MACHINERY'S REFERENCE SERIES

EACH PAMPHLET IS ONE UNIT IN A COMPLETE LIBRARY OF MACHINE DESIGN AND SHOP PRACTICE REVISED AND REPUBLISHED FROM MACHINERY

No. 13—BLANKING DIES

CONTENTS

INTRODUCTION.

It is rather difficult to classify and give proper definitions of the many varying kinds and types of dies used on the power press for rapid production of duplicate work. While there are, of course, some general classes into which all tools of this description may be divided, the various types overlap, so to say, and one is sometimes in doubt as to the proper classification of tools which combine the features of different types. In the following, however, the distinctions between the main types have been pointed out in general outlines, the definitions being broad enough to permit of adjustment according to special conditions.

All dies may, in the first place, be divided up into two general classes: *cutting dies* and *shaping dies*. Cutting dies include all dies which simply cut or punch out required pieces of work from the stock fed into the press, without changing the condition or form of the stock in the plane in which it was located in the material from which it is cut. Shaping dies include all dies which change the form of the material from its original flat condition, producing objects in which the various surfaces are not in the same plane. The last mentioned main subdivision often includes also the characteristics of the first, that is, some shaping dies are, in fact, a combination of cutting and shaping dies, the blank for the work to be shaped or formed being first cut out to the required outline from the stock, and then shaped to the desired form.

The main classes of dies, as will be recognized, are based on the *use* of the dies. The first of the classes mentioned, cutting dies, may, however, be further subdivided according to the *construction* of the various types of dies in this class. We then distinguish between four distinct types, *plain blanking dies*, *follow dies*, *gang dies*, and *compound dies*.

Plain blanking dies are the simplest of all types of dies, and are used to cut out plain, flat pieces of stock having, in general, no perforations, the work being turned out complete at one stroke of the press.

Follow dies, not infrequently also termed tandem dies, are used for work which must be cut out from the stock to required shape, and at the same time be provided with holes or perforations of any kind. The principle of the follow die is that while one part of the die punches the hole in the stock, another part punches out the work at a place where at a former stroke a hole has already been punched, so that a completed article results from each stroke of the press, but, in reality, two operations have been performed on the work before completion. The follow die cannot be depended upon to turn out very accurate work, because it depends largely on the skill and care of the operator for the production of duplicate work. In both the plain blanking and the follow dies, the punch, or upper member, and the die, or lower member, of the complete tool, are distinct elements, the work being cut out or perforated by the entering of the punch into the holes provided for it in the die.

Gang dies are used when several blanks are punched out simultaneously from the stock. The advantage of the gang die over the plain blanking die is the saving of time.

Compound dies differ from plain blanking and gang dies in that the simple punch and die elements are not separated, one in the upper and one in the lower half of the complete tool, but these elements are combined so that both the upper and the lower part contain each a punch and a die. The faces of both punches, dies and strippers are normally held at the same level, and the strippers are spring supported so as to give way when the stock is inserted between the faces, and the press is in action. The springs are so adjusted that they are strong enough to overcome the cutting resistance of the stock, after which they will be compressed until the ram reaches the end of its stroke. A compound die produces more accurate work than the three types previously referred to, for the reason that all operations are carried out simultaneously at one stroke, while the stock is firmly held between the spring-supported opposing die faces. The disadvantage of the ordinary compound die is the difficulty encountered in "setting up," and the complexity of the design, which usually requires more or less frequent repairs.

The second main division of dies, the shaping dies, cannot be subdivided according to the construction of the dies in the same manner as the cutting dies. Shaping dies are usually designed more or less on the compound principle, outlined above, but owing to the great variety of work performed in shaping dies, the designs vary too greatly for a classification on the basis of constructional features. They may, however, be divided into sub-classes according to the general use to which they are put. We would then distinguish these four main subdivisions: *bending dies*, *forming dies*, *drawing dies*, and *curling dies*.

Bending dies are used when part of the surface of a piece of work is pushed from its original plane into a new shape in such a manner that the bent work does not form a closed curve.

Forming dies are used when the blank is required to be formed into a hollow shape, by being pushed into a cavity in the die.

Drawing dies are used for the same purpose as forming dies, but the process differs therein that an outer portion of the flat blank to be formed is confined between two rigid flat surfaces, so that, when drawn radially inwards from between them, no wrinkles can form.

Curling dies are used for bending over the ends or edges of the work into a circular cross section, like the turning over of the edges of hollow objects of sheet metal, etc.

Finally, we must mention the sub-press die, which, however, cannot be defined as a special class of die, but merely as a principle on which all the different classes of dies, cutting as well as shaping dies, may be worked. The sub-press principle is simply that the upper and lower portion of the die, the punch and die, are combined into one unit by guide rods fastened into the lower part of the die and extending through holes in the upper part, or by some other provision for guiding. This construction permits of a high degree of accuracy, eliminates the necessity of lining up the punch and the die each time they are set up on the press, and thus saves a great deal of time and cost.

In the following, we shall, however, deal only with the simpler forms of cutting dies, plain blanking and gang dies, except in Chapter V, where reference will also be made to some of the more complicated types of dies.

CHAPTER I.

METHOD OF MAKING BLANKING DIES.

From a mechanical standpoint it can truthfully be said that we are living in an age of dies. Never before has the industrial world made use of the punch and die as it is doing to-day. And no wonder; for this useful tool in all its different phases has proved beyond all reason-

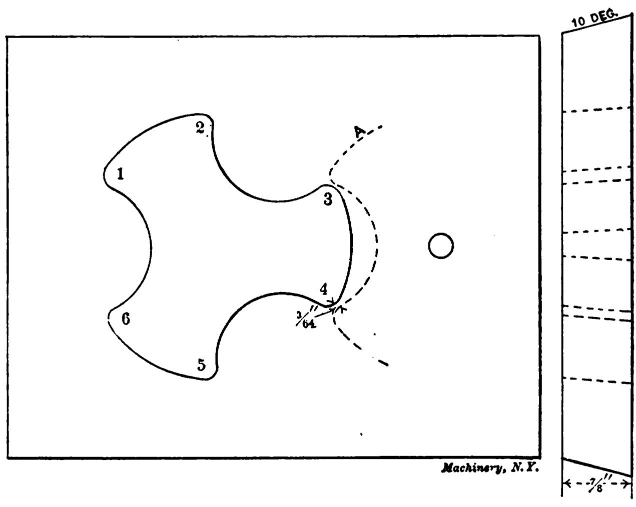


Fig. 1. Die used as Example in Illustrating Principles of Making Blanking Dies.

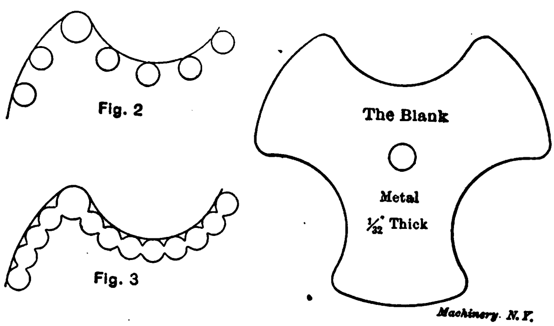
able doubt that it can turn out more work in less time than the combined efforts of a room full of milling machines, shapers, and drill presses. To those who are unfamiliar with the die and its work the above may not appear feasible; but one has only to visit a modern sheet metal factory to be convinced of the surprising rapidity with which the power press with its punches and dies will turn out not only work of all kinds of shapes and sizes, but accurate work as well.

Of the many different kinds of dies in use, the blanking die is probably the most widely employed. The reason for this is that almost all work that requires the use of various other kinds of dies has its beginning with the blanking die; for it is this die that cuts the work from the flat stock before it is completed by the other dies. In making the blanking die there are a few essential points to be taken into consideration, among which are the following:

1. Use good tool steel of a sufficient length, width, and thickness to enable the die to hold its own.

2. In laying out the die, care should be taken that as little of the stock as possible is left over, as waste, in cutting out the blanks.

3. Be sure not only that the die has the proper amount of clearance (which should be no more than two degrees and no less than one degree); but also that the clearance is filed *straight*, so as to enable the blanks to readily drop through.



Figs. 2 and 3. Method of Removing Surplus Stock or "Core."

4. In working out the die, machine out as much as possible; don't let the file do it all.

5. In hardening the die, do not overheat the same, as the cutting edge of a die that has been overheated will not stand up to the work, and requires so much sharpening in order to produce perfect blanks, that at its best it is nothing more than a nuisance.

In laying out the blanking die, the face of the die is first polished smooth and drawn to a blue color by heating. This gives better satisfaction by far than using coloring acid, for it gives a clear white line on a dark surface to work to, and is easier on the eyes, particularly when working by artificial light as is often necessary. When the die to be laid out is a blanking and piercing die, allowance of 3/64 inch must be made for the "bridge," *i. e.*, the narrow strip of metal that separates the holes in the stock from which blanks have already been cut. Fig. 1 shows how this is done; the dotted line *A* is drawn merely to show how the die is laid out.

After the die is laid out it is ready to be worked out. Now there are several different ways of working out the surplus stock in a die of this kind. One is to drill say a half-inch hole at a safe distance from the line, and then fasten the die in a diemaker's milling machine and mill out the stock close to the line with a taper milling cutter, which gives the die the necessary clearance, thereby saving considerable time when filing out the die.

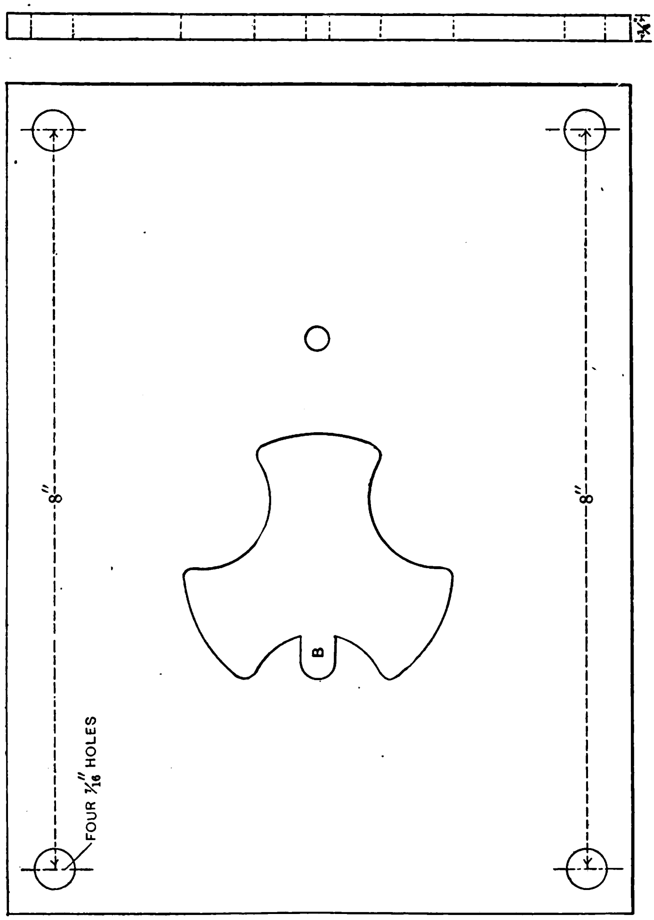


Fig. 4. Stripper Plate.

