May 3, 1955 B. GERSHON 2,707,510

METHOD AND APPARATUS FOR FORMING FOLDED EDGES

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FIG. 2

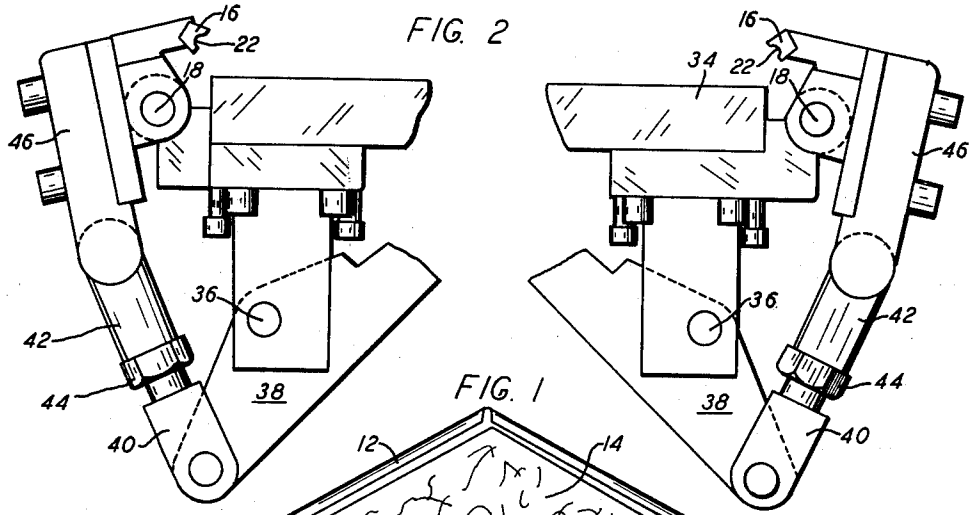


FIG. 1

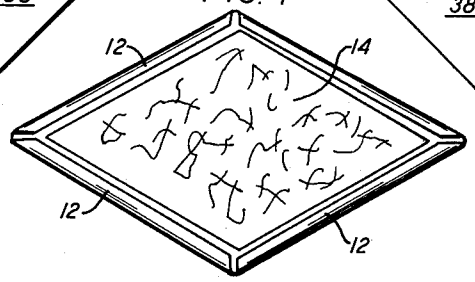


FIG. 3

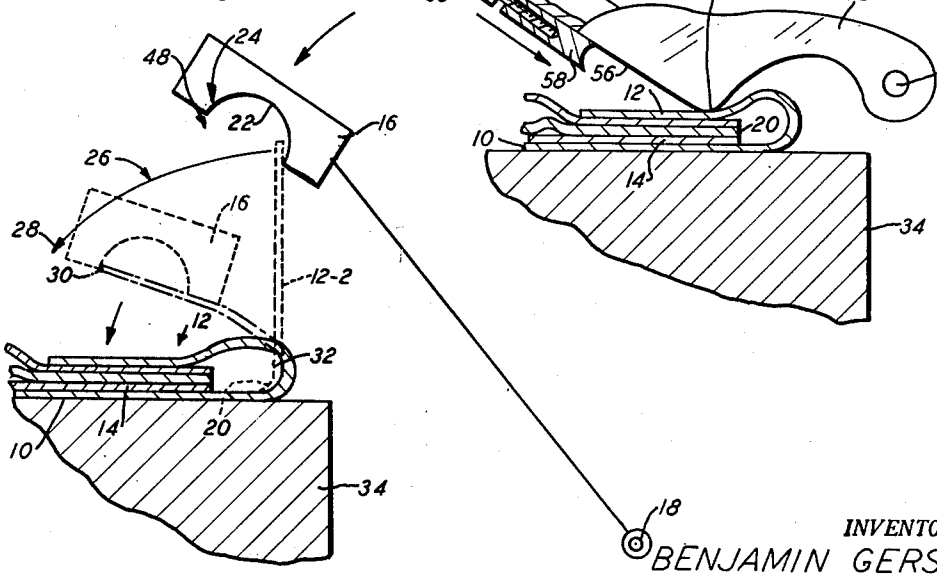


FIG. 4

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METHOD AND APPARATUS FOR FORMING FOLDED EDGES

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14 Claims. (Cl. 153—15)

My invention relates to manufactured articles, including parts made of sheet metal, and includes among its objects and advantages a rounded edge of large curvature, and a cheap and expeditious means for forming the same without the use of special dies for each shape produced. It is particularly advantageous in connection with the manufacture of stove mats of the type disclosed in my prior U. S. Patent 2,474,102, issued June 21, 1949.

