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FORMING AND DRAWING PRESS

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8 Claims. (Cl. 18—19)

1. This invention relates to a forming and drawing press for sheet materials, and particularly thermoplastic materials, which require a certain amount of heat to condition the material for the forming and drawing operation.

Primarily the object of this invention is to provide a relatively simple and inexpensive press that can perform deep draws in relatively short time cycles, and can trim and strip the formed article during the same stroke that forms the article. In this manner, great economies are effected over present day practices which ordinarily require movement of the formed article to a separate machine for trimming, or practices in which the trimming is accomplished by a separate instrumentality which comes into play after the forming stroke is completed.

According to my invention, the downward stroke of the press accomplishes the draw and the trim, with the return stroke taking care of stripping the formed article from the male die. Hence, in one complete stroke of the press, the article is formed, trimmed, and stripped from the press.

Further and other objects and advantages will become apparent as the disclosure proceeds and the description is read in conjunction with the accompanying drawings, in which

Fig. 1 is a side elevational view showing a preferred embodiment of my invention;

Figs. 2, 3, and 4 are fragmentary vertical sectional views through the forming elements of the press, showing the male die at different positions of its stroke;

Fig. 5 is a plan view of the press with portions being broken away to expose lower parts; and

Fig. 6 is an enlarged view showing the cross-sectional shape of the female die.

In compliance with section 4588 of the Revised Statutes, a preferred form of the invention is disclosed in the drawings and will hereinafter be described, but it should be understood that the invention may be variously embodied within the scope of the appended claims.

General organization

The press in general comprises a bed 10 having a pair of uprights 11, and a pair of guideposts 12 upon which the press superstructure is mounted. This superstructure includes a platform 13, a fluid operated ram cylinder 14, and control mechanism, generally designated 15.

The hydraulic or pneumatic cylinder 14 operates a piston ram 16, which carries at its lower end a guide plate 17 from which an upper heating pad assembly, generally designated 18, is spring mounted. The male die assembly, generally designated 19, which includes a trimmer, is also carried by the guide plate 17.

A lower heating pad assembly generally designated 20, is mounted on the bed 10, and it has associated with it a female die 21 which cooperates with the male die to form the desired piece.

When a blank of sheet material 22 to be processed is placed over the female die and the cylinder 14 is operated to cause the guide plate 17 to descend, the cooperating heating pads 18 and 20 serve to heat the material to a pliable state, and thereafter the male die descends into the female die to form and draw the material with the trimmer operating to trim the upper edge of the formed piece as soon as the male die has descended into the female die the desired depth. Continued travel of the male die through the female die takes the formed piece completely through the female die, whereupon return travel of the male die serves to strip the formed piece from the die.

Press bed and superstructure

The press bed 10 is preferably made of cast iron or cast steel and has a central aperture 25 over which the lower heating pad assembly 20 and female die 21 are mounted. The uprights 11 are securely fixed to the base 10, as are also the guideposts 12, and the platform 13 is secured to the uprights 11 and guideposts 12 by nuts 26.

The ram cylinder 14 may be either pneumatically or hydraulically operated, and the stroke of the piston 27 within the cylinder 14 is determined by the size of draw to be made. The piston is fluid operated in both directions of movement, with a conduit 28 supplying fluid under pressure to the top of the piston for moving the ram 16 downwardly, and a conduit 29 supplying fluid under pressure to the under side of the piston to move the ram 16 upwardly. The conduits 28 and 29 also serve as exhaust passages, and control of the cylinder is effected by the control unit 15 which includes a four-way valve 30 of any suitable construction which permits the conduit 31 leading to the source of fluid under pressure to be connected either to the conduit 28 or conduit 29 according to the position of the valve 36, and to automatically connect the other conduit to suitable exhaust conduits, not shown, but openings for which are indicated at 32 and 33. The opening 32 is the exhaust opening for the
upward stroke of the piston 27, and the opening 33 communicates with the conduit 25 for exhausting the cylinder 14 when the piston 27 is moving downward.

Inasmuch as it is desirable to have the piston 27 move downward at a slower rate than the return stroke, the passage or opening 33 is provided with a controllable restriction in the form of a needle valve 34, and by suitable adjustment of this valve, the timing of the downward stroke may be adjusted to the requirements of the particular drawing or forming operation.

If desired, the opening 32 could also be provided with a similar needle valve, although this is ordinarily unnecessary.

