BLANKING AND PUNCHING

BLANKING BY BLANKING AND PIERCING DIES

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BLANKING BY BLANKING AND PIERCING DIES

CONSTRUCTION AND USE OF CUTTING DIES

PURPOSE AND KINDS OF DIES

1. Purpose of Dies.—The purpose of blanking and piercing dies is to produce duplicate pieces of sheet metal having holes and outlines of any desired shapes. Not only are the pieces made in duplicate as to patterns and quality, but they are produced more rapidly than by any other method of cutting and piercing sheet metal. Furthermore, the cost per piece is lower when the number of parts is great enough to absorb the original tooling cost. The cost of making the dies is extremely high in comparison to the tooling required for other methods, but the operating cost is low enough to offset the cost of tooling on production of large quantities of parts. Since present aircraft production is high, many different parts are required in sufficient number to warrant the use of expensive dies, not only to reduce the cost per unit but to increase the rate of production. The making of such dies requires skilled diemakers, but the dies may be used by relatively unskilled and quickly trained workers, since the accuracy of the product depends entirely on the dies and not on the skill of the press operators.

2. Kinds of Dies.—The kinds of cutting dies commonly used in the aircraft industry include conventional dies; continental, or push-through dies; magnetic-type blanking dies, known in different plants by other names, such as pierce-blank templets and press templets; and adjustable dies. The conventional or standard dies, which may be piercing, blanking, progressive, gang, or compound, are used in punch presses for making both aluminum-alloy and steel parts, when the production is high enough to warrant their use. The first cost of this type of die is high, but this disadvantage is offset by the high rate of production that is possible. Continental dies are less expensive to make, and the cost of setting them up in the press is only about one-tenth that with conventional dies, but the production rate permissable is lower than with the standard dies and the die life is shorter. However, continental dies may be made for the economical production of a very small number of parts. Magnetic-type blanking dies, of which the punch is made of plow steel and the die usually of rolled Kirksite, also offer an economical means of blanking and piercing many parts required in aircraft manufacture. The first cost of such dies is low, they can be made quickly, and they can be set up in a very short time in a punch press adapted for their use. The last type mentioned, or adjustable dies, offer a quick, economical method of perforating and notching, and eliminates a great deal of the time that would be required for making other types of dies.

CONVENTIONAL DIES

3. Blanking Dies.—Of the various types of dies that are in use, the blanking die is probably the most common, since it is used to cut out blanks, or flat pieces of stock, thus performing the first operation of a sequence or series. It is also employed in more combinations for operations with other dies than is any other type.

The simplest kind of blanking die consists of a punch that blanks out the stock by pressing it into an opening in the mating die. For blanking aluminum alloys, the punch is generally made of annealed tool steel, whereas the die is made of hardened tool steel. To keep the maintenance cost low, it is desirable to lubricate the cutting edges of the punch and die as well as the stock itself with a mixture of engine oil of medium grade, a small percentage of fatty oil, and kerosene. The punch is usually attached by means of cap screws to a punch plate, which in turn is fastened to a part called the punch holder, or shoe. The die is generally attached to a die shoe, or bed, by

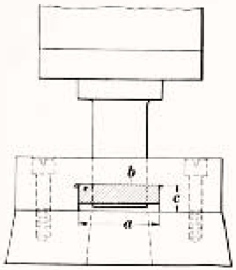
cap screws and dowel pins. To make such a die practical for production work, various forms of attachments must be added, such as strippers to remove the stock from the punch after the operation is performed, and gages, guides, and pins to aid in locating and guiding the stock being fed into the dies.

4. Piercing and Perforating Dies.—Piercing, as accomplished in piercing dies, is fundamentally the same as blanking and consists of punching small holes, such as rivet holes, in a part. The term blanking is applied to the operation if the holes are large, but generally the use of that term indicates that the cut out portion is the part required.

Piercing and blanking may be combined in a single die or performed in entirely separate operations, depending on the design of the part. When many closely spaced holes are punched, the operation is usually designated as perforating and the dies are called perforating dies. Both piercing and perforating dies require various attachments, as do blanking dies, to make their operation practical and economical.

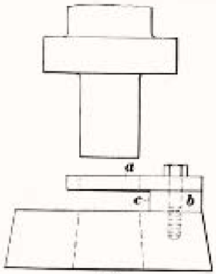
5. Purpose of Strippers.—The primary purpose of a stripper on any form of cutting die is to remove the work from the punch. When the punch ascends after cutting, the strip of metal from which the piece was punched will be carried up by the punch unless a stripper is provided to act as a stop for the strip. A second purpose of strippers is to prevent distortion of flat stock, especially on piercing and blanking operations in progressive dies, the stripping device in this case being attached to the punch or the punch plate. Likewise, a special stripping plate must be provided on compound cutting dies to maintain flat stock.

6. Forms of Strippers.—The simplest form of stripper, shown in Fig. 1, has an opening of width *a* for guiding the stock *b*, and of height *c* equal to the thickness of the stock plus the necessary clearance for free feeding of the material. The amount of clearance depends on the thickness of the stock punched. As some materials are distorted more than others by the action of



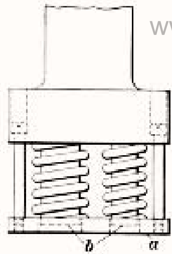
(a)

FIG. 1



(b)

FIG. 2



(c)

FIG. 3

the punch, the amount of clearance varies. The stock *b* is shown against the under surface of the stripper, which is the case while the punch is being withdrawn from the stock.

The open-side form of stripper shown in Fig. 2 consists of a plate *a* with a spacer *b* that provides a guiding edge *c* along which the stock is fed. The open-side construction affords a clear view of the operation, allows for variations in the width of the stock, and eliminates end withdrawal when the punched work must be gaged during the operation.

7. On most dies, strippers of the spring type are used. In Fig. 3 the stripper *a* is attached to the punch holder by fillister-head screws and is supported by springs around the punches *b*. It is adjusted so as to stand slightly below the cutting end of the punches. When the ram of the press descends, the stripper clamps the work and holds it under pressure, thus preventing distortion as the punching is done. The position of the springs depends on the size of the die, the smaller dies being made as shown with the springs around the punch, whereas on the larger dies the springs are placed around the screws.

8. A third purpose of a stripper of the permanently mounted type is to act as a guide for punches, as shown in Fig. 4. The stripper *a* is held by the screws *b* and a dowel *c* to the die *d*, and carries bushings *e* which are accurately located to guide the punches f while they penetrate the stock *g*. This construction also aids in setting up the dies if no guide pins are

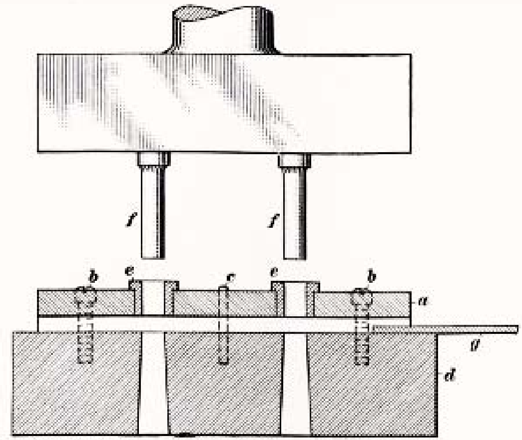


FIG. 4

used, because the bushings are made a close fit around the punches, and the clearances of the die openings need not be considered in the set-up. The bushings may be made of hard steel or bronze, with a punch clearance of from .0005 to .001 inch. The height of the bushings is usually made from $1\frac{1}{2}$ to 2 times the diameter of the punch.

9. Guide Strips.—Material passing through a die is guided by means of guide strips or pins, and stop pins. The guide strips maintain the path the stock is to follow in its travel through the die. They may be individual strips, made only for guiding and registering the metal from either one or both sides, or they may be embodied in the stripping arrangement, as shown in Figs. 1 and 2. When the stripper is attached to the punch, as in Fig. 3, auxiliary guide strips are necessary on the die. Instead of using full length guide strips, guide pins may be set in the face of the die and the stock guided along these pins.

10. Stop Pins.—Stop pins are used to register or locate the stock while it is being fed through the die, so that the openings are cut to a calculated dimension, either to provide accurate

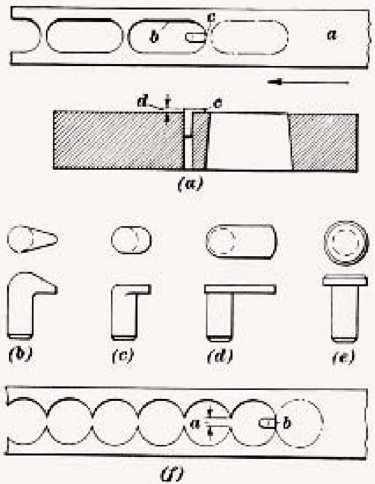


Fig. 5

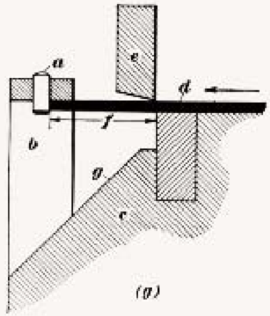


Fig. 6

spacing or to effect saving of material. Improper design of such pins reduces the efficiency of the die and may cause shifting of the stock and breaking of the punch.

Stop pins may be divided into two groups, namely, the fixed type and the movable type. The movable type of pin may be operated automatically by the movement of the ram, by an adjustable screw in the punch holder, or by the openings, or perforations, in the stock.

11. Fixed Stop Pins.—Stop pins of the fixed type are shown in Fig 5 (*a*) to (*e*). They are set into the die and have no adjustment; therefore, in case of wear, they must be replaced by new pins. In view (*a*), the strip stock *a* is fed in the direction of the arrow and is stopped when the edge of the punched opening *b* comes against the end *c* of the stop pin. The pin has a height *d* above the surface of the die, and the stock must be lifted before it can be slid over the pin to the next position. The pins in views (*b*) to (*e*) are similar, but have ends of various shapes to accommodate differently shaped perforations.

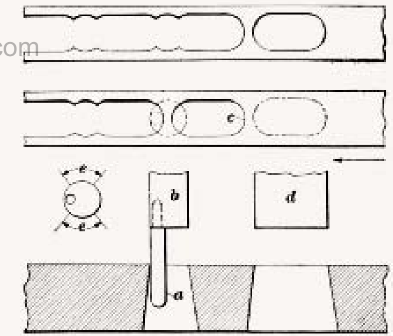


Fig. 7

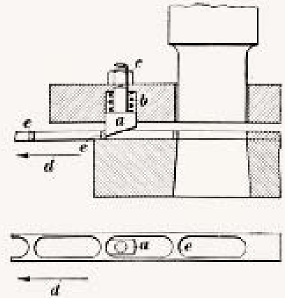


Fig. 8

The pin in view (*e*) has a turned head and when worn can easily be replaced by a new pin of correct diameter.

A fixed pin may be arranged for continuous feed, as shown in view (*f*), by spacing the stock layout so that one punching will overlap the preceding one and form a gap of width *a* for the stop pin *b*, thus eliminating the lifting of the stock over the pin as in view (*a*). Another application of the fixed stop pin is shown in Fig. 6. The pin *a* is mounted in a bridge *b* over the die *c* and projects downward into the path of the stock *d*. After the cut-off, or shearing, die *e* descends, the piece that is cut off to the length *f* drops onto the inclined face *g* and falls out of the way, so that no lifting of the stock is required. Instead, it is simply fed forward each time until its end strikes the stop pin.

12. Movable Stop Pins.—In Fig. 7 is shown a movable stop pin *a* inserted into an auxiliary punch *b*, which removes the web *c* between the holes formed by the punch *d* so as to effect a continuous feed. The punch *b* cuts only on the sections *e* and not on the full circumference.

To avoid lifting the stock over the stop pin, the arrangements shown in Figs. 8 and 9 may be used. In Fig. 8, the stop pin *a* has an inclined face and is forced downward by a spring *b*, the nut *c* limiting the downward movement. Thus, when the stock is fed forward in the direction of the arrow *d*, the web *e* of a

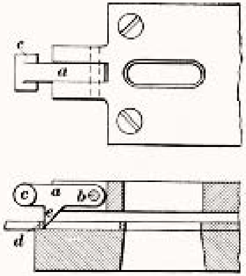


Fig. 9

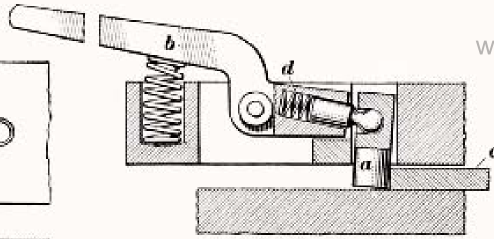


Fig. 10

punched hole strikes the inclined face of the pin and lifts it. As soon as the web passes under the pin, the stock is drawn back in the direction opposite to the arrow *d* until the web strikes the pin. The stock is then correctly registered for the next operation. The arrangement in Fig. 9 is similar, except that the pin is replaced by a latch *a* pivoted at *b* and having a weighted end *c* that causes it to drop after the web *d* passes the point *e*.