Another method, which is most commonly used, is to drill out the surplus stock on a drill press, after the manner shown in Figs. 2 and 3, which is done as follows: The six holes for the corners numbered 1, 2, 3, 4, 5, 6, Fig. 1, are first drilled and reamed taper, after which the other holes are drilled. These holes are drilled an even distance apart, and must therefore be spaced off, and then spotted with a prick punch before they are drilled. The best way to do this is to first scribe an inside line at a distance from the outside line equal to one-half the diameter of the holes to be drilled, then space off, and spot. In spacing off, do not use dividers, but use a double prick punch. Using a pair of dividers requires too much time, besides the points get dull quickly enough without using them when it is unnecessary.

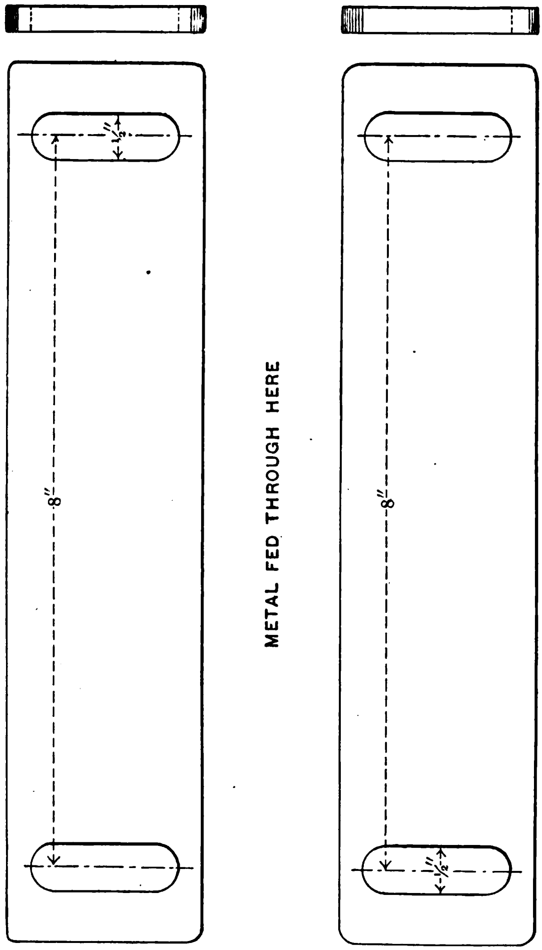


Fig. 5. Gage Plates.

After the centers have been lightly spotted with the double prick punch, use an ordinary prick punch and make the spots a trifle deeper, so that the drill will more easily take hold.

In drilling, use the method shown in Figs. 2 and 3, for in this way the holes can be drilled closer together, thereby making it easier to get rid of the surplus stock and saving the time of broaching out the webs. The die blank should be slightly tipped by placing a narrow strip of flat stock under the edge of same, as shown in Fig. 6, when the die is being drilled. This is done to give the necessary clearance, and does away with that time-killing operation of reaming the holes with a taper reamer from the back after they are drilled. After the surplus stock is gotten rid of, the die is finished up by filing, using a coarse file to begin with, and finishing with a smooth one.

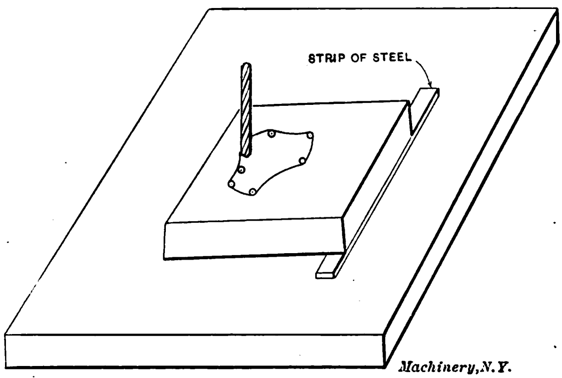


Fig. 6. Method of Obtaining Clearance when Drilling out the "Core."

Usually the die is made to fit a sample blank or a templet. This is done by entering the templet from the back as far as it will go after the die has been filed to the inside of the line. A lead pencil is then used to mark those parts of the die where the templet bears.

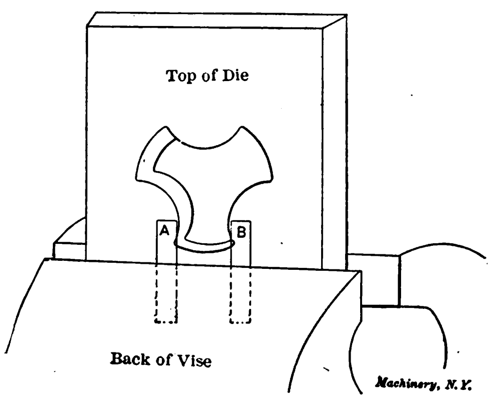


Fig. 7. Guarding the Corners in Filing the Die.

The templet is then removed, the pencil marks filed out, the templet again entered and so on, until it is worked through the die. In filing out a die of this kind, where there is any danger of injuring that part of the die which has already been finished, use two strips of sheet steel, *A* and *B*, in the manner shown in Fig. 7, the round corners which are already finished being thus protected from the edges of the file.

In hardening the die, heat it to a cherry red, preferably in a gas furnace or a clean charcoal fire, and dip endwise into the solution used for hardening. When the die is sufficiently cold so that it can be taken hold of by the hands, withdraw it quickly and place it on the fire until it has become so warm that it will make water sizzle when dropped thereon; then immerse once more until cold. This is done to relieve the internal strains caused by hardening, and acts as a preventive to cracking. The face of the die is now polished, and the temper drawn to a light straw color, after which the die is allowed to cool of its own accord in oil. When cool, the die is ground on a surface grinder on the top and bottom, and if it is required it is lapped to size, which completes the operations.

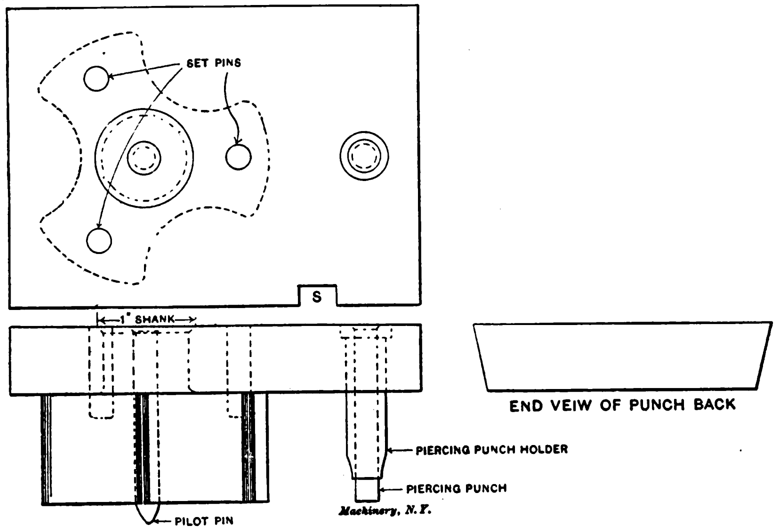


Fig. 8. Punch used with Die in Fig. 1.

The punch is made after the manner shown in Fig. 8, and needs very little explanation. The .dovetail punch back shown holds the punches in position, and is securely held in the press by the aid of a key. The slot *S* forms a position stop by engaging in a stud in the dovetail channel in the ram of the press, thereby eliminating the necessity of again resetting the tools in case the punch requires sharpening. The blanking punch is made from a tool steel forging, and is machined and sheared through the die in the usual manner. The one-inch shank is made a good driving fit in the punch back, and is upset as shown after the punch is driven in. The three set pins help to more securely hold the punch in position, and prevent it from turning.

The piercing punch is held in position by the piercing punch holder, which is driven tight in the punch back. The piercing punch is lightly driven in, and is made of drill rod, and can be very readily replaced in case it is broken. The pilot pin is also made of drill rod, and can be very easily and quickly taken out when the punch requires sharpening.

The stripper and gage plates for this die are shown in Figs. 4 and 5. They are fastened by four 7/16 cap screws to the die bed, used for holding the die in position when in use, and form, without doubt, not only the best, but by far the cheapest of the various methods employed for this purpose. While this method cannot be used on all kinds of blanking dies, it can, however, be used with the best of results on dies similar to the one described, and eliminates the unnecessary operation of drilling and tapping holes in the die itself to hold the stripper and gage plates in position. Not only that, but the gage plates as shown are used in connection with many other dies of a similar nature, thereby doing away with the necessity of having a set of gage plates for every die, as would otherwise be the case.

As the illustrations speak for themselves, no more explanation seems necessary, except perhaps that the slot *B* shown in Fig. 4 is to allow for an automatic finger to act as a position stop for the metal when it is run through.

CHAPTER II.

BLANKING AND PIERCING DIES FOR WASHERS.

One of the simplest dies to make, coming under the head of blanking and piercing dies, is perhaps the die for blanking and piercing brass washers. The reason for this is that in making this die, the file and vise are not used; the construction and shape of this die are such as to allow it to be made by machinery. To lay out a single washer die is a very easy matter, but to lay out a die for cutting two or more washers at one time, so as to cut the greatest amount of blanks from the least amount of stock, is not understood as it should be. One of the reasons for this is that it is the custom in some shops to have the foreman, or some one else appointed by him, lay out all the dies before they are given to the die-maker to work out.

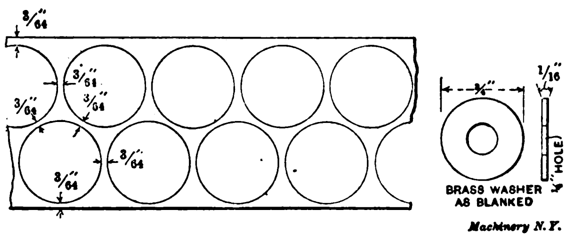


Fig. 9. Stock after having been run through the Die in Fig. 10, and Washer to be made.

In laying out a washer die for blanking two or more washers at one time, one of the main points to be remembered is that all the holes from which the blanking and piercing are done must be laid out in an exact relation to each other, so as to eliminate the possibility of "running in" (*i. e.*, cutting imperfect, or half blanks, by cutting into that part of the metal from which blanks have already been cut). The required amount of blanks must also be considered, for it sometimes happens that the amount wanted does not warrant the making of a die that will cut more than one at a time.

Fig. 10 shows how a die is laid out for blanking and piercing two washers at one time, so as to use up as much of the metal as possible. As shown, the ¾-inch holes marked *C* and *D* are the blanking part of the die, while the ¼-inch holes *A* and *B* are the piercing part. The distance between the center of *C* and *A* is 51/64 inch, as is also the distance between *D* and *B*. By referring to Fig. 9, which shows a section of the stock after it has been run through this die, it will be seen that there is a narrow margin of 3/64 inch of metal, known as "the bridge," between the holes. In laying out the die this margin must be taken into consideration, which is done in this manner: diameter of washer to be cut plus bridge equals distance from center to center, *viz.*, $3/4 + 3/64 = 51/64$. The dotted circle shows that the die is laid out so that one washer is skipped in running the metal through at the start. This is done in order to make the die a substantial and strong one. It can be very readily seen that if the circle *E* was the blanking part instead of *D*, the die would be a frail one, and would not be strong enough for the work for which it is intended.