In the accompanying drawing:

Figure 1 is a perspective of a stove mat;

Figure 2 is a side view of one type of forming mechanism;

Figure 3 is a greatly enlarged partial view, partly in section, of the relative movement of the parts of Figure 2, during the forming operation; and

Figure 4 is a similar view of an alternative process and apparatus.

Many sheet metal articles can advantageously be fabricated from sheet metal of good quality, having a thickness of the order of magnitude of thirteen thousandths of an inch, but when such articles present the edge of a metal plate, a cut edge is almost as bad as a knife edge, so far as handling it is concerned, and rolling the edge to present a peripheral shape that can readily be grasped by the hand is practically necessary. The mere folding of such a piece of metal, much as one folds a piece of paper, can be practiced, but it is likely to leave an edge configuration with a radius of curvature not much more than the thickness of the metal. Thus, a sheet thirteen thousandths of an inch thick would be likely to present an edge twenty-six thousandths of an inch thick, with a radius of curvature of only thirteen thousandths, and such an edge is still too thin to be engaged comfortably with the fingers or palm of the hand. To produce a rounded edge with a radius of curvature from two to five times as great is difficult without affording guidance to the metal by means of forming dies. Forming dies of the size and shape required are difficult to manufacture and expensive to maintain.

Referring to the drawings, the pad of Figure 1 is a rectangular plate of sheet metal, plane before fabrication and substantially plane after fabrication. The four edges **12** are folded in according to the invention, and in the embodiment disclosed they clamp and compress the filler **14** of asbestos fiber or the like. In manufacture, the pad **10** has its edges turned up, as indicated in the dotted-line position **12–2** of Figure 3. Then the pad **14** is laid on the body, and a forming tool **16** moves down in an arc about a center at **18** until the flap is forced into the full-line position and downwardly beyond the full-line position by about the thickness of the metal. Upon withdrawal of the forming tool the resilience of the parts returns them to the full-line position of Figure 3.

The bending of the edge up to the position **12–2** can be accomplished readily in a number of ways and most simply in an ordinary brake. This leaves the metal with an arcuate portion at **20** subtending an angle of ninety degrees. In the embodiment illustrated in Figures 2 and 3, the tool **16** has a semicircular groove **22** in its lower face. The right side of the groove makes the initial contact with the flange in the position **12–2**, but because the center **18** is located much further from the edge of the flap than the hinge formed by the arcuate portion **20**, the edge of the flap moves across the arcuate groove rapidly.

The tool **16** moves in a path with a radius of curvature more than twice the width of the flap, while the edge of the flap tends to move in a path with a radius of curvature substantially equal to the width of the flap, but the flap edge is compelled to deviate from that path during an intermediate portion of the folding movement.

As soon as the tool is about half way between the two positions indicated in Figure 3, the edge of the flap will have come in contact with the bottom of the groove at some such point as **24** on the bottom of the groove, at which time the edge of the flap will be substantially at the point **26** in Figure 3. Thereafter, the edge is unable to continue to move substantially around the center at **20**, and instead of continuing on down to the point **28**, it is forced to follow a path ending at the point **30**.

This thrust against the end of the flap compels the arcuate portion **20** to yield and back away, with the result that the fold in the metal is moved back to the final position indicated in full lines in Figure 3. This returns a little metal to the plane body portion, and the double distortion contributes to the metallurgical hardness of the product at the precise place where wear and abrasion will be greatest in use.

Immediately after passing the point **30** the edge of the flap slips out of the groove and subsequent rotation of the flap will be substantially around the center **32** of Figure 3, with a very slight amount of sliding movement between the flap and the face of the tool **16** nearest the hinge.

In Figure 2 I have indicated suitable mechanism for moving the tool **16**. The relatively fixed platen **34** is rigid with pivots **36** located below each end. Each pivot **36** supports a walking beam **38** pivotally connected at its outer end with a pitman made up of two coaxial parts **40** and **42**, with adjustment means at **44** for making fine adjustments in the length of the pitman. The upper end of the pitman **42** is pivoted to the carriage **46** mounted on the pivot **18** and carrying the tool **16**. Throughout the forming movement, the effective contact portion at the right side of tool **16**, and the effective abutment portion along the left side of the groove **22**, remain parallel to their axis of rotation, which axis is indicated at **18** in Figure 3.

