PRACTICAL DIE-MAKING

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A COLLECTION FROM THE LATEST INFORMATION ON DIES AND DIE-MAKING

COMPILED BY

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FIRST EDITION

McGRAW-HILL BOOK COMPANY, INC.
239 WEST 39TH STREET, NEW YORK
6 BOUVERIE STREET, LONDON, E. C.
1916

THE MAPLE PRESS YORK PA

INTRODUCTION

The best information in any line of work does not come from the work of any individual but from the combined experience of many. Each contributes his share and the combination gives us a far wider range of information than we could secure in any other way. So in compiling this book it has been the aim to secure facts and examples from many sources in order that every reader may find some of the work just suited to his needs. No originality is claimed and full credit is given so far as possible in the list of authorities in another part of the book.

THE AUTHOR.

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CHAPTER I

BENDING AND FORMING DIES

The use of punches and dies for forming sheets and rods of metal has grown to far greater proportion than was dreamed of a few years ago, and new applications are being discovered every day. Beginning with the simpler forms, such as bending dies, the different types which are in more or less common use will be taken up, showing the designs and practice which has been found to give satisfaction in shops in various parts of the country, with some from English shops as well. A good beginning is shown in the simple example given by Fig. 1.

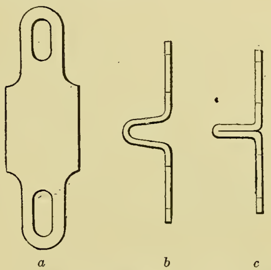


Fig. 1.—A simple bending and forming job.

In Fig. 1 is shown a blank *a*, cut and pierced by the usual tools, not shown here; *b* is the result of the first bending operation and *c* the finished article. The pieces were made from cold-rolled stock 0.062 in. thick. Before they were made in the tools shown some tools were used which necessitated three separate handlings. They were formed as at *b*, then closed and afterward planished.

Fig. 2 shows a plan of the dies themselves—for there are really two dies placed side by side in one bolster. *A* is the front die and *B*,*B* the moving parts of the rear dies. *C*,*C* are mild steel pins which are a push fit in bolster *D* and in the dies.

Fig. 3 is a section on line x-y, Fig. 2, and shows plainly the construction of the rear die which consists of a piece E arranged to receive the sliding members B. It will be seen that when pressure is put upon the latter they will descend and approach each other. Pressure pins are placed beneath them as shown, and also a spring to expand them on the up-stroke. The angle of the slides is about 15 degrees.

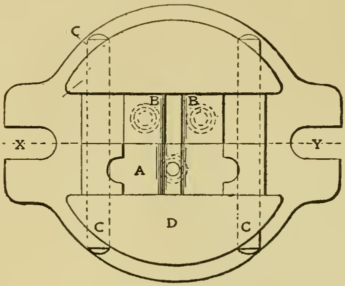


Fig. 2.

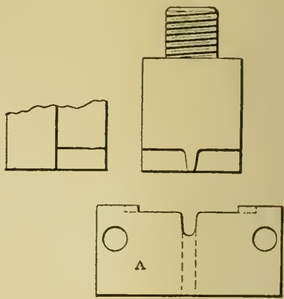


Fig. 4.

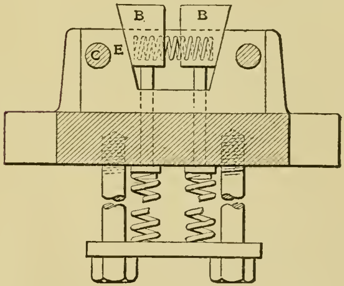


Fig. 3.

Figs 2 to 4.—The dies for bending and forming.

Fig. 4 gives a side view of the front punch and die which give the first bend.

The illustration, Fig. 5, shows the essentials of a bending punch and die for making right-angle bends in sheet or strip stock. It is particularly well adapted to long narrow strips which must be formed at right angles, and are common in typewriters, adding machines, electrical-measuring instruments and the like.

It has always been a more or less difficult problem to make a right-angle bend (that is truly a right-angle bend) without a forming and bumping operation. This is because the stock will spring back after the bend. The bending die as shown, using a roll as a means to form the bend, overcomes this difficulty. The left-hand side of the illustration shows the punch and the die closed at the end of the forming operation; the right-hand side their normal or rest position.

The strip is shown at *A*, and at *B* the work after forming, it being understood that the bend is to be made on both ends of the

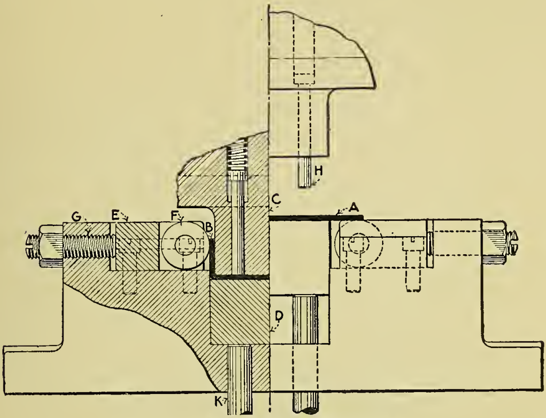


Fig. 5.—Making a right-angle bend.

part. The punch is shown at *C* and at *D* the die block and stripper. A movable slide *E* is held in position by any convenient means of gibbing. This movable slide carries the forming roll *F*, and an adjusting setscrew *G* provides means for taking up for wear and varying the pressure in the forming operations which is another advantage over the common form of bending die. The strippers *H* remove the formed part from the punch *G*. The rods *K* extend through the bed of the press to the die stripper springs. The work is nested in the position shown at *A*, and as the punch descends the part to be formed is gripped between the face of the punch *C* and the die block and stripper *D*. As it is carried on down past the rolls *F* they roll the stock up against the punch, effecting an accurate and permanent right-angle bend. The part is removed from the die in the usual manner by a die stripper.

The advantages of this die, as can be readily seen, are the increased life brought about through the use of the roll, it always presenting new surfaces in the action of the forming operation, and the feature of being able to adjust for different pressures as well as take up for wear.

A Hand-bending Fixture.—A method of hand-bending the pieces is shown in the fixture illustrated in Fig. 6. These pieces

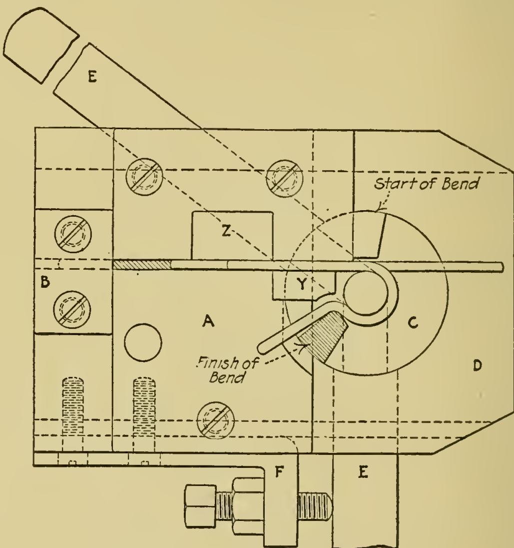


Fig. 6.—A hand-bending fixture.

are made of No. 26 (0.063 in.) music wire. The length before bending is $1\frac{13}{16}$ in. The fixture is made with a tool-steel bending-form, piece *A*, and a gage point for the wire *B*. The wiper *C* is also made of tool steel and a base *D* of cast iron. The handle *E* is made of cold-rolled steel and *F* is an adjustable stop.

The manner in which the fixture is used is as follows: When the wiper *C* is at rest against the stop on *A*, the wire to be bent is inserted in its slot, gaging with the projecting stop pin in *B*. Then with the wiper it is followed around until the handle *E* comes against the stop-screw when the piece will be formed. The screw in *F* permits any adjustment required to suit different tempers in the wire.

Bending a Hook.—The accompanying illustrations, Fig. 7, show tools for bending the hook, which as shown, is more than a half circle. These tools consist of the punch *A*, which fits a suitable holder in the foot press, a stationary die *B*, which is a tight fit in the slot *H* and held in position by screws, and the tumbler die *C*, which is an easy fit in the slot *H* and located by the pin *D*. The hardened-steel piece *E* driven into the die *C* serves both as a stop for adjusting the die *C* to the right height and for a weight to bring it back into position after the bending operation. In

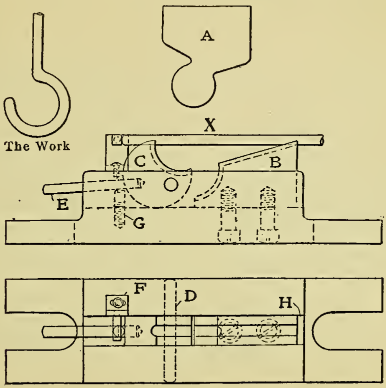


Fig. 7.—A novel hook bender.

operation the wire is laid across the top of the dies *B* and C, fitting in the grooves and against the gage *F* as shown at *X*. As the punch descends the hardened-steel pin *E*, resting against the screw *G*, resists the pressure until it reaches the lower part of the die *C*; the pressure then causes the upper part to tip forward, following around the form of the punch *A* and bending the hook as shown, as the punch ascends, taking the hook with it, the weight of pin *E* brings *C* back into position. The hooks are then knocked off by a spring knock-off fastened to the stationary part of the press while the operator is putting another wire in position. A girl can do 100 gross per day with these tools.

Hot Bender for Forming Hooks.—The bending machine shown in Fig. 8 is of a novel form for forming hooks out of $\frac{5}{16}$-in. hot steel. The full lines in the illustration show the position of the moving parts after the hook is completely formed. The initial position of these is shown by the dotted lines. The stock is placed in as at *Q* and is acted upon by the bending pins *K* and *P* on the segments *A* and *B*, which are rotated by the downward movement of the racks *F* and *G*. The initial bend at the left-

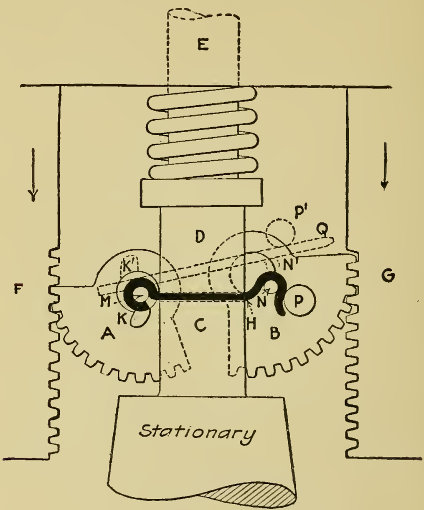


Fig. 8.—Forming hooks hot.

hand side of the hook is produced by the downward action of the upper die *D*, which is forced downward by spring pressure preceding the action of the racks. The centers for the segments *A* and *B* are mounted in a casting which forms one piece with the lower die *C*, but which for the sake of simplicity is not shown. Since the stock is worked hot, the pressure furnished by the spring on the upper die *D* is sufficient to prevent the work from slipping or pulling.

An Interesting Bending Die.—A die made to bend the arms on item plates used in the adding machines manufactured by the

Duco Adding Machine Co., St. Louis, Mo., is shown in Fig. 9. One of the parts may be seen in the foreground.

It is important that the arms be bent without being stretched, so they may fit into the mechanism without trouble. For this reason the die is different from the ordinary bending die. The piece to be bent is laid with the center hole *A* over the locating pin *B*, with the arm between the two pins *C* and extending over the V-block of the die. As the upper portion of the die descends, the member on which the item plate is located is pressed downward, swinging on the hinges *D* until it strikes the surface *E*. This beveled surface is parallel with the surface *F* of the V-block, so that the two bends produced are right-angled.

If the upper die were the ordinary rigid kind, the bends would be severely stretched, and the distance from the center hole to the

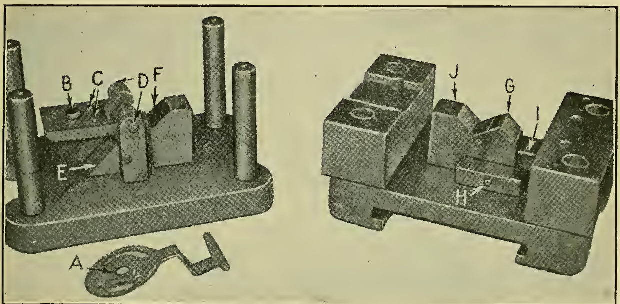


Fig. 9.—Bending dies for adding machines.

first bend could not be depended upon, as slippage or difference in density of the metal would make considerable error. To allow for this, the member *G* is hinged at *H* and is kept against the stop *I* and away from the part *J* by a spring, when in normal position. As the upper part of the die descends, the spring allows the member *G* to swing toward the member *J* and compensate for the movement of the metal being bent. This type of die gives extremely accurate results, no trouble whatever being experienced in obtaining interchangeable parts.

In order that the parts of the subpress will always be put together correctly, the posts on one end are set closer together, so that it is impossible to get the upper part on the wrong way.

This method is followed on all the sub-press dies used in the shop which is superior to the method of using posts of different diameters, as is often done. Where different sizes of posts are used it is necessary to keep separate diameters of bar stock and also use another set of tools for finishing the holes. This is, of course, more expensive, not only in that extra tools and stock must be used, but because more time is taken for the work that must be done on both the punch and the die plates.

Tools for Forming Wire Handles.—The sketches show the two pairs of tools used for making the wire handles shown at *A*, Fig. 11. The first operation and the tools which form the straight wire into staple shape, are shown in Fig. 10. The wire was cut and the ends rounded; in this operation, care must be taken to

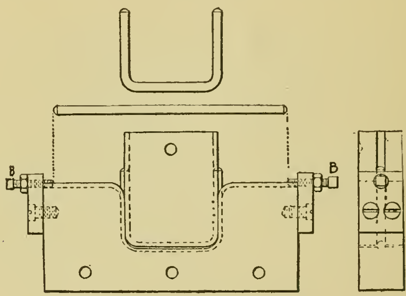


Fig. 10.—The first operation.

have the wire finished exactly the length required to fill up the impression for the ears in the die *E*, Fig. 11. The length can only be accurately obtained by experiment after both pairs of tools are finished.

Having ascertained the right length of wire, the two adjustable screws *B*, Fig. 10, must be set and locked with the nuts provided, being careful to have both sides of the staple come the same length, the corners of the die must be well rounded and polished and be exactly the same shape to insure the wire drawing down evenly on each side. The use of three short pieces of wire will facilitate setting the tools; the two upright wires should be free enough to be easily moved by hand.

The press must be so set that it will give a sharp blow, the groove in the bottom of the die being left shallow to allow the punch to hit the wire, which will result in throwing the ends of the staple slightly inward, not sufficiently to make it cling to the punch, but enough to set it so as to enable it to be easily withdrawn from the die. It is well to use oil in this operation.

When making these tools a special cutter was made for the grooves and used on the miller; this did a good, quick job. The punch and die are hardened and the temper drawn, leaving the bottom of the die rather softer than the corners, which have to withstand the most wear.

The second operation is shown in Fig. 11. It consists of bending the staple-shaped wire into the required shape for the handle,

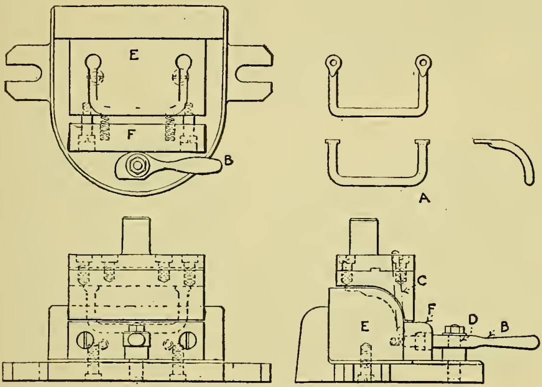
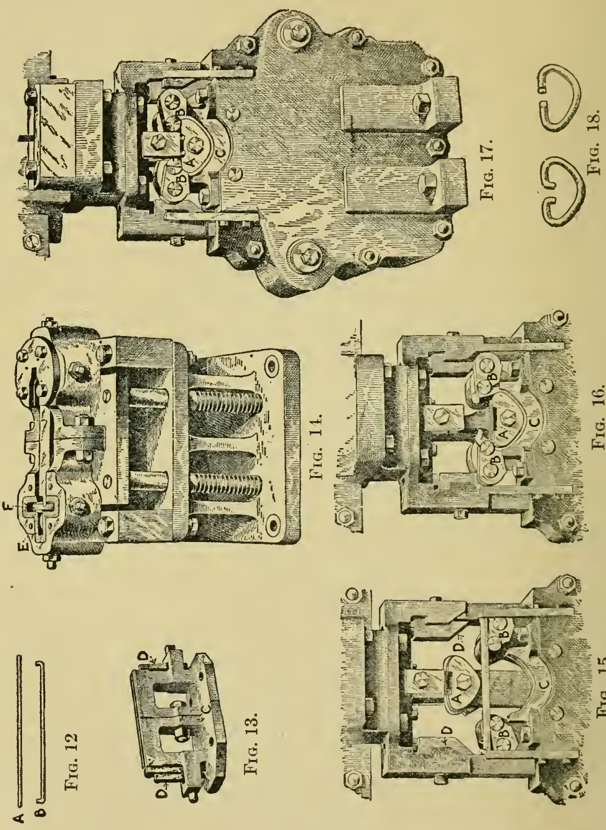


Fig. 11.—Bending the ends.

and flattening the two ends. The punch is omitted on the plan, which shows the die ready to receive the staple-shaped wire shown by the thick lines *C*, held in position by the sliding piece *F*, which is actuated by the lever *B*. The success of this operation depends upon the result of the first operation. The die has to withstand a backward thrust, which is resisted by a strong back of the bolster, which must be bolted down tightly to the press, the staple must be held well into the die by the piece *F* and the cam must come up on the center so that the considerable thrust forward caused by bending the wire will be taken by the pivot *D* and not have a tendency to move the hand lever *B*. The punch and die, the piece *F* and the cam end of the lever *B*, are hardened and slightly drawn. These tools produced a good article, are simple to make and operate, and stood up well.

Forming Dies for Milk-can Handles.—The show room of the Taylor & Challen Co., Ltd., Constitution Hill, Birmingham,



Figs. 12 to 18.—Forming handles for milk cans.

Eng., contains many extremely interesting samples of sheet- and rod-metal stamping and forming.

Among the interesting die work is the making of handles for milk cans, these cans being different from our own in both shape and capacity. The cans are tall, much smaller at the top than the base and are said to hold 20 imperial gal., though usually filled with about 17 gal. on account of weight in handling. The handles for these are made by the dies shown in Figs. 13 to 17.

The first operation cuts the rod, Fig. 12, which is about 3/8 in. in diameter to length as at *A*, the ends being turned down as at *B*, by the dies shown in Figs. 13 and 14.

The upper portion is shown upside down as in Fig. 13, the base being in halves as at *C*. At each end is a steel punch *D*, held by setscrews and adjusted by screws between the ends and the holder *C*.

The lower die is shown in Fig. 14, the cover plate being removed from the left side to show the rollers beneath. Three V-shaped holders *E*, set at right-angles, carry hardened-steel rollers *F*, each having a small axle. The plates hold them in place, the opening shown guiding the rods to be bent.

The ejector is connected to the plate, this being supported on four rods which are guided in the bolster and forced upward by the four springs shown. The ends are heated before bending.

The Third Operation

The third and final operation in producing the finished handle is accomplished by the dies shown in Figs. 15 to 17. The bar with bent ends is put in place as shown, the ends resting on the outer supports, which give the proper angles to the ends as related to the other bend.

The curved block *A* is forced down ahead of the ram itself, bending the rod between the rolls in the ends of the arms *B*,*B* and against the bottom block *C*, as in Fig. 16. Then the ram itself comes down and the wedges *D*,*D* begin to act on the side arms *B*,*B*, forcing them in and bending the ends over, until the handle is completed in Fig. 17. The handle itself is shown in Fig. 18.

Tool for Forming Eyes in Wires.—The tool shown in Fig. 19 was designed for forming an eye on the ends of wires in cases where the production did not warrant making forming-machine dies; the cost of bending had to be nominal and the eyes of certain required dimensions.

The tool has a base block *A*, to which is fastened with spacers a cover B. The straight wire is pushed between the pins D and E against the adjustable stop C. The two pins are driven in a gear F meshing with a segment G, provided with a handle and pivoting on J. A spring K always brings the handle back against a stop pin M in the position shown.

By turning the segment, the eye is formed and by bringing the wire against the guide H, the eye is brought on the center of the wire. This latter can then be taken off while the handle is released. With some practice, a boy can produce 400 eyes an

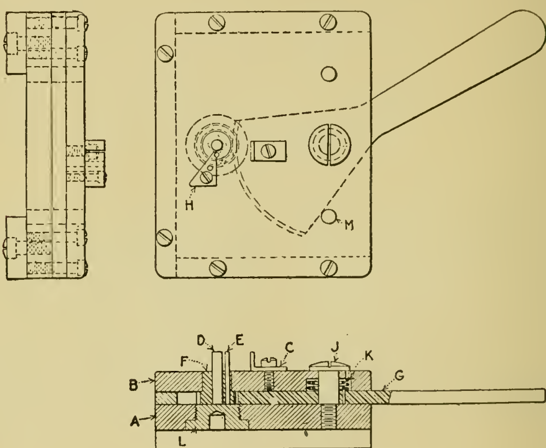


FIG. 19.—Die for bending eyes.

hour. The plug L allows gears with different sizes of pins to be easily inserted.

Ring Making in the Punch Press.—The accompanying illustrations, Figs. 20 and 21, show a pair of tools for the punch press. They produce at one blow a ring that it formerly took two blows to form, and as the second operation was done in a pair of toggle tools, the stripping from the punch was done by hand. Thus the tools shown effected a big saving.

The cycle of operations was follows: The stock, which was of soft brass 0.378 in. wide by 0.031 in. thick, was fed by the operator, through the slot A, up to the stop B. The punch in descending cut off the blank with the cutting edges C. At the instant the stock was severed the mandrel *D* bent, or raised the blank into the form of a U. The mandrel *D* was mounted in a sliding piece *E* which, as the mandrel reached the bottom of the die, recedes into the punch proper *F*, thus allowing the punch to gather the ends of the blank together and complete the rounding of the ring.

On the upward stroke of the press the ring is stripped from the mandrel by the spring-actuated stripper *G*. This is actuated, as shown by the two plates *H* which are fixed at the back of the bol-

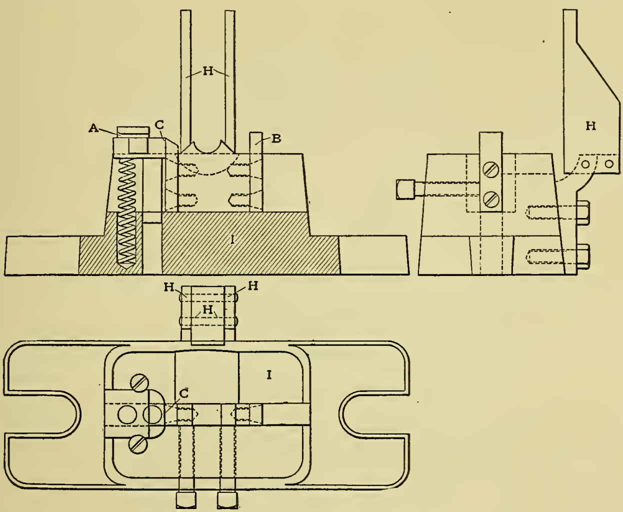


Fig. 20.—Dies for bending rings.

ster *I*. The incline of these plates engages with the horns of plate *J* and so makes the stripper travel forward on the upward stroke of the press, and backward on the downward stroke. As the rings were stripped from the mandrel they dropped into a chute which led to a pan under the press.

Inspection will show that the slot *A* through which the stock was fed, is formed in the upper part of a plunger. By this means the stock was held as in a vise during a greater part of the stroke, and could only be fed forward when the punch was on the upward stroke and the stripper was about to commence the stripping operation. This slot was the only gage or guide required besides the stop *B*, and it was this plunger which allowed the press to run continuously. The operator's only business was to feed the stock forward.

The die was made, and the cutting members as well as the stop *B*, were screwed to it, as shown, to facilitate grinding and repairs.

In like manner the punch proper, of tool steel, was screwed to the punch holder, of mild steel, and the cutting member of the punch was screwed to the punch itself.

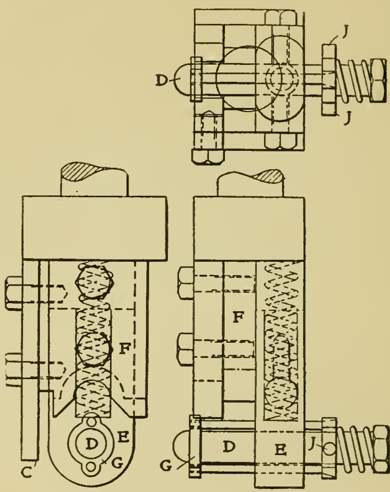


Fig. 21.—The punch and former.

An Unusual Forming Operation.—The forming of the piece in Fig. 22 was completed in two operations. The first operation was bending the four ears at right angles to the body of the part and also forming the slight radius between the ears. The second operation was forming the piece as shown, making three distinct bends; this was accomplished by using a novel method of attaching the ram to the punch holder instead of the usual method of making the side ram a part of the die; the upper right-angle bend is made by the swinging ram, using the top of the punch as a forming die.

The construction and operation of the tool is shown in Fig. 23.

The swinging ram *A* first strikes the angle block *B*; the tension of the springs *C* is sufficiently stiff to cause the ram to ride up the angle, allowing room for the work to pass it, and after forming the right-angle bends, the blocks *D* strike the hardened steel plugs *E* pushing the forming plate *F* down and keeping it in constant relation to the punch. The swinging ram is now pushed forward by the pivoted cams *E* striking the cam blocks *H*. At the end of the stroke the swinging ram is in a horizontal position, one end resting on the stop face of the angle block *A*, the other end forming the work. A knockout device was added which pushed the work from the punch.

Forming a Small Brass Clip.—The brass clip shown in Fig. 24 is formed complete in one stroke of a single-acting press by the punch and die shown in Fig. 25. As will be seen, three down-

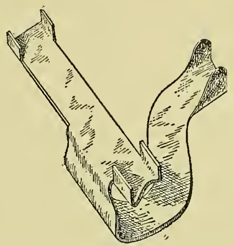


Fig. 22.—A difficult bending job.

ward bends are made and one upward. The blank is located by the pin *A* and the set edge *B*. The stud *C* is flatted, as shown in the end view and carries the locating pin *A*. The semicircular piece *D* for forming the upward bend is an easy sliding fit in the forming-die block *E*.

The punch descends, forcing the clip down over the stud *C* for the first bend. Further descent compresses the spring *H* back of the punch *J* and bends down the sides *M*. Then the projection *G* on the punch strikes the piece *D* and forms the upward bend, as shown in the end view.

Forming a Sheet-metal Roll with Hubs.—In operation No. 1 in Fig. 26 is shown one end of a formed-up sheet-metal roll with hubs formed as an integral part of the roll, and also the operations necessary for completing the piece. As this was only evolved after various forms were tried, such as solid rolls turned in the

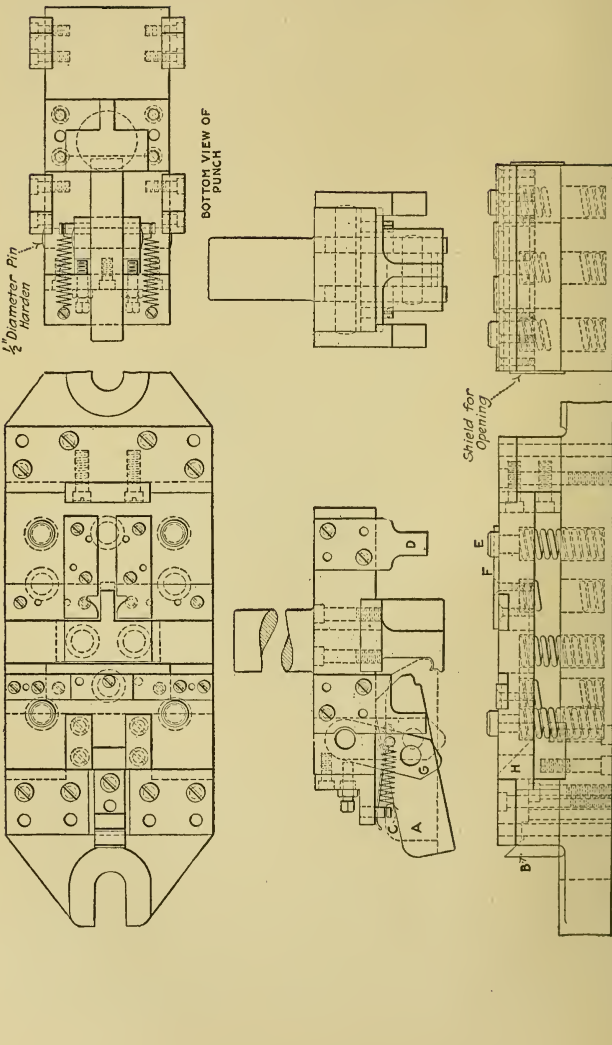


FIG. 23.—Die for bending the ears of the clip.

automatic screw machine, and rolls made by cutting off lengths of tubing into the ends of which turned steel plugs were swaged, it is quite certain that for some purposes this represents a roll which is highly satisfactory from a point of cost.

The blanking dies used are shown in Fig. 26, each length of roll having its own die. The only points worthy of note on this

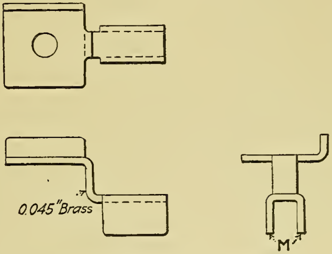


FIG. 24.—The clip to be bent.

die are the tool-steel face welded to the soft-steel base plate, and the method of holding back the spring stripper sufficiently to allow the punch to be inserted in the die freely while setting up. This is accomplished by the hooks *A*, the stripper plate being

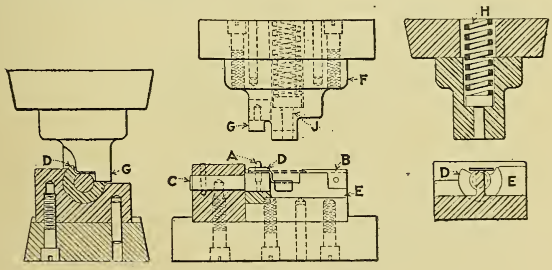


FIG. 25.—The dies used.

forced back in a vise while the hooks are inserted and pried out after the set-up is completed.

These dies for the first operation were designed with a spring stripper so that the scrap from another job, which was of irregular outline, might be used. As this scrap was not of sufficient amount, or a regular output, the die shown was also made to use a solid stripper and rear guide, with stock sheared to the proper width, the spring stripper then being removed.

In Fig. 27 is shown the die which is used for the second and

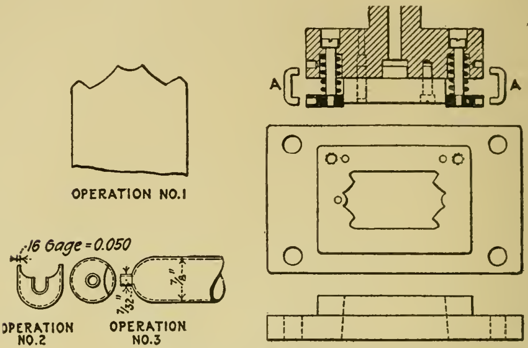
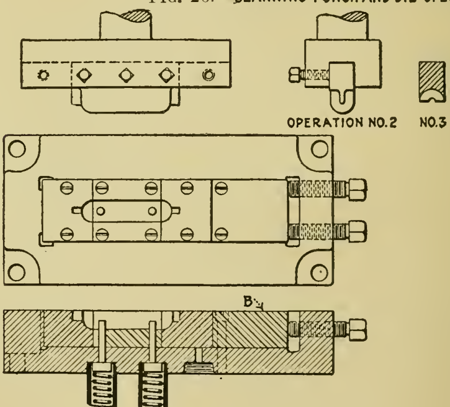


FIG. 26. BLANKING PUNCH AND DIE OPERATION



FORMING PUNCHES AND DIE OPERATION NO.2 & 3

FIG. 27.

FIGS. 26 and 27.—Forming a sheet metal roll.

third operations, with separate punches for the two operations; there are several points in this die worthy of note.

To take care of two sizes the ends and center of the die are made in sections fitting into the cast-steel die and set up solidly together by means of the end set-screws, a filler block *B* being used when the short section is in the die.

The spring strippers below are removable, as they cannot be used for the second operation of forming.

The same punch holder is used for the punches of both operations and both sizes. To facilitate setting up the die in alignment with the punch, a solid turned roll is used (not shown) for the last operation and the punch brought down upon it. For the first operation of forming, a formed blank is used to align the punch and die, as usual, and to locate the blanks the ordinary method of a plate with a hole shaped to fit the blank is employed.

It may be stated that these rollers were (and probably are) used in the shelving of a metal case for heavy, large office books,

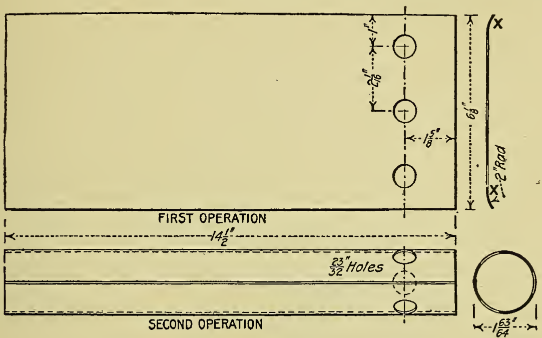


Fig. 28.—Making a tube in two operations.

to prevent the sliding and consequent wear on the books and the manual labor of shoving them in and out on closely spaced deep shelves.

Making a Steel Tube in the Power Press.—The tube illustrated is made of 16-gage hot-rolled steel and has three 23/32-in. holes in one end. When finished, it is used in a muffler for automobiles. It must, therefore, be strong enough to withstand the constant shocks and vibrations from road use as well as the compression it is subjected to by having the caps pulled up against the ends by a 3/8-in. bolt.

The holes in the tube are equally spaced and must be accurate in position to correlate properly with the other holes, and for this reason a compound blanking die and punch is used.

It will be noticed that the blank is slightly turned on both edges, as shown at *X*, Fig. 28. This is done by having a 2-in. radius ground on the blanking punch, as shown at *X*, Fig. 29. This curve gives the blank a start when curling, which is necessary where a perfectly round tube is desired. It also gives the joint the desired V-recess to receive the brass when being brazed in a later operation.

The compound blanking die and punch is very simple and strong, and under ordinary conditions will last a long time. The punch is seated in the shoe *A*. The die shoe is at *B*. The shoe *A*

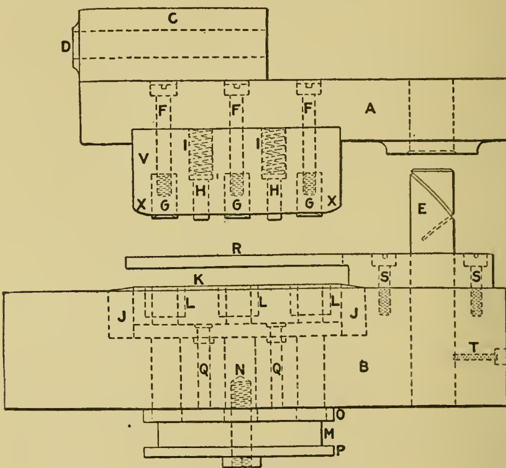


Fig. 29.—Blanking die and punch.

is made of cast steel—strength being desired with as small a size as possible. The die shoe, which is larger, is made of cast iron, not having a high unit stress.

The punch, instead of having the common stud, has a solid head *C*, with bolt holes *D* which secure it to the press ram in such a way that it cannot pull or twist and cause shear.

The end view only of the blanking die and punch is shown. The punch and die is 14½ in. long. It has been proved that a solid head *C* and the guide pins *E* on this type of press tool give them longer service and less die trouble, with the advantage of being easier and faster to set up.

The punch *V* is made of hardened tool-steel and is seated in the shoe *A*. It is held in position by nine 3/8-in. fillister-head screws *F*. Three of these screws secure the three perforating punches *G*, which are hollow-ground to prevent slugs raising out of the die by sticking to the punch. The blanking punch *V* is counterbored to seat the two stripper pins *H*, which have the springs *I* strong enough to release the work from the perforating punches *G*. These springs have the punch shoe *A* for backing.

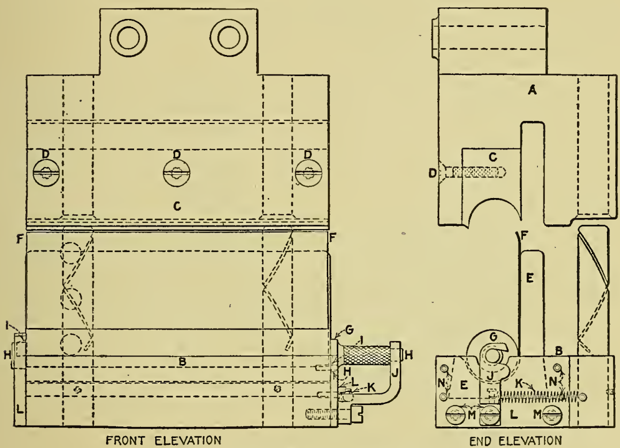


Fig. 30.—The second operation die.

The sectional die *J* is made of hardened tool steel and is seated in the shoe *B*. The pressure pad *K* in the blanking die has the three bushings *L* to correspond with the perforating punches *G*. This pressure pad has a perpendicular motion of 3/8 in., which is necessary to release the blank. The required motion is supplied by the rubber bumper *M*.

The bumper *M* is 6 × 7/8 in. and is held in position by the bolt *N* and the plates *O* and *P*. The knockout pins *Q* are hardened tool steel. The steel is stripped from the punch *V* by the stripper *R*, which is open in front to allow the quick removal of the blank. The stripper is held in place by the six fillister-head screws *S*.

The guide pins *E* are ground to force in the shoes *B* and secured by the headless screws *T*. They are hardened and have oil grooves for proper lubrication.

The second-operation die and punch is shown in Fig. 30. This die and punch must be held as securely as the blanking die and punch. It has a solid head and guide pins, with a lead *E* on the die.

The punch *C* is hardened tool steel and is set in the shoe *A*, being held in position by the screws *D*. The die *E* is hardened and set in the die shoe *B*. The blank *F*, as shown, is curled around the arbor *G*, which revolves in the bearings *H* when the punch descends. The bearings *I* are chamfered to permit the free removal of the arbor *G*.

When the blank *F* starts to curl, the arbor has a tendency to raise, and the lever *J* is used to prevent it doing so. The spring *K* serves to hold the lever *J* in position while in operation.

The plates *L* are fastened on the end of die by the screws *M* and the dowel pins *N*. They act as bearings for the arbor *G* and as gages for the tube *F*.

Die for Forming a Tube in One Operation.—This die consists of the bedplate *A* suitable for the press at hand; the die *B*, the mandrel *C*, the punch *P* and the cast-iron punch holder *E*.

Fig. 31 shows the punch up with the blank dropped in, and the mandrel in position. The weight of the mandrel has a tendency to crowd the blank over against the punch and allow the mandrel to start in the die. If the blanks are placed in the die with the burr in toward the mandrel there is no tendency to buckle back.

Fig. 32 shows the die in the closed position and needs no further explanation. Figs. 33 and 34 show the style of tube which has been made by the hundred thousands in this die. The little ears that lock it together pass in the grooves in the die shown by the dotted lines in Fig. 32. The blanks are dropped in the die with the ears down and formed as a plain tube would be, except that the ears are left out at the first stroke as shown by the dotted lines in Fig. 33, after which the mandrel is turned with the tube until the ears are standing up and struck another blow, which closes the ears in position.

This die will form a tube ⅛ in. thick or less and there seems to be no reason why it would not operate with any gage. Tubes 8 and 10 in. long, of XX tin 1/16 and 1/8 in. in diameter inside measurement, have been made in this die.

The open front is very convenient for feeding blanks and a fork can be used at one side of the die to pull the tubes off the mandrel. It is more convenient to lift the tubes out of the die with the mandrel, pulling them off outside, than to remove the mandrel while the tube is in the die.

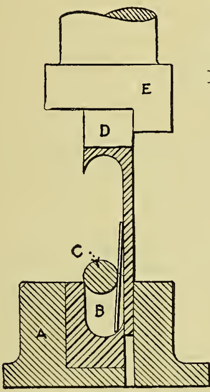


FIG. 33.

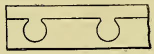


FIG. 34.

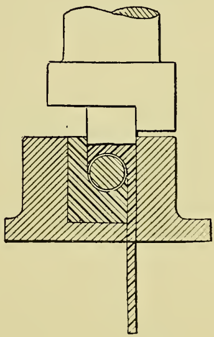


FIG. 31. FIG. 32.

FIGS. 31 to 34.—Dies for forming a tube.

Punch and Die for Small Tubes.—The die shown in Fig. 35 has given excellent results in piercing rows of holes in a small tube. The details are self-explanatory. The die nest should be adjustable to take the strain off the die and be lowered after piercing each row of holes in order to easily index the tube.

Wiring Pieced Sheet-metal Buckets.—It is customary to do this operation on what is called an open-face or horning press, equipped with a knee and table slide. When using this, the operator is compelled to push a heavy die, fastened to this slide, under the punch, which, after wiring, has to be pulled out again to remove the wired body and insert another. As these operations are repeated constantly all day long the operator is apt to be played out, when the day is done, by this hard and heavy work.

To increase the output without fatiguing the operator the arrangement here outlined was designed and built. The principal mechanical feature involved is the use of the Geneva stop for the intermittent action of the large table on which the dies were placed.

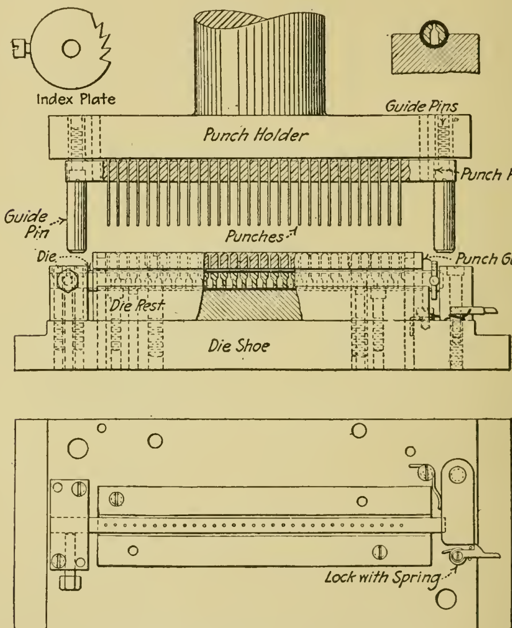


FIG. 35.—Punch holes in small tubes.

The horning press above referred to forms the nucleus of the whole proposition. The outfit is shown both in detail and assembled. The changes made are shown without any attempt to portray the exact appearance of the slide of the press itself, which is standard and has a 3-in. throw of crank to allow the table to swing in and out as the punch descends and rises.

