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Miller et al.

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[45] **July 31, 1973**

[54] **APPARATUS FOR DEFORMING SHEET MATERIAL**

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[52] **U.S. Cl.** **72/382,** 72/385, 72/397, 72/465

[51] **Int. Cl.** **B21d 13/02**

[58] **Field of Search** 72/382, 385, 397, 72/403, 465

[56] **References Cited**

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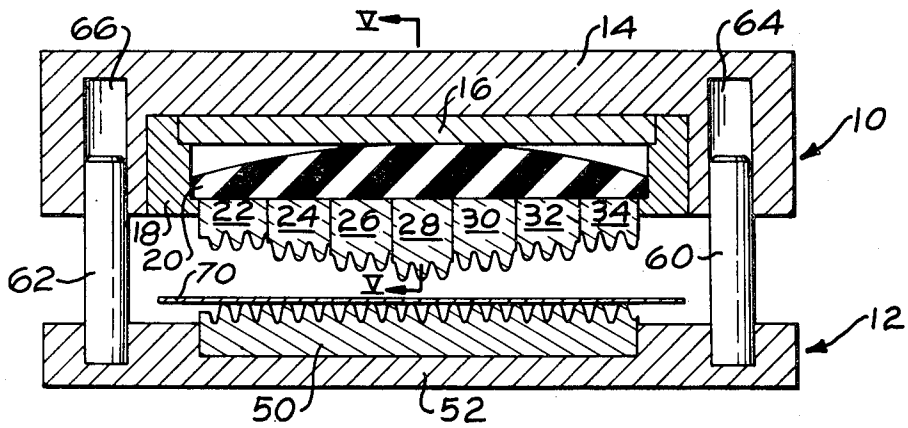
[57] **ABSTRACT**

A die assembly for deforming sheets in which a first member is segmented to provide a collapsible crowned surface, and another member is substantially planar. The segments are backed by a resilient pad-like member which permits a controlled progressive loading of the segments. The assembly permits the deformation of a sheet material workpiece by means of stretching and gathering said material progressively outwardly from the central portions of said workpiece.

