Oct. 13, 1959 H. HELLWIG 2,908,315

DIES FOR POWER PRESS AND THE LIKE

Filed Oct. 3, 1955 2 Sheets-Sheet 1

FIG_1

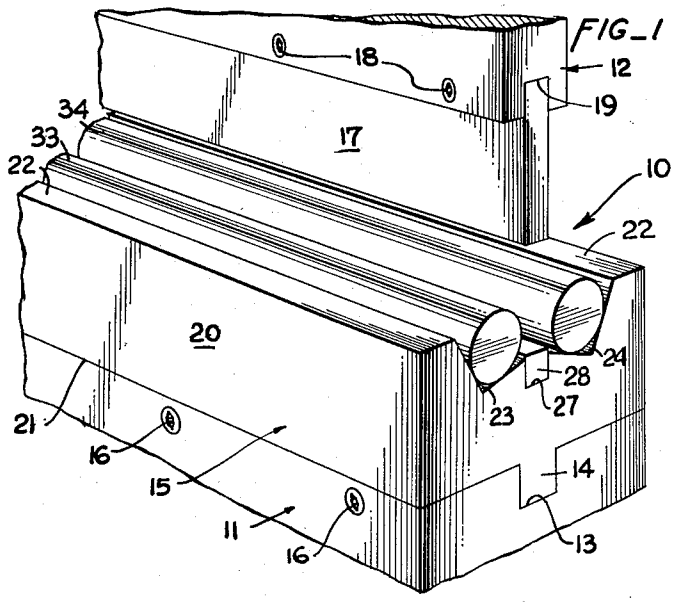


FIG_3

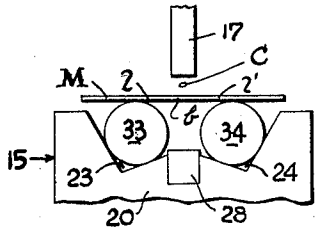


FIG_4

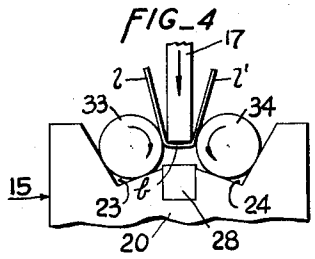


FIG_2

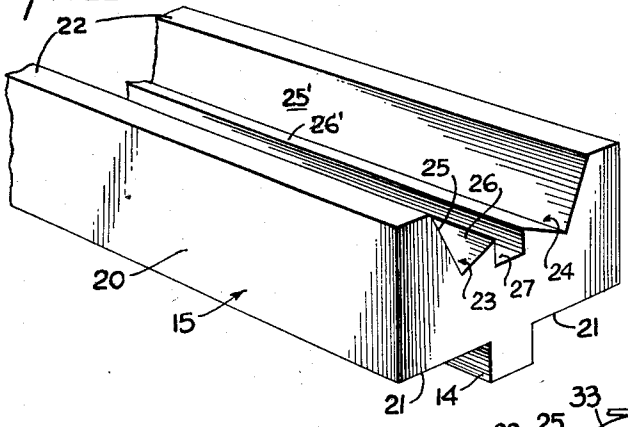
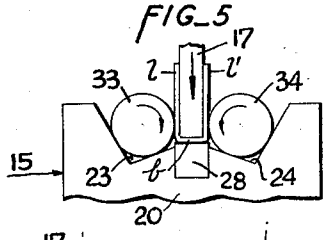


FIG_5



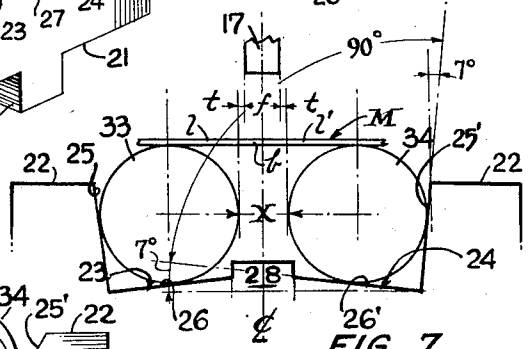
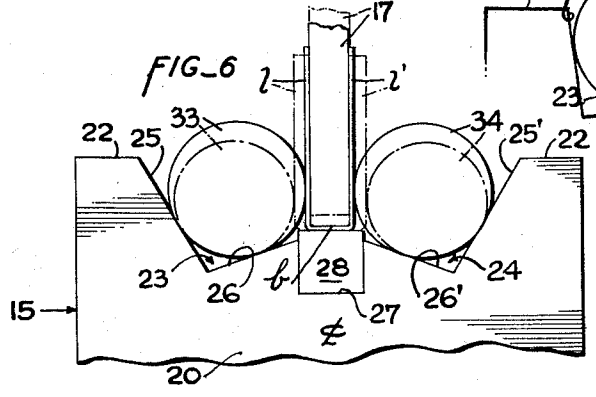


FIG_7.