The press is mounted on a special base *A*, Fig. 36, also shown in

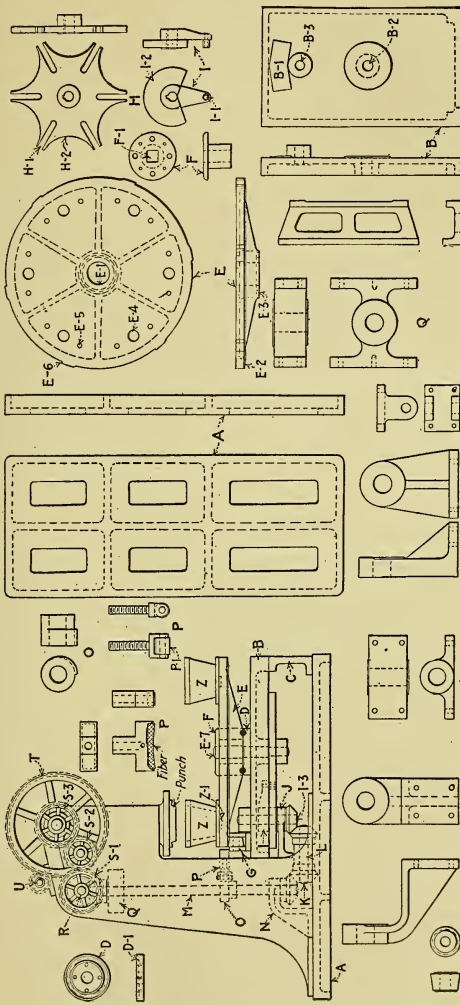


FIG. 36.—Machine equipped for wiring sheet metal buckets.

the detail drawing. The table support *B* is fastened to the face of the press and secured to and supported by the outside leg *C*, which in turn is fastened to the base *A*. On the top of *B* is the round disk *D*, which has a ball-race for 1-in. balls, enabling the large circular table *E* to turn readily. The disk *D* is fastened to the supporting table *B* from below by capscrews.

The table *E* is machined as shown in the detail and has a large hole through the center at *E*-1, into which is inserted the large bushing *F*, which is fastened to the table *E* by capscrews and dowel pins. The bushing *F* has a square shaft hole *F*-1 in the center. The table *E* is further provided with an extreme outside riding edge on the under side, *E*-2. In addition it has the ball-race *E*-3, which matches the ball-race *D*-1 in the disk *D*. It is supported nearest the press face and dirctly under the slide of the press and takes the pressure when the punch is curling the metal around the wire. Two brackets *G* with a taper roller *G*-1 support the table *E*. The brackets *G* are fastened to the patches *B*-1 on the top side of the table support *B*.

The Dies

As six dies *Z* are used, there are the same number of holes in the face of this table *E*, marked *E*-4. They are equally spaced and correctly located to bring each die in position. All the bases of the dies have a boss *Z*-1, which fits in *Z*. The six dies are each bolted to the table by two capscrews. Around the outside rim of the table *E* are six projections *E*-6 used, as will be explained later, to regulate the swing of the table.

The shaft in connection with this has a square end as at *E*-7, which fits closely into the large bushing *F* and is held in position by a large flanged screw at the top end. This shaft *E*-7 revolves in a long bearing *B*-2 in the table support *B*, and on the bottom end is attached the Geneva stop wheel *H*, which is a steel casting machined with six slots *H*-1 and six arcs *H*-2 to connect with the pin wheel *I*, which is also a steel casting. The Geneva stop wheel is secured to the shaft *E*-7 by a key and taper dowel pin.

The pin wheel *I* is machined and has a roller as at *I*-1 that slides in the slot *H*-1 of the Geneva wheel, and has the outside turned to the arcs *I*-2, so that when in position it will just turn in the arcs *H*-2 and form a positive centralizing stop for the large revolving table *E*. This pin wheel *I* is attached to the shaft *I*-3 by both key and taper dowel pin, and has a long bearing *B*-3 in the table support. It is further supported by the bracket *J*, which is fastened to the face of the press and is also detailed.

At the lower end of this shaft *I*-3 is attached a steel miter gear, which is the first of a series, and meshes with a similar gear on the horizonal shaft *K*, which runs in a long bearing *L* fastened to the base *A*. At the other end of this shaft *K* is another miter gear, which in turn meshes with a gear attached to the vertical shaft *M*, which is held in position and runs in the bearing *N*, also fastened to the base *A*. On this shaft *M* is attached the brake cam *O*. This actuates the fiber-faced brake attachment *P*, which comes into contact with the outside periphery of the large table *E*. Two spiral springs hold this brake attachment and the roller *P*-1 against the cam *O*.

The shaft *M* has an upper bearing *Q* (also shown in detail) fastened to the inside of the walls of the press. On the end of this shaft is another steel miter gear, which in turn meshes with the miter gear fastened on the shaft *R*. This has its bearings in the machine proper, and projects through on the left-hand side of the machine far enough to attach the large spur gear *S*-1, which is meshed with the idler gear *S*-2 and in turn with the spur gear *S*-3, which is the same size as *S*-1 and is directly attached to the crankshaft of the press itself. The original flywheel of the press itself has been converted into a large spur gear *T* as shown, and is connected to the main shaft *U* of the machine. This main shaft runs in bearings at the top and has a small pinion mounted on it. It extends beyond the rim of the large gear *T* and is equipped with a tight-and-loose pulley, not shown.

The Operation

The action is as follows: The main shaft *U* gives momentum to the large gear *T* and turns it at the rate of 18 r.p.m. When the clutch is released, this large gear *T* carries the crankshaft of the press with it, and as the large spur gear *S*-3 is attached to this, the movement is carried right through the chain of gears. As the last gear is attached to the shaft of the pin wheel *I*, it is revolved and the roller enters the slot in the Geneva stop. This is directly attached to the shaft of the revolving table, and swings the wheel and table a sixth of a turn and puts the next die in position. To overcome the great inertia of the heavy table with its six large dies *F*, the six projecting lugs *E*-6 on the outside rim come in gentle contact with the brake control. The cam of this in operating pushes the shoe forward, causing it to exert a slight but constantly increasing friction to overcome the swing of table.

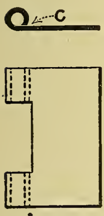
When the table is almost in position the pressure is suddenly released, and the table is gently and without jar brought up against the edge of the brake shoe. The ram of the press has been descending all this time, and shortly after the table has become stationary the punch goes through its functions of wiring. As it lifts and clears the top of the die the action is repeated, and as the treadle of the press is locked the machine keeps on working constantly.

Two boys are required to operate the machine, one to take out the finished bucket and drop in the new one to be wired, and the other to place the wire in position.

This machine has proved successful in every way. The output of the two operators has been increased from 2400 buckets, by the old method, to from 9000 to 10,000 buckets a day by the new without any hard physical labor.

About Curling Tools.—Tools used for curling work, under the press, have a variety of forms, the simplest type, those for curling hinges, being, generally speaking, the least satisfactory. Take for instance a tool for curling the hinge shown in Fig. 37. The usual type of tool described in text-books for doing this kind of work is shown in Fig. 38 and is simply a block having a hole *A* drilled in it, and with a slot *B* shaped through to admit the hinge blank. The drawing of the hinge, which is shown with the tool, will most likely show the curl nicely tucked in as at *C*, Fig. 37.

However, the usual method of using such a tool, that is, by placing a blank in the tool and bringing the press down on it, will not give a curl as shown. The result will be as at *D*, Fig. 39, where it will be seen that the leading part of the curl has refused to curl. The reason for this will be clear if we consider the enlarged section shown in Fig. 40. In this class of work the stock is never very flat and to get the blanks in and out of the tool easily it is usual to have the stock slack in the slot. The consequence of this is that when the blow comes, the blank is leaning over slightly and the piece takes its first bend from the point where it touches, as at *H*, Fig. 40. Having started to bend here, the leading portion will have nothing to cause it to bend afterward unless, of course, it is being formed round a pin. A simple way of preventing this, and one that will assure a curl that is closely tucked in, is to have the hinge blanking tool ground off at the corner so as to give a reverse shear at this point. That is, there will be an initial bend at this point.



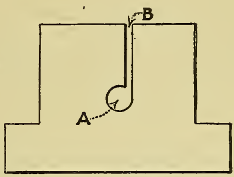


Fig. 39.

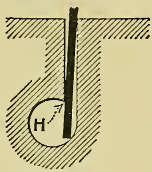


Fig. 37. Fig. 38. Fig. 40.

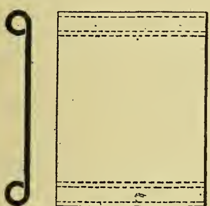


Fig. 41.

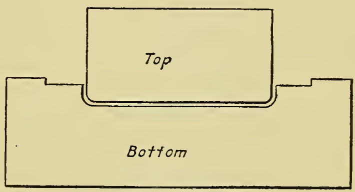
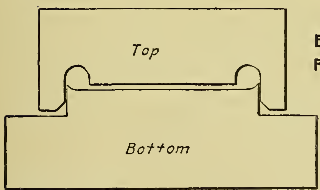


Fig. 42.



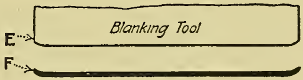


Fig. 44.

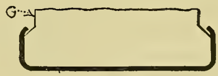


Fig. 43. Fig. 45.

Figs. 37 to 45.—Details of curling tools.

A specific case which happened some years ago will serve to illustrate this point. Designs came down into the shop for tools to curl the hinge shown in Fig. 41. The tools as designed are shown in elevation in Figs. 42 and 43. The idea was to place the blank on Fig. 42, bend it and then complete the curl with the tool shown closed in Fig. 43. This pair of tools made a very poor curl and it was decided to put in another tool to give an initial bend to the end. Instead of this, however, the blanking tool had the ends ground off as shown at *E*, Fig. 44, with the result that the blank when punched was as shown at *F*.

The top tool of Fig. 42 was then cut away as at *G*, Fig. 45, and the first bending operation left the piece as shown. From this tool it was removed by sliding off, and the tool shown in Fig. 43 then made a completely satisfactory curl of the hinge.

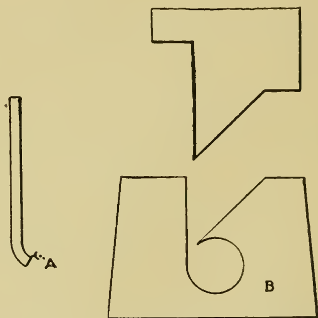


Fig. 46.—A point in curling metal.

A point in roll hinge making which may also be used in other curling operations is to start with the blank as shown at *A*, Fig. 46. Then a die similar to *B* will roll the edge without the use of a wire inside to keep it round. This obviates the necessity of removing the wire which often binds.

An Adjustable Curling Chuck.—The tendency of packers who put up staple articles in tins is to have the top end of the can body curled or beaded inwardly, so that the user will not run any danger of injury on a sharp, rough edge.

The device shown in Fig. 47 is an adjustable beader or flanger for round-can bodies, either pieced or seamless, straight or taper, and is so arranged that all sizes of cans within its capacity can be made, either beaded or flanged, internally or externally as desired.

Should the pieced bodies be formed too large or too small, they can be corrected in the rolling operation so that the cover will fit.

At *a* is the normal pieced can body, the top curled inwardly and walls straight so that the cover may be slipped on easily.

At *b* is another style where the head is curled outwardly and the cover fits inside: this is used on coffee and tea pots, etc.

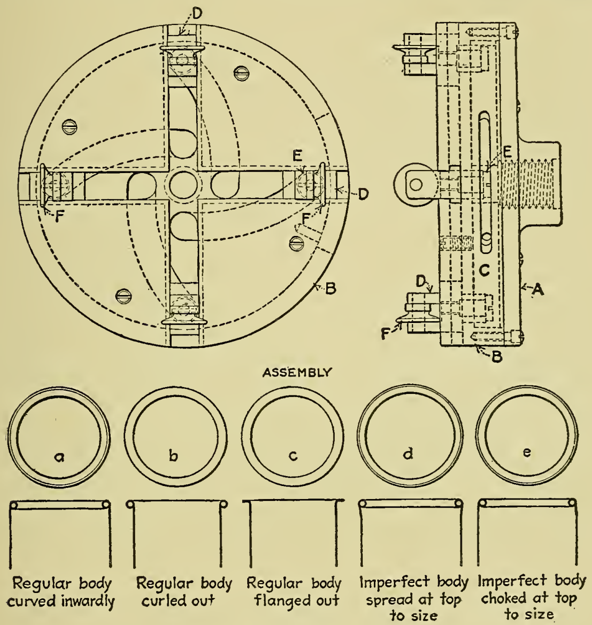


FIG. 47.—An adjustable curling chuck.

At *c* is a can body flanged outwardly ready to have the bottom double-seamed.

At *d* is shown how the body has been made too small and in curling is opened out to the proper size so that the cover will fit.

At *e* is shown the reverse, in that the body is made too large and is choked in and brought to size.

An adjustable device for this purpose therefore has its advantages, as it can be made to accommodate itself to all conditions of previous operations and corrects work that would otherwise be defective.

The device is usually screwed on the spindle of a lathe or double seamer and can be operated in either a vertical or horizontal position. It is shown assembled with the rollers spread to the largest size it will curl. The back or spindle plate *A* is cast iron, machined all over and has a thread to fit the spindle nose. It has a shoulder on the face which fits the top plate *B*; several fillister-head screws secure this to the top plate *B*.

The top plate *B* is also cast iron, machined all over and recessed to fit the spindle plate *A*. On the face are T-slots cutting it into quarters. In these the roller brackets *D* slide. In the bottoms of these are clearance slots for the bracket studs and rollers *E*. On the outside rim is an adjusting slot through which the cam disk *C* is actuated. Headless setscrews hold this cam disk *C* from shifting when set and in operation.

The cam disk *C* is made of machinery steel finished all over. The outside fits the recess in *B*. It is just thick enough to turn freely when the spindle plate *A* and the top plate *B* are fastened together. There are four curved milled cam slots. These are used in connection with the studs and rollers *E* which actuate the curling-roller brackets *D*. On the rim are two holes for the adjusting pin which moves the disk back and forth to locate to the proper diameter the rollers held in the brackets *D*.

There are four roller brackets *D* made of machinery steel and machined to fit the T-slot in *B*. The bottom is drilled and tapped for the stud *E*. The projecting lug is slotted for the curling rollers and is drilled for the roller pin. There are also four steel studs and rollers *E*. The roller only is hardened and ground.

The curling and flanging rollers *F* are made of tool steel and hardened. They are so arranged that both internal and external curling of a beading can be done. The inside wall is curved and allows the roller, when used for external curling or flanging, to clear itself and not cut into the inside wall of the can body.

The assembly shows the rollers set for inside beading. If an outside bead is required, the rollers are turned and adjusted to the proper diameter of the can body. This same rule applies to the flanging operation, either inside or outside.

In connection with the curling chuck which is constantly revolving when in operation, a stationary tailstock plate or treadle disk is used. The face of this is arranged in a series of steps to fit the various sizes of cans and centers them for the revolving rollers. The can body itself does not revolve.

A modification of the above device is adopted for wiring such articles as garbage pails, ash cans and buckets of every description.

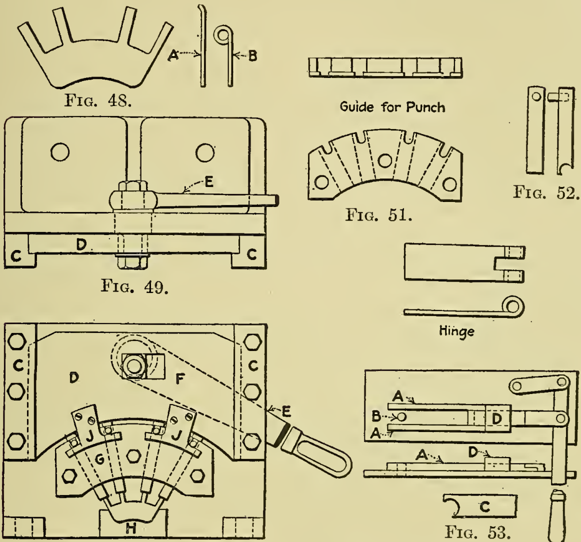


Fig. 48. Fig. 49. Fig. 50. Fig. 51. Fig. 52. Fig. 53.

Figs. 48 to 53.—Several curling tools.

More Curling Tools.—The steel stamping shown in Fig. 48 has four prongs, which require to be curled round as shown at *B*; all four are curled at the same stroke of the machine, one which has been used in our shop for several years. In blanking out, the stamping is given just a slight bend at the end of the prongs, as shown at *A*, Fig. 48, to give the curling tools a start. The tool is shown in plan and elevation in Figs. 49 and 50, respectively. The main part is an angle plate bolted to a convenient stand, not shown, which has two strips *C,C* attached to the front, in which slides the plate *D*.

This plate is raised and lowered in the guides by means of the lever *E*, which is attached to the eccentric pin working in the slot *F* cut in the plate *D*. Underneath the slide *D* a guide for the four punches *G* is bolted to the angle plate. The punch guide is slotted to receive the punches, so that they line in the same plane as the prongs of the stamping to be curled. The guide is shown in Fig. 51. It will be noticed that the slots do not come right through the plate, so that the punches are kept back against the angle plate. Each of the punches has a pin fixed in it as shown in Fig. 52. This pin works up and down in the slot shown in Fig. 51, and serves to lift the punches up when the lever is raised, which is accomplished by the two small plates *J* fastened to the plate *D* in Fig. 49 catching against the pins. The stamping is held in the cradle *H* against the angle plate. To work the machine, the stamping is simply placed in the cradle with plenty of grease and the lever is pressed down, thereby forcing the punches down in the grooves and the punches curl the ends of the prongs over. When the lever is raised, the punches rise also and the stamping is released by the punches.

A Hinge Tool

Another tool for making a hinge is shown in Fig. 53. This tool is used at the blacksmith's fire for making a hinge out of $1\frac{1}{2} \times \frac{1}{2}$-in. iron. The blank is given an initial slight bend as before and is then heated to nearly a white heat and placed between the guides *A*,*A* against the stop *B*. The tool is then forced down by the hand lever and curls the plate easily. When the lever is returned to its original position it knocks the hinge out automatically by rolling it over on the curled part in the tool.

An enlarged view of the end of the tool is shown at *C* and a plate is fixed across the guides *A*,*A* as at *D* to prevent the tool from rising up.

If a plate is required to be curled at both ends, this can easily be done by having two levers, similar to the one shown, working at either end, or it would probably work if one of the tools were fixed to the plate and the part to be curled forced against it by the sliding tool at the other end, thus making two bends in one operation.

Seaming Die.—The details of Fig. 54 show two dies for forming and locking an inside seam on small cans, buckets or other round or oval tin bodies.

The seam of the shell is formed at about 35 degrees to the left of the center of the die and is closed on the die shown in front elevation. They are similar to horning dies.

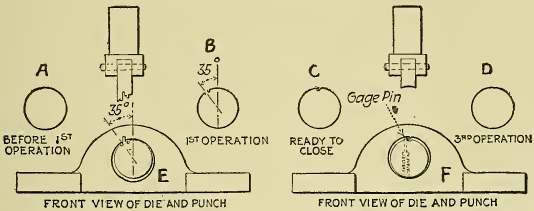


Fig. 54.—Forming and locking seams.

The size of the die and the press depends upon the size of the work. The dies shown were built for a bench press with open front. The shell before the seam is formed is shown in *A*. In *B* it is shown with the seam formed. *C* shows shell ready to be closed and *D* shows it closed. It will be noticed that as the seamed shell is formed off center, when put on center the tendency is to close it in the right direction.

CHAPTER II

PUNCHING, SHEARING AND BLANKING

While it is difficult to keep all punches and dies in separate fields owing to the combinations which are often found in one operation, it is thought best to classify them to some extent at least. This will, it is hoped, make it more convenient to find the desired information without reference to the index.

Punching Holes in Block Links of Bicycle Chains.—This proved a most troublesome job to get started, but was successfully worked out as shown. The fixture was to punch the holes in the center blocks of bicycle-chain links.

The most important problem was to make the punches hold up. The chain blocks were $\frac{3}{16}$ in. thick and the holes only 0.161 in. diameter, so the punches were considerably smaller in diameter than the thickness of the metal to be punched. The press was running 210 r.p.m. and the proprietor would not consent to a reduction of speed. Owing to the small size of the punches it was feared they would not hold up; but to make sure of this, a temporary punch, die and stripper were made, the chain blocks laid on the die and punched.

The punches held up better than expected, but the chain blocks were mashed and spread. The next move was to make a tool-steel plate $\frac{3}{16}$ in. thick with a hole in the center just the shape and size of the chain block, in which the chain block was a snug driving fit. Guides were made and a stripper on the die to locate and hold the plate. A block was driven in the plate and punched; driving in the next block drove the punched block out. The operation was slow, but quite a number were punched in this manner, showing that the punches would cause very little trouble from breaking, but would have to be ground quite frequently. The pitch and size of the holes were maintained much better in this manner than by drilling. It did not require a stripper over the blocks but only over the plate, as there was considerably more friction between the blocks and the plate than between the blocks and the punches.

At this point an interesting and unexpected feature of the job turned up. It was intended to ream the holes after they were punched, but when this was tried it was found necessary to anneal them. The holes had a smooth burnished surface that was so hard that a reamer would only stand up for two or three blocks. Whether this was due to the thickness of the metal in proportion to the size of the hole, or to the metal being so closely confined, or to the speed of the machine, no one seemed to know. This difficulty was obviated by not reaming the holes at all, as it was found that by making the holes in the die only about 0.001 in. larger than the punches there would be no breaking out of the metal in the punched holes, and the holes were so smooth that they could not be improved by the reamer. It was also found that the punches, too, became dull quicker than they would

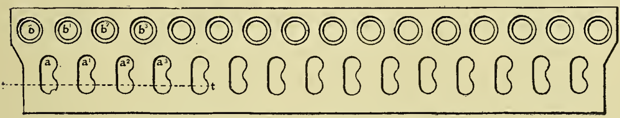


Fig. 55.—Plate for holding blocks being punched.

have done if more clearance had been allowed between the punch and die.

This gave sufficient experience to enable us to make a practical fixture for punching these blocks, which was done in the following manner: Fig. 55 shows the jig or plate for holding the blocks while they were being punched. It was made 3/8 in. thick, or twice the thickness of the blocks; this was done so that the holes a, a^1, a^2, etc., could be made a snug driving fit for the blocks in the lower half of the hole, while the upper half was made larger so the blocks could be dropped into them easily. It was quite easy to fill this jig by dropping a block in each hole, and they would rest with their top sides about on a level with the upper surface of the jig, as shown at *a*, Fig. 56.

The holes b, b^1, b^2, etc., are pilot holes 3/8 in. diameter countersunk at the top. Fig. 56 is a cross-section on the line *t,t* of Fig. 55 and shows the punches, punch-holder, jig and die. *A*, Fig. 56, is the punch-holder proper, *B* is a square block into which the punches *C* are driven—only one punch is shown, the other is directly behind it; this block fits closely in the recess made for it in the holder *A* and is held in place by a clamp and two screws in the holes *H* and H^1.

It was necessary to make this block, because the punches needed grinding so often; the block could be taken out, the punches ground and the block put back without resetting the die. Two or three of these blocks were finally made for each machine and the blocks changed when the punches needed grinding. *G* and G^1 are the pilots; two pilots were used because it was necessary to locate the jig very close, in order to always punch the

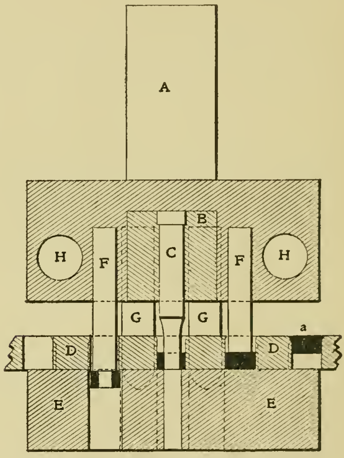


FIG. 56.—Punch and die for chain blocks.

holes in the center of the blocks. *F* and F^1 might be called pushers, because their purpose was to push the blocks in and out of the jig. The stripper is not shown; it was fastened to the bolster plate and only extended over the edge of the jigs. *D* is the jig and *E* the die.

In using this fixture three jigs were made for each press and three persons assigned to each press—two filling the jigs and one operating the press. After a jig was filled the operator would run it through the press as if it were a strip of steel he was punching. At the first stroke the pusher *F* would push the first block from the loose to the tight part of the jig. At the second stroke

C would punch the first block and F would push the second one in. At the third stroke F^1 would push the first block out of the jig into a box below, while C and F were working on two other blocks. After this a block would drop in the box at each stroke, so it took seventeen strokes for fifteen blocks. After the operator ran the machine a few days he punched blocks so fast that the punches got very hot and would not stand up for more than 15 minutes at a time. A cold blast of air was tried on the punches, but it did no good, so the speed of the machine had to be reduced to 160 r.p.m. This did very well, and the punches would quite

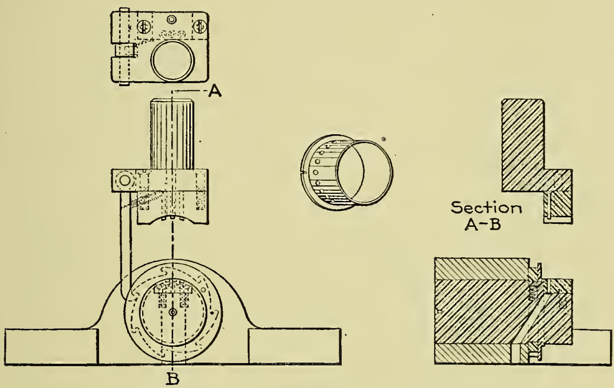


Fig. 57. Fig. 58

Figs. 57 and 58.—Dies for perforating shells.

often hold up for five hours. It would probably have been better to reduce the speed still more. The results obtained from these dies were so satisfactory that six specially built automatic drilling machines were discarded.

Perforating Die for Round Shells.—In Figs. 57 and 58 is shown a die for perforating round shells. Attention is called to the manner in which the punchings pass from the die. The punchings follow the opening indicated in the section as open and drop down through the bottom of the press. The shell after being perforated is shown in the center.

The shells were formerly perforated in a die which allowed the punchings to drop into the shell, but this was bothered by the small punchings sticking to the shell, owing to the shell and punchings being oily from the oil used in drawing. After giving the new method a trial, it was found advisable to arrange all similar perforating dies in this way.

A Piercing, Blanking and Forming Die.—Fig. 59 shows a bath-tub overflow strainer, and Fig. 60 a plan of the die minus the stripper plate for making it. Fig. 61 is a cross-section of the punch and die.

The die block *A* was a piece of Sanderson annealed tool steel, $1\frac{1}{4} \times 4\frac{1}{2} \times 8$ in. This block was planed to fit the bolster *B* and then laid out as shown in Fig. 60. The slotted part of the die was roughed out by drilling a series of holes within the lines laid out. This was done by strapping the blank on a faceplate of a dividing head and drilling it by indexing around for twelve divisions. The large hole and the clearance hole under the piercing dies were then bored in the lathe.

After this roughing-out process the blank was heated to 1600°F. and then packed in lime until cool. This annealing was done to relieve any strains in the die block. If this practice were followed more in the making of expensive tools, there would be fewer cracks in hardening and less distortion. After annealing, the blank was ground on top and bottom, and bridges left from drilling removed and the holes filed to gage. The holes for fastening the gage and stripper plates were then drilled and tapped. The die was now ready for hardening.

This was a task requiring great care and judgment on account of the great variation in the thickness of metal. The die was heated in a gas muffle to 1725°F., and then quenched in cotton-seed oil. After cooling it was put into an oil tempering furnace and heated to 500°F. and then allowed to cool. The blank was then ground on both sides and the large hole ground to size.

The next operation was making the punch-holder plate *C*. This was done by clamping the holder against the face of the die and the small holes transferred. The round hole in the center of the piercing die was drilled and reamed through, using the die as a jig. After drilling this hole a plug was fitted in it to keep the parts from shifting. The two parts were now strapped to the faceplate of a lathe, the large hole trued up with an indicator and the hole for the blanking and forming punch *D* bored. The parts are then separated and the slots for the piercing punches *E* worked out.

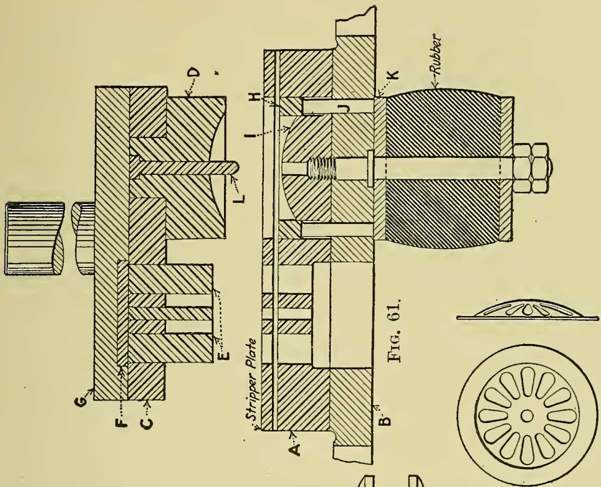


Fig. 61.

Fig. 59.

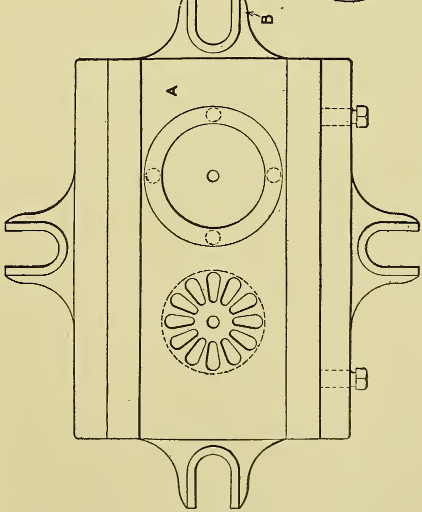


Fig. 60.

Figs. 59 to 61.—Tools for a bathtub strainer.

This method of finishing the punch-holder after the die was hardened was to overcome the inaccuracy of the center distances, due to the possible shrinkage of the die in hardening.

The twelve oval punches were made between centers on the milling machine. The stock was cut off long enough to allow for a driving dog and the cutting off of the center in the end of the punch. The flat sides of the punches were milled with a spiral cutter, the head being indexed around to the proper angle. The rounded sides were milled with half-round formed cutters. In this manner the punches were easily duplicated. The piercing and blanking punches were hardened on one end only, the other being left to allow for riveting on the back side of the punch plate. A round, hardened-steel plate *F* was fitted into the punch-holder shank *G* to back up the piercing punches.

The blanking and forming part of this die can easily be understood from the drawing. A pressure ring *H* was fitted into the die and over the forming head *I*. This ring is supported by four hard pins *J*, bearing on the spring plate *K*. The pressure ring serves two purposes—that of holding the blank while forming and ejecting it when the punch returns. The pilot *L* served to locate the blank in the center.

This has proved a very successful tool and is used on a No. 21 Bliss single-acting blanking press.

An Adjustable Cropping and Piercing Die.—In a factory whose product was principally press work, it was necessary to produce a large quantity of metal strips, cropped and pierced in various lengths and settings; the average number per setting was about 5000 pieces.

The usual method adopted was to crop to length in a power press, and pierce to pattern by means of locating jigs, in a hand press. This method, it will be seen, entailed considerable handling and shop room and as the material used was of light gage, varying from $\frac{3}{8} \times \frac{1}{8}$ in. to $1 \times \frac{3}{16}$ in., and from 7 in. to 28 in. long, it was decided to experiment on the adjustable cropping and piercing die here described, capable of performing the whole work in one operation. The eventual result was a steady output of finished strips at the rate of 700–800 per hour at an average of one-tenth the previous cost.

A special feature is the construction of the punches and dies, which effect a considerable saving in money and time.

The general arrangement of this adjustable die is as follows: The top tool *A*, Fig. 62, is of mild steel 2¾ × 2¾ × 30 in., having six 1-in. tapped holder holes 1¼ in. deep drilled at intervals of 2 in. from the center to the right-hand side. This allows adjustment to obviate undue side stress on the plunger of the press, owing to the cropping operation, which is the heaviest, having to be performed at the extreme end of the right side of *A*. A good rule to follow is to mount the top tool holder in the hole nearest to one-third the length of the strip to be operated upon; thus for the strip *K*, Fig. 63, the holder would be mounted in the hole nearest to 7 in. from the cropping die, which is actually the third from the end.

Owing to the extreme variance in the recesses of press slides, it is useless to suggest any particular size for the holder, but it is advisable to have the flange at least 2½ in. diameter to relieve the side strain falling on the thread. An important point is the provision of the holes *M*, Fig. 62, for the tie rods *N*, which are bolted in turn at the highest point possible on the slide of the press and relieve the inclination to spring at the moment of compression.

The female dovetail *B*, Fig. 62, should be accurately machined, and twenty-nine ⅜-in. tapped holes are drilled equidistant from end to end and used as necessary in holding the punches, by means of square-head setscrews.

The Bottom Tool and Stripper

The bottom tool *D* and the stripper *E* are illustrated in Fig. 63. The first is a casting and the second a strip of 2¾ × ⅜-in. black mild steel. A female dovetail is cut to within 2½ in. of the cropping end and here a square depression 1½ × 1½ × ¾ in. deep is provided for receiving the cropping die and a hole sufficiently large to allow the scrap to fall is continued through. This is 1⅛ × 1⅛ in. in this case and is rough cored.

Central to and running the whole length of the dovetail *C* is the channel marked by dotted lines *G*, which terminate at the base in five holes marked *H* on the plan. This arrangement allows a fall for the punchings and, as there is little side pressure, does not detract from the strength of the casting *D*, which is fastened to the bed of the press by dogs bearing on the wings *J*. As in the case of the top tool the dovetail should be nicely

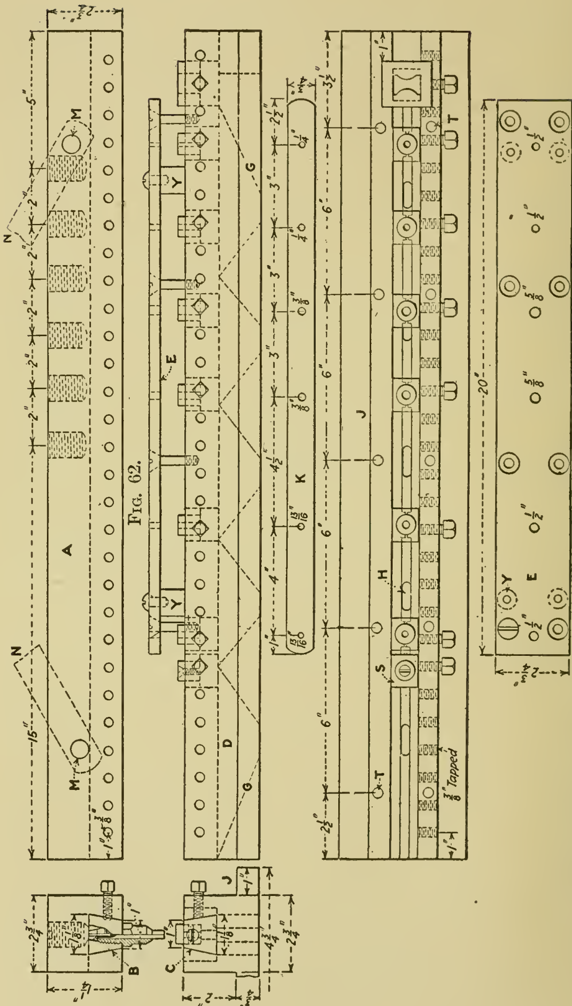


Fig. 62.

Fig. 63.

Figs 62 and 63.—Cropping and piercing dies for different sizes.

machined and the face and the base planed. Ten holes should be drilled at points marked *T* for holding the various strippers and 3/8-in. tapped holes should be drilled in the side, 1 in. apart, as shown. The stripper *E* explains itself and is drilled as required. In this case four distance pieces are fastened permanently at *Y* and locate the strip shown finished at *K*.

The Punch.—Fig. 62 illustrates the punch and die construction, the former being in three distinct parts, namely, the punch holder, the punch sleeve and the punch. The holder should be case-hardened and nicely fitted to the dovetail *B*, and as many should be provided as may appear necessary, having regard to the number of holes to be pierced at one setting. A 9/16-in. tapped hole is drilled half way through the center and taper reamed from 1/2 to 7/16 in. completely through. The sleeve is of mild steel, and in this illustration is dimensioned for a 1/4-in. punch. The thread and taper are, however, standard for interchanging. A three-way slit is cut at the taper end and the taper is so proportioned that when the sleeve is tightened completely, it forms a strong grip on the punch.

The punches are merely pieces of drill rod cut off, ground to the length required and kept in stock. This material has been known to punch over 55,000 holes without fracture.

The Die

The die also has three parts, the die holder, the die and the setscrews. The holder is of mild steel to fit the dovetail and has a recess in the center 3/4 in. in diameter by 5/16 in. deep for the die, with a hole completely through for the scrap to fall through. The die is of tool steel hardened and tempered and a groove is turned to take the point of the setscrews. A good fit in the die is essential and therefore it is advisable to grind to the correct diameter after hardening and tempering. An extra die holder may be tapped in the center and fitted with a fillister head screw, thus forming a stop, as illustrated at *S* on the plan, Fig. 63.

This tool is used on a Bliss-Stiles No. 4 press and in adapting the idea for general use, the following points should be observed:

Determine the thickness of the bolster so that when piercing, the slide of the press is as high as the screw adjustment will allow.

Fix the apex of the triangle formed by the tie rods *N*, Fig. 62, as high on the slide as possible. See that the slide is free from side play and thus obviate broken punches.

Punch Press Shearing Operation.—An order for several thousand of the pieces shown in Fig. 64, was made from soft steel 0.020 in. thick drawn up into shells, in two operations, in the usual manner. The difficult proposition was to cut off one side and part of the end, the cut having to be in a slanting direction, leaving the edge at the end a part of a circle with a 1¼-in. radius.

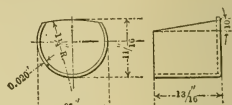


Fig. 64.

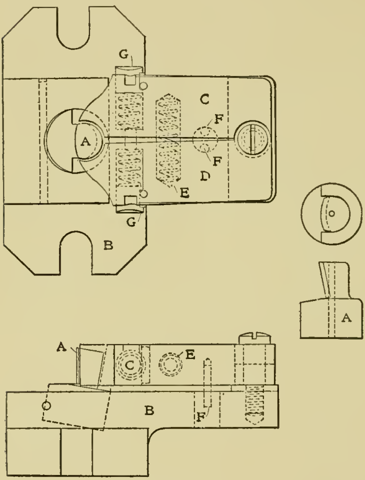


Fig. 65.

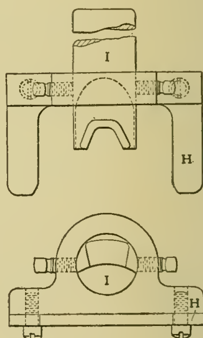


Fig. 66.

Figs. 64 to 66.—A punch press shear.

The tools illustrated in Figs. 65 and 66 accomplished the operation successfully.

The lower shear *A*, Fig. 65, which has a hole through it to facilitate the removal of the shell after the operation has been performed, is so mounted in the shoe *B* that its shearing face stands perpendicularly. The clamps *C* and *D* are pivoted on the extension of the shoe, as shown, and are kept open by means of the spring *E*, to allow the shell to be placed on the shear post *A*. Two pins *F*,*F* in the clamps extend into the hole drilled in the shoe limiting the amount of opening. The spring buffers *G*,*G* are arranged to engage with the inner faces of the yoke plate *H*, which is secured to the upper shear *I*, Fig. 66, and serve to securely clamp the shell to be cut, and support it right up to the shearing edges of the post *A*.

Objections to be pointed out are: First, the difficulty of setting the tool up in the press, which might be overcome by arranging guide posts and thus making it into a sort of subpress fixture. Second, the fact that when shearing post *A* needs grinding it must be thrown away and replaced with a new one, as it cannot be ground without losing its necessary dimensions.

Punch and Die for Two Sizes of Wrenches.—The engraving, Fig. 67, shows a punch and die for making wrenches. In this

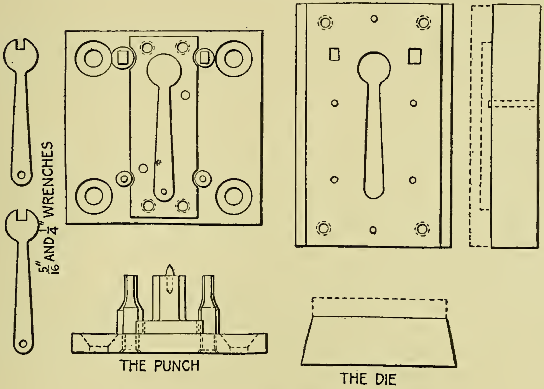


Fig. 67.—Two wrenches from one die.

die the punches are so arranged that by running the stock through either way a different size wrench is blanked out. The size of the body remains the same, but the square is changed. In blanking a 5⁄16-in. wrench the stock (10-gage sheet steel) is fed through from the right-hand side and held against the stop pin on the opposite side.

In changing for a 1⁄4-in. wrench this stop pin is driven down below the surface of the die and the one on the opposite side is driven up. The stock is then fed through from the left-hand side. No changing of punches is necessary. After the wrenches are blanked they are flat-dropped, tumbled, and case-hardened.

Shearing Dies for Ball-bearing Cones.—Back in the early days of the safety bicycle, when the selling price of a good machine ranged around a hundred and fifty dollars, little attention was paid to economical production, nor did the real squeezing come until the price fell below one hundred. But with the price hovering around seventy-five, it became a grand scramble for labor-saving devices and short cuts. Stampings took the place of machined forgings in some cases, and various other changes took place.

It was during this wholesale digging after short cuts that the two dies shown were evolved, and since they are so extremely simple they may possibly be of use to someone for other classes of work.

The firm was making a line of cones similar to Fig. 68 and these cones were made on an automatic screw machine, from round bars of cold-rolled steel. The automatics, turned, tapped and cut off the cones, leaving nothing else to be done on them, but to cut in the wrench holds, and harden them.

A few years earlier a milling machine would have been rigged up to mill the flat wrench holds on them, but now a punch and die was made to shear out these places. Fig. 69 shows the side and end views of the die. It was made of a solid block of tool steel and set into a cast-iron plate.

The cones were slipped into the hole in the die, sheared off and knocked out by hitting the plunger with one hand.

In Fig. 70 is seen the shearing punch used. This punch was made of one piece of round tool steel and was milled out, after which a slight clearance was scraped in by hand. Two sides were made alike, so that when one side became dull the punch was turned around.

At first a bevel was ground on the cutting edges, but this was soon abandoned and the punches ground perfectly flat on the bottom. This gave just as good results in the work and the edges did not chip off as much.

