Feb. 14, 1956 S. GOLBERT 2,734,474

METHOD OF STRETCH-BENDING SHEET METAL

Filed May 4, 1951 3 Sheets-Sheet 1

Fig. 1

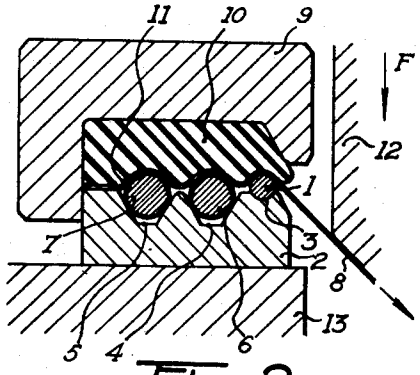


Fig. 2

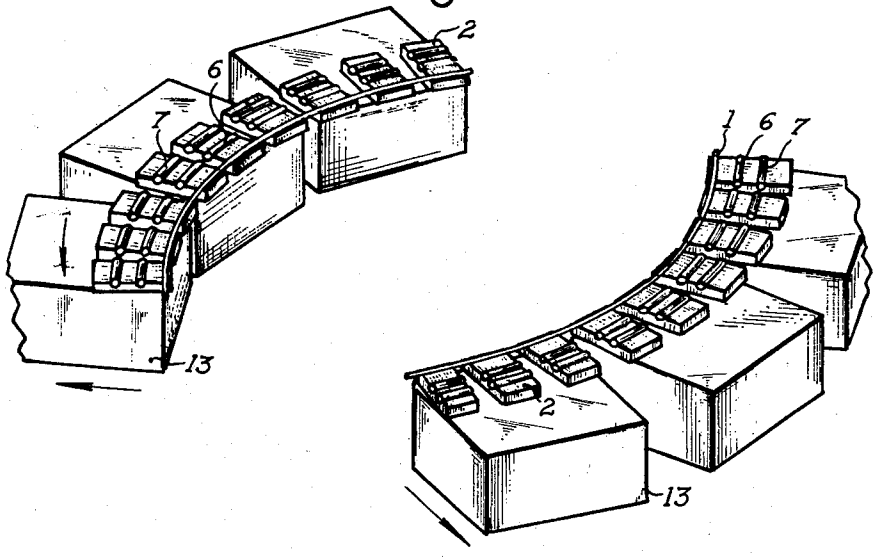


Fig. 6.

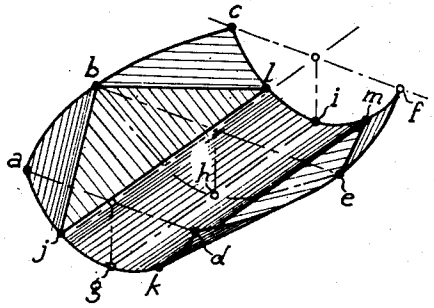
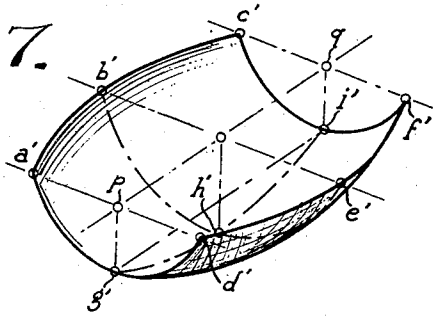


Fig. 7.



INVENTOR
SERGE GOLBERT
By: Hamilton, Lake & Co.
AGENTS

Feb. 14, 1956 S. GOLBERT 2,734,474

METHOD OF STRETCH-BENDING SHEET METAL

Filed May 4, 1951 3 Sheets-Sheet 2

Fig. 4.

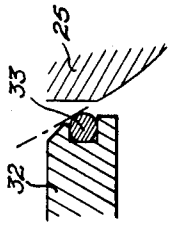


Fig. 5.