FIG_6



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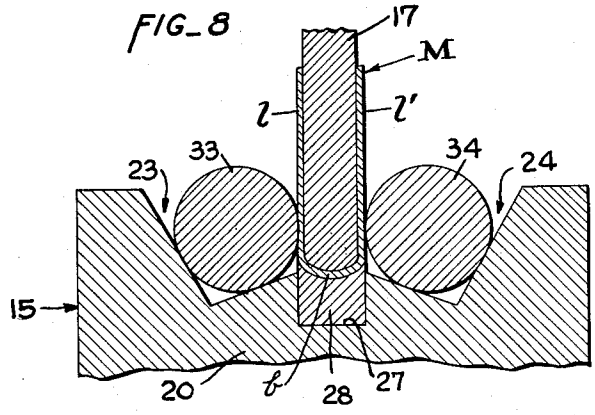
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Oct. 13, 1959 H. HELLWIG 2,908,315

DIES FOR POWER PRESS AND THE LIKE

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FIG_8



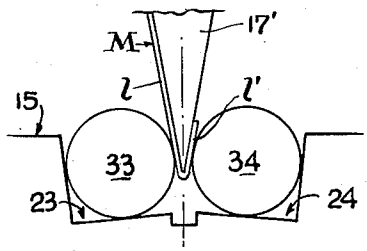


FIG_11

FIG_10

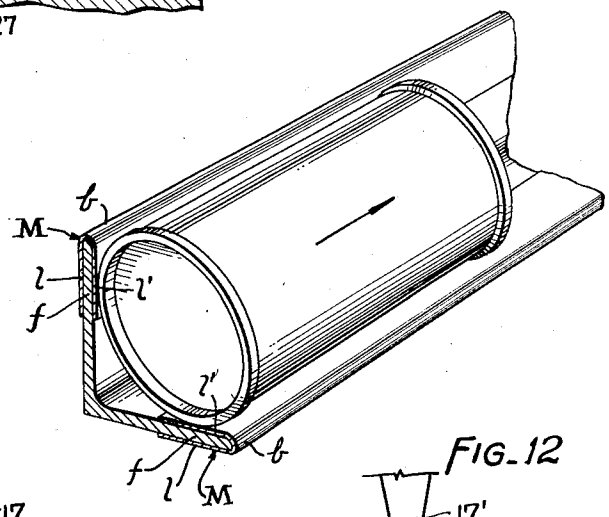


FIG_9

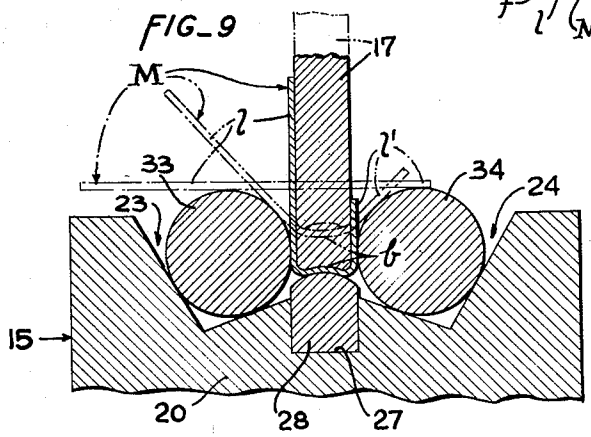
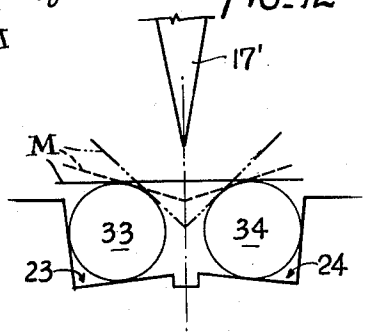


FIG_12



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United States Patent Office 2,908,315 Patented Oct. 13, 1959

2,908,315

DIES FOR POWER PRESS AND THE LIKE

Harold Hellwig, San Jose, Calif.

Application October 3, 1955, Serial No. 538,097

10 Claims. (Cl. 153—21)

This invention relates to forming dies for sheet metal and more particularly to a novel bed die for metal forming presses. In the sheet metal art it has not been uncommon to use free floating rollers in connection with forming dies. However, never, so far as I am aware, has it been the practice of bending and forming very long pieces of metal on die beds embodying free floating rolls. A good example of the type of sheet metal forming posing a problem in metal fabrication is illustrated in U.S. Patent No. 2,567,096, issued to Karl L. Berrar on September 4, 1951. This patent shows angle iron can conveying flights in commercial cookers which are some twenty feet in length. As explained in the Berrar patent it has become the practice to face the flanges of these angle iron flights with stainless steel facia clips. Since the cans travel a serpentine path through the cooker they must necessarily glide lengthwise along the angle iron flights and it will therefore be appreciated that a minimum number of butt joints in these facia clips is preferred.

In the prior practice of forming bends into metal several complex steps have been required. For example a first operation by a press accomplishes a partial bend which must be followed by a change of position of the partially bent metal and a subsequent operation under the press for completing the job. Moreover, in the case of U bends the foregoing multiple steps must be repeated for each break or corner bend. This prior known method and apparatus is fraught with spoilage due to human error in one or another of the steps or by reason of incorrect placement of the partially bent material relative to the dies. The present invention contemplates the provision of a press bed die capable of accurately forming such elongated facia clips and other U bends in a minimum number of operations.