13. As continuous feeding is the most economical procedure, more elaborate stop pins are less expensive to use, even though they may cost more to make or buy. In Fig. 10, the stop pin *a* is operated by an adjustable screw in the punch holder. As the ram descends, the adjustable screw strikes the lever *b* and raises the stop pin above the stock *c*. Since the pin has approximately $\frac{1}{32}$-inch play in its hole, it is forced by the spring *d* against the far side of its hole so that it rests on top of the stock. On the upstroke of the press, the stock may be fed forward until the stop pin drops into the hole just punched, and registers the stock for the next operation. With this type of pin, the operator simply feeds the stock forward with a steady pressure.

14. Guide Pilots.—When a part is pierced in one operation and blanked in the next, guide pilots, or pins, are placed in the cutting end of the blanking punch to locate the stock for the blanking operation. The pilots should be accurately mounted in

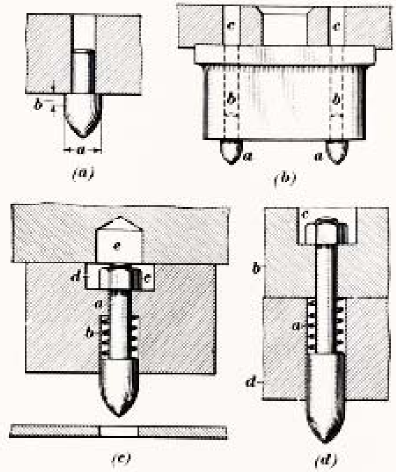


Fig. 11

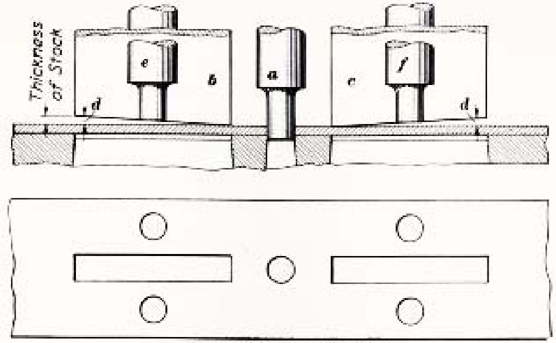
the punches, so as to locate the stock precisely. A pilot that is permanently mounted by being driven into the punch is shown in Fig. 11 (*a*). It has a diameter *a* for a distance *b* equal to the thickness of the stock, and its end is tapered to a point. The shank should be a good press fit in the punch, and the large end should be concentric with the shank for accuracy in alinement. A punch fitted with permanent pilots *a* is shown in view (*b*). Drilling both the holes *b* full length as well as matching holes *c* in the punch plate, allows the use of a pin to drive out the pilots.

15. The plunger type of pilot is shown in Fig. 11 (*c*). Its shank *a* is surrounded by a spring *b* that is under pressure from a nut *c* on the end of the shank. A hole *d* counterbored in the top of the punch is provided for the nut. A hole *e* in the punch plate allows the nut and pilot to rise when the pilot fails to enter the punched hole, and prevents damage to the part being blanked. A similar construction is shown in view (*d*). The spring *a* rests against the punch plate *b* and the counterbored hole *c* for the nut is formed in the punch plate. The pilot is longer but is guided accurately by the punch *d*.

16. Clearance Between Punch and Die.—The clearance between the punch and the die depends on the material to be punched. For dural, the clearance may vary from 8 to 14 per cent of the thickness of the stock, according to the hardness of the material being blanked. If the blank is to be held to size, the clearance is deducted from the diameter of the punch. However, if holes are to be punched to the exact size, the clearance is added to the dimensions of the die. Any drawing of a die design should show definitely whether the punch is to be smaller or the die opening larger. In addition, the important dimensions should be given tolerance to insure that they will be accurately finished by the die maker. On piercing dies the clearance between the punch and die may be made less than with blanking dies, usually not more than 5 per cent of the metal thickness, in order not to lift the metal sheet on the return stroke of the ram.

17. Die Relief.—When punchings are to pass through cutting dies, die relief, or angular clearance, is required to prevent them from sticking in the opening. The amount of clearance depends on several factors; namely, the kind of material, its hardness and thickness, the accuracy to be maintained, and the type of die. Clearance angles of from 1 to 2 degrees are commonly used on long-life dies, whereas angles up to 5 degrees may be used on temporary or short-run dies. If the clearance is started at the extreme top of the die, regrinding the top face enlarges the die opening. It is considered better practice to start the clearance at a distance of from $\frac{1}{16}$ to $\frac{1}{8}$ inch below the cutting edge to allow for regrinding the die. The wall at the top of the die opening is thus kept straight and the original size is maintained throughout the life of the die.

18. Shear on Punches and Dies.—When the face of a punch or die is so formed that one part of the edge cuts in advance of the remainder, or one edge cuts in advance of other edges, the punch or die is said to have shear. The primary object of providing shear is to distribute the work performed over the entire length of the stroke, instead of punching the whole blank in the same plane. The force required is thereby



Plan of Punched Stock

Fig. 12

reduced, and a press of a given capacity may be employed for blanking operations for which, otherwise, it would not be powerful enough. Other reasons for providing shear are: to reduce the strain on the punch or die; to gain certain advantages in holding and alining the stock; to produce a bend in simple forms; and to create certain stresses or conditions in the stock for the other punches. For example, the long narrow strip shown in Fig. 12 is to be punched with two rectangular holes, a centrol hole, and four other holes. The punch *a* for the central hole enters the stock first and is followed by the punches *b* and *c* for the rectangular slots. The rectangular punches have shear, as indicated by the angle *d*, and thus flatten or iron out the stock and stretch it in preparation for the punches *e* and *f* for the side holes, these punches being located half the thickness of the stock above the lowest points of the punches *b* and *c*. Reversing the angle of shear on the rectangular punches would compress the metal toward the center. In this case the punch *a* would be made shorter so as to enter last of all.

19. Two ways of giving shear to a die are shown in Fig. 13 (*a*) and (*b*). In view (*a*) the face of the punch is square, whereas the top face of the die is sloped at a slight angle *a* on each side of a diametral line. Cutting begins at the points *b* at opposite ends of a diameter and continues down to the low

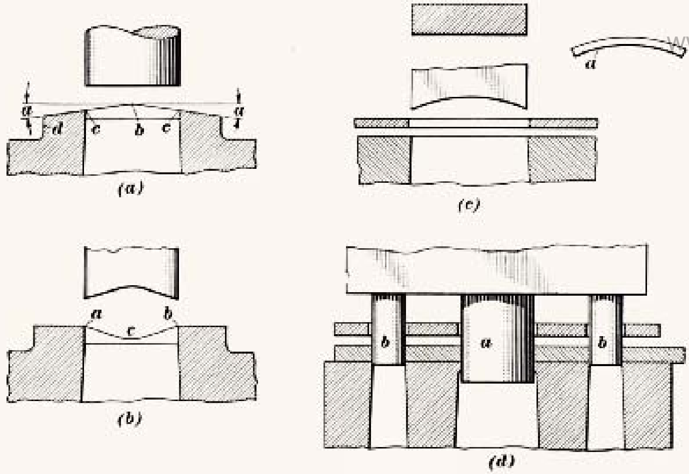


Fig. 13

points *c* at the sides. The boss *d* is raised around the opening of the die to enable the die to be reground repeatedly. In view (*b*) the die is given shear by making the ends high and the middle low. Cutting begins at points *a* and *b* simultaneously and proceeds to points *c*. The punch also has shear, its face being low in the middle.

20. If the punch is flat and the die has shear, as in Fig. 13 (*a*), the blank produced will be flat, but the stock will be distorted. On the other hand, if the punch has shear and the die is flat, as in view (*c*), the blank will be bent, as shown at *a*, but the stock will not be distorted. If both the punch and the die have shear, as in view (*b*), the blank and the stock both will usually be distorted. If it is desirable to have the blank bent because of succeeding operations, the punch is given shear. The direction of curvature of the blank will follow that of the end of the punch.

21. Punches are generally given shear by grinding them to a wedge shape so that the stock is pierced at first along a

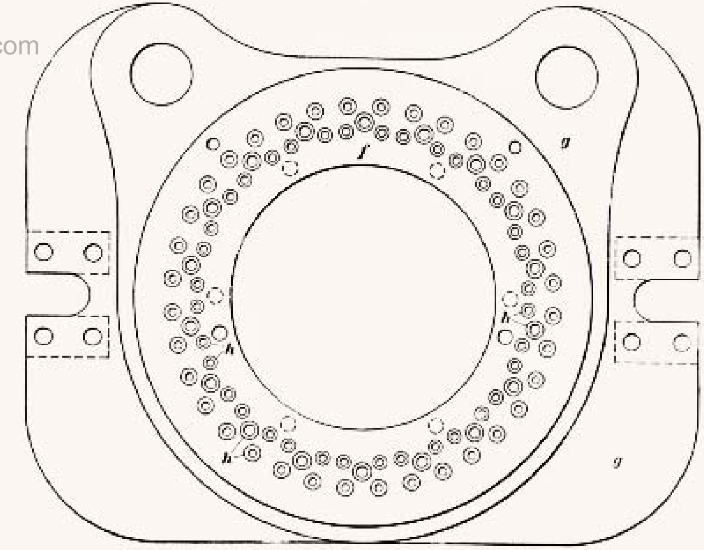


Fig. 14

line only and then gradually to the shape of the hole. Making the punches of different lengths, so that the holes are punched in sequence, gives the equivalent of a shearing effect. In Fig. 13 (*d*), for example, the large punch *a* is made the longest, so that it pierces the stock first and holds it to prevent any shifting while the smaller punches *b* enter the stock. The power required at each stage is less than would be needed if all the piercing were done in one plane. As neither the punches nor the dies have shear, the blank and the stock will remain flat.

22. Piercing Die for Ring.—A die designed to pierce a number of holes in an annular ring is illustrated in Figs. 14 and 15. A plan view of the die is shown in Fig. 14 and a cross-section of the punch and the die in Fig. 15. The piercing punches *a* are set in the punch plate *b*, which is attached to the punch holders *c* by means of dowels and several socket-head cap screws *d*. A spring-actuated stripper *e* serves to strip the blank from the punches after the holes have been pierced, and

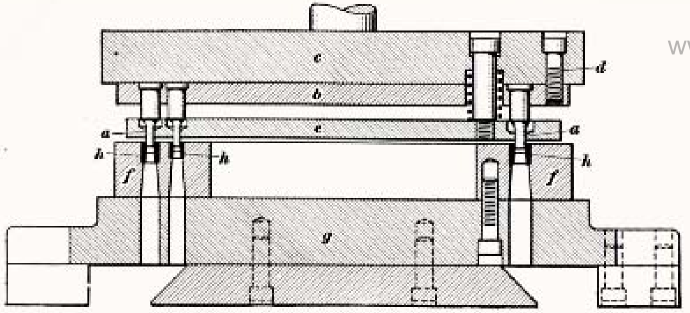


FIG. 15

also guides and supports the punches during the piercing operation. The die *f*, shown in both illustrations, which is doweled and fastened by cap screws to the die shoe *g*, has hardened bushings *h* to provide cutting edges and to take the wear in place of the die itself. The diameter of such a bushing may be greater than the counterbore in the die by .0001 or .0002 inch, or it may be made the same size since a press fit will hold the bushing in place. The area of the shoulder on which the bushing rests must be great enough to withstand the pressure exerted on the metal by the punch during piercing. The bore of each bushing is given an angular relief to provide clearance for the slug. The use of such bushings also permits changes in the size of the holes punched, whereas on solid dies no change can be made without additional work and expense. Bushings can also be replaced easily when they are damaged by broken punches.

