March 4, 1958 G. R. ALLEN 2,825,385

ADJUSTABLE SECTIONAL FORMING DIE

Filed Jan. 14, 1957 2 Sheets-Sheet 1

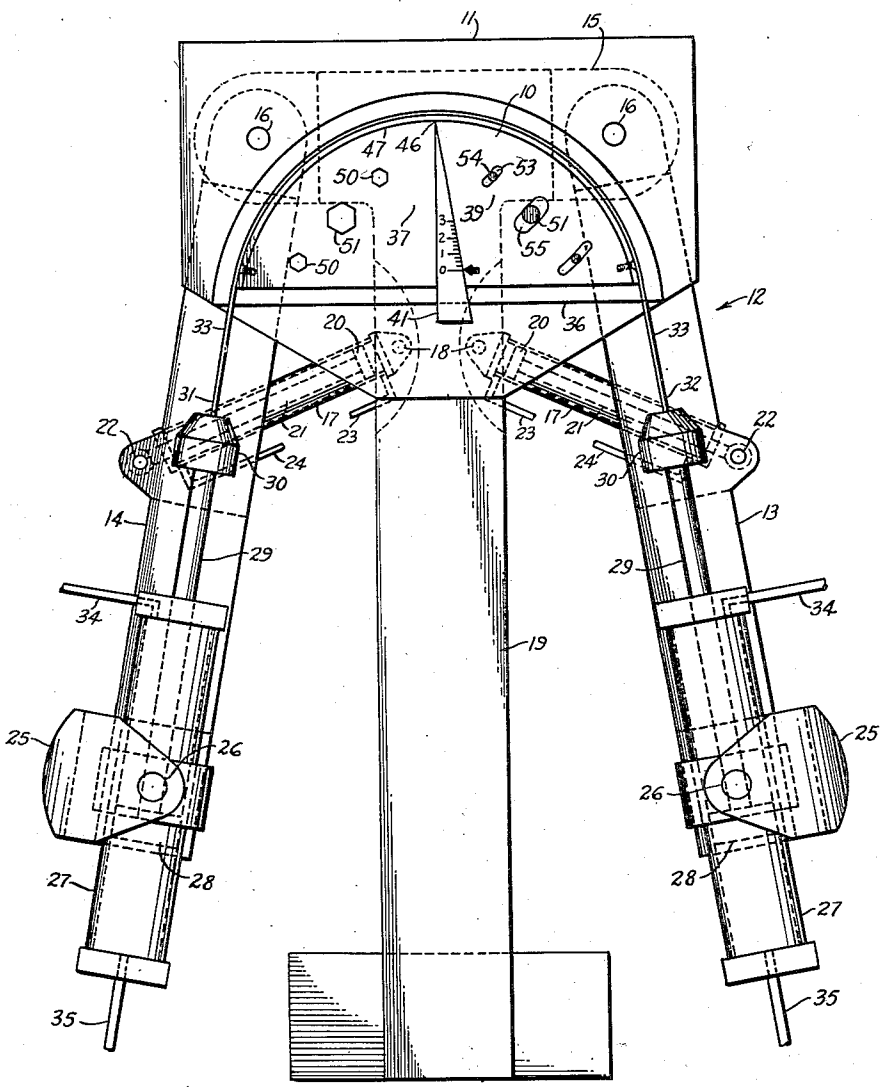


fig-1

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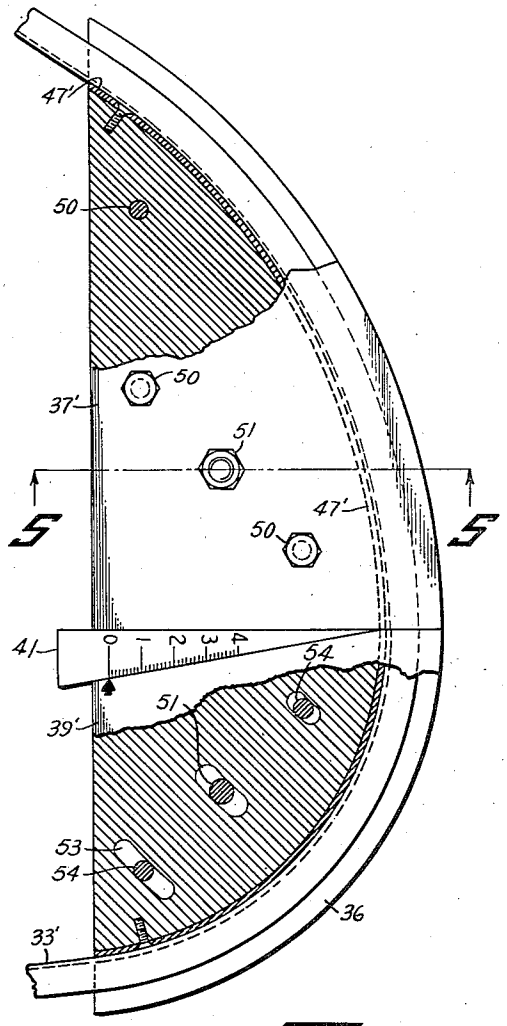


fig-4

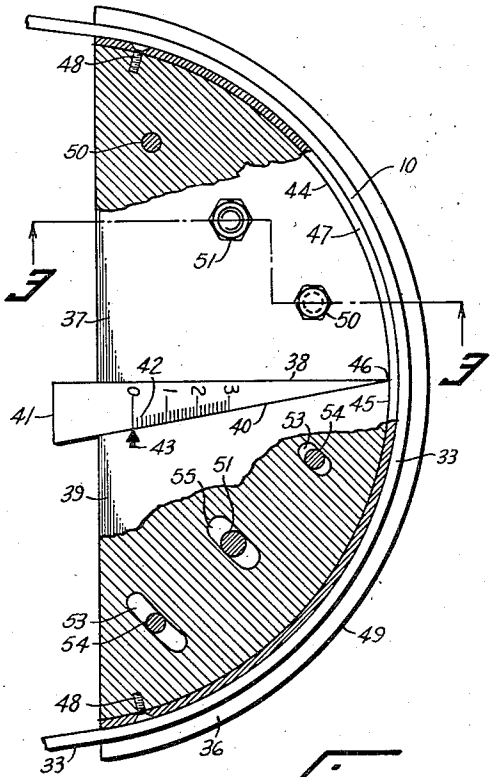


fig-2

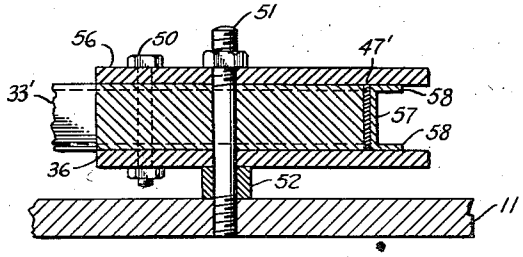


fig-5

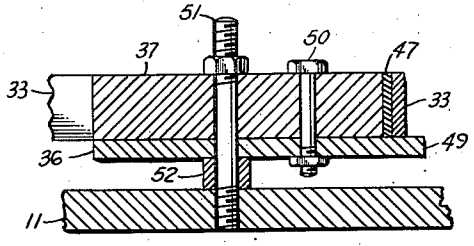


fig-3

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2,825,385

ADJUSTABLE SECTIONAL FORMING DIE

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8 Claims. (Cl. 153—32)

This invention relates to the construction of a die against the curved face of which a metal strip is pulled to bend the strip to the shape of the die face. A machine of this type is shown in U. S. Patent to R. Seifried, 2,357,027 in which the shaping die is attached to a stationary table. It is customary to make such shaping dies of one piece of metal such as aluminum, and after the strip is bent and the tension thereon released, the end portions of the strip, due to the elasticity of the metal, spring out from the die. Due to this spring-back, the strip no longer has the desired shape to which the die face was made and it is usually necessary to cut away some metal from the end portions of the die to compensate for the spring-back. This is usually done by trial and error and after each cutting away of some metal, a metal strip is stretched against the die to determine whether the correct shape has been achieved. This is an expensive method for securing a die of the correct size and/or shape and a main object of my invention is to provide a die construction whereby this expense is greatly reduced.