The present invention has as one of its objects the provision of an elongated bed die for a power press embodying valleys on either side of press center for receiving a pair of rollers of comparable length which serve as gauges to establish a space for the receipt of the finished form and male die as well as providing a flat bed for supporting the metal prior to the forming operation.

In connection with the foregoing it is a further object of this invention to provide a roller type female die bed calculated to receive the male pressure member of the die plus two thicknesses of the metal being formed with assurance that little or no slippage, albeit scratching, will occur on the metal being formed.

With a press bed die of the foregoing character a change in diameter of rollers employed affords a change in thickness of the final U bend although the same dual valleyed bed die is employed. With a die bed of this kind it is therefore a simple matter to alter the same by using bed rollers of different diameter to suit the specifications of the job at hand. By this arrangement U bends ranging from stock flange thicknesses in breadth down to flat overlap bends or hems can be accomplished with one and the same die bed in conjunction with die bed rollers of a predetermined diameter.

In addition to the foregoing the present die arrangement is also suitable for forming hems or as a hem starter. In this connection the bed die is the same as for making U bends while a different form of male die is employed.

These and other objects and advantages of the present invention will become apparent in the following description when read in the light of the drawings in which:

Fig. 1 is a fragmentary perspective view of one end of a power press embodying dies constructed in accordance with the present invention.

Fig. 2 is a perspective view of the main body only of the press bed die of Fig. 1.

Fig. 3 is an end view of Fig. 1, at slightly smaller scale, showing a piece of flat metal supported therein prior to the forming operation.

Fig. 4 is a view similar to Fig. 3 showing the forming operation partially completed.

Fig. 5 is a view similar to Figs. 3 and 4 showing the forming operation completed.

Fig. 6 is a view similar to Fig. 5, but at larger scale, showing variations in gauge or thickness afforded by the present invention.

Fig. 7 is a geometric diagram of a bed die embodying the principles of the present invention.

Fig. 8 is a transverse section similar to Fig. 6 showing a different bight finish formed on the U bend in the metal worked upon.

Fig. 9 is a transverse section similar to Fig. 8 showing a piece of flat metal offset relative to press center to accomplish a U bend in which one leg is shorter than the other. This view also shows a bight finish different from that of Fig. 8 as well as Fig. 6.

Fig. 10 is a fragmentary perspective view of an angle iron can flight with a can supported therein and with stainless steel U clips formed on the dies of the present invention superimposed on the tips of the flanges of the angle iron can flight.

Fig. 11 is a cross section through the die bed of Fig. 7 showing a different form of male die operative therewith for starting and/or forming a hem in a piece of metal.

Fig. 12 is similar to Fig. 11 but showing only partial bends for shaping the metal into different angular shapes.

In the drawing, Fig. 1 depicts a power press **10** including a press bed **11** and a press beam **12** movable toward and from the press bed under power in any conventional manner. These power presses are quite long, the press bed **11** being suitably secured to a foundation between upstanding guides (not shown) between which the press beam **12** spans for up and down movement under extreme pressure by pressure exerting means of any well known design.

Presses of the type generally explained are constructed to receive various shapes of dies for effecting different types of bends in sheet metal. To this end the press bed **11** is provided with a keyway **13** running the full length thereof for receiving a key **14** formed on the underside of a female bed die **15**. Along the outer edges of the press bed **11** a plurality of set screws **16** are provided for securing the key **14** within the keyway **13** and for holding the female bed die **15** in proper position, i.e., at press center beneath the path of stroke of the beam **12**. A somewhat similar arrangement is used in connection with the press beam **12** which carries a male die **17** for movement therewith. The press beam **12** is also provided with a plurality of set screws **18** on both its sides for gripping that portion of the male die **17** which fits into a groove **19** running the length of the press beam in per-

fect alignment with the longitudinal center of the press bed **11**.

This invention is concerned principally with the male and female dies **17** and **15** respectively as shown and now to be described. Since the female die **15** is secured to the foundation or bed **11** of the press it will be referred to herein as a stationary die. Likewise since the male die **17** is secured to the press beam **12** for movement therewith toward and from the female die it will be referred to as a movable die.

The stationary die **15** as seen in the drawings comprises a main body **20** having a flat lower surface **21** from which the key **14** extends for insertion into the keyway **13** in the foundation bed **11** of the press. The lower surface **21** of the die **15** rests firmly upon the foundation bed **11** and is secured thereto against longitudinal movement by the set screws **16** as previously explained.

Coming now to the pertinent structural aspects of the stationary die **15**, the latter has a flat upper surface **22** recessed or configured to provide dual valleys **23—24** within the main body **20** of the die. Each valley **23—24** is symmetrical relative to the longitudinal axis of the die body **20** so that the configuration of the die is somewhat W-shaped cross sectionally. Thus as seen in the drawings the dual valleyed upper surface of the die **15** is provided with diverging outer walls **25—25'** and converging inner walls **26—26'**. The outer and inner walls **25—26** form the valley **23** on one side of press center (left side Fig. 6) and the outer and inner walls **25'—26'** form the valley **24** on the other side of press center (right side Fig. 6).