23. Piercing and Cut-Off Die.—A clip for the stringer attachment in the emergency exit of an airplane may be produced by the piercing and cut-off die shown in Fig. 16. The punch is shown in view (*a*), the die in (*b*), and the assembled punch and die in (*c*). All the screws and dowels needed for assembly are not shown. The clip is to be made with one rounded and one square end and with a pierced hole near each end. Strip stock, as *a*, is fed from right to left under the strip-

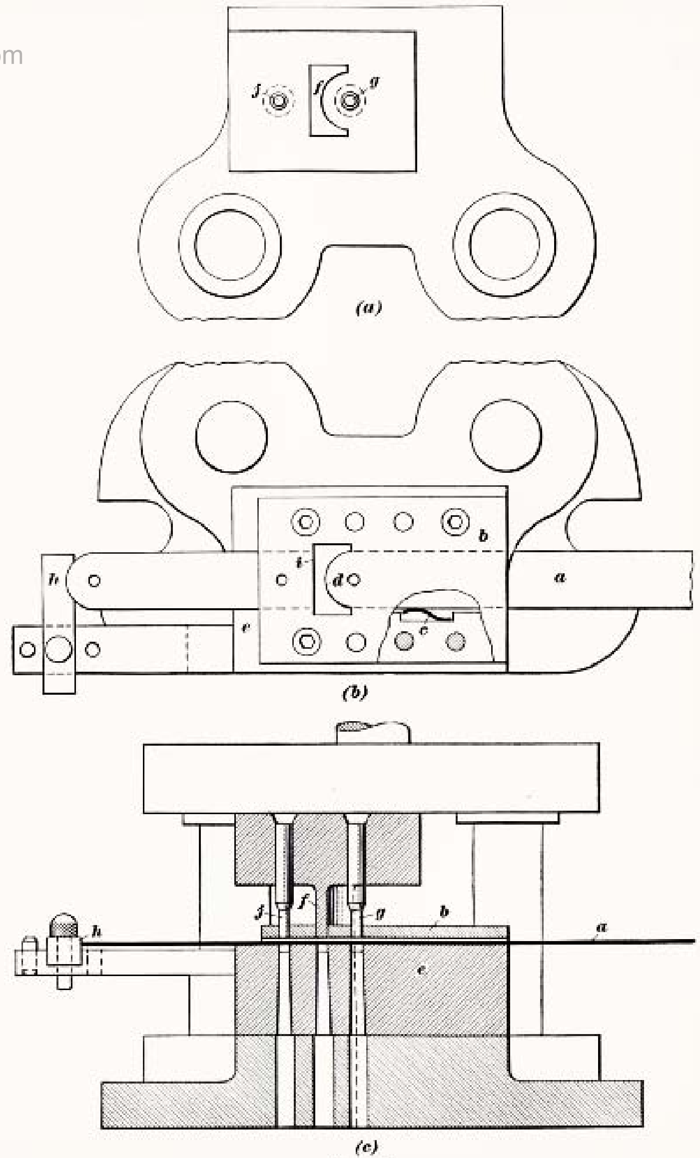


FIG. 16

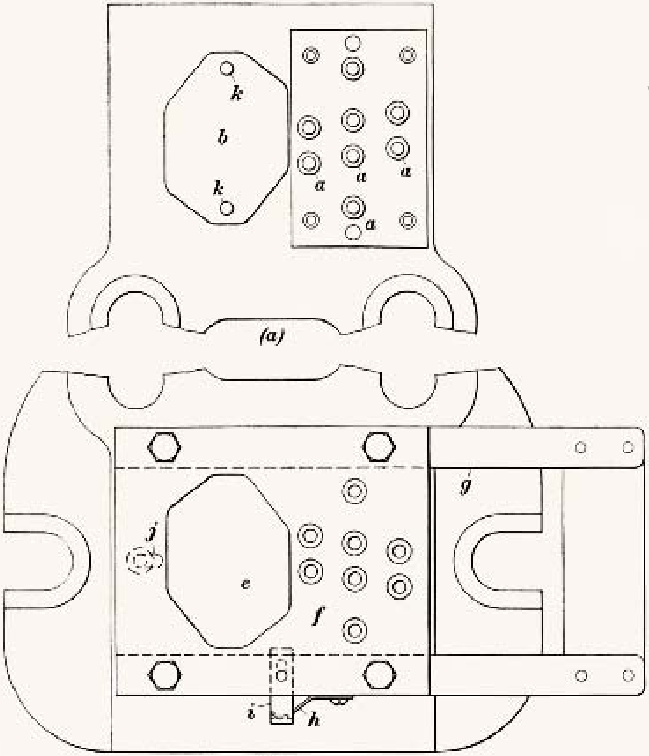


FIG. 17

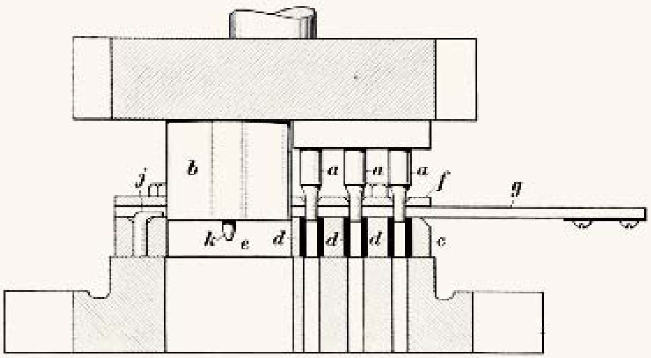


FIG. 18

per *b* and is held against the guide strip by a spring *c*. In the first operation, the stock is brought to a point where it overlaps the semi-circular opening *d* of the die *e*. The press is then tripped, and the punch *f* shears off the end of the stock to the desired semi-circular shape, while at the same time the punch *g* pierces a hole. The stock is fed in until its end comes against the stop *h*, and the press is tripped again. This time the punch *f* cuts the blank off the end of the strip along the line *i*, while at the same time it is cutting the semi-circular end of the next blank. Also the second hole is pierced by the punch *j*. To insure that the blank is cut off completely, the punch *f* is made somewhat wider than the stock. After the first operation of shearing the end of the stock is performed, a complete blank is produced at each stroke of the ram and falls to the bed of the press.

24. Progressive Piercing and Blanking Dies.—Progressive piercing and blanking dies, also called follow or tandem dies, are those in which one part of the die punches holes in the stock while another part blanks out the completed piece containing the holes punched in the preceding stroke. Thus, two operations are performed on the same strip at each stroke, but on different pieces; and a finished piece is produced at each stroke, but in separate operations.

A progressive die used for piercing and blanking gussets for the intercostal, or brace, of the trailing-edge skin is shown in Figs. 17 and 18. Fig. 17 (*a*) is a plan view of the punch inverted, (*b*) a plan view of the die, and Fig. 18 an assembled view, as seen from the front, with some parts in section. All three views follow the same lettering scheme. The punch consists of the piercing punches *a* for punching eight holes in the part and a blanking punch *b* for cutting out the part. The die *c* has hardened bushings *d* to receive the piercing punches and an opening *e* in the die itself to receive the blanking punch. The die and the blanking punch are made of an oil-hardening tool steel, and the piercing punches and bushings of hardened drill rod. The die, blanking punch, and punch plate are attached to the shoes by the customary dowels and cap screws.

25. The strip stock, which is *24ST* Alclad of .025-inch thickness, is fed from the right to the left under the stripper *f*, Fig. 18, and is guided lengthwise by the guide strip *g* against which it is held by a spring *h*, Fig. 17 (*b*), acting through the bracket *i*. In the first stroke of the press ram the eight holes are pierced in the stock, which is then fed in until its end comes against the stop pin *j*. The second stroke of the ram blanks out the pierced part and punches the holes in the next part. As the stock is fed progressively through the die for the following pieces, the trailing inside edge of the large hole is located against the stop pin for each stroke. To aid in locating the stock precisely, guide pilots *k*, Fig. 18, are fitted in the blanking punch and enter the end holes already punched in the preceding operation.

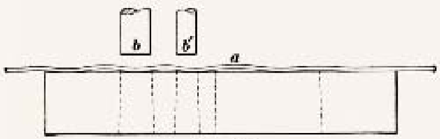


FIG. 19

26. Accuracy of Progressive Dies.—When stock is punched in progressive dies, inaccuracies may appear in the blanks because the stock will not remain flat on the die. An exaggerated case is shown in Fig. 19. If the wrinkled stock *a* were pierced with the punches *b* and *b'*, the holes would be too far apart when the stock is straightened out. If the stock is blanked after it has been pierced, the holes in the blanks will be closer to the ends than is desired, because the stock is straight when the blanking punch is in contact with it and returns to its curved condition after the pressure of the punch is released.

27. More accurate results can be obtained by using a spring-supported stripper, as shown at *a*, Fig. 20, than by using the type on the die illustrated in Fig. 18, since a constant pressure is maintained on the stock during both operations. The screws *b*, Fig. 20, are used for adjusting the position of the stripper, the counterbored holes *c* enabling the bolts *d* to be

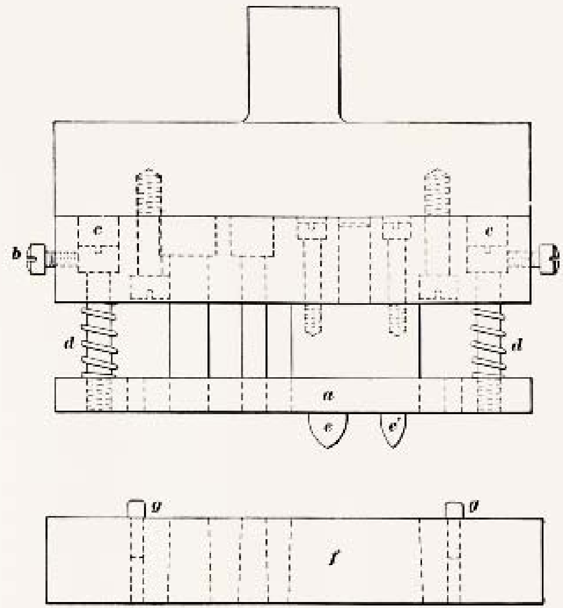


FIG. 20

adjusted vertically. In setting up the punch-and-die assembly, the stripper is raised until the punches project beyond it; otherwise, alining the punch and die would be difficult. After the punch is located in line with the die, the stripper is set so that it will extend downward a little beyond the ends of the punches. Therefore, the stripper will flatten the stock before the piercing or blanking is done. Pilots *e* and *e'* in the blanking punch that enters the opening *f* in the die, and guide pins *g* locate the stock for the punching operations. Since the spring-supported stripper flattens the stock before punching, there is no danger with this die of the holes in the blank being distorted by the pilots.

28. Compound Piercing-and-Blanking Dies.—When holes must be located in a blank with greater accuracy than can be obtained with a progressive die, a compound piercing-and-

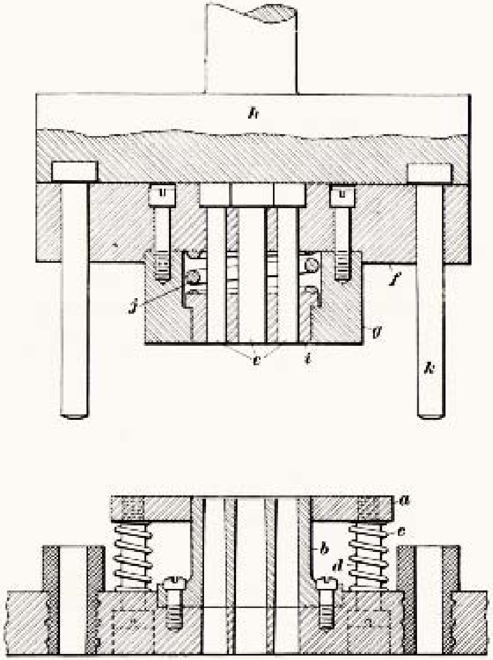


FIG. 21

blanking die may be used to perform both of these operations at the same time. In a compound die, the upper and lower members each contain a punch and a die. This type of die is expensive, because of the time required for the accurate tool work needed. When large quantities of parts are to be made, however, the original cost of the die is offset by the rapid production that is possible.

An example of a compound piercing-and-blanking die is shown in Fig. 21. The stripper *a* fits over the die *b*, which acts both as a blanking punch and as a die for the center holes. The stripper is adjusted by springs *c* and screws *d* to project slightly above the top face of the die when it is in its highest position. The piercing punches *e* are carried by the punch plate *f*, to which is screwed the upper die *g*. When the ram *h* descends,

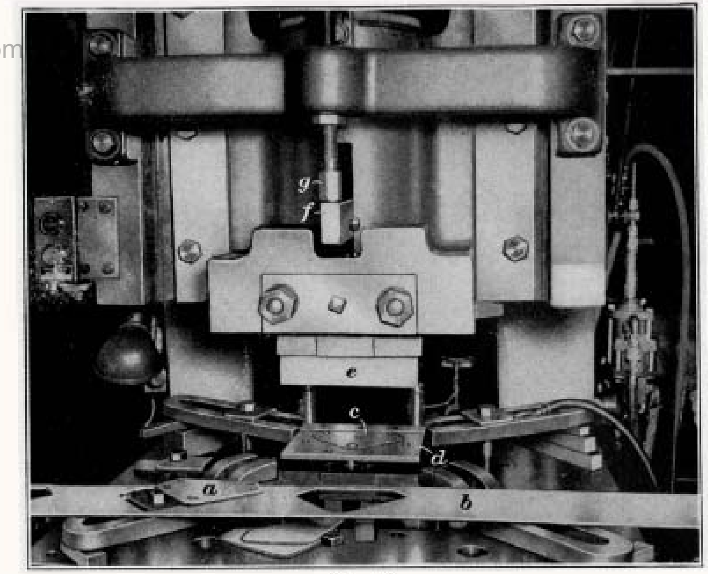


FIG. 22

the stock is gripped between the lower face of the die *g* and the top face of the stripper *a*, which is depressed until the stock touches the upper surface of the die *b*. As the ram continues to descend, the die *b* blanks the stock and the punches *e* pierce the three holes. The blank passes into the upper die *g*, pushing the stripper, or knockout, *i* upward. On the return stroke, the stripper *a* strips the stock from the lower die *b*; at the same time, the knockout *i*, actuated by the spring *j*, ejects the blank from the upper die. The guide pins *k* keep the dies correctly alined. Instead of steel bushings for the guide pins, as shown in previous illustrations, these bushings are made of babbitt, which is poured directly around the guide pins when the die is being made.

