United States Patent

Hoffman

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[45] **Aug. 22, 1972**

[54] **HEM FORMATION**

[72] Inventor: **Bernard L. Hoffman,** Trenton, N.J.

[73] Assignee: **Frederick A. Krause Associates, Inc.,** Frenchtown, N.J.

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[52] **U.S. Cl.** .....**72/348,** 113/120 AA

[51] **Int. Cl.** **B21d 19/12**

[58] **Field of Search**.....72/348; 113/1 F, 120 C, 120 AA; 220/74

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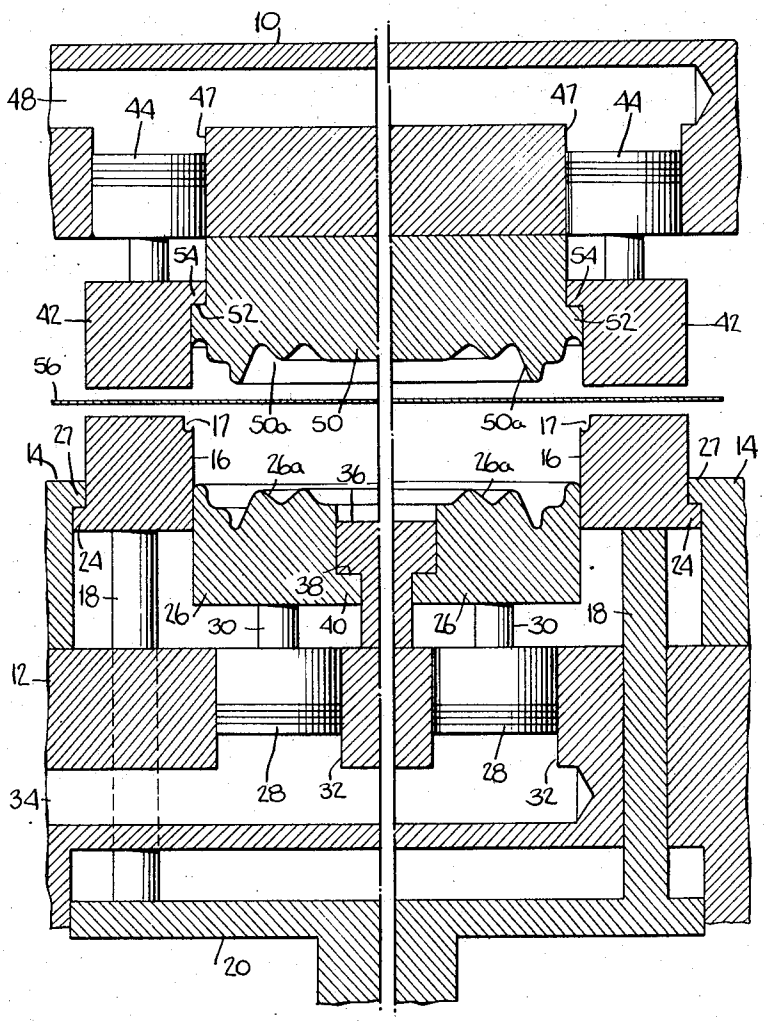
Primary Examiner—Richard J. Herbst

Attorney—Ward, McElhannon, Brooks & Fitzpatrick

[57] **ABSTRACT**

Hems are formed on the edges of sheet metal objects by forcing the edge of the objects against a concavely curved forming element. This is done in a press which applies force in the plane of the sheet metal while supporting its sides against buckling.

