

## CHAPTER XIII.

## MISCELLANEOUS.

## MANIFOLDING WORK IN DIES.

It has been taken for granted, in describing various press-working operations in which the use of dies is involved, that but one thickness of metal was to be worked at a time, although in describing the drawing process reference was made to working two or three pieces at once. It is obviously possible, however, to thus manifold work, as it may be termed, in various bending and forming operations, providing the same condition is admissible as in drawing conical pans inside of one another, viz., that the inner ones shall be smaller than the outer. In coining-work a duplication of pieces in the dies at one time is of course out of the question. In cutting and punching flat sheets or bars we obviously have the most favorable conditions for going through several thicknesses at once, as all the blanks thus cut would be practically of the same size. As a matter of fact, two or three thicknesses of thin metals, such as tin-plate, sheet-iron, etc., are often cut at a single stroke of the dies by being piled one upon another when fed. The writer has recently made some definite experiments as to how many layers it is possible to thus cut, and has succeeded in making as many as a dozen blanks at a time.

It is evident that under such conditions the upper blank which touches the punch must act as the punch for the next one, and that for the one below it, and so forth. Thus the metal is being cut by a tool no harder than itself, with the

result that might be expected, a certain crushing and tearing around the edges which gives a very uncouth effect. The lower blanks and the upper " margins " are not only extremely rough where cut apart, but are somewhat bent up around the edge into a little conical flange, thus making the blanks slightly cup-shaped. This bad effect of course increases with the number worked at once, getting worse and worse on the blanks as they are removed farther from the punch, and on the margins as they are farther from the top of the lower die.

In practice two or three layers of metal are probably about as many as it is worth while to attempt to cut at one time, although if smoothness and flatness are of no consequence more might be worked in some cases. It may be asked why several layers of thin metal will not punch as well as with the same total thickness aggregated into a thicker plate. It is true that in the latter case the pushing down of all the lower parts of the blank have to be done by portions of its own material above, but in the former case, of a number of separate plates, we have a laminated structure in which each layer can slide somewhat over the adjacent one, as the fibres are bent out of their normal plane.

In working paper it has been found that very many more layers can be cut at a time than in the case of metal.

#### PAPER-WORKING.

The greater portion of the ensuing remarks upon paper-cutting are extracts from an article published by me in *The American Machinist*, giving the results of certain experiments which, though not exactly germane to the subject of this book, may be of interest as showing some of the doings of an ordinary press and dies originally made for metal working.

" The object of the experiments referred to was: 1st, to ascertain the best angle of cutting edges for ordinary male and female dies, when used in cutting paper and pasteboard; 2d,

to see how many thicknesses could be successfully cut under various conditions; 3d, to note the pressure required. For this purpose a pair of round dies, cutting to a diameter of  $1\frac{1}{2}$  inches was used, a section and top view of the same being shown in Fig. 427.

“ In the first batch of experiments the punch and die were both made perfectly flat with the angles *A* and *B* each 90 degrees, the edges being sharp and the punch fitting the die with a close but easy sliding fit, say, not over one five-thousandth of an inch loose.

“ The second condition of the dies was as in Fig. 428, with the lower die still flat, and the punch beveled out so as

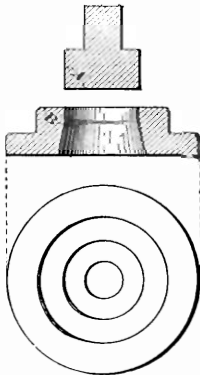


FIG. 427.

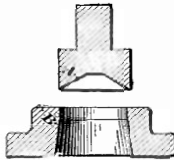


FIG. 428.

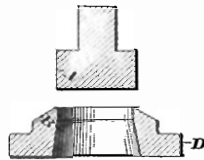


FIG. 429.

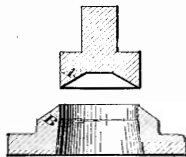


FIG. 430.