29. A similar type of compound die is shown set-up in a punch press in Fig. 22. The part *a* is pierced with six holes and blanked from $\frac{1}{8}$-inch *21SRT* stock *b*. The lower die *c*,

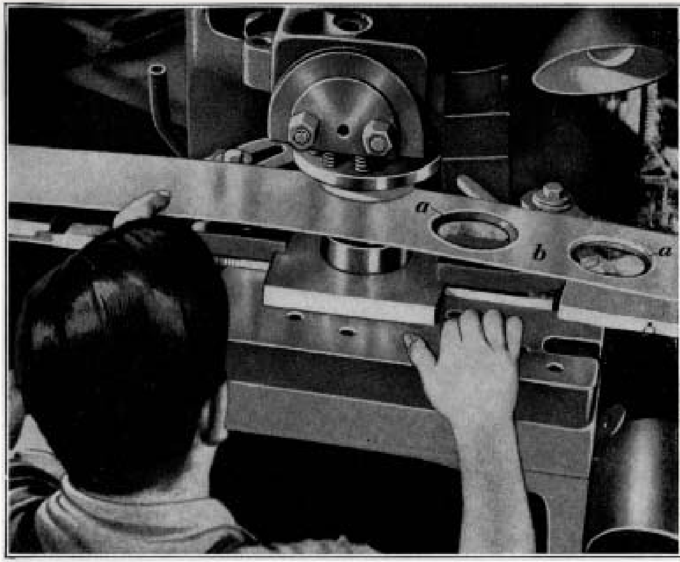


Fig. 23

which is surrounded by the spring-supported stripper *d*, blanks the stock and acts as the die for the piercing punches that are set in the upper die *e*. This compound die operates in the same manner as the one shown in the preceding illustration, except that the knockout, instead of being spring-supported, is actuated by a cross bar *f* that strikes an adjustable bolt *g* as the ram rises. For each punching operation, the strip stock *b* is fed far enough to leave sufficient material between the holes for a similar blank, which is punched out with the stock turned over on its other side. Nesting the blanks in this way saves a considerable amount of material that would otherwise be scrapped.

30. Blanking and Forming Die.—Many parts are of such a nature that they can be blanked and formed in a single operation. A common example in the aircraft industry is the blanking and flanging of lightening holes, which are desirable in many parts to reduce their weight. Also such holes may be used in place of beads in large, flat, lightly-stressed areas to

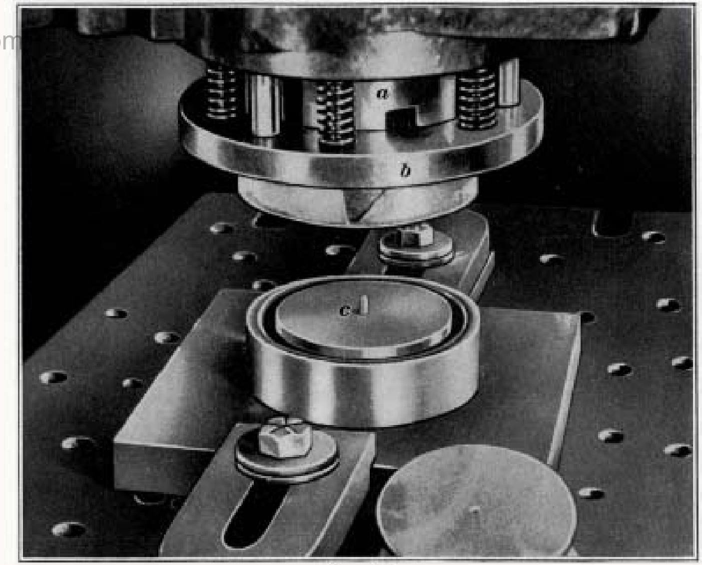


Fig. 24

reduce "oil-canning." To increase the stiffness of the flat section, a flange or bead should be formed around the hole. In Fig. 23, lightening holes *a* are being blanked and their edges flanged in the strip stock *b*. As shown in Fig. 24, the die consists of the forming and blanking die *a*, which is surrounded by a stripper *b* that is of the spring type. To avoid scratching the metal while it is being removed from the die, the lower part of the stripper is covered with cloth. In some cases, even the punch and die may be covered. A common method of fastening the cloth to the various parts is to use shellac as an adhesive. The blanking of the hole is performed by the central part *c* of the lower die, which is shaped around its outer edge to the form required on the flange of the hole. When the ram of the press descends, the stripper comes into contact with the stock and holds it in place as the upper die *a* continues on down to blank the material and flange its edge.

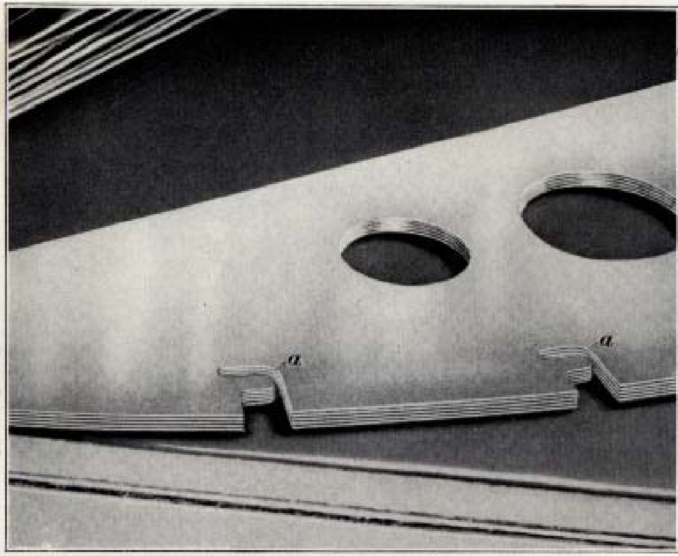


Fig. 25

31. Notching Die.—Notching is essentially a blanking operation in which the cutting is not done around the whole punch but usually around only three sides. In Fig. 25 a number of *24SO* Alclad wing ribs are shown with their edges notched at *a* to receive stringers. These cut-outs are made on the notching die shown in Fig. 26. The die *a*, which has an opening of the same size and shape as the required cut-out, is fastened by cap screws and dowel pins to a die shoe *b* that is clamped to the bed of the punch press. The punch *c* is likewise fastened by cap screws and dowels to the punch plate *d* which in turn is attached to a punch holder *e*. The stripper plate *f* is spring-supported from the punch plate *d*. The wing rib, which has previously been cut to its required outline with the exception of the stringer notches, is inserted against the stop pins on the die and each cut-out is made in one operation of the press.

32. Class B Dies.—The dies that have previously been illustrated and described are Class A dies and are made of tool

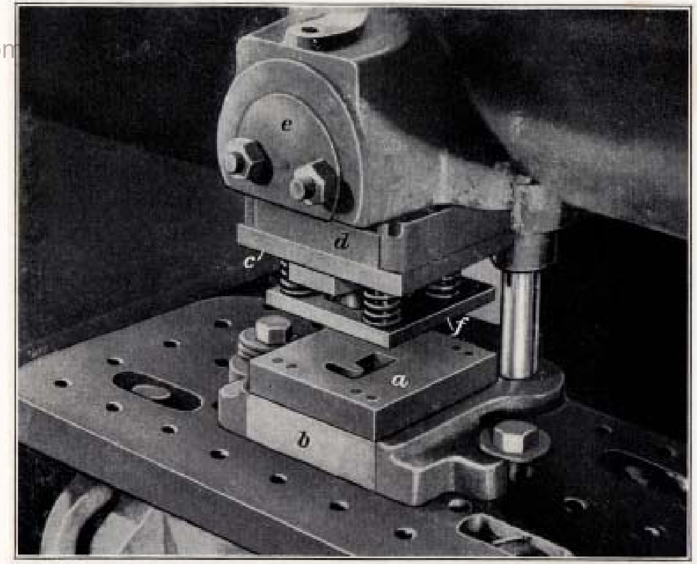


Fig. 26

steel by skilled tool and die makers. Another type of die, which is similar to the Class A die but less accurate, is the Class B die. The tolerance maintained with Class B dies is $+\frac{1}{16}$ inch, but they are cheaper than Class A dies, more durable than magnetic-type blanking dies, and entirely satisfactory for simple parts with a small number of holes and a thickness of not more than $\frac{1}{4}$ inch.

The punch and the die of a Class B set are made of plow steel, and their shearing edges are either case-hardened, or ground off, built up with welding rod, and then ground to fit. The parts of the die are either welded together, or screwed and doweled together as with a Class A die. In the construction of a Class B die, however, the parts are not fastened permanently to die shoes. Instead, they are drilled with standard holes by using a drill jig, and attached to the shoes by cap screws that can be quickly removed to change the die sets. Therefore, one set of die shoes can be used for a variety of dies,

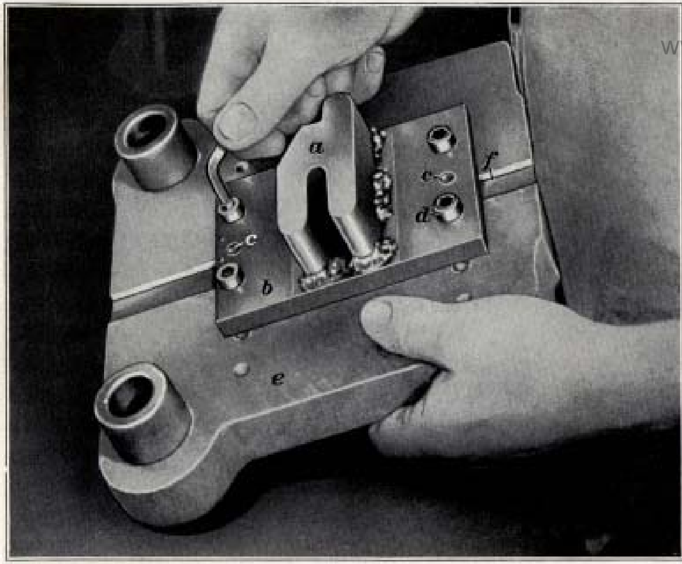


FIG. 27

all of which have been jig-drilled to adapt them to the die shoes.

33. The punch and die of a Class B set are shown in Figs. 27 and 28, respectively. The punch *a*, Fig. 27, is welded to a punch plate *b*, which is fastened by two dowel pins *c* and four socket-head screws *d* to the punch-holder *e*. The punch can be removed, when die sets are to be changed, by unscrewing the cap screws and prying the punch plate off the dowel pins by inserting screwdrivers under opposite sides of the plate in the groove *f*.

The corresponding die *a*, Fig. 28, is welded to two strips *b*, which are doweled and screwed to the die shoe *c*. A stripper *d* is fastened by cap screws to the die and is raised from the die face by spacers *e* that allow the stock to be fed underneath the stripper and guide it cross-wise. The whole die unit can be changed in the same way as the punch and punch-plate assembly, when another die set is to be mounted in the die shoes.

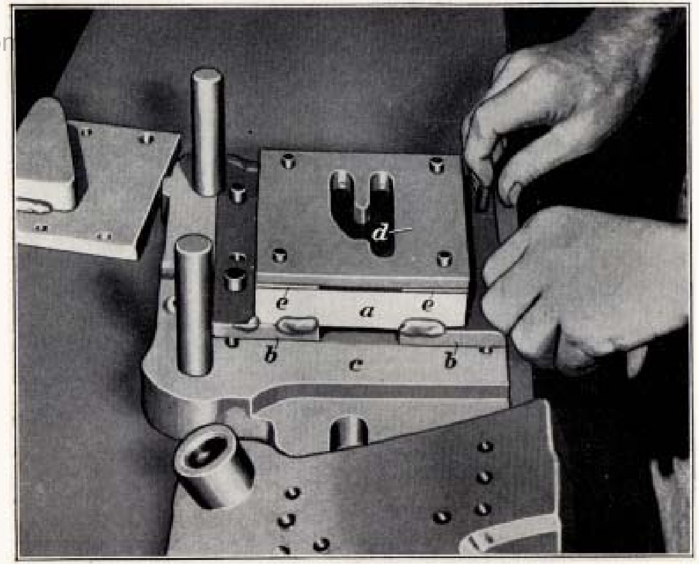


FIG. 28

34. Blanking on Special Machine.—A hydraulic punching machine that was specifically designed for blanking and notching circumferential stiffeners is shown in Fig. 29. It consists of a series of hydraulic cylinders *a* arranged in a semi-circle on standards *b* which can be adjusted in a radial direction on the base plates *c*. This adjustment of the standards permits the use of the machine for punching parts of different radii. The operator of the machine stands in the open bay formed by the base plates and, with a foot-operated valve, controls the pressure in the oil lines *d*.

At the end of each piston rod, a die set *e* is mounted, as shown more clearly in the close-up view, Fig. 30. The piston rod *a* is attached to the punch holder *b* of the die set, and the punch holder and the die shoe *c* are provided with guide pins *d* to insure accurate alinement. The part to be punched is located carefully on the dies *e* and the foot valve is then tripped. The punch *f* in each die set punches the stock, which on the upstroke is removed from the punch by the spring stripper *g*.