6 Claims, 8 Drawing Figures



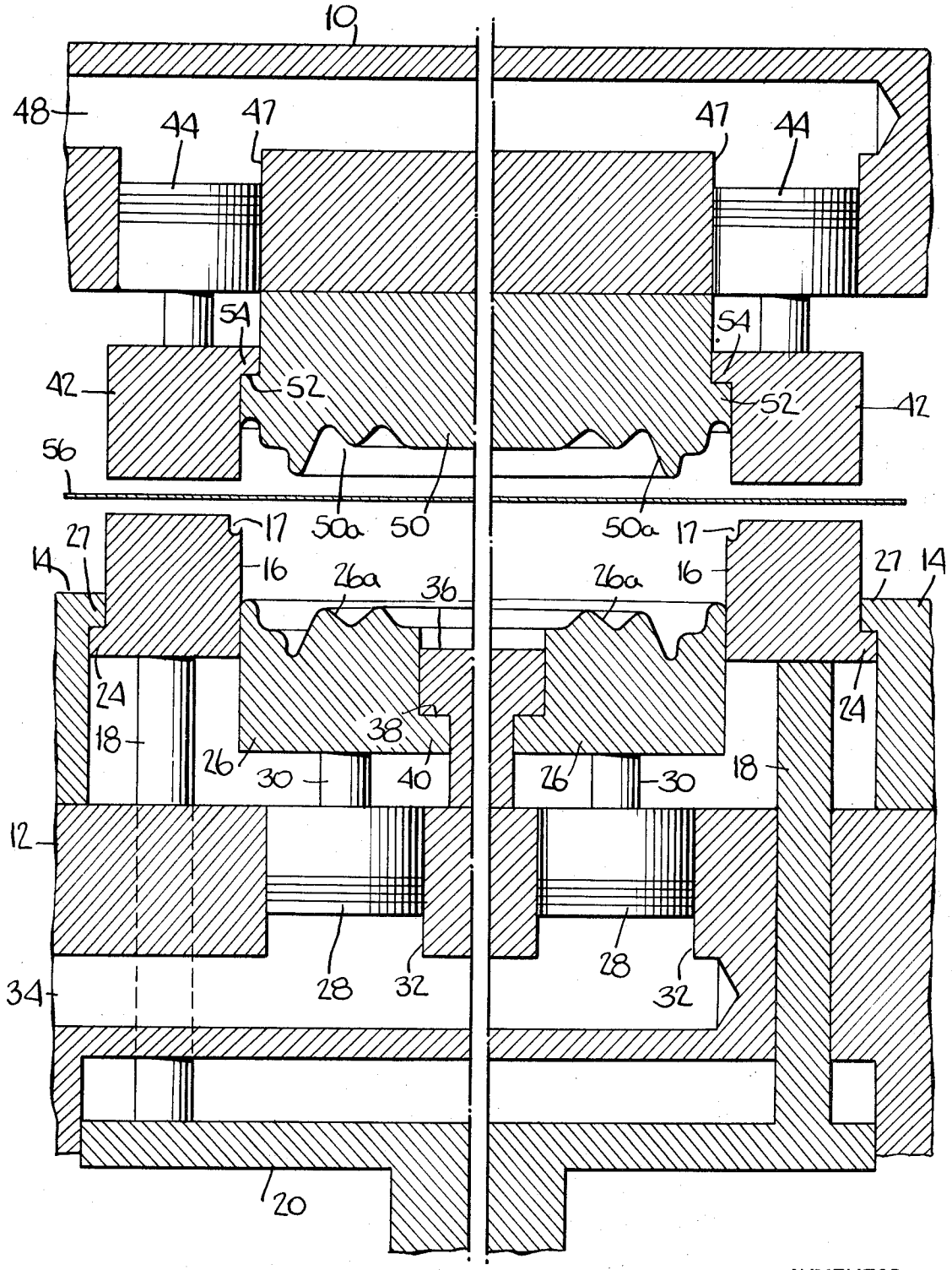


Fig. 1.