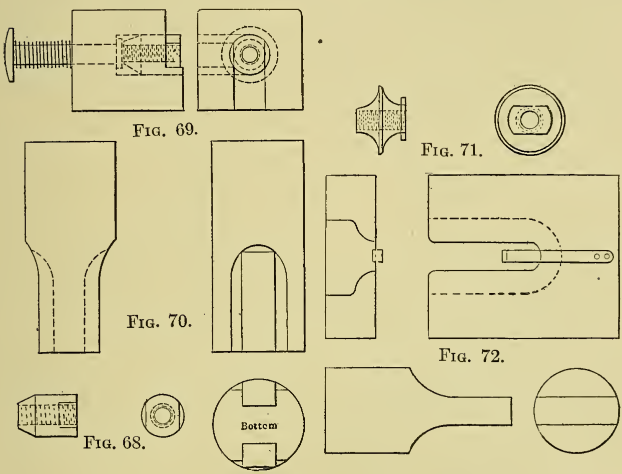
Nothing was used to hold the cones except the friction in the hole, but they had no tendency to turn and break the punch, as was at first feared.

A set of punches and dies was made for each size of these cones and these were used for three or four years.

Another class of cones made by this firm were also made from round bars of cold-rolled steel on automatics, but owing to the shape, they had to be sheared for the wrench holds in another style of die.

The shape of this cone is shown by Fig. 71 and Fig. 72. It was made from a flat piece of steel which was slotted as shown. A flat spring stop, with a big end, was used to prevent the cones from being shoved in too far.

The cones were simply slipped into the slot in the die, with the thin flange of the head on top, and then shoved down through



Figs. 68 to 73.—Shearing cones for ball bearings.

with the punch shown by Fig. 73, a hole in the bed plate letting the cones drop down into a box.

As will be readily seen, the punches and dies were very easily made, scarcely any hand work being needed and very little steel used.

So smooth was the work of these tools when kept sharp, that except for the few that were nickel-plated, none of the cones were polished, but were simply case-hardened, ground a little on the bevel face, and sent out.

Punch and Die for Ratchets.—At *A*, Fig. 74, is shown a small ratchet, $\frac{5}{8}$ in. in diameter, made on automatic screw machines.

The teeth were formerly milled on an automatic gear-cutting machine. Hobbing was tried without increasing production, so shearing the teeth with a punch and die was suggested. To do this with as few motions and as handily as possible the punch and die shown in the illustration was designed.

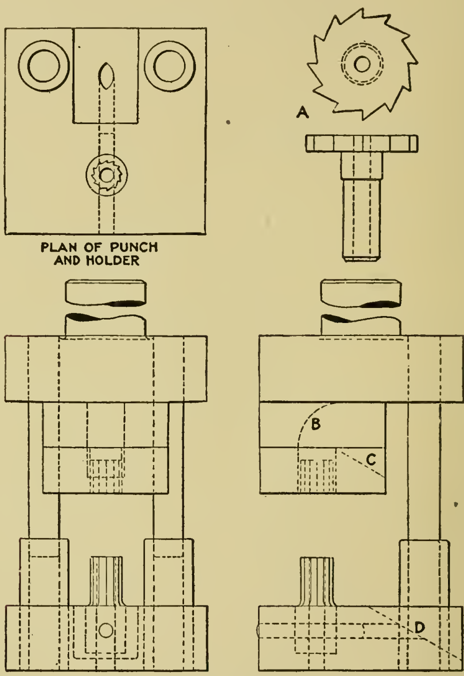


FIG. 74.—For punching ratchets.

The object in having the punch and die reversed is to make it easier to feed and locate the work.

The ratchets are placed on the punch with their stems in the hole. The punch forces them far enough through the die to require but little force to push them the rest of the way, thus avoiding upsetting the ends. The next piece forces the one ahead of it against the curved surface *B*, causing it to tip over onto the incline *C*. The jar of the press keeps them moving out of the way down the inclines *C* and *D*.

The hole in the lower member should not fit the stems too closely and may be countersunk a little to help in placing the ratchets. To avoid confusion the screws and dowels for holding the two upper blocks to the punch holder are not shown.

This punch and die did very satisfactory work and increased the production on this operation several hundred per cent.

Punch and Die with Automatic Spacing Device.—The accompanying illustrations show a semi-automatic punch and die designed for accuracy on work of a somewhat peculiar nature.

Referring to Fig. 75, it will be seen that the work produced consists of evenly spaced holes in a narrow strip of metal, this

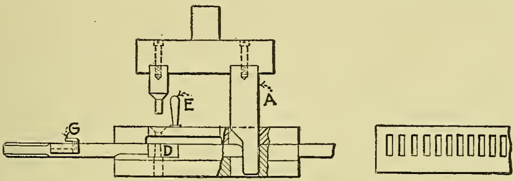


FIG. 75.—Punching evenly spaced slots.

was 18-gage, or 0.05-in. cold-rolled sheet, and the purpose of the holes was to form the adjusting supports for shelving which could be spaced to suit convenience.

As a considerable quantity of these strips was required from time to time and it was necessary that the spacing on all different lots should be exact, not only from one hole to the next, but between any two holes, the ordinary type of stop or gage pin was unsatisfactory.

For one reason it would wear slightly and a couple of thousandths on the pin meant nearly ⅛ in. on the full length of the strip, and then also it was practically impossible to fit two pins exactly alike, in case one was broken off or a new die made. These difficulties were entirely overcome in the manner shown.

Referring to the punch and die, Fig. 76, it will be found that there is no gage pin but instead, a spacing bar, with the required spacings permanently established and by the nature of the plunger A, Fig. 75, each stroke of the press indexes the work forward the required amount.

The action and operation are as follows: to start, the index bar *B* is drawn to the right until the stock support *C* strikes the die block *D* when the work is pushed against it as a stop and the first hole punched, the dog being prevented from operating on this first stroke by a wire hook held in the hand, which pulls back the dog by means of the knob *E*. The work is now fed forward by hand and hooked over the pin *F* and the latch *G* swung around to prevent its springing off when the second hole is punched with the rod held out of engagement as on the first stroke. For the third and remaining strokes, the dog is allowed to operate and the foot kept on the treadle until the piece is finished, each stroke spacing and punching its own hole complete.

As a difference of a few thousandths between any two holes was in no ways vital, no more accurate locating device than the

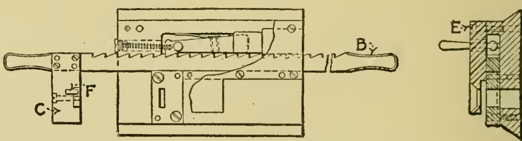


Fig. 76.—The automatic spacing device.

forward movement of the dog was necessary, it being only required to avoid the cumulative error introduced by a long or short gage pin. This the device shown accomplished, besides making a considerable saving on the punching time, as evidenced by the piece-work rates. It also reduced spoiled work to almost nothing.

A Multiple Hand Punch.—Fig. 77 shows a hand punch for piercing three small holes at once in a thin brass shell. The plan gives a clear idea of the principle, which leaves little to explain. The cam plate is made of mild steel, the body of gray iron and the punch holders are of round cold-rolled stock.

The bushing or die in the center is forced into the cast-iron body a short distance, and further secured with a setscrew (not shown, nor, for the sake of clearness, are the holding-down lugs shown on the elevation). This bushing is hardened and ground and the capscrews are case-hardened. The small holes going through the punch holders permit broken punches to be driven out.

Punching Tool for a Fiber Washer.—This tool was designed to avoid a second handling of the small fiber washer shown in Fig. 78. The general construction of the tool can be readily understood from Fig. 79. The bolster and cutting die *A*, the forming die *B*, the piercing die, the guide *C* for the punch *D*, which also acts as a stripper for the punch holder *E*, were all made of cast steel. The punch holder was made of mild steel.

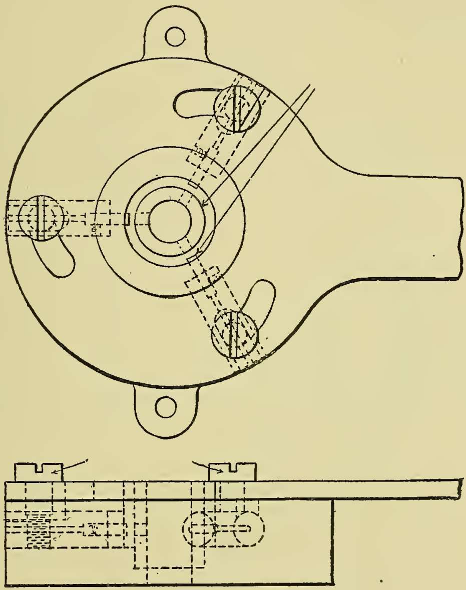


Fig. 77.—Multiple hand punch.

The piercing punch *F* was fitted with the strong square-section springs *G* and *H*, the latter being rather the weaker.

The action of the tool was as follows: The punch *D* engaged the material and formed it to shape; owing to the relative strength of the springs *G* and *H*, the spring *H* gave way and allowed the punch *F* to pierce the material, whereupon the punch *D* blanked it out. The tool was very successful and made a good job of the washer.

Compound Die for Celluloid.—The compound die shown in Fig. 80 is intended for piercing and blanking celluloid, which is used extensively in the manufacture of eyeglasses. The work is left in the strip from which it is easily and quickly removed. The pressure required to force the blank back into the celluloid is small as compared with that used for metal, hence the compact construction of the die.

The tool consists of a shank *A*, to which is screwed the piercing-punch holder *B*. A die *C* is in turn screwed to the holder *B*, which is recessed to admit of the knockout *D* sliding therein.

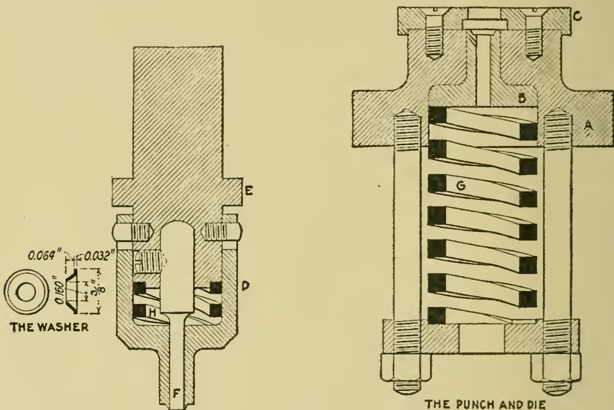


Fig. 78. Fig. 79.

Figs. 78 and 79.—Tools for punching fiber washer.

This knockout is operated by the spring *I* through the pin *H*. The punch, which is placed at the bottom or in the regular die bed, is made as illustrated at *E* and has a stripper *K* held against the studs *G* by the springs *F*. The pins *L*, which are hardened and ground, are for the purpose of setting the tool in the press and also to prevent shearing of the punch. When the piercing punches break, they may be easily replaced by heading over a piece of drill rod, hardening and replacing the defective one.

On such work as these tools were designed for, they last almost indefinitely.

Hot Punching of Forgings.—A somewhat radical development in the field of drop forging has been made and tested out by the Consolidated Press Tool Co., Hastings, Mich. This shows what has been accomplished in the way of hot-punching drop-forgings, in some cases eliminating machine work. The operation might almost be called a secondary forging.

A plant of this kind installed in a large automobile works shows some interesting results. The machines used are large double-acting crank presses designed especially for this work; the larger press weighs 50,000 lb. and stands about 13 ft. high.

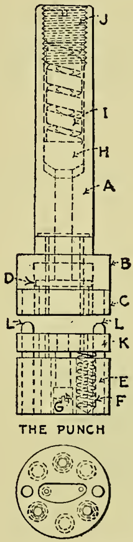


Fig. 80.—Die for punching celluloid.

This has a capacity of punching a hole 4½ to 5 in. in diameter in stock 2¼ to 2½ in. thick when heated to 1400°F. The furnaces are placed convenient to the presses to facilitate handling the work. These open at both ends, the pieces being put in at the back and worked toward the front by the helper, reaching the proper temperature when at this end.

Figs. 81 and 82 show work both before and after punching. The first is a connecting-rod and the second a support for the differential bearing, these being selected as good examples of the new process.

Punching Two Holes at Once

After the connecting-rods have been forged, as the one at *A* in Fig. 81, they are reheated and placed in the holding dies shown

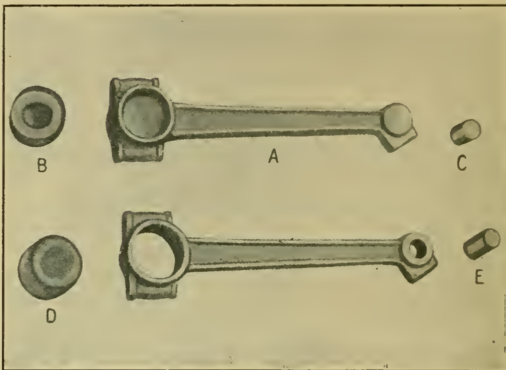


Fig. 81.—Connecting rod and punches used.

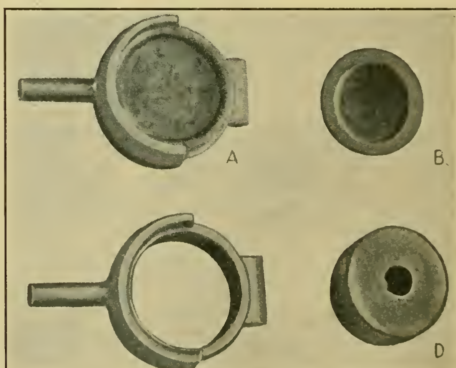


Fig. 82.—Bearing support and punches.

in Fig. 83. These dies are duplicates of the forging dies and can be made adjustable for length. The upper die is held in the outer slide, which comes down on the work before the inner slide descends. This inner, or punching, slide then comes down, punches the holes, and returns; the outer slide lifts, the work is taken out, and a fresh piece put in. But while the operation takes little time, there were many interesting problems to work out to secure complete success.

The small hole is punched $^{27}/_{32}$ in. in diameter from the solid through a section 1 in. thick, while at the large end the punched hole is $1^{59}/_{64}$ in. in diameter through a section $1\frac{1}{2}$ in. thick, although the punch takes out only the draft on the sides of the hole. The two punchings may be seen at *B* and *C* in Fig. 81. The large hole is not machined, except to mill cross-grooves for

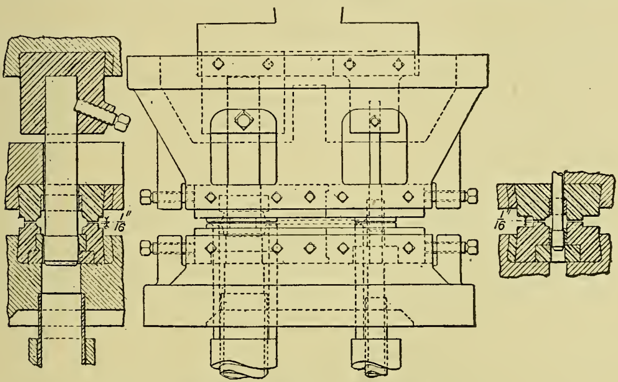


FIG. 83.—Dies for hot punching.

anchoring the babbitt, while the small hole leaves $^{1}/_{32}$ in. to be removed, making it $^{7}/_{8}$ in. in finished diameter.

In a similar manner the larger hole is punched in the differential bearing support, this hole being punched $3^{9}/_{16}$ in. and afterward bored to 3.67 in. The amount of machine work saved can be seen from the size of the piece punched out, as shown at *A* in Fig. 82, although this does not show the metal in the draft at the sides of the hole.

Perhaps the most interesting features of the process are the punches and the way they are handled. These are shown at *D* and *E*, Fig. 81, and at *B* and *D*, Fig. 82. The smaller punch in Fig. 81, $^{27}/_{32}$ in. in diameter, is of high-speed steel; the others are of cast iron, which is employed for all punches over 1⅛ in. in diameter.

White cast iron is used. The punches are turned, hardened in cyanide, and ground straight except for the beveled ends. Both the steel and the iron punches are beveled in the same way, and both last from 200 to 500 holes, a wear of $\frac{1}{64}$ in. being allowed before discarding.

In operation, the helper places a heated piece in the dies, the operator having already put a punch in the holders. Moving a lever trips the press, and the outer slide with the upper half of the holding die comes down over the work. Then suitable arms push the punches under the inner slide, which forces them through the hot forging, allowing them and the punching to drop in a pan of water below. The punches are recovered by the operator with a pair of tongs.

Fig. 83 shows how the punches are driven through the work by the plunger; how the plungers, or drivers, are held; and the way in which the die is adjusted for center distance between the two holes. The large hole is shown at the left and the small, or upper, end at the right.

Some of the advantages of this process are apparent. The cost of heating is eliminated because this is part of the heat-treatment and would be done in any case. The pieces are heated 200° hotter than needed for the punching, or 1600°, in order to fit into the heat-treating specified. The forgings are of manganese steel.

The two holes are punched as quickly as one, the number being limited by the capacity of the machine. One machine handles an average of 100 connecting-rods per hour. Add to this a charge of 20c. per 100 holes for tool cost, setting-up and repairs, and the economy of the method becomes apparent.

This, however, is not the only economy. This being in reality a reforging operation, it saves practically all forgings which may have come out of the first dies a trifle long or short; the holding dies reshape them wherever necessary. Further, the cone-ended punches force the metal into the dies, compressing it and making it more dense around the holes.

Cutting Two Blanks at Each Revolution.—The accompanying illustration, Fig. 84, shows a blanking die which was recently made, to cut out two blanks of 16-gage material at one revolution of the press, and it worked to perfection. This shows the die with the stripper plate removed. The heavy lines show the openings made in the die for punches *A*, *B,B* and *C,C*. *D* is a stop made of machine steel, case-hardened. *E,E* are gages for the stock to slide between under the stripper plate. *F,F,F*, in dotted lines, represents the first blank as it is operated on until it slides off the die through the gap *H*, between stop *D* and gage *E*. *G* in dotted lines, represents the second blank until it is blanked through the opening *A* in the die. Opening *A* in the die is made a little longer than the blank *G*, so as to overlap the ends, and let the punch that fits into opening *A* cut only on the sides. Punches *B,B* should be ground along the line of the

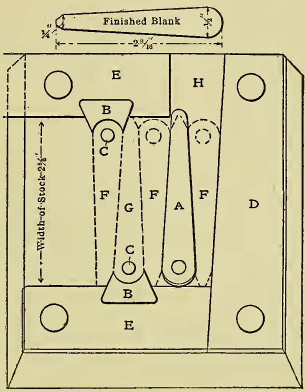


Fig. 84.—Double blanking die.

gages so that their backs can enter the die before their fronts cut the stock. This die works best in an inclined press, as then blank *F* can slide off the die.

To operate, insert the stock between the gages far enough for punches *B,B* to cut a half moon out of each edge and perforate the small hole *CC* with the first stroke of the press. For the second stroke of the press advance the stock until the perforated hole in blank *G* comes in line with the pilot that fits into opening *A*. This will cut blank *G* through the die and let the scrap from the end of the strip slide off the die through gap *H*. Now advance the stock until it strikes the stop *D*, and with the next stroke of the press you will cut two blanks, one going through the die and the other sliding off through gap *H*.

Piercing, Curling and Cutting-off Die.—The steel plate shown at *A*, Fig. 85, is part of a typewriter. The hooks in these plates were formerly made as shown at *B* and *C*, a slow and costly method. Now this punch and die are used which are of the pillar-press type. The shearing and curling punches are made as shown at *D* and fitted into a punch plate; they can be removed for grinding.

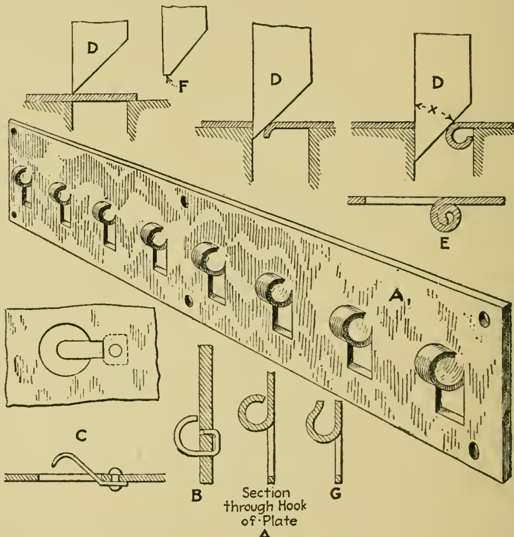


Fig. 85.—Piercing and curling a typewriter plate.

A conventional stripper plate is screwed to the die and a flat bar with an adjustable stop is screwed to the die-holder. Simplicity and ease in curling the hooks is the feature of this tool.

The operation of forming the hooks is clearly shown, the beveled side of the punch curls the hook. The secret of successfully forming the hooks lies in having the proper angle *X* on the punches; this angle is determined by experiment, it varies with different grades of stock.

By having the proper angle on the punches, it was found that the hook can be completely curled up if desired, as shown at *E*. In operating this tool the stock is fed to the cutting-off edge of the die and the holes and hooks are pierced and formed, stripped against the stripper plate, moved along again to the stop and cut off and so on. A complete plate is produced at every stroke of the press.

The flat *F* on the end of the punch will produce hooks as shown at *G*. This method has greatly increased production and reduced the piecework price.

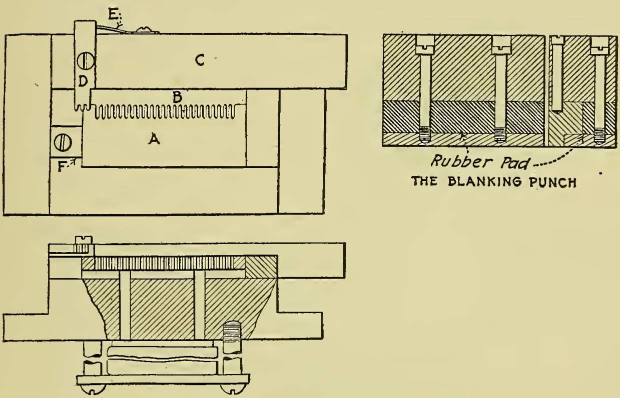


Fig. 86.—Blanking tools for staples.

Press Tools for Tin Staples.—The illustrations, Figs. 86 and 87, show a cheap set of press tools for staples. These have replaced more costly tools, make no scrap and have cut the cost of material in half.

The stock used with the old tools was tinned strip steel $^{13}\!/_{16} \times$ 0.013 in., which was brought from the continent. The strip tin was fed to the die by a roll feed on the front of the press, running at 140 r.p.m., one staple being blanked at each stroke. At the back of the press was a series of rolls that bent the staples at right angles as the strip fed through the blanking tools. They were then cut to the required length, 3 in. for 25 staples, 6 in. for 50 staples, and the like.

The new tools, as shown, are more simple, and although there are two separate operations, blanking and bending, the output is greater, as 25 staples are blanked with each stroke of the press and 25 are bent at right angles at each stroke. The new tools are made to fit either the power press or the screw press; they are shown here in the screw press.

Fig. 86 shows the blanking tools, where *A* is the steel die, *B* the stripper, *C* the guide for the stock which also keeps the blanking punch up to its work, *D* a stop which is pushed in for the first blank and when released is held back by the spring *E*. The teeth on the stop *D* are used as a guide and stop for the remainder of the blanking. After each stroke of the press the

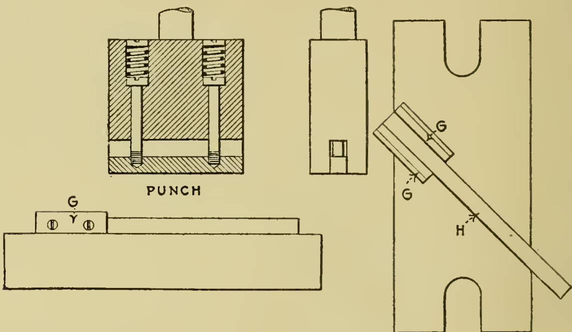


FIG. 87.—The bending die.

tin is pulled toward the operator about ⅛ in. and pushed along till the teeth on the stop *D* locate the stock in the right position, the raised piece *F* keeping the tin in line with the stop *D*, while the blanked strip travels underneath the stop.

In the front elevation and part section there can be seen the pressure pad and stripper, which require little explanation.

A milling cutter was made to the required dimensions to cut the die, punch and stripper. This made the job of tool making comparatively easy. The bending die is shown in Fig. 87. This is set at an angle to the base to make it handy for the operator to feed the strip along. The guide pieces *G,G* are screwed to the forming die and when the strip of tin is first fed up, only two or three staples are bent, as this helps keep them central. After this twenty-five staples are bent at each stroke of the press. The former *H* is made quite long, as this helps to support the staples and also acts as a guide.

The punch is shown in section and end view to illustrate how the staples are prevented from leaving the bending die with the punch.

The sheet of tin is turned upside down after each strip is cut off. This procedure keeps all the burr on one side, otherwise there would be a burr on the top of one side and a burr on the bottom of the other side of each strip of staples.

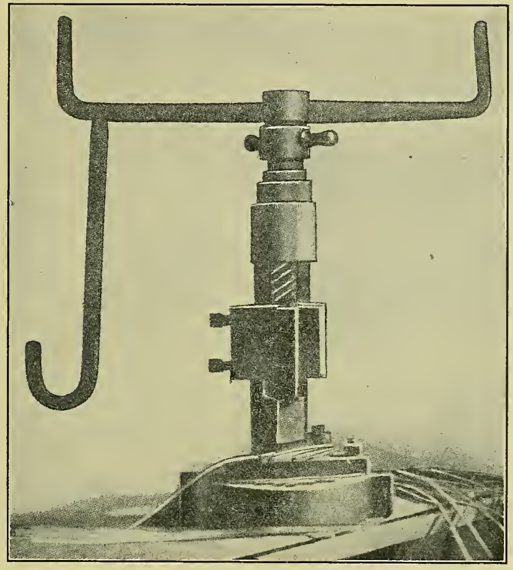


Fig. 88.—Hand press used for making staples.

The first strip of staples cut from the tin plate has to be fed through a second time, as there is only one side perforated on the first strip. From one sheet of tin, 24 × 25 in., we get 32 strips with 200 staples on each, making a total of 6400 staples (or paper fasteners). This is double the output by the old method.

American tool makers will, no doubt, smile when they see the illustration of the screw press, Fig. 88. There are fifty of these to one power press in the vicinity of Wolverhampton, England, where these tools were used. They do seem prehistoric, but a girl doesn't mind blanking brass 1/8 × 2 × 3-in. stock on them.

A Blanking Die and Forming Tool for a Clip.—The illustrations, Figs. 89, 90 and 91, show a blanking die and forming tool for a small clip. The forming tool is quite different from the usual.

Fig. 89 shows two views of the clip, one as the blank comes from the blanking die and the other as it is formed up ready for use.

This clip is used on the keyboards of typesetting and casting machines. They are made from half-spring steel and being used in large quantities must be made cheaply.

The punch and die, Fig. 90, is a simple follow die. First the hole is punched, then the stock is moved along. A finished blank and the hole for another are made with the next and subsequent strokes. A boy can punch about 8000 per day.

The former, Fig. 91, consists of a block of steel *A*, with eight slots or grooves *B* spaced 45 degrees apart in the center. A plunger *C* works through the center of the block with two collars *D*,*E* turned on it about 1/4 in. apart. You will see at Fig. 91 that the eight pawls *F* work in the slots and are centered in the block with the tail of each working in the groove in the plunger.

The plunger has a pilot *G* on the top end which fits the hole in the blank. The blank is dropped in a form which sets the wings in their proper place. The punch *H* is just the shape of the finished clip. The punch *H* descends and holds the blank firmly on the plunger *C* and pushes it and the plunger on down into the die. As the plunger is forced down it draws the tails of the pawls *F* down with it. As they are centered at one side, the tops of the pawls are forced in and when the press is at the bottom of its stroke the pawls are forced up tight against the punch.

As the press ascends the spring *I* on the bottom of the plunger forces it up, opens the pawls and frees the formed blank which sticks to the punch. A stripper set at the proper height strips the blank nearly off the punch. When the operator is putting another blank in he gives the formed piece a slight knock which removes it from the punch. It falls in a trough and is carried to a box under the press. A boy can easily form 5000 per day on an ordinary single-acting press. When assembling the pawls in the base *A*, all the pins upon which they are fulcrumed except

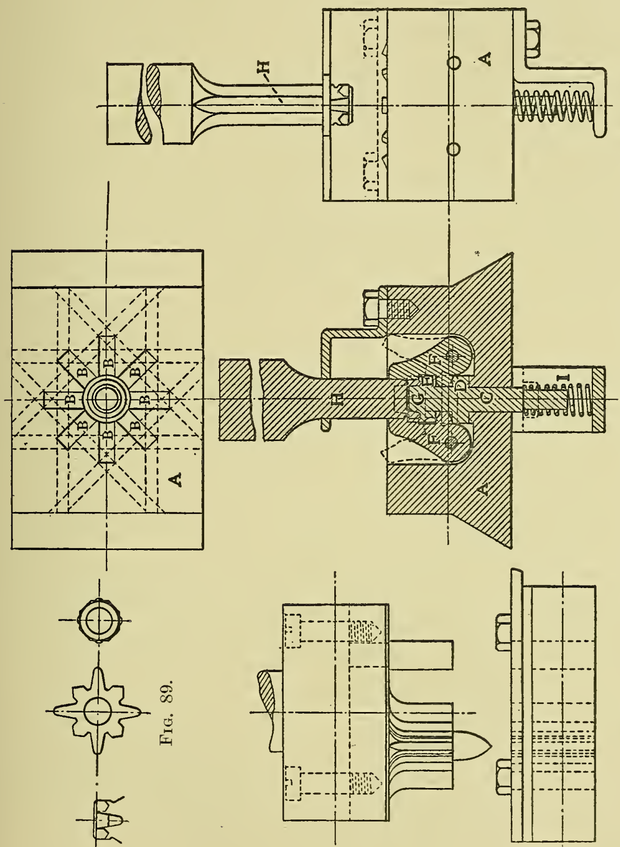


Fig. 89.

Fig. 90.

Fig. 91.

Figs. 89 to 91.—The work and the dies.

the last can be driven from the outside. The last pin is dropped in from the top, the block *A* being recessed for that purpose. A small cap fits on top of the pin and is held in place by two screws.

Thickness of Blanks.—In the design of dies for press work, the thickness of the stock often plays a more important part than appears at first glance. For instance, the blank shown at *A*, Fig. 92, could readily be made in the follow die *B* providing the metal were thin enough. This die pierces the two holes *C* at the first stroke and at the second stroke, the whole blank *A* is punched. With heavy metal, say 1/8 in. thick, the tongue *D* might be found rather weak and liable to break.

To avoid any chance of trouble and without adding to the number of stations on the follow die, it should be made as shown at *E*. At the first stroke in this die, the two holes *C* are pierced and also the opening, which in the die *B* is cut by the tongue *D*. In the second stroke the blank is cut by the die *G* which has

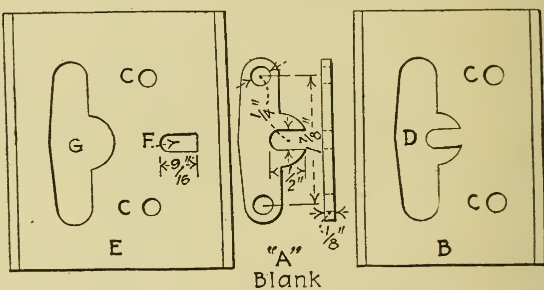


FIG. 92.—Effect of thickness of stock.

no delicate members liable to fracture. The punch and die for *F* pierce a hole 1/16 in. longer than shown on the blank *A*, which assures their being blanked with an open end.

Die for Can Top and Bottom.—A die and punch for making a 3⅜-in. seal top and a 2-in. bottom for tin cans is shown in Fig. 93. This die was planned to work without springs. At *A* is a knockout pin, the shoulders at *B* and *C*, respectively, doing the work. The washer *B*, working against four pins *D*, which in turn bear against the ring *E*, ejects the product from the punch. The pad *C* ejects the bottom from the punch.

The four pins in the die bear against a spring rubber, which holds the edges of the product smooth and also ejects it from the die. The product *F* is placed into an edging die and the edge at *G* is turned down. This seal top is used on paint and molasses cans generally, and admits a cover which is held by friction. The product *H* is the bottom of the can.

Tools for Cutting-off Angle Iron.—Dies for cutting off small angles vary widely in design and while it is not easy to say which

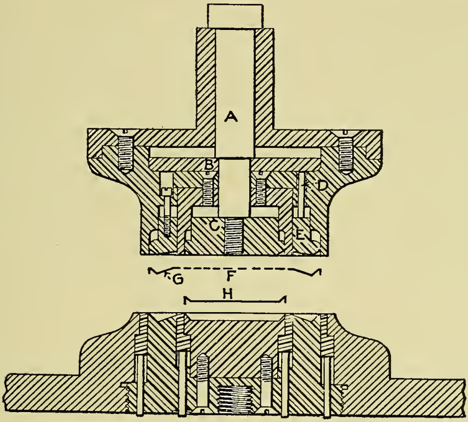


FIG. 93.—Dies for tin cans.

is the best type, the one shown will be found useful in many places.

In Fig. 94 is shown a simple, inexpensive tool which is satisfactory for certain angles and purposes. This has a 90-degree punch and die block. The punch is made solid, and the die is

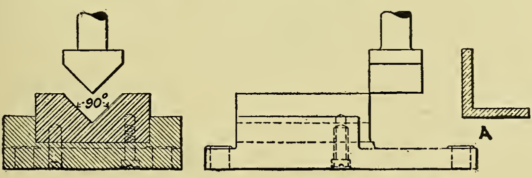


FIG. 94.—Dies for cutting-off small angles.

one piece of tool steel set into a cast-iron shoe. For light angles with sharp inside corners, as shown at *A*, this style of cutting-off tool answers very well, especially if it does not matter if one end of the piece cut off should be distorted somewhat. The tool is sharpened by grinding the adjacent faces of the die and punch; no back taper is required.

For angles having fillets in the inside this type does not answer, except for rough work, for the reason that at least one end of the piece cut off will have its shape destroyed, as illustrated at *B* and *C*. This will be the end which is not supported on the outside by the die, the sharp end of the punch striking the fillet and forcing it down before the outer corners begin to cut off. This will invariably happen in a die like Fig. 94, and can be only partially overcome by rounding the end of the punch to conform to the fillet.

To avoid this, a die, as shown in Fig. 95, must be used. This, it will be noted, supports the stock under both ends cut. The cutting blade is set between the built-up 90-degree pieces and cuts off; the deformed portion is punched off as scrap. It is not necessary to build such an elaborate tool as that shown in Fig.

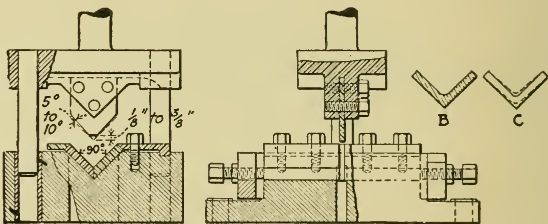


FIG. 95.—For cutting square edges.

95, so long as the principle remains the same, but the one shown is a remarkably successful tool of the type.

The punch of this die is not made to conform exactly to the shape of the die, nor to the inside of the angle, for the reason that by giving it a shear in the manner shown, it cuts much easier and produces a cleaner and more nearly square end on the stock. The punch in this particular die was made of 5/32-in. thick tool steel, ground flat on both sides, hardened and drawn to a dark yellow. The cutting sections of the die were of high-speed steel, in four parts as shown, which, when dull, could be easily removed and ground on the ends. These are set up against a spacer (not shown), which allowed the required clearance between punch and die, and located the die sections in relation to the punch. These dies were ground with 1- or 2-degree back taper.

The guide posts were added largely to reduce setting-up time, as well as to insure correct positioning of the punch and die in all set-ups. They are not necessary to the proper working of the die.

Particular attention is called to the shape of the punch, the flat nose, and the edges undercut 5 to 10 degrees from 90 degrees. The shape was the result of considerable experimenting to reduce the stress of cutting and increase production between grindings.

The die, in Fig. 95, will cut perfect pieces without distortion, 1/8 in. long from 1/8 in. thick filleted angles. The tool shown in Fig. 94 on pieces of that length would produce only mis-shaped slugs.

CHAPTER III

DRAWING SHEET METAL INTO VARIOUS SHAPES

This is another department of press work which has made great advances in a comparatively short time. Cold sheets are now drawn and shaped almost at will, into forms which was considered impossible but a few years ago, the marvel being that cold metal will withstand such stresses without tearing. This is allowing the use of sheet metal for many parts which were formerly made of castings and machined in various ways. Examples of this class of work will be shown in this section.

Drawing a Difficult Shell in a Single-acting Press.—This shows a drawing die, with some novel features. Fig. 96 shows the five operations required on a single-acting press to produce the finished shell shown in Fig. 97.

Operation 1 shows the blanking and drawing die which knocks the shells out with a kicker that passes through the back of the press and rests on the top of the stripper. The cross-section and the punch in position shows the little knock-off pin which disappears during the operation and which pushes the shell away from the stripper to which it is held by suction. An enlarged view of the pin is shown at *A*.

The punch has a thread cut on it to screw into a plate ½ in. thick. This plate bolts to the ram of the press and takes all the pull and strain from the setscrew. The blank from this die is shown at *C*.

The second-operation die is shown in part cross-section, and is held in a cast-iron shoe, not shown. A cap bored to take the shell *C*, is threaded and screwed into the shoe. It locates the die and holds it. It bears on the 45-degree angle *X* of the die. The draw from this operation is shown at *D*. This punch also screws into the same plate as the previous punch.

In operation 3 the punch only is partly shown, but it and the die are made in the same manner as the previous punch. The punch used in this operation is chamfered to give the shell a start in the die for the fourth operation. The shell from the third operation is shown at *E*, and *F* is a bottom view of it. The fourth operation produces the shell marked *G*, and *H* is a bottom view of it. The reason of the chamfer is plain as the corners on the shell are required to come as sharp as possible, and if this had not been done in the third operation, the fourth would have made a bad mark about ¼ in. up on the shell, which would have required a lot of polishing to get out.

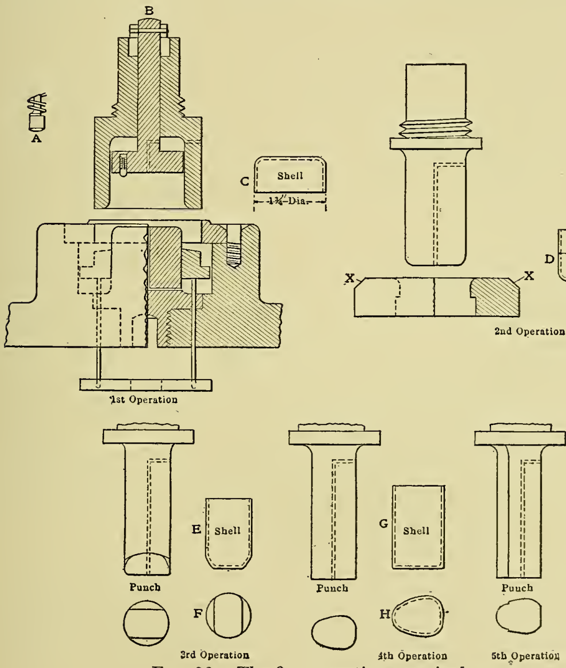


FIG. 96.—The five operations required.

The fifth and final operation is now to be done. The punch is made to the exact size and shape (shown reduced in size in operation 5, Fig. 96). The die is shown large in Fig. 97 in order to make it clear. This was first made to suit the punch but the recesses *I* in the steel tore and scratched badly. The die was then slotted out at *J*, one face of each slot coming out at a sharp point in the die. This slot was made about $3/16$ in. wide. A pair of rollers O was then made and finished out the part of the die marked K.

The edges of the rollers were slightly rounded at L to avoid breaking and to make I the shape required. Holes were drilled at right angles to the slots for pins for the rollers to turn on, and in a position to bring the edges of each roller a trifle below the edge of the die. When the shell from the fourth operation was

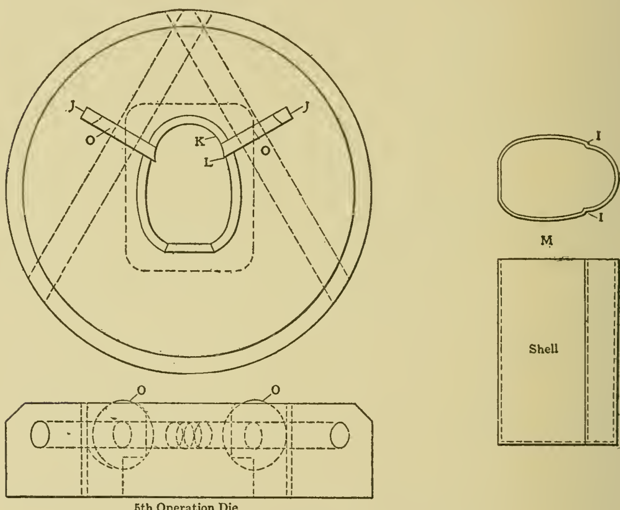


FIG. 97.—The last die and the finished shell.

placed in the die it started to draw the body first, and as soon as that started it struck the rollers, which rolled in the recesses. This left the recesses as smooth as the body of the shell, and it required very little buffing to finish them.

These operations were all done in a single acting press. The finished shell is shown at M; it is $1\,15/16$ in. long by $1\,1/4$ in. one way and $7/8$ in. the other. It is made of sheet steel 0.045 in. thick.

Forming Rivets in Soft Sheet Steel Parts.—It is easy to assemble work that has rivets struck up in soft steel stock far enough to allow the riveting of small parts of thin gage, such as flat springs, etc. This method of handling work is used extensively in manufacturing sewing machine attachments and will be found accurate and a labor saver.

An example of this work is shown at *A*, Fig. 98. The die *B* and punch *D* are made in the following manner. Drill and ream the die to the outside size of the rivets. Transfer the holes in the die to the templet *C*, made of steel, and counterbore the holes

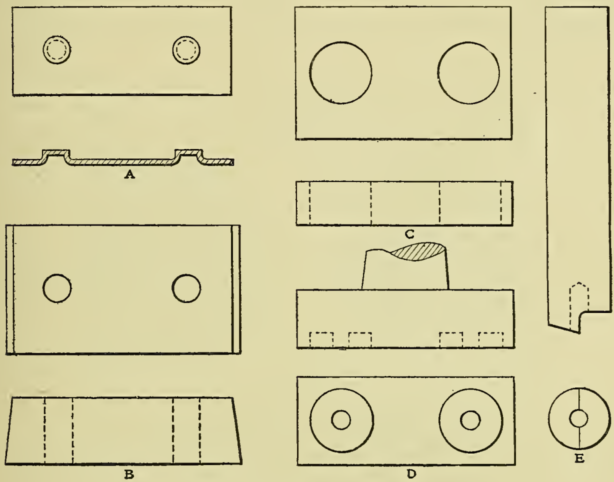


Fig. 98.—Forming rivets in soft steel.

in it for the hollow mill *E*. Clamp the templet *C* on the punch *D* to guide the hollow mill *E* for forming the tits on the punch, remove the stock from around the tits that are formed and the tools are ready to harden.

The same die will answer to punch the holes but it is better to have two dies, gages being screwed on the die to locate the work.

Piercing Thick Stock.—Two interesting press jobs are shown in Fig. 99. At *A* and *B* are shown two brass watch plates. The original blank was 0.095 in. thick; all the holes in it were pierced in a subpress die at one stroke. The smallest holes are approximately 0.037 in. in diameter, so that the stock is almost three diameters in thickness. Carbon-steel punches were at first used, but these would not stand up for many pieces. High-speed steel drill rod was then tried and no further trouble was encountered.