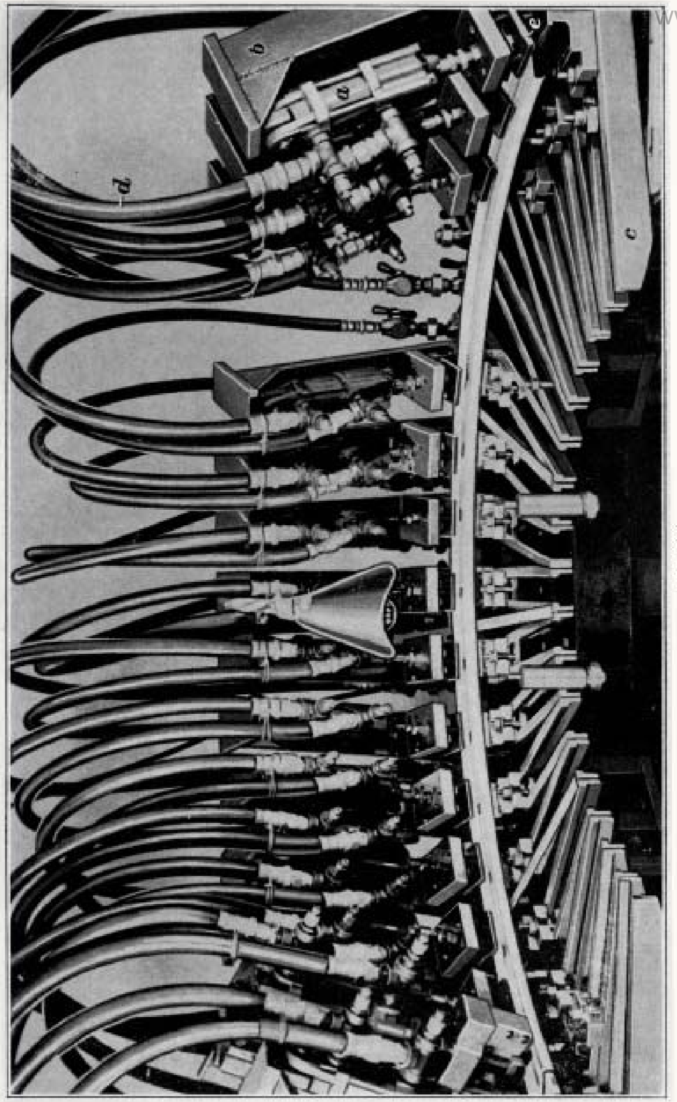


Fig. 29

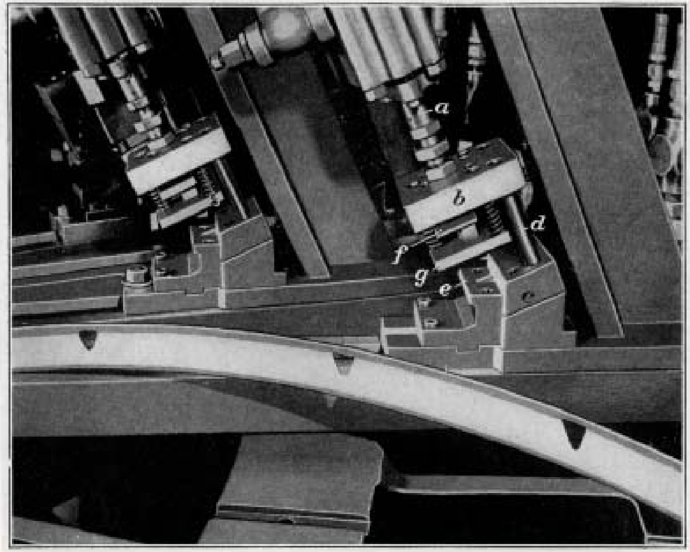


Fig. 30

CONTINENTAL DIES

35. Construction of Continental Dies.—A continental, or push-through, die is the simplest type of steel die. It consists of a loose punch and a die of the same shape as the desired part, together with a stationary stripper attached to the top face of the die. Such accessories as spring-operated strippers and knockouts are not usually required, and die shoes are not used. With the continental die set shown in Fig. 31, the punch *a* is forced by the ram of the press to pass through the stock *b*

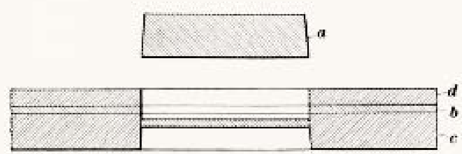


Fig. 31

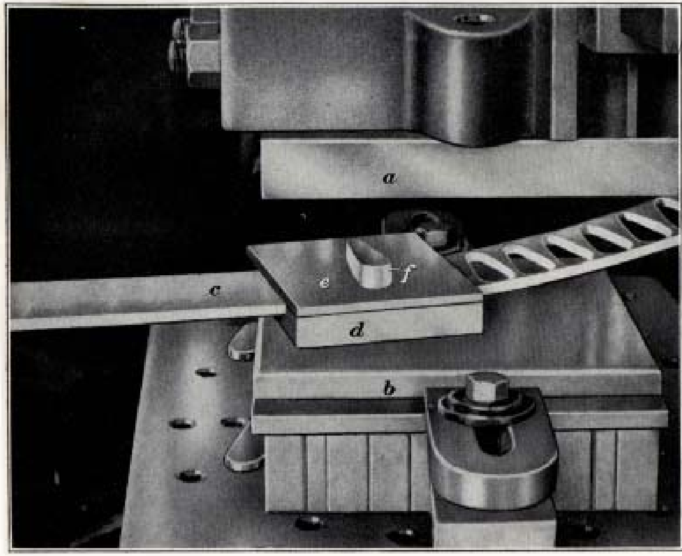


FIG. 32

and into the opening of the die *c*. The stripper *d* is raised above the top face of the die by spacers along two edges in order that the stock may be fed lengthwise between the die and stripper. The spacers are selected to give a clearance of approximately .020 inch for light stock, and $\frac{1}{32}$ inch for thicker material. The stripper, besides stripping the stock from the punch, also serves to locate the punch directly above the hole in the die.

The punch and the die are made of case-hardened low-carbon steel, such as S.A.E. 1025, for light service; of high carbon tool steel when strength and endurance are required; and of a non-shrinking oil-hardening tool steel for the blanking of large, intricate designs. The punch is made straight from the cutting edge for a distance of $\frac{3}{32}$ inch, and then is given a clearance taper of 5 degrees. The die should also be made straight from the cutting edge, usually for about $\frac{1}{8}$ inch, and then tapered 3 degrees. For a plain blanking die set, the die should be about $\frac{1}{4}$-inch thick for stock up to $\frac{1}{16}$ inch in thickness, $\frac{3}{8}$-inch thick

for stock from $\frac{1}{16}$ to $\frac{3}{32}$ inch, and $\frac{1}{2}$-inch thick for stock from $\frac{3}{32}$ to $\frac{1}{8}$ inch. The punch is generally made $\frac{1}{8}$-inch thicker than the die.

36. A continental die for $\frac{1}{4}$-inch aluminum-alloy strip stock is shown in Fig. 32. Heavy flat plates *a* and *b* are fastened to the ram and bed, respectively, of the punch press. The strip stock *c* is inserted between the die *d* and its stripper *e*, the punch *f* is placed in the hole in the stripper, and the part is sheared out by the press forcing the punch through the material into the die opening. The punch and sheared blank are then pushed out of the die, the stock is moved forward, and the process is repeated to blank out the other parts. Since the die must be removed from the press and then replaced each time a piece is blanked, and considerable time is required for removing the punch and sheared blank from the die, this type of die is slow for producing a large number of duplicate parts. However, it is faster than cutting the blanks by hand methods and, being so much less expensive than conventional dies, it offers a good compromise for producing many different parts.

37. Cost Comparison of Conventional and Continental Dies.—A study of the comparative tooling and operating costs of conventional and continental dies has been made by one aircraft company to determine a practical method of die selection. The cost data were based on both labor and material cost for making the die, labor cost on press operation, plus an overhead of 100 per cent on all labor. The average cost of making a continental die was found to be approximately $20, whereas, the average cost of conventional dies is approximately $100. In different companies, the average cost of conventional dies may vary widely, according to the refinement with which the work is done. Some find that, on the average, their conventional dies cost only three times as much as their continental dies. In the design of either the conventional or the continental die, it is important to include all the features necessary to perform the job with the least effort, waste of material, and labor cost; to embody the finer points of design that cause the operation of the die or the assembly of parts to prove less costly; and at the same time to keep the design as simple as possible.

38. In addition to the die costs, the labor cost on press work must be considered. With a conventional die the operating costs are much lower than with continental dies. Therefore, as the number of parts to be produced increases, the total cost of making the parts with a continental die will equal, at some point, the cost with a conventional die. Below this quantity a continental die is more economical, whereas a conventional die would be better for a greater number of parts.

The study made by the aircraft company included various cost ratios and showed that if the cost of making the conventional die is twice that of the continental die, the critical number of parts is about 7,500. At a three to one cost ratio, the critical number is about 17,500; at four to one, about 27,000; at five to one, about 35,000; and at six to one, about 44,000. These data are based on an estimated production of 260 parts per hour with continental dies and 1,000 parts per hour with conventional dies, or a production ratio of approximately 1 to 4. However, a more probable production ratio would be 1 to 10, rather than 1 to 4. The final decision of whether to use a conventional or a continental die, if only these two types of dies are considered, depends on the adaptability of each type for the part in question, the comparative cost data, the consideration of any variable factors, such as the rate of production, that might effect the comparative costs, and the possibility that future requirements may differ from the present production estimate.

MAGNETIC-TYPE BLANKING DIES

39. Application of Magnetic-Type Blanking Dies.—A recently developed type of blanking and piercing die, known in different aircraft factories by such names as the pierce-blank templet or PBT, press templet, or type D die, has greatly facilitated the fabrication of sheet-metal parts. This die is simple in construction, is much less expensive than conventional dies, costing only about $20 for a 6 by 8 inch size, and can be made quickly by relatively unskilled labor. The cost of setting up the die in a press is low, since the punch is simply set over dowel pins in the lower shoe of the die set, and the die is set over dowels in the upper shoe and held there by permanent magnets in the face of the shoe.

Dies of this type are capable of blanking parts, with accurately locating tooling holes, at higher speeds than is possible with routing. Intricate designs can be blanked cheaply as compared to the cost with other types of dies, and the size of blanks that can be produced is limited only by the size of the press available, since the dies can be made in sections that are splined and riveted together.

40. Some limitations are imposed on the design of parts to be blanked in this type of die. Aluminum alloys up to .081 inch in thickness can be blanked with a maximum production of 5,000 parts; normalized chromium-molybdenum steel can be blanked up to .051 inch with a maximum production of 2,000 parts; and annealed corrosion-resistant steel can be blanked up to .025 inch with a maximum production of 1,000 parts. A tolerance of +.010 inch can be maintained. The minimum width of cut-outs in an aluminum-alloy part is $\frac{1}{4}$ inch with a recommended minimum of $\frac{5}{16}$ inch, and the minimum corner radius is $\frac{1}{16}$ inch with a recommended minimum of $\frac{3}{32}$ inch. For steel blanks, the recommended minimum width of cut-outs is $\frac{1}{4}$ inch, and the recommended minimum radius is also $\frac{1}{4}$ inch. Holes smaller than approximately $\frac{1}{8}$ inch cannot be pierced in steel or in aluminum alloys over .064 inch thick.

41. Construction of Magnetic-Type Die.—A magnetic-type blanking and piercing die is shown in Fig. 33. The die *a* is made of rolled Kirksite, which may be from $\frac{3}{32}$ to $\frac{1}{4}$ inch in thickness, and is fastened by flush rivets *b* to a $\frac{1}{4}$-inch steel backing plate *c*. Piercing punches *d* are set within the blanking area of the die to pierce corresponding holes in the blank and are retained by a $\frac{1}{8}$-inch steel plate *e*.

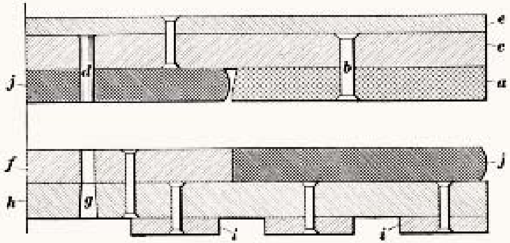


Fig. 33

The punch *f* is made of ¼-inch plow steel, such as S.A.E. 1045, or a chromium-molybdenum steel, depending on the material to be blanked. The punch is machined to size and then used to shear the Kirksite die to its correct shape, the die opening having an inside taper of from 15 to 30 degrees. Holes *g* are machined in the punch to correspond to the piercing punches *d*, and the punch is riveted to its backing sheet *h*. Spaced backing plates *i* permit slugs from the piercing punches to fall to the bed of the press; these slugs may be blown out by compressed air if desired. Rubber or neoprene strips *j* are cemented around both the punch and die to act as strippers. Because of the excessive pressure of the rubber, both punch and die are made ½-inch thick for blanking material over $\frac{1}{16}$ inch in thickness; otherwise, the pressure exerted by the rubber might swell the die and make it unusable. For a part having a narrow section or cut-out, the die may be made ½-inch thick to facilitate placing more rubber under the part to aid in stripping the stock. In the latter case, the increase in thickness of the die does not necessitate a proportional increase in the thickness of the punch if a ¼-inch punch shears the sheet metal satisfactorily.