INVENTOR.
BERNARD L. HOFFMAN

BY

Ward McElhannon Brooks & Fitzpatrick
ATTORNEY

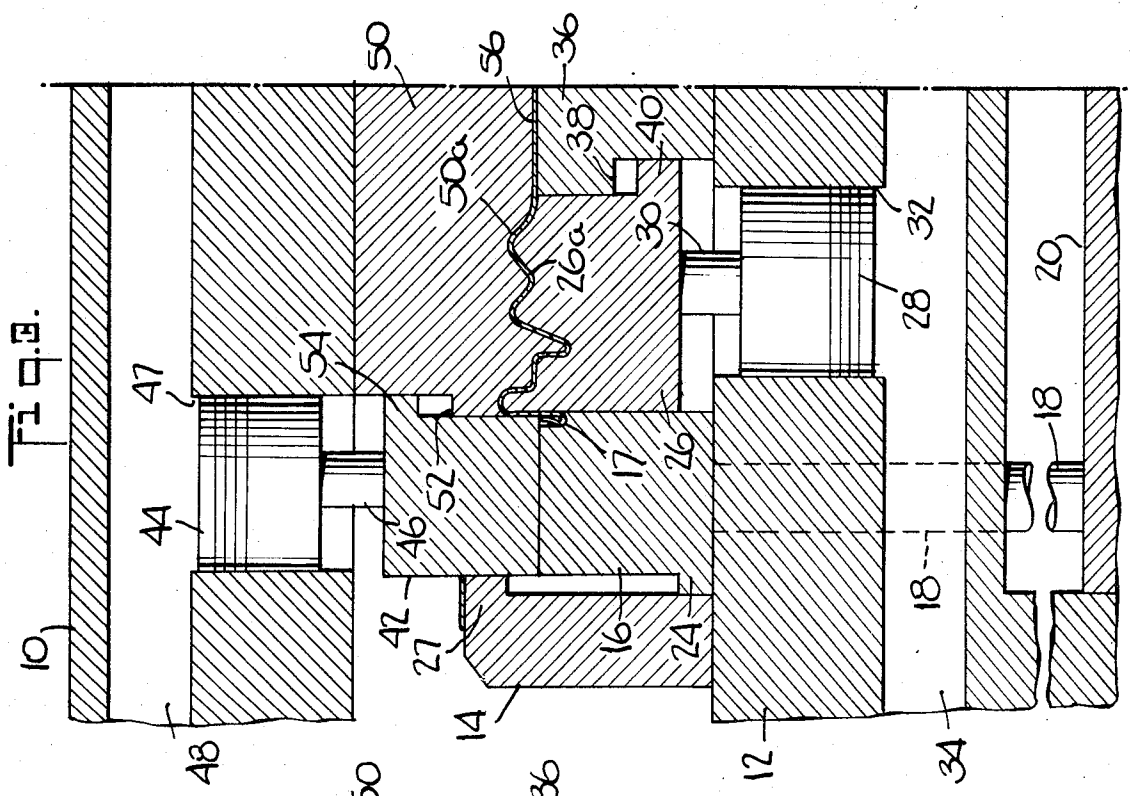


Fig. 3.