Another important point in laying out a die of this kind is to lay out the die "central," *i. e.*, laying out the die so that when it is keyed

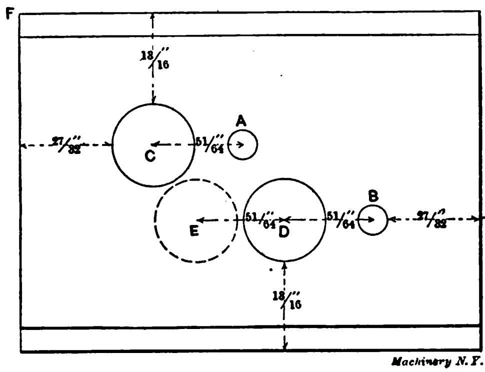


Fig. 10. Plan View of Die for Punching two Washers Simultaneously.

in position ready for use in the center of the die bed, it will not have to be shifted to the right or left side in order to make it line up with the punch. It may not be amiss to say in connection with the above that the punch back which holds the blanking and piercing punches in position should also be laid out "central"; this will be more fully described later on.

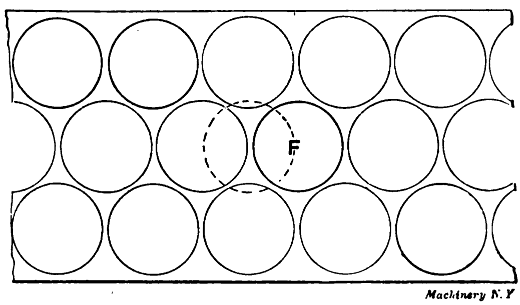


Fig. 11. Stock after having been run through Die in Fig. 12.

Fig. 12 shows the layout for blanking and piercing three washers at one time, and hardly needs any explanation; the explanation given in connection with Fig. 10 sufficiently explains Fig. 12.

Fig. 11 shows a section of the stock after it has been run through this die. It can be seen that the holes match in very closely together, and that very little stock is left. It is also seen that the three holes punched are not in a straight line, in so far as the width of the metal is concerned. This is done in order to save metal; the dotted circle *F* is merely drawn to show that wider metal would have to be used if the holes were in a straight line.

Fig. 13 shows the plan of a die for blanking and piercing eight washers at one time. The parts which are numbered are the blanking parts, while the parts that are lettered are the piercing parts of the die. This die is laid out similarly to Fig. 12, with the exception that there is provision for eight blanks instead of for three. Fig. 14 shows a section of stock after it has been run through this die. To give a better idea as to how the blanks are punched out in the manner shown, the sixteen holes in the metal from which blanks have been cut are numbered and lettered the same as the die. It should be understood

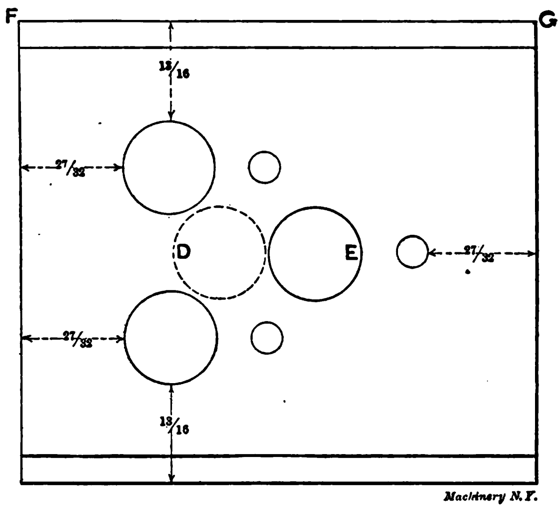


Fig. 12. Plan View of Die for Punching Three Washers Simultaneously.

that the metal is fed through in the usual way, which is from right to left, and that the ¼-inch holes are first pierced out, before the ¾-inch blanks are cut.

By referring again to Fig. 13, the layout for cutting two, three, four, five, six and seven blanks can be determined. The parts numbered and lettered 1—*A* and 5—*E* are the layout for two blanks. For three blanks: 1—*A*, 2—*B*, and 5—*E*. For four blanks: 1—*A*, 2—*B*, 5—*E*, and 6—*F*. For five blanks: 1—*A*, 2—*B*, 3—*C*, 5—*E*, and 6—*F*. For six blanks: 1—*A*, 2—*B*, 3—*C*, 5—*E*, 6—*F* and 7—*G*. For seven blanks: 1—*A*, 2—*B*, 3—*C*, 4—*D*, 5—*E*, 6—*F*, and 7—*G*.

The die bed used for holding the die in Fig. 13 in position when in use should have its dovetail channel running in the direction *KL*, while the dovetail channel for the dies shown in Fig. 10 and 12 should run in the direction *FG*. The reason for this is the longer bearing surface for the dovetail obtainable by such arrangement.

It should be remembered that all holes in dies of this kind are lapped or ground to size after hardening; they should be perfectly round and have 1 degree clearance. In some shops the holes are left straight for ¼ inch, and then tapered off 2 degrees.

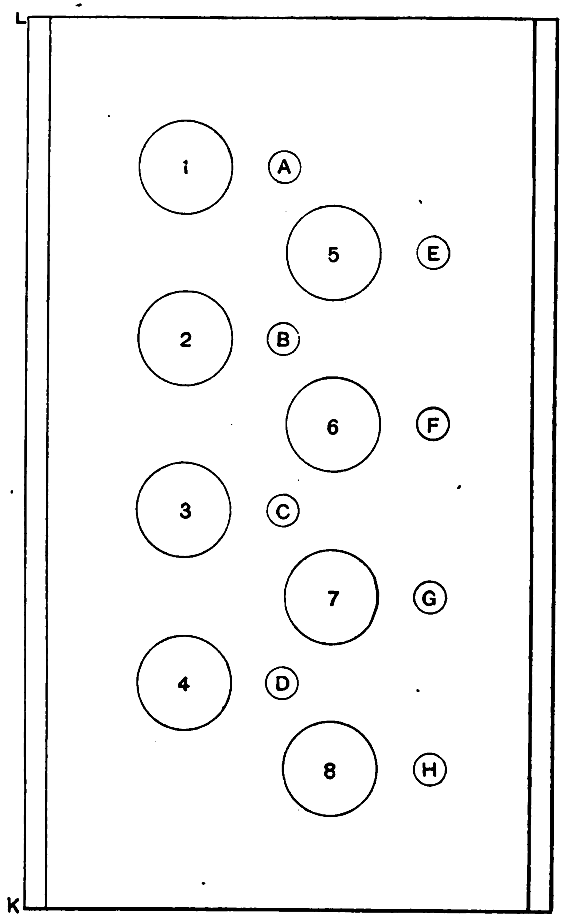


Fig. 13. Plan View of Die for Punching Eight Washers Simultaneously.

An important point to bear in mind in making the punch is to have a perfect "line up." It may not be generally known, but it is nevertheless a fact, that blanking tools that blank, or that pierce and blank two or more blanks at one time, will run longer without sharpening, cut cleaner blanks, and, in fact, give all around better results, if the punches are a perfect "line up" with the die, than if they are lined up in the so-called "near enough" way. A perfect line up, as referred to in the above, is a line up that will allow a punch that consists of two or more punches to enter the die the same as if the punch consisted of just one punch. The advantage of the perfect line up over the other is that when in use the punches do not come in too close contact with the edges of the die. They enter the die, but do not bear against the edges in such a way as to dull the die, or round over the sharp cutting edge of the punch.

A punch that is almost a perfect line up will enter the die, but it requires more force to make it enter. Why? Because in entering, one of the punches, for instance, rubs hard against the side of the die, and

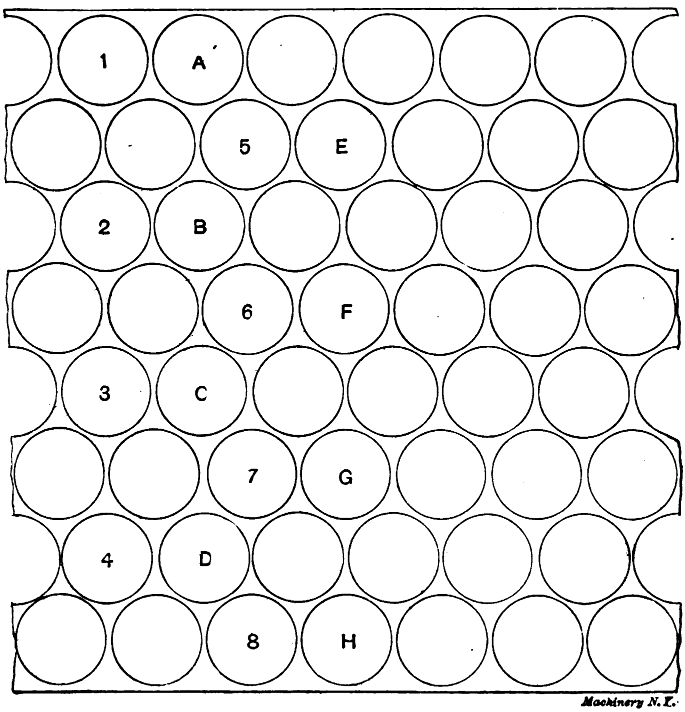


Fig. 14. Stock after having been run through the Die in Fig. 13.

if set up in the press and allowed to run, that punch, no matter how small, will dull the edges of the die as well as the edge of the punch itself. The result is that the press must stand idle while the tools are being sharpened, and if the real cause of the trouble is not remedied, it is "the same old thing" over and over again.

Just a few words in regard to making the punch. In making the punch, the punches must be made so that they will fit the die not too loose, nor too tight. The blanking punches are hardened and ground to size. The taper shank is finished to size after hardening, so that when the punches are driven into the punch back they will stand straight and not lean to one side.

In laying out the dovetail punch back, first clamp the back central on the face of the die. This is done so that when the punches are driven in position in the punch back, and set central in the ram of the press, ready to be used, no shifting is required in order to make the punch line up with the die, which is keyed in the center of the die bed. After clamping the punch back in this position, the blanking part of the die nearest the end is scribed on the face of the punch back. Do not scribe all the holes and rely upon finding the center of each circle thus scribed with a pair of dividers, and then true up these centers on a faceplate in order to get a perfect "line up"; this method increases the chances of error, especially when there are six or eight

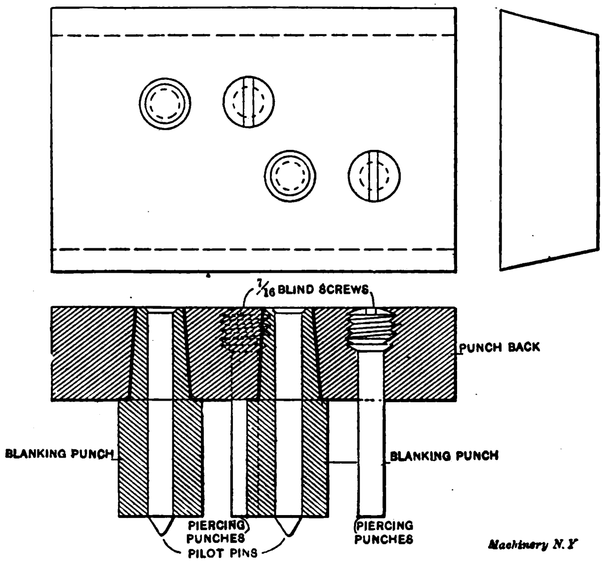


Fig. 15. Punch Back, with Punches inserted.

punches to be set in position. A better way is to scribe one circle as stated above, and remove the punch back from the face of the die; find the center of the circle scribed; true up this center, and drill and bore out the hole to fit the taper shank of the blanking punch.