The watch plates as originally blanked out were not flat, and several methods were tried without any reasonable degree of success. It was eventually decided to try shaving them. A die with guides was made so that 0.003 in. could be shaved off each side, the pierced plate being pushed edgewise through it. The plates thus treated came out within 0.0003 in. of flat and were

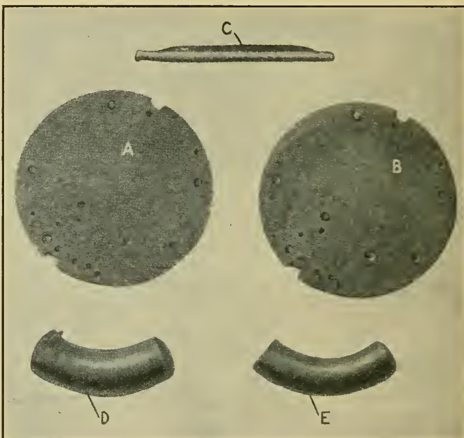


FIG. 99.—Piercing thick watch plates.

very satisfactory. Beyond throwing up a slight burr on the holes, which had to be burred in any case, there was no distortion. One of the shavings is shown at *C* curled up just as it came from the shaving die.

Drawing Curved Shell.—The bending of tubes, especially if they are thin, is always a bothersome job. At *E* is shown a brass tube or shell about 1/4 in. outside diameter with a very thin wall and closed end. A few of these were wanted for an experimental job. Instead of making a special set of drawing tools, to draw up the shells, and a set of bending tools to curve them, the whole job of drawing and bending was done in two operations with very simple make-shift tools.

There were on hand plenty of shallow cup-shaped blanks which were suitable. An angle plate *A*, Fig. 100, was bolted to the press table *B*. Attached to *A* was the die holder *C* with the wide-mouthed die *D*. Mounted on a pivot *E* in *A* was an arm *F*, which carried a curved drawing punch *G*. A link *H* connected *F* to the press ram *I*. A cup-shaped blank *K* was inserted as shown, the press tripped and a curved shell was drawn as shown. A second drawing with a smaller punch and die brought it to the required size. The punch was made as follows:

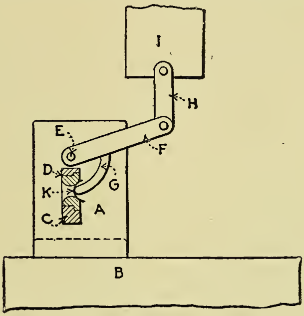


FIG. 100.—Drawing a curved shell.

A piece of drill rod of the correct diameter but considerably longer than required was heated, wound around a mandrel of suitable size, a piece cut from it, one end rounded off and the other fitted to the lever *F*.

Blanking and Drawing Shells at One Stroke of a Single-acting Power Press.—The accompanying illustrations show a method used successfully by a large concern for the rapid production of shells similar to Fig. 101 in a single-acting power press. Referring to the sketch, *A* in Fig. 102, represents the frame of a regular power press, while *B* represents the plunger or slide with up-and-down movement; *C* is a solid tool-steel combination blanking and forming die, the recess in the center being used for drawing the cup over tool-steel post *D*.

The cutting die *E* is placed and located by setscrews and dowels in cast-iron die holder *F*, which in turn is held to the bolster plate of the press by studs *G* and *H*. *K* is a stripper to push the cup from the vertical post after the forming operation is completed. The portion of part *K*, which is marked *K*-1, is in the form of a horseshoe, while portion marked *K*-2 is a handle. Part *K*-2 is often connected to the plunger of the press with a bell-crank lever motion, thereby allowing the caps to be automatically knocked off on the up-stroke of the press.

In addition to the above these tools are provided with a stripper for use in connection with the sheet metal as it is fed in from the reel. This allows the use of an automatic friction or ratchet roll feed, thereby allowing the operator to take care of more than one machine.

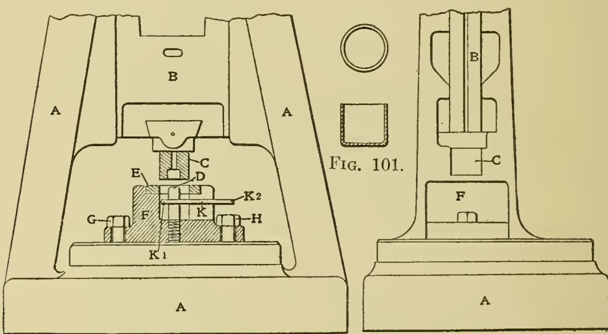


Fig. 101.

Fig. 102.

Figs. 101 and 102.—Blanking and drawing shells at one stroke.

The size of the shells manufactured mostly with this equipment vary from 0.010 to 0.050 in. in thickness; from 1/8 in. to 7/8 in. in depth and from 1/4 in. to 1 1/2 in. in diameter respectively. Each shell included in the sizes cited above is done at one stroke of the press either from sheet steel, silver, gold, copper, or brass. In making the drawing longer an allowance of about 0.003 in. should be made for clearance between the stock and the forming punch and die. A fine hole should also be left running through the center of drawing post *D* in order to prevent any air pressure occurring during the formations of the cap. The other parts are extremely simple to make and it is feasible to perform the work either in an inclinable or upright press.

The output of a press with automatic feed on the smaller sizes varies from 110 to 140 per minute, while the output on a machine fed by hand ranges from 50 to 90 per minute.

Press Tools for Oval Flasks.—As every tool maker knows, it is easy to draw thin round work even, but with ovals, such as the outer casings of drinking flasks, there is considerable difficulty to those not familiar with the work. The chief trouble is when the first draw is started from a round blank, as it causes an uneven thickness of metal, which forms corrugations on each side, so the blank must be oval as shown in Fig. 103, when all trouble will be eliminated.

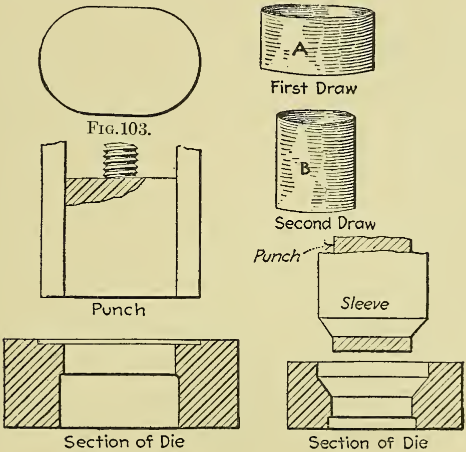


Fig. 104. Fig. 105.

Figs. 103 to 105.—Tools for an oval flask.

The first drawing tools, that is, a combination of blanking and drawing at one operation, are shown in Fig. 104. The second and final operation is shown in Fig. 105, which reduces the diameter ¼ in. all round; it will be noticed that the punch for this operation carries a sleeve; this is necessary to iron the wrinkles out of the sides, as the metal is only about 0.02 in. thick. After the shells are drawn they are trimmed on a lathe which cuts the edges evenly.

The necessity for polishing the tools to a glass-like surface should be emphasized, as the least scratch will show. In fact, it is a good plan to burnish them with a hard steel burnisher, when they may be used for standard silver or german silver (if of good quality), and the finished work will be found first-class.

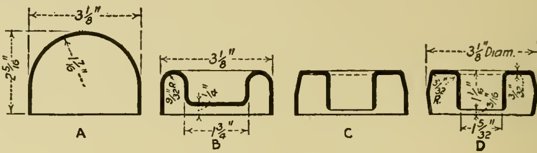


Fig. 106.—Pressed steel pulley.

One-piece Pressed Steel Pulley.—A one-piece pressed steel pulley can be produced by what is known as the inside out method, can be made with the least number of operations and without annealing. The four operations required are shown consecutively in Fig. 106.

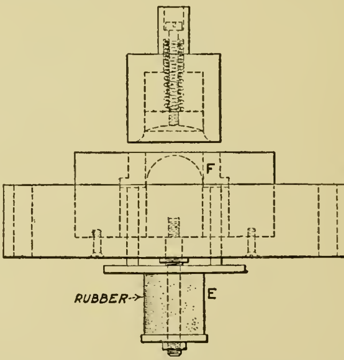


Fig. 107.—First operation—die and punch.

The first operation, *A*, Fig. 106, is developed from a blank of cold rolled steel, 0.095 in. thick and is produced in a single-acting press with the combination blanking and drawing die and punch shown in Fig. 107. The 12 × 6-in. adjustable rubber bumper *E* beneath the press places enough pressure on the pressure pad *F* in the die to prevent wrinkles forming in the blank.

This insures a shell that is of uniform thickness and straight edges that need no trimming.

The second and third operations will run in one press with the dies and punches, Figs. 108 and 109, fastened side by side and adjusted to give each operation the desired pressure and at the same time to equalize the pressure on the press to prevent press trouble.

The second and third operations are formed in dies with knockouts to prevent the pulley from sticking in the die, thereby allowing the operator to quickly transfer it from one die to the

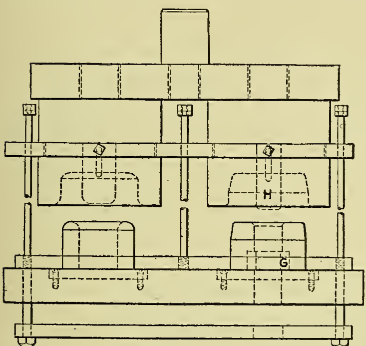


Fig. 108.—Second and third operations—tandem dies and punches.

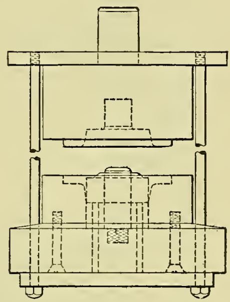


Fig. 109.—Fourth operation—die and punch.

other and at the same time supply the first die again. The knockout is positive; it is controlled by two $\frac{5}{8}$-in. rods screwed to the ram, passing through the bolster plate, and fastened to the kicker on the bottom of the die.

The third operation bevels the pulley $\frac{3}{32}$ in. at one side of the crown and punches out the bottom. This die has a cutting die *G* beneath the drawing die. The draw punch *H* is $\frac{1}{4}$ in. longer than the desired length of the hub and has $\frac{1}{4}$-in. radius on the end, which prevents the metal from stretching but punches out the bottom when the hub of the pulley comes in contact with the cutting edge of the die *G*. The edge will be a feather-edge, but this is taken care of in the succeeding operation.

The stretch in this hub is small, and when the die and punch are kept smooth, the walls of the hub will not be over 0.006 in. thinner than the original thickness. This is considered very good where a large production is desired and where 0.006 in. on the outside of the hub is of little account.

The fourth operation puts the bevel on the opposite side, thereby finishing the crown, and at the same time sizes the hub and bevels the feather edge caused by punching out the bottom of the hub previously.

The hub is sized to $1\frac{5}{32}$-in. inside diameter, the sizing punch being 0.008-in. taper.

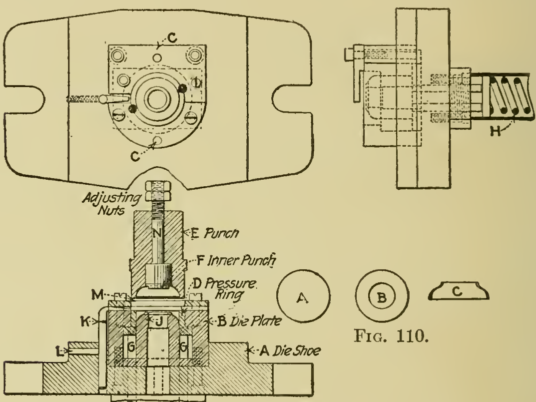


Fig. 110.

Fig. 111.

Figs. 110 and 111.—A drawing punch and die.

A Drawing Punch and Die.—In the accompanying illustrations is shown a novel method of constructing a blanking and forming die, whereby the work is produced in one operation on a single-action press.

At *A*, Fig. 110, is shown the blank produced by the first action of the punch on the sheet stock; at *B* is the result after the inner punch has pierced the hole and at *C* is shown the completed piece, after the outer punch has formed the shell to the required shape.

The construction details of the punch and die are shown in Fig. 111 where *A* represents the die-shoe which is bored to receive the die plate *B* which is pressed into *A* and held in place by the two dowels C,C. The die-plate B is counterbored in its lower end to receive the pressure ring D and is bored in its upper end for the diameter of the blank which it is required to produce. At E is shown the punch which fits into the punch holder of the press and is used to produce the outside diameter of the blank, while F represents the inner punch which pierces the required hole in the blank. The tension pins G,G are held against the pressure ring D by the action of the tension spring H. The former J is bored to permit the scrap produced by the piercing operation passing through and dropping into a box on the

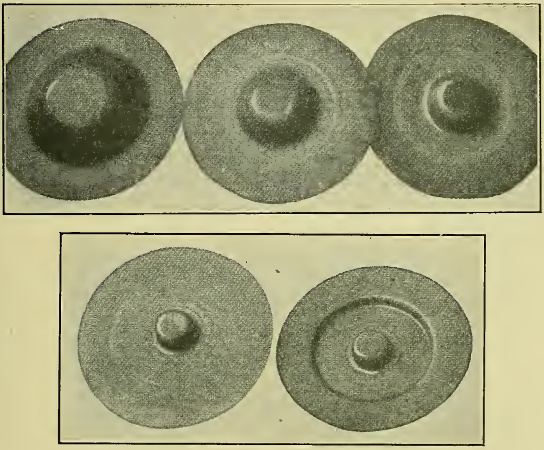
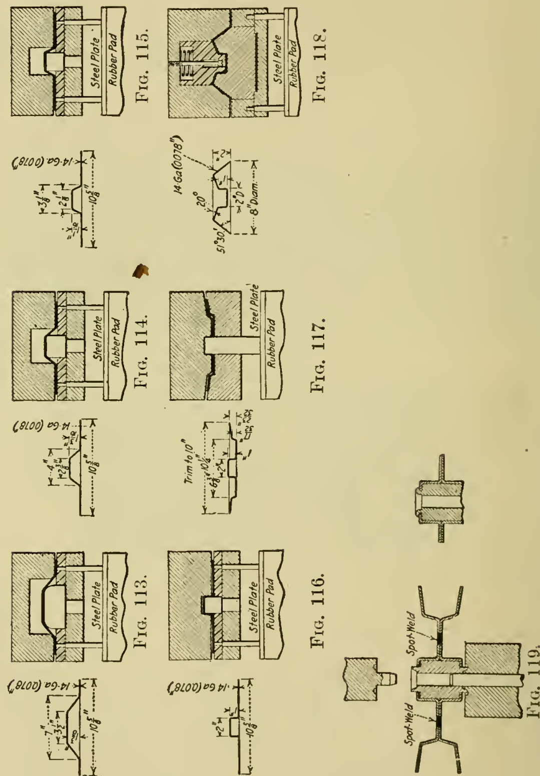


Fig. 112.—Stages of drawing a fan pulley.

floor. Its upper end acts as the die for producing the inner diameter of the pierced blank.

The stop K is held in position by the setscrew L and makes contact with the stock on the blanked hole produced in the scrap which has passed the die. The stripper plate M is held by two screws and dowels, as shown. The positive knockout N is a sliding fit in the punch E, having adjusting nuts on its upper end which govern the depth of its movement.

In operation, the stock is fed against the stop K and the punch descends and blanks the outside diameter, the stock being supported by the pressure ring D so as to prevent buckling or wrinkling. As the stroke continues downward the inner punch *F* pierces the inner hole in the blank and continuing to its lowest position forms the metal to the required shape. In ascending, the positive knockout *N* strikes a stop which forces the knockout downward and ejects the work.



FIGS. 113 to 119.—Making a hub for a fan.

Drawing Dies for a Fan Hub.—As it is rather difficult to draw a small hub on a large disk, this article may be of use to those who have similar work to do.

In Fig. 112 are shown the shapes of the samples in consecutive stages. The disk used is of 10⅞-in. diameter. The first operation reduces it about ¼ in. in diameter and raises the hub shown as far as the metal will go without straining it. The metal is ordinary cold-rolled steel plate 0.078 in. thick, and not special drawing stock. The dies might possibly have worked better if they had had hardened-steel drawing edges, but as they were for a limited production, they were made of cast iron.

In Figs. 113 to 118 are shown the tools for the six operations necessary.

After the last forming operation, a soft-steel insert is made as shown in Fig. 119 and pressed into one side; the other side is then pressed onto it. The hub is placed between the points of an electric spot-welder and welded at about four places.

The ends of the steel insert are next beaded over with a beading punch and die, after which the hub is drilled and tapped for setscrews. It is then punched for the blade rivets, when it is ready for assembly into the fan wheel.

Making a Fuse Clip.—The following illustration shows a modern method of making the fuse clip shown in Fig. 120.

Individual Dies and Operations

The vital points of this clip are the sides A,A, which fit into the terminals, and to insure good contact they have a certain amount of spring. The fuse ribbon is attached to B. The edges clamp it so that solder connections are easily made. A simple blanking die is shown in Fig. 121. To obtain the spring action mentioned, the blank is cut so that the grain of the copper runs lengthwise. The other sides do not require this spring action.

The die for the second operation is shown in Fig. 122. It is a piercing die of simple construction, with two bushings set in the bolster. This piercing die is used so that the blank will shear properly when in the die, Fig. 123.

In this operation the cuts are made in line with the edges of the pierced holes, the parts are also bent downward in this die and the gaging is done at the same points as in Fig. 122. The punch (not shown) has a spring pad attached to prevent the blank from sticking to the punches. No stripper is necessary for the die, as the turned-down ends have a tendency to spring out slightly and release themselves.

The tools for the fourth operation shown in Fig. 124 are for closing the ends, as shown at *B*, Fig. 120. The side with turned-up ends is placed under the forming die *A*, Fig. 125, and closed with the punch *B*.

In Figs. 126 and 127, the last operation is shown. This forms the piece to the proper shape. The gaging is done from the four corners as shown in the illustration. The die has a spring pad, which holds the blank and prevents it from buckling when the

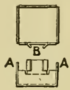


Fig. 120.

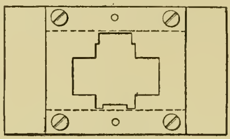


Fig. 121.

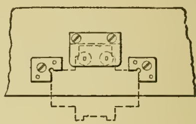


Fig. 122.

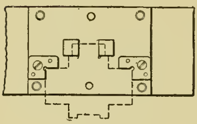


Fig. 123.

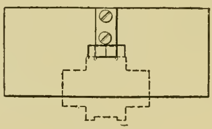


Fig. 124.

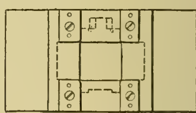


Fig. 126.

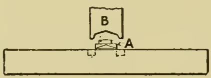


Fig. 125.

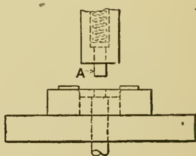


Fig. 127.

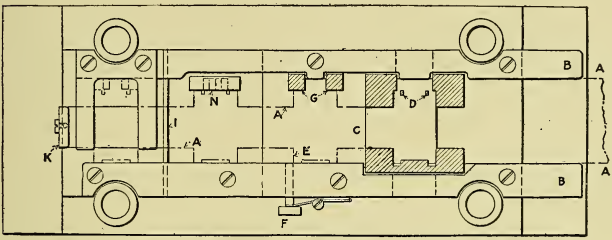
Figs. 120 to 127.—Dies for making a fuse clip.

punch enters. To prevent it sticking to the punch, a spring pin *A* is used. The sides *A*,*A*, Fig. 120, have no tendency to hug, owing to the grain of the metal, but the opposite sides, not having this spring, will at times cling, especially if the metal is slightly thick. Sharp corners must also be avoided, otherwise fracture is liable to occur.

The Gang Die

In order to increase production, the die shown in Figs. 128 and 129 was designed. All the operations previously described and illustrated are taken care of with this tool. By referring to the broken outline *AA*, Fig. 128, the method of operation is shown progressively. The stock enters at the gaging point *BB* as far as *C*, when the first operation is performed; namely, cutting the corners and piercing the holes at *D*. The next step is to move the strip to the point *E* where the gage *F* is pushed forward to locate properly the cutting and bending of the ends at *G*. At the same time the corners are cut and the holes *D* pierced. The strip is again moved forward to the point *F* and four operations are

Fig. 128.



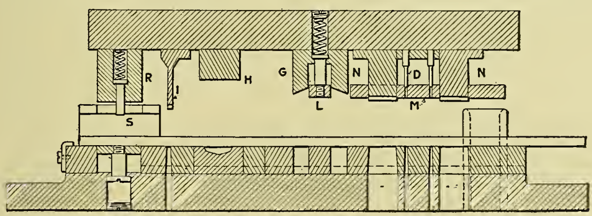


Fig. 129.

Figs. 128 and 129.—Gang die for fuse clip.

performed, the third closing the ends *H* and cutting off at *I*. The last move is to bring the stock to the gage *K*. At this point the piece is folded and the other operations are done simultaneously. The push gage *F* is used only when starting a new strip. The spring keeps it in proper place.

At Fig. 129 is shown a side view of the punch and die and the cross-sections are of the principal points, such as the piercing punches *D*, which engage at *D*, Fig. 128. Also the punches *G* corresponding to *G*, Fig. 128. The stripper *L*, Fig. 129, prevents the work from sticking to *G*. The stripper *M* embraces the punches *D,N,N*. The closing die is shown at *H*, the cut-off punch at *I*, and the folding punch at *R*.

A pressure pin *S* assists in holding the work securely while the cut-off punch severs the blank from the rest of the strip. The die is of pillar construction, making it self-contained. The punch holder and the bolster are of machine steel. Dies are sectional where permissible, making the up-keep, repair, and the like, easy tasks.

The actual costs of the dies are not available, but the first set cost in the neighborhood of $85 and the gang dies about $130. The production with the individual dies was about 150 finished pieces per hour. With the gang die the production is easily brought up 1000 finished pieces per hour.

Thus with an increase in cost of a little over 50 per cent. for the gang dies, we have an increase in production of nearly 600 per cent.

Making Sheet-metal Boxes.—In making sheet-metal boxes such as are used for protecting electrical installations consisting of cutouts, switches, fuses, etc., good judgment is essential in designing the necessary tools because first cost is generally considered an important factor.

The numerous different designs and sizes, varying in length, width and depth, make the problem of manufacture an interesting one, especially when the quantity produced of any one kind is small. The construction of proper dies in such cases would be prohibitive because the tools would probably never repay their cost. Therefore, to produce the boxes in question the equipment regularly used generally consists of notching, corner-cutting and piercing dies for the blank, and a break or bending machine for forming or folding the box.

In order to explain the method more fully the accompanying illustrations will assist in describing one way of making a sheet-metal box from material about $\frac{1}{16}$ in. thick.

The box shown in Fig. 130 is rectangular and the corners must be tight; that is, no opening or crack is permissible at *A*. The development of the blank is made apparent in Fig. 131, which shows the proper allowance made for the lap *A*, which is bent up at a right angle before folding the sides of the box. This lap is afterward spot-welded to the proper side, making a closed corner as shown in Fig. 130.

Proper Mass-production Method

To produce boxes in quantities the proper way would undoubtedly be to make one blanking die, one piercing die, one lap- or ear-bending die and one folding die for each size box, in order to minimize the operations, handling of stock, etc. Assuming, however, that conditions are otherwise and that a variety of sizes is wanted, it will readily be seen that it would not be profitable to construct individual dies for each size. Therefore, it is

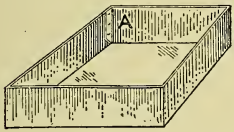


Fig. 130.

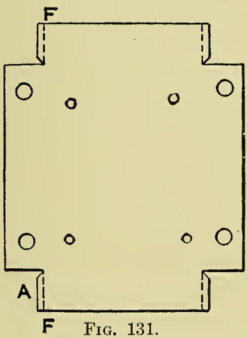


Fig. 131.

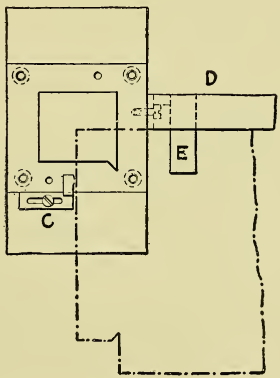


Fig. 132.

Figs. 130 to 132.—The box, blank and notching die.

necessary first to consider the tool cost and to provide a set of tools that can be adapted for all sizes within a reasonable range; hence, the following method is more practical.

The stock is sheared to correct size and a corner-cutting die, as shown in Fig. 132, is used for notching the corners. The opening is large enough for notching the blank for the box with the greater depth.

A machine-steel bolster on which the tool-steel die is mounted is so arranged with the adjustable gages *C* and *D* as to properly facilitate gaging the blank, which is shown in broken outline. The gage D has rests E for supporting and assisting in holding the blank flat.

The boxes are generally provided with various holes and openings on the bottom and sides for fastening to walls or meter boards, also openings for conduits and cables. These holes are pierced before folding the box, and individual dies are used, having proper locating gages attached to facilitate rapid operating.

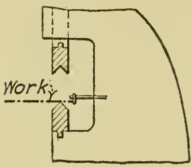


Fig. 133.

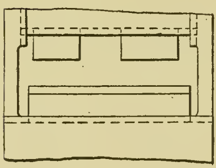


Fig. 134.

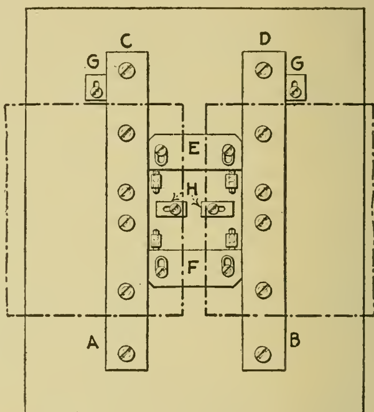


Fig. 135.

Figs. 133 to 135.—Dies for bending and cutting corners.

Owing to the size of the sheet and the different locations of the holes, the piercing dies are made on the style of a bushing, inserted in the bolster and held in place with a set screw, the stripper being attached to the punch. After the holes are pierced the laps, or ears, are formed, using a break or bending machine similar to the design shown in Figs. 133 and 134. Arranging the dies as indicated in Fig. 134, the ears can be bent on the dotted lines F of the blank shown in Fig. 131, two ears being bent at one stroke, thus completing the bending of the ears in two strokes.

Folding

The folding operation is done in the same machine, and when space permits and with proper arrangements of the dies, the ear-bending and folding can be completed in one handling, making six strokes of the machine for each box. Generally, a number of dies of various widths are kept in stock so that a number of different combinations can be arranged. With this tool equipment a variety of sizes of boxes can be made, but the cost of production is high. Although the problem of handling the pieces has been considered, the operations are necessarily slow, and the larger the sheet the slower the production, on account of the different movements necessary in handling.

In order to improve upon the method described, the factor of handling the product must be considered first; the problem resolves itself into making fewer strokes of the press in producing a box and still keeping the tool cost down as low as is consistent with the quantity required.

The following illustrations show adjustable dies which have been found of great assistance in speeding up production and reducing manufacturing cost.

The corner-cutting die is shown in Fig. 135 doing the same work as shown in Fig. 132. Two operators are required, one in front of and the other behind the press. In starting, the operator in front cuts his sheet and pushes it through to the second operator, who cuts his side at the same time that the first, operator is handling his next sheet.

One notable feature, besides producing one piece at each stroke is the simple method of handling the stock. No awkward turning movements are necessary, one operator simply puts the blanks in the press and the other takes them out, and where a conveyor scheme is used for removing the finished blank, the stroke of the press becomes as regular as clockwork.

Sectional Die

In its construction the die shown in plan in Fig. 135 is composed of sectional pieces fastened to a bolster plate. The stationary pieces *A*, *B*, *C* and *D* are doweled and screwed fast with fillister-head screws. The adjustable pieces *E* and *F* have oblong slots for the screws, and, to insure the dies from shifting, adjustable stops are provided which act as braces. To adjust for the different sizes, the pieces *E* and *F* are moved in or out, as are also the side gages *G* and end gages *H*.

The punches (not shown) are also fastened to a plate, adjusted and braced similarly to the dies *E* and *F*. They are ground taper to produce a shearing cut and the heel is made sufficiently long to allow it to enter the die far enough to insure rigidity during he cutting.

With the piercing dies the same scheme is used as before, there being no other practical method whereby all holes can be punched at one stroke of the press.

For bending the ears so that one blank is produced at each stroke of the press, the same principle is used, that is, two operators to one press.

Besides being more accurate than the bending machine, it will be noted that adjustments for the different sizes are equally rapid.

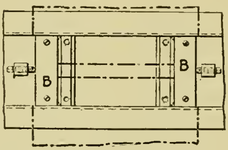


Fig. 136.

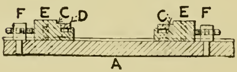
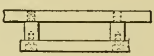


Fig. 137.



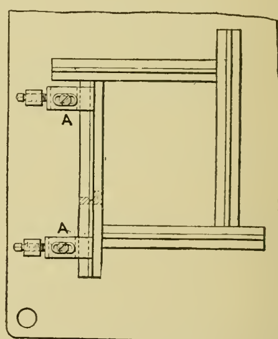


Fig. 139. Fig. 138.

Figs. 136 to 139.—The improved dies.

The die is clearly shown in Figs. 136 and 137. At *A* is the bolster to which the dies *B* are fitted, their ends machined taper or dovetailed to fit the bolster. Each has a recess at *C* which acts as a gage for the blank, and also a spring pad *D* which tends to hold the blank flat when bending the ear. Setscrews in the dies *E* and the stops *F* prevent shifting.

The punch (not shown) is constructed on the same plan except that the stop screws are placed in the center of the holder instead of the ends, as in the die. The punches tend to shift inwardly while the die tends to shift outwardly.

Folding Operations

For the folding operation the die shown in Fig. 138 is used. Besides being very simple in construction, the great range of adjustment makes it valuable, and it would be universal in its scope but for the fact that a separate punch plate and spring pad must be provided for each size. These, however, are made very cheaply, generally from cold-rolled flat stock, requiring no machining except on the sides and ends. Referring to Fig. 138, the four hardened-steel strips are shown in the arrangement, held in place by the clamps A, which are backed up by adjustable stop-screws.

The bolster is provided with a rubber to actuate the spring pad. As a new pad is made for each size, it is an easy matter to set up a job. The method of procedure is to place the pad in the center of the bolster and place the die strips around it.

The punch is shown in Fig. 139. The plate is supported by the studs which are screwed in the holder, which is always fastened to the head of the ram. Additional holes are tapped in the holder for the different locations of the studs as the sizes vary.

Boxes made from zinc are extensively used in protecting installations, especially when inclosing the meter and cutout, and considerable trouble is often encountered in folding the box. The sides often break entirely off or fracture on the bending line, especially so when running with the grain. This fact is more noticeable when the metal is cold, so to eliminate breakage as much as possible, the blanks are placed in hot water or some heating apparatus convenient to the operator.

Press Tools for Making a Swivel.—The tools shown herewith were designed for making the swivel ring for a small lot of swivel hooks used on dog leashes, swords and the like, as shown in Fig. 140.

An end elevation of the press tools used to form the double ring on top of the large ring is shown in Fig. 141. The wire is first cut and bent U-shaped, as shown at Fig. 143. It is placed between the jaws *A*, *B*, Fig. 141, then the handle *C* is brought over locking the *U*-wire in the vise, so that it can be formed round the piece *D* and the tit *H* by the punch *E*, which is brought down on the die and turned round by hand with the aid of the bar *F*. The punch is then raised and brought sharply down to flatten the double ring on top, leaving it as shown in Fig. 144. When the locking handle *C*, Fig. 141, is released, the vise is opened by the action of the spring *G*; the iron-wire ring is then quite easily removed by hand.

A plan of the tools is shown in Fig. 142 with the vise locked on a U-shaped wire ready for the punch *E*, Fig. 141, to be brought down. The tit *H* on the end of punch *E* enters the hole *J* and the wire is formed round it by the two projections *K*,*K*, which draw the wire toward the center pin *N* and then continue to

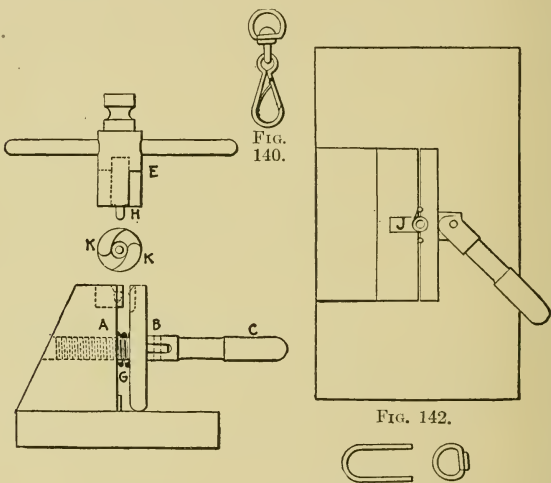


Fig. 140.

Fig. 142.

Fig. 141. Fig. 143. Fig. 144.

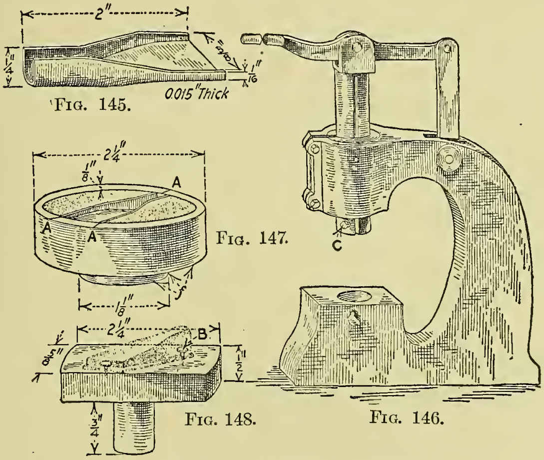
Figs. 140 to 144.—Tools for making a swivel.

turn the ends of the wire around the pin. The ring is made from soft-iron wire 0.1 in. diameter and is cut and formed on a standard four-slide wire-forming machine running at 120 r.p.m., and finished on a press at the rate of 25 per minute. The total cost of the tools was $20.

The same job could be made in one operation at a little extra cost for tools on a standard automatic wire machine at the rate of 100 per minute.

Making a Small Forming Die.—The punches and dies here illustrated were to turn out the piece shown in Fig. 145 and were to be formed in a hand press as in Fig. 146.

The cup-shaped piece, Fig. 147, was first made of hardwood. This was filled with plaster of Paris and while soft the model (which had been submitted with the job) was pressed into it, centralizing by marks, as indicated at *A* in Fig. 146. When the plaster had set, the model was taken out and the mold trimmed up smooth on top and edges with a file, it was then sent to the foundry, where a fine iron casting was made from it. This was smoothed up in the form and machined where indicated. Two countersunk holes for fastening to the press were then drilled, as shown. This completed the die.



Figs. 145 to 148.—Making a small forming die.

The piece shown in Fig. 148 was then made from a hardwood block, turning the stem to fit the hole in the spindle of the press. The die was next set into place in the press and a piece of cardboard wound around it and held with a rubber band to form a cup. The model was next placed in the die and after placing the piece shown in Fig. 148 in the spindle, plaster of Paris was run into it and allowed to set. The die and model were oiled so that the plaster would not stick to them. The plaster was anchored to Fig. 148 by two large-headed tacks shown at *B*. Some thick paper was then glued to the stem of the punch to allow for small finish. This was sent to the foundry and cast of fine iron. It was then smoothed and finished in the same way as the die, care being taken that the stem ran true before turning. It was next placed in the spindle with the die and model in place and spotted for the setscrew point at *C*. By this method a very satisfactory job was turned out.

Reinforcements for Tapped Holes in Brass.—In the production of electrical appliances, instruments, supplies, and the like, which are made of sheet metal and have holes pierced in the punch press, which must later be tapped, some trouble will be encountered when it comes to using stock less than 1/16 in. thick, especially if the tapped hole must resist any strain. In order to

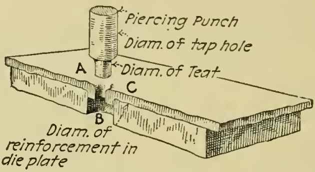


FIG. 149.—Reinforcements for tapped holes.

provide the greatest possible thickness of metal to tap through, the stock is pierced and the punch which does the piercing has an enlargement which passes down through the metal far enough to force the metal out on the under side, forming a reinforcement or greater thickness for the tapping of the hole.

In the illustration, Fig. 149, are shown the type of punch used, at *A*; at *B*, the hole in the die-plate, and at *C* a section of the metal after the punching and forming has been completed. The size of hole in the die-plate governs the outside diameter of the reinforcement.

The dimensions given in the table have been found to give excellent practical results in the tapping of holes in half-hard brass. The dimensions for the tapped holes required, the diameter of the piercing punch used, the diameter of the forming portion of the piercing punches and the outside diameter of the reinforcement when finished, are given for brass 0.031 in., 0.400 in. and 0.050 in. thick.

Others feel that where a long draw is required (say over twice the thickness of the metal), a single drawing punch as shown is apt to crack and break the edge of the draw as shown in Fig. 150, herewith.

Size of tap	Diam. of tap hole, inches	Diam. of piercing punch, inches			Outside diam. of reinforcement, inches
		0.031 brass	0.040 brass	0.050 brass	
3–48	0.082	0.045	0.052	0.060	5/32 × 1/32
4–32	0.087	0.053	0.060	0.068	5/32 × 1/32
4–36	0.093	0.063	0.070	0.078	5/32 × 1/32
5–40	0.105	0.071	0.078	0.086	5/32 × 1/32
6–32	0.113	0.079	0.086	0.094	5/32 × 1/32
7–32	0.128	0.087	0.094	0.102	5/32 × 1/32
8–30	0.138	0.095	0.102	0.110	5/32 × 1/32
8–32	0.141	0.103	0.110	0.118	5/32 × 1/32
3–48	0.082	0.043	0.050	0.058	11/64 × 1/32
4–32	0.087	0.051	0.058	0.066	11/64 × 1/32
4–36	0.093	0.061	0.068	0.076	11/64 × 1/32
5–40	0.105	0.069	0.076	0.084	11/64 × 1/32
6–32	0.113	0.077	0.084	0.092	11/64 × 1/32
7–32	0.128	0.085	0.092	0.100	11/64 × 1/32
8–30	0.138	0.093	0.100	0.108	11/64 × 1/32
8–32	0.141	0.101	0.108	0.116	11/64 × 1/32
3–48	0.082	0.041	0.052	0.056	3/16 × 1/32
4–32	0.087	0.054	0.059	0.064	3/16 × 1/32
4–36	0.093	0.059	0.066	0.074	3/16 × 1/32
5–40	0.105	0.067	0.074	0.082	3/16 × 1/32
6–32	0.113	0.075	0.082	0.090	3/16 × 1/32
7–32	0.128	0.083	0.090	0.098	3/16 × 1/32
8–30	0.138	0.091	0.098	0.106	3/16 × 1/32
8–32	0.141	0.099	0.106	0.114	3/16 × 1/32
3–48	0.082	0.051	0.058	0.066	3/16 × 3/64
4–32	0.087	0.059	0.066	0.074	3/16 × 3/64
4–36	0.093	0.069	0.076	0.084	3/16 × 3/64
5–40	0.105	0.077	0.084	0.092	3/16 × 3/64
6–32	0.113	0.085	0.092	0.100	3/16 × 3/64
7–32	0.128	0.093	0.100	0.108	3/16 × 3/64
8–30	0.138	0.101	0.108	0.116	3/16 × 3/64
8–32	0.141	0.109	0.116	0.124	3/16 × 3/64

Reinforcements for Tapped Holes in Brass

This breaking is overcome by making the drawing punches as shown at Fig. 151, the number of steps depending upon the size of hole and depth of draw required. In fact, this is the only shape of punch that gives satisfactory results in drawing holes in all metals, and it is useful where a boss is to be drawn in a large sheet of metal. In small work this type of punch will pierce first and then continue drawing the hole it has pierced in one operation, but in other than small work it is best to make the piercing and drawing separate operations.

In Fig. 152 is shown a plan and elevation of a brass ring to which three small springs had to be assembled; they were previously assembled by piercing six holes in the ring and assembling the ring and springs by using eyelets. By using the same pierc-

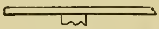


Fig. 150.

Fig. 151.

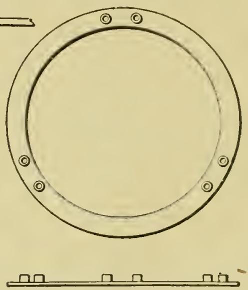


Fig. 152.

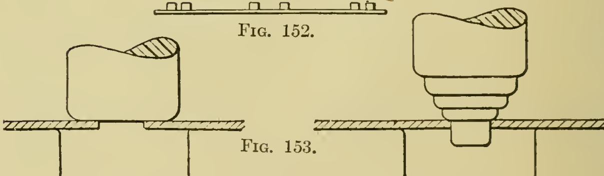


Fig. 153.

Figs. 150 to 153.—Other methods of reinforcements.

ing tool and only changing the punches the projections were drawn from the ring as shown at Fig. 153. These projections took the place of the eyelets and made the assembling much easier. The thickness of the ring was 0.04 in., thickness of drawn projection 0.02 in. and the depth about 0.1 in. The drawing punches in this case had four steps or sizes on each, allowing the lengths of draw to be such that no two sizes were being drawn at the same time.

In drawing steel greater care has to be taken to prevent the open edge of the hole cracking, and usually a greater number of drawing edges on the punch are desirable and the shape and size of the radii are important, while the annealing of the pierced hole is an advantage in deep drawing.

In Fig. 153 is shown how the two kinds of punches act upon the stock or pierced hole. It is easily seen that there is a great sudden strain upon the metal with the single punch, which has a tendency to crack the edge of the hole before it draws, while with the multi-

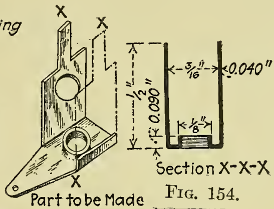


FIG. 154.

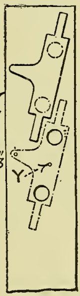


FIG. 155.

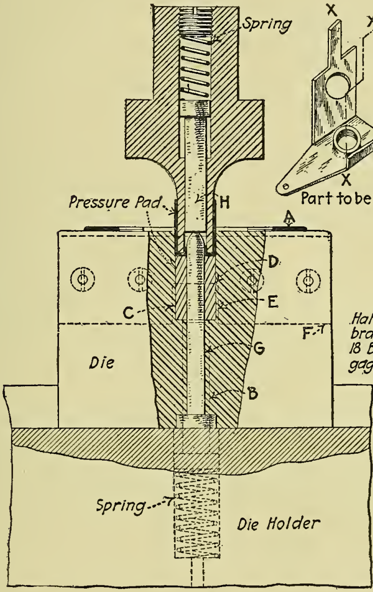


FIG. 156.

FIGS. 154 to 156.—Still another reinforcement.

size punch it is only a small amount of metal round the hole that is influenced; it is, in fact, an expanding punch which draws. A taper punch has no better effect than the radius-end single-size parallel punch.

Another die made to bend and draw a reinforcement so as to give more thread room is shown in Fig. 156.

The part is shown in Fig. 154 with the drawn portion and the increased thread space in comparison with its thickness of stock.