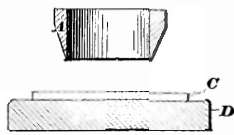


FIG. 431.

to make the angle of cutting edge at *A* 60 degrees, which angle seemed to be (after a few trials with other inclinations) the most appropriate for the purpose.

“ Under condition third, the punch was flat and the die beveled to an angle of 60 degrees, as in Fig. 429.

“ Under condition fourth, both punch and die had their edges beveled at *A* and *B*, to angles of 60 degrees, as in Fig. 430.

“ With dies in condition first, from one to five sheets of manilla paper, .012" thick, could be cut at a time when piled together, the cutting being reasonably smooth. When ten

were cut at a time some of them were rough and ragged, and with twenty at once the roughness was too great for any ordinary purposes, both with the "blanks" and "margins." With pasteboard .057" thick (one sheet at a time), the cutting was very good, and with two sheets at a time, slightly ragged. With pasteboard of a softer quality, .105" thick (one sheet at a time) the cutting was fairly good only, being slightly ragged.

"In all these cases, as might be expected, both blanks and margins remained flat.

"Under condition second, much smoother edges were produced when cutting a number of sheets at a time, on account of the sharp angle of the punch—work almost smooth being produced ten at a time, and fairly good twenty at a time, the pasteboard also showing better results than before. As might be expected, however, the paper blanks were bent upward into the concave recess of the punch, when cutting more than about five or six at a time, to an extent calculated to render them useless for ordinary purposes. This was especially the case when cutting twenty at once, a number of the uppermost blanks in the pile being very much wrinkled, and the pasteboard blanks showing a raised bead near the edge caused by the radial compression. As might also be expected in this case, the margins remained flat, without injurious wrinkles.

"Under condition third, with the punch flat, and the die having an edge whose section was an acute angle, the expected again happened, the paper blanks being flat and smooth all the way through, and the margins being permanently bent and wrinkled when cut in piles of more than five or six sheets at a time—so much so as to render them unfit for ordinary use. With twenty sheets at a time the lowermost margins were embossed out to a cup-shape where they were forced over the conical portion of the lower die to about  $\frac{3}{16}$  inch

deep, while the central ones of the pile had a depressed flange something on the counterbore order, the uppermost ones being nearly flat, but slightly wrinkled. In the case of the pasteboard something of the same effect occurred, but not to so great an extent.

“ Under condition fourth, the cutting was still smoother than in any of the other cases, with less of the ragged-edge effect, even twenty sheets at once being cut in fairly good shape. As might be supposed, however, the evils cited in the last two paragraphs, viz., cupping and wrinkling of the blanks, in the one case, and of the margins in the other, were here united as twin evils, although the distortions did not seem to be quite as great in either case as with the other dies.”

In regard to the actual and relative pressures required for paper-punching under the various conditions named, no accurate records were made, but the figures varied from 3000 to 6000 pounds per square inch of section cut. The lower pressures were attained with the sharpest angles, as in Fig. 430.

“ In Fig. 431 are shown the tools for a more usual method of cutting paper, pasteboard, cloth, leather, etc., than by the use of the male and female dies just under consideration. These work upon the chiseling principle, and consist of a hollow cutter with its angle *A* at the cutting edge about 20 degrees, and its depth from 1 inch to  $1\frac{1}{2}$  inch, together with a matrix or anvil, *C*, upon which the cutting is done—usually a sheet of copper, soft-brass, lead or pasteboard, the latter being probably the most frequently used. This rests upon an iron plate, *D*, set upon the bed of the press. In some cases, however, a wooden anvil, preferably with the end grain toward the cutters, is used in place of the plate *C*. The cutter is usually placed by hand upon the pile of paper sheets, which are slid under the ram-driven platen of the press. This of course descends upon the top of the cutter, and pushes it down exactly in contact with *C*. The blanks are generally removed

by hand, although in some cases the cutter is reversed, and so mounted upon a lower die-plate (something after the fashion of Fig. 429) that the blanks may fall through of themselves as they are pushed down by the following blanks in succeeding operations. In still other cases they are pushed upward by an automatic knockup, worked by springs or otherwise. In either of these last-named cases a spring-stripper is sometimes furnished for pushing the pile of margins off from the outside of the cutter, instead of removing them by hand."