Fig. 15 shows how a punch of this kind is made. The punch as shown is used with the die shown in Fig. 10. After the hole is bored to size, the already finished blanking punch is driven in tight in the manner shown. Two narrow parallels say $\frac{1}{2} \times \frac{3}{4}$ inch are now laid on the face of the punch back, and the blanking part of the die that corresponds with the punch driven in is slipped over the same, until the face of the blanking die rests upon these parallels, after which the die is clamped tightly thereon. The next hole is now trued up with a test indicator until the hole runs dead true. The die is then removed, and the hole for the taper shank is worked out, and the punch driven in. Where there are more punches to be set in, the same method is used until they are all in position. This insures a perfect line up, providing that ordinary care and precaution has been used in doing the work. In boring out these holes it is best to use a bolster having a dovetail channel, and to hold the punch back in position with a key. This is better than using straps to fasten the punch back to the faceplate, as the straps are likely to interfere with the parallels and the die, when locating the exact position for the holes to be bored.

In locating the position for the piercing punches, it sometimes happens that the holes are so small that they cannot be bored. The holes are then transferred by a drill that runs true and is the same size as the holes in the piercing die, the die being used, so to speak, as a drill jig.

Fig. 15 shows how the piercing punches are held in position. The punches are made of drill rod, and are prevented from pushing back by hardened blind screws as shown. If thin, soft metal is used, the method for holding the two pilot pins in position shown in the previous chapter may be employed. When the piercing punches are made and held in position as shown in Fig. 15, a spring stripper is sometimes used, and is fastened to the punch back, and the holes for the piercing punches in this stripper are made a sliding fit, in order to prevent the punches from springing or shearing. When the ordinary form of stripper is used, the piercing holes are also made a good sliding fit.

CHAPTER III.

MAKING BLANKING DIES TO CUT STOCK ECONOMICALLY.

A most important point for the die-maker to bear in mind in making blanking dies for odd shapes is to lay them out so that the minimum amount of metal will be converted into scrap. In fact, hardly too much stress can be laid upon this one point alone. It is an easy matter to waste a considerable percentage of the stock by lay-outs which may *appear* to be fairly economical. The die-maker should make a careful study of the most economical relation of blanking cuts to one another and to the stock. It is the object of the present chapter to point out by actual examples how stock can be saved which may be converted into scrap if the die-maker is not constantly watching out for possible economies. As an illustration, it sometimes happens that by laying out the dies so that the blanks are cut from the strip at an angle of 45 degrees, as shown in Fig. 17, a considerable economy of metal can be effected over a right-angle arrangement, that is, one to which the dies are set so as to cut the blanks straight across the strip. The angular location permits the use of narrower stock and materially reduces the amount of scrap metal. Fig. 16 shows the plan of the die, and needs little or no explanation, as the manner in which it is laid out is obvious; the plan of the strip shown in Fig. 17 also clearly shows how the die is laid out.

Another method that is often used to save metal is that shown in Figs. 19 and 20. This method is used where the required amount

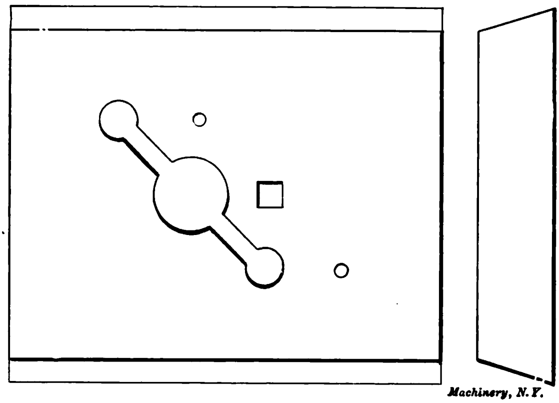


Fig. 16. Example of Blanking Die.

of blanks does not warrant the making of a double blanking die; also when, unavoidably, there is a considerable amount of stock between the blanks after the strip has been run through as shown at *A* in Fig. 19. To save this metal the strip is again run through in a reverse order after the manner shown in Fig. 20, thereby using up as much of the metal as it is possible to do. Besides blanking and piercing

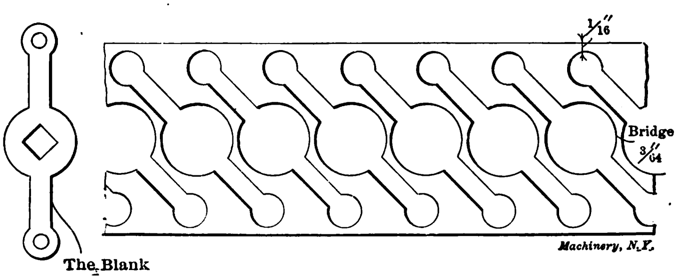
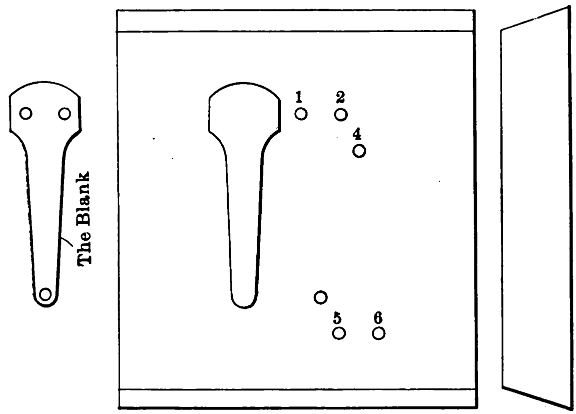


Fig. 17. Section of Stock after having been run through Die in Fig. 16.

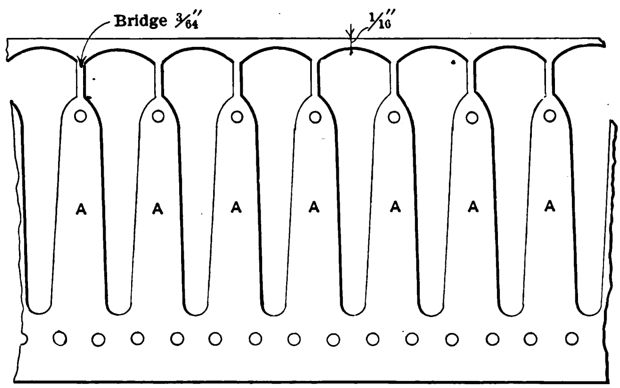
the blank when running the metal through the first time, the holes numbered 4, 5, and 6, Fig. 18, are also pierced. This is done for the reason that when the metal is run through the second time it prevents cutting of "half blanks" by "running in," or, in other words, the liability of cutting imperfect blanks by cutting into that part of the metal from which blanks have already been cut. This guiding action is effected by three pilot pins in the blanking punch (not shown) which engages in the three pierced holes, made when the strip was run through the first time. The pilot pins engaging with the pierced holes cause the second lot of blanks to be cut centrally with the holes, and also to be accurately centered between the portions of stock from which the blanks have already been cut. When this die is in



Machinery, N.Y.

Fig. 18. Another Example of Blanking Die.

use, the metal is run through in the usual way from right to left until half of the required amount of blanks are cut, after which the piercing punches for the holes are taken out and the metal is run through again and the other half of the required amount of blanks is cut.



Machinery, N.Y.

Fig. 19. Stock after having once been run through Die in Fig. 18.

In laying out this die, which is done after the manner shown in Fig. 28, the line *A* is used as the center line for the piercing holes numbered 1 and 2 in Fig. 18, and the line *B* is the center line of the blanking part of the die. The line *C* is the center line that shows the center of the next blank to be cut and is laid out 53/64 inch from the line *B*. This dimension is fixed by the fact that the widest part of the blank is 25/32 inch, and the bridge between the blanks is 3/64 inch, the sum of which equals the distance from center to center of adjacent blanks. The line *D* is the center line for the blank *C*, Fig. 20, which is cut when the metal is run through the second time, and is made at 0.414 inch or one-half of 53/64 from the line *C*, Fig. 28, inasmuch as the blank is cut centrally between that part of the metal from which the blanks *A* and *B*, Fig. 20, are cut.

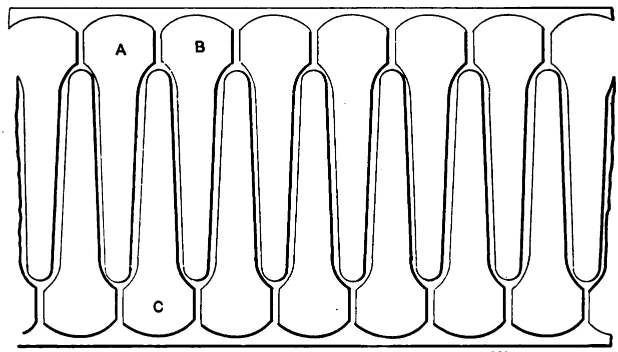


Fig. 20. Stock after having been run through Die in Fig. 18 twice.

Fig. 21 shows a double die for blanking and piercing brass, producing the shape shown in the sketch at the left; it is laid out so as to save as much of the metal as is practically possible without added expense in so far as the operation of blanking and piercing is concerned. By referring to Figs. 22 and 23 it can be seen that the strip of metal from which the blanks are cut is run through a second time for reasons that will be given. One reason is that wider metal can

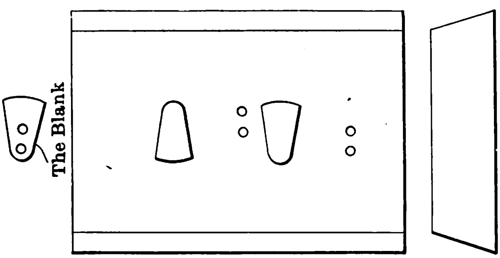


Fig. 21. A Third Example of Blanking Die.

be used by doing so, which in itself is a saving in so far as the cost of metal is concerned. Wide brass can be bought at a lower price per pound than narrow brass; the other reason is that a strip of metal 1/16 inch wide and as long as the entire length of the strip is saved on every strip that is run through. If narrow metal were used there would be waste of ⅛ inch of metal (*i. e.*, 1/16 inch on each side) of every strip run through, and on two strips from which no more blanks can be cut than from the wider strip shown in Fig. 23 there

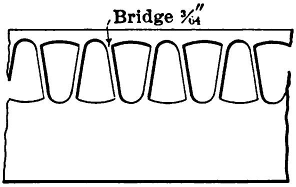


Fig. 22. Stock after having been run through Die in Fig. 21 once.

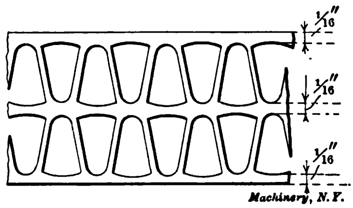


Fig. 23. Stock having twice been run through Die in Fig. 21.

would be a waste of ¼ inch of metal. On the other hand, by using wide metal the waste would be only 3/16 inch, as indicated in the cut. Fig. 29 shows how this die is laid out, and should be sufficiently clear to explain itself.

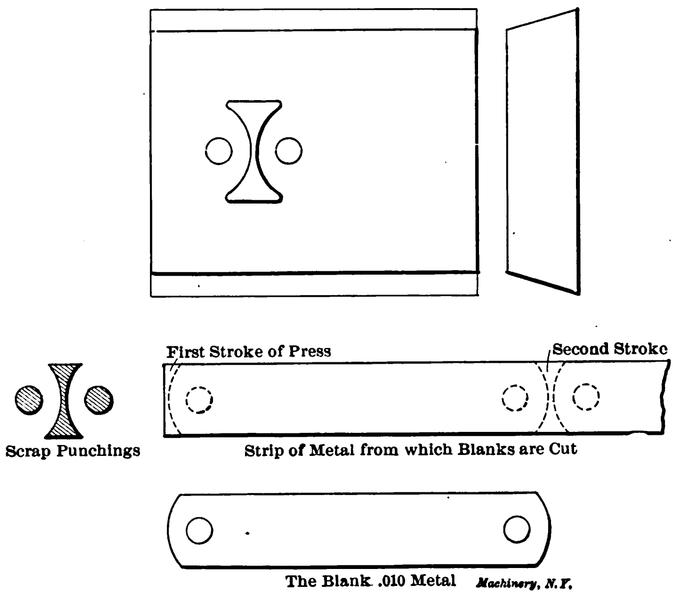


Fig. 24. Blanking Die for Producing Links.