7

In the perspective view one side leg is removed to show the drawn boss.

The sequence of operations necessary to manufacture this part is: First operation, blank and pierce all holes; second operation, bend and draw the boss for the tapped hole; third operation, tap the drawn hole.

Fig. 155 shows the stock layout for the blanking and piercing die; the size of the hole *Y* determines the length of the drawn boss. If this hole is made large the drawn boss will not be long and, again, if the hole is small you can obtain a longer boss, because it is the amount of metal left after you pierce the hole which determines the length of boss.

Fig. 156 shows the punch and die with the part in position completely formed and with the correct size of hole corresponding to the proper tap-drill size for the tapping operation.

One of the blanks is shown at *A*; at *B* are two pins with springs to operate the pressure pad. These have two projections *C*, one on each side, which stop against *D* in the cut-out portion *E* in the plate *F*. There are two of these plates secured to the side of the die, which retain the pressure pad. The pin *G* draws the boss and is provided with a point to enter the pierced hole. The pin *H* in the punch removes the completed part.

Pressed Versus Machine-finished Parts.—In the manufacture of interchangeable parts, used in the assembly of adding and addressing machines, registers, scales, typewriters and the like, in which a large quantity of duplicate parts of a tubular or hollow cylindrical form are used, which must be not only concentric but interchangeable, and yet low in production cost, it becomes quite a problem for the shop superintendent to decide which is the best, quickest and cheapest way to produce such parts.

If the quantities required are small, say not over 1000 pieces per lot and the lots are far between, and if cheapness need not be a prime factor in his calculation, the superintendent will invariably decide in favor of screw machines, either automatic or hand operated, and it depends largely on the condition of these machine tools, the skill of their operators and the stringency of the inspection limits how large a percentage of perfect, that is, interchangeable, parts will be obtained from a given lot.

Another reason why screw machines are generally favored for this class of work is because of their adaptability to various forms of cylindrical work without a great investment for special tools. A nominal figure for forming tools and reamers is all that is reckoned. This factor is, perhaps, the trap in which many otherwise shrewd shop managers are caught; they see only the low initial cost for tools, but overlook entirely the loss per lot due to slow production, to work spoiled or not passing inspection, and to the fact that their screw-machine department becomes overtaxed with work that could be done advantageously with special tools in punch presses or with special machinery. They deprive themselves of the use of their screw machines and millers for work that cannot be done to good advantage in any other way.

Examples of the Work

The drawings will furnish an instance of this.

Fig. 157 represents a hollow shaft with slots running parallel to its axis. Fig. 158 shows a slotted filler for Fig. 157. Fig. 159

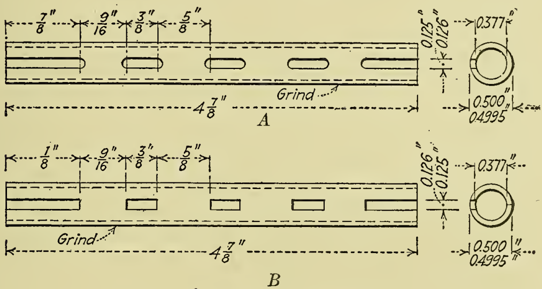


Fig. 157.—A slotted hollow shaft.

is a view of a spacer tube, and Fig. 160 illustrates a threaded housing for a ball race.

After a superficial examination of the illustrations nearly every practical man would assign these parts to the screw machines for the first operation, to be followed, where required, by a slotting operation on the miller. In fact these parts had been made for years in just this way in one factory until it was realized that they were costing considerably more than their allotted allowance in the assembly of the machines.

On account of the close limits on length and concentricity of the outside with the hole, the inspection loss had been great and the time of production slow, so that the screw machines fell behind with other work. This necessitated working overtime and even night shifts at higher wages. This meant an increase of pay-roll, an increase of power and light bills and raised the entire overhead charge, directly affecting the production cost of the screw-machine department in total.

The parts shown by Figs. 157-*A* and 159-*A* were made of seamless steel tubing of sufficient wall thickness to allow machining of the pieces both inside and outside. The hole was first bored and reamed to size, but since tubing of such wall thickness could not be secured absolutely true and the drill and reamer followed the old hole, subject to the law of least resistance, it was impossible to get concentric work until the outside surface was finished in a later operation by driving the pieces on arbors and turning them between the collet and center. By this method true work was obtained, but the finish depended on the sharpness of the cutting tools and the cutting speed of the machine. Anybody acquainted with the machining of unpickled steel tubing knows what that means.

A Change in Material

Finding this method unsatisfactory a change was made in the material and the parts made of cold-drawn steel stock of the largest diameter of the finished pieces, depending on the accuracy of the stock for the outside surface, the size of the reamer and copious lubrication for the size and smoothness of the bore. It also depended on good luck for the trueness with which the drill and reamer would come out on the other end, or rather meet in the center (inasmuch as the automatics had only a 2-in. feed and it was necessary to add another drilling and reaming operation on a hand machine).

On account of a lower price for cold-drawn stock as compared with steel tubing and because the machining of the outer surface of the hollow shaft, Fig. 157-*A*, was omitted, the final cost of these pieces was about one-third lower as made of cold-drawn material in the manner last described than when made of tubing, in spite of the additional drilling through the center. However, even at this reduction the price was too high because of the large inspection loss due to eccentric work, as well as to rough or oversize holes.

The part Fig. 160 was also made of cold-drawn stock, on an automatic. The thread had to be absolutely true with the bore and was chased on the lathe as indicated in Fig. 160-*A*. The part Fig. 158-*A* was made of special gaged cold-drawn stock cut off on a hand screw machine and then slotted and milled at great expense in two operations.

The drawings marked *B*, showing these parts somewhat modified in their appearance but serving the identical purposes,

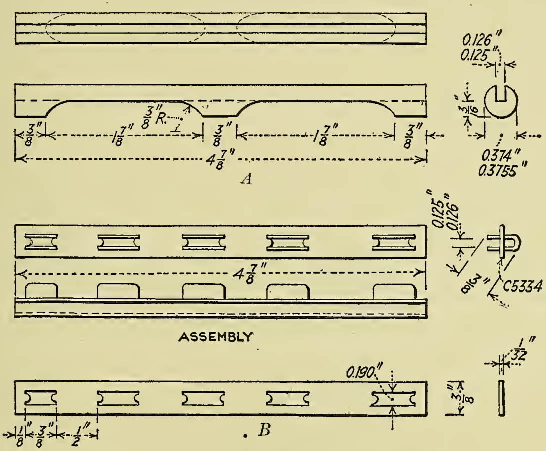


Fig. 158.—Slotted filler for hollow shaft.

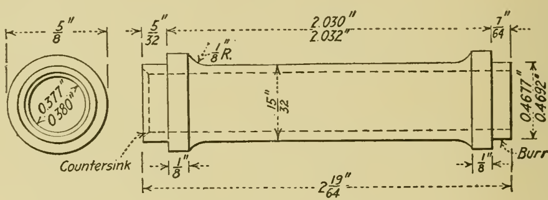
will show clearly how they finally dispensed altogether with the expensive screw-machine and milling operations. This left these machines available for other jobs, thus cutting out expensive overtime and night work and incidentally reducing the cost of the products to a surprising extent.

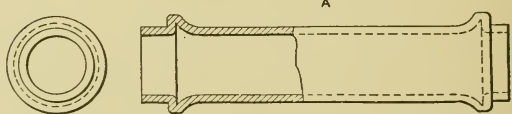
They are now making part Fig. 157-*A* in one-tenth, part *B* at less than one-tenth, part Fig. 158-*B* at one-fourth, and part Fig. 159-*A* at one-third of their former costs and the products are finished better now than when made under old conditions.

Greater Economy and a Better Product

It will be noticed that all of these parts, with the exception of *B*, Fig. 158, which is die formed of seamless steel tubing of a gage to give correct diameter at the shoulders and requiring no machining or finishing, are now formed of cold-rolled, open-hearth strip steel in special dies and require little or no machining. In spite of their great cheapness the pressed products are far more satisfactory and uniform, and therefore interchangeable, than were the expensive machined pieces. An added advantage of the pressed pieces is their smoothness and wearing qualities, due to the rolled surface of the raw material.

The transformation of this production from bar steel on the screw machines to cold-rolled strip steel, formed to shape in special dies in the punch press, required an investment of about





B

Fig. 159.—A spacer tube.

$500, but the saving on the first lots repaid this expenditure and left a profit besides.

The examples given in the preceding, while based on facts, are by no means suggested as a criterion by which other conditions should be regulated; they merely express one man's opinion and illustrate how one firm dealt with perplexing conditions and remedied them to their entire satisfaction.

Making a Pressed-steel Bicycle Hub.—The pressed-steel bicycle hub is drawn from a 4⅛-in. blank of 18-gage cold-rolled steel, but can also be made from 18-gage seamless tubing, thereby eliminating the first three press operations and making it possible to complete this hub in four operations. It is more economical to make them from annealed seamless tubing, if one considers the cost of dies, punches, labor, steel, presses, etc.

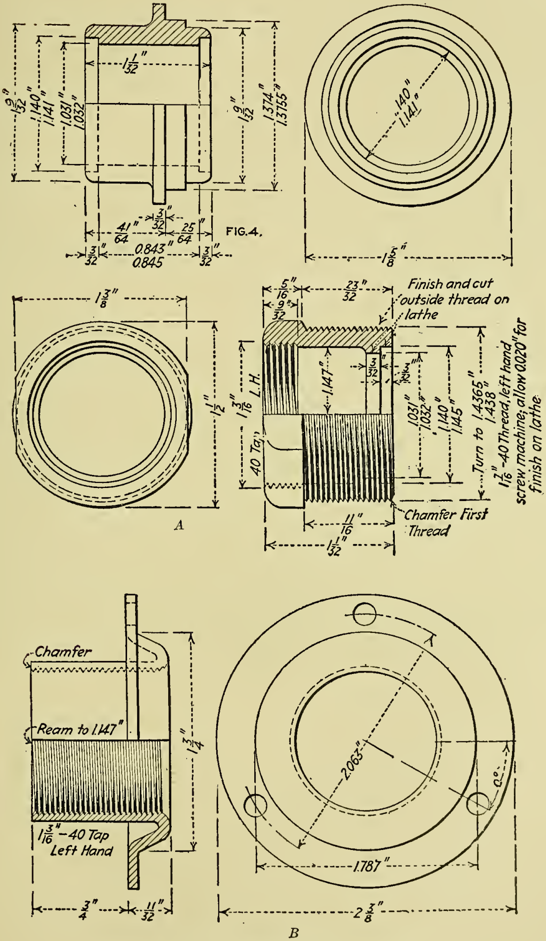


FIG. 160.—A threaded-ball race housing.

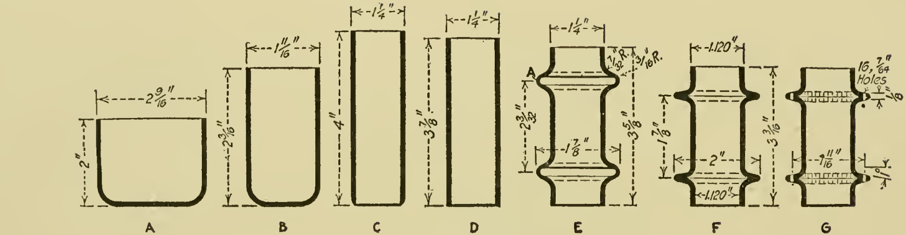
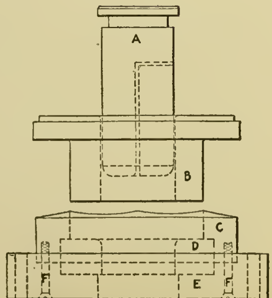
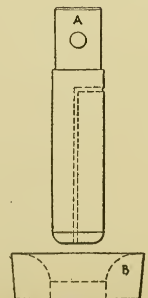


Fig. 161.



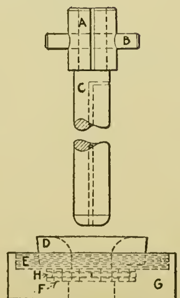
1ST OPERATION

Fig. 162.



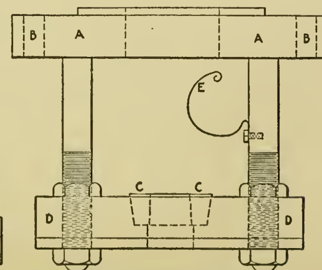
2ND OPERATION

Fig. 163.



3RD OPERATION

Fig. 164.



UNDERSLUNG PERFORATING DIE HOLDER USED IN 3RD OPERATION

Fig. 165.

Figs. 161 to 165.—Making a pressed-steel bicycle hub.

Hubs made from cold-rolled steel have a better appearance and are finished more easily for the nickel plater. The operations are shown in sequence in Fig. 161.

The first operation is blanked on a double-action press. This press will give greater satisfaction and a greater production than a single-action press and a compound die. When using a compound die, the press must be stopped to remove each shell, whereas with a double-action press the shell is drawn through the die, dropped into a receptacle under the press and automatically conveyed to the next press, where it is run through the second operation. The press can, therefore, be run continuously on each sheet of stock.

First Operation

The first-operation die and punch are shown in Fig. 162. The drawing punch *A* and the drawing die *D* are of high-speed steel. While ordinary tool steel will do, it wears faster and develops scratches oftener than high-speed steel, making it necessary to stop the press and polish the die and punch. It will be found that high-speed steel gives greater satisfaction, the upkeep costing less and the production being greater.

The blanking punch is shown at *B*. The blanking die *C* is set in a cast-iron plate with the drawing die *D* set underneath it; these are held together with flat-head screws *F*.

Air holes are provided in the punches of the first, second and third operations. It costs little to put these air holes in punches and there is great saving on stripper repairs, as punches with air holes strip the shell more easily.

Second Operation

The second-operation tools, shown in Fig. 163, consist of a straight punch and round die set in a die holder *G* in the manner shown in Fig. 164. The punch *A* has a hole through the shank to secure it by means of a through pin *B*, Fig. 164.

The inserted die *B*, Fig. 163, is cheap and lasting, as compared with a large solid die, because it can be shrunk and brought back to size a number of times. It can be replaced in a few seconds when it becomes necessary, and does not require as much material as a solid die. Its great advantage over the solid die is the facility with which it can be replaced, thereby not holding up production.

The third-operation shell *C*, Fig. 161, has no bottom. It is perforated on an underhanging perforating die shown in Fig. 165 at *C*. The body *A* is set underneath the third-operation die and fastened with capscrews to the bolster plate at *B*. The perforating die *C* is set into a large adjustable retainer *D*, and can be adjusted to let the drawing punch *C*, Fig. 164, perforate the bottom of the shell after drawing it through the die *D*, Fig. 164. When the shell is stripped from the punch, it is gently thrown out of the way of the succeeding shell by the spring *E*, Fig. 165.

The dies for the third operation are the same as those used in the second. When the diameter of the punch is less than

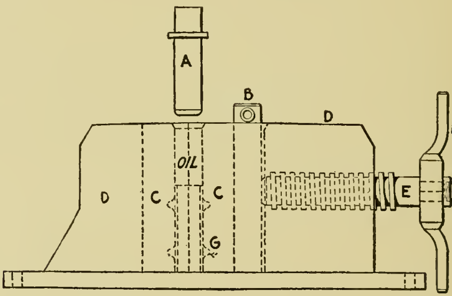


Fig. 166.—Expanding the hub.

the hole in the ram, it is more economical to use a bushing *A*, as shown in Fig. 164, thereby avoiding the use of steel of large diameter for the punches. The die-holder *G* has a threaded bushing *E* to seat the die and at the same time retain the stripper *F*, which is sectionally held together by a wire spring *H* to allow the necessary expansion when the shell is pushed through it. It then closes around the punch and strips the shell when the punch is withdrawn.

The fourth operation is done on a double-end trimming lathe; in it the shell is trimmed to 3⅞ in. in length.

The Fifth Operation

In the fifth operation the shell is expanded at *G*, with the aid of lard oil, in the die and punch shown in Fig. 166. The dies *C* are made in halves and are set in the heavy cast-iron holder *D*, being held solid by the screw *E* and the handle *F*. The spacing block *B* is removed instantly when the screw pressure is released. This saves time which would otherwise be taken up in turning the screw far enough back to allow the hub to be put in place and removed.

The dies and punches are highly polished. The punch *A* is ground a close fit for the 1¼-in. hole in the die, so as not to let the oil escape when the punch descends. The die is kept overflowing with oil by an automatic pump. The punch *A* is adjusted so it will enter the die about 1⅛ in., thereby giving the desired result.

It will be noticed that the hub at *A* is stretched and thinned out more than at any other point. This is desirable and makes it easier for the sixth-operation die to give it the proper shape.

Sixth Operation

The sixth-operation die and punch, shown in Fig. 167, is a toggle die and punch that does a neat and satisfactory job. It is necessary that the hub be held to an accurate diameter on the inside, as each end eventually will retain a ball-bearing cup pressed into place.

The bar *A* is connected to the dies *G* and *J* by the links *B*, which force the plungers *C* against the die *D*. The plugs *F* in the plungers size the inside of the hub and at the same time act as guides.

The die *D* is in halves and is opened to insert or remove work by turning the screw *E*. Cams have been used in place of the screw, but the screw works better.

The lower end of the front half of the die *D* is seated at *H* and is free to work back and forth the necessary distance to replace the finished hub. Two tapped holes *I* are to fasten the dies to the press. The gibs *K* are to hold the plungers *C* and at the same time allow them the necessary sliding freedom.

Seventh Operation

The seventh operation shown in Fig. 168 is also done with a toggle die and punch which operates similarly to the one for the sixth operation. It pierces sixteen holes 7/64 in. diameter in each flange.

At *A* are shown the dies held in place by screws. Each die is in two parts to allow the hub to be placed in and removed from the die when finished. It is opened and closed by the screw *C* and the handle *G*.

The perforating punches *D* are held by plates fastened by screws. The punches are made as short as possible to lessen

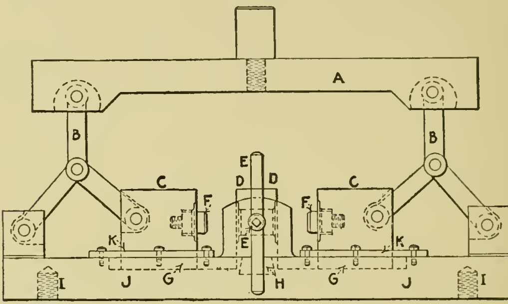


FIG. 167.

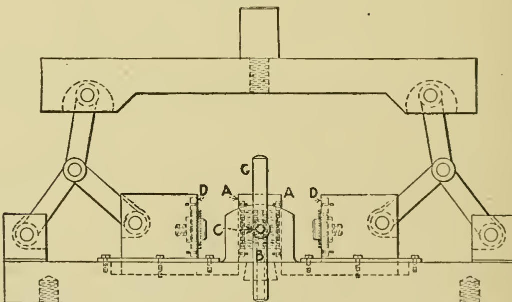


FIG. 168.

FIGS. 167 and 168.—Upsetting and perforating the flanges.

the risk of bending and breaking. They should be oiled frequently with a little lard oil, which insures longer life and better results. At *B* is shown the clearance slot that is necessary to remove the piercing scrap.

The first, second, third and fifth operations give better results when performed in draw presses not running too fast, while the sixth- and seventh-operation dies and punches can be used in ordinary quick-acting presses.

Hollow Balls from Flat Stock.—It was required to make a lot of hollow balls as shown at *D*, Fig. 169. The diameter was to be ½ in. They were to be of sheet brass of sufficient thickness to withstand the stress of closing-in without collapsing. It is important that the right thickness of metal be used, for if the stock be too thin it will collapse when being closed-in at the last two operations, and if the metal is too thick the closing-in operation will be rather difficult; there will be unnecessary wear on the punches and dies, and also a waste of stock.

By experimenting it was found that the size which gave the best results was No. 20 B.w.g. or 0.035 in. for ½-in. balls.

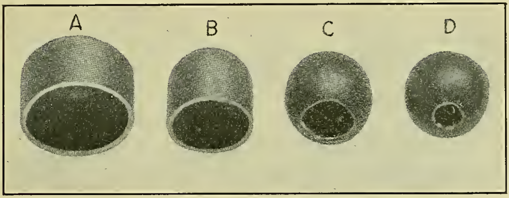


FIG. 169.—Making hollow balls from flat stock.

TABLE OF THICKNESS OF STOCK FOR BALLS OF GIVEN DIAMETER

Diameter of ball	Thickness of stock	Diameter of ball	Thickness of stock
⅛	0.010	½	0.035
3/16	0.014	⅝	0.042
¼	0.018	¾	0.049
5/16	0.022	⅞	0.058
⅜	0.025	1	0.062
7/16	0.032		

THE PUNCH AND DIE

In Fig. 170 is shown the punch and die for blanking and drawing into the cup, shown at *A*, Fig. 169. A feature of this die to which I would like to direct special attention is the stop *A*, Fig. 170. This style of stop, which is simple, differs from the common type, familiar to most tool makers, in that it has a movement in a horizontal as well as in a vertical direction. This is attained by making the finger a rather loose fit on the pin *B* and filling the edges around the hole to allow the finger to move in a horizontal direction through a small arc. The slot in the stripper into which the finger is fitted is milled about 1/32 in. larger at the end nearest the center of the die, showing so much play for the finger.

The spring *C* holds the working end of the finger pressed down by the die and also pressed against the direction of the feed, so that when the stock is fed against it the finger is forced back to 1/32 in. against the back of the slot and is brought to a positive stop. Then when the punch is nearing the end of its stroke the adjustable rod *D* comes down on the board end of the finger, causing the working end to rise clear of the stock, when the spring forces it back to the forward side of the slot, where it remains until the stock is fed in for another stroke. The finger will then drop into the hole which has just been punched in the scrap, and the same operation is performed as before.

The blank is punched out of 1 1/8-in. wide stock and drawn up as shown. The cup is lifted out in the upper die, clear of the stripper, when it is ejected by the knockout *E* and falls into the receptacle at the rear of the press, which should be inclined at about 45 degrees.

The Second Drawing

In Fig. 171 are shown the punch and die for the second drawing, and the result is shown at *B*, Fig. 169, and in detail in Fig. 171. It will be observed from the detail that the cup is 0.050 in. smaller in diameter than the finished ball. The reason for this is to allow for "bulging" when the ball is being closed-in in the following operation. The punch and die for the first closing-in are shown at Fig. 172, and the piece after this operation is shown at *C*, Fig. 169, and also in detail in Fig. 172.

In Fig. 173 are shown the punch and die for the last operation, which completes the ball as required in this case. If it were required to bring the ball down to a greater degree of refinement than is possible on a press, then it would have to be rolled between disks in the same manner as ball bearings, when the opening shown in the ball at *D*, Fig. 169, would be entirely closed and the ball would be brought down to within 0.001 in. of correct diameter as well as sphericity.

This latter method has been used in the manufacturing of gold beads and other novelties, such as hatpin heads and the like. If it is required to manufacture a solid gold bead an economical way is to make the head out of sheet copper plated to whatever thickness of gold we desire to put into the bead. The copper plate should be strong enough to stand up under the

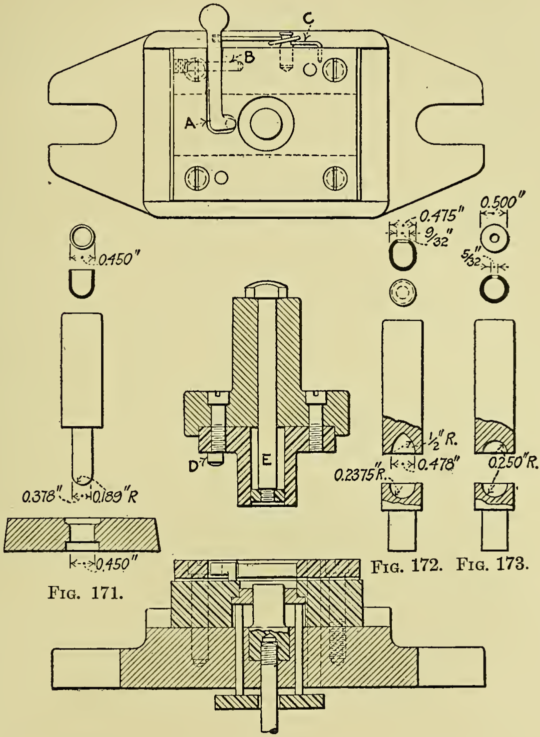


Fig. 170.
Figs. 170 to 173.—Tools for making hollow balls.

stress of closing-in. The ball is then drawn up in the manner described, with the gold on the outside of the ball. The copper is then dissolved in a solution of 1 part muriatic and 11 parts sulphuric acid, leaving the thin wall of solid gold.

Method of Making Door Knobs.—In Fig. 174 is shown a very economical combination die for such work as making sheet-metal door knobs. This is what is known as a regular combination die and is made as follows: The base *A* is of cast iron and forms the center of the drawing die *B*. Above is the knock-

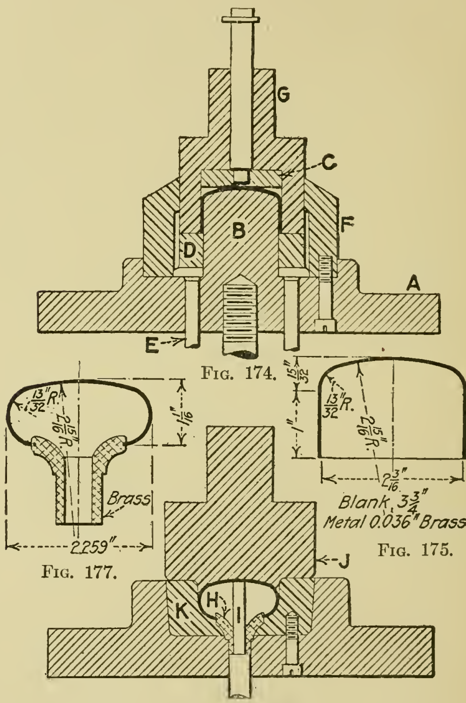


Fig. 174.

Fig. 175.

Fig. 177.

Fig. 176.

Figs. 174 to 177.—Combination die for door knobs.

out pad *C*; this does not have to conform to the shape of the shell, for the drawing alone insures the metal being formed around the cast-iron center *B*. The draw ring *D* is forced up by heavy rubbers which act on the four pins *E*. The cutting edge *F* is inserted in the lower cast-iron die-holder and held by screws.

The punch *G* is made of one piece of tool steel properly hardened and ground, as shown.

After it leaves the combination die, the shell is trimmed on the outer edge to the height indicated in Fig. 175. It is then placed in the lower die, Fig. 176, but before putting the shell in place the brass center piece of the knob *H* is put in the die. The punch then descends and forms the shell around the curved shape, forcing the metal, or shell, into the groove in the brass center *H*. On the return stroke of the press the knock-out pin *I* lifts the combined shell and center out of the die, completing the operation, as shown in Fig. 177.

In the closing die, the punch *J* is made of one piece of steel and fits the combination die *K*, so that when this punch comes into contact with the bottom of the shell it will not distort it in any way during the rest of the operation. The die *K* is made of tool steel worked out to the shape of the cast-brass center *H*, and also the shape of the ball, or knob.

Deep Drawing of Metals.—The drawing of metals, as the deep forming of cup- or shell-shaped hollow bodies is erroneously called in the shop language, because as generally practised the operation is one of pressing or pushing rather than drawing a desired form, is still a mystery to a large number of metal workers.

The advance and rapid improvements in the making of cold-rolled strip steel and the phenomenal increase in its uses have opened an almost unlimited field of usefulness for the material.

The most important part of the forming operations on deep hollow bodies consists in holding the flange flat and preventing it from crimping. Drawing dies, in their main parts, consist:

1. Of one or several punches, if more than one forming operation is required to give the body the desired depth and shape, which is generally the case; each following punch is a step nearer to the final shape and inside dimensions of the piece than the preceding one.

2. Of a ring, frame or hollow block, the die, into which the metal is pushed. There may be also one or several required to finish the piece, according to the depth or difficulty of its shape, but in many cases several punches can be used in connection with the same die, inasmuch as it is the punches which give the shape to the piece and it is not absolutely essential that the shapes of the dies should correspond to those of the punches, although in

many cases it is beneficial that they should because they help to straighten out and stiffen the formed cup.

3. Of a so-called drawing ring, which is in most cases a flat plate or frame with a hole in it of the approximate largest diameter of the piece. This drawing ring is fastened either to the stripper slide of the press, if a double-acting drawing press is used, or is fastened to the die shoe or punch-holder in such a way that a rubber or spring buffer applies a stiff pressure against it.

The purpose of this drawing ring is to keep the rim or flange of the blank flat and prevent it from crimping. The pressure of the buffer must be regulated to allow the blank to slide with the downward motion of the punch, but be at the same time stiff enough to prevent the formation of wrinkles around the flange of the blank. The surfaces of the die and drawing ring must be parallel and smooth and should be well lubricated with a thick oil or drawing compound to make them slippery. The pressure of the drawing ring must be uniform to allow the stock to slide in equally from all directions. The upper edge of the die should be well rounded and sharp corners, which tend to lock the metal, should be avoided or at least, if the finished product requires them, the forming of these should be delayed to the last operation when the desired depth of the body has been reached.

While these general notes apply to all deep drawing operations on semi-spherical, cylindrical, cone- or cup-shaped hollow bodies and the cited difficulties are common to all of these, still they are easy in comparison with forming cubic, prismatic or polygonal shapes because the absence of corners in the former shapes gives the metal a more equal resistance and the formation of wrinkles at the flange is uniformly on radial lines toward the center of the blank and can therefore be taken care of more easily than in the later case, where the crimping takes place in the corners only. The stock which does flow over the straight edges of the die does not get its due share of concentration and the surplus stock is crowded together in the corners and as it cannot either condense or stretch there fast enough, because locked on all sides by the straight flanges, it hardens quickly, and the result is that the material tears. The sharper and fewer the corners, the more readily the stock will break there, a three-cornered cup will therefore form harder and break quicker at the corners than a four- or a six-cornered one.

The three samples shown in Fig. 178 are evidence of the tend-

FIG. 178.—How steel tears in drawing.

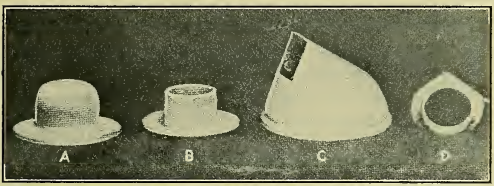


FIG. 179.—Four samples of drawing.

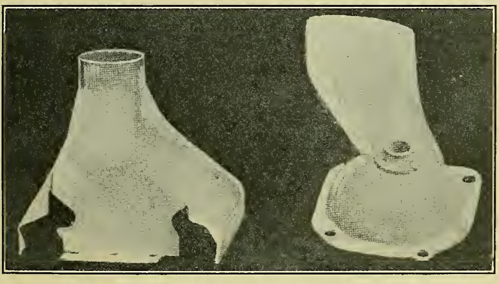


FIG. 180.—Difficult deep drawing.

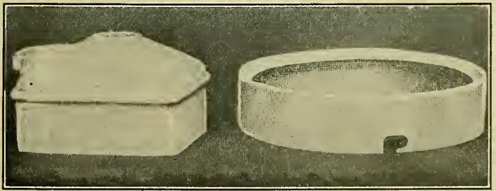


FIG. 181.—Cases of bronze.

ency of steel to tear on the grain. In each case, the dies had to be altered to less acute angles where the stock broke and the final shapes were brought out in the succeeding operations, after sufficient material had been pressed to the full depth.

Four samples of comparatively simple pressed parts, of cylindrical or cup shape, are shown in Fig. 179. The material is "deep-drawing" cold-rolled strip steel of the same grade and temper as used for the work in Fig. 178. These pieces were pressed in from one to four operations. Fine threads $1\frac{7}{16} \times 40$ in. were cut in *B* and *D* with a collapsing tap without previous boring on a screw machine at 128 ft. surface speed per minute; the threads were perfect and not torn.

Two samples of difficult deep-press work are shown in Fig. 180. These polygonal cups have many irregular and dangerous corners, which made it difficult to lay out the blanks, and the corners lock the material, which is 0.032-in. "deep-drawing" cold-rolled steel.

The cylindrical and rectangular cases shown in Fig. 181 were made of 0.04-in. bronze metal and are, on account of their large size, not difficult to press.

To resume, there are six cardinal points to be considered in order to obtain satisfactory results in forming hollow bodies. viz.:

1. Soft, ductile, uniform metal.
2. A properly constructed set of punches and dies, enabling the material to flow, rather than to be stretched or drawn into the desired shape.
3. Avoidance of sharp corners or edges when possible.
4. Properly adjusted drawing rings to keep the flanges from crimping.
5. A slow-acting press, preferably of the toggle type.
6. A correctly proportioned blank, the dimensions of which are either found by the "cut-and-try" method, or by weighing the model and calculating therefrom the size of the blank or by the more scientific and reliable graphical method, by laying out the blank on the drawing board.

Drawing Brass Shells and Other Press Work.—Little information is usually available as to the actual working methods used in drawing shells from brass, copper and steel.

Brass is rolled in several grades or tempers, such as dead-soft, soft, quarter-hard, half-hard, hard and high-hard. Hard and high-hard brass cannot be drawn without first being annealed;

half-hard and quarter-hard can be bent or formed in snarp angles and in some cases drawn in shallow shells, but for deep-drawn shells such as cartridges, a soft brass must be used to start with and then be annealed between operations. Some do much more annealing than is necessary because they are not equipped with the proper tools and machines to do the work. To gain the maximum efficiency one must equip with the best apparatus on the market for the work, this being often paid for out of the first month's production.

To save operations the larger shells can be blanked and drawn part way in one operation, or if a double-drawing press, such as the Bliss, is used they can be blanked and the first and second draw also done in one operation. Again, small shells can be blanked and cupped four or six at a time with "push-through" dies on a cam press. In the case of the Bliss toggle-action double-drawing press, the shell is blanked and cupped on the upper dies (which are push-through dies) and is then dropped into the lower dies and receives the second draw while the metal is still warm from the first draw, thus saving the annealing.

Production Rates on Small Shells

With a double-action cam press the smaller shells can be cut and drawn from the strip with push-through dies, four at a time, at the rate of 150 to 200 shells per minute; and can, after annealing, be reduced on the double-action cam reducing press at the rate of about 80 per minute.

Clean lard oil of good quality is one of the best lubricants for brass, but if the brass receives too much heat in the annealing, the shell often cracks along the sides or breaks out entirely at the bottom. In annealing, care should be taken not to get the shells too hot; a dull cherry-red is about right, and the work should be allowed to cool by itself if the best results are to be obtained. If the work must be cooled more quickly, use warm water. Much work is ruined by heating the shells too hot and then immersing them in cold running water.

For a shell drawn from light thin brass, a very effective lubricant is made by using one part of hard soap dissolved in one part by measure of warm water and one part of clean lard oil. The work cannot stand long in this state after being drawn, as the alkali in the soap will corrode the brass.

Clean lard oil is mentioned because it seems best to call attention to a practice in some shops of saving the oil that has been used on screw machines and sending it to the pressroom to be used on the dies. This oil is all right for cutting, but is very poor for drawing, as it is often filled with small particles of steel that do grave harm to the drawing tool. The practice is bad, as a tiny particle of steel will cling to the dies and more will collect until soon there is enough to scratch the work. The scratching of the sides of the shells should be watched for all the time by the operator, especially on work which is drawn two or three times. If the shell is scratched in the first draw, after it is annealed and drawn the second time the scratch will be enlarged or will sometimes break through the metal entirely and spoil the work.

Importance of Clean Lubricant

The radius on a drawing tool should at all times be kept perfectly smooth. When it becomes rough or scratched from constant use, it should be stoned off with a fine stone and then polished with finest emery or crocus cloth. The operator should watch this and also the oil or other lubricant that he is using and see that they are kept free from dirt and sediment.

After stoning the dies care must be taken to see that no small particles of the stone are left embedded in them. They should be washed off with gasoline. Sometimes the metal will flake off and cling to the dies, but this will not take place if plenty of the lubricant is kept on the work. If it should take place in spite of this, it is evident that the metal is too soft and shows that it can be drawn without annealing.

Copper shells are drawn in much the same way and the same conditions apply as in drawing brass shells. A very soft copper is used to start with and is annealed between operations the same as with brass. As for lubricants, lard oil can be used, but very good success is obtained with soap, oil and warm water. Drawn copper shells are little used except in electrical work and as a base-metal for silverware for the reason that copper is so much more expensive than brass.

The Problem of the Steel Shell

Steel shells often present very difficult problems, which can only be solved by experiment; but a few suggestions can be given which may be of some help. Lard oil is successfully used as a lubricant on cold-rolled steel and also when deep-drawing steel up to 0.020 in. thick, but for steel over that gage a great variety of materials as lubricants are used.

In one case it seemed almost impossible to get an oil or other lubricant heavy enough to keep the shell from scratching and the metal from flaking off on the dies. This was a shell drawn from cold-rolled steel 0.0625 in. thick. As a last resort dry white lead, mixed with machine oil to a thickness similar to heavy paint, was tried with marked success. The principle involved in this case was to furnish a lubricant heavy enough to produce a light film that would maintain itself between the metal and the die. While this mixture was a success as a lubricant, it was difficult to remove the lead from finished work. It could not be dissolved in any acid dip and could only be removed by washing each piece separately in gasoline. White French zinc ground in oil, mixed with the machine oil was then tried. This did excellent work, but was too expensive.

Successful Lubricant for Drawing Steel

At last an exceptionally good lubricant was found for both cold-rolled and deep-drawing steel, which was both cheap and easy to dissolve in a dip or to clean off. It is composed of machine oil and precipitated chalk. It is used only on metal over 0.030 in. thick.

In some cases where steel shells have to be drawn more than once they have to be annealed, and, in doing this, care must be taken not to get them too hot. They are brought to a nice bright red and then allowed to cool covered with air-slaked lime. This gives very good results, and 0.020-in. spring steel and 0.015-in. tool steel in shallow shells have been drawn by annealing in this way and then retempering afterward.

The cardinal points in all drawing work are to keep the dies perfectly smooth and in good order and to use a good lubricant.

Pressure Required to Draw Sheet Metal.—In view of the small amount of information available on the pressure required to draw sheet metal, a study of this work was made at the Frankford Arsenal at Philadelphia, Pa. These data deal with the drawing of cartridge cases for projectiles or fixed ammunition.

In the language of the ammunition department the term "pro-

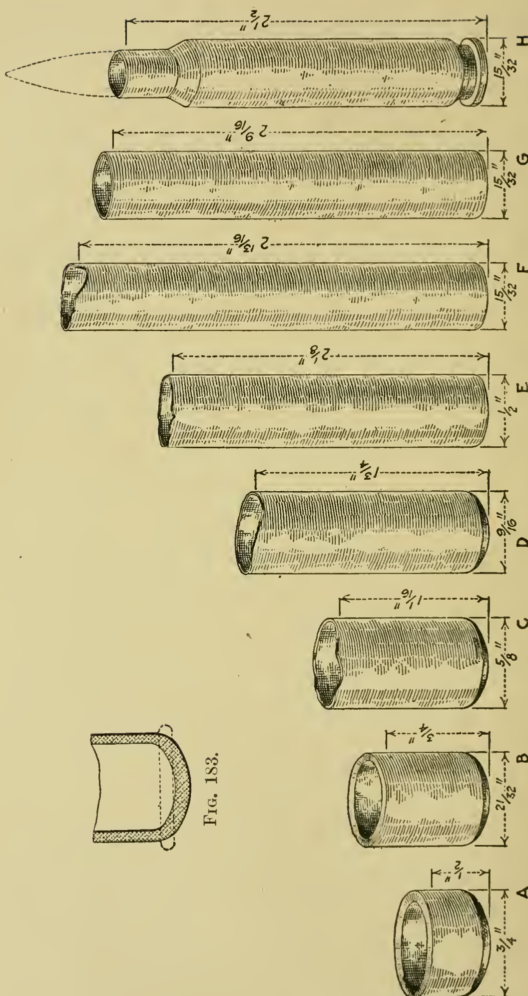


Fig. 182.

Fig. 183.

Figs. 182 and 183.—Eight stages of drawing cartridge cases.

jectile" refers to the complete ammunition ready to be placed in the gun, the "case" contains the powder and also holds the "shell" in the outer end. These terms will be used throughout the article.

Beginning with the ammunition for the new Springfield rifles, which have replaced the Krags and which have a bore of 0.3 in., we have the various operations as shown in Fig. 182.

At first a sheet of cartridge brass No. 12 gage, or 0.0808 in. is fed from the strip under a punch through a press carrying four punches. This blanks out four cases at each stroke and cups them by inside plungers operated by the double-acting ram. These blanks are 1⅟16 in. diameter before cupping, the outer diameter of the cup being ¾ in. and the depth about ½ in. This press runs at 102 r.p.m. and requires 15 hp. to drive it with the four punches. This means 408 cups per minute. The cup is shown at *A*, Fig. 182.

Lard oil has been found the best lubricant for this operation, although the further drawing of the cases is done with what is known as Lovewell compound.

Five Drawing Operations

There are five drawing operations to take the shell to the full length and to the proper thickness. The first drawing *B* increases the length about 5/16 in. and only two shells are drawn at once. These are drawn at the rate of 92 strokes per minute, or 184 cases, 2¾ hp. being required for this operation.

The next two draws, *C* and *D*, are performed four at once at the same speed as No. 1, making 368 pieces per minute with 7 hp. The second draw increases the length about ¼ in., while in the third draw the length increases from ½ to ⅝ in., with corresponding extensions on the other two operations.

The fourth and fifth operations *E* and *F* complete the case as far as length is concerned and are done two at each stroke, at the same rate, 92 per minute. The fourth operation adds a little over ½ in. to the case, while the fifth makes it ⅝ in. more, or a total length of 2¾ in. on the low side. The third and fourth operations require 3½ hp. each at the rate of output named.

These cases are annealed between each operation.

The other operations are: Trimming as at *G*, heading and preparing for the primer, reducing the end to receive the shell, turning under the head, and so on to the finished cartridge, as seen at *H*.

Another example of press work which is of interest is the making of the jackets for the shell, which are of cupro-nickel. These blanks are 7/8 in. diameter and 0.023 in. thick. They are punched and drawn five at a stroke at 102 strokes per minute, making an output of 510 jackets per minute from one machine which requires 6 3/4 hp. The thickness on the metal is reduced from 0.023 to 0.018 in. by this operation.

Drawing Larger Shells

The case for the one-pounder, which means the field gun, in which the projectile weighs 1 lb., begins as a disk 2.85 in. diameter, 0.205 in. thick and weighs 6 1/2 oz. When finished it measures 5.65 in. long and has an inside diameter of 1.457 in. with walls 0.04 in. thick.

The blanks are first cut about 1/2 in. deep and five operations are required to draw them to their full length. They are annealed, pickled and washed between each operation, the pickling being to remove the scale formed by annealing; an oil of vitriol pickle is used. This makes the drawing operations easier on the dies. Different compounds are used, among them the Acme and the New Era. It is understood that both of these have oil as one of the ingredients. These are drawn in small hydraulic presses at the rate of about 10 per minute for each draw, and require 1 ton pressure.