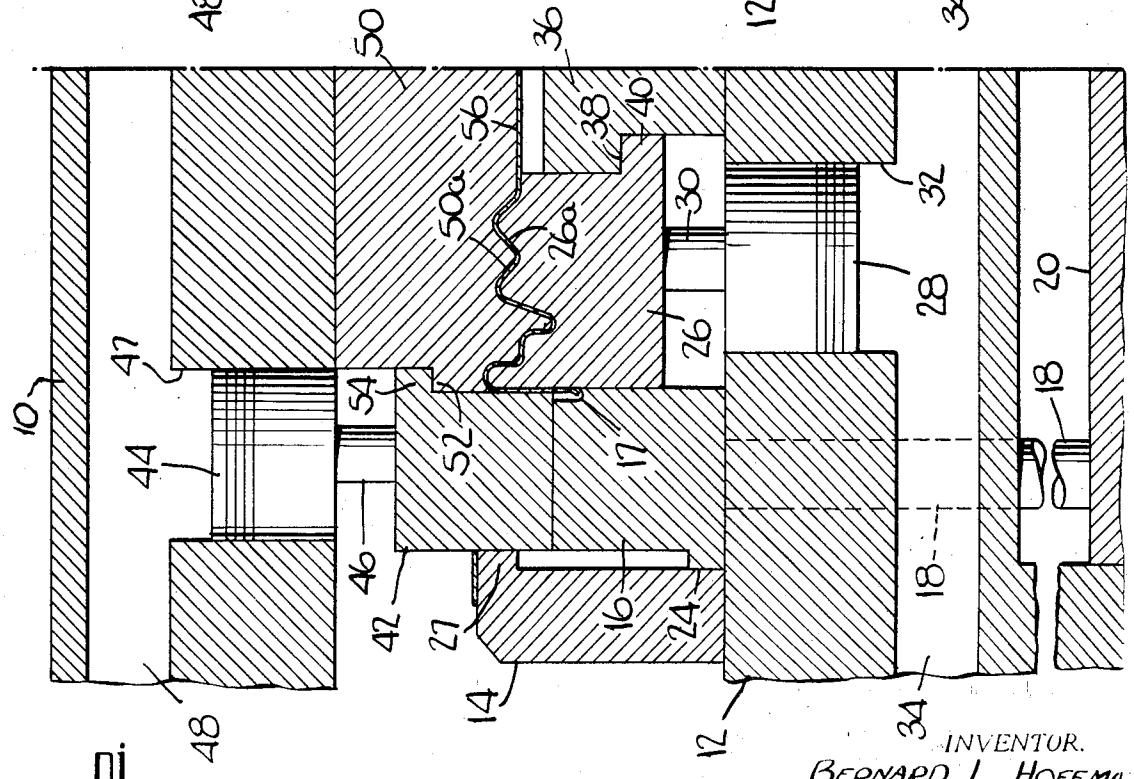


Fig. 2.

INVENTOR.
BERNARD L. HOFFMA

BY

ATTORNEYS

Fig. 4.

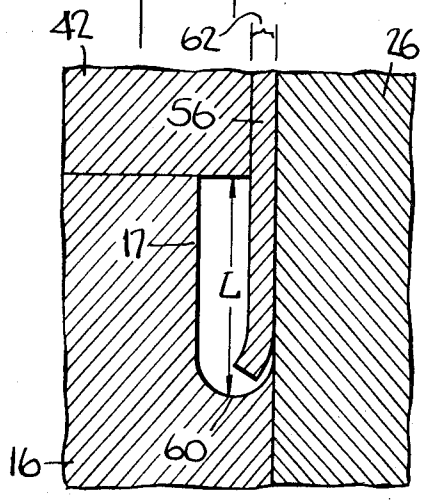


Fig. 5.

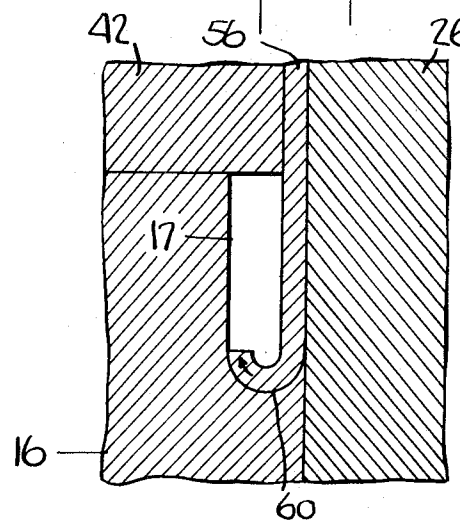


Fig. 6.

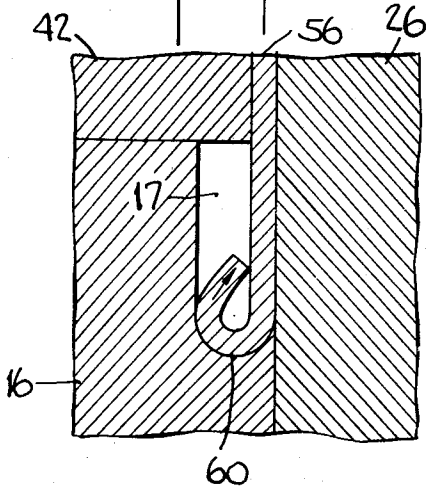


Fig. 7.