To fully understand the manner in which the metal is gradually worked up after each stroke of the press, short sections are shown in Fig. 25. At the first stroke four holes are pierced and two plain blanks —with no holes—*A A* are cut out. At the second stroke there are also four holes pierced and the two blanks *B B* are cut that have the holes pierced at the previous stroke. At the third and fourth strokes

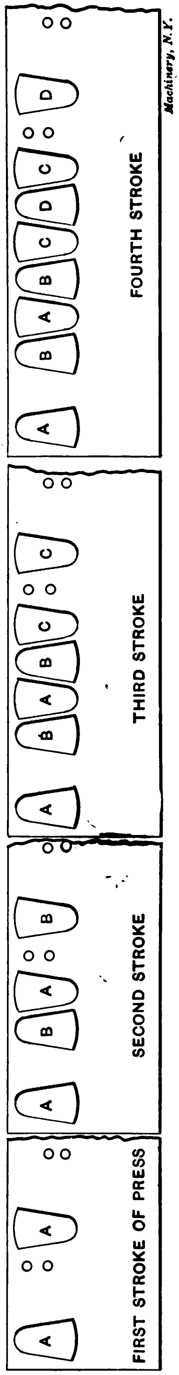


Fig. 25. Appearance of Stock after each successive Stroke of the Press.

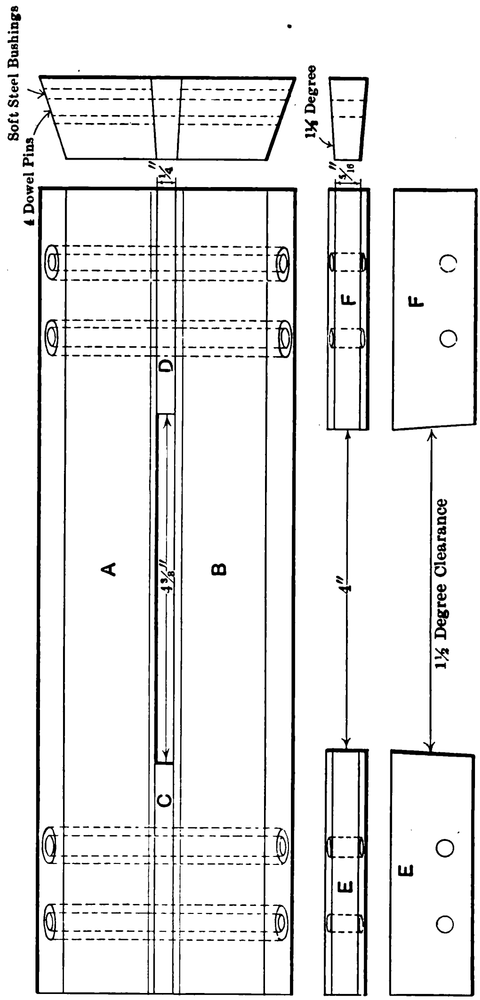


Fig. 26. Die with Interchangeable Parts, permitting Two Sizes of Blanks to be Punched by Changing the Center Pieces only.

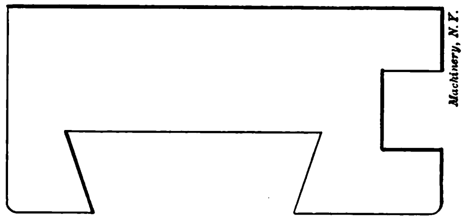


Fig. 27. Gage for Planing Die Blanks.

the holes begin to match in with each other, as shown, so that when the metal is run through it will look like the strip shown in Fig. 22. It should be borne in mind that four holes are pierced and two blanks are cut at each stroke of the press; also that the metal is fed after each stroke a distance equal to the distance from the center of *A* to the center of *B*, as indicated in the strip marked "second stroke," Fig. 25, and which is 25/32 inch (see Fig. 29). By way of further explanation it may not be amiss to state that the distances from the center of *A* to *B*, *B* to *C*, *C* to *D*, and *D* to *C*, as shown in the strip marked "fourth stroke" are each 25/64 inch, or half of 25/32 inch.

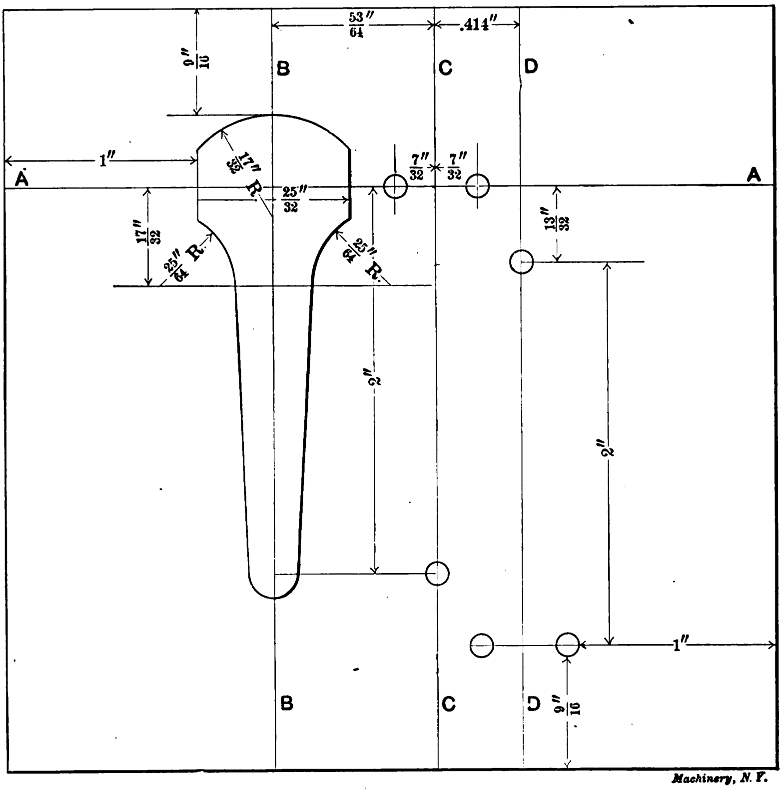


Fig. 28. Layout of Die shown in Fig. 18.

While the dies shown in Figs. 24 and 30 are commonly known, it may not be out of place to say a few words with reference to them, as they form an important part in the economical production of sheet metal goods. The first or Fig. 24 shows a die that is used to produce from narrow ribbon a long blank with rounded ends and with a hole pierced in each end. The principal feature of this style of die is that there is very little waste of material in the production of the blanks, as will be noted from the sketch of the scrap punchings shown at the left, and another feature is that by the aid of an adjustable stop, not shown, almost any length of blank can be made without al-

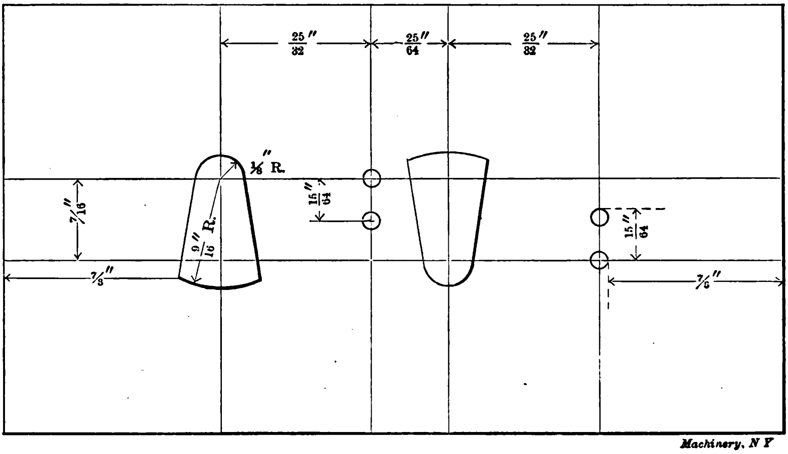


Fig. 29. Layout of Die shown in Fig. 21.

tering or resetting the tools after they have been set up in the press. The working part of the die is laid out a little to the left of the center so as to give sufficient length for the gage plates which are fastened to

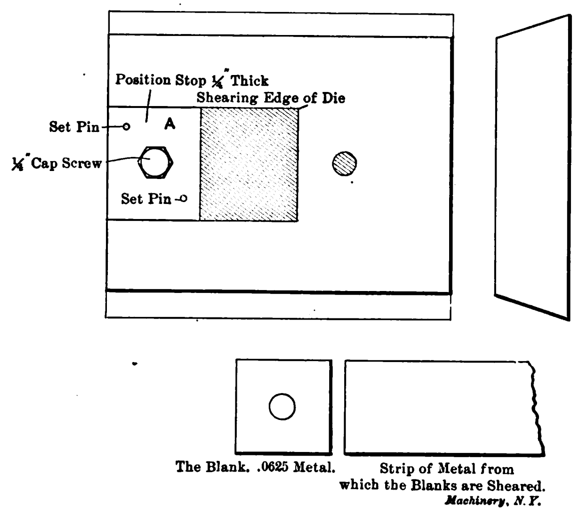


Fig. 30. Blanking Die for Square Washers. Shaded Portions in Die indicate Parts punched out from Stock.

the die by 1/4-inch cap-screws. These gage plates are used to keep the metal in position while it is being fed from right to left as the blanks are cut from the strip.

Fig. 30 is a combination piercing and shearing die and is used for producing the 1-inch square washer shown in the cut. The principal feature of this die is that there is no waste of metal in producing the blank, only, of course, the ¼-inch round punching taken from the center. The strip of metal in this case can be fed from right to left or front to back, as preferred.

CHAPTER IV.

CONSTRUCTION OF SPLIT DIES.

A die of great importance in the production of sheet metal parts is the split die. There are two principal reasons for using the split die. One is that it sometimes happens that the blanks to be cut are of such a shape that the die can be more quickly and cheaply made by making a split die than by making a solid or one-piece die. The other reason is that when the required blank must be of accurate dimensions, and there is a chance of the solid die warping out of shape in hardening, the split die is preferred because it can be much more easily ground or lapped to shape.

Fig. 31 shows the manner in which the ordinary split die is usually made. After the die is worked out, it is hardened and ground on the top and bottom. The two sides *A* are then ground at right angles with the bottom.

The cutting parts of the die, *B*, are next ground at an angle of 1¼ degrees with the bottom, so as to give the necessary clearance in order that the blanks may readily drop through. The key *D* is now set in place, and the die is keyed in the die bed by the aid of a taper key. The key *D* prevents the die from shifting endwise; the keyway should have rounded corners as shown, which not only give added strength, but also act as a preventative to cracking in hardening. The last operation is to grind the two circular holes. This is done by first lightly driving two pieces of brass or steel rod into the holes until they are flush with the face of the die. The exact centers are then laid out and spotted with a prick punch, care being taken so as to get the centers central with the sides *B*. The die is now fastened to the faceplate of a universal grinder, and the center mark is trued up with a test indicator until it runs exactly true. The brass rod piece is then driven out, and the hole ground to size, with 1½ degree taper for clearance. The other hole is next ground out in a similar manner, which completes the operations in so far as the die is concerned. It often happens with a die of this kind that when it is placed in the die bed and the key driven in place, it will "close in." To overcome this, the die is relieved after the manner shown at *C*, which does not in any way prevent it from being securely held in place when in use.