Cases for the 3-in. Projectiles

The cases for the 3-in. field guns start as disks 5.805 in. diameter and 0.313 in. thick, the blank weighing 2.544 lb. When finished they are 10.8 in. long with walls 0.04 in. thick. The disk is first cupped and then requires five drawing operations; the last draw being about 5 in. in length.

In the drawing of these cases the metal at the bottom remains at practically the thickness of the blank used, until the heading operation. The bottom remains in the form of a rounded or cupped end, until the heading operation flattens out and expands a portion of the metal in the head to form a rim for holding the case in the gun and giving a grip for the ejector. The change of form which takes place is indicated in Fig. 183.

In the case of the 3-in. cases the metal is forced out from $\frac{3}{16}$ to $\frac{1}{4}$ in. each side of the body, or the diameter is increased from $\frac{3}{8}$ to $\frac{1}{2}$ in. This also thins the head and leaves it perfectly flat, ready to be bored for the primer. The heading operation in this case requires a pressure of 625 tons. It is done on a single machine which is equipped with two sets of dies, so that one can be loading while the other is operating on a case. In this way 500 cases a day are headed up, which is at the rate of $62\frac{1}{2}$ per hour in the eight-hour day.

Another somewhat similar example is the 3-in. case for the 15-pounder, in which the disk or blank is 9.38 in. diameter by 0.438 in. thick and weighs $9\frac{1}{4}$ lb. The cupping operation requires 120 tons pressure and there are eight drawing operations in addition to this. These draw the case to a total length of $27\frac{1}{4}$ in. with the outside diameter $3\frac{1}{4}$ in.

The whole case is then tapered the entire length in two operations until the diameter has been reduced from $3\frac{1}{4}$ to 2.97 in. and the point swaged down an inch in diameter and for a space of about $4\frac{1}{2}$ in. to hold the projectile. These two operations require 150 tons each. The cases are annealed between each operation to about 1200°F., the output being 400 per day. The heading operation on this side case takes a pressure of 750 tons.

A Larger Field Gun

On the case for the 4.72 field gun the blank is 9.3 in. diameter, 0.754 in. thick and weighs 15 lb. 7 oz. This is cupped and has nine drawing operations. The cupping pressure is 124 tons and this pressure gradually reduces to the last operation, which requires about 25 tons and increases the length about 10 in.

The heading increases the diameter about $\frac{5}{16}$ in. on each side or about $\frac{5}{8}$ in. total, and takes 1500 tons pressure. This is done at the rate of about 10 per hour, counting the total handling in the machine.

In the 6-in. shell for the Armstrong gun, the blanks are left 11.6 in. diameter, 0.77 in. thick and weigh 25 lb. each. The first operation cups them about 3 in. deep and 13 further operations are required to secure the desired length of 24 in. The finished thickness is about 0.05 in. on the walls and about 0.5 in. on the head. The cupping pressure is 150 tons. There are nine drawing operations. The required pressure drops from

10 to 15 tons with each successive draw, requiring about 25 tons for the last draw, which increases the length about 9 in.

The heading operation requires 1800 tons and about 90 cases in eight hours is a good average output.

The 6-in. howitzer case is practically the same diameter as the other, but is only 10¼ in. long when finished. For this reason it requires a blank only 9.68 in. diameter, the thickness being 0.5 in. and the weight 9 lb. This has seven drawing operations in addition to the cupping, 110 tons being required for the first operation, this decreases until 25 tons suffices for the last draw. The finished thickness of the walls is about 0.04 in., and the output from 90 to 100 per day. The heading is practically the same as in the 6-in. Armstrong case.

Dies for a Drawn Copper Shell.—The problem of making tools for manufacturing copper ferrules with only one drawing and without annealing, was solved in the manner shown in Figs. 184 to 191. These ferrules were for a cartridge fuse the inside dimensions being, diameter 1½ in.; length 1¼ in.; thickness of stock 1/16 in. with the ends flat and the sides parallel for electrical contact. Only one drawing, one flattening and one trimming operation was necessary.

Many considered that it was impossible to draw to this depth in one operation as the usual procedure is to make the first shell larger in diameter and shallow, closing it in by reducing dies after the various annealings. Then it would have to be trimmed and the end flattened and sized. Usual methods were discarded, the first problem being to find the right diameter of the blank, and do more or less experimenting.

Instead of following the usual calculations we cut a blank that was obviously too large and placed it between two pieces of cold rolled steel as in Fig. 184. These plates were ½ in. thick and clamped together with screws so that the tension on the blank to be drawn might be regulated to suit.

The hole in the lower plate *B* represents the outside diameter of the ferrule and the hole in the upper plate *C*, the inside diameter of the ferrule. This also acts as a guide for the punch. The end of the punch was left square in the experiment first to see just how deep a draw could be made before fracture occurred. Previous experience had shown that it was impossible to draw 1/16-in. copper to any great depth and retain a square bottom, so that the first result of a cup nearly ½ in. deep was encouraging enough to make a second trial. In this the shape of the opening in the bottom plate was changed as shown in Fig. 185. This shape lessens the resistance of the metal to drawing owing to the increase in the angle of the opening, the idea being to give the blank the shape of a disk before pushing it through the die. This result was very good when it is considered that a square-bottomed punch was used, but the fracture would occur at the bottom when the metal crowded in too much at the top.

Finding Possible Depth of Draw

The next step was to make the end of the punch round as shown in Fig. 185 and another blank tried to see if the one draw plan would work out in practice. This gave a shell without a fracture and after several trials the punch shape shown in the dotted outline in Fig. 185 was found to be best suited for this work. These experiments were made in an arbor press and, having proved that the draw could be made in one

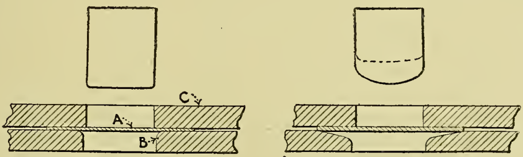


Fig. 184. Fig. 185.

Figs. 184 and 185.—Dies for drawing shells in one die.

operation, the work was put on the power press and further information secured as to the speed which could be maintained. This showed that thirty-five strokes per minute was the fastest which could be used satisfactorily, although speeds as high as sixty strokes per minute were tried. At the higher speed every shell would fracture but thirty-five strokes gave entire satisfaction.

Sufficient data having been obtained during the experimental drawings both as to the size of the blank and the kind of press to use, the work was put on a press of the single-acting type. Experiments were also made with the plates producing an even tension on the blank during the drawing operation while the punch draws the shell, giving the same conditions as exist in a double-acting press.

Uniform Prfssure on the Blank

In designing the die attention was paid to the fact that with a single-acting cut and draw die, the tension on the pressure ring increases as the cutting punch descends in the die, which has a tendency to stretch the metal. With heavy stock and a deep draw as in this case, fracture of the sides of the cup would be sure to result. It therefore became necessary to so design this die as to keep an even pressure on the drawing ring and the die was made as illustrated in Figs. 186 and 187, in which *A* is the cutting and drawing punch and *B* the knockout. The plate *C* is fastened to this punch and has the controlling pins *D,D* screwed into it. These are adjustable to obtain the proper relation to the contacts pins *E,E*, these being fastened to the buffer plate *F*. There is a cutting die *G* and a pressure ring *H* which slides on the drawing plug *I*.

The pins *K,K* support the pressure ring and are fastened to the sliding bushing *L*, which in turn connects with the plate *F*. This construction conforms with the ordinary dies of this type, the details being shown in the plan view and cross-section. The cutting die and drawing plug are fastened to the plate *M*.

The bolster plate *N* is drilled to receive the contact pins *E,E*, which must operate freely. The buffer rod is shown at *P*, the washer at *T*, and the adjusting nut at *S*. It will be noted that the angle on the cutting punch and the pressure ring is the same as in the experimental plate in Fig. 185 and also that the plug *I* is shaped like the experimental punch.

Dishing the Blank

As the cutting punch enters the die, the blank, before being drawn over the plug, is dished to the required angle. The controlling pins are adjusted so as to allow as little pressure as possible, this pressure remaining the same throughout the draw. By this arrangement a single-acting drawing die is made to act on a double-acting principle. It also has the advantage of being able to dish the blank, which would be hard to do in a double-acting die.

Squaring the Bottom

The next operation is to flatten the end, this being one of the requirements of the job. The flattening die is shown in Figs.

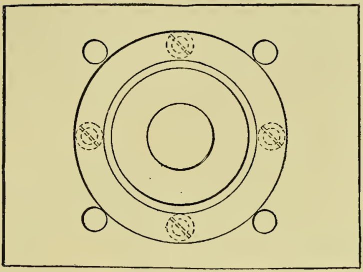


Fig. 186.

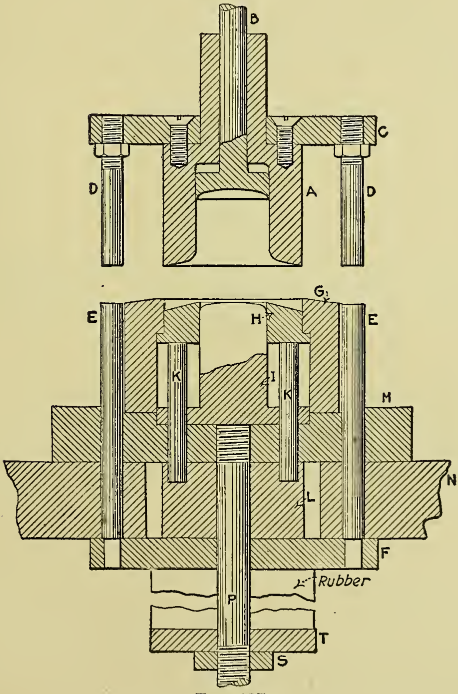


Fig. 187

Figs. 186 and 187.—Dies used for drawing shell.

188 and 189, and is so simple as to need no explanation. The flattening punch is shown at *A*, the knockout at *B*, the die at *C* and the bolster at *E*. During the flattening operation a small bulge appeared at *F* as shown in the dotted outline, but this was of no consequence as this defect was remedied in the next operation.

In the first operation the shell was drawn only deep enough to leave a bell mouth at *G* (see outline, Fig. 189), to give the results necessary in the third and last operation, namely, sizing and trimming, shown in Figs. 190 and 191.

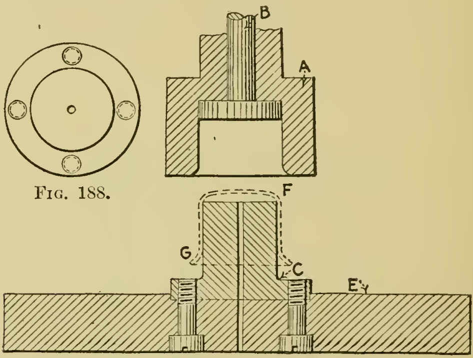


Fig. 188.

Fig. 189.

Figs. 188 and 189.—Dies for squaring the bottom.

The shell is drawn about 0.005 in. larger in diameter in the first operation to allow for sizing or ironing out the sides in the sizing die. This die is made as nearly accurate to size as possible and is highly polished to avoid scratching and galling.

Trimming to Length

The principle used in trimming is somewhat different from the ordinary trimming die where the shell after trimming would have a similar appearance to the dotted outline of the shell shown in Fig. 189, only not so pronounced, after which it would be pushed through a die in order to close the end. In this case the metal is cut while forcing the shell through the die, being forced against the cutting edge of the punch.

Referring to Figs. 190 and 191, *A* is the punch holder, and *B*, the cutting or trimming punch, is made to the exact size to fit the die *G*. The pilot *C* is turned the same diameter as the inside of the shell, the shoulder of the pilot clamping the cutting punch fast to the holder by means of the nut *E*. The scrap cutting punches are shown at *D*.

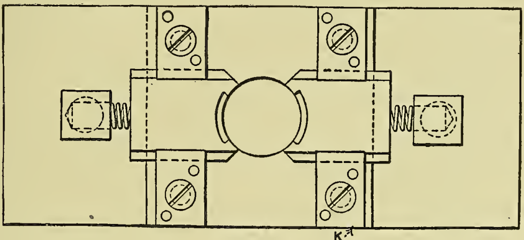


Fig. 190.

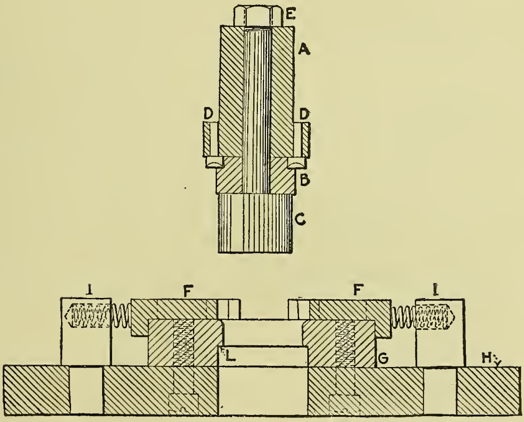


Fig. 191.

Figs. 190 and 191.—Punch holder and trimming punch.

The die *G* is equipped with sliding gages *F,F*, which open as the shell passes through. These gages are beveled on the sides and held in position by the guides *K*, which are screwed fast to the die. The gages *F,F* are actuated by the springs nesting in the posts *I,I*, these being fastened to the bolster *H*.

The die being of the required diameter and the shell slightly larger, the action is that of burnishing, leaving a smooth shell, stretching it very slightly.

The punch being smaller enters the shell easily and straightens it up as it starts to go through the die. The stripping is done at the shoulder of the die *L*.

Copper being of a soft nature, especially drawing copper, it is necessary to have a good fit between the die and punch *B* to avoid a burr. If it is correct, thousands can be trimmed before the sharpening of the face becomes necessary.

Excellent results in trimming steel products of odd shapes have also been obtained by this method.

Drawing 18-lb. Cartridge Cases on Bulldozers and Frog Planers.—The exigencies of war often bring out unheard of methods and devices. The Canadian-Pacific's Angus shops turned out thousands of cartridge cases, using such apparently unsuitable machines as bulldozers, for every press operation except heading and indenting, and they not only secured a high-grade product, but the ultimate capacity of 3000 cases per day. Moreover, there was not one man employed on this work who had previously worked in a brass-drawing shop or had experience of a similar nature.

A truck-shop building was cleaned out and made over into the cartridge department. As a bit of dust or grit on one of the drawing dies or plungers makes an ugly scratch in the case, and it was considered more advisable to keep this shop free from smoke and dust than to try to avoid transportation. Therefore, as the nearest available building for the annealing furnaces was the blacksmith shop across the midway, this shop was used for the drawing operations, and the indenting and heading presses were also installed there.

List of Operations

The operations as performed on cartridge cases at the Angus shops were as follows:

1. Blank	10. Anneal	19. Second trim
2. Cup	11. Third draw	20. Head
3. Anneal	12. Anneal	21. Semi-anneal
4. First draw	13. Fourth draw	22. First taper
5. Anneal	14. Anneal	23. Second taper
6. Second draw	15. Fifth draw	24. Head turning
7. First indent	16. First trim	25. Parallel cutting
8. Anneal	17. Anneal	26. Stamp
9. Second indent	18. Sixth draw	27. Shop inspection

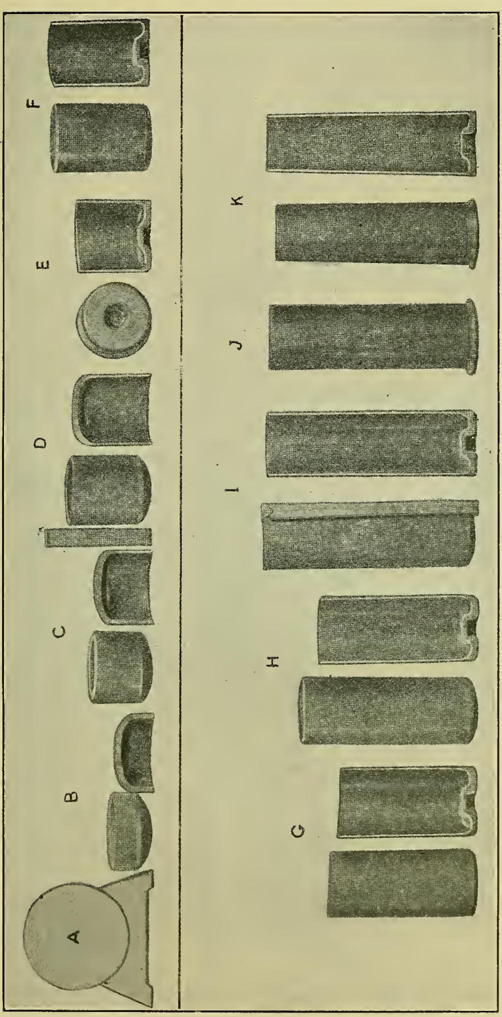


FIG. 192.—All stages in the drawing of 18-lb. cartridge cases.

There were six drawing and seven annealing operations; the cupping and first four draws being handled on bulldozers, and the last two draws, on frog planers. The round blank is punched out of strips of sheet brass, and each disk weighs 3 lb. 9½ oz. at the start. By the time it has become a finished case, it has lost 1⅒ lb. due to trimming, the finished weight being 2.49 lb.

All stages in the process are represented in Fig. 192. The round, flat blank punched out of strip brass is shown at *A*; the cup made directly from this is shown at *B*, and *C* and *D* repre-

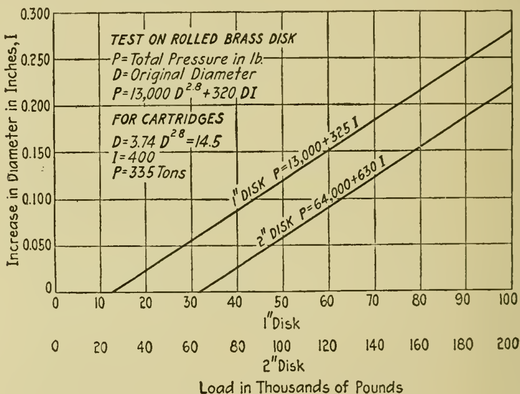


Fig. 193.—Result of experiments in drawing.

sent the first and second draws respectively. The indented case is shown at *E*, the indenting being performed after the second draw. The third, fourth, fifth and sixth draws are shown at *F*, *G*, *H* and *I*. At *J* is the headed cartridge case, while *K* represents the completely tapered case with its base machined and ready for the primer, which, of course, is not furnished at this shop nor attached until the complete cartridge is in government hands.

Motor-driven Machines

The bulldozers and planers are all motor driven. There are four of each of these machines, one of the bulldozers being provided with three sets of plungers and dies and the others having but one set each. On the bulldozers, the die is mounted on a special crosshead, and the plunger, on the rail. On the planers, the punch is mounted on the rail, and the die-holder, on an angle-block on the table.

Little was known at the start about the pressures required to accomplish the various drawing and heading operations. To throw light on this subject, experiments were made with brass disks of the same composition as the cartridge cases, the effect of pressure upon them being studied. The results of these experiments are shown in Fig. 193, and they served as the basis for calculations when the presses were built.

The evolution of the punches and dies for this work was a matter of much labor on the part of the toolroom foreman, W. H. Whitehouse, and while Mr. Vaughn, of the Canadian Pacific was assured in his own mind of the practicability of

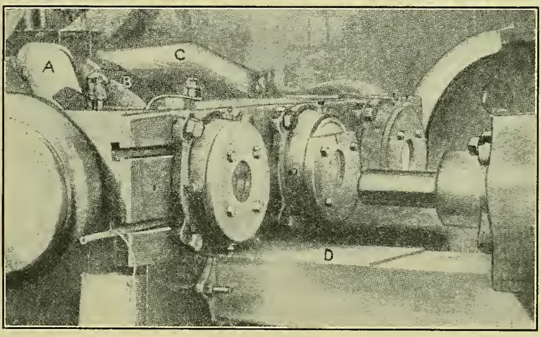


Fig. 194.—Drawing cases in a bull-dozer.

drawing such work on bulldozers, it was a matter that had to be proved, no precedent being known for such novel use of a machine of this type. The first set of plungers and dies were worked up to be tried on a single bulldozer. After experiments extending over two weeks' time, successful cases were produced, and when the first three of these had been secured, the Canadian Shell Committee was notified of the feasibility of making cartridge cases in this way. The entire committee was at hand within a day or two to witness the demonstration of bulldozers in their new rôle, and as a result, a large contract for cartridge cases was placed with the Angus shops.

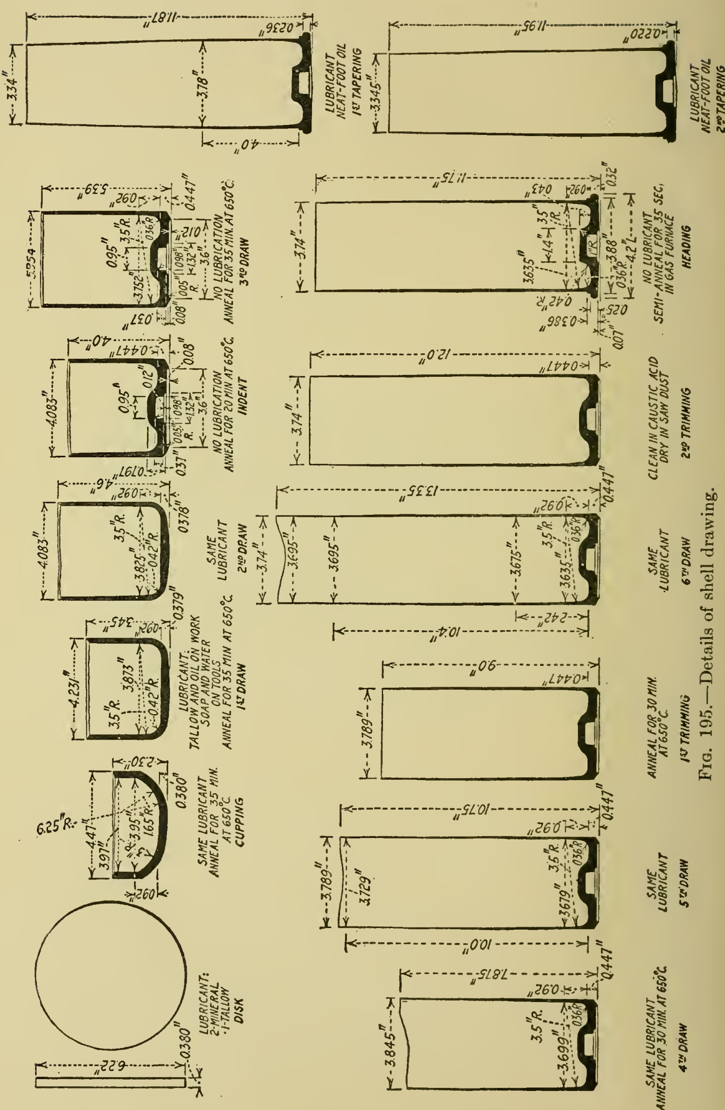


FIG. 195.—Details of shell drawing.

One of the bulldozers, a modern machine, has been equipped with three sets of plungers and dies. The center one takes care of the cupping of the disk, while the two outside ones handle the first draw. A recess is provided behind the plate *D*, Fig. 194, to hold the flat disk as the plunger advances. Plates of this kind are necessary only for the cupping operation, as for all of the succeeding draws the cup or shell is slipped over the plunger while it is in its withdrawn position.

An ingenious method of discharging the pieces after each operation has been devised in the simple form of galvanized-iron conductor pipe, as shown at *A*, *B* and *C* in Fig. 194. These convey the pieces to the back of the machine, where they roll down a chute into boxes. As each case passes through the die,

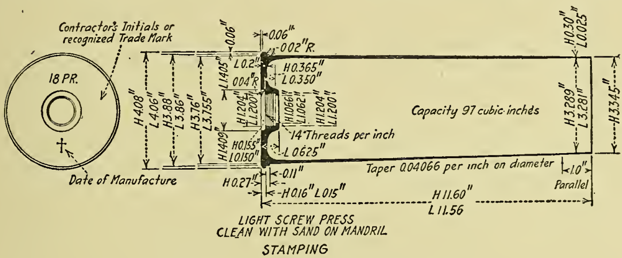


FIG. 196.—Dimensions of 18-lb. shell.

it pushes forward the ones ahead of it, causing them to climb the hills in the pipes.

Frog planers were used for the last two draws for two reasons: first, they have a longer stroke than the bulldozers; second, they are more accurate. A special head was mounted on the planer cross-rail, from which the feed screws have been removed, and upon this the plunger holder was secured, the plunger fitting into it on a standard taper. The die was held upon a heavily ribbed cast-iron angle-block, the whole thing weighing some 4 or 5 tons and serving not only to secure the die-holder, but also to prevent the table from rising.

Good Reasoning Employed

At first thought, the natural plan would apparently be to mount the die-holder upon the cross-rail and the plunger upon

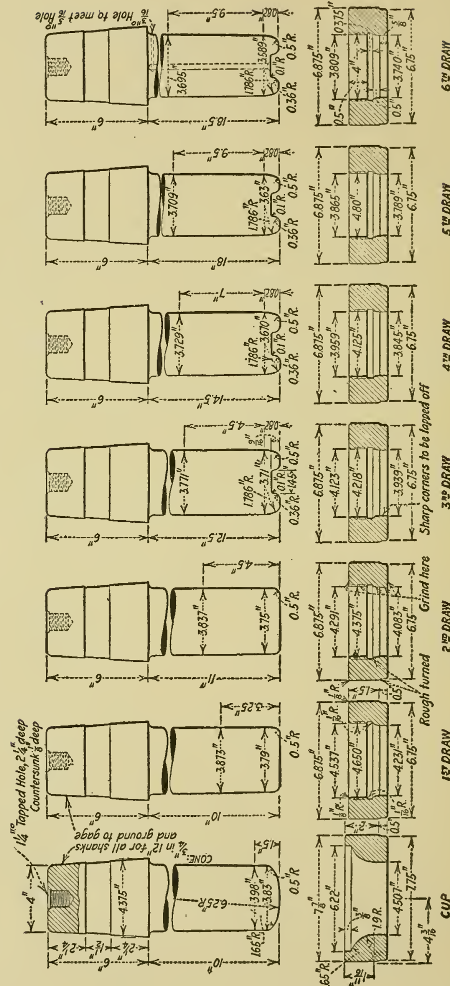


FIG. 197.—Details of plungers and dies.

the angle-block. There was good reason for the opposite procedure, however, since any lift that occurs during the operation will undoubtedly take place in the planer table and not in the cross-rail, which is a rigid member. The plunger, on account of its long overhang, would be thrown out considerably by a few thousandths of an inch rise of the table; whereas the die, having a thickness of but 2 to 2½ in., is not perceptibly

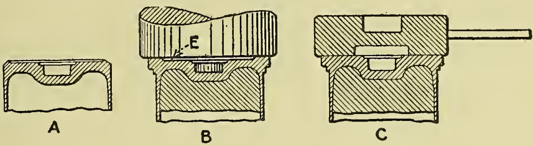


FIG. 198.—The heading punches.

affected, as evidenced by the fact that the thickness of shell in these cartridge cases did not vary over 1/1000 in.

In determining the suitability for a planer for the last two draws, a bulldozer cross-head was clamped upon a planer table and the punch was put upon the clapper block. After the feasibility of the machine was demonstrated, a cut was taken off of the table top and one side so that they indicated to 1/1000 in. The die- and punch-holder seats were then bored with a long bar lined up from the table and both holes finished at one setting.

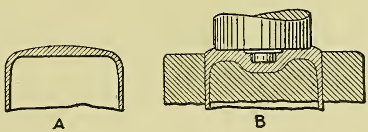


FIG. 199.—Indenting the shell.

Four hundred cases are considered a "lot." To this, 10 per cent. is added as an allowance for loss.

Full details of the shells in various stages are shown in Fig. 195, these being secured from actual sections. All dimensions and tolerances are given in Fig. 196. All necessary details of the plunges and dies used are shown in Fig. 197. These dimensions are from actual practice and can be followed in any similar work.

The heading punches are shown in Fig. 198 and those used for indenting, in 199. The details of the heading punch and composite dies appear in Fig. 200.

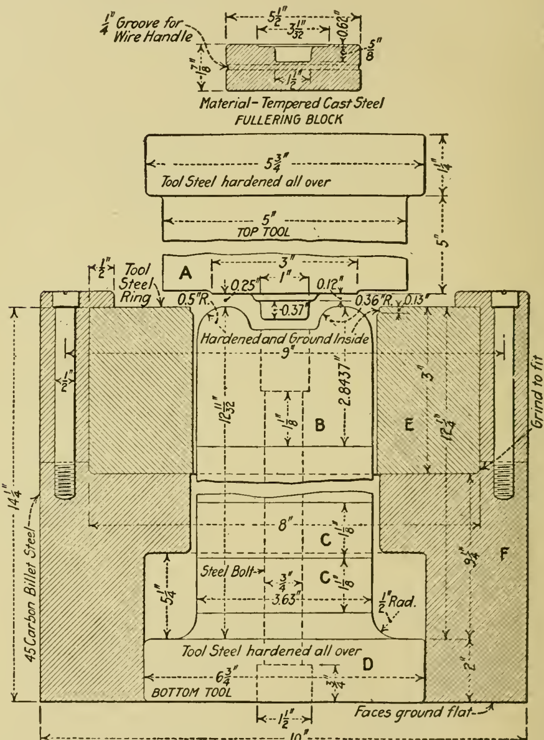


Fig. 200.—Details of heading punch.

CHAPTER IV

PRESS TOOLS IN CLOCK AND OTHER MANUFACTURE

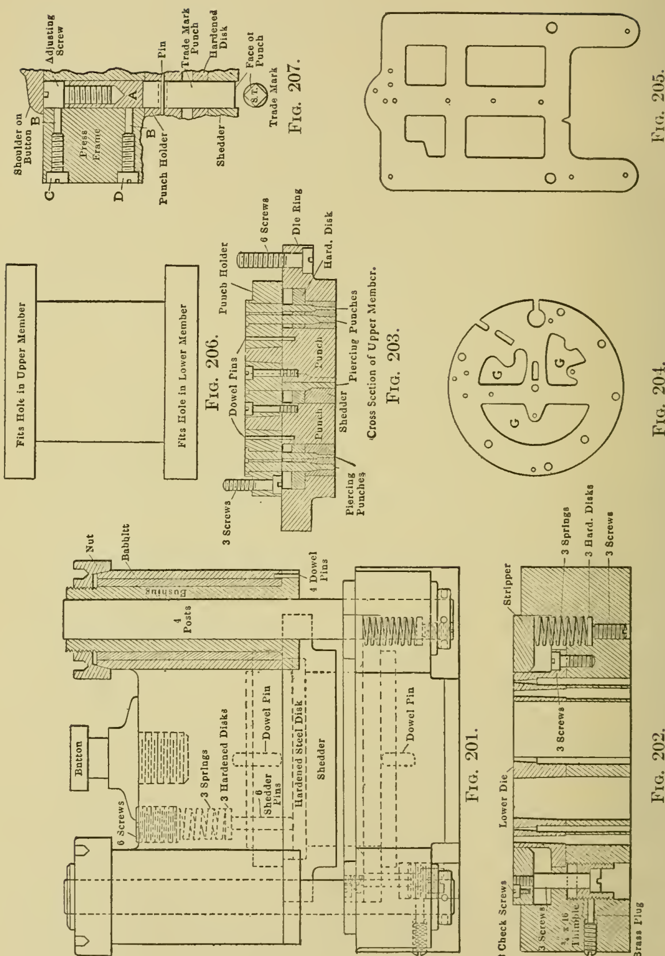
Some Sub-press Dies.—The Seth Thomas Clock Company, of Thomaston, Conn., makes most of its own dies, and the accompanying drawings show some original ideas that the concern has perfected and introduced from time to time in connection with its die-making methods in order to obtain the best possible results. Credit should be given to C. H. Bell, foreman of the die room and G. B. Buckland, head diemaker.

A Novel Set of Pillar-press Tools

Here is a set of tools for cutting out clock plates, or clock frames, as they are also called, that will stand up and run day after day without requiring the services of a diemaker to keep them going is an A-1 job, as clock plates are usually made of, say, 0.050-in. metal, and have anywhere from 25 to 50 or more holes pierced, many of the holes being of the same diameter as the thickness of the metal. It is, therefore, obvious, that not only the punch and die, but the press itself that holds the punch and die in position and in correct relation to each other, must be properly made in order to give satisfactory results.

The set of pillar-press tools, shown in Figs. 201 to 203, produce the circular clock plate in Fig. 204. That press tools constructed as here shown will accomplish all that is desired, may be illustrated by referring to Fig. 205, which shows a brass clock plate 0.055 thick made in one operation and containing fifty-three holes (not all shown), many of the holes being of the same diameter as the thickness of the metal; yet 7 tons were cut at one run without the breaking of a punch or a minute's stop for repairs.

Fig. 201 gives a general idea as to the construction of the tools which are used for cutting out the circular plate, shown in Fig. 204, which is made of 0.055 metal and has twenty-eight holes pierced and seven prick-punch marks which are all made in one operation. When it happens that the required size of cer-



Figs. 201 to 207.—Press tools for clock plates.

tain holes is less than the thickness of the metal to be used, the locations for these holes are pricked by a punch made similar to the round piercing punches, except that it is pointed and made a trifle shorter. This saves the time of drilling out the holes later on by the aid of a drill jig.

The Construction of the Tools

After the upper and lower members have been machined and the four pillar posts placed in position, as shown in Fig. 201, the fixture shown in Fig. 206, which fits the hole recessed out for the lower die, is set in, and the upper member slipped over until the bottom of the hole recessed out for the punch holder tests on the fixture, thereby bringing the upper and lower holes exactly in line with each other.

The babbitt is next poured into the open space between the bushings and the frame of the press, and is composed of a special mixture, which has been found to be less liable to shrinkage than any other composition they have experimented with, and is as follows: Six parts of lead, two parts of tin, one part of bismuth, one part of antimony.

When thoroughly cool the upper member is worked up and down to detect any unncessary play or looseness of fit; also to see if the upper and lower holes are in an exact alinement with each other. The flanges on the bushings are then secured to the frame of the press by four pins, and the four projecting shoulders of the frame of the press near the threaded part of the bushings are now beveled off by a special revolving cutter which has a projecting tit which fits the hole in the bushing. The nut which screws onto the bushing is beveled on the inside to correspond with the bevel on the frame of the press. When the nuts are tightened up, they not only prevent the bushings from working down, but also hold them central with the beveled shoulders on the frame of the press regardless of the babbitt.

It will be seen that the babbitt plays no part in the working of the tools, that its chief aim is to help line up the upper and lower members with each other and hold them in this position until the bushings are pinned in position and the nuts tightened up.

Fig. 202 shows a cross-section view of the working parts of the lower member of the pillar press.

The Lower Die

The lower die is held in place by three $\frac{1}{4}$-in. fillister-head screws in the flanged part of the die which fits in the recess of the press and is further prevented from turning by a $\frac{1}{4}$-in. locating pin; this pin also locates the die in its exact position whenever it is taken out and put back in place.

By referring to the clock plate, Fig. 204, the shape of the face of the die can be readily seen; the die is made from an accurate master plate containing the various holes which are in the exact position and relation to each other required.

The Stripper

The stripper is made a nice sliding fit on the outside of the lower die, and strips the metal from which the plates are cut from this die by the aid of three springs, as shown.

A very ingenious method is used to control the upward motion of this stripper. Of the various methods tried in the past by this concern the one illustrated has proved to be the best, and is now used in connection with all dies of this kind; also when occasion requires no regular subpress tools.

As shown, the threaded part of the three screws that screw into the stripper from the bottom are prevented from working loose by the three check screws that are screwed into the face of the stripper. The threaded thimble is drilled and counterbored to receive the head of the screw, as shown, and has a screw-driver slot by which it is screwed into the frame of the press. This thimble controls the upward motion of the stripper and is prevented from turning or loosening by a headless screw which forces the brass plug into the threaded part of the thimble, as shown in Fig. 202.

The Upper Die Ring

Fig. 203, shows the working parts of the upper member of the pillar press and consists of the upper die ring which is held in place by six $\frac{5}{16}$ in. fillister-head screws. The inside of this die ring fits the outside of the lower die and cuts the circular or outside form of the clock plate, as shown in Fig. 204.

The Shedder

The shedder is made a nice sliding fit in the hole in the die ring, and not only sheds the clock plates from the punches, but helps to keep the punches in line with the lower die, and also supports them and prevents them from springing or breaking.

The holes in the shedder for the different punches are transferred from the lower die after the die is hardened and set in place. The shedder is left soft for fear of distortion of the steel in hardening; so that the holes for the punches are in an exact line with the holes in the lower die and this plays a most important part in the successful working of the tools.

Securely fastened to this shedder by the aid of screws and dowel pins is a hardened steel disk, upon which six pins are continually pressed by springs, as shown in Fig. 201. The holes in this disk for the punches are made large enough so that the punches do not come in contact with it. The hardened disk prevents the shedder from being roughed up by the six operating pins.

The Punch Holder

The punch holder, Fig. 203, for different punches is held in the upper member of the press by three 1/4-in. fillister-head screws and a 1/4-in. locating pin. The holes into which the various punches are driven are laid out from the same master plate that was used in laying out the holes in the lower die.

The Punches

The piercing punches are lightly driven in from the back and are prevented from pulling through by the flanged head, as shown. The punches which cut out the larger of the irregular holes which are marked *G* in Fig. 204, have taper shanks which are driven into the punch holder, and are still more firmly held in place by the aid of screws and dowel pins.

Stamping the Trade-mark

When it so happens that the clock plates are to be stamped with a trade-mark, or lettered or numbered in any way, the device shown in Fig. 207, is used in connection with the tools described. The operation is done at the same time the plate is cut and pierced without added expense insofar as the operation itself is concerned.

This method, which is original with the Seth Thomas Clock Company, is the result of considerable experimenting, and is at present used when required on all tools of this type with the best of results.

Referring to Fig. 207, the trade-mark punch, the outside of which is made a nice sliding fit in the shedder, is lightly driven into the punch holder. The steel pin shown not only prevents the punch from turning and dropping through in case it becomes loose in any way, but also helps to locate it in its proper position when put back in place after it has been taken out. The hole for the pin is elongated to allow for the adjustment of the punch.

The distance from the face of the trade-mark punch upon which the design for the trade-mark is cut to the face of the shedder is equal to the thickness of the metal to be used. The round steel piece *A*, together with the adjusting screw, forms the means for adjusting the trade-mark punch in order to give the proper depth to the trade-mark when stamped on the clock plate. The adjusting screw bears against the shoulder of the button as represented and is prevented from loosening by the brass plug *B* which is forced against the head of the screw by the screw *C*. The screw *D* prevents the part *A* from loosening and also prevents it from turning when the adjusting screw is raised or lowered.

It should be stated that the four pillar posts have the usual spiral grooves to facilitate oiling; also that the arrangement for feeding and guiding the metal in connection with these tools is not shown, but is similar to those generally used and needs no explanation.

A Novel Set of Subpress Tools

This set of subpress tools is of more than ordinary interest, due to the fact that they cut and pierce four blanks at one time. Fig. 208 shows the lower member of the subpress with a plan of the punches and work just above in Fig. 209. Fig. 208 includes the usual form of stripper whose upward motion is controlled in the manner indicated; it is similar in construction to the one already described in connection with Fig. 201.

The Stripper

The face of the stripper is represented in Fig. 210 and is made in five parts, as shown, to facilitate the working out of the irregular-shaped holes which are made a sliding fit for the blanking punches.

The small round hole numbered 1 is the hole where the punch comes through which pierces the hole in the metal for the gage pin. This punch is held in place in the lower member of the subpress, and is shown in Fig. 209.

Hole 2 is the escape hole for the punchings from the gage-pin hole, while the hole numbered 3 is the hole for the gage pin.

The Blanking Punches

The manner in which the blanking punches are held in position in the lower member is shown in Figs. 208 and 209. Fig. 209 shows the punches in position with the stripper removed. The round flanges on the blanking punches are fitted into the recessed holes and are held in place by screws and dowel pins. The punches when in use perform the function of both punch and die, as the punches also act as piercing dies for the small round hole in the blank. The small holes shown in Fig. 208 are the escape holes for the scrap punchings that are thus pierced out.

Laying Out the Die

In laying out the die there were three important points taken into consideration: The first was to construct the die so that it would be strong enough to do the work. The second was to lay the die out so that the greatest number of blanks would be cut from the least amount of metal. The third was to lay out the die accurately so that there would be no "running in," that is to say, no cutting of imperfect or half-blanks when running the metal through on account of "a wrong layout."

The Construction of the Die

Figs. 211 and 212 show that the die is made in five sections which are held in place by screws and dowel pins. The die itself is held in the upper member of the press by four fillister-head screws and the usual locating pin.

By referring to Fig. 213, which shows a strip of metal after it has been run through the press, it can be seen that the metal

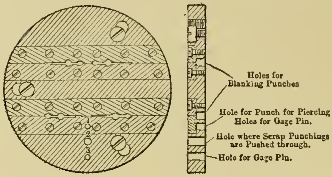


FIG. 210.

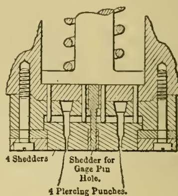


FIG. 212.

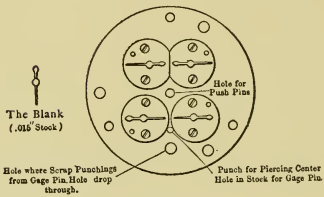


FIG. 209.

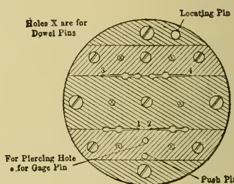


FIG. 211.

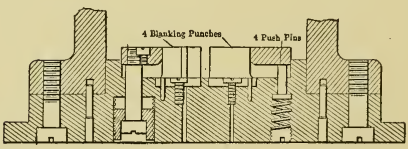


FIG. 208.

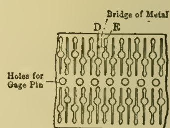


FIG. 213.

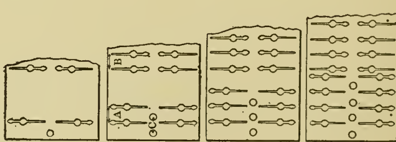


FIG. 214. FIG. 215. FIG. 216. FIG. 217.

FIGS. 208 to 217.—Subpress tools for clock hands.

is pretty well used up, that there is very little stock left that has not been converted into blanks.

Fig. 211 shows the layout of the die, which is made so that the points numbered 1 and 2 point toward each other while the points numbered 3 and 4 point just the opposite way. This is done to allow the holes in the metal from which the blanks have been cut to match up more closely with each other; that is, more metal would be wasted if the die was laid out so that the circular bodies of the blanks were all cut in a straight line with each other.

Accuracy in Layout

In laying out the die the first step to be taken after the manner in which the blanks are to be cut from the metal has been decided upon is to find the distance from *D* to *E*, Fig. 213, which is done by adding the width of the blank to the bridge of metal. In order to make the die strong the irregular holes are spread apart in the manner shown in Fig. 211. The distance from the center of these holes (which are numbered 1 and 3, 2 and 4) is accurately spaced off by taking the distance from the center of the hole *D* to the center of the hole *E* in consideration. In this case the distance from the center of 1 to the center of 3 is seven times the distance from *D* to *E*. It can readily be seen that this distance must be exact, for the reason that if it was too long there would naturally be an unnecessary waste of metal, owing to the fact that there would be too large a bridge of metal between the holes after the metal had been run through. On the other hand, if this distance was too short the holes would run into each other as the metal was being gradually run through, which would mean that the blanks cut would be imperfect or half-blanks.