Referring again to Figure 3, it will be apparent that while the edge of the flap moves from the point **26** to the point **30**, there will be a very heavy force tending to move the plate **10** to the right. Any such movement would interfere with the operation and produce a defective shape, and if the folding is for one edge at a time only, there must be effective clamping means to clamp the plate **10** to the platen **34**. However, in the forming of articles where identical opposite edges are formed simultaneously, as indicated in Figure 2, the forces exerted at opposite edges of the sheet are in opposite directions and balance each other so that each folding tool during the folding operation functions also as an anchor, to insure proper functioning of its twin on the other side of the platen.

It will be apparent that with suitable adjustments for the movement of the tools **16** a wide variety of shapes and sizes can be produced with a single set of tools, without any radical or extensive adjustments or rebuilding of the equipment.

An incidental advantage of great commercial importance is that a finished product within a predetermined relatively close tolerance can be produced quickly and expeditiously in large quantities, from original plates in which the tolerance or variation in size between different individual plates is a little more than twice as great as the desired tolerance for the finished product. Thus, referring to Figure 3, if the flap in the position **12–2** were twenty thousandths of an inch higher than shown in the drawing, it would move up nearly half the distance from the position shown in the drawing toward contact with the bottom of the groove **22**, the edge would get into abutment with the groove bottom at some such point as forty-eight and the distance between the centers **20** and **32** would be increased by a trifle less than half the excess metal present at the edge of the flap. Such variations in height would result from bending the flaps up to position **12–2** over a fixed form, so that the centers at **20** are always spaced the same distance, and sheet irregularities result in variations in the height of the flap.

In most manufacturing operations, it is more convenient to form the flaps in an edge brake. Then variations in sheet size result in flaps of constant height with the centers **20** spaced at various distances. Upon reference to Figure 3, it will be apparent that if the center **20** is shifted to the right (oversize plate), the edge will get down considerably below the point **26** before thrust begins, and the back off will be reduced. If the center **20** is shifted to the left, thrust will begin sooner and last longer. Therefore, the equipment secures the same automatic compensation for size variation, for both manufacturing procedures.

It will be apparent that the bending operation shown is in no way limited to one in which there is a filler **14** to be clamped by the flap. It is readily adaptable to any edge conformation in which the finished edge needs to be of relatively large radius, compared with the thickness of the metal.

Referring now to Figure 4, when the number of parts to be produced is so small that the complete adjustment of the complete machine of Figure 2 is not warranted, the same method of forming can be produced with the same platen **34**, by providing a pivot at **50** for a hand actuated shoe **52**. The shoe has a heel at **54** to engage the flap **12** about midway of its length and a flat face carrying a pusher **58** actuated by the screw **60** and handle **62**. With the flap **12** extending vertically up, as in Figure 3, the workman merely swings the shoe far enough to bring the flap down about forty-five degrees. Then he spins the screws **60** until the pusher **58** engages the edge of the flap, and after he feels that contact, he gives the screw **60** a half turn or three-fourths of a turn additional to push the fold back, precisely as in Figure 3. Thereafter, he backs the pusher away and moves the shoe on down to the position illustrated in Figure 4, and the job is done.

After the forming tool **16** passes the dotted line position of Figure 3, the entire forming force is concentrated on the flat face of the tool at the right side of the groove **22**. This portion of the tool performs the final clinching action against the workpiece and limits the inward extent of the curved portion defining the edge bead in the finished product.

The distortion of the edge by folding tends to shorten the metal along the fold. This action need only be a few thousandths of an inch on each of the four sides to cause the central portion of the finished product to buckle a little and snap back and forth like the bottom of an oil can. "Oilcanning" has long been a problem

in the manufacture of such products. Experience shows that the method shown substantially eliminates this tendency to "oilcan." I believe this to be because the complete freedom of the metal near the fold, during the last ninety degrees of folding, allows it to yield longitudinally of the edge, whereas if it were being gripped by a massive forming die, the yielding would be prevented by the die, and removal of the die would let the residual stress oilcan the product.

The increased radius along the edge also improves the appearance and may increase the strength by about one hundred per cent and the stiffness by about three hundred per cent, at the same time that the platen **34** has enough engagement to eliminate camber along the edge.

The automatic compensation is also effective to compensate for deviations from an exactly square shape in the original blank. A blank twenty or thirty thousandths of an inch shorter along one side than along the opposite side will produce a finished product with the discrepancy reduced to less than one half the discrepancy in the original blank.