42. Multiple-Type Magnetic Blanking and Piercing Die.—A magnetic blanking and piercing die-set for a tank baffle is shown in Fig. 34. The die *a*, as in the case of that shown in the preceding illustration, is made of rolled Kirksite and is fastened by means of flush rivets to a steel backing plate *b*. Large punches *c* and small piercing punches, surrounded by rubber grommets *d*, are set within the blanking area of the die. The punch *e*

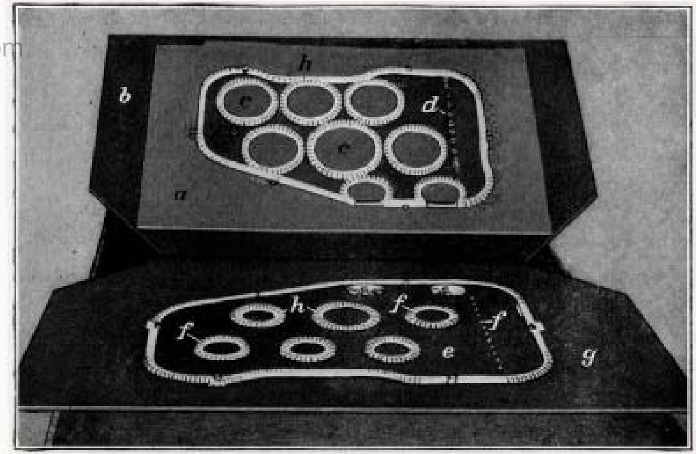


Fig. 34

has corresponding holes *f* and is riveted to its backing sheet *g*. Rubber or neoprene strips *h* and the rubber grommets, or washers, *d* around the small piercing punches strip the material from the punch and die.

43. The die-set illustrated in Fig. 34 is used in the hydraulic press shown in Fig. 35. In most cases this type of die is used in mechanical punch presses, but, in this case, the large size of the die required a hydraulic press. On the bed of the press is clamped a bolster *a* having a number of pins *b* set in its surface. These pins allow the slugs from the piercing punches to fall through the die. Dowel pins *c* serve to locate the die in the press. A shoe *d* having magnets set in its face is clamped to the ram of the press and holds the punch. Safety screws may be used to aid the magnets in holding the die firmly and also for securing the punch on the bolster.

In Fig. 36 the die set is shown located in the press and a blank *a* has been cut from the sheet stock. In using this type of die, care should be taken to lower the ram just far enough that the punch barely cracks the metal through the die and goes no further. If the punch is allowed to enter the die too far, the

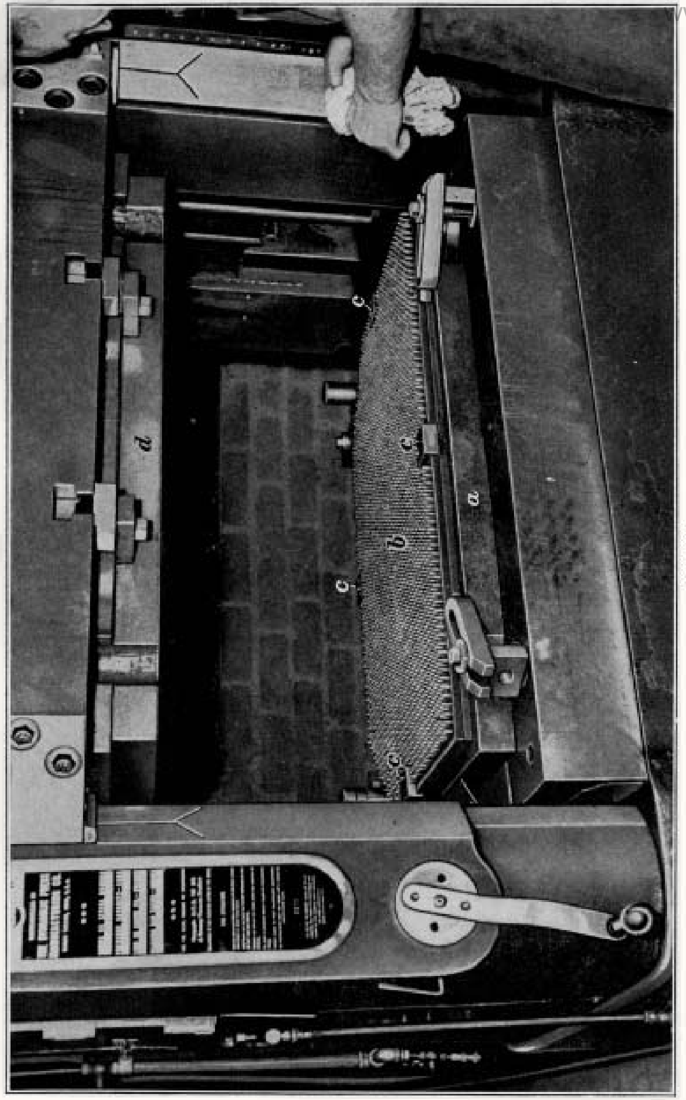


Fig. 35

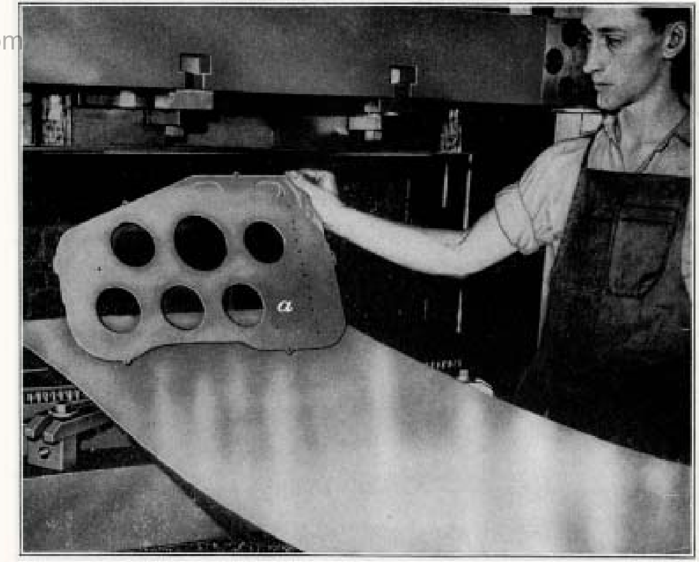


Fig. 36

rubber stripper in the die will be cut and soon become unusable. In operation, the Kirksite is flattened slightly by the pressure so that its opening tends to close around the die, thus compensating for wear.

44. Steel Dies.—Steel, as well as Kirksite, may be used for the die block. In general construction, the two types of dies are the same and differ mainly in their cost and length of life. A Kirksite die is cheaper to manufacture than a steel die, but the life of a steel die is usually much longer than that of a Kirksite die when working the same material. Therefore, the advisability of using steel instead of Kirksite is largely determined by the number of parts that the die is to produce. As a general rule, steel dies are used more extensively than are the Kirksite dies for blanking and piercing aluminum-alloy stock of thickness over .064 inch, and for performing similar operations on sheet steels, especially on stainless steel.

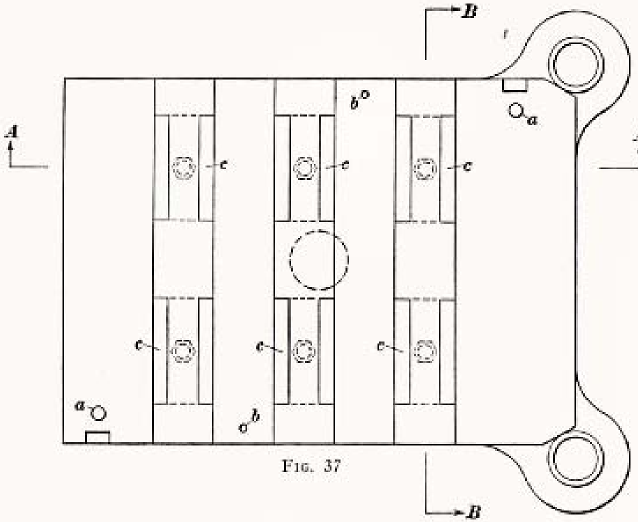


Fig. 37

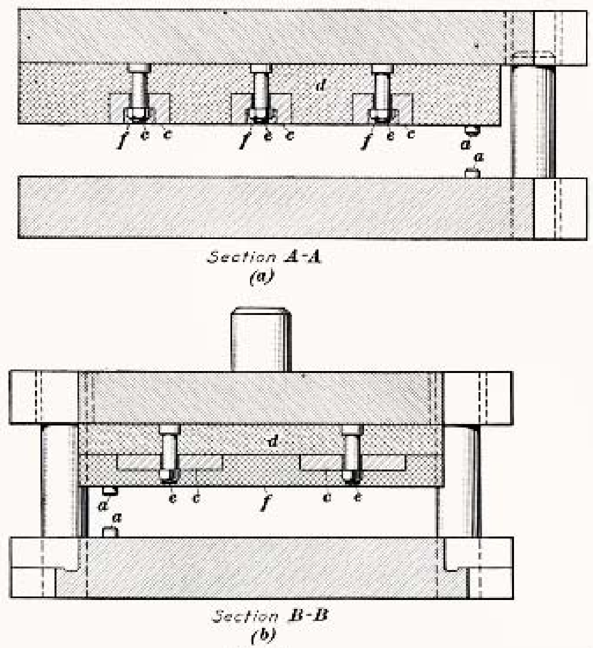


Fig. 38

45. Magnetic Die Shoes.—The magnetic die shoes are made in each plant in a variety of sizes to handle the various die sets in use, and differ in the method of locating the magnets in the different sizes. The construction shown in Figs. 37 and 38, however, is typical of that employed in making these sets. In Fig. 37 is given a plan view of the punch holder, or upper shoe, in an inverted position. In Fig. 38 (*a*) is shown a section of the assembled shoes along the line *B-B*, Fig. 37, and in (*b*) a section of the assembled shoes along the line *A-A*. Dowel pins *a* locate the punch and die in their proper positions, and holes *b* are provided to receive the safety screws. Permanent magnets *c*, Fig. 38, are set in a cast aluminum block *d*, which is fastened by dowels and cap screws to the punch holder. The magnets are held by bolts *e*, and the space around the magnets and bolt heads is filled in with a bismouth alloy *f*, known as Cerromatrix.

ADJUSTABLE PERFORATING DIES

46. Use of Adjustable Perforating Dies.—Adjustable perforating dies are being used in aircraft work for many types of operations. With these dies, holes of any shape can be punched and many notching operations can be performed. They are especially useful where a small quantity of parts are to be produced in a minimum length of time and at a low tooling cost. Since, for many parts, standard adjustable punches and dies can be used, the time lost waiting for dies to be built and extended delays in production caused by die breakage are eliminated. With the die shoes mounted in the press, assorted jobs can be tooled up by simply changing the position of the retainers, or holders, for the die bushings and punches. For special jobs it may be necessary to have suitable punches and dies made to specification.