The best mode of constructing the female die **15** is exemplified in the geometric diagram of Fig. 7. In this connection it will be understood by those skilled in the art that any female die having a V-shape in which the included angle is 14° or less will have a binding effect upon a comparable wedge shaped male die. In other words, any two such companion dies within such angle will form a taper bind. Consequently, I have selected an angle of 7° off vertical for each of the outer side walls **25—25'** of the female die. Putting it in another way, the included angle between these outer side walls **25—25'** is preferably not much less than 14° or that of a binding taper and not much more than 28° for purposes counteracting pop out of the rollers as will later be explained. Although a piece of metal forced into a V-shaped female die of 14° or less would become locked into the same such reaction will not occur in the present arrangement by reason of the rollability of other die parts to be more fully explained.

The outer and inner walls of each valley are disposed at right angles to each other and consequently the inner walls **26—26'** will be disposed at an acute angle relative to horizontal of not less than 7° or more than 14° off horizontal. This being the case, the two inner walls **26—26'** will converge at press center a slight distance from the floor of the valleys formed in the die body **20**.

At the point of convergence of the two inner walls **26—26'** a groove **27** is cut longitudinally of the entire die body **20**. The width of this groove is preferably comparable to the broadest U bend which can be made on the die so as to receive an anvil **28** against which the bight portion of a U bend will bear in the final stage of the metal forming operation as will later become apparent.

In conjunction with the dual valley stationary die **15** just explained, the present invention contemplates the provision of a pair of gauging rolls **33—34** each of a length comparable to that of a main body of the die **15** and each adapted to seat in a respective one of the valleys **23—24** as seen in Fig. 1 of the drawings. These rolls **33—34** may be conventional round bar stock such as cold rolled steel or if desired may be highly polished hardened steel rounds. In either event the arrangement is the same relative to each roll and the valley with which it is associated and therefore only one such arrangement need be defined.

As seen in Figs. 6, 7, 8 and 9, the roll **33** rests firmly within the valley **23** with which it is associated. The roll **33** has tangent engagement with both the outer and the inner wall **25** and **26**, respectively. Since the dual valleys **23—24** are symmetrically disposed relative to press center C indicated by a dot-dash line, Fig. 7, it will be apparent that when the rolls **33—34** are of the same diameter, they too will be symmetrically arranged relative to press center when they are seated in their respective valleys. Since the diameters of the rolls **33—34** are the same the peripheral edge of each tangenting a vertical line parallel to and adjacent press center will be equally spaced from the center line C of the die **15**. Thus as will be seen in Fig. 7, the two rolls **33—34** provide a gap X between them by reason of their disposition in the dual valleys **23—24**. By the same token it will be appreciated that when rolls of greater diameter are used the gap X between them becomes narrower than when the rolls are of lesser diameter. This is illustrated in Fig. 6 by the larger diameter rolls shown in solid lines as compared with the rolls of lesser diameter as shown in dot-dash lines in the same view. In all cases the axis of each roll is well below the upper surface **22** of the stationary die **15**.

Normally with a V-type female die the width W of the die must be at least 8 times *t* (thickness of material) in order to obtain a true radial bend in the metal being worked upon. This is especially so in the forming of U-bends or hems as distinguished from a mere angle bend as shown in the U.S. Patent to Hughes, No. 1,633,744 of June 28, 1927, or the Italian patent to Luigi, No. 318 of 1872. In the structure provided by the present invention there is no way of establishing width of die in this manner but it should be remembered that the initial bend from a flat plate to a right angle or a little less than 90° requires only reasonable edge support close to 8 times *t*. However, as the male die continues on to close the metal worked upon toward a hem form the flanges of such metal tangentially engage the rolls at points well within the limits of 8 times *t* (the thickness of the metal being worked upon).

The distance between the two rolls **33—34** designated X in the diagram of Fig. 7 is determined by the thickness of the flange *f* which is to receive a metal clip made on the dies of the present invention and by adding to that measurement two thicknesses *t* of the metal which is to be formed into a U-shaped clip. The equation is expressed: $X=2\times t+f$. For example, assuming that the flange to be fitted with a clip is $\frac{5}{16}$ inch and the metal to be formed is $\frac{1}{32}$ inch thick the required gap $X=2\times\frac{1}{32}+\frac{5}{16}=\frac{6}{16}''$ or $\frac{3}{8}$ inch.