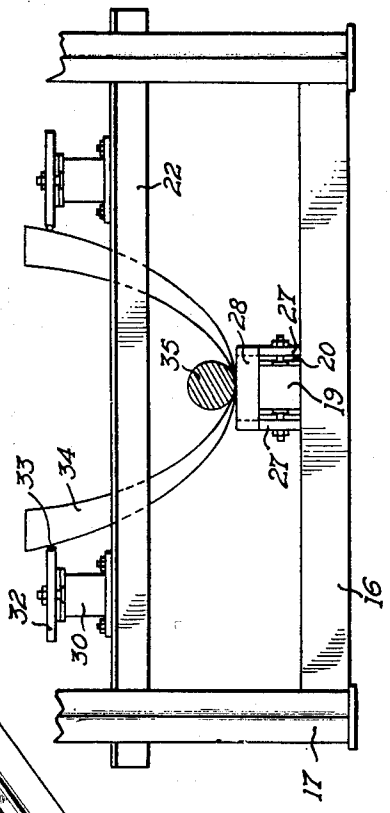
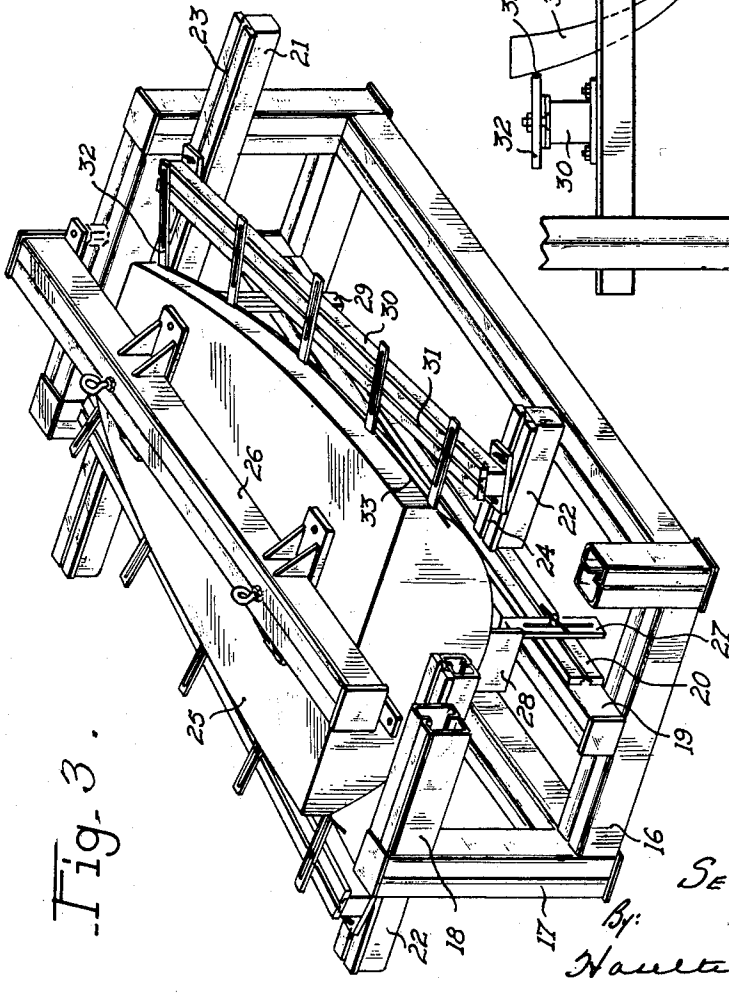


Fig. 3.