6 Claims, 5 Drawing Figures



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SHEET 1 OF 2

Fig. 1

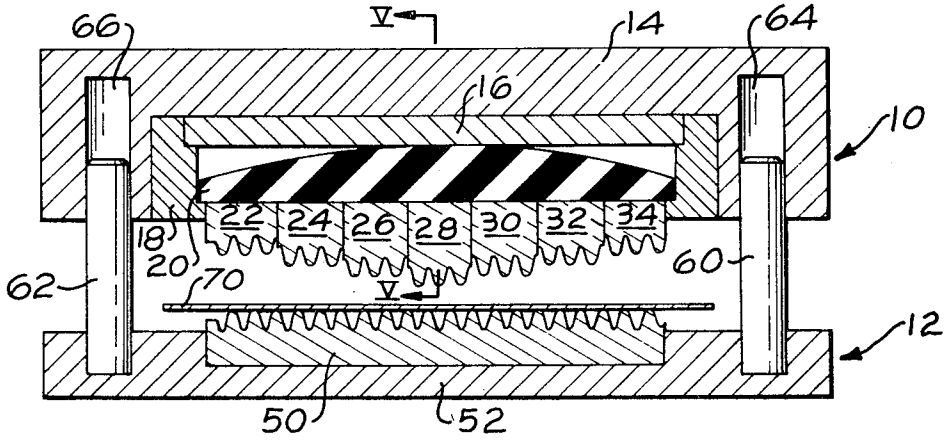

Fig. 2

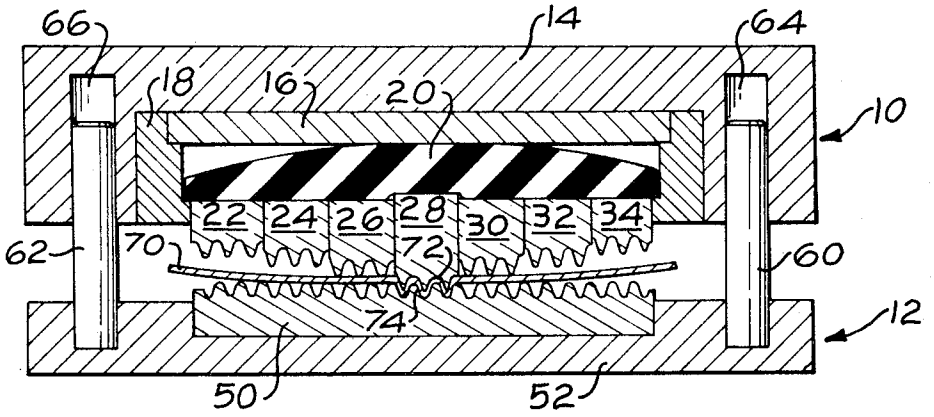

Fig. 3

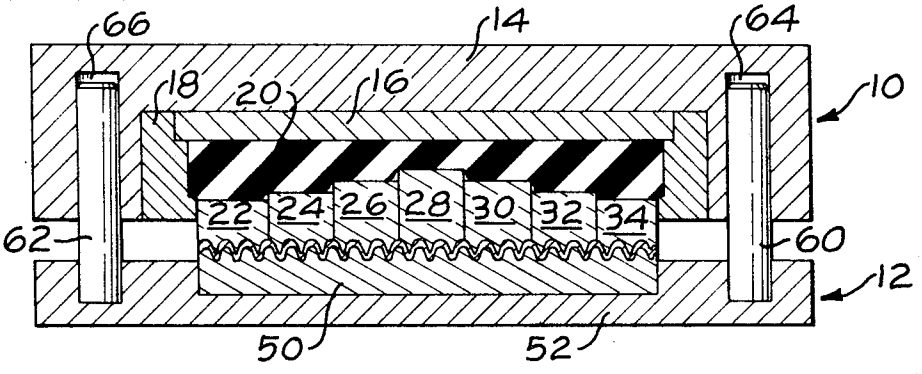

Fig. 4

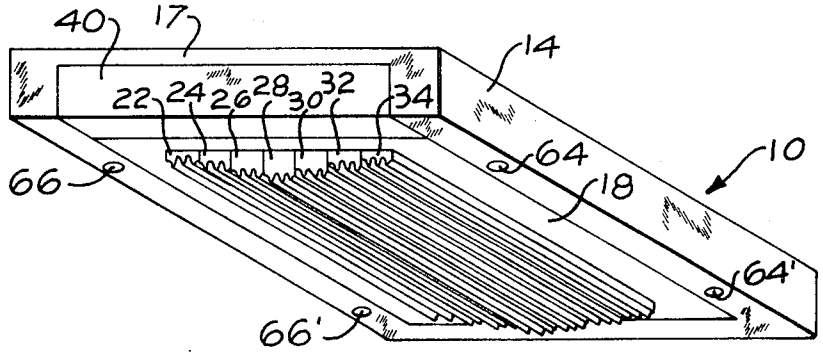
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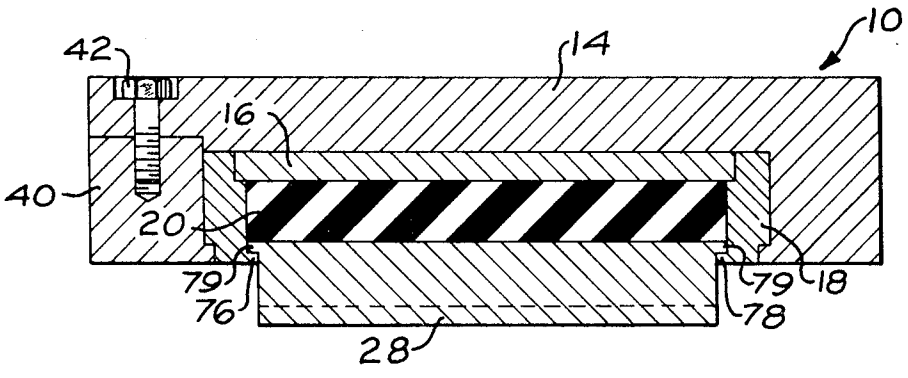
Fig. 5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APPARATUS FOR DEFORMING SHEET MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to a die assembly and method for deforming sheet material.