**Lower heating pad and female die**

The heating pad, generally designated 26, comprises a lower rectangular plate 45 and an upper circular plate 41, both being provided with centrally located apertures to receive the female die 21. The under surface of the plate 41 is provided with an annular recess 42 to receive a heating element 43, the capacity of which may be varied to suit conditions. Ordinarily, however, for use with cellulose acetate sheeting or like materials, it is desirable to heat the material to about 230°F, and for this purpose, a 750 watt, bimetallic controlled, heating element is satisfactory.

The lower plate 40 is secured to the bed 10 by cap screws 44 which have a clearance with the plate 45, as indicated at 45 in Fig. 5, so that the position of the plate may be properly adjusted with reference to the center of the press. The plate may also be held down by clamps such as indicated at 49 in Fig. 5. A suitable layer 47 of insulation material is interposed between the plate 40 and the bed 10 to prevent heat transfer from the heating pad to the bed.

The circular plate 41 of the lower heating pad assembly is faced ground and polished to present an extremely smooth surface to the material being operated upon. It is secured to the plate 45 by means of flat head machine screws 48, which are applied on the under side of the lower plate 45 so that the top surface of the heating pad 41 is free from all broken surfaces which might tear or mar the material being formed.

The female die 21 is made of tool steel and is preferably hardened to 60-62 hardness on the Rockwell C scale. It, too, is ground and polished on all surfaces which come in contact with the thermoplastic material. The die is characterized by having a large-radius, flared, drawing surface 49 which merges with a vertical flat portion 50 which corresponds to the actual size and shape of the drawn piece. Immediately below the flat 50 is a sharp shoulder 51 which serves to strip the formed piece from the male die after the male die moves upwardly. Preferably the shoulder 51 presents a right angle surface to effectively accomplish this stripping action.

The radius of the flared section 49 will vary according to the size of the die, and for a 4' opening, the radius may be on the order of %". Obviously, the flared section 49 might consist of some other smoothly curved shape, but sharp or small radius edges should be avoided.

The outer rim 52 of the female die has a ground surface to provide a light tap fit with the corresponding recess in the plate 41, and the die is firmly held in place within the heating pad assembly by a plurality of Allen head set screws, one of which is shown at 53 in Fig. 2.

**Upper heating pad and pressure plate**

The upper heating pad and pressure plate assembly comprises a top plate 60, a bottom plate 61, and a pressure pad 62, with an annular heating element 63 being sandwiched between the plates 60 and 61 in a recess 64 that is provided in the lower plate 61. The plates 60 and 61 are held together by countersunk screws 55, and the pressure plate 62 is recessed into the lower plate 61 and is held in place by screws 55 which pass through the plates 60 and 61 without being threadedineto.

The pressure pad 62 is made of cold rolled steel, ground and polished for cooperation with the similarly polished upper face of the lower heating pad assembly. Hence, the thermoplastic or other material which is placed over the die opening for forming is suitably heated by the upper and lower pads, and the pressure pad cooperating with the lower heating pad actually forces the material as it is drawn into the female die cavity.

The upper heating pad assembly is mounted on a spring pad 67, which is supported from the guide plate 17 by studs 68 having nuts 69 applied to their upper ends. Springs 70 are interposed between the guide plate 17 and the spring pad 67 to permit the spring pad to move toward the guide plate 17 against the compression of the springs 70, but separation of the two plates is limited by the adjusted length of the studs 68.

The attachment of the upper heating pad to the spring pad 67 is preferably made with a bayonet type connection which includes bayonet slots 71 in the upper plate 60, and headed bolts 72 provided with wing nuts 73 at their upper ends. A sheet of insulating material 74 is interposed between the plate 60 and spring pad 67 to prevent undesired dissipation of heat through the spring pad. All components of the heating pads are made of material possessing good thermal conductivity properties, so that heat from the heating elements is effectively transmitted to the material being processed.

The lowermost position of the spring pad 67, and hence the pressure pad 62, is limited by adjustable stops 75 so that the material being processed will not be squeezed too tightly between the pressure pad 62 and the lower heating pad 20. Preferably a number of these stops 75 are provided to assure equal adjustment about the entire die area.

**Male die and trimmer assembly**

The guide plate 17 is carried by the ram 16 and is guided in its movement by bushes 80 riding along the guideposts 12. The effective distance between the piston 27 and the guide plate 17 may be adjusted by a turnbuckle arrangement 81, which is held in adjusted position by lock nuts 82 and 83.

Secured to the guide plate 17, and suitably centered with respect to the axial opening 24, is a downwardly extending stub shaft 85 over which is telescoped a spring retainer 86, which is firmly held in place against a flange 87 on the stub shaft 85 by means of the male die, generally designated 88, which is threaded on the stub shaft 85. The die 88 has a collar 91 which fits tightly against the spring retainer 86, and the trimming die 91 is telescoped over this collar and is held against the die 88 by a plurality of springs 82.