INVENTOR
SERGE GOLBERT
By:
Hamilton, Lake & Co.
AGENTS

Feb. 14, 1956 S. GOLBERT 2,734,474

METHOD OF STRETCH-BENDING SHEET METAL

Filed May 4, 1951 3 Sheets-Sheet 3

Fig. 8

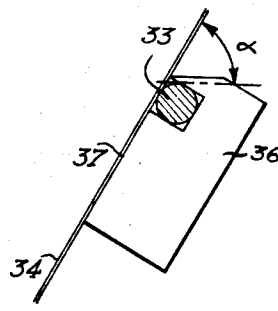


Fig. 11

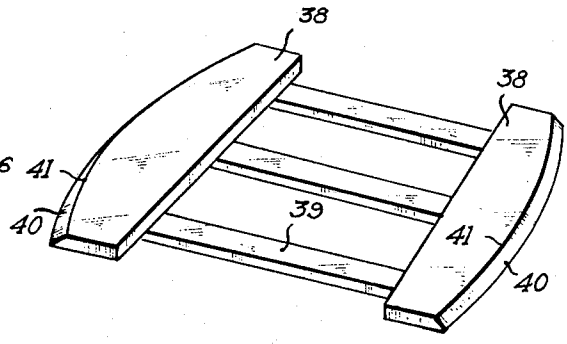


Fig. 9

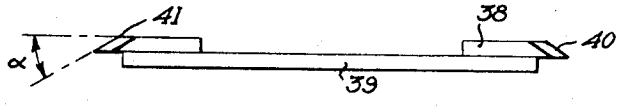
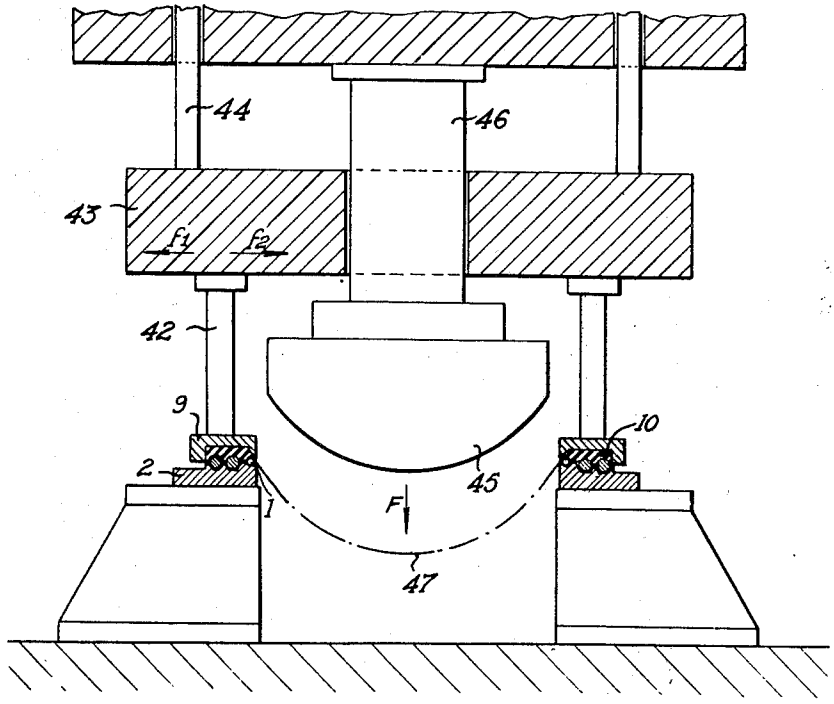


Fig. 10



INVENTOR
SERGE GOLBERT
By:
Wanetine, Lake & Co.
AGENTS

United States Patent Office 2,734,474
Patented Feb. 14, 1956

2,734,474

METHOD OF STRETCH-BENDING SHEET METAL

Serge Golbert, Paris, France, assignor to Societe Nationale de Constructions Aeronautiques du Sud-Est, Paris, France

Application May 4, 1951, Serial No. 224,545

Claims priority, application France May 15, 1950

2 Claims. (Cl. 113—51)

As a rule, the shaping of a limited number of convex sheet metal parts subjected to a single or double curvature is performed through the conventional stretch-bending method in which the blank is held along two generatrices by a pair of rectilinear side clamps and subjected to the action of a shaping punch. The latter is fixed to the movable plate of a hydraulic press and moved towards and pressed against the blank.

The stretch-bending method is particularly suitable for the production of generally rectangular sheet metal parts having a pronounced transverse curvature compared with its longitudinal curvature, which is the case, for example, with fuselage elements. This method is also convenient for forming elements having a single curvature.