In some recent experiments I found that a cutter of this kind would cut smoothly some 300 thicknesses of ordinary printing-paper at a time, the whole pile being about 1 inch thick. The pressure per square inch of section cut was, roughly speaking, some 2000 to 3000 pounds, the larger diameters naturally taking the least force per inch, on account of less stretching of the margins, proportionately, being required.

The purposes for which paper is cut into definite shapes are of course very numerous. Among them are playing- and photograph-cards, labels, valentines, and so-called paper dolls of every imaginable complexion and every degree of beauty and ugliness.

The forming and drawing processes are also practiced upon paper and other soft substances—usually when in a dampened condition, with the dies kept hot upon a bolster having a steam-coil inside. Similarly, an operation analogous to coining is performed upon thick pasteboard and sometimes on leather.

In nearly all these cases the presses are the same as those used for metal-working.

#### HAMMER-BLOWS.

In comparing the efficacy and general desirability of a quick hammer-like blow, as given by a drop press, with the

slower pressure given by a crank-driven ram or the ram of a hydraulic press, there are various circumstances to be taken into account. In general, where hard work is to be done through a very short distance, as in smashing out wrinkles or embossing a shallow design in sheet-metal, etc., a given pressure can be obtained for less money with a drop press than with its more expensive rivals. This is because of its simplicity as an agent for storing power, there being, as with other members of the hammer family, no kinetic mechanism through which heavy pressures must be conveyed from a power-storing fly-wheel. The lifting of a weight by any rough device that is strong enough for its work, with no particular accuracy of motion, and the subsequent letting go of it, so that gravity may do the rest, gives us an ideal simplicity, the only accurate mechanism necessary being a pair of columns to guide the hammer-like ram so that it will fall in its proper place.

The varying circumstances above referred to are too numerous to be scheduled here. Among them are the temperature of the metal, its thickness, its capacity for quick flow among its particles, etc. One important point in favor of a slow, positive, action is that the metal is affected uniformly, or nearly so, all the way through, while with a quick hammer-blow it is, on account of the inertia of its own particles, affected mostly upon the outside. This causes variations of density, and in heavy forgings an openness of internal structure not conducive to the greatest strength. Witness the "piping," or central cavities, sometimes occurring in large shafts which do not get pressure enough to squeeze them together.

In the case of small articles of hot metal the chilling of the surfaces by the action of dies which are massive in proportion to the work is a serious objection to the use of a slow-moving ram. It is, however, more important to attain a quick opening of the dies than a quick closing together, as a com-

paratively slow closing has the advantage above mentioned of allowing the metal to flow properly, while every moment that they remain closed upon the work gives a clear loss of heat. This is especially the case where a number of successive blows are to be given, and for such action the drop press is not a suitable machine, as the lifter does not act immediately, or with great initial rapidity. For such work a trip-hammer has been found a very useful tool, although the accuracy of its motion is not all that can be desired.

A heavy, geared, toggle press might seem to be a good machine for the hot squeezing of small articles weighing but a few ounces. This is not the case, however, as the terminal closing and initial opening are so slow with a toggle-motion that the work is as cold as the dies before it is fully squeezed. A non-geared; rather fast-moving machine is evidently desirable, and it is quite possible to construct a big, special, press whose kinetic arrangement shall give the ram a moderately quick closure and a more rapid opening,—at the same time retaining some of the advantages of a toggle-motion in the way of avoiding friction under heavy pressure. The general characteristics of such a machine were well described by a friend of mine with the analogies, “As strong as an elephant, and as quick as a cat.”