The characteristics of these springs will depend on the thickness of material, size of the die, etc.
but normally will exert a total force of 500 pounds or more to effectively trim the formed piece.

The male die 88 conforms in shape to that of the female die, and its total depth corresponds to the depth of the draw desired. Preferably the male die is relieved at the bottom as indicated at 93 in order to prevent air entrapment and to facilitate stripping. For the same purpose, ports 94 are formed in the die for communication with the atmosphere through slight reliefs 95 along the upper face of the male die.

The particular shape of the male die also has the advantage that the marginal flange 96 tends to form a slight ridge in the bottom of the drawn piece, which gives the piece added strength.

The male die 88 is preferably made of cold rolled steel and is ground and polished to the desired dimension.

The trimming die 91 is made of tool steel and hardened and drawn to approximately 50-58 Rockwell C hardness, which is slightly less than the hardness of the female die so that all wear takes place on the trimming die which may be readily removed for grinding and sharpening.

It will be understood that the trimming edge 97 of the trimming die 91 is ground to extreme sharpness, as this die, when it descends upon the female die, serves to pinch the heated material after the desired draw depth has been achieved, with the result that the piece is properly trimmed and heat-sealed along its trimmed margin.

**Operation**

In operating the press, the sheet material to be processed is placed over the cavity in the female die, and with the sheet in place, the valve 30 is operated to start the downward stroke of the ram.

The timing of this stroke is adjusted by the needle valve 34, and this is determined by the thickness of the material, type of material being used, depth of draw, etc. As the ram descends, the upper heating pad first comes into contact with the material being processed and is firmly pressed against such material so that heat is applied from both top and bottom to such material. The stops 75 prevent the upper heating pad from pinching the material to such an extent that it cannot flow through the pads when the draw is being made.

While this heating is taking place, the male die is descending at a rate dependent upon the adjustment of the needle valve 34. After a predetermined time interval has elapsed between the contact of the upper heating pad with the lower heating pad, which interval is sufficient to permit the material to be raised to the desired temperature, the male die 88 descends upon the portion of the material which lies over the female cavity, and continued descent of the male die causes the material lying between the heating pads to take the form of the male die and be ironed smooth by the passage of the material over the rounded surface of the female die and between the male and female dies at the flat portion 50 of the latter.

When the male die has descended to the desired depth of the draw, the trimmer die 91, which is being yieldingly urged against the male die by the springs 92, strikes the rounded surface 49 of the female die and causes the piece to be trimmed, and further movement of the male die downwardly carries the trimmed piece through the flat 50 of the female die and between the male die and the trimmer die 91, the trimmer die 91 remaining in its seated position upon the female die.

After the downward stroke of the ram has been completed, the valve 30 is moved to "up" position, and as the male die moves upwardly, the upper edge of the formed piece, which has a tendency to spring outwardly slightly due to inherent resiliency, and the place on the female die where the trimming took place, strikes the shoulder 51 and strips the piece from the die. After the ram reaches its uppermost position, the scrap material is removed, and the operation is repeated.

Obviously, it is within the skill of the ordinary mechanic to provide feeding mechanisms for the press, if desired, and also to cycle the press in relationship to the feed. Also it should be understood that the press may be used with a variety of sheet materials, although it is most useful in connection with thermoplastic materials. Other materials, for example, which may be used are paper, leather, metal foil, etc.

I claim:

1. A forming and drawing press for sheet material, the combination of a female die characterized by having a smooth horizontal portion and a smooth vertical portion, which latter portion conforms in shape to the cross-sectional shape of the piece being formed, and a curved section of relatively large radius joining said horizontal and said vertical portions of the die, a male die adapted to enter the female die to draw and form the desired article, and a trimmer die mounted on the male die and movable with it during at least a portion of the downward stroke of the male die, said trimmer die being mounted on the male die coaxially therewith and having a sharp trimming edge which mates with said curved section of the female die and pinch trims the formed piece when the male die has entered the female die a distance corresponding to the desired depth of the article being formed, and spring means continually urging the trimming die against the male die.

2. In a forming and drawing press for sheet material, the combination of the heated female die having horizontal and vertical portions joined by a flared section characterized by its absence of small-radius curves, a male die adapted to enter the female die, a trimming die having a sharp trimming edge, said trimming die being mounted on the male die coaxially therewith, spring means continually urging the trimming die downwardly toward the male die, said trimming die having a configuration which mates with the flared portion of the female die, whereby when the male die has entered the female die a distance corresponding to the desired depth of the article being formed, the trimming die pinch trims the article by the force of said spring means urging the trimming die against the flared section of the female die.