Others may readily adapt my invention for use under various conditions of service by employing one or more of the novel features disclosed or equivalents thereof.

As at present advised, with respect to the apparent scope of my invention, I desire to claim the following subject matter:

1. A method of reverse folding a sheet metal flap along a substantially straight edge portion of a main body of sheet metal, which comprises: rotating the flap portion to be folded over, more than half way back into parallelism with the undistorted body portion; exerting thrust on the exposed edge of the partially folded flap to force the curved metal adjacent the fold line to take in a little of the flap metal and return a little metal to the plane body portion; and completing the rotation to bring the main flap portion into substantial parallelism with the body portion.

2. A method according to claim 1 in which rotation is continued throughout the period of thrust.

3. A method according to claim 2 in which thrust is generated by forcing the outer edge of the flap to move in a predetermined path inclined in toward the hinge constituted by the curved metal in the partially formed fold.

4. A method of reverse folding sheet metal flaps along substantially straight opposed parallel edge portions of a main body of sheet metal, which comprises: rotating the flap portions to be folded over more than half way back into parallelism with the undistorted body portion; exerting thrust on the exposed edges of the partially folded flaps to force the curved metal adjacent the fold lines to take in a little of the flap metal and return a little metal to the plane body portion; and completing the rotation to bring the main flap portions into substantial parallelism with the body portion, extending toward each other.

5. A method according to claim 4 in which both flaps lie on the same side of the plane of the main body.

6. A method according to claim 5 in which both flaps are folded simultaneously and in synchronism, so that the thrust on each flap is counterbalanced by that on the other flap, and clamping the body is unnecessary.

7. Equipment for folding opposite parallel edges of a sheet metal plate comprising, in combination: platen means for supporting the plate with the edges to be folded turned up substantially ninety degrees from the plane of the plate into flaps both extending in the same direction away from the plane of the plate; contact means guided in a predetermined path for engaging each flap along a line intermediate the fold line and the outer edge of the flap, to push the flap on over into substantial parallelism with the main plate; abutment means for engaging the outer edge of the flap means during the rotational movement of the flap means to thrust said edge toward the fold line and compel the metal at the fold line to yield

and back away; said bending and abutment means being arranged for actuation in synchronism on both flaps, whereby the horizontal component of the abutment forces on each flap is substantially balanced by the horizontal component of the abutment force on the other flap, and clamping the main body is unnecessary.

8. Equipment for folding over the edge of a sheet metal plate comprising, in combination: platen means for supporting the plate with the edge to be folded turned up substantially ninety degrees from the plane of the plate to form a flap; contact means guided in a predetermined path for engaging the flap along a line intermediate the fold line and the outer edge of the flap, to push the flap on over into substantial parallelism with the main plate; and abutment means for engaging the outer edge of the flap means during the rotational movement of the flap means, to thrust said edge toward the fold line and compel the metal at the fold line to yield and back away.

9. Equipment for folding over the edge of a sheet metal plate comprising, in combination: platen means for supporting the plate with the edge to be folded turned up from the plane of the plate into a flap; contact means guided in a predetermined path for engaging the flap along a line intermediate the fold line and the outer edge of the flap, to push the flap over into substantial parallelism with the main plate; abutment means for engaging the outer edge of the flap means during the rotational movement of the flap means to thrust said edge toward the fold line and compel the metal at the fold line to yield and back away; and means for actuating said bending and abutment means.

10. Equipment according to claim 9 in which said abutment means is rigid with but spaced from said contact means, and has a face directed toward said fold line; said abutment face terminating in an edge parallel to said contact means; and said contact means and abutment means are moved about a remote center on the opposite side of said fold line from said abutment means; whereby the folding movement carries the plane containing said contact means and abutment edge past said fold line, and the contact means pushes the flap off the edge of the abutment means.

11. Equipment according to claim 10 in which said contact means is one side edge of a semicircular groove parallel to the fold line and opening in the direction of folding movement, and said abutment means is the opposite side of the same groove.

12. Equipment according to claim 11 in which said abutmeans and contact means move in a circular path with a radius of curvature more than twice the width of the flap.

13. Equipment according to claim 12 in which said abutment means and contact means rotate about the axis defining the center of curvature of their path; said axis being parallel to said abutment and contact means.

14. Equipment according to claim 9 in which said contact means and said abutment means are different portions of a single rigid tool structure.

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