Fig. 26 shows a rather novel form of a split die; this die with a slight change practically takes the place of two dies. It is used for piercing slots in brass plates. The size of the slot for one style of plate is 4⅜ inches long by ¼ inch wide; for the other plate the slot is 4 inches long by 5-16 inch wide. The cutting part of the die, shown in Fig. 26, is made in four sections, *A*, *B*, *C*, *D*. The cut fully explains itself and therefore needs no detailed explanation. It may not be out of place, however, to say that the soft steel bushings, as shown, are used to allow for the contortion of the parts *A* and *B* in hardening. It may be added that the four bushings shown in the piece *A* were driven in first; then solid pieces were driven in the part *B;* then the holes were drilled in these latter pieces, being transferred from the bushings in the part *A*. In Fig. 26 are also shown the parts used in connection with this die for piercing the 4 x 5-16 inch slot. These parts are made as shown, and are hardened only at the cutting ends. Outside of the fact that this style of die practically takes the place of

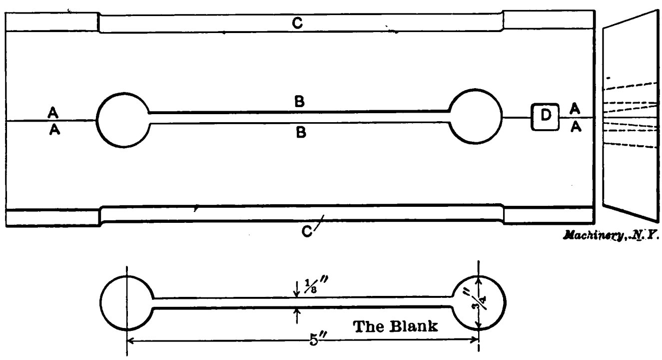


Fig. 31. Example of Split Die.

two dies, there is still another feature in connection with it that will bear mentioning; there is no special or extra die bed required for this die when in use.

It may not be amiss at this time to say a few words with reference to die beds. (In some shops this part is called bolster, die block or die holder.) Perhaps the most commonly used and the best die bed for general use in the press room is the style of bed shown in Fig. 32. This die bed is principally used for the reason that the screws that fasten the die bed to the bed of the press do not have to be screwed entirely out, either in placing the die bed in the press or in taking it out, as the slots *C* and *D* are made at right angles with each other for just this reason.

The dovetail channel is planed so that when the die is keyed in position the center of the die is central with the slot *C*. The side of the die bed marked *A* is planed at an angle of 10 degrees, and is parallel with the slot *C*. The side marked *B* is planed at an angle of 13 degrees and is at an angle of 1 degree with the centerline. The reason for planing this side to an angle of 13 degrees instead of ten is that the increased angle causes the die to lie flat, and prevents it from raising or tilting up in any way when the key is driven in.

In speaking of the key, it may well be added here that the taper-key method of holding blanking dies in the die bed is the best of the various methods which are generally used. The set-screw method is doubtless the poorest of all. The key as shown in Fig. 32 is driven in on the front side of the die bed. This is optional, however, as the practice differs. In some shops the key is driven in on the front side while in others it is driven in on the back.

Of late years there has been a tendency among large concerns to have all their die beds for the power press made from semi-steel castings, or of machine steel for certain classes of heavy work, instead of from gray iron as heretofore. This is being done because a gray

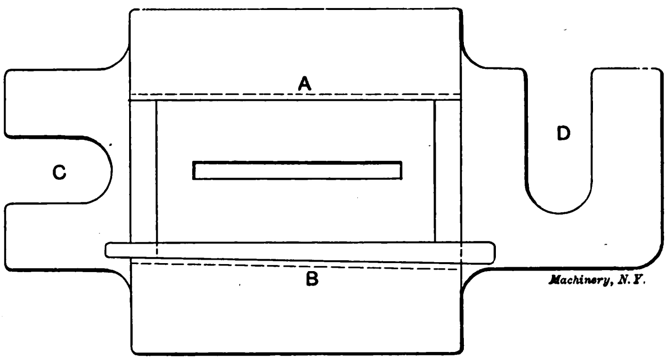


Fig. 32. Example of Die Bed.

iron bed that is used day after day for holding dies for cutting heavy metal will not stand up during long and hard usage as it should. Past experience has proven that gray iron die beds in time become out of square; then, again, they sometimes crack. With the semi-steel, or the soft steel die bed, this does not happen. It has been found that semi-steel and machine steel die beds pay for themselves many times over.

In planing up the stock from which the blanking dies are sawed off before they are worked out, a gage similar to the one shown in Fig. 27 should be used for planing up the different widths of dies. In this way the dies will be of a uniform width and thickness, which makes it possible to have them interchangeable with the respective die beds for which they are used.

CHAPTER V.

NOVEL IDEAS IN DIE MAKING.

A few years ago, what is now the Providence Mfg. & Tool Co., of Providence, R. I., began the manufacture of a mechanical accountant, the invention of Mr. Turck, the present superintendent of the shop. Mr. Turck's experience, so far as shop work and tool design is concerned, had not been in the direction of die-making, so that in equipping the new plant for the manufacture of the accounting machine he was at first hampered by his lack of knowledge on this subject. The die work required was of a high order. The construction of machines of this type is often such that errors are cumulative. Several similar parts are used, attached to each other in series, for instance, in such a way that if the holes by which they are riveted to each other are slightly wrong in their dimensions, the error will be multiplied by the number of parts. The machine depends for its operation quite largely on the action of pawls upon fine ratchet teeth, and on the meshing of fine pitched gears and toothed segments with each other. The effect of cumulative errors in such circumstances would be to throw these fine pitched ratchets and gears out of step, and make the operation of the machine impossible. Long leverages are also a disturbing factor. When a long, slender member is located by two rivet holes close together, it takes careful work in punching those rivet holes to bring the parts into alignment. In the following some very interesting tools, used mainly for blanking purposes, but also for bending and other operations necessary to complete the product, are shown.

In the halftone in Fig. 33 are shown a number of press-made parts. Some of these are interesting in themselves, while others are remarkable principally for the methods used in producing them. Part No. 12, for instance, is a very simple piece, but the punch and die used in piercing the holes, while not unusual so far as surface appearances go, will serve well to illustrate some of the original practices of this shop. This punch and die, shown in Fig. 35, perform the simple operation of punching the nineteen small holes in the blank, which is located over die *A* by the carefully fitted aperture in jacket *B*. The punch is composed of a body *C*, a cast-iron holding plate *D* in which the small punches *E* are driven, a stripping plate *F*, held as shown, and forced outward by the compressed rectangular ring *G* of rubber behind it.

The Construction of a Piercing Punch with a Novel Stripper Plate.

The making of this punch and die follows, in general, the order given below. Stripper *F* is first made of tool steel. The holes for the dowels *H* are next drilled. Then the holes through which punches *E* pass are laid out from model or drawing, as the case may require, and drilled to a *larger* diameter than the punches which are to pass through

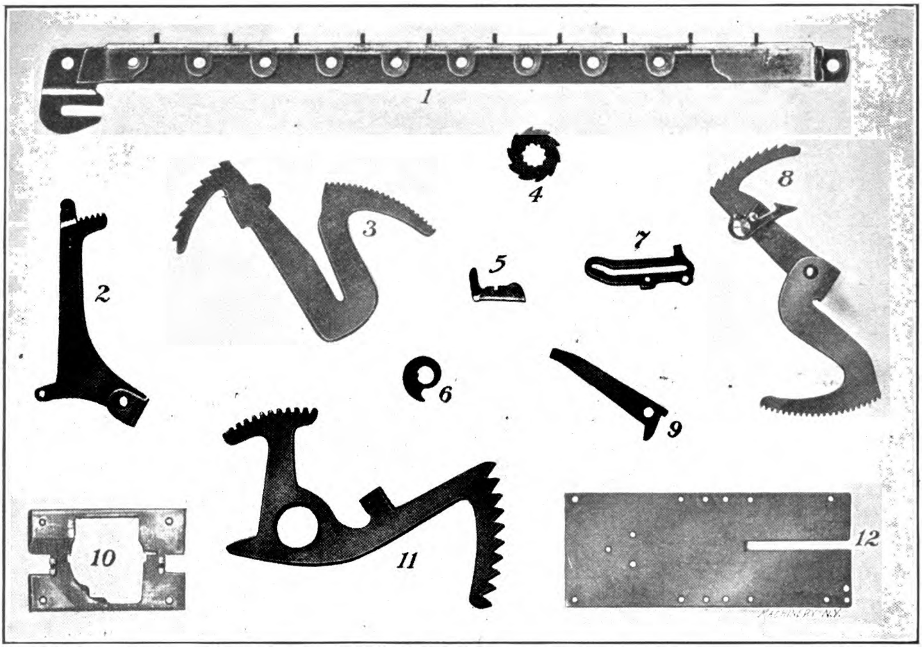


Fig. 33. Some Examples of Good Press Work.

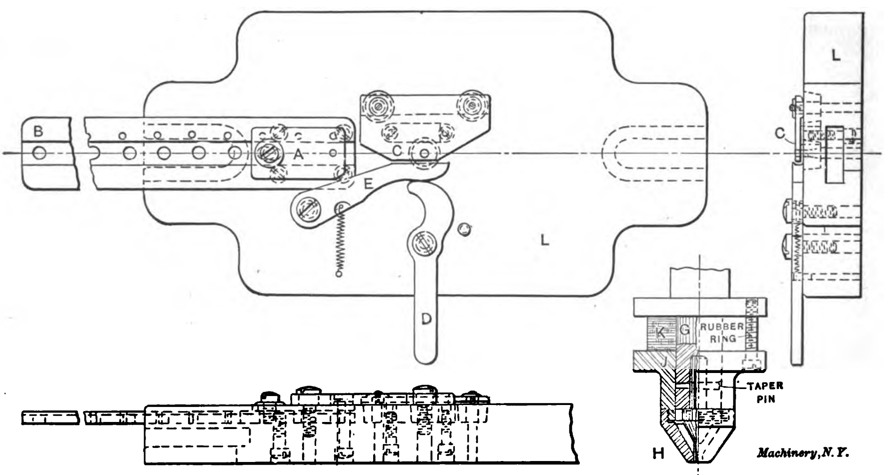


Fig. 34. Construction of Die for Double Punching.

them. After these holes have been drilled, the plate is hardened and ground, and the holes for the punches are filled up again by driving into them plugs of tool steel wire, of suitable size. The location of these holes is now laid out again on plate *F*, and this time very carefully; then they are finished to the exact size, or slightly below, if they are to be lapped. Since the body of the plate is hard, it cannot cave in or wear as it would if left soft. A full bearing on the stock to be blanked is absolutely necessary if the work is to be well done. The plugs allow the plunger holes to be located after the hardening of plate *F*, thereby preventing displacement from the heat treatment. To the stripper plate are now riveted the four dowels *H*, which enter holes in the stripper rim or "collet" *J*, and locate the plate. Small round-headed setscrews bear on pins *H* and hold *F* and *J* together. Punch holder *D*, of cast iron, is machined to fit closely in collet *J*, and the holes for the punches are transferred to it from stripper plate *F*. The punches *E*, made of tool steel wire, are now driven into the holder, headed over at the back side, and ground flush. The punches may then be hardened in the usual manner. Before being assembled on the punch body *C* with the rubber spring *G*, a hardened steel backing *K* is inserted between *D* and *C* to take the thrust of the hardened punches.