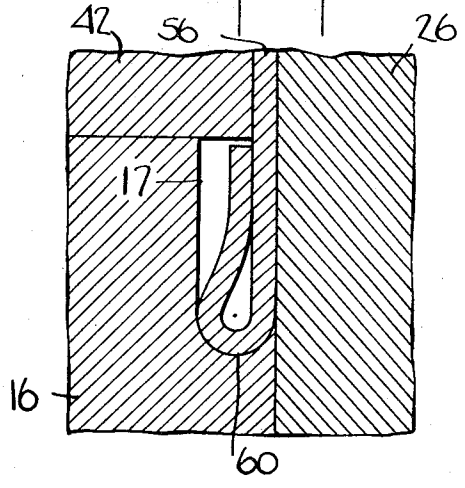
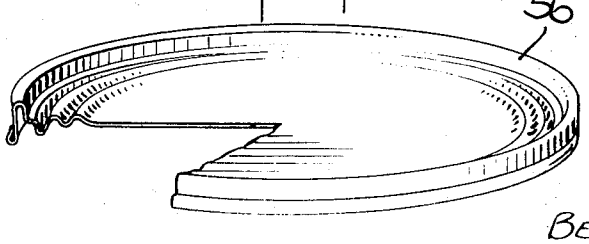


Fig. 8.



INVENTOR.
BERNARD L. HOFFMAN

BY

Wood McCammon Brooks & Litzenberg
ATTORNEY.

HEM FORMATION

This invention relates to metal forming and more particularly it concerns the provision of hemmed edges on sheet metal objects.

The present invention is particularly useful in connection with metal stamping and drawing operations which form various shaped objects from sheet metal blanks. In many cases, the objects produced by stamping or drawing have a raw edge which, if left exposed, is weak and unsightly, and often dangerous. For certain applications, the edge may be curled around; and special curling dies may be provided for this, either in combination with the stamping or drawing press or in a separate curl forming machine. In certain other applications, however, a curled edge is not desirable for it may interfere with other portions of the drawn object or the assembly incorporating the drawn object. In the case of drum covers, for example, some edge reinforcing must be provided; and yet, in order to conform properly to the outer lip of the drum to which they are fitted, the peripheral edges of these drum covers must be essentially flat. In such cases a hem or folded back edge formation should be provided.

Prior hem forming techniques have involved a two step process where a first right angled bend was made near the edge of the drawn object, thus forming an outwardly extending flange. The flange was thereafter bent all the way back against the adjacent surface of the object to complete the hem formation. This general approach to hem formation has not been entirely satisfactory, for it was not possible to insure that the folded back flange would lie fully up against the side of the object. Also, in the case of curved objects, such as cans or lids, the first outward bend, which forms the flange, caused undue stretching of the metal. Also, these prior hemming techniques required a plurality of separate operations which could not readily be integrated with the stamping or drawing operation which formed the object itself.

The present invention avoids all of the above difficulties. According to the present invention, it is possible to provide a fully formed hem along the edge of a sheet metal object with a minimum of difficulty and expense, and with less chance of metal fracturing than has heretofore been possible. This hem moreover, may be produced with the very machinery which forms the stamped or drawn object and it may be produced along with the object in a single integrated operation.

The hemming of sheet metal objects is produced, according to the present invention, by pushing back with a concavely curved surface on the edge of the metal in the direction of the plane of the metal. This causes the metal edge to bend back around, following the contour of the curved surface to form a U-shaped configuration in a manner somewhat similar to the manner in which edge curling is obtained. According to the present invention however, the radius of the reverse bend is maintained at a value far smaller than the minimum radius at which curling may be carried out. It has been found that by using such a small radius, the metal edge does not merely butt up against the metal surface, as it does in curling when the curl radius becomes too small. Instead the metal edge actually moves back along the surface of the metal away from the bend. The bent back portion of the hem is thus urged to lie flat back against the surface of the object. Further, the metal,

though worked over a greater extent of its area, is not worked as severely as in prior hemming techniques wherein a flange is formed whose outer edge is stretched, often to the point of tearing.

The present invention involves the provision of means including a contoured forming surface which is movable in a given direction, and means laterally supporting a sheet metal object so that its surfaces lie substantially in the plane of movement of the forming surface. The radius of curvature of the forming surface is about one and one half times the thickness of material which may be accommodated in the lateral support means. This ratio of metal thickness to radius of bend ensures that the bent back material will proceed back along and against the adjacent metal as the hem is widened; and yet it does not overpower the column strength of the metal except in the region of the bend.