#### EFFECTIVE PRESSURE IN DROP PRESSES.

A mysterious efficiency is sometimes claimed for a drop press blow, as having some wonderful inherent property not attainable by an ordinary ram pressure. There is, however, nothing in such a blow but what can be resolved into the simple elements of force measured in pounds and motion measured in feet or inches. In estimating the actual pressure attained it is not even necessary to go into the mathematics of the laws of gravitation, as a simple calculation which will resolve

the action of the hammer into foot-pounds is all that is required.

If, for instance, a one-hundred-pound ram is lifted ten feet there must necessarily be (disregarding for the time being the friction of the guiding columns as of little account) 1000 foot-pounds of stored energy, which is bound to be given out during the time that the ram is being stopped by its action upon the work. If this action takes place during the last one foot of its fall, then the average pressure through that foot will be 1000 lbs., dying away to nothing as it reaches the bottom of its stroke. If the distance through which work is done is one inch, then the average pressure will be 12,000 lbs. If, as is more likely in sheet-metal work, the actual pressure is required through, say, one tenth inch, then the average pressure will be 120,000 lbs. In other words, the total foot-pounds divided by the distance in feet through which the ram is doing effective work will give the average number of pounds pressure exerted upon the same. In practice some 10 per cent may be deducted from these figures for friction and motion wasted in heat, etc.,—the amount varying with circumstances.

This, however, is assuming that the anvil or bed of the press is of ample weight, so that much of the force of the blow will not be wasted in moving it and its supports. The latter should not be of springy timber-work, as of old, but of solid masonry, extending down to bed-rock where feasible.

As compared with a drop press a slow-running mechanical or hydraulic press is better for cold metals, which usually will flow better to a new form if treated slowly than when called upon for a violent and sudden disarrangement of their particles. The same thing may be said in regard to hot metals of such large bulk that there is little danger of the chilling of the surfaces by contact with the dies. The truth of this statement may be verified by citing the fact that within a few years past

many of the great steel-works in this country and Europe are substituting hydraulic presses of enormous power (10,000 tons pressure being considered nothing remarkable) for the big steam-hammers formerly used. The action thus obtained upon great ingots of white-hot steel used for forging cannon, steamer-shafts, and such work, is found to be both quicker and better.

### TESTING PRESSURES.

The pressure required for doing any sort of die work, from cutting to coining, is often a desirable thing to know, but is generally with press-users a sadly unknown quantity. The most accurate method of obtaining this knowledge is to use a regular testing-machine, arranged for compression, preferably equipped for giving an automatic record of the pressures at each instant of the closing of the dies, which are temporarily mounted therein. Such tests are usually not available in a press-working shop, but a rough test used in my own practice for ascertaining what a press ram would do has been to place between two flat, hardened, plates, one mounted upon the bed and the other upon the ram, certain pieces of bar-iron, of the same size and quality as certain other ones which had been previously tested for compression in a regular laboratory. The value of this of course depends upon the uniformity of the metal, but for approximate work it has been found sufficient to use  $\frac{1}{2}$ " square American iron—annealed and cut up in short pieces, 1", 2", 3", 4", and 5" long, etc.

These pieces, when laid on their sides and smashed to about  $\frac{7}{16}$ " thick, so as to widen to  $\frac{9}{16}$ " wide, represent somewhere near one ton (of 2000 pounds) pressure for each  $\frac{1}{2}$ " in length. 1" would therefore represent 20 tons; 2", 40 tons; 4", 80 tons, etc. For lighter pressures, smaller sections of iron could be used and the system could be carried out with various other modifications. Doubtless copper would be more uniform and

give better results than iron, but might not be as cheap and convenient to get hold of. At a future time I hope to make public more accurate records in regard to the behavior of different qualities of iron, and to give a more definite rule for reading results.

I also hope to further develop a certain device to which I have given considerable study, but have not yet perfected. This is a portable, recording, compression-testing machine, in the form of a bolster which can be placed upon the bed of any ordinary press. To its upper surface will be secured any die in which work is to be tested. By allowing sufficient resistance between the dies the capacity of the press can of course be tested also. The difficulties to be overcome are chiefly due to the small available space at command and to the great range of pressures requiring to be weighed with the same instrument.