The rubber spring *G* is cut from sheet stock and may be made either from separate strips built up on each of the four sides of the punch, or from rectangular rings, if that can be done without wasting the stock. Screws *L* are adjusted to bring the face of the stripper flush with the faces of the punches, after which headless setscrews *M* are screwed in to make the adjustment permanent. Screws *L* may then be taken out and replaced without losing the adjustment. The punch holder *D* and pad *K* are held to the holder by screws *N* and dowels *O*.

A Piercing Die with Inserted Tool Steel Plugs for Cutting Edges.

The body *A* of the die is made of soft steel or cast iron. In this body are driven standard taper plugs of tool steel of suitable size, and so arranged as to be in position to furnish a tool steel material for all the actual cutting surfaces of the die. In the case shown in Fig. 35, nine of these plugs are used, carrying from one to three holes each. In making the recesses for these plugs standard tools are used. The seats are first drilled nearly to size, and then finished with a tapered end mill or counterbore, which is kept carefully ground to the proper dimensions, so that when the plug is driven in until it binds tightly on the taper, it will also seat on the bottom. These various plugs *P* are prevented from turning in the holes by dowel pins *Q*, in most cases, or, where the plugs run into each other (as shown in two cases in the die here described), by the interlocking of the flat abutting surfaces. These precautions make it possible to remove the plugs at any time and return them accurately to their original positions.

The die plate *A* having been fitted with its plugs as described, the holes in stripper plate *F* are now transferred to it by any suitable means, all these holes being received in the tool steel plugs as explained. The plugs may now be removed, to be hardened and lapped separately. The clearance holes for the scrap are drilled, and the plugs are returned to their proper places. The jacket *B*, which locates the blank on the die, may, if desired, be punched from stock of suitable thickness by the blanking die used for making the blank

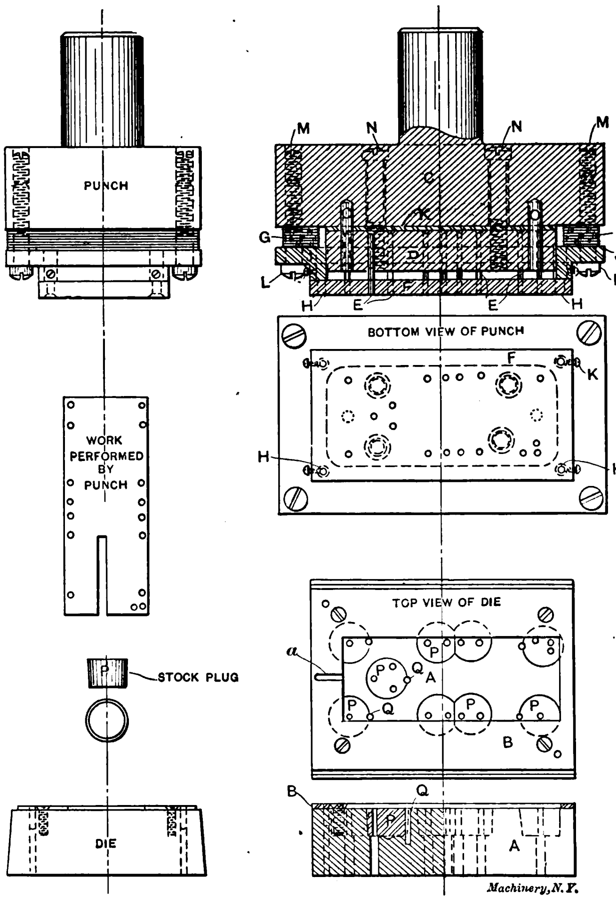


Fig. 35. A Piercing Punch and Die involving some Original Ideas.

to be operated on in this piercing die. The edges of the opening are then merely filed enough to allow the work to enter and be withdrawn easily. A slanting groove, as shown at *a*, is cut with a round file into the jacket at one end to permit the insertion of a pick or awl to remove the work.

The points of interest in this die are: The rubber-backed stripper plate; the use of a soft stripper plate bushed in the manner described with hardened tool steel; and the insertion of plugs of tool steel in a soft die block to form the cutting edges of the die.

The rubber spring has proven very satisfactory. It will last for a number of years in dies having ordinary use, if it is not exposed to oil and other deteriorating influences. Being in the upper member, there is little likelihood of its being spoiled in this way. The use of this stiffly spring-supported stripper plate gives a punch and die of the design shown all the advantages of a sub-press, so far as concerns the ability to punch small holes in thick material and leave thin walls of metal between open spaces in the punching. As evidence of the ability to do work of this kind with a punch and die of the style just described, parts 7 and 10 in Fig. 33 may be particularly noted. Here the holes are considerably smaller in diameter than the thickness of the stock, and the internal spaces have been punched so close to the edge, in places, that the remaining section is narrower than it is thick.

The method of bushing the stripper plate by drilling the holes large originally, plugging them with tool steel wire after hardening, and redrilling them to the proper size, makes it possible to harden the surfaces in contact with the work, without distortion of the dimensions between the holes. Plates of large size, even, are made in this way.

The advantage claimed for the method by which the stripper plate is made may also be claimed for the use of hardened plugs in a soft die body, since it is possible to harden these parts individually without changing their location with reference to each other. In addition, both of these schemes allow changes to be made in the dies with a minimum of trouble and expense. If it is desired to change the location of a hole in the die, the old plug may be removed and a new one inserted. In the same manner, new holes may be drilled in the stripper plate in which new tool steel wire plugs may be driven for new guiding holes for the punches, although the change is limited by the size of the plugs. This consideration is of considerable importance if the parts manufactured are subject to improvement from time to time. This provision reduces the expense of spoiled work as well, since it is not necessary to throw away an expensive press tool if one or two of the holes are wrongly located.

Rubber-backed vs. Sub-press Dies.

It will be noted that part No. 12 in Fig. 33 (for which the punch and die just described were designed) is made in three operations. Under ordinary conditions, experience seems to indicate that this procedure is preferable to the use of the sub-press. The rubber spring supported stripper plate, as just described, gives all the advantages of the sub-press, so far as ability to do fine work on thick stock is concerned. Slender punches are supported by the stripper in the same way as in the sub-press; the rubber spring holds the stripper so firmly onto the work that the distortion of thin stock is prevented. The sub-press certainly has the advantage of ease of setting in the machine, since it is not necessary to carefully line up and punch and die.

which are in permanent alignment. It is possible, however, that the high initial cost of the sub-press would in many cases more than pay for the extra wages of an experienced and careful man in setting up tools during the lifetime of the punch and die. It must also be admitted that work cannot be done as rapidly with the three sets of tools necessary for making the piece in the manner here described, as would be possible if a sub-press were used. The saving in first cost, however, and in the cost of subsequent operations, is believed to be sufficient in the case of the Providence Mfg. & Tool Co. to show a

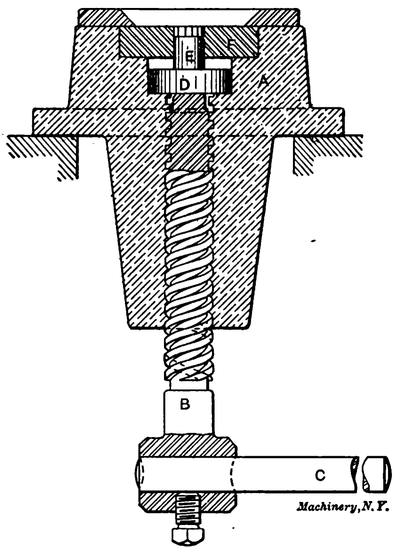


Fig. 36. Die for Bringing Up Drawn-down Corners.

balance on the right side of the sheet for the simpler form of press tool. It should be said in this connection that this firm freely makes and uses the sub-press die.

The Thickening of Corners Drawn Out in Blanking.

An operation of particularly great interest is a coining process used for reshaping the points of gears, ratchets, etc.—such parts, for instance, as are shown in samples 4 and 6. In such a piece as No. 4, whatever the design of the die, the blank produced will be found to have the points drawn down thinner than the stock thickness. To bring the part back to uniform thickness with sharp points, the device shown in Fig. 36 is used. Here we have an attachment to a hand screw press. The body *A* is fastened to the bed of the press. The screw *B* projects through the bed and carries at its lower end a handle *C*, which is adjusted to one side or the other to bring it in position to be swung by the foot of the operator. In a counterbore in body *A* is seated the plug *D* and the ejector *E*. *D* and *E* are forced upward by the action of screw *B*. At *F* is a die, given the shape desired for the outline of the finished part; it is slightly enlarged, however, for a short distance at its upper end. The part as it leaves the blanking press is purposely made a little large in outline at the points where the thinning occurs, due to the drawing out of the stock. When the piece is inserted by the operator in the upper end of this tapering die, the extra metal thus provided is forced inward to thicken the points to the required amount as the punch is brought down upon the work by the hand of the operator. When the piece has been forced to the bottom, it is clamped between the plane surfaces of ejector *E*

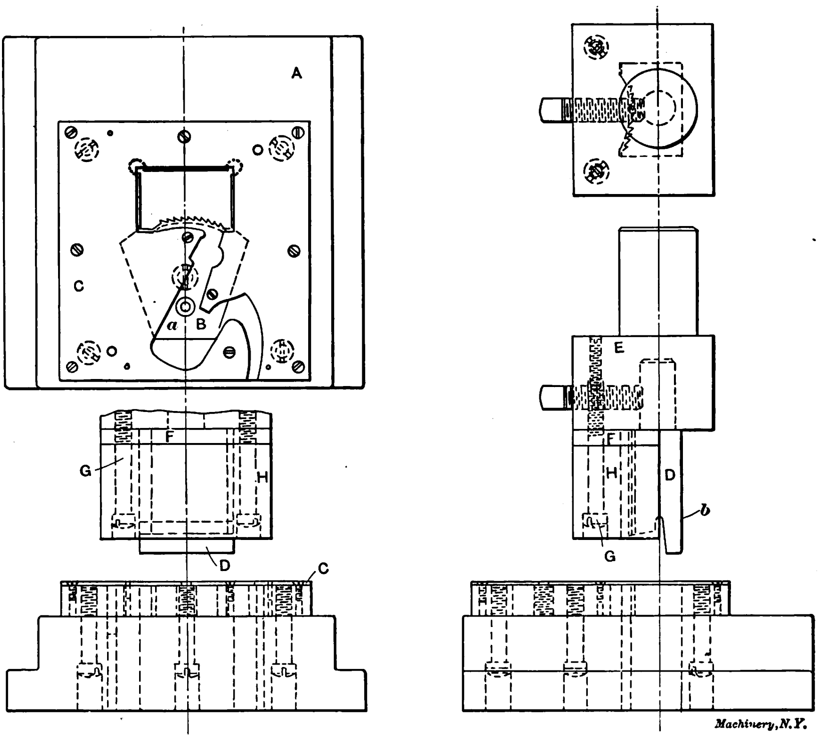


Fig. 37. Example of Type of Die used for Shaving.

and the punch above it (not shown), and the metal is forced to flow to that part of the blank where it is most needed. The result is a flat ratchet with plane faces and uniform thickness. It will be understood, of course, that during this coining operation ejector *E* and plug *D* seat in the counterbore in body *A*, screw *B* being lowered out of contact. A push of the operator's foot on handle *C* brings the ejector up again until the piece is forced out of the die. The thread of the screw is of such a steep pitch that the screw will return again by its own weight.