In one of its aspects the subject invention involves the provision of hem forming means in conjunction with drawing or stamping machinery in such manner as to permit the hem to be formed in conjunction with the drawing or stamping operation. At the same time, the hem formation is undertaken with the forming elements subject to the direct action of the die shoes of the forming press, and not subject to the hydraulic action of die cushions. This is achieved by providing the various die elements in such an arrangement that the object being drawn is drawn over the lateral surface of a die element which is projected upwardly but which is retractable under high press closing forces. A die element having a concave hem forming surface is mounted securely on the same die shoe as the retractable die element and immediately adjacent thereto. As the die shoes continue to come together the drawn object, together with the retractable die element, is forced down against the forming surface of the fixed die element. This permits the hem to be formed under the full force of the die shoes.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes of the invention. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the spirit and scope of the invention.

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings, forming a part of the specification, wherein;

FIG. 1 is a side elevational view taken in section and partially cut away illustrating drawing and hem forming machinery according to the present invention in its condition set to begin drawing an object from a sheet metal blank;

FIG. 2 is a view showing a typical portion of the machinery of FIG. 1, in its condition after drawing an object and before producing a hem thereon;

FIG. 3 is a view similar to FIG. 2 showing the machinery in its condition after forming a hem on the drawn object; hem

FIGS. 4–7 are enlarged fragmentary view showing, sequentially, the action of the hem forming elements of the machinery of FIG. 1; and

FIG. 8 is a perspective view, partially cut away, of an object drawn and hemmed by machinery according to FIG. 1.

The drawing and hem forming machinery of FIG. 1, includes a pair of upper and lower die shoes **10** and **12** which are adapted to be moved vertically toward and away from each other between closed and opened positions by external means (not shown) such as a punch press. A plurality of forming elements are mounted on each die shoe. Certain of these elements are reciprocally movable with respect to their associated die shoe by means of various piston and cylinder arrangements to be described.

The lower die shoe **12** is provided with an external annularly shaped shear block **14** which is solidly affixed to the upper surface of the shoe. Immediately inside the shear block **14**, there is provided a lower clamp ring **16** which is mounted by means of various push rods **18** to a common yoke **20** located under the lower die shoe **12**. The common yoke **20** is subjected to hydraulic pressure from external means (not shown) which biases it upwardly toward a protracted position as shown in FIG. 1. The shear block **14** is provided with an inwardly extending shoulder **27** which intercepts a corresponding outwardly extending shoulder **24** on the lower clamp ring **16** and thus serves to limit the uppermost or protracted position of the ring **16**. The inside upper corner of the lower clamp ring **16** is grooved to provide a hem forming recess **17** which extends about the entire circumference of the ring.

A lower contour ring **26** is provided immediately inside the lower clamp ring **16**. The lower contour ring **26** is also reciprocally movable on the lower die shoe between an uppermost protracted position as shown, and lower retracted position. The lower contour ring **26** is biased upwardly by the action of lower contour ring pistons **28** which act through push rods **30**. The pistons **28** fit into piston bores **32** in the lower die shoe **12**; and these bores communicate via passageways **34** to an external hydraulic pressure source, not shown. The external pressure source maintains substantially constant hydraulic pressure upon the pistons **28** and thus maintains the lower contour ring **26** biased toward an uppermost position as shown in FIG. 1. The lower contour ring is formed with corrugations **26***a* on its upper surface for shaping an object being drawn.

There is additionally provided a central mandrel **36** which is permanently affixed to the lower die shoe **12**. The central mandrel **36** is formed with an outwardly protruding shoulder **38** which engages a corresponding shoulder **40** on the lower contour ring **26** and thus limits its uppermost position as indicated in FIG. 1.

The upper die shoe **10** is provided with an upper clamp ring **42** in alignment with the lower clamp ring **16**. The upper clamp ring **42** is reciprocally movable in a vertical direction with respect to the upper die shoe **10** and is urged to a downward or protracted position by means of upper clamp ring pistons **44** which operate through push rods **46** on the upper clamp ring **42**. The upper clamp ring pistons **44** move up and down within piston bores **47** forming in the upper die shoe **10** and these piston bores in turn are connected via a hydraulic passageway **48** to an external source of constant hydraulic pressure (not shown).