#### ELECTRIC DRIVING.

Until recently power presses have been driven with belts from countershafts or from line-shafting, but it is now becoming the fashion, to some small extent, to equip each press with an individual electric motor. It is to be hoped that this fashion will increase and multiply, as the advantages of such driving are too numerous to be mentioned in detail here. Obviously, the convenience of standing a machine anywhere, in any position, and connecting to it by a pair of wires dropping from the ceiling, or, preferably, coming up through the floor, are manifest, especially as the speed can be accurately controlled, and the power is used only at the exact time, and to the exact amount needed, without waste from shaft-friction, belt-resistance, etc. Furthermore, the advantages of clear overhead shop-room, with its incidental increase of light, cleanliness, and safety, are almost beyond computation, when compared with the methods of our grandfathers and our

fathers—and of ourselves, in those ancient times some four or five years ago, before we knew about these things.

The above remarks do not refer to an electric or magnetic press proper, as mentioned in an earlier chapter. Such direct driving of a press ram by electro-magnets has not as yet been developed very far, except in the analogous case of rock-drills, and perhaps occasionally an electric hammer.

#### POWER REQUIRED FOR PRESSES.

The horse-power required to drive a press is usually quite small in comparison with that absorbed by many other machines of about the same general size. This is because the speeds are comparatively slow, and the down-strokes, which do the hard work, are intermittent. Again, we have in literature few, if any, definite data based upon dynamometrical tests of actual work.

An approximate estimate of the power that a mediumly tight driving-belt of a power press can supply may be made by the old rule of multiplying the diameter of the driven pulley (which oftentimes is the fly-wheel also) by belt-width, both in inches, and by revolutions per minute, dividing the product by 3000, the quotient from which will be the horse-power. Such result may be discounted quite freely by guess—say from 25 to 75 per cent. This is to allow for the halcyon moments of waste time, so to speak, between the down strokes of the ram, when the belt is doing almost nothing, except, indeed, at certain times to restore the depreciated speed of the heavy fly-wheel that is (or ought to be) present in every such machine in order that a part of the power may be freely stored therein for each critical time of need. The discount referred to will be greater in instances where the main shaft is stopped after each stroke by its clutch, because in such case the ram will be actually at work during a less proportion

of its total time than with a continuously running shaft. The observer must judge in each particular case as to how much of the time actual work is being done in overcoming friction or otherwise. Of course much better than all this would be the use of a good recording dynamometer (could a suitable one be obtained), from whose records the power used could be averaged.

An excellent substitute for the above-mentioned instrument, in cases of electric driving, is the presence of an ampère-meter or watt-meter in the circuit. The voltage being known, a little mental translation will enable the observer to read the greatly varying horse-power at each individual instant.

#### FUTURE DEVELOPMENT.

The wonderful evolution of some of the various processes involved in the art which is the subject of this treatise has before been referred to. It is a well-known fact that our commercial metals are all the time being developed into a more suitable quality and form for being acted upon by dies, and that hundreds of inventors are busily at work contriving new devices for the household, the ship, the farm, the road, and every other department of human activity. Moreover, the tendency is constantly to cheapen and unify various parts of these devices, striking them out in dies from malleable material rather than producing them by the older processes of hand-forging and casting. It is impossible to predict how far this line of evolution may go in the future, but at present the prospects seem to point toward a more and more thorough and frequent use of the processes in question as the years go on.

Unquestionably very many articles of common and necessary use, which serve to add to the pleasure, convenience, and consequent happiness of mankind, and womankind, too, have been increased in number and improved in quality by the

facility with which they can be produced in presses and dies. Truly, if the man is to be commended who can "make two blades of grass grow where grew one before," how much can be said of those men whose toiling brains and hands are providing the means by which not two only, but two thousand, useful and beautiful things can be furnished to the waiting multitude for a price at which but one could be obtained by their fathers and their grandfathers! Shall not the Recording Angel say of each of these busy workers, like Abou Ben Adhem, he "loves his fellow-men"?