For purposes of illustration, let it be assumed that in the present arrangement, as shown in Fig. 6, the gap X is $\frac{3}{8}''$ and that the diameter of each roll **33** and **34** is $1\frac{1}{16}''$. Now then when the rolls **33** and **34** are replaced by rolls of $1\frac{5}{16}''$ diameter each as per the dot-dash illustration in Fig. 6, the gap X becomes widened, for example, to $\frac{9}{16}''$. In such case, the thickness of the metal being formed into a U clip being thickened now to $\frac{1}{16}''$, the flange *f* upon which such clip will fit is *X* minus $2\times t$ or $\frac{9}{16}-2\times\frac{1}{16}=\frac{7}{16}$. Thus it will be seen that by changing the diameter of rolls **33—34** employed, a U clip thus formed will fit a unit having a different thickness.

In connection with the foregoing it will be understood that the thickness of the male die **17** must at all times correspond to the flange thickness *f* or that dimension determined by the gap X minus two thicknesses of the metal to be formed. In other words, using the examples noted above in the case of the gap X of $\frac{3}{8}''$ less two thicknesses of the $\frac{1}{32}$ inch metal the male die would be $\frac{5}{16}''$ whereas in the case of a gap X of $\frac{9}{16}''$ less $\frac{1}{8}''$ (two $\frac{1}{16}''$ thicknesses) the male die would be $\frac{7}{16}''$.

Referring to Fig. 3, a blank of sheet metal designated M is laid flat upon the two rolls 33—34 which support the sheet in a horizontal position. Obviously to prevent galling the rolls 33 and 34 should each be made of material dissimilar from the material from which either the material of the female die or the metal to be worked upon. If the metal to be worked upon is common sheet metal these rolls 33—34 may be of stainless steel. If the metal to be worked upon is stainless steel the rolls 33—34 should preferably be of dissimilar material such as nylon rolls or round stock. Since the U clips are to extend lengthwise, for example, on the flanges of an angle iron can flight, the metal M comes in strips of a length comparable to the length of the press bed and dies. For purposes of this description the strip M will be considered as having three principal zones, *l*, *b* and *l'* across its width. The zone *b* which is centermost is to become the bight portion of a U clip while each of the zones *l* and *l'* become the legs of the U clip to be formed. If the U clip is to have legs of equal length the entire metal strip is placed on the die 15 with its longitudinal center congruent to press center, center line C, as depicted in Fig. 3. However, if one leg *l'* of the U clip is to be shorter than the other the metal strip M is offset relative to press center as illustrated in Fig. 9. In either of the two situations just explained, the gap X has already been determined and the male die 17 is of a thickness comparable to the zone *b* or space between the legs of the U bend to be formed.

Now when the press 10 is operated the movable die 17 descends under pressure exerted upon the press beam 12. The press bed 11 being truly horizontal, the metal strip M will likewise be level and struck by the bottom end of the male die 17 uniformly along its entire length. The elongated metal strip M immediately yields under the pressure exerted by the male die 17 and bows at press center since the strip rests tangentially upon the two rolls 33—34. Although the action from start to finish is continuous, an initial part of the bend is illustrated in double dot-dash lines, Fig. 9, and somewhat farther along the bend would appear as illustrated in Fig. 5. In Fig. 4 it will be noted that the bottom of the movable die 17 has just about reached a horizontal plane struck between the centers of the rolls 33—34. Up to this point there has been relatively little rotation of the rolls 33—34 because the legs *l* and *l'* of the metal strip have in a sense rolled about the upper inner quadrants of the rolls 33—34 with little if any slippage occurring between the metal strip and the surface of the rolls. Nevertheless, by reason of the downward force of the movable die 17 against the center zone *b* of the strip M, a distinct corner bend occurs in the strip M about each corner of the male die. In other words, that portion *b* of the strip which later becomes the bight of the U clip is hardly in direct contact with the bottom of the male die but rather is bowed downwardly relative thereto which indicates that the major force is exerted against the strip M where it engages the corners of the male die. This force is opposed by the tangent engagement of the legs *l*—*l'* of the strip M with the respective rolls 33—34 at their points of contact with the strip M. While this tangent support of the metal strip is greatest before the strip is engaged by the male die, the distance between these points of contact diminishes as the bottom of the male die progresses toward the horizontal plane in which the centers of the rolls 33—34 are disposed.

Since the rolls 33—34 rest free in their respective valleys 23—24 it will be apparent that they tend to turn unidirectionally with the motion of the leg portions of the metal strip about them. In this connection it is important to note that there is only a slight difference in dimension between that portion of the legs *l* and *l'* from the point of contact thereof with their respective rolls 33—34 to zone *b* and the quadrant of the circumference

of the rolls about which the legs *l* and *l'* are supported. In other words, when the legs *l* and *l'* in a sense walk around this quadrant of the rolls 33—34 while bearing with extreme pressure against the same these rolls need only turn a slight degree (within 30°) in order to move unidirectionally with the leg members *l* and *l'*. It will therefore be apparent that there is a minimum of relative movement between the leg members and the surfaces of the rolls 33—34, thus minimizing scratching of the surfaces of the legs *l*—*l'* at their point of contact with the rolls.