3. In a forming and drawing press for sheet material, the combination of a female die, a male die adapted to enter the female die to form and draw the sheet material, a trimming die mounted coaxially with the male die and having a sharp trimming edge on its outer surface, and spring means continually urging the trimming die toward the male die, said trimming die moving away from the male die only when the trimming die strikes and bottoms on the female die.

4. In a forming and drawing press for sheet material, the combination of a female die having horizontal and vertical portions joined by a flared section, the flared portion of the die being...
characterized by its absence of small-radius curves, and the vertical portion of the die conforming in shape to that of the article being processed, said female die having a substantially right angle stripping shoulder beneath the vertical section of the die, a male die adapted to enter the female die to form and draw the desired article, a trimming die mounted coaxially with the male die and movable therewith, spring means continually urging the trimming die toward the top of the male die, said trimming die bottoming on the flared section of the female die to pinch trim the article after the male die has descended into the female die a distance corresponding to the desired depth of the article being processed, the trimming of said article on the flared section of the female die prior to passage of the top margin of the article across the vertical section of the die causing said top margin to expand slightly when the male die passes completely through the female die, whereby on the return stroke of the male die the finished piece strikes said right angle shoulder and is stripped from the male die.

5. In a forming and drawing press for sheet material, the combination of a female die having horizontal and vertical portions joined by a flared section, the flared portion of the die being characterized by its absence of small-radius curves, and the vertical portion of the die conforming in shape to that of the article being processed, said female die having a substantially right angle stripping shoulder beneath the vertical section of the die, a male die adapted to enter the female die to form and draw the desired article, a trimming die mounted coaxially with the male die and movable therewith, spring means continually urging the trimming die toward the top of the male die, said trimming die bottoming on the flared section of the female die to pinch trim the article after the male die has descended into the female die a distance corresponding to the desired depth of the article being processed, the trimming of said article on the flared section of the female die prior to passage of the top margin of the article across the vertical section of the die causing said top margin to expand slightly when the male die passes completely through the female die, whereby on the return stroke of the male die the finished piece strikes said right angle shoulder and is stripped from the male die, and is stripped from the male die.

6. In a forming and drawing press for sheet material, the combination of a press bed having a central opening therein, a lower heating pad and female die assembly mounted over said opening, a ram, a male die carried by the ram, an upper heating pad assembly spring-mounted on the ram for movement therewith for at least a portion of the ram's stroke, said upper heating pad assembly coating with the lower heating pad and female die assembly to heat the material being processed by the press prior to descent of the male die into the female die, a trimming die mounted on the male die coaxially therewith, and spring means continually urging the trimmer die against the male die.

7. In a forming and drawing press for sheet material, the combination of a press bed having a central opening therein, a lower heating pad and female die assembly mounted over said opening, a ram, a male die carried by the ram, an upper heating pad assembly spring-mounted on the ram for movement therewith for at least a portion of the ram's stroke, said upper heating pad assembly coating with the lower heating pad and female die assembly to heat the material being processed by the press prior to descent of the male die into the female die, a trimming die mounted on the male die coaxially therewith, and spring means continually urging the trimmer die against the male die, said upper heating pad including a pressure pad detachably secured thereto.

8. In a forming and drawing press for sheet material, the combination of a press bed having a central opening therein, a lower heating pad and female die assembly mounted over said opening, a ram, a male die carried by the ram, an upper heating pad assembly spring-mounted on the ram for movement therewith for at least a portion of the ram's stroke, said upper heating pad assembly coating with the lower heating pad and female die assembly to heat the material being processed by the press prior to descent of the male die into the female die, a trimming die mounted on the male die coaxially therewith, spring means continually urging the trimmer die against the male die, and means for limiting the distance between the upper heating pad and the lower heating pad and female die assemblies.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,665,203</td>
<td>Delf</td>
<td>Apr. 10, 1928</td>
</tr>
<tr>
<td>2,265,116</td>
<td>Helmsdale</td>
<td>Sept. 9, 1941</td>
</tr>
<tr>
<td>2,270,187</td>
<td>Dulmage</td>
<td>Jan. 13, 1942</td>
</tr>
<tr>
<td>2,290,744</td>
<td>Simmons</td>
<td>Sept. 22, 1942</td>
</tr>
<tr>
<td>2,425,390</td>
<td>Palmer et al.</td>
<td>Aug. 12, 1947</td>
</tr>
</tbody>
</table>