variety of other purposes. Not only do these tubes find their active vocation in squirting forth these semi-liquid substances, when pressed to do so, but they are themselves squirted into existence, so to speak.

This process consists in squeezing a thick flat disk of metal so tightly in a deep female die that its particles flow outward and upward around the punch. This is made enough smaller than the die to allow room for the desired thickness of wall. The result obtained is evidently an amplification of the *fin* shown at *c*, Fig. 409. Any desired shape of neck can obviously be formed at the same time, and a proper hole can be perforated therein. Such tubes are usually made, a considerable number at a time, in gang-dies, set in a hydraulic press.

Somewhat akin to the process just described is the squirting of continuous lead and tin pipes through a die and around a mandrel, from an annular mass of metal to which enormous pressure is applied.

SPEED AND PRESSURE.

The speed employed in the operations we have been considering should not be too fast to obtain the fine impressions usually required. It is probable that the ordinary speed of a drop press ram might in some cases give the metal scarcely time enough to flow, but there is no difficulty in practically running such machines at a speed of from 100 to 200 strokes per minute, 120 being the usual standard for small coins in the United States mints, and 100 for the larger ones. Such limit as exists seems to be a matter of press-jerking rather than slow-flowing. In a machine designed by the writer (see Fig. 138, page 68) the customary 6″ feeder-stroke and $1\frac{1}{2}''$ ram-stroke were replaced with strokes of $\frac{3}{4}''$ and $\frac{1}{8}''$, respectively. The result was a speed of 200, with scarcely perceptible jar or noise.

Regarding the pressure required for ordinary coining but few data are available. The force applied to any given coin, however, of course considerably exceeds the ultimate compressive strength of that particular piece of metal, otherwise it would not flow. The approximate pressures supposed to be used in the U. S. mints are as follows: For dimes, 30 tons; quarter-dollars, 60 tons; half-dollars, 100 tons; dollars, 160 tons—all of 2000 pounds each.

PRESSES USED.

The presses used for medals, of which but small quantities are usually required, are generally hand-fed, and are either of the screw- or toggle-driven type. Drop presses sometimes come into play, but are more difficult than others to keep in a condition conducive to the accurate working and maintenance of dies—to say nothing of their too fast speed.

For regular coinage in government mints, and in some cases in the factories of medal- and badge-makers, automatic presses are used in which the planchets are simply piled by hand into a long vertical tube, the machine doing the rest upon its own responsibility.

In general, coining machines must be of much stiffer design than the average run of presses, and of comparatively enormous power. They are usually made with two straight columns, placed as near together as possible, and with very deep cross-members—all with a view of preventing "springiness" to the greatest possible degree.