One of the major problems in a die for accomplishing U bends has been the tendency for the male die to become bound or locked between the side walls of the female die. It is well known that a wedge driven into an opening or taper will lock therein when the included angle between side walls is 14° or less. This is what is generally known as a locking taper. This therefore is one of the minimum limitations in die forming tools for accomplishing U bends. However, other factors such as spring back or tendency of the U bent material to spread outwardly after completion of the U bend, have a bearing on withdrawal of the male die and work from the female die. This withdrawal can be assured in the present invention by reason of the diverging disposition of the outside walls 25—25' in combination with the rollers 33—34 loosely laid therein. It will therefore be appreciated that any slight divergence between outside walls 25—25' will suit provided the spring back of the material worked upon is minimal. For best results and all around utility I desire to dispose the outside walls at not less than 7° to vertical so that the included angle between them is not less than 14°. In the present disclosure (Fig. 7) it will be noted that by reason of the two outer walls 25—25' being at an angle of binding taper (14°) relative to each other, each such wall stands at 7° off vertical and therefore presents a wall at such a great inclination that the rollers engaging these walls will not pop out when the male die and metal are forced down between them. Another aspect of the present invention is to maintain each of these outside walls 25—25' at such an angle to vertical as to deter or counteract pop out when the maximum side thrust from the material and male die reaches a point horizontally of the axis of the rollers 33 and 34. Experience has taught that the same resistance to pop out of the rollers can safely be obtained when the outer walls stand at 14° off vertical. While there is a margin of allowance beyond a 28° included angle between these outer side walls 25—25' as a safety factor it is preferable to stay within a great enough inclination to counteract pop out. Therefore, it may be said that the maximum desired included angle between the outside walls 25 and 25' preferably should be not substantially greater than 28°. Moreover, although these outer walls might be disposed at an angle of binding taper which would normally prevent withdrawal of a piece of metal bent directly against the same, since the free rolling rollers are interposed between these diverging walls and the metal being formed, the latter is at all times free for withdrawal without prying or distortion thereof. In other words, either hems or U bends can be made in the present die arrangement with assurance that the metal will not become locked within the die. Consequently any bend formed on the present die, hem or U shaped, is free to be withdrawn without effort other than that required to lift the piece itself.

The foregoing relates to the theory of operation of the bed die 15 to the stage at which the bottom of the male die 17 has progressed to a plane congruent to a horizontal line extended between the centers of the rolls 33—34. At this stage the bight zone *b* of the strip M is like a chordal bow across the bottom face of the male die 17 while the leg portions *l* and *l'* have reached parallelism or near parallelism with the side walls of the male die. During the balance of the stroke of the mov-

able male die 17 the leg portions *l* and *l'* of the metal strip M are pressed firmly against the respective side walls of the male die, assuming a vertical tangency with respect to the innermost peripheries of the rolls 33—34 on the stationary female die 15.

It should here be noted that the bottom face of the male die need not necessarily arrive at its full bottomed stroke in order to complete the U bend just explained. That is to say, as soon as the bottom of the male die passes the horizontal plane between centers of the rolls 33—34 the U bend will be complete except for whatever shape is desired to be impressed upon the bight *b* of the metal clip. It is also important to note that the rolls 33—34 are free to turn due to the downward motion of the metal clip through the last stage of the forming operation. Consequently, little or no slippage will occur between the surfaces of the rolls 33—34 and the outer surfaces of the legs *l*—*l'* by reason of the lack of relative movement a minimum of scratching will occur on the outer faces of the legs *l*—*l'* by reason o fthe lack of relative movement between the rolls 33—34 and the leg members *l* and *l'*.

The U clip thus formed may, if desired, be removed from the dies for application to the flange of an angle iron or any other unit which is to be faced by such clip. Such U clip will have a bight *b* which is slightly arcuate which may well satisfy the need. However, if a truly flat bight *b* is desired it will be obvious that this can be accomplished by running the male die 17 all the way down. In this manner the bight *b* becomes flattened between the bottom face of the male die 17 and the top surface of the anvil 28.

Other formations may be impressed upon the bight portion as desired. This is accomplished by providing the desired mating shapes on the bottom face of the male die and top face of the anvil. Examples of variations are depicted in Figs. 8 and 9 of the drawing. In Fig. 8 a convex arcuate bight with rounded corners is shown being formed. In Fig. 9 the formation of a bight with a concave face bordered by bead-like corners is shown. It is apparent that other shapes may be accomplished as desired by change in shape of the male die and anvil 28.

In connection with Figs. 11 and 12, I have shown a die bed similar to the one already explained but with a different form of male die 17'. In this disclosure the male die 17' is wedge shaped so as to come to a line running congruent to press center. This wedge shaped male die 17' preferably has its side walls disposed at approximately 22½° relative to each other or each at 11° 15' relative to a vertical plane at press center. As illustrated in Fig. 11, when the movable die 17' is pressed against the metal M there is a point of pressure against the latter along the line of press center. Therefore a corner bend will be made along press center, the legs *l* and *l'* of the metal piece following around the upper inner quadrant peripheries of the two bed rollers 33—34 as before.