Conventional sheet deforming systems employ two mating die members which shape sheet material which is placed between them by uniformly stretching the material to fit a given pattern when the dies are brought together. The entire workpiece is treated at one time and deformation occurs substantially simultaneously in all areas of the workpiece. The maximum deformation permitted by such conventional arrangements is limited by the tensile properties of the material being shaped. A very thin workpiece such as a stainless steel sheet having a thickness of approximately 0.003 inches will frequently tear when subjected to a strain of approximately 25 percent with conventional corrugated die shapes. As the desired amount of deformation increases, the tendency to tear increases. This is due to the appearance of high strain areas occasioned by a lack of uniformity in the material stretching process. Material is not permitted, by such conventional means, to gather at each point of deformation to provide a uniform distribution of pressure and strain throughout the area of the workpiece which is deformed.

OBJECTS OF THE INVENTION

An object of this invention is to overcome the above briefly described problems while providing a method for deforming a sheet material workpiece to a degree not permitted by conventional die press processes.

Another object is to provide a die assembly which will permit material to be gathered during the deformation process to reduce the amount of strain required to obtain a given desired shape.

Another object of the present invention is to provide a die assembly which is capable of progressively deforming a sheet material workpiece in a manner which minimizes the reduction in material thickness required for the deformation to assure a more uniform stress profile in the shaped workpiece.

Other objects and advantages of the present invention will become readily apparent upon reference to the accompanying drawings and following description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional elevational view of the segmented die assembly of the present invention in its open position;

FIG. 2 is a sectional view showing the assembly in a partially closed orientation;

FIG. 3 is a sectional view which shows the disposition of elements when the assembly is completely closed;

FIG. 4 is an isometric view of the upper die assemblage; and

FIG. 5 is a sectional view, taken along the line V—V of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIGS. 1–3, the present apparatus is shown in each of a plurality of operative positions. An upper die assemblage is shown generally at 10 disposed in a position which is vertically above a planar lower die assemblage shown generally at 12. The upper assemblage includes a segmented portion which provides a collapsible die half. An upper frame member 14 is provided as is a plate member 16, a holder member 18, a contoured resilient pad member 20 formed of a relatively dense elastic material such as neoprene rubber or the like, and longitudinally-oriented individual die segments 22 through 34. As shown, the segments diminish in height symmetrically outwardly from the center member 28.

With reference to FIGS. 4 and 5, the manner in which the apparatus is assembled will be described. Holder member 18, having ledge portions 76 and 78, supports the individual die segments 22 through 34, resilient pad member 20, and plate member 16. Each die segment has flange portions 79 which engage said ledge portions. This subassembly is inserted into an open end 17 of the upper frame member 14, and an end cap member 40 is positioned and secured as shown by fastening means such as bolt 42, or the like.

The present die assemblages are designed for use in conjunction with conventional press equipment. In some cases, the upper die assemblage 10 may be substituted for a conventional upper die platen and this would be the only change required for the conversion of a typical hydraulic or mechanical press into one which could be used for forming sheet material in accordance with the subject invention. Furthermore, since the sheet material workpiece is deformed by the present system in a single strike operation, the economical production rates of conventional press methods are maintained.

Referring once again to FIGS. 1–3, it will be noted that the lower die assemblage 12 contains a die platen 50 which is fixed within a lower frame member 52. Guide pins 60 and 62, secured to the lower frame member 52, engage guide pin bores 64 and 66, respectively, within the upper die assemblage 10. While only two guide pins and two bores are shown in FIGS. 1–3, additional pins and bores, such as bores 64′ and 66′ shown in FIG. 4, may be required to effectively guide the upper and lower die assemblages during the forming operation.

The operation of the present apparatus and the method performed thereby will now be described.

FIGS. 1–3 respectively illustrate three progressive positions taken by the die assemblages during the deforming process. The relative lateral disposition of the assemblages will be maintained during all phases of the operation by means of close sliding tolerances between the guide pins 60 and 62 and their respective bores 64 and 66.