The comparative slowness of operation resulting from the use of a hand and foot power press and hand feeding is, in a measure, characteristic of this shop. It is the belief of the superintendent that better results can be obtained at times by methods like that shown than by more "modern" ones. The aim is, through careful workmanship and careful inspection, to have the parts so nearly right when assembling time comes, that no fitting will need to be done in the assembled machines. No fitting is, in fact, allowed. Certainly the method described for striking up the corners of these ratchets is a much less dangerous one than would be the case if a power press were used, so the idea has its advantages, so far as safety is concerned, at least.

A Typical Shaving Die.

In such parts as are shown at 3 and 11 in Fig. 33, the ratchet teeth and gear teeth are only roughed out in the blanking die, being finished by a second cut or "shaving" process. A typical die and punch for

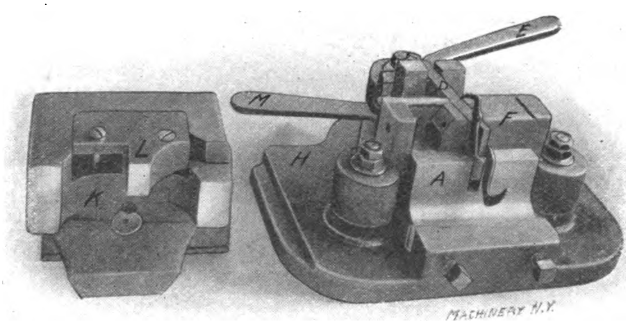


Fig. 38. Bending Attachment with Removable Die. Operation Completed.

this operation are shown in Fig. 37. Here, as in Fig. 35, the work is held by a rubber spring backing while the punch is at work. The die is made of a soft body *A*, in which is inserted the hardened piece *B* carrying the cutting edges which are to form the ratchet teeth on the work. This piece *B* has its teeth cut on it in the milling machine, the hole at *a* serving to center the piece for this operation. This gives assurance that the teeth will be properly spaced, and cut accurately to the proper radius. A rectangular opening with carefully machined sides is made through the die block *A*. Into this opening the toothed cutting edges of piece *B* project. As in Fig. 35, a "jacket" *C* is provided for locating the work over the cutting die. The punch *D* is set into a holder *E*, which in turn is fastened in the ram of the machine. A projecting guiding surface, *b*, on the punch, enters the rectangular opening in the die and bears against it on the back and sides. This keeps the cutting surface of the punch up to its work against the cutting edge of the die. As shown, the cutting edge of the punch is beveled. This gives a slight top rake to the edge, and produces a shearing cut as well, the outer corners coming into action before the center of the outline reaches the stock. The rubber spring backing at *F* is held by screw *G* between the pressure block *H* and the punch holder *E*. It performs the same functions at the stripper plate in the other die.

Bending Punchings to Provide Double Bearings.

It will be noticed that samples 1, 5 and 8 in Fig. 33 have been made on the principle of bending the punchings to give a double bearing at pivotal points, the long bearing insuring lateral steadiness of the part without making it necessary to resort to the use of castings with long hubs. This principle is carried out throughout the calculating machine which is this firm's principal product. In some cases, espe-

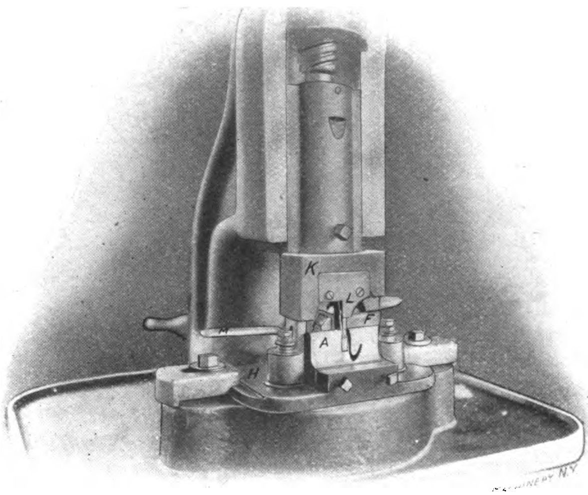


Fig. 39. Bending Device in use in Screw Press.

cially where the pivot holes are punched previous to bending, as is the case in sample 8, very accurate work must be done in the bending to bring the part to exactly the right form. In the sample referred to, for instance, the ratchet teeth on one side and the gear teeth on the other must bear a definite relation to each other, and to the axis about which the part rotates. The bending tools by which the forming operation is performed for this part are shown in the halftones in Figs. 38 and 39 and the line cut Fig. 40. Referring to Fig. 40, the blank for part 8 (shown at No. 3 in Fig. 33 before the piercing of the pivot holes) is laid on top of former *A*, where it is located by the pins *B B* which enter the pivot holes. In this position the part lies between the fixed jaw *C* and the movable jaw *D*, which are then clamped together on the blank by bringing handle *E* to the position shown, where its wedge-shaped cam surface *b* has entered between the long ends of the jaws *D* and *C*, and brought the outer ends together.

The jaws *D* and *C* and lever *E* are all attached to the holder *F*, which is a sliding fit on three vertical posts *G*, fast to the base *H* of the fixture. Slide *F* is held to the upper extreme of its travel against the lock nuts and washers at the top of posts *G* by spiral springs *J* at each

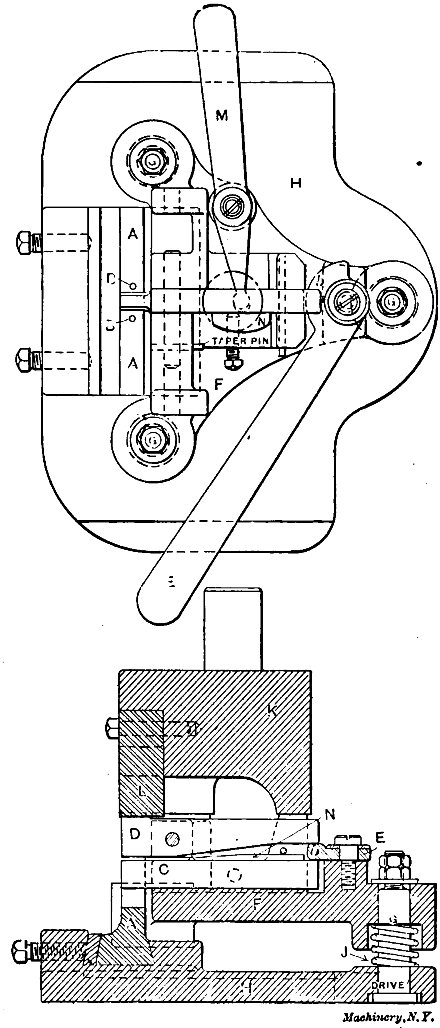


Fig. 40. Construction of Bending Attachment.

post. These parts are shown to good advantage in the halftone, Fig. 38. *K* is a plunger mounted in the ram of the press. It bears on finished projections on slide *F* at three points as shown, while the hardened part *L* bears on the top of lever *D*, directly over the work. When *K* and *L* strike slide *F* and lever *D* in their descent, they carry with it the slide and its attached levers, and the work as well, against the slight resistance of springs *J*. The work grasped between the levers is thus carried down through the opening in die *A*. This action serves to bend the part to the form desired. Fig. 39 shows the operation completed. As shown, this work is done in a hand screw press. This is another example of manufacturing methods which at first sight seem rather crude, but which have proved, in the opinion of the superintendent of this shop, to be most satisfactory, his contention of greater accuracy and more uniform results from such methods applying particularly in the case of forming operations of this kind.

The piece is ejected from the tool at the completion of the bending by lever *M*, which thrusts forward the ejector *N*. This ejector is at its working end slightly less in thickness than the stock of the punching operated on, and is thus able to enter freely between the jaws

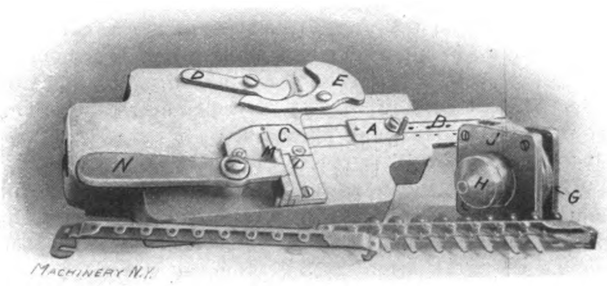


Fig. 41. Double Punching Die shown in Fig. 34.

and eject the work. In this tool, members *A*, *C* and *D* are changed for different parts, the rest of the structure being the same, and serving for a number of different operations.

A Die for Double Punching.

In the case just described, where double bearings occur, the holes are punched before bending. This is not always the case, however. In samples 1 and 5 in Fig. 33, the parts are first bent and then punched, the operation being performed in a very interesting way. The punch descends and makes the hole in the upper thickness of the stock. Continuing through an intermediate die, and carrying before it the punched-out stock, it arrives at the second or lower thickness of stock. The continued movement of the punch then presses the little plug of punched-out metal through the lower thickness of stock, and this forms the second hole. Strange to say, it has been found in practice that this second hole is generally the better one of the two, even though it is made with a soft plug of steel instead of with a hardened punch.

The line cut Fig. 34 and the halftone Fig. 41 show the double punching tools used in making the pivot holes in sample 1, Fig. 33. This, it will be seen, is a progressive operation, all the parts in the lot being punched for one of the holes, after which the die is altered and the next hole in order is punched in all parts—and so on. The piece to be operated on is located lengthwise by slipping it over a gage pin in sliding block *A*, which may be adjusted to any position on slide *B* to suit the hole it is desired to punch at the time. Being located on block *A* in the manner described, it is swung around until the intermediate die *C* enters the channel formed by the two sides of the work. Cam lever *D* is then swung to the position shown in the line cut, where it has brought clamp lever *E* against the stock, holding it firmly in position for the operation. The punch *F* is a simple turned piece of hardened steel, held by a taper pin in punch holder *G*. It is surrounded by a stripper *H* which is screwed to a holder *J*, backed by the usual rubber spring at *K*. This serves to hold the work firmly during the operation, and strip the work from the punch when it returns to its upward position. As before described, the punch in its descent breaks through the upper thickness of stock, carries the plug of soft metal thus formed before it until it comes in contact with the lower thickness, where it forces the plug through, and forms the lower hole. It will be noticed that intermediate die *C*, though held firmly so far as displacement horizontally in any direction is concerned, is yet provided with a rocking face where it bears on the body of the die *L*. This arrangement takes the strain of the punching from the slender intermediate die, which is thus bent downward until it is firmly supported by the stock of the part being worked on beneath it. For removing the work after the operation, an ejector *M* is provided, with a handle *N*, which operates in a way which will be easily understood from an inspection of Fig. 41. It is not shown in Fig. 34, having been added at a date later than that of the drawing from which this cut was made.

Practice in Hardening Punches, Etc.

Blanking punches are hardened in this shop in a way that is originated here and not practiced elsewhere, at least not to any great extent. After the blanking punch has been cut into the female portion of the die, and finished ready for hardening, it is placed in the fire and brought to a slightly lower heat than ordinarily used for hardening clear through. Cyanide is then deposited on the parts of the tool to be hardened—that is, on the periphery of the cutting edge. It is allowed to "soak in," it sometimes being necessary to apply cyanide two or three times, depending on the size and bulk of the punch. It is then again brought to the proper heat, which should be a little lower than is ordinarily used for hardening clear through. Then it is quenched in oil. With large and bulky pieces it is first necessary to immerse the work in water as a preliminary cooling operation. This immersion should merely be a dash into the water and out again, after which the piece is put into the oil until cooled.