Furthermore, different metals spring back different amounts after they are stretched around a die and released so that to make two parts composed of different metals to the same shape and size ordinarily requires two dies of slightly different shapes. For example, if an aluminum strip and a stainless steel strip are stretched against the same convex die face, due to stainless steel having approximately 50 percent greater spring-back than aluminum, the ends of the formed stainless steel strip will be spaced apart by a distance substantially greater than the distance between the ends of the aluminum strip. In other words the two strips formed on the same die face are not the same size or shape. According to my invention the die is made adjustable so that the contour of the die face can be changed enough to vary the shape and size of strips which are stretched against it, thereby saving the cost of a second die.

Further objects of the invention will become apparent as the description thereof proceeds. For a better understanding of the invention, reference is made to the accompanying drawings, in which:

Fig. 1 is a top view of a die embodying the invention mounted in a stretch forming or bending machine parts of which are shown schematically;

Fig. 2 is an enlarged top view partly in section of the die shown in Fig. 1;

Fig. 3 is a sectional view of the die of Fig. 2 taken on line 3—3;

Fig. 4 is a top view, partly in section, showing a modified form of die and;

Fig. 5 is a sectional view of the die of Fig. 4 taken on line 5—5.

Referring to Fig. 1 the die 10 is secured to the stationary table 11 of a stretch press 12 which has a pair of long arms 13, 14 pivoted to the main frame 15 of the press by pivot pins 16. Arms 13, 14 are oscillated simultaneously by hydraulic means comprising a cylinder

17 whose inner end is attached to a pivot pin 18 journaled in a rearward extension 19 of main frame 15. A piston 20 is slidable within each cylinder 17 and is attached to the inner end of a piston rod 21 whose outer end carries a pivot pin 22 journaled in arm 13 or 14. Oil or other pressurized fluid is supplied to the inner end of cylinder 17 by a pipe 23 or supplied to the outer end of the cylinder by a pipe 24 from a source (not shown) of oil under pressure in a known manner. Each arm 13 and 14 has attached thereto a bracket 25 through which a pivot pin 26 passes which is attached to a long cylinder 27. Slidable within cylinder 27 is a piston 28 which is fastened to the outer end of a piston rod 29 whose inner end carries a chuck 30. Chucks 30 are adjustable in a known manner to grip the opposite ends 31, 32 of metal strip 33 to be bent to the shape of die 10. Fluid under pressure is supplied to the inner end of cylinder 27 by a pipe 34 or to the outer end of the cylinder by a pipe 35 from a piping and valve system (not shown) of the type disclosed in the aforesaid patent which will maintain a constant tension on strip 33 while it is bent against the face of die 10.

The die of Figs. 1 to 3 comprises four main parts, namely a generally semi-circular support plate 36 on the top of which is placed a fixed block 37 having a straight edge 38, an adjustable block 39 having a straight edge 40 disposed at an angle of approximately 10 degrees to edge 38 and a wedge 41 whose opposite faces contact edges 38 and 40. Along one side the top face of the wedge may be marked with linear graduations 42 as for example, inches subdivided into eighths, and block 39 has a cooperating index mark 43. The arcuate faces 44, 45 of blocks 37, 39 meet at the point of tangency 46 to form a continuous die face which is covered by a band 47 of cold rolled steel about 3/16 inch thick. A pair of countersunk screws 48 pass through band 47 and anchor its ends to blocks 37 and 39 so that band 47 acts as a spring to return block 39 to the position shown in Fig. 2 after it has been released from an adjusted position as later described. Plate 36 has an outer arcuate face 49 which extends out past band 47 and bent strip 33 to partly support the latter as it is being bent to shape.

Block 37 is attached to plate 36 by two bolts 50 and a pair of larger bolts 51 anchor the die to table 11 of the press. A spacer sleeve 52 surrounds each bolt 51 and keeps the die spaced at a level above table 11 (see Fig. 3). Die block 39 has two arcuate slots 53 extending therethrough and through which a pair of securing bolts 54 pass which are similar to bolts 50 and secure block 39 to support plate 36. One of the bolts 51 passes through an arcuate slot 55 which extends through plate 39, the slots 53 and 55 being concentric about the point of tangency 46.