47. Perforating Fire Wall with Adjustable Dies.—A part that can be perforated with adjustable dies is the fire wall shown in Fig. 39. This piece has one large rectangular hole and many smaller round holes to be pierced. The punch set-up for

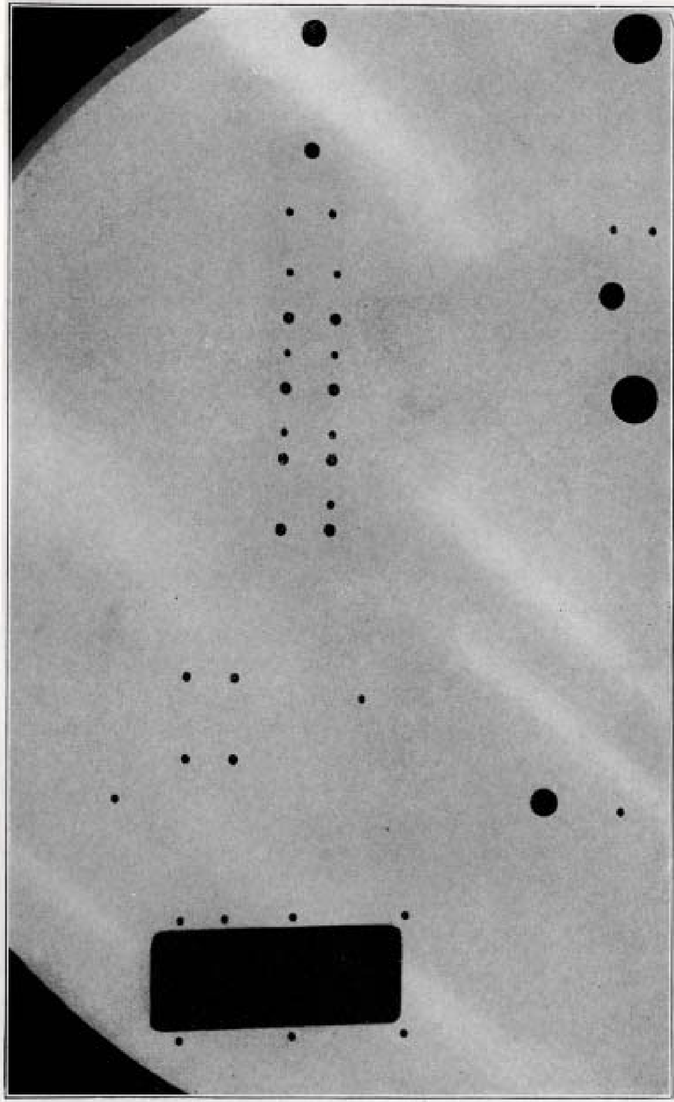


Fig. 39

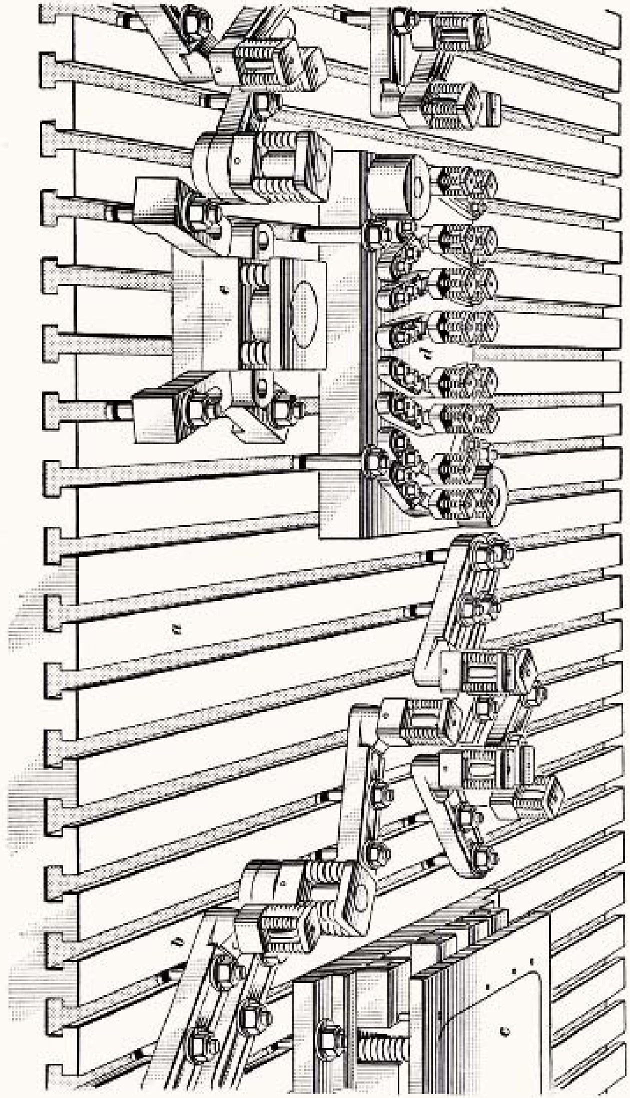


Fig. 40

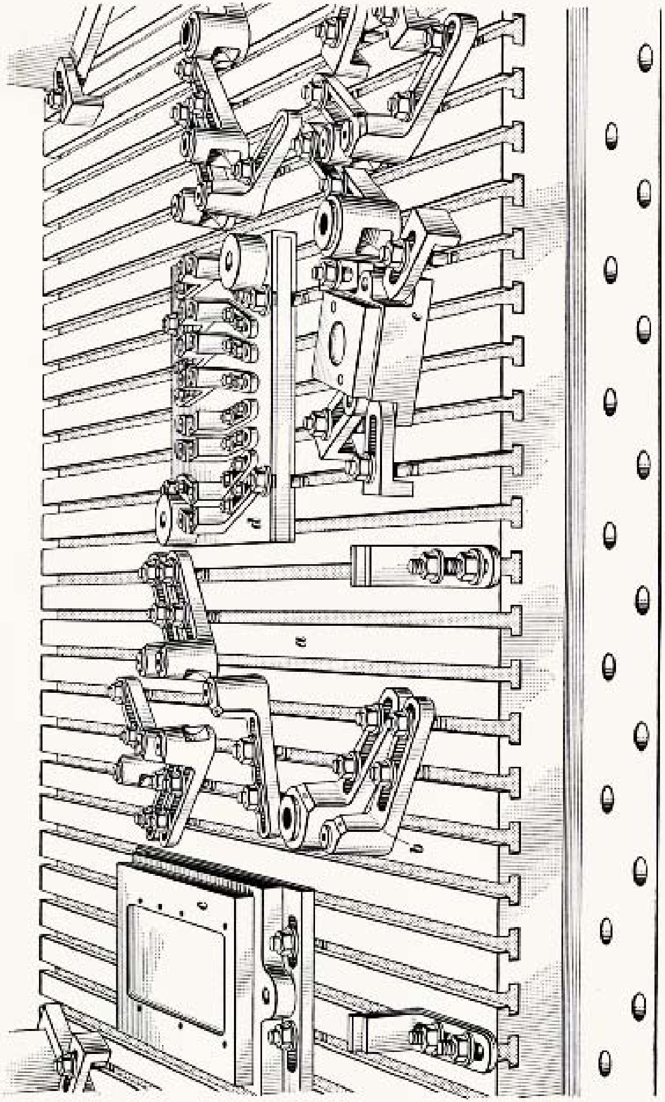


Fig. 41

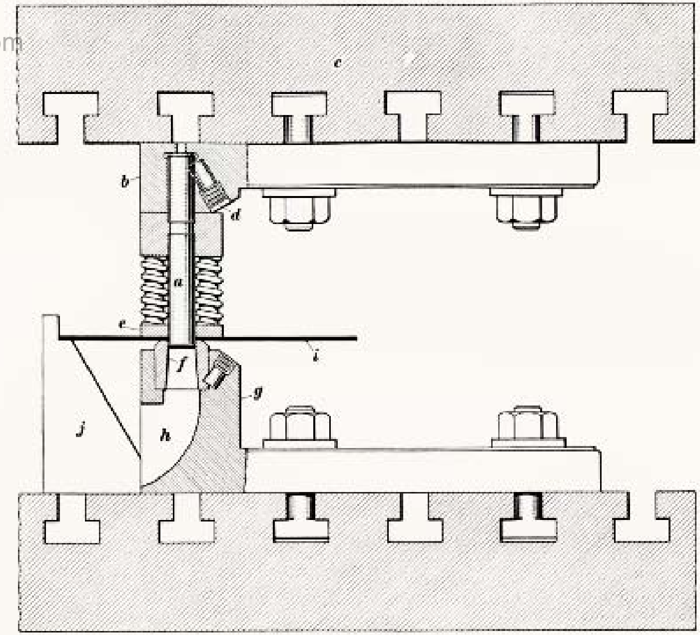


Fig. 42

this operation is shown in Fig. 40, and the die set-up in Fig. 41. The die shoes *a*, which have T-slots to receive the heads of the clamping bolts, are mounted in the press, one on the ram and the other on the bed. To these die shoes are attached the retainers *b* that hold the punches and dies. Thus, the rectangular hole in the fire wall is blanked by the punch *c*, Fig. 40, and the die *c*, Fig. 41. The series of evenly spaced holes in the center of the part are pierced by the punches assembled on one plate at *d*, Fig. 40, and the corresponding dies at *d*, Fig. 41. The other holes in the fire wall are pierced by their respective punches and dies.

48. The action and construction of the punch and die units are shown in Fig. 42. The punch *a* is held in its retainer *b*, which is bolted to the die shoe *c*, by means of a set screw *d*

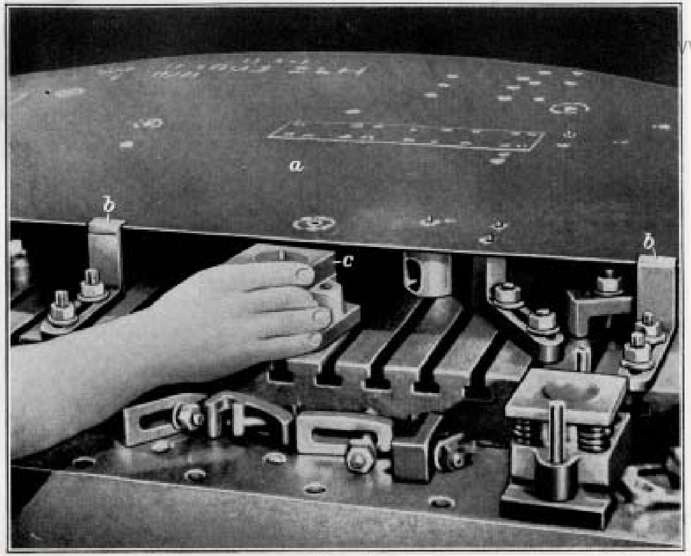


Fig. 43

that fits in a notch in the shank of the punch. The stripper *e* around the punch is supported by four springs that provide adequate stripping action. The die bushing *f* is also held in its retainer *g* by means of a set screw. An aperture *h* in the die retainer just below the bushing permits the slugs of metal that are cut from the part to fall through to the die shoe. The work *i* is located against the edge stop *j* and pierced by stripping the ram. The stripper unit holds the work steady as the punch pierces it and then strips it from the punch.

49. Setting Up Adjustable Dies.—The only tooling required to set up adjustable dies is a layout templet of the part. The templet, which is made of sheet steel $\frac{1}{16}$ inch in thickness, is drilled with holes $\frac{3}{32}$ inch in diameter at all points where holes are to be punched in the finished part. The templet can then be used to locate the dies in the press, which may be either mechanical or hydraulic.

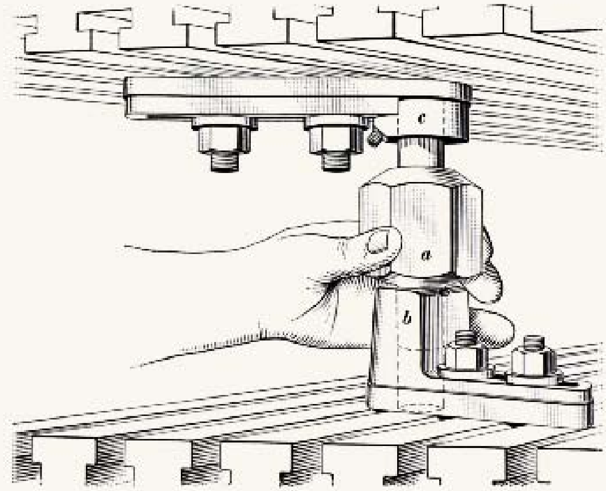


Fig. 44

The first step in the set-up operation is to mount the die shoes in the press. Then the die retainers are placed on the bottom shoe, and a pilot plug is inserted in each retainer. These plugs are made cylindrical to fit in the retainers, and a needle point on the upper end of each plug serves to locate the retainer, with the aid of the templet, in its correct position. The templet is placed over the retainers, as shown at *a* in Fig. 43, and located against the edge stops *b* that are clamped on the shoe. The retainers are located so that the needle point of each pilot plug fits into its proper templet hole, and are then bolted securely in position. These retainers are clamped with two bolts. A convenient method of adjusting the retainers accurately is to tighten the nut nearest the large end of the retainer and leave the end one fairly loose. The retainer can then be bumped gently to its proper position, and both nuts drawn tight. Additional dies, such as the one shown at *c*, may be located under the templet and bolted in place.