A circular upper mandrel **50** is affixed to the upper die shoe **10** in alignment with the lower contour ring **26** and the lower mandrel **36** on the lower die shoe **12**. The upper mandrel **50** is formed with corrugations **50***a* on its lower surface which coincide with, and cooperate with the corrugations **26***a* on the lower contour ring **26** in the formation of a drawn object. An outwardly protruding shoulder **52** extends circumferentially about the upper mandrel **50** and engages corresponding inwardly extending shoulders **54** on the upper clamp ring **42** thus limiting the lowermost or protracted position of the clamp ring as shown in FIG. 1.

The arrangement thus far described serves to press down upon and form a sheet metal blank **56**. The sequence of this forming operation and the interaction of the cooperating contours of the various forming elements can be seen in FIGS. 1, 2 and 3 which show respectively the above described arrangement in different portions of the drawing and hem forming cycle.

Operation of the device begins by closing or bringing together of the upper and lower die shoes **10** and **12**. This initially causes the upper clamp ring **42** to press down upon the metal blank **56** and squeeze an annularly shaped region thereof between the facing surfaces of the upper and lower clamp rings **42** and **16**. The hydraulic arrangements for urging the upper and lower clamp rings toward their protracted positions shown in FIG. 1, are such that the closing of the die shoes first overpowers the force of the common yoke **20** so that the lower clamp ring **16** becomes retracted while the upper clamp ring **42** remains protracted. As a result, the blank **56** is carried downwardly toward the shear block **14** and eventually becomes sheared between the upper surface of the block **14** and the outermost corner of the upper clamp ring **42**, as shown in FIG. 2.

As the die shoes **10** and **12** continue to move toward each other under the influence of the not shown die punch apparatus, the blank **56** is drawn out from between the clamp rings **42** and **16** and down over the outside of the lower contour ring **26**. At the same time, the corrugations **26***a* and **50***a* in the mutually facing surfaces respectively of the lower contour ring **26** and upper mandrel **50** come together over the blank **56** and shape its outer regions as shown in FIG. 8. The action of the upper and lower clamp rings **42** and **16** in squeezing the blank **56** during the drawing operation maintains the outer regions of the blank in flattened condition. This prevents wrinkling of the blank and thus insures a proper and even consistency in the finished drawn piece.

The drawing and corrugating action continues until the various die elements assume the arrangement shown in FIG. 2, with the lower clamp ring **16** fully retracted and bottomed against the lower die shoe **12**. With the various elements in this position, the drawn blank **56** is fully formed except for its hem. The outer edge of the blank, which was sheared between the shear block **14** and the upper clamp ring **42** extends into the hem forming recess **17** in the lower clamp ring **16**. As shown, there exists a slight outward flare on the

edge of the drawn blank. This slight flare occurs as a result of the fact that the edge of the blank comes out from between the facing surfaces of the clamp rings and into the recess **17** ahead of the inner corner of the upper clamp ring **42** over which the drawing takes place.

As the die shoes **10** and **12** continue to move toward each other to form the hem, the upper clamp ring **42** and the lower contour ring **26** become retracted into their respective die shoes **10** and **12** against the hydraulic bias urging them outwardly. The drawn blank is now clamped between the upper mandrel **50** and the lower contour ring **26** and it moves downwardly with these elements toward the lower die shoe **12** and against the lower clamp ring **16** which abuts against the shoe **12**.

The lower edge of the blank is brought to bear against the lower surface of the recess **17** during this final closing action and it becomes bent around and back up against itself to form the finished hem as shown in FIG. **3**. The die shoes **10** and **12** are thereafter opened, and the protraction of the lower clamp ring **16** urges the finished hemmed object out of the device.

Turning now to FIGS. **4–7**, it will be seen that the recess **17** formed in the lower clamp ring **16** is actually an elongated groove with a concavely curved lower forming surface **60**. The vertical length of the groove is indicated by the distance L which is actually twice the finished hem width. There is provided a lateral space **62** between the mutually facing lateral surfaces of the upper clamp ring **42** and the lower contour ring **26**. This, as shown in FIG. **4**, permits accommodation of the drawn metal blank **56**. The radius of curvature of the lower forming surface **60** is chosen to be approximately one and one half times the lateral space **62**.