From the above it will be clear that by loosening bolts 54 and the bolt 51 which passes through slot 55, and moving wedge 41 toward the left in Fig. 2, die block 39 can be moved up about point 46 as a pivot point until its inclined edge 40 is again seated against wedge 41 when bolts 51 and 54 can again be tightened. This adjustment shortens the distance between the ends of band 47 and changes the shape of the peripheral face of the die by an amount depending on the distance wedge 41 was withdrawn. By setting wedge 41 at different positions as indicated by the graduations 42, it will be clear that the shape or size of the die may be controlled within certain limits.

In using the die in stretch press 12, it is bolted to table 11 and fluid admitted to pipes 23 to move pistons 20 out in their cylinders until arms 13 and 14 are in alignment with each other. The chucks 30 are then moved toward each other until they grip the ends 31 of metal strip 33 by admitting pressurized fluid to pipes

35. Strip 33 at this time is usually straight and substantially tangent to the center of metal band 47. Pressurized fluid is now admitted to pipes 34 to move pistons 28 in cylinders 27 by an amount sufficient to stretch strip 33 somewhat beyond its elastic limit. While a constant tension is maintained on the strip, pressurized fluid is admitted to pipes 24 to move pistons 20 and arms 13, 14 in until they reach the position shown in Fig. 1. This movement has caused strip 33 to be wrapped along the peripheral face of band 47 and conformed substantially to its shape. Fluid is then admitted to pipes 35 to move pistons 28 in until strip 33 is no longer under tension when its ends are released from chucks 30. If the strip is composed of most flexible metals such as stainless steel, aluminum or brass, due to the elasticity of the material, the portions of the strip in contact with the ends of band 47 spring out slightly and leave the band after the tension is released, this phenomenon being known as spring-back. This spring-back varies with the composition of the alloy being bent and also with the heat treatment it has received. For example, hard stainless steel has approximately 75 percent more spring-back than the same material in the annealed condition.

If due to spring-back a formed part is too large that is, the distance across its ends too great when it is taken off the die, the operator loosens bolts 54 and 55 and moves wedge 41 down in Fig. 1 by an amount which will compensate for the oversize. A second strip is then stretched in the manner described and when the tension on the strip has moved die block 39 in against wedge 41, the machine is stopped while the operator again tightens bolts 54 and 55 to lock die block 39 in place. The machine is again started and the forming completed.

From the above it will be clear that by measuring several bent strips formed with different settings of wedge 41, the operator can make up a table listing for different graduation readings of wedge 41 the corresponding sizes of the bent strips produced. With such a table the operator can then set wedge 41 at the proper reading before starting to bend a strip with the assurance that the spring-back of the material has been compensated for and that the strip will be of the desired size and shape after forming.

In certain cases the steel band 47 may be omitted from the die and the strip 33 stretched directly against the arcuate faces 44, 45 of blocks 37 and 39. This may cause a line or small projection to appear across the bent strip at the point of tangency 46 for certain positions of adjustment of wedge 41. The presence of band 47 prevents such surface defects and the band also acts as a spring to hold the blocks 37, 39 in assembled relation while biasing block 39 away from block 37 about tangent point 46 as a pivotal center. If blocks 37, 39 are made of aluminum or an aluminum rich alloy, bending stainless steel strips directly against them causes galling of the softer metal and rapid wearing away of the die face. The presence of steel band 47 prevents this from happening.

Figs. 4 and 5 show a die construction generally similar to that above described except as to the shape of die blocks 37', 39' and the presence of an additional supporting plate 56 through which the several securing bolts 50, 51 and 54 pass. In this case the metal strip 33' to be bent is of channel shape and has a vertical web 57 connecting its horizontal flanges 58. The peripheral face of the die is not circular but its curvature changes along its length, as shown. As in the previous modification, the operator can loosen the bolts 51 and 54 and adjust wedge 41 to control the shape and/or size of the bent strip. As the bending of channel 33' proceeds, the supporting plates 36 and 56 continually bear against the flanges 58 in the regions where the bending is taking place and prevent undesirable small wrinkles from forming in the flanges. After the ends of channel strip 33' are gripped in the chucks 30, the machine is operated in the manner above described to effect the bending. While the use of the die for bending strips of rectangular and channel cross sections has been illustrated, it is to be understood that strips of other sectional shapes such as Z, T, hat sections and others may be bent by suitably shaping the die face which bears against the strip.