50. As soon as all the die retainers are located on the die shoe, the templet is removed and the pilot plugs are replaced

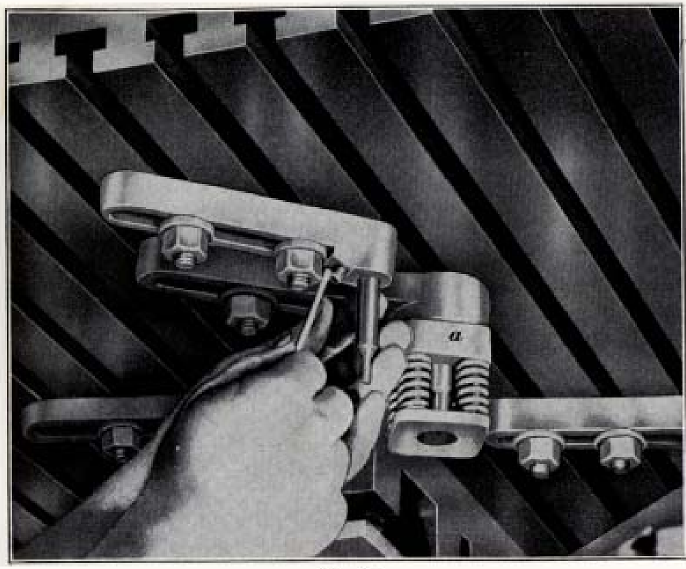


FIG. 45

with set-up plugs. These plugs are machined on both ends so that one end fits into the die retainers and the other into the punch retainers. As with the die retainers, the punch retainers are first clamped loosely to the upper shoes, and then located in their correct positions and bolted securely. The set-up plug *a*, Fig. 44, insures accurate alinement of the punch and die retainers. With the plug located in the die retainer *b*, the ram is lowered and the punch retainer *c* adjusted until it fits over the upper end of the plug. The retainer can be bumped gently for slight adjustments until the set-up plug rotates freely and slips vertically without binding. The retainer bolts should then be drawn tight and the alinement rechecked with the plug, to make certain that the punch retainer has not been shifted. It is good practice to tighten the bolts gradually and at the same time to rotate and slide the plug as a continuous check. The ram of the press is then raised and the set-up plugs are removed. The die bushings are placed in their retainers and locked by their

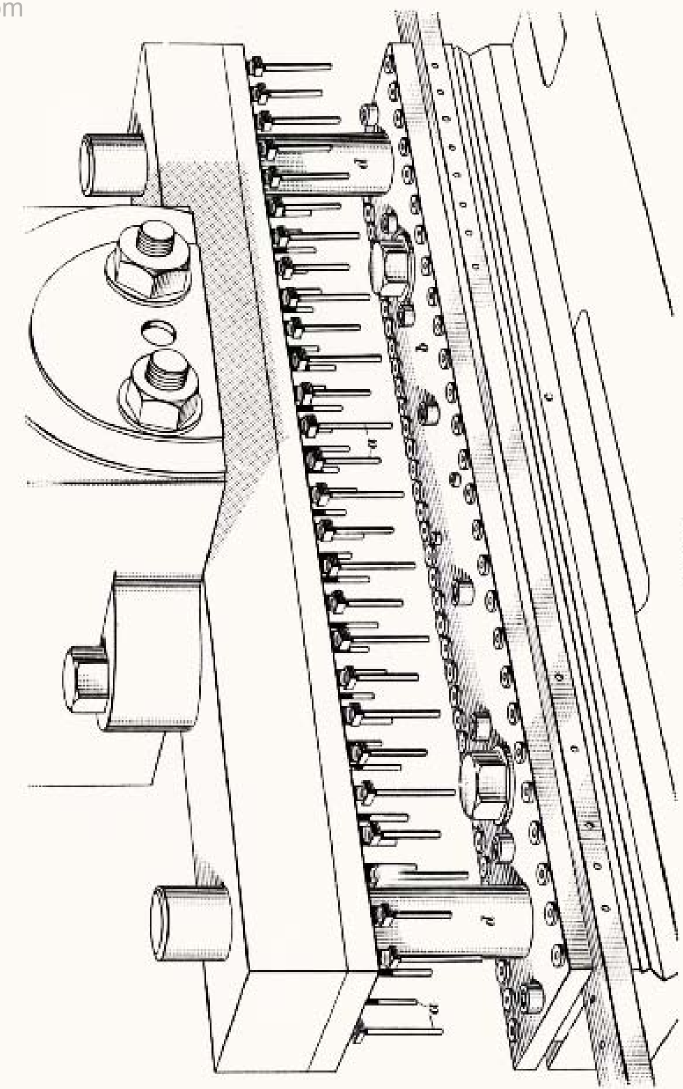


FIG. 46

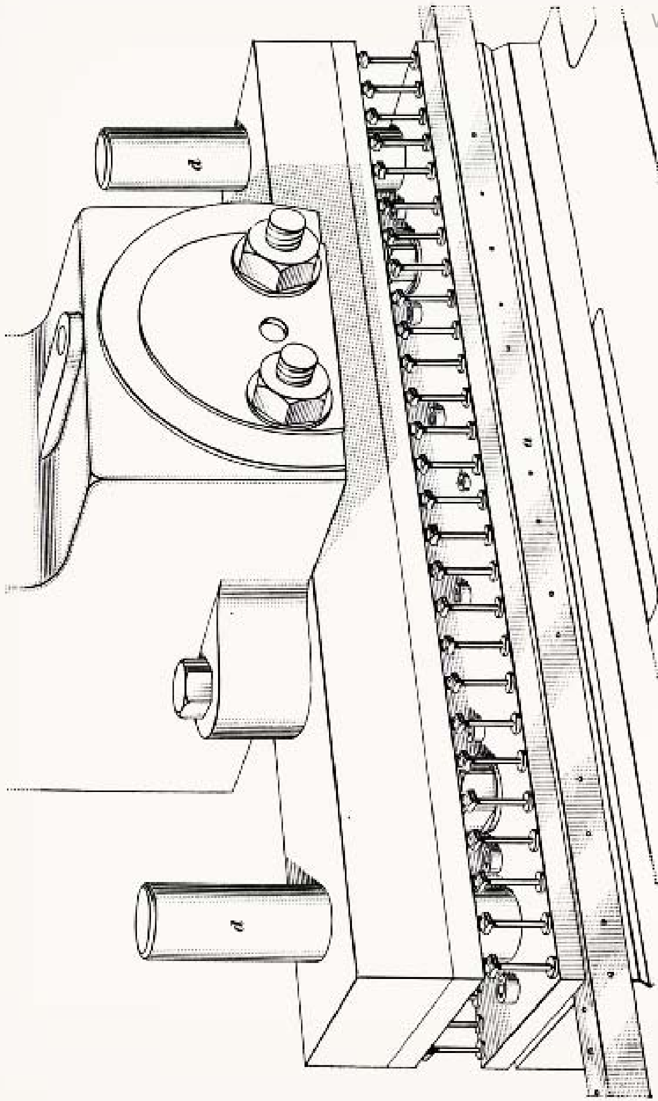


FIG. 47

set screws. The punches also are inserted in their retainers and locked, as shown in Fig. 45. Next the stripper unit, similar to that shown at *a*, is placed over the punch and fastened by means of a set screw on the side of its upper plate.

51. The method of locating larger die sets, such as the one shown at *c*, Figs. 40 and 41 differs somewhat from that just described, since these sets are not of the retainer type. The die is located on the bottom shoe by means of a pilot plug fitting into a templet hole. This part of the operation is the same as that followed in locating the die retainers. The punch, however, must be located in a different manner. First it is placed on the die and the ram is lowered until it just touches the top of the punch unit. Clamps are then used to fasten the punch securely in its correct position. This type of punch also is provided with a spring-supported stripper. When many holes, either large or small, are to be punched close together, the stripper unit can be arranged to cover a number of punches.

52. Adjustable Perforating Gang Dies.—Perforating gang dies are used for punching a large number of holes in either sheet metal or extruded stock. They can be used to good advantage in aircraft work for punching the large number of rivet holes required in stringers and similar parts. A die of this type with adjustable punches is shown in Fig. 46. The punches *a* are screwed into the punch plate and, during the perforating operation, pass through bushings in the stripper plate *b* and corresponding bushings in the die plate *c*. The punches are adjustable to pierce holes of either $\frac{3}{4}$-inch or $1\frac{1}{2}$-inch spacing. To insure perfect alinement of the punches and the bushings, two heavy guide pins *d* are used.

The edge of the stock to be pierced, in this case a *24ST* stringer 82 inches long, is inserted in the slot between the stripper plate and the die, as shown in Fig. 47, and a series of holes is pierced by tripping the ram. The stringer *a* is then moved along for the next set of holes and is positioned by a stop pin at the end of the die.

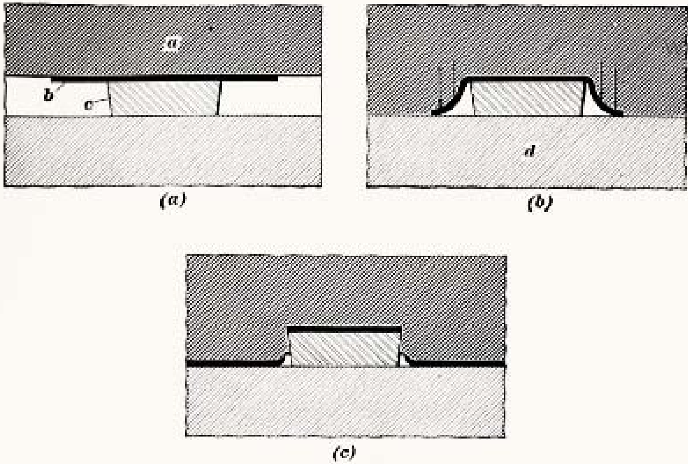


FIG. 48

HYDRO-PRESS BLANKING DIES

53. Hydro-Press Blanking.—A method of blanking that has been used in the aircraft industry to a considerable extent, but which is now seldom employed except for special cases, involves the use of a steel, Kirksite, or steel-edged masonite for the punch, and trapped rubber for the female die. The operation is performed in a single-action hydraulic press that is equipped with a rubber pad enclosed in a cast-iron container, which is bolted to the upper platen of the press. Presses equipped with such pads are known as hydro-presses. The disadvantages of blanking in a hydro-press are as follows: the damage done to the rubber pad by the cutting action; the considerable amount of scrap material involved; the slow rate of production; and the liability of damage to the press because the shearing takes place instantaneously and with a severe shock. The process is applicable to blanking only *SO* stock and then in few instances, such as producing beaded or flanged lightening holes, or forming and trimming slightly contoured sheets. The combined forming-and-blanking action is not satisfactory for fabricating ordinary flanged parts.

54. Principle of Hydro-Press Blanking.—Blanking on a hydro-press is produced by a combination of stretching and shearing as the pressure exerted by the rubber pad increases. When the ram first descends as in Fig. 48 (*a*), the rubber *a* locks the material *b* to the shear die *c*, which is generally made $\frac{3}{4}$ inch in height and given a side clearance angle of 6 degrees. As the ram continues to descend and pressure is developed between the rubber pad and the sheet metal, the overhanging part of the material is bent down, as shown in view (*b*), until it is locked to the press table *d*. Tension is built up in the unsupported area between the point where the stock is held to the table and the cutting edge of the die until the material is sheared along the cutting edge, as in view (*c*).

55. The die illustrated in Fig. 48 is of the simplest type and removal of the scrap is usually difficult. Therefore, such dies may be modified by placing them on an auxiliary plate, by using a support block, or ring, around the whole die, or by building the support block in the die itself. Removal of scrap is facilitated when the number of shear dies is used on the hydro-press table, since the dies are placed about 1 inch apart and serve as support blocks for each other. Again, on the type of die illustrated, no means is provided for holding the material on the shear die. This can best be done by the use of locating pins in the die, over which fit corresponding holes in the sheet stock. Two pins are sufficient for short parts, whereas for long, narrow, parts three such pins can be used to advantage. Other methods of preventing the material from slipping as the pressure is developed and the rubber begins to flow, are to lay an auxiliary soft-rubber sheet over the material, or to place a metal hold-down plate, which has the exact contour of the shear die, on the sheet metal and over the die.

56. Forming and Shearing Lightening Holes.—Generally, lightening holes are cut in the blanks before the parts are formed, but the holes can be cut and the flange or bead formed in the hydro-press in one operation. One type of form block used for the flanging and shearing of the lightening hole is shown in Fig.

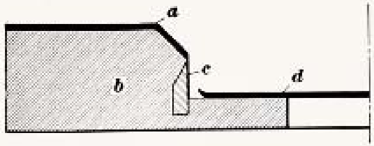


FIG. 49

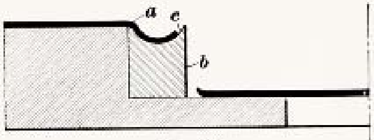


FIG. 50

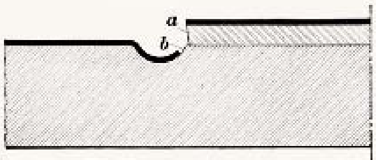


FIG. 51

FIG. 52

49. The part *a* is formed by the pressure of the rubber pad to the shape of the Kirksite block *b* and is sheared over the cutting edge of the steel insert *c*. The scrap *d* drops into the die cavity. A die that is similar but that beads the lightening hole instead of flanging it, is illustrated in Fig. 50. The sheet-metal *a* is sheared along the cutting edge of the steel insert *b*, and the bead is formed in the depression *c* in the insert. A die having a steel insert to act as the shearing edge has a longer life and is more satisfactory than a die made entirely of Kirksite.

57. On both the dies just described, the scrap drops into the die cavity and must be removed during the run, if a large number of parts are being formed; otherwise, the scrap will fill the cavity and interfere with the shearing operation. To obviate this condition, the die shown in Fig. 51 has been devised. The shearing die *a* is raised above the rest of the die. As the rubber descends, it shears the stock over the cutting edge of die *a* and then forms it in the bead *b* around the die. Since the scrap remains on the top of the shearing die, it can be removed easily when the table is unloaded.

58. Forming and Shearing Cell-Door Skin.—A slightly contoured part, such as a cell-door skin, can be formed and sheared in one operation in a hydro-press. As shown in Fig. 52, the finished part *a* has a slightly irregular contour in both directions. The sheet stock is placed on the die and, if desired, a soft rubber blanket can be placed over the sheet metal in order to save the rubber pad. As the pad descends, it locks the sheet metal on the locking bead *b* and prevents it from shifting as more pressure is developed. The material then shears along the cutting edge of the die, thus trimming off the scrap *c*. Both the part *a* and the scrap *c* can be removed readily from the die.