The position of the apparatus during the first step of a typical cycle is shown in FIG. 1. A sheet of material comprising a workpiece 70 is inserted between the upper and lower die assemblages. The centermost die segment 28 is higher or larger than the adjacent segments 26 and 30. It should also be noted that segments 26 and 30 are larger than the die segments 24 and 32, which, in turn, are also larger than outermost segments 22 and 34. With the die segments arranged in this manner, the center die segment 28 will contact the workpiece 70 first and will deform a central section of the workpiece between the mating pattern 72 of segment 28 and the pattern 74 of the related area of die platen 50, as shown in FIG. 2. Because the die segment 28 is larger than the adjacent die segments 26 and 30 and because its vertical displacement is inhibited by the loading afforded by the resilient pad member 20, the work-

piece central portion is substantially deformed before the adjacent segments **26** and **30** engage the workpiece. As a result, the sheet material has the opportunity to gather or to be drawn inwardly toward the center of the workpiece after the initial deformation. The amount of material stretch or the incremental strain which is required to complete the total deformation is thereby reduced. In a similar manner, die segments **26** and **30** will have completed the deformation of the material between these segments and the bottom die platen prior to the engagement of the material by the die segments **24** and **32.** The material deformation process continues in this manner as the two die assemblages are brought together and sequential deformation steps which permit the material to progressively gather are performed on the workpiece during a single strike operation. As each die segment engages the workpiece and is vertically displaced relative to the other segments, the resilient pad member **20** will be displaced porportionally in the area of the given die segment. As indicated in FIG. **3,** at the completion of the engagement stroke, resilient pad member **20** will have been compressed and deformed, and will have virtually filled the cavity provided therefor. The pad member, during the deformation stroke, will have exerted a substantially equal load upon all of the die segments.

Thus, the sequential deforming function provided by the progressive action of the individual die segments permits a workpiece sheet to gather as it is being deformed or stretched, while the continuous displacement and compression of the resilient pad member assures uniform loading on each of the die segments and a more consistent thickness in the pattern formed in the workpiece.

The particular die segment and mating platen surface patterns shown in the drawings are somewhat exaggerated for illustrative purposes. Also, while for the sake of simplicity and clarity only seven individual die segments have been shown, it should be noted that normally a greater number of die segments would be employed in the apparatus. The precise number is dependent upon the size of the workpiece to be fabricated, the physical properties of the material to be worked, and the degree of deformation.

If a corrugated sheet workpiece having very high ridges relative to ridge width were desired, it would be appropriate to use die segments having only one or two corrugations per segment instead of three corrugations as shown in the drawings. Furthermore, if die segments having only a single ridge are used, the material would be thereby subjected to low tensile forces during the deformation process and this would result in the formation of a plate structure caused mainly by the folding and subsequent gathering of material rather than the stretching and gathering thereof.

In view of the foregoing, it is readily apparent that the apparatus of the present invention provides not only a new structure, but also a means to perform an improved method for deforming sheet material. The instant die assembly and method permit the workpiece material to gather during the deformation operation.

While the invention has been described and shown with particular reference to the preferred embodiment, it will be apparent that variations and modifications are possible within the spirit of the inventive concepts and we do not intend to be limited, except by the scope of the appended claims.

We claim:

1. A die assembly for deforming a workpiece of sheet material comprising;

a planar die member,

a plurality of collapsible crown-shaped die members disposed for relative movement toward and away from said planar die member,

resilient means associated with said plurality of collapsible crown-shaped die members for progressively loading said plurality of collapsible crowned die members to deform said workpiece outwardly from its central portion as said planar die member and said plurality of collapsible crowned die members are moved together, said plurality of crown-shaped die members being arranged for relative movement and diminishing symetrically in size transversely outwardly from the centermost member.

2. The invention of claim **1** wherein said plurality of collapsible crowned die members are mounted in frame means for supporting said members and said resilient means.

3. The invention of claim **1** wherein said resilient means is a pad member fabricated from relatively dense elastic material.

4. The invention of claim **3** wherein said pad member has four edge surfaces and two other surfaces and wherein at least one of said surfaces is contoured.

5. The invention of claim **2** wherein said frame means include at least one member having a flange formed thereon and wherein each of said collapsible crowned die members has a flanged portion which cooperates with said flange of said frame means to retain said members within said frame means and to limit movement of said members toward said planar die member relative to said frame means.

6. The invention of claim **2** wherein said frame means include a rigid plate member and wherein said resilient means is disposed in said frame means between said plate member and said plurality of crown-shaped die members.

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