As can be seen in FIG. **4**, the facing surfaces of the upper clamp ring **42** and the lower contour ring **26** provide lateral support over at least a portion of the blank **56** as it is forced down against the concavely curved lower forming surface **60**.

The lower edge of the blank engages the forming surface **60** during the last phase of the forming operation and the vertically directed forces in the plane of the drawn blank cause its lower edge to bear down upon and follow around the lower forming surface so that it begins to curb around as shown in FIGS. **5** and **6**. Because of the very small ratio of forming surface curvature radius to blank thickness, the blank will become more bent back than curled; and accordingly, its bent back edge approaches the adjacent lateral surface in a direction pointing away from the bend as shown in FIG. **6**. Continued closure of the die shoes cause the blank edge to follow the adjacent surface, moving upwardly away from the bend until it finally assumes a finished hem configuration as illustrated in FIG. **7**.

It will be noted that the entire region of the bent back portion of the hem becomes worked, i.e., bent and then unbent, in carrying out a hem forming operation according to the present invention. Although more extensive working is thus produced there is actually less intensive or concentrated working that is produced with conventional techniques where a flange is formed and then bent back. The hem producing technique of the present invention moreover, is more easily carried out and may readily be integrated with standard drawing machinery.

Although a particular embodiment of the invention is herein disclosed for purposes of explanation, further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A method of forming a hem along an edge of a sheet metal object, said hem comprising a flange lying against the adjacent metal of the object, said method comprising the steps of bending said edge back against said object by pressing against said edge in the plane of the region of said object adjacent said edge with a concavely curved forming element having a radius of curvature approximately one and one half times the thickness of the metal which forms said edge, and continuing to press with said element against the bend thus formed by an amount sufficient to force said edge back along said object away from said bend, with the edge pointing away from the bend.

2. A method of forming a hem along the edge of a sheet metal object, said hem comprising a flange lying against the adjacent sheet metal of the object, said method comprising the steps of first forming a U-shaped bend in said metal object at a location close to its said edge whereby the edge is bent back against the adjacent metal, said U-shaped bend being formed to a major radius of approximately one and one half times the sheet metal thickness and then applying sufficient force against the base of said U-shaped bend to drive said edge back along said adjacent metal away from said bend, with said edge pointing away from said bend.

3. A method as in claim **2** wherein the force applied to said base is countered by an opposing force in the leg of said U-shaped bend away from said edge.

4. A method as in claim **3** wherein said leg away from said U-shaped bend is laterally supported.

5. Apparatus for forming a hem along the edge of a sheet metal object, said apparatus comprising, means for supporting a sheet metal object in a manner such that the metal adjacent its edge lies in a fixed plane, said supporting means comprising a first support element having a supporting surface which lies in a first fixed plane and a second support element having a supporting surface which lies in a second fixed plane parallel to but displaced from said first fixed plane to accommodate the metal of said object, a hem forming element having a concavely curved forming surface and means operative to move said forming element along one of said fixed planes such that its said forming surface initially engages the edge a sheet metal object supported by said supporting means, the radius of curvature of said forming surface being about one and one half times the thickness between said first and second fixed planes to cause the edge of such sheet metal object to be bent back against the adjacent metal surface and, when so bent back, to face away from the bend thus formed, whereby continued movement of said forming element will produce a longer hem by urging said edge further back from the bend so formed.

6. Apparatus as in claim **5** wherein said supporting means comprises a die press assembly for forming said object from flat sheet metal stock, said die press as-

sembly including a pair of openable and closeable die shoes and pressure projectable and retractable forming elements on said shoes, means connecting said hem forming element to one of said die shoes, a lateral supporting element immediately adjacent said forming element and means mounting said lateral supporting element for projection up from said one die shoe during the formation of an object by said assembly and for retraction following such formation upon further closing of said die shoes while said hem forming element is under the direct action of said one die shoe whereby the forces applied to said object during the hem forming operation are applied directly through said die shoes.

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