In the case of starting a hem one leg *l'* of the metal will of course be shorter than the other leg *l*. The two die rollers 33—34 are selected to provide a gap X having slightly more than the thickness of the vertex or "point" of the male die plus double the thickness of the metal to be bent. Thus when the male die 17 descends to a level in which its pointed end enters the gap X as seen in Fig. 11, the metal M will be bent into the start of a hem. Thereafter the pre-bent metal is removed from the dies 15—17' and flattened in the usual manner, thus producing a clean uniform hem in one edge of the strip of metal M.

Referring now to Fig. 12, I have shown the two rollers 33—34 dimensioned to provide a gap X wider than as shown in Fig. 11. By running the punch or male die 17' down only part way the metal M is bent to any desired angle. Thus it will be appreciated that various angular bends are possible on the bed die 15 constructed in accordance with the present invention.

From the foregoing it will be apparent that I have provided a novel type of press bed die facilitating a U bend in elongated metal strips with a minimum of slippage between the metal and the die. Moreover, since the press bed die includes dual valleys and comparable rolls supported therein it is a simple matter to change the gap between these rolls by a mere change in size of rolls. Thus the need for several bed dies of different shape is avoided and one and the same die bed can be used in forming various widths of U bend, hems and the start of hems.

While I have described my new bed die in specific detail it will be appreciated by those skilled in the art that variations, alterations and/or modifications may be resorted to without departing from the spirit of my invention. I therefore desire to avail myself of all variations, alterations and/or modifications as fairly come within the purview of the appended claims.

What I claim as new and desire to protect by Letters Patent is:

1. An elongated power press including a press beam movable toward a press bed, said power press including a male die on said press beam and a female die on said press bed adapted to cooperate in bending an elongated metal strip, said female die having its top surface configured to provide dual V-shaped valleys each on an opposite side of and equidistant from press center, said valleys each having outer and inner walls disposed at a substantially right angle relative to each other and the outer walls of said dual valleys being disposed at not less than 14° and substantially not more than 28° relative to each other, a pair of rolls of comparable diameter supported within spaced relation in the dual valleys with their axes disposed below the top surface of said female die for supporting said metal strip in horizontal position and for providing a gap between them calculated to receive said male die plus at least twice the thickness of the metal strip to be bent.

2. In a power press having an elongated press bed and a press beam movable toward and from the same along press center for bending an elongated strip of metal into a U clip in a single operation, the combination of a male die on said press beam for movement therewith, a female die on said press bed having its upper surface configured to provide a groove of W shape in which the apex at center of said shape lies congruent to press center straddled by dual V-shaped valleys, each said valley presenting inner and outer walls substantially perpendicular to each other, the outer walls of said valleys each being disposed at approximately 7° relative to vertical, and a pair of elongated bars of equidiametered round stock each supported in one of said valleys with the axis of each bar below the upper surface of said female die the diameters of said round stock bars being calculated to provide a gap between them equal to the thickness of said male die and double the thickness of said strip of metal to be bent.

3. In a power press having an elongated press bed and a press beam movable toward and from the same along press center for bending an elongated strip of metal into a U clip in a single operation, the combination of a male die on said press beam for movement therewith, a female die on said press bed having its upper surface configurated to provide a groove of W shape extending along to and centered on press center providing a symmetrical arrangement of similar valleys on either side thereof, each said valley presenting inner and outer walls, the outer walls of said valleys being disposed at substantially no more than 28° nor considerably less than 14° relative to each other, a pair of equidiametered elongated bar rollers each supported in a respective one of said valleys for supporting said elongated metal strip horizontally below said male die, the diameters of said elongated bar rollers being such as to dispose the axes thereof below the upper surface of said female die and to provide a gap between said bars equal to the thickness of said male die plus double

the thickness of said strip of metal to be bent, and an anvil formed on said female die at the point of convergence of the inner walls of said valleys to receive and engage that portion of the metal strip engaged by the bottom face of said male die.

4. In a power press including a male die movable along a vertical axis, a press bed die comprising a die body having dual V-shaped valleys formed in its upper surface symmetrical to press center, each said valley having an inner and an outer side wall disposed at substantially right angles relative to each other, the inner wall of each of said valleys being disposed at an acute angle of not much less than 7° to substantially no more than 14° relative to horizontal and in a plane converging with each other at press center, and a pair of rolls seated within said dual valleys with their axes below the upper surface of said press bed die for providing a gap between said rolls at press center adapted to receive said male die and the material worked upon between them.

5. In a press including a male die reciprocable along a vertical axis, a press bed die cooperating therewith for shaping a strip of flat metal into a U bend comprising a die body having dual V-shaped valleys formed in its upper surface symmetrical to press center, each said valley having an inner and an outer side wall disposed at substantially right angles relative to each other, each of the outer walls of said valleys being disposed at a locking taper angle of at least 7° and not substantially greater than 14° relative to vertical, and a bar of round stock supported in each said valley with its axis substantially below the upper surface of said press bed die and its periphery in tangent engagement with the inner and outer walls of a respective one of such valleys, said bars of round stock being of equal diameter for supporting said strip of flat metal in horizontal tangency transverse of press center and for providing a gap between said bars on a plane congruent to the centers of said bars.