While my improved die has been shown mounted on a stationary table, it may also be attached to a rotary table such as the table 2 of U. S. patent to Bath, 2,514,830. In this case one end of the strip to be bent around the die is inserted in a clamp carried by the table and its other end is attached to a clamp connected to the end of a piston rod as shown in Figs. 1 to 3 of said patent. When so used, adjustment of wedge 41 can compensate for different amounts of spring-back in the same manner as above described.

This invention may be embodied in other forms or carried out in other ways without departing from the spirit or essential characteristics thereof. The present embodiment of the invention is therefore to be considered as in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Having thus described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

1. A shaping die having a curved peripheral face against which a strip of metal may be stretched to bend the strip to the shape of said face, said die comprising a supporting plate; a first block attached to one face of said plate in a fixed position thereon and having a plane end face; a second block having a plane end face disposed at an acute angle to the end face of said first block; means for detachably securing said second block to said one face of said plate in adjusted position relative to said first block; and a wedge having a pair of converging surfaces in contact with the plane end faces of said blocks, said blocks having curved peripheral surfaces which meet together to form the curved peripheral face of the die.

2. A shaping die as claimed in claim 1, in which said wedge and one of said blocks are provided with scale graduations and a cooperating index mark to indicate the adjusted position of said wedge with reference to said one block.

3. A shaping die having a curved peripheral face against which a strip of metal may be stretched to bend the strip to the shape of said face, said die comprising a curved band of flexible hard material; a pair of blocks having curved peripheral faces in contact with the inner face of said band and a pair of opposed end faces disposed at an acute angle to each other; a common support for said blocks, one of said blocks being immovably secured to said support; a plurality of screw threaded fasteners arranged to connect the other of said blocks to said support in any one of a plurality of adjusted positions; a wedge having a pair of converging surfaces in contact with said opposed end faces; and means for attaching said band near its ends to said blocks.

4. A shaping die having a curved peripheral face against which a strip of metal may be placed and stretched to bend the strip to the shape of said face, said die comprising a supporting plate; a first block having a plane end face; one or more threaded fasteners attaching the bottom face of said block to the top face of said supporting plate at a fixed position thereon; a second block having a plane end face disposed at an acute angle to the end face of said first block and a bottom face in contact with the top face of said supporting plate, said second block having a plurality of slots extending between its top and bottom faces; threaded fasteners passing through said slots and said supporting plate to secure said supporting plate and second block together with said second block in a desired adjusted position relative to said first block; and a wedge having a pair of converging surfaces in con-

tact with the plane end faces of said blocks, said blocks having curved peripheral surfaces which meet together to form the curved peripheral face of the die.

5. A shaping die as claimed in claim 4, in which a flexible metal band is attached to both of said blocks and substantially covers the entire curved peripheral surfaces thereof, the exposed face of said metal band constituting said curved peripheral face.

6. A metal-forming die comprising a pair of parallel spaced apart supporting plates; a first block disposed between and in contact with said plates and having a flat end face; means for securing said block to said plates in a fixed position; a second block disposed between and in contact with said supporting plates, said second block having a plane end face disposed at an acute angle to the end face of said first block; one or more threaded fasteners securing said second block to said supporting plates in adjusted position relative to said first block; and a wedge having a pair of converging surfaces in contact with the plane end faces of said blocks, said blocks having curved peripheral surfaces located between said supporting plates and which substantially meet together to provide a curved die face.

7. A die as claimed in claim 6, in which said second block is provided with one or more slots, said threaded fasteners passing through said slots and said supporting plates to secure said second block between said supporting plates in any one of a plurality of adjusted positions.

8. A die as claimed in claim 6, in which a band of hard flexible material is attached to both said blocks and substantially covers the curved peripheral surfaces thereof to provide a curved die face against which the metal to be formed is stretched.

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