The distance that 1 and 2 should be located from each other is determined principally by the relative strength of the die between the holes, as is also the distance between 3 and 4.

Running the Metal Through

The metal is run through in the usual way by the aid of guide pins, not shown. The short section of metal shown in Figs. 214 to 217 clearly shows how the metal is run through from the start, also how the holes gradually match in with each other after the fourth stroke of the press.

It must be understood, however, that the blanks are pushed back into the metal by the upper shedders (shown in Fig. 212) after they are cut, and are taken out after the metal has been run through. The holes in the short strips of metal are drawn merely to give a clearer idea as to the manner in which the blanks are cut from the metal, also to enable the reader to more readily grasp the idea as to the manner in which the die is laid out.

Fig. 214 shows that on the first stroke of the press four blanks are cut, as is also the hole for the gage pin. The blanks are pushed back into the metal by the shedders, which also tend to straighten or flatten them out in doing so.

The scrap punching from the gage-pin hole is also pushed back into the metal by the shedder shown in Fig. 212, as there is no convenient way in which the punching can be gotten rid of by allowing it to escape by way of the upper member of the press.

Fig. 215 shows the metal after the second stroke. The scrap punching from the gage-pin hole that was cut on the first stroke of the press is now pushed through the metal by a push pin shown in Fig. 211, and allowed to escape through the hole numbered 2 in the stripper shown in Fig. 210 and drops through the hole in the frame of the lower member of the press which is shown in Fig. 209.

By referring again to Fig. 215 it will be seen that the distance from the center of one gage-pin hole to the center of the next, as shown at *C*, is the same as the distance between the centers of the irregularly shaped holes *A* and the centers of *B*, and that after every stroke of the press the metal is fed or moved along just this distance, until the entire strip of metal has been run through.

After the second stroke of the press the gage-pin holes engage with the gage pin and form a position stop for the metal, thus preventing the feeding of the metal too far or not far enough when passing it through the dies.

Figs. 216 and 217 show the metal after the third and fourth stroke and also show how the holes in the strip gradually match up with each other until it appears like the strip shown in Fig. 213, after it has been run through.

Split Dies

The split dies shown to reduced scale in Figs. 218 and 220 are used for blanking out clock hands, and are shown merely to give an idea as to the manner in which the blanking dies for this operation are made.

Fig. 218 represents a split die for blanking the long clock hand in Fig. 219. The two sections are doweled together in the manner indicated which prevents them from shifting endwise. When in use the die is held in the die bed by the usual key.

The semicircular notch marked *X* engages with a round stud in the die bed and prevents the die from shifting in the bed when in use. This method is used by the Seth Thomas Clock Company on all ordinary blanking dies, and while not being new is nevertheless one that should be made more use of than it really

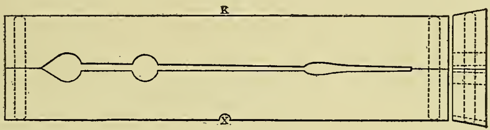


Fig. 218.

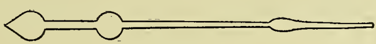


Fig. 219.

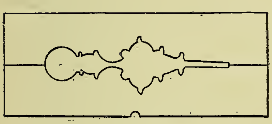


Fig. 220.

Fig. 221.

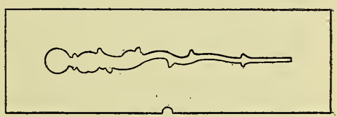


Fig. 222.

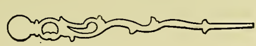


Fig. 223.

Figs. 218 to 223.—Clock hands and dies.

is. The key which locks the die in the bed is driven in on the other side of the die at *K*, Fig. 218.

Fig. 220 shows a split die that borders on the artistic, and is used for cutting the outside form of the clock hand in Fig. 221. The fancy perforations on the inside of the blank are made in a separate operation.

Fig. 222 is another artistic blanking die for the clock hand in Fig. 223. This die is not split for the reason that the blank is of such a design that it cannot be halved by a straight line. The perforations here are also left for a separate operation.

A Subpress Perforating Die.—It is generally considered bad practice to use perforating dies in a long-stroke press as they do not usually give satisfaction. The illustration shows a perforating die for fruit graters for a press with a stroke of 3½ in. The die had to punch four rows of twenty-eight holes each, and from one side of the holes to a lip, as shown in the half-tone, Fig. 224. The holes in the die were No. 45 drill size, eight holes to the inch.

To overcome the long stroke of the subpress, the die illustrated was designed and proved a success.

Fig. 225 shows the assembled die. The bedplate of the die *A* is a machine-steel plate, onto which the subpress housing *B* is fastened by means of four capscrews *C*. Into this subpress

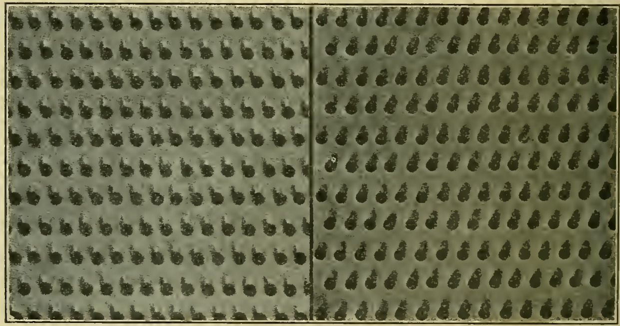


Fig. 224.—Perforations in a fruit grater.

housing a machine-steel sleeve *D* is fitted, a nice sliding fit. This sleeve *D* is planed at the bottom to receive the punch plate *E*, which is fastened to the sleeve by six flat-head screws.

The lower die *F* is fastened to the machine-steel bedplate by six flat-head screws in proper alinement to the punches.

The stripper *G* is fitted to the punches a nice sliding fit, and four ⅜-in. pins *I,I* (two of them only shown) provide a guide for the stripper. The four pins *I* are a driving fit in the bedplate *A* and in the subpress housing *B*, and are a sliding fit in the stripper *G*. Two slots are worked through the subpress opposite each other at *KK* and two ½-in. tapped holes put in the slide *D*.

The two screws *L,L* are screwed into the sleeve *D* to prevent it from turning and from being pulled out of the subpress.

The plunger *M* is made of machinery steel, a loose fit in the sleeve *D*, and provided with a shoulder *N*. The sleeve *D* is

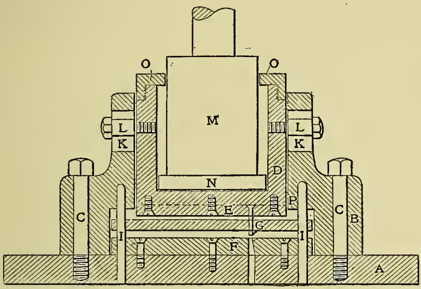


FIG. 225.

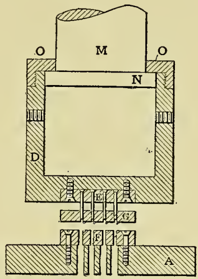


FIG. 226.

FIGS. 225 and 226.—Subpress perforating die.

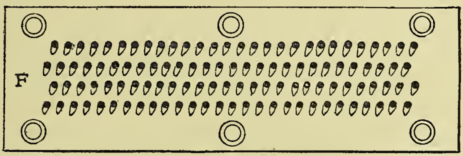


FIG. 227.

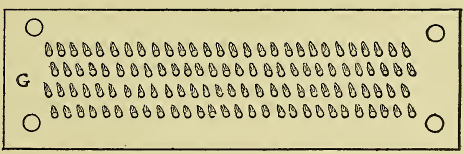


FIG. 228.

FIGS. 227 and 228.—Top of die and stripper.

threaded at the top and the ring *O* is screwed onto the sleeve *D* Fig. 225 shows the punches almost at the lowest position of the down-stroke, and the punches (of which one only is shown) ready to penetrate the metal. Fig. 226 shows the sleeve with punches attached to it, and the plunger *M* in its highest position.

The advantage in a die like this is first that only about ½ in.

or one-seventh of the press stroke is needed for piercing the hole and stripping off the material, and six-sevenths of the time the punches are at rest.

Fig. 227 shows the top view of the die *F*, and Fig. 228 the bottom view of the stripper *G* upside down. It will be seen that the holes in the die *F* are round holes, with one side worked deeper to make it appear oval on the top.

The stripper is exactly the counterpart of it; the little projections on the stripper fit in the depression of the die and are the forming parts for forming the grater lips on one side of the pierced hole.

The die is set like any other subpress die. The punches are set so deep into the die that the stripper and punch plate come close together. This is necessary, because the stripper has to do the forming of the grater lips after the punches have pierced the material. The stroke of the press is then adjusted, so that when the crank is at its highest point the shoulder of the plunger *M* has pulled the sleeve *D* with the punches up. In doing this the stripper goes up with the sleeve about 1/4 in. strikes the subpress housing at *P*, and strips the material from the punches. The punches stop in this position awaiting the down-stroke of the plunger. In this manner the long-stroke press was used satisfactorily.

Subpunching Clock Wheels.—Fig. 229 shows a subpress die and set of tools for a five-armed brass wheel. As in other work of this kind, the wheels are returned to the strip of brass and carried along with it, to be removed later.

The punch is made up of five sections *A* for the five openings between the wheel arms. These sections when assembled are secured in the holder *B* which also carries the pier ing punch *C* for the central hole in the wheel. The outside die *M*, by which the wheel is blanked, is located as shown, with the shedder *E* occupying the annular opening between the die *D* and the exterior of the punch sections *A*.

The lower die is composed of a central spider *F*, milled out so as to leave five ribs of the right thickness for the arms of the wheel. Over this central member the shell *G* is tightly fitted. This has shallow, vertical grooves in the interior to receive the edges of the ribs and prevent them from springing sideways when the die is in operation.

The die case *H* and the bottom shedder *I* are arranged as

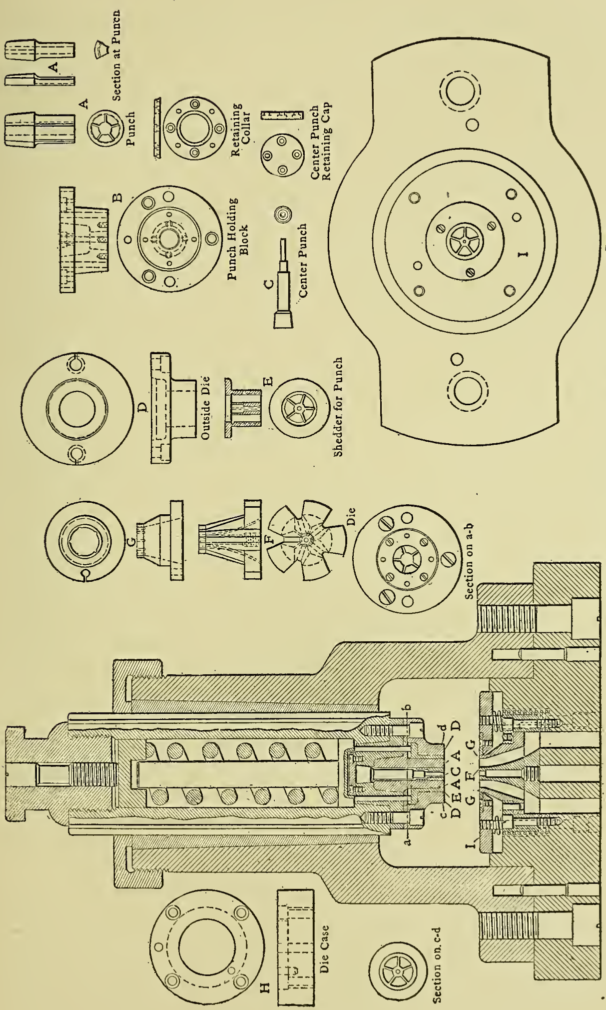


FIG. 229.—Subpress and details of die for clock wheels.

indicated in the sectional view. Other details of tools and subpresses are also clearly shown, making further explanation unnecessary.

Building a Sectional Subpress Die.—This assumes that the subpress is already made and that the babbitt bearing has been cast with the piston in place; also that the piston has been ground to a finish and the base of the press has been roughed out. When the piston is drawn from the bearing, it comes out with difficulty and it will be noticed that the babbitt has a dark glazed surface. This dark glaze does not signify that the piston bears all over, as the babbitt usually contracts more at the bottom than at the top. The glaze should be removed by scraping, taking off as little as possible. If the piston is worked up and down in the bearing a few times, it will show where it bears and it should be scraped until a good bearing is secured. If, after scraping, the piston works too freely, close in the babbitt by means of the nut *N* at the top in Fig. 230. Owing to friction, it is difficult to turn the nut when forcing the babbitt down, but as there is always some play in an ordinary thread, by tapping the nut with a piece of lead the babbitt can be driven down and the taper will close it in on the piston.

The piston should bear well all over and fit tight enough so that *A* and *B*, Fig. 230, can be machined, using the centers of the piston to swing the job. Although the piston has been ground from its centers, it should be tested with the indicator to see if it still runs true. A good indicator is indispensable on this class of work and should be used freely, as a few movements with this tool will show the slightest error and save time when the die is assembled.

If the piston fails to run true the center or centers in error should be rebored. The piston should then be inserted in the press and seat surfaces *A* and *B*, Fig. 230, machined to a finish. For the finishing cut a keen tool and slow feed should be used, giving the tool time to cut a smooth, true surface. Before removing from the lathe the cut should be tested for truth.

The base of the subpress, Fig. 231, should be swung on the faceplate and all the seats worked at the one setting, the same care being exercised as in the preceding operation. When using the faceplate on the lathe, great care should be observed to have it run true if true work is desired.

For boring the seat in the piston for the die and shedder, the steadyrest and split bushing *E*, Fig. 240, are used. The bushing gives a good bearing and cannot be dispensed with, as the oil grooves in the piston, if held without the bushing, cause it to jump when they strike the jaws of the rest.

Insuring Concentricity

The die holder *D*, Fig. 230, may be finished to size, slotting the clearance for the blades of the shedder at *E*, and turning the seats for the shedder and die concentric with the part of the holder which rests in the seat of the piston. The surest way to have the seat for the die concentric with all other seats is to bore it after it has been screwed and doweled to the piston, using the split bushing *E*, Fig. 240, and a steadyrest. The holder for the sections of the shedder part *C*, Fig. 230, may also be finished, but the hole for the punch and shedder parts *C* and *D*, Fig. 231, should be left a little larger in diameter than the seats, so that a finish cut may be taken later.

The blanks for the sections of the punch, die and two shedders are roughed out, leaving about 0.015 in. on the face for grinding and about $\frac{1}{8}$ in. on the outside diameter. Lines are laid out, crossing each other at right angles and $\frac{1}{32}$ in. from the center, as shown in Fig. 236. The intersecting points of these lines are to be the centers of the finished die, punch, and so on. These points should be prick-punched, and by laying out each section from its own center, we can cut into the sections and machine to the lines. Before quartering the blanks, the stock on the punch and die shedder are milled away as required; then putting in dowel and screw holes, the blanks are ready to quarter. Each section should be machined, leaving an allowance for grinding. Owing to the method to be pursued, the hole in the center cannot be bored, so the pieces are hardened.

Grinding the Sections

The work is now ready for the block shown in Fig. 234, 235 and 237. This is made large enough to suit the work, and with a base wide enough to insure it standing squarely upon the magnetic chuck of the grinder. Particular pains should be taken to get it as nearly square as possible, as the squareness of the sections depends upon the squareness of the block, and unless the sections are square, the die is worthless.

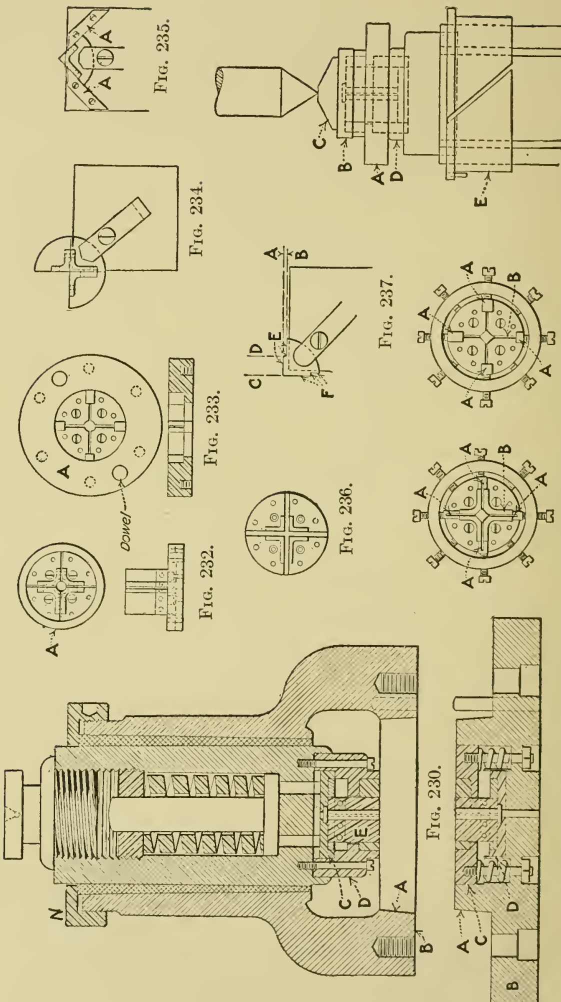


Fig. 230. Fig. 231. Fig. 232. Fig. 233. Fig. 234. Fig. 235. Fig. 236. Fig. 237. Fig. 238. Fig. 239. Fig. 240.

Figs. 230 to 240.—Details of the subpress die.

Strapping the sections upon the corner of the block, as shown in Fig. 237, the surfaces *E* can be ground, measuring from *A* to *B* and from *C* to *D*. Had the central hole been bored while the sections were soft, it would be more difficult to measure with the required degree of accuracy than it is direct from the corner. This side finished, the block is turned over and the operation repeated on the surfaces *F*.

In grinding the sections shown in Fig. 234, we must see that they are ground so that the dowel holes line up. The first step for grinding the center hole is shown in Fig. 235. By bringing each section to bear upon the knife-edge pieces *A*, all the sections can be ground exactly alike. They should all be roughed first and then finished without disturbing the wheel.

Grinding the Hole

When the sections are screwed upon a plate for holding them while the hole and outside are ground, pieces of stock of the proper thickness are placed between the sections. For the die shedder pieces 0.0205 in. thick are used and for the other three, pieces 0.0193 in. thick are used. When the die shedder is ground and put into the holder it is finished, as the holder fits freely in *C*, Fig. 230. The die shedder has no purpose other than shedding the die of the blank, so, therefore, the holder can be finished independently, taking the usual care to have the hole in the center of the sections come in the center of the holder.

Screwing the sections in position on the plate for grinding requires the greatest care, as the position of the sections on the plate when they are ground is the same as the position they occupy when they are in their holders.

The assembly for grinding on the die and punch shedder is shown in Fig. 239. The size of the plugs *A* should be such as will allow the sections when screwed together by means of the spider, to hold the plugs in place and have the slots *B* the proper width. When the sections are screwed on the plate so that each plug touches both sections at the end of the slot, and the pieces of stock 0.0195 in. thick are a sliding fit, then put a round plug in the square hole in the center, swing all on the faceplate, locating so that the plug runs dead true and then grind the hole and outside to finish sizes.

In Fig. 238 the plugs *A* are used to locate the sections the same as the plugs in Fig. 239. In grinding the outside no allowance should be left for drive, as this will cause the sections to close in. The sections should now be screwed and doweled in their respective holders.

Finishing the Holders

In Fig. 240 is shown the method for finishing the holders for the punch and punch shedder. The punch shedder is important as it guides the blades of the punch. The punch is pushed through the shedder from the bottom. The part *E* is a ring of steel which has been ground so as to have the same width at all points, and is made just wide enough to keep the parts of the punch, other than that part touching the ring, from bearing on the shedder. The portion of the punch protruding from the shedder is entered into the die, the part *C* placed between the center and the bottom of the punch and the center brought to bear just hard enough to bring the punch and shedder squarely against the die, which has been screwed and doweled to its final position in the press. With the test indicator, the piston nearest the die holder should be tested and also the bottom of the punch and shedder. If they all run dead true, conditions are then ready to finish the punch and shedder to fit their seats in the base of the press.

Assembling

The top and bottom of the press have already been screwed and doweled together. The punch and shedder are now inserted in the die in the same manner as they are in Fig. 240, using the same ring in the same place. In this position the punch and shedder should be pressed into their seats and screwed and doweled. It will be remembered that the die was left 0.001 in. small. This was done to have it a fit for the punch, so that we could perform the preceding operations. These sections should now be taken out and ground or lapped 0.0005 in. on all the parts which are to cut. We will then have 0.0005 in. spare between the punch and die all around, insuring a clean break and no burr.

Tools Used in Making Eyeglass Bridges.—As generally made, the fingerpiece eyeglass bridge consists of a piece of round wire, cut to a define length, and then worked into shape by a number of machine operations.

The first six of these operations are shown at Fig. 241, where *A* represents the blank cut to length in a press tool, *B* after the first upsetting operation, *C* after the second upsetting operation, both done in the special tool shown in Fig. 242, *D* after flattening the pad in an ordinary striking die having a flat-bottomed punch and set in a subpress, *E* after hollow milling the tit by means of the special fixture, and *F* after having the tap drill-hole pierced with the punch and die shown in Fig. 243.

The special press tool shown in Fig. 242 consists of a body casting *A*, with a pair of dies *B*,*B′* arranged in a horizontal slot; one *B* held stationary in the slot, and the other *B′* fastened in the slide *C*. These dies are held together by the spring *D* and are opened,

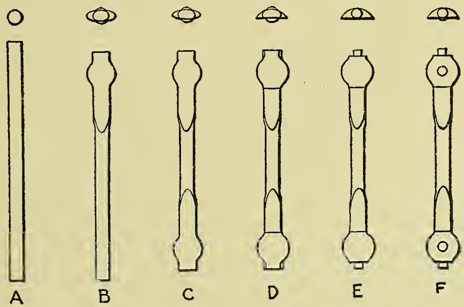


Fig. 241.—Making eyeglass bridges.

to insert the wire between them, by the lever *E*. This lever is pivoted in the slide, and has an eccentric portion working against a pin in the base.

Sliding vertically in the base are two slides; one *F* adjusted by the screw *G*, and held against it by the spring shown, which carries the upsetting punch, and another *H* which acts as a cam to close and lock the dies *B*,*B′* together—also the post *I*, the purpose of which is to prevent the ram block *J* from turning. The slide *H* is adjustable laterally by the two taper wedges *K* which are adjusted from the top by two screws *L*. The holder *M* is for the purpose of locating the first pad made for the second operation; these pads are of oval cross-section and it is necessary to have their major axes in line. This holder slides longitudinally in the block *N* and is prevented from turning by a key in the block working in a key slot in *M*.

All the slides are milled into the face of the base casting and are held in place by the cover-plate *O*, screwed in place as shown. It will be noticed that the sliding cam *H* is adjustable in an oblong hole in the ram plate.

Operation of the Tool

The operation of the tool is as follows: The dies are opened by means of the lever *E*, a blank wire is inserted between the dies

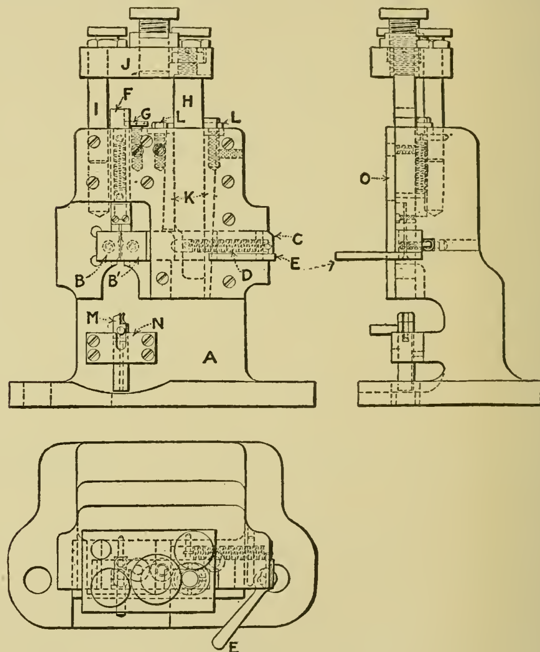


Fig. 242.—Upsetting dies.

and pushed up against the upsetting punch in *F*, the lever is then released and the spring holds the blank from dropping. When the press is tripped, the slide *H* forces the dies *B,B′* together on to the wire, gripping it firmly, and locks them together. As the press nears the bottom of its stroke, the ram plate comes into contact with the punch holder *F*, forcing the punch onto the dies and the stock into the recess shown. All the movements are unlocked when the press is at its highest point and the blank is removed by opening the dies. The end upset is inserted in the holder *M* and pushed against the upsetting punch as in the first operation.

These pads are upset at the rate of 300 dozen bridges per day of 10 hours. A hard wire is used and it is necessary to anneal both ends before upsetting; this is done by dipping the ends into melted borax at 1200°F. Annealing by means of melted borax is believed to be original with the writer and as it is proving an excellent method of annealing the ends of temples, bridges, and other parts made of gold-filled stock, the process will be described.

Annealing the Stock

Crystal borax is melted in a pot until the pot is nearly full. The first melting of the borax is a deceitful process as it will rise and bubble over the top of the pot if much is put in at a time, and will not melt until it reaches a red heat. The work, tied in bunches, is dipped into the red-hot borax to any desired depth and heats almost instantly; the heated ends are then dipped into boiling water, removed, and dried in sawdust. Borax is better than any other medium for annealing such work as the surface of the work where heated is thoroughly protected from oxidizing and any borax sticking to the work after heating will be removed in the boiling water. There is no danger of overheating the work by this method, as the borax may be kept at a constant temperature.

After the bridges have the ends upset they have the ends struck to form the clip with a flat top as described before.

The punch and die used to pierce the tap drill hole is shown in Fig. 243. The complete unit consists of a punch *A*, made of drill rod, held in the punch-holder *B*, this being held in the shank *C* by the screws shown. Sliding on *C* is a stripper *D*, which is pressed downward by the spring *E* acting through the sliding piece *F*. The stripper is prevented from falling away from the shank by the screw *G*, working in an elongated slot. The spring is made of flat wire to obtain the necessary pressure in the limited space provided The construction of the die is as shown.

Dies Which do not Waste Stock.—This shows a set of follow-on tools which have given satisfaction in actual service. They were set up in a No. 20 Bliss press running at 80 r.p.m. with a single roll feed, turning out 160 finished brackets per minute. The tools are in constant use every day, and to avoid delay, a second set of tools has been made so that one set can be running

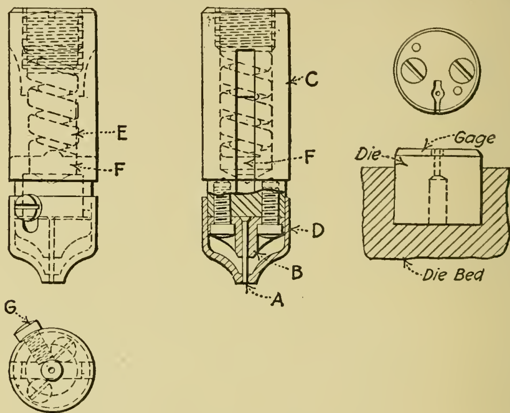


Fig. 243.—Piercing punch and die.

when the other set is being repaired. It is not unusual for these tools to run 120 hours and then they only require sharpening, about an hour's job for the tool setter.

The finished articles are shown in Fig. 244. They are used for supporting spring roller blinds, are made from strip steel $\frac{1}{32}$ in. thick and are pierced, embossed, bent at a right-angle, and

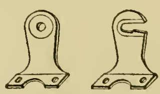


Fig. 244.—Curtain bracket.

blanked in one operation without waste of stock, except the piercings.

A view of the strip steel after the seventh stroke of the press is shown in Fig. 245. After the seventh stroke two finished brackets, left and right, as shown at Fig. 244, are produced at each stroke of the press. One bracket falls into a box under the press and the other shoots away from the tools as it is cut off on the end by the punch *G*, Fig. 247, and falls into a barrel at the

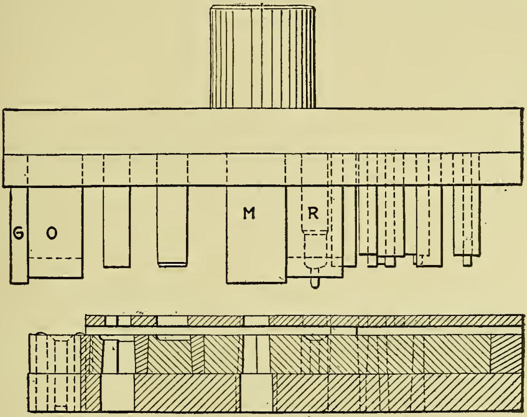


Fig. 247.

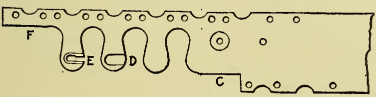


Fig. 245.

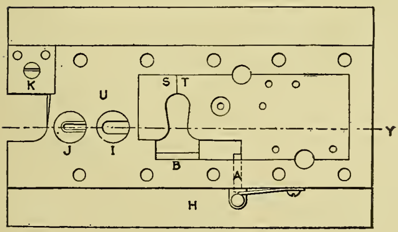


Fig. 246.

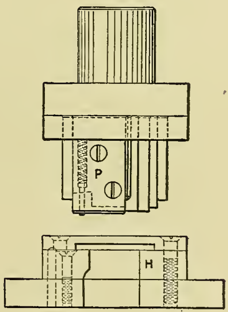


Fig. 248.

Figs. 245 to 248.—Stock saving dies.

back of the press. The strip steel comes in reels weighing about 70 lb. each and is fed to the tools by a single roll feed attached to the front of the press, feeding front to back.

When starting the press the stock is fed in by hand to the stop *A*, Fig. 246, then the roll feed is put in action, the stop *A* will now be idle as the spring keeps it out while the press is running. The part *B* acts as a positive stop when the bending and cutting punch *R* has done its work, the stock will now be allowed to pass along the width of another blank, when the blanking punch *M* will perform the operation leaving the strip steel as shown at *C*, Fig. 245.

The next operation is the embossing shown at *D*, which is followed by piercing the slot *E*. Bending at right angles follows as shown at *F*. The last operation is performed by the cutting punch *G*, Fig. 247, when the finished bracket shoots off into a barrel at the back of the press. The piercing and blanking die *S* and *T* is made in two pieces to avoid trouble in the hardening. They are then screwed to the mild-steel bolster *H*, Fig. 246. The embossing and piercing dies *I* and *J* are made of tool steel and are a driving fit in the mild-steel plate *U*, Fig. 246. All the piercing punches are made of drill rod upset on the end and a good fit in the ½-in. drill-rod sleeves, which are a driving fit in the pad *L*, Fig. 247, which is fastened to the punch holder by six ⅜-in. flat-head screws and four ¼-in. dowel pins. The blanking punch *M*, Fig. 247, should be left long enough to push the blank through the die. The bending punch *O*, Fig. 247, has two pressure pins, one only being shown at *P*, Fig. 248. These keep the work in position while it is being bent at *K*, Fig. 246.

These tools have been in use over six months, and they are as good today as when first made, new punches and parts being replaced as they wear or get broken. A youth can run two presses, comfortably making 320 brackets per minute.

An Interesting Punch and Die.—We recently made a die for piercing seven 1/32-in. holes through aluminum 0.040 in. thick. A description of the tool used might interest others, as it is ordinarily difficult to punch a hole of a diameter less than the thickness of the metal.

In this case it was not possible to make an ordinary subpress die such as is used by watchmakers, for, as will be seen by Fig. 249, the holes are in the top of a shell nearly an inch deep, and the punch-holder, therefore, has to have sufficient stroke to allow the piece to be put on and taken off.

As will be seen from Fig. 250 the punches are but little over ¼ in. long and are a snug sliding fit in *A*. The rods *B* are a snug sliding fit in the punch plate *C*, the back plate *D* and the punch-holder and stem. This means that the punches are rigidly supported when they enter the metal and during the stroke. The rods *B* are rigidly connected at the top by the piece *E* which has in the center a screw *F*, which acts as a striker for the knock-out in the press.

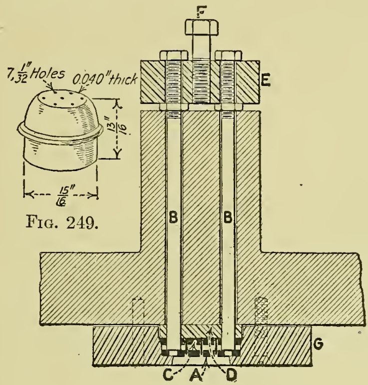


Fig. 249.

Fig. 250.

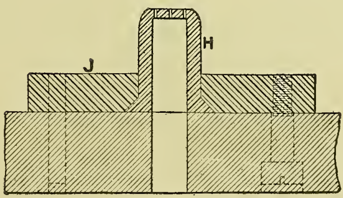


Fig. 251.

Figs. 249 to 251.—Piercing die and its work.

The locknuts on the rods come solidly against the stem of the punch-holder, so that there is no danger of the punch or stripper being broken by bad adjustment of the press. In operation the punches lift the piece off of the die, where it is a loose fit, and it is stripped at the top of the stroke. The press being inclined, it drops off at the back, leaving the operator with both hands free for feeding.

The punch plate *C* is held by the beveled edge of *G* against the block *D*. The piece *G* is held by two screws and two pins in the same manner as the die holder. The die *H*, stripper, punch plate, and the back block were all turned from a rod of tool steel and hardened. The pieces *J* and *G* are cold-rolled steel, left soft and fitted after the working parts had been hardened. The punches themselves are made from piano wire, which we used without heating, finding that we could upset them sufficiently without drawing the temper.

The die is mounted in a shoe and punch-holder having two 1-in. subpress pins mounted a little to the back. The bosses around the pins come together at the bottom of the stroke so as to avoid the possibility of setting the punch too low. The pins are fast in the die and a sliding fit in the punch-holder.

This die gave good results the first time it was used and has continued to do so. It was made by one man in less than two days.

Progressive Drawing, Piercing and Blanking Dies.—The samples shown in Fig. 251 represent a most successful and ingenious example of die work for the progressive drawing, piercing and blanking of brass work. This shows pieces of the stock of four different pieces all made by the same process, three of which are made in eight stages and the smaller piece, a lock escutcheon, in seven stages. The larger piece shown in Fig. 251 is of sheet steel 0.020 in. thick and the draw is 7/8 in. deep. It is remarkable to make as deep a draw as this at the rate of 150 per minute progressively without annealing, for not only must the tools be made correctly but the stock must be suitable. The other three pieces shown are brass of about the same gage as the steel mentioned.

All of the dies are used with a roll feed. Fig. 252 shows the dies for the second largest piece shown in Fig. 251. Fig. 252 is not to scale or in proportion, but is merely to show the general principle on which the dies are made. They are of the subpress type and must be accurately made. The lower half contains the perforating die marked *A*-1 and the seven punches marked *B*-1 to *H*-1. The top half contains the perforating punch marked *A* and the seven dies marked *A* to *H*. The end view of the upper half partly in section in the center of drawing die *B* shows the automatic knockout marked *M*, one of which is in every die from *B* to *H*. These are actuated by the round rocker bar marked 7, the shape of which is plainly shown in the sectional end view.

This rocker bar is actuated by a lever not shown which is fastened at 8 on the bar 7. This lever is connected to the press bed by a rod fastened at the proper point, to give it its movement on the up-stroke of the press. At the first stroke of the press the strip of metal is perforated by the die marked *A*-1. The second stroke repeats this operation, leaving a round blank, still fastened to the stock by the two side members which are plainly shown in Fig. 251.

The object of these perforations is to put the stock into drawing shape to avoid the buckling which would otherwise make this job impossible. The third stroke makes the first draw by the punch *B*-1 into the die *B*. The drawn piece is stripped from the punch *B*-1 by the spring stripper marked 6 and positively

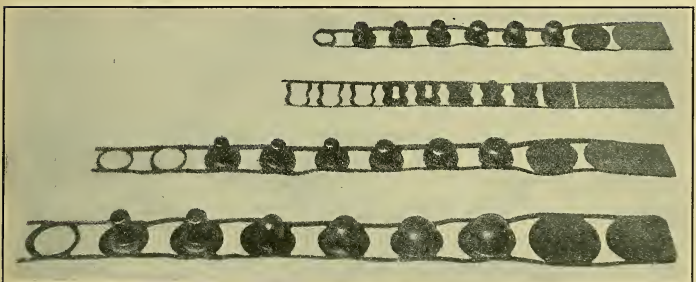


Fig. 251.—Work from progressive dies.

ejected from the die *B* by the ejector *M*. In the fourth stroke the first draw goes over the punch *C*-1 while *B*-1 is making another draw, *C*-1 and *C* are identical in size and shape with *B*-1 and *B* and herein lies the secret of the success of the whole job. They start off the register for the succeeding operations right and keep it so. *D*-1 is the second drawing punch. *E*-1 and *F*-1 are the succeeding ones. *G*-1 is the perforating punch which acts with the die *G*. The plugs are ejected by the ejector *M*; *H*-1 is the final blanking punch which completes the operation.

These dies are used in an inclined press and are run on brass about 200 r.p.m. The spring stripper plate 6 rests normally above all punches as shown by the dotted lines in the side view. In the top view of the lower half the stripper plate is raised by the springs held in the depressions marked *X*. The superin-

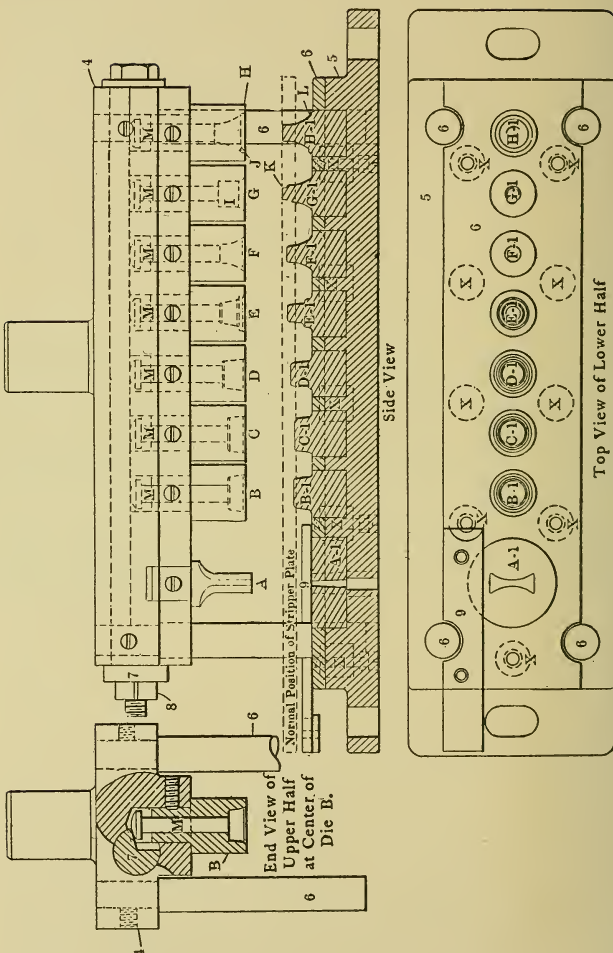


FIG. 252.—Dies for third piece in Fig. 251.

tendent of the works said that it could be accomplished only by using a special lubricant. This lubricant is made of fish oil and white lead.

Double-operation Die.—This die, shown in Fig. 253, completes two operations at one stroke of the press, it cuts out the bottom of a drawn pan, 8 in. diameter in the bottom, 10 in. at the top,

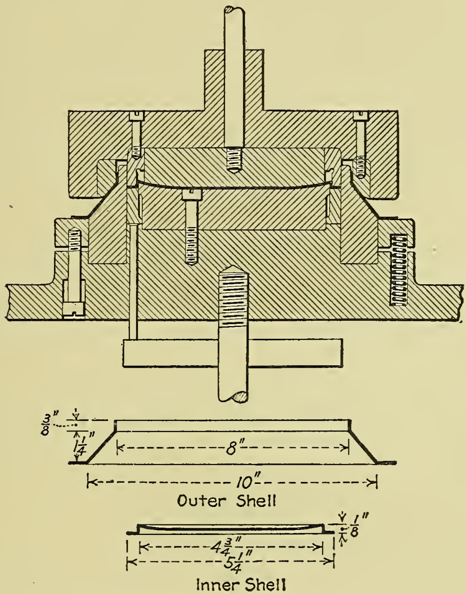


FIG. 253.—A double-operation die.

1¼ in. deep, and at the same time flanges up the bottom of the pan ⅜ in. high, and forms the bottom of a small water pail, without any waste of material, or any extra labor on the part of the operator.

The die works as follows: When the punch is at the highest point of the press stroke, the stripping, or gage ring (actuated by springs) for the taper shell moves up so that the pan will rest on top of the cutting edge of the lower die, properly locating the pan.

The punch has also a cutting edge inserted on the inside of the main punch, and on its downward stroke this cuts out a certain-sized blank and carries it down on the inside of the die forming the blank into the pail bottom. When this blank is cut from the bottom of the main pan and while the cutting punch is descending on the inside of the die, the outer punch is forming the flange on the outside die, and the moment the press starts back on its upward stroke, the spring ring on the outside follows the punch up to a certain point, stripping the outside taper shell from the die. It is left loose so that it can be easily removed. The inside drawing ring which is actuated by a rubber or spring, lifts up the inside shell, or bottom, level with the top of the cutting edge. It can then be readily removed from the die when removing the outside shell. This rubber or spring need not be very strong as there is no drawing, merely forming here.

The inside cutting edge is independent of the main punch, it consists of a ring, hardened and ground, setting inside of the main punch. A knockout pad in the center is for ejecting the bottom from this center punch, making the die simple and at the same time economical. There is about $3/16$ in. left for wear on the top of the cutting edge of the lower die, about the same amount on the cutting ring of the inside upper punch, and as the inside punch is ground off to resharpen, the back of the cast-iron pad, or knockout pad, can be faced off to suit whatever is removed by grinding on the face of the cutting punch, keeping the punch and pad in the same proportions.

Upsetting the Ends of Boiler Tubes.—This shows dies which have solved the problem of upsetting boiler tubes without leaving any marks or grooves. At *C*, Fig. 254, is shown the header with swell or taper neck for the first operation. This expands the tube as shown at the upper end of *F*. The object of the expansion is to prevent grooves on the collars, as shown at *H*. The header *D* was used in upsetting boiler tubes in the old way, but it leaves grooves on the collars. This header can, however, be used for the second operation and leave a perfectly smooth finish, as shown at *G*. The die *B* with headers is used for both operations. *F* shows the collar after the first operation done in the new way; the end of the collar is the same thickness the tube was before the first operation; the heavier part of the collar being at the back. *G* is the finished collar after the second operation in the new way. *E* is the tube before the first operation. *H* is the collar showing the groove when made in the old way. *A* and *B* are the dies.