6. In a power press including a male die reciprocable along press center, a press bed die comprising a die body having a W-shaped top surface providing a valley having an inner and outer wall on each side of press center and in which the included angle between the outer side walls of both valleys is not much less than 14° and substantially no more than 28° and in which the inner wall of each valley is substantially normal to the disposition of the adjacent outside wall, a roller of dissimilar material supported within each said valley with the axis of each roller below the top surface of the press bed die and the periphery of each roller in tangent engagement with the walls of the valley in which it is disposed, said rollers being of such diameter as to provide a gap between said rollers, the width of said gap being determined by the diameters of said rolls.

7. A bending die for making a U-type bend in a sheet of metal of known thickness comprising a lower die for mounting horizontally on the bed of a power press having a plunger, said lower die having a straight groove extending longitudinally in its upper surface, the side walls of such groove being upwardly equally divergent by an angle less than 14° from a vertical mid-plane of the groove, said groove having two bottom walls sloping downwardly and outwardly from the longitudinal center line thereof toward the side walls of said groove, a pair of elongated rollers each of a uniform diameter less than one half the width of said groove resting by gravity one on each outwardly sloping bottom wall of said groove in tangential engagement therewith and with the adjacent side wall thereof, and an upper die for mounting on the plunger of such press, said upper die having a male forming projection thereon of substantially the same length as said rollers and adapted to be centered over the groove in said lower die, said male projection being of uniform cross sectional shape and of a width at its maximum penetration between the rollers equal to the distance separating said rollers less twice the thicknes of a sheet of metal to be bent by the dies, whereby, when the dies are shut upon a sheet of such metal overlying the rollers to force said sheet of metal and the male projection between the two rollers such sheet of metal will be rolled down between said rollers and into a reverse bend lying closely along the two sides of the male projection and when the dies are thereafter opened the rollers will roll upwardly along the diverging side walls of said groove to release the male projection and the sheet of metal formed thereon.

8. A bending die for making a U-type bend in a sheet of metal of known thickness comprising a lower die for mounting horizontally on the bed of a power press having a plunger, said lower die having a slotted groove extending longitudinally in the upper side thereof, the side walls of said groove being equally spaced apart throughout their effective lengths, a pair of elongated rollers, each of circular cross sectional shape and of uniform diameter throughout its length and less than one half the width of said groove, resting by gravity in said groove and normally free for movement inwardly and upwardly transversely of the roller axis, and an upper die for mounting on the plunger of such press, said upper die having a downwardly extending male forming projection thereon adapted to be centered over the groove in said lower die, said male projection being of uniform cross sectional shape throughout its length and of a width at its maximum penetration between the rollers equal to the distance separating said rollers when the latter are in pressure engagement with the side walls of said groove less twice the thickness of a sheet of metal to be bent by the dies, the side walls of said groove being disposed at an angle to each other of not more than of the order of 28° of upward divergency so that when said rollers are subjected to lateral pressures by the entering therebetween of the male projection with a sheet of such metal thereon the rollers will be restrained by said side walls against lateral separation and thereby roll such sheet into a U-type bend with the metal thereof lying closely along the two side walls of said male projection.

9. A bending die for making a U-type bend in a sheet of metal of known thickness comprising a lower die for mounting horizontally on the bed of a power press having a plunger, said lower die having a straight groove extending longitudinally in its upper surface defined by flat side and bottom walls, a pair of elongated rollers each completely circular in cross section and of a diameter less than twice the depth of said groove resting by gravity in the groove in tangential engagement with the side and bottom walls thereof, and an upper die for mounting on the plunger of such press, said upper die having a male forming projection thereon of substantially the same length as said rollers and adapted to be centered over the groove in said lower die, said male projection being of uniform cross sectional shape and of a width at its maximum penetration between the rollers equal to the distance separating said rollers less twice the thickness of a sheet of metal to be bent by the dies, whereby, when the dies are shut upon a sheet of such metal overlying the rollers to force said metal and the male projection between the two rollers, such sheet of metal will be rolled down between said rollers and into a U bend with side walls lying closely along the two sides of the male projection on the upper die.

10. A bending die apparatus for making a return bend in a sheet of metal of predetermined thickness comprising a lower die for mounting horizontally on the bed of a power press having a plunger, said lower die having a straight groove extending longitudinally in its upper face and defined by flat side and bottom wall surfaces, a pair of elongated rollers each of completely circular cross section and of a diameter less than one half the width of the groove and less than twice the depth thereof resting by gravity in the groove and mounted therein solely by tangential engagement of its periphery with the side and bottom wall surfaces of the groove, and an upper die for mounting on the plunger of the press, said upper die having a h

zontally elongated male forming projection adapted to be centered over the groove in the lower die and being of uniform cross sectional shape and of a thickness equal to the distance between the rollers less twice the thickness of the sheet metal to be bent by the dies whereby, when said sheet of metal is disposed horizontally on the two rollers and the dies are forced toward each other, the sheet of metal will be rolled down between the rollers and into a return bend having side walls engaging the side faces of the male projection on the upper die.

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