During the stretch-bending operation the blank is subjected to a relatively low bending stress, just beyond the elastic limit, while the tensile stress applied thereto greatly exceeds this limit. With this distribution of the deforming stresses the elastic contraction is very small and the sheet practically retains the shape of the shaping die. However, this blank stretch-bending method offers a very serious drawback in that it leads to a substantial loss of sheet material. In fact, to ensure the progressive deviations of the lines of force between the curved shape and the rectilinear jaws of the blank-holding clamps, more particularly for parts having a double curvature, requires sacrificing after stretch-bending a relatively large area of sheet material in the zone which units the stamped part of the blank with the rectilinear clamped parts or flanged edges thereof and to which the length of sheet material clamped by the jaws and forming said flanged edges is to be added.

The aforesaid joining zone may be slightly reduced by using blank holders made of several elements arranged in polygonal fashion; however, this arrangement still requires the presence of a relatively wide joining zone to prevent, on the one hand, the formation of wrinkles due to the compressive stresses exerted and, on the other hand, overstressed points where the jaws meet, both wrinkles and overstressed points being incipient fractures as a rule. If the tensile stress is applied through the blank holders, the shaping die remaining still, the distribution of stresses is improved but the conditions of operation and notably the dimensions of the wasted sheet material remain unchanged.

In order to fully eliminate the aforesaid joining zone and the substantial loss in sheet material resulting therefrom, the main object of the present invention is to provide a method of stretch-bending plane thin sheet metal blanks wherein the blank freely bearing on a device reproducing the contour of the longitudinal trim lines of the stamping to be obtained, is flexed by the application along a substantially longitudinal line thereof of a uniformly distributed stress less than the elastic limit of the material forming said blank, in order to attain end heights with respect to said contour at the most equal to those of the transverse trim lines of the stamping, longitudinal

clamping lines, which exactly reproduce the curves forming said contour, being drawn on the blank in said flexed state, and the angle of said flexed blank with a horizontal transverse line at each point of said drawn clamping lines being determined, then said thin sheet metal blank is allowed to spring back to planar shape under its own elasticity by removing said stress and in said planar shape is pre-formed with flanged edges used for clamping the same during the stretch-bending step, the inner edges of said flanged edges coinciding with the developed drawn clamping lines while their angle with the remaining planar part of the developed blank is equal at each point of their inner edges to the angle determined at the corresponding point of said clamping lines when the blank was flexed, then the flanged edges of the pre-formed blank are clamped by means of a clamping device reproducing the contour of the longitudinal trim lines of the stamping to be obtained so that their inner edges coincide with said contour, which induces flexing of the blank part comprised between said flanged edges, owing to the fact that, on the one hand, the blank has been pre-formed with flanged edges at a determined angle with respect to said part and, on the other hand, said inner edges in said clamped state are closer together than the developed drawn clamping lines, said flexed part of the pre-formed and clamped blank being finally stretch-bent around a shaping die the shape of which reproduces that of the stamping to be obtained, the flanged edges being cut out after the stretch-bending step has been performed.

With the novel method of this invention, it is possible to obtain a greater number of shapes than those afforded by rectilinear blank holders owing, on the one hand, to the better distribution of the lines of force and, on the other hand, to the reduction in the length of the stretched fibers, the allowable elongation being in reverse ratio to the length.

The accompanying drawings forming part of this specification illustrate diagrammatically by way of example a practical embodiment of a device for carrying out the method of the invention. In the drawings:

Fig. 1 is a vertical section illustrating the fitting of a blank to be shaped by stretch-bending in holding jaws made in accordance with the teaching of this invention.

Fig. 2 is a perspective view of the bottom supporting members, without the clamping or holding jaws, utilized for stretch-bending thin sheet metal blanks, these members being disposed according to the contour of the longitudinal trim lines of the stamping to be obtained.

Fig. 3 is a perspective view showing the special frame used for determining and drawing the clamping lines on the sheet metal blank, said special frame being adjusted in accordance with a form reproducing that of the stamping to be obtained.

Fig. 4 shows the position of a drawing bead supporting member in the special frame, in relation to the form.

Fig. 5 is a central transverse section of the special frame shown in Fig. 3 and illustrates the manner in which the blank used