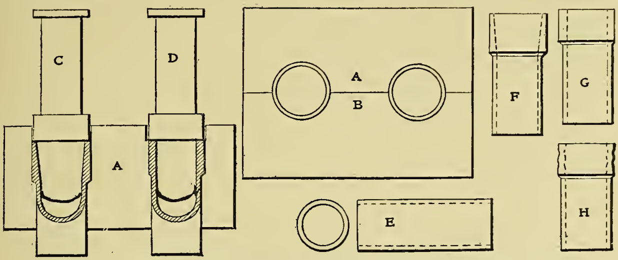


FIG. 254.—Upsetting ends of boiler tubes.

The advantage of the new taper header is not only the better and smoother finish, but also in the length of collar. With the old header (now used for the second operation) collars could

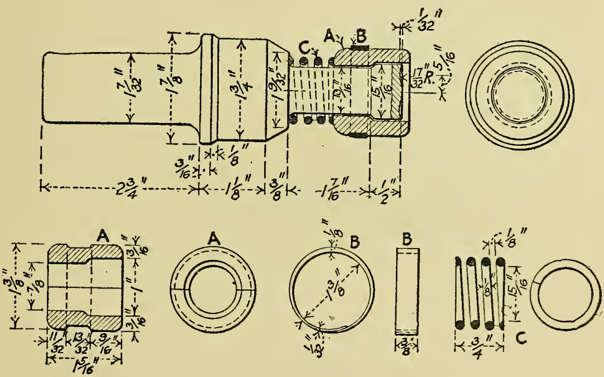


FIG. 255.—Die for heading stay bolts.

only be made up to 3 in. long, while with the new or both headers collars of 5 in. or longer can be made.

On a bulldozer or bolt machine, where the two headers can be adjusted for use at the same time, collars can be finished with one welding heat for both operations, if not over 3 in. long.

Die for Heading Stay-bolts.—This device, shown in Fig. 255, is used with an air hammer. The sleeve *A* on the end of the die goes flush against the boiler plate and keeps the tool in position. The sleeve is split in halves as shown and held by the spring *B*. As the head of the stay flattens out, the sleeve is still kept against the plate by the spring *C*.

CHAPTER V

DATA AND SUGGESTIONS ON THE MAKING OF DIES

While the preceding pages have been filled with suggestions for various kinds of dies, this section deals more particularly with methods of construction, data as blanks, stripping pressures, etc., etc.

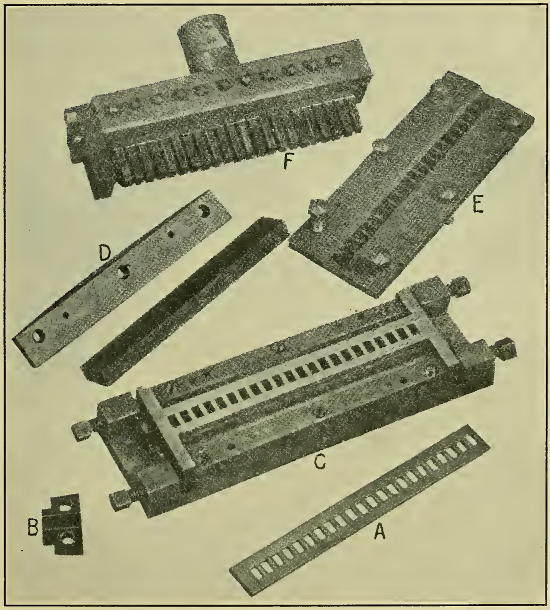


Fig. 256.—A sectional die for a sheet-steel rack.

An Interesting Sectional Die.—An interesting and successful sectional die for a sheet-steel rack is shown in Fig. 256. Of three unsuccessful attempts, two were to make a solid die for punching the entire number of holes. In each case some of the bridges between the holes cracked in hardening. The third unsuccessful attempt was to make a solid die that would punch every other hole in the piece and then index the piece for the remaining holes. This die was produced without cracking or breaking in hardening, but the work was not satisfactory, because of distortion of the thin bridges by the second punching operation. A knowledge of these three failures caused the adoption of an entirely different method, with satisfactory results.

In Fig. 256, the letter *A* indicates a finished piece made with the die. It is made from stock 7/8 in. wide and 1/16 in. thick,

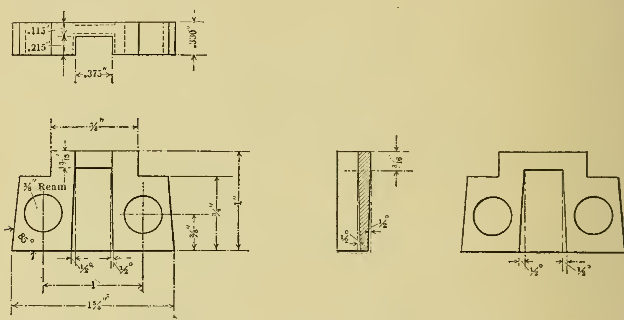


FIG. 257.—A section of a built-up die.

and serves as a rack meshing with a pinion. The conditions of the mechanism of which it forms a part are such that great accuracy is required. The finished piece must be exactly 7.590 in. long and contain twenty-two holes each 0.325 in. long by 0.215 in. wide, and the space between the holes must be exactly 0.115 in. wide.

This die was built up of individual pieces, so designed that they should be exact duplicates, and capable of being produced by machine work with very little handwork. A detail of one of these pieces is shown by Fig. 257.

From a bar of 1/2 × 1 1/8-in. annealed tool steel twenty-two pieces were milled 0.330 × 1 × 1 5/8 in. and two longer pieces to form the ends. In the twenty-two pieces a slot was milled 0.215 × 0.375 in. Two holes were then drilled through one of these pieces, and this piece was used as a drilling jig to drill the others. The piece to be drilled was located in the drilling jig by means of a square key fitted to the slot which had been milled. Then the various clearances were milled, as shown by the drawing, Fig. 257. After this, the pieces were milled to 5-degree angles to fit in the bolster, and a clearance was milled on each of the two upper corners for the set edges.

A Reliable and Economical Forming Die.—Figs. 258 to 263 show a method of making a forming die which can easily be

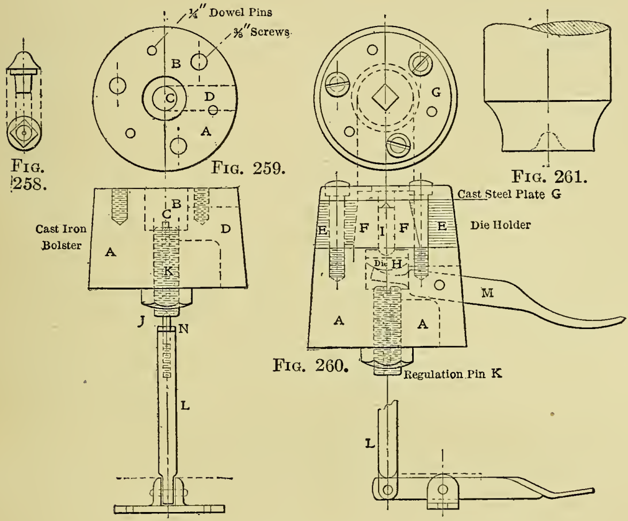


Fig. 262. Fig. 263.

Figs. 258 to 263.—Details of a forming die.

repaired, will stand as great a strain as a solid one and also avoid the chances of cracking in the hardening. In this case the die is hardened and tempered in two separate parts. The work for this die is a brass rivet as shown in Fig. 258.

The first step is to face bolster *A*, Fig. 259, top and bottom, bore and thread hole for bumping and regulation pin *K*. This pin to be of best cast steel and the lock nut, drilled through center is to be hardened and tempered. Cut slot *D* ½ in. in width for hand lever *M* as shown in Fig. 260. Tool extractor *S*, Figs. 262 and 263, is most satisfactory and can be easily fixed underneath any press and gives greater power in extracting product.

The base of die is now completed with the exception of screw holes for securing die-holder *E*. Turn die-holder *E* same diameter as top of *A* as shown in Fig. 260. Bore holder *E* for die *F* leaving 1/16 in. taper at back. Die *F* must be turned a nice fit in *E* and to stand about 3/16 in. above it as in Fig. 260. Bore die *F* same size as shank on work required as Fig. 258 leaving about 0.004 in. taper at mouth, allowing the product to be extracted more easily. See that this bore is nicely polished. Turn cast-steel plate *G* to fit over die *F* leaving right thickness for the forming of the square flange as in Fig. 258. Plate *G* and holder *E* must be secured to bolster *A* by means of screws and three dowel pins. Cut square for flange central with bore in die *F*.

This plate *G* will have the greatest strain and require special attention in hardening and tempering. Temper to almost blue, die *F* to be left harder only tempering to light straw. Plate *G* can be changed for different shaped flanges as required. It can also be repaired easily, as this is the part where the wear and tear in a solid would take place, necessitating a new die throughout. Plunger *H* must be of cast steel hardened. The jack *I* must nicely fit bore in die *F*. This jack has a centering tit so as to center the product ready for drilling which was required in this case. Figs. 262 and 263 is the foot extractor fitted with hardened steel peg *J* which works through pin *K* and forces the product out of die. This peg can be regulated if required by screwing *K* into extractor *L* and fastening with lock nut at *N*. Fig. 261 is the top die or punch which cannot be left too strong.

A Combined Blanking and Forming Die.—Fig. 264 shows a combination blank and forming die for brass caps for carriage-bolt heads, such as are used in laundry machines.

A is the forming punch; *B* is the blanking punch; *C* is a split sleeve which catches in the groove cut around the forming punch; *D* is a sleeve that locks and releases the blanking punch.

The coiled spring *E* pushes the blanking punch back and locks it as you see it on the sketch. *F* is the punch-holder; *G* a pin through *F* and *A*; *H*, the die pressed into an iron block; *I*, the blanking part; and *J*, the forming part of the die. The shoulder on *B*, near the cutting edge, is to hold *B*, while *A* goes down and forms up the cap.

A Sectional Die that is Easily Made.—A sectional elevation of a blanking and drawing die is shown in Fig. 265. This can be used on any standard double-action press to make seamless oblong covers with a flange up to ¾ in. in width without trimming, which would be necessary with most dies. The construction of this die is such that it can be made in any machine shop with the use of their regular machines without going to a regular diemaker.

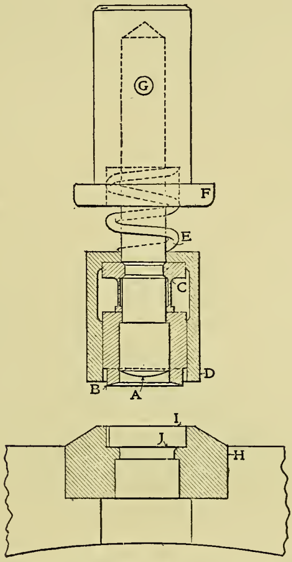


Fig. 264.—Combined blanking and forming die.

Referring to the illustration, *A* is of hardened tool steel and secured to the wrought-iron bolster plate *B* by screws *C* and dowels *D*. The friction ring *E* is of hardened tool steel and is held in place by the pins *F*, which are driven into the cast-iron pad *G*. The cutting ring *H* is of hardened tool steel and is welded to the wrought-iron plate *I* which is secured to the bolster plate *B* by screws *J*.

The gage pins *K* are driven into the cutting-ring plate *I*. The punch ring *L* is of hardened tool steel and secured to the steel

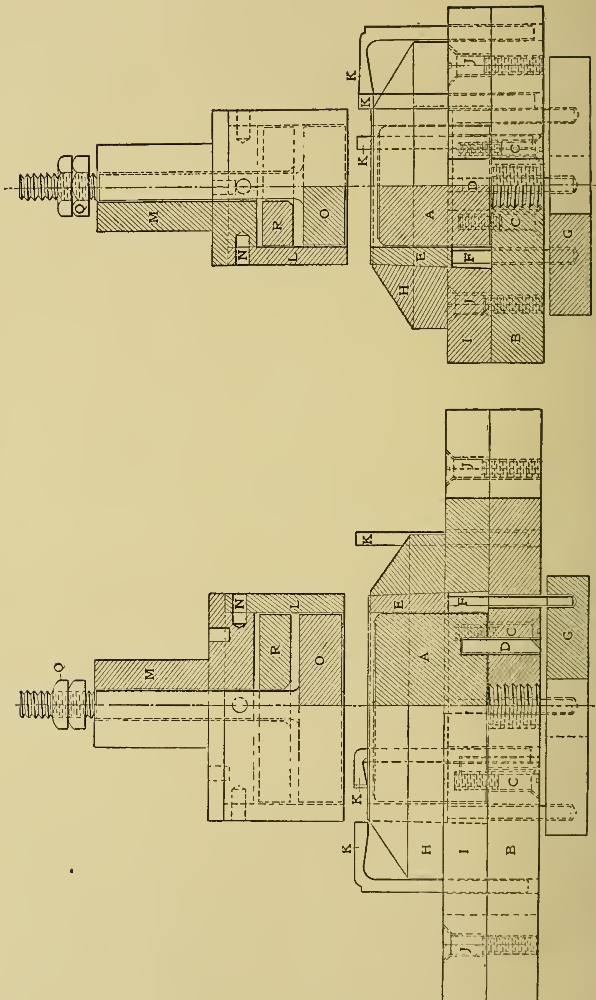
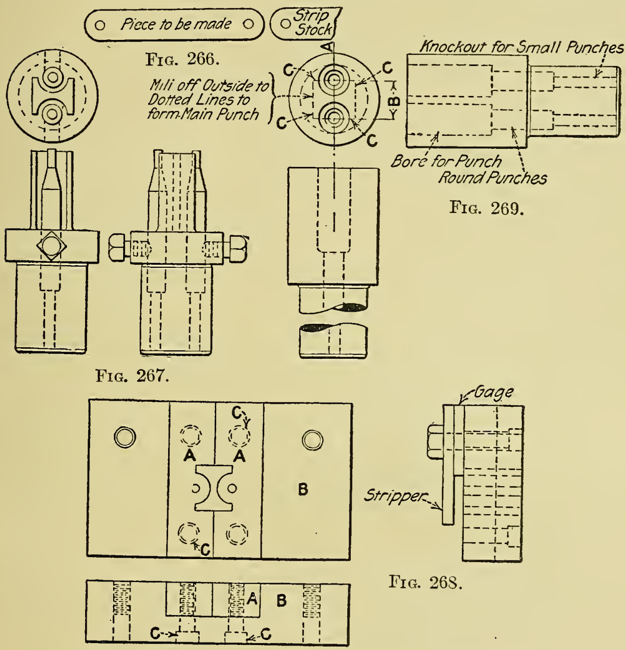


Fig. 265.—Sectional blanking and drawing die.

punch body *M* by dowels *N*. The knockout pad and stem *O* is made from one piece of steel and is held in place by the nuts *Q,Q*. The washer *R* is of cast iron so that it can be taken out and ground as the punch ring *L* gets worn.

Making a Difficult Die Rapidly.—This die, while quite common, is not an easy one to make in the usual manner. It cuts off, rounds



Figs. 266 to 269.—Method of making difficult die.

the ends and punches the two small holes. Fig. 266 represents the piece to be made and one end of the strip. By this method you get perfectly rounded ends with the holes accurately centered.

In Fig. 267 is shown the punch and in Fig. 268 the die, in three views. In this method the punch is made first. Fig. 269 shows the method of making a punch, most of the work being done on the lathe. First turn up the blank as indicated, then finish the shank and lay out the centers of the small punches, as shown in *A* and *B*. Have an adapter for the lathe faceplate to fit the punch shank. Locate one center and bore out complete the three sizes, as shown—that is, the inside diameter of cut-off punch, the hole for the small punch and also the knockout hole for the small punch. Reset to the other center, and repeat. Next mill or shape, as shown by the dotted lines *C*. The punch is then practically finished.

The die is easily made by using two tool-steel pieces inserted in a mild-steel die block, as shown in Fig. 268. By making the two pieces *A* exactly the same size, you can clamp them both edgewise and almost finish to size in the shaper. This type of die is rather difficult to make when made in one piece, as is the usual practice.

Cast-iron Blanking Dies.—It is often necessary, especially in a job shop, to make a small number of blanks, but not enough to warrant the manufacture of a regular tool-steel punch and die.

If the blanks are not over 0.035 in. thick, the die and punch can both be made of ordinary cast iron. Such a set, if properly fitted, will produce several hundred blanks equally as well as the more expensive type generally used. There seems to be no reason why it will not work on stock thicker than 0.035 in.

The small wear of cast iron, even in its natural state, indicates that cast-iron dies might be made in large quantities at the foundry by inserting chills the shape of the blank. Perforations, if any, must, of course, be made with the proper amount of clearance.

Dies made by this method cost very little, the punch being of tool steel, as usual. A cast-iron punch and die have been used for experimental motor field and armature laminations, producing the highest type of stampings.

A Positive Stripper.—A punch and die for piercing 144 holes in 20-gage iron in the location indicated in Fig. 270 was made as shown. As the holes were 0.2285 in. diameter and the metal 0.0375 in. thick, the ordinary spring-actuated stripper, with the long punches which necessarily go with it, did not give very good results, so a positive stripper was used.

In the die (not shown) the holes were located, drilled and taper broached for clearance in the usual way, and the holes for the subpress pins were bored, reamed and chamfered. The die was then hardened and the holes in the punch-holder were transferred from the hardened die.

Referring to Fig. 270, *A* is the cast-iron punch-holder, *B* the punch pad, which was made of 7/8-in. boiler plate, held to *A* by 1/4-in. machine screws and located by the subpress pins which

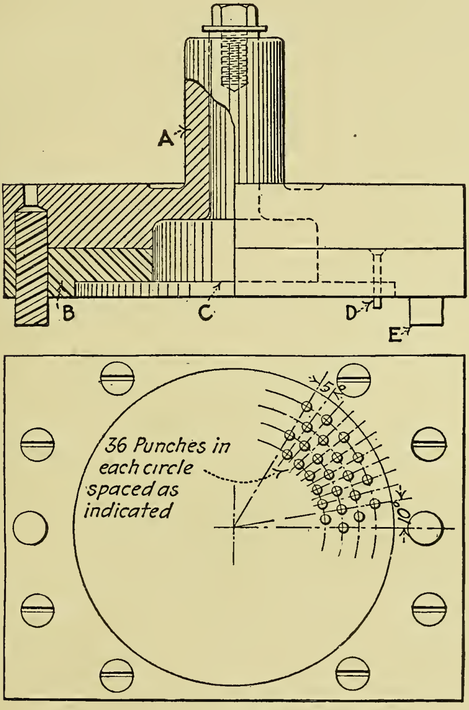


FIG. 270.—Die for 144 holes.

act as dowels. The stripper *C* was made of boiler plate and machinery steel, built up to save turning; the *D* punches were made of No. 30 drill rod, headed over as indicated, hardened in oil and drawn; the subpress pins *E* were tool steel hardened and ground.

The stripper C was turned a close working fit in A and B and drilled and reamed a close working fit on the punches D. The shank of the stripper C extended 1/4 in. above the shank of the punch-holder A and was held from dropping out by a 3/8-in. capscrew and washer.

In operation the stripper came into contact with the work and slid up into the holder, thus supporting the punches while they pierced the work and entered the die.

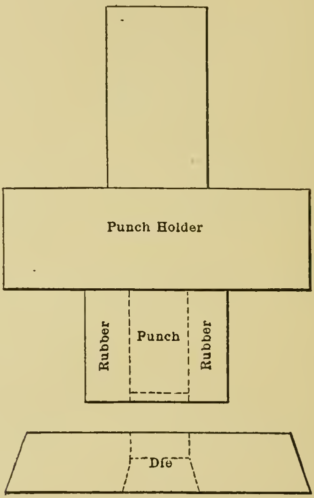


Fig. 271.—Using a rubber stripper.

As the punch ascended the capscrew struck the kickout on the press, forcing the stripper down and thus stripping the work from the punches. In order to lessen the stress on the press the inner row of punches was 3/64 in. shorter than the outer row, 1/32 in. shorter than the second row and 1/64 in. shorter than the third row.

There are other cases where a rubber stripper, as shown in Fig. 271, is found useful.

Force Necessary to Strip Work from Punches.—Nearly all shops which have much to do with punching of steel and other metals have their own standards for both punches and dies.

But, unless they have had actual punching experience, they are apt to be at a loss as to the amount of taper to give the punches.

No one who has not made actual stripping tests realizes that the largest percentage of punches are broken in stripping, and this depends largely on the taper of the punches.

Some argue that the taper on a punch allows the metal to close around the punch and makes stripping harder. This does not seem to be borne out by tests made by H. D. MacDonald. He made punches with 2-degree taper, with 1-degree taper and straight, and punched a piece of machinery steel 2 in. wide, 2½ in. long and ⅝ in. thick with each punch. These pieces were then taken to a Riehle testing machine and each stripped in the same way.

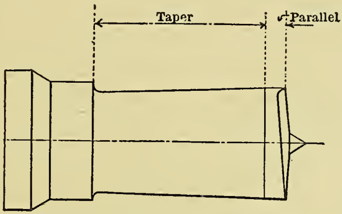


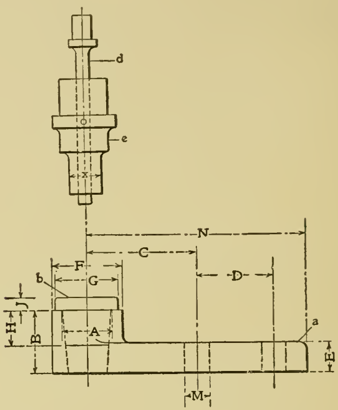
FIG. 272.—The proposed punch.

The first punch with a 2-degree taper stripped at 550 lb., the second with 1-degree taper at 780 lb., and the straight punch required 2000 lb. All three punches were 23/32 in. in diameter.

This shows very clearly that the tapered punch strips more easily and will stand up better against breakage. On the other hand, it will not last as long as a straight one as it cannot be ground without losing its size.

It is suggested that a punch made as shown in Fig. 272, with a short straight portion and tapered 2 degrees behind the straight, might be a satisfactory compromise.

Suggestions for Press Tool Standards.—A simple, yet durable, punch and die outfit is shown in Fig. 273, which for small work can be easily changed from one job to another without changing the holders, providing the diameters of the blanks are the same or nearly the same. The holder *a* is a drop forging. The distances between the centers of the screw holes and the die are made to a standard jig. The die *b* is of tool steel hardened and ground, the taper of the dies and holders being 3 degrees. The drawing punch *d* is of tool steel hardened and ground, and *e*, which is the blanking punch, of tool steel, is also hardened and ground on the diameter *x*. The punches are secured in their respective holders by square-head setscrews.

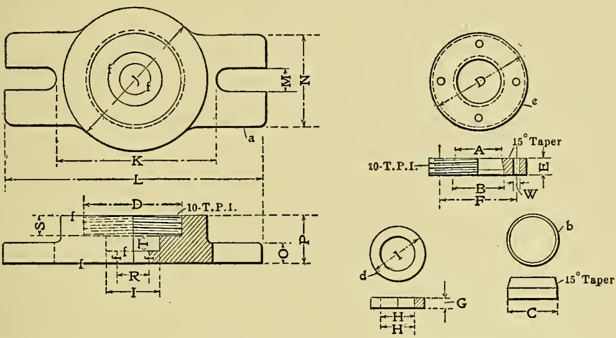


A	B	C	D	E	F	G	H	J	M	N
3/4	1	1 3/4	1 1/4	1/2	1 1/8	1	1/2	1/4	3/8	3 1/2
1	1 1/8	1 3/4	1 1/4	1/2	1 3/8	1 1/4	3/4	1/4	3/8	3 1/2
1 3/8	1 1/2	1 3/4	1 1/4	5/8	1 7/8	1 3/4	1	3/8	3/8	3 1/2
1 5/8	1 7/8	2	1 1/2	3/4	2 1/8	2	1 1/4	3/8	1/2	4
1 7/8	2	2	1 1/2	1	2 3/8	2 1/4	1 1/2	1/2	1/2	4
2 1/8	2	2	1 1/2	1 1/8	2 5/8	2 1/2	1 3/4	1/2	1/2	4

Fig. 273.—Die-holder sizes.

The dies are forced into their holders, screwed to the bolster plate and the tops of the dies are ground in a surface grinder so that the metal will feed over them easily. In like manner the blanking punches are ground, while the drawing punches may be left as they are without grinding.

Fig. 274 is a set of tools which may be used for work too large to be done with the tools shown in Fig. 273. These tools can be used for cutting and drawing, drawing, or drawing and redrawing. The die-holder *a* is of cast iron finished as indicated; *b* is the first die of tool steel hardened and ground in which is cut

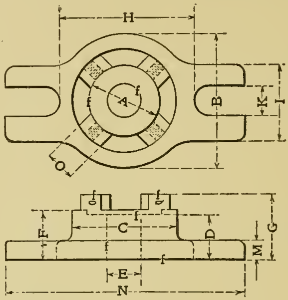


A	B	C	D	E	F	G	H	H′	I	J	K	L	M	N	O	P	R	S	T	W
2	2⅜	2¼	4⅝	13/16	3 7/16	½	2 1/16	1 11/16	2⅝	6¾	7¼	12	1⅛	4¼	⅞	2¼	1⅝	15/16	11/16	⅜
2½	2¾	2⅝	4⅝	13/16	3 7/16	½	2¼	1⅞	3	6¾	7¼	12	1⅛	4¼	⅞	2¼	2	15/16	11/16	⅜
2⅞	3⅛	3	6	⅞	4⅞	¾	3	2	3⅜	8	8¼	13	1¼	4½	1	2½	2⅛	1	11/16	½
3¼	3⅝	3½	6	⅞	4⅞	¾	3¼	2½	3⅞	8	8¼	13	1¼	4½	1	2½	2⅝	1	11/16	½
3¾	4 1/16	3 15/16	6	⅞	4⅞	¾	4	3	4¼	8	8¼	13	1¼	4½	1	2½	3⅛	1	11/16	½
4¼	4⅝	4½	8	1	6⅞	⅞	4	2	5⅜	11	12	16	1¼	4½	1¼	3⅛	2	1⅛	⅞	½
4¾	5⅛	5	8	1	6⅞	⅞	4½	2⅝	5½	11	12	16	1¼	4½	1¼	3⅛	2¾	1⅛	⅞	½
5 3/16	5 9/16	5 7/16	8	1	6⅞	⅞	5	3⅜	5⅞	11	12	16	1¼	4½	1¼	3⅛	3½	1⅛	⅞	½
5½	6	5⅞	8	1	6⅞	⅞	5	3⅝	6	11	12	16	1¼	4½	1¼	3⅛	3¾	1⅛	⅞	½

FIG. 274.—Die block sizes.

the shape of the blank, or the diameter of the drawn shell. These dies have a 15-degree taper on a side. For cutting and drawing, or drawing, these dies bottom on a steel ring *d* which may or may not be case-hardened. For redrawing, another ring of the same dimensions as this one, except for the bore, is used, and the redrawing is done with a "floating" die $\frac{1}{32}$ in. smaller in diameter than the bore of the ring and 1/64 in. lower than the ring. The reason for having the redrawing die a floating die is that, should there be any discrepancy between the centers of the two dies, the drawing punch will locate the lower die so that it will have to come right anyway.

At *e* is shown the die ring or retaining ring of tool steel, the taper at the inside being 15 degrees on a side to suit the taper



A	B	C	D	E	F	G	H	I	K	M	N	O	Screw
2 1/8	6 1/8	4 7/16	1 7/8	1	1 15/16	2 7/8	7 3/8	3 1/2	1 1/8	1 1/8	13 3/8	1 3/4	1/2″×2″
3 3/8	7	6	1 7/8	1 1/2	1 15/16	2 7/8	8 1/2	3 1/2	1 1/8	1 1/8	13 1/2	2 1/8	1/2″×2 1/4″
4 1/4	7	7	2 5/16	1 7/8	2 1/8	3 1/8	7 3/4	3 1/2	1 1/8	1 1/8	13 3/4	3	1/2″×2 3/4″
5 1/8	7 7/8	7 7/8	1 3/4	3	2 1/4	3 1/8	8 1/4	4	1 1/4	1 1/8	14	3	5/8″×3″
6 1/4	9	9	2	3 5/8	2 1/4	3 1/2	9	5	1 3/8	1 1/8	14	3	5/8″×3″
7 1/4	10 1/4	10 1/4	2 1/8	4 7/8	2 1/4	4	9 3/8	5	1 3/8	1 1/4	16 3/4	2 3/4	5/8″×3″
8 7/16	11 5/8	11 5/8	2 3/16	5 7/8	2 1/4	4	11 1/2	5 1/4	1 1/2	1 1/4	17	2 3/4	11/16″×3″
9 1/4	11 3/4	11 3/4	2 3/16	6	2 1/4	4	11 1/2	5 1/4	1 1/2	1 1/4	17 1/2	2 3/4	11/16″×3″

FIG. 275.—Die block sizes.

on the dies. The thread on these rings and in the die beds in all cases is 10 per inch, and four holes are drilled, as shown, to allow tightening. The dies when new project from 1/8 to 3/16 in. above the bed and retaining ring to allow them to be ground.

It will be seen that many sizes of shells can be blanked or drawn in the same bed without removing the bed from the press, as all rings and dies are made to a standard gage.

Fig. 275 is a poppet bed of cast iron; the taper of the dies used is 5 degrees on a side, and they are held in place by four tool-steel setscrews with the ends reduced and hardened. Such beds are used mostly for the redrawing of shells and not for blanking.

Laying Out Stepped Dies.—A short time ago we had to make a number of large dies for automobile doors. Fig. 276 shows the general shape of the lower half of a large subpress die used for piercing a number of holes in one of the doors. As the doors were of an irregular shape, it was necessary to have the dies (which were located in the bosses) of different heights to conform. They were all too big to clamp to an angle plate and lay out as we do small dies, using a height gage.

The dies were strapped to the platen of a small planer and the tool *A* (which was simply a square piece of machine steel with a

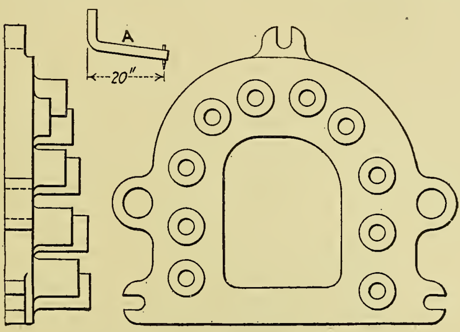


Fig. 276.—A stepped die.

stiff scriber fastened in one end) was made and clamped in the planer tool holder. It had to be made long as shown, as the dies would not go between the housings. To lay out the work, a 24-in. scale was clamped to the rail and an index-finger, made from thin sheet metal, was clamped to the saddle with the end resting on the scale. This gave us a means of getting our dimensions in one direction, while another scale laid in the way with one end kept against the platen and a conveniently scribed zero mark, furnished us a way of getting our dimensions in the other direction.

The rail was raised and lowered to bring the scriber into contact with the work and the lines were scribed by moving the platen or the head. A center could be established by a slight blow on the top of the scriber. This proved to be a quick way of laying out the dies, and as accurate as the work called for.

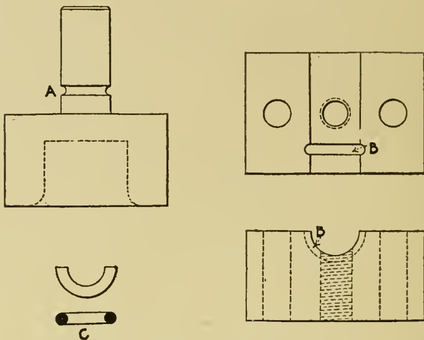


Fig. 277.—Method of holding a punch.

Method of Holding Punches in Place.—Combination drawing and reducing punches which pulled out of their holders, even when the screws were set up hard against tapered flats, were replaced by the method shown in Fig. 277.

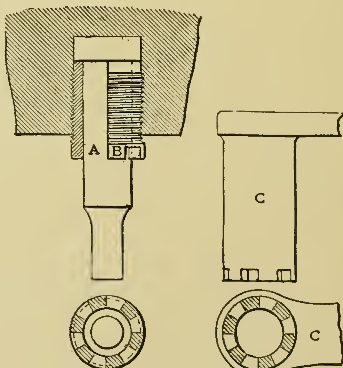


Fig. 278.—Another punch holder.

A semicircular groove *A* was cut around the punch, while the clamping plate of the press gate had a similar groove *B* cut in it.

A half-ring *C* of round bessemer wire was made to fit the combined half-round grooves in the punch shank and the clamp. This ring was then set into these grooves, and the clamp was tightened.

Equipped in this manner a punch will hold no matter how severe the duty.

Another method is shown in Fig. 278. This can also be used in making multiple-punch tools, where it is often necessary to locate the punches as close as possible to prevent handling the work more than once. The design shown has been found very efficient on heavy work.

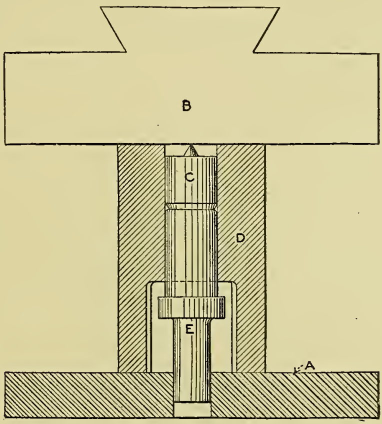


FIG. 279.—Method of relocating punches.

The punch *A* is held in place by the threaded sleeve *B*, which is tightened up with the special wrench *C*.

This arrangement also permits of any punch being removed or replaced without disturbing the others.

Relocating Misplaced Punches.—An error was made in laying out a combination, three-at-a-time piercing, shearing and blanking die. Instead of making a new die and punches, the method shown in Fig. 279 was used by the tool-room foreman:

A correct die was made and the punches that had been sheared in the spoiled die were used. A piece of cast iron *D*, with a hole the same diameter as the punch shank, was bored and faced. A slot was milled in one side of the bottom to allow the punch *E* to be seen when in the die *A*. The center punch *C* was then inserted and the punch and die brought together in the screw press until it marked the punch block *B*. It was then indicated up in the lathe and bored to suit the punch. This proved satisfactory and saved the cost of the punches.

Chart for Deflections and Loads on Rubber Pads.—In designing a punch and die for a trimming and embossing operation, it was necessary to emboss before trimming; consequently the stripper, which was backed up by the rubber pad and stripper

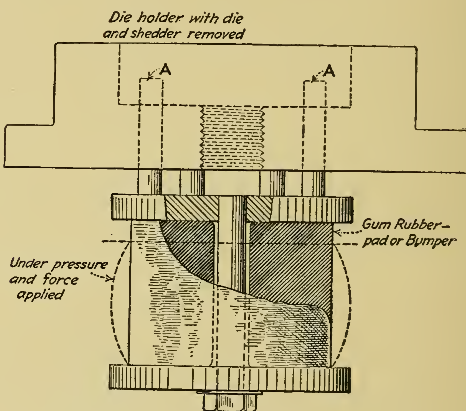


Fig. 280.—Rubber stripper used in tests.

pin *A*, as shown in Fig. 280, had to withstand the resistance of embossing.

Considerable experimenting gave the definite figures which have been put in the chart given in Fig. 281.

At the left-hand side of the chart is found the deflection or compression of the rubber and at the bottom the corresponding average load or weight necessary to compress the rubber pad.

For instance, if the rubber is to be compressed ¼ in., as is usually the case with a bending die, follow the horizontal deflection line at ¼ in. until it meets the diagonal line and then follow down the vertical load line at this point at the bottom, and it is found the rubber will offer a resistance of 340 lb.

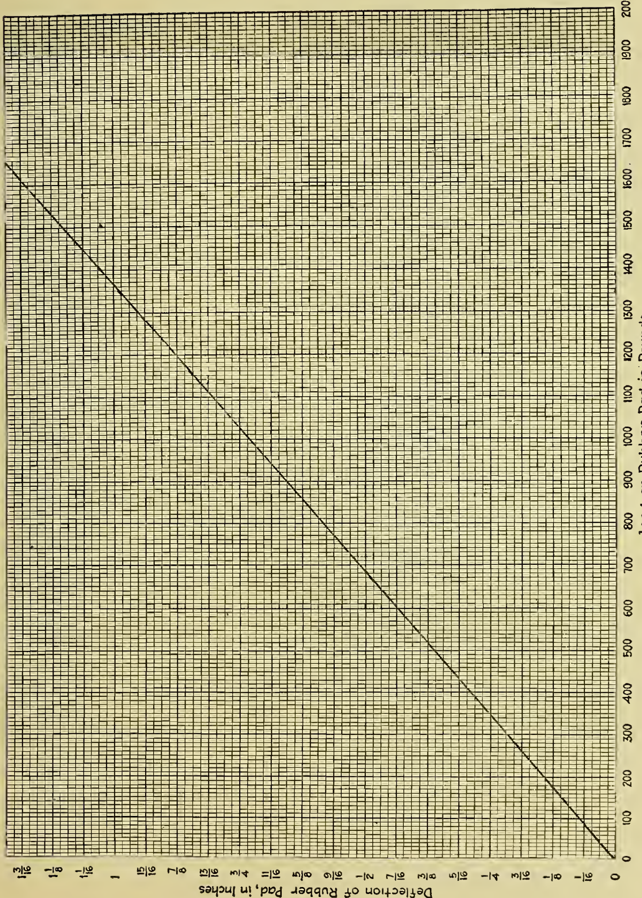


FIG. 281.—Results of experiment with rubber stripper.

Chart for Cup Blank Diameters.—A series of cup curves were plotted and the result is given in Fig. 285. It has been noticed that upon taking a blank of any diameter and drawing it into a number of plain cups the tops, when connected, formed a curve similar to those shown in the chart.

With this as a working basis the curves were plotted for each ½-in. difference in blank diameter from 0 in. to 12 in., using the American Machinists' Handbook formula $B = \sqrt{D(D + 4H)}$, which is the correct surface formula for plain cups with sharp corners. As this formula does not take into account the radius at the bottom of most drawn cups as in Fig. 282, which increases the height of the cup over a sharp-cornered cup of equal cup and blank diameters, the following formula was worked out with this in view:

$$C = \frac{R(0.43D + 0.143R)}{D}$$

Fig. 283.

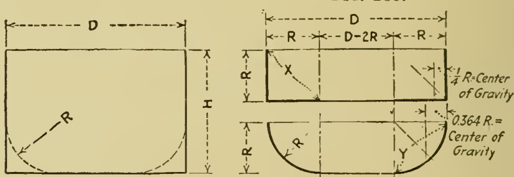


Fig. 282. Fig. 284.

Figs. 282 to 284.—Three cup blanks.

The derivation of the American Machinists' Handbook formula is here given as well as the height-correction formula and methods of using the chart:

C = Height correction.
H = Height.
R = Radius.
D = Diameter.
B = Blank diameter.

American Machinists' Handbook Formula

Area at bottom of cup $= \frac{D^2\pi}{4}$.

Area of shell $= D\pi H$.

Total area $= \frac{D^2\pi}{4} + D\pi H$.

Blank diameter having this total area

$$\sqrt{\frac{\frac{D^2\pi}{4} + D\pi H}{\frac{\pi}{4}}} = \sqrt{\frac{4}{\pi}\left(\frac{D^2\pi}{4} + D\pi H\right)} = \sqrt{D^2 + 4DH}$$

$$= \sqrt{D(D + 4H)}$$

Height Correction Formula

Area of ring section X, Fig. 283, $= 2R\pi(D - 0.5R)$;

Area of ring section Y, Fig. 284, $= (D - 0.728R)\pi\frac{(\pi R)}{2}$

Difference in area between X and Y $= 2R\pi(D - 0.5R) - (D - 0.728R)\,\pi\frac{(\pi R)}{2}$

The height of a shell whose diameter $= D$, and whose area $=$ difference between X and Y

$$= \frac{2R\pi(D - 0.5R) - (D - 0.728R)\,\pi\frac{(\pi R)}{2}}{D\pi}$$

$$= \frac{2R(D - 0.5R) - (D - 0.728R)\frac{(\pi R)}{2}}{D}$$

$$= \frac{2RD - R^2 - 1.57RD + 1.143R^2}{D}$$

$$= \frac{0.43RD + 0.143R^2}{D}$$

$$= \frac{R(0.43D + 0.143R)}{D}$$

To illustrate the use of the chart, Fig. 285, consider the following examples: Having given a cup whose diameter is 4 in. and whose height is 8 in., with sharp corners, to find the blank diameter.

Find the 4 in. on the cup-diameter scale and the 8 in. on the height scale. The intersecting curve will be found to be the 12-in. blank curve.

If instead of a sharp-cornered cup we have a radius of 1½ in., it is first necessary to find what increase in height of cup this radius will make over a sharp-cornered cup 4 in. in diameter. It will be found that the 1½-in. radius line will fall 23/32 in. (scaled)

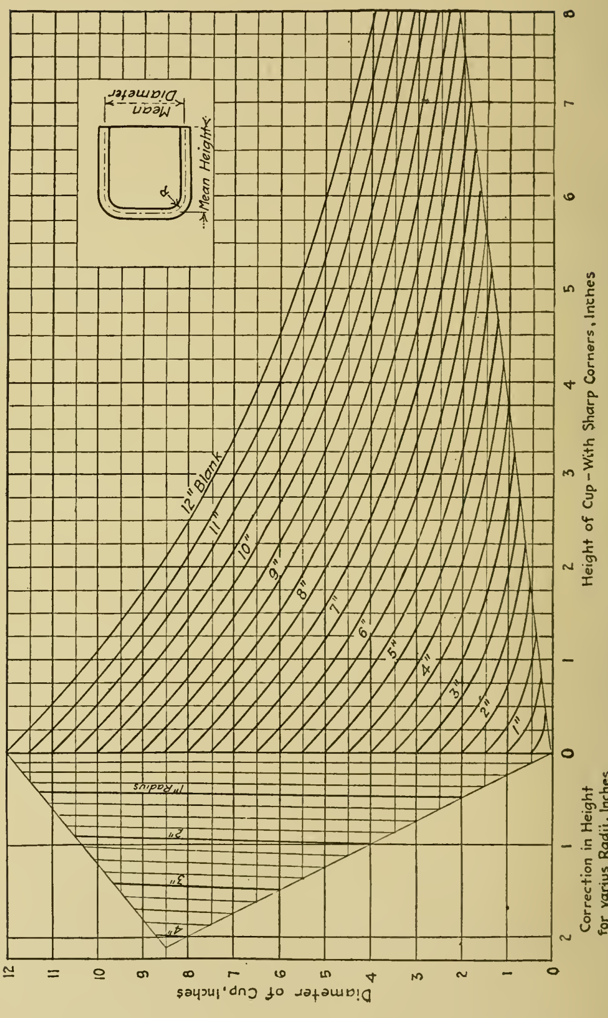


FIG. 285.—Chart for diameters of cup blanks.

below the zero line, in the height correction scale at its intersection with the 4-in. cup-diameter line. Deducting this $^{23}/_{32}$ in. from the 8 in. height we have $7^{9}/_{32}$ in., and it will be seen from the chart that the new blank diameter curve will be $11\frac{1}{2}$ in. slightly full.

In plotting the curves mean cup sizes were considered, as shown in the chart, but outside cup sizes are sufficiently close, except in cases of very thick metal. It should also be understood that the cup must have a uniform metal thickness.

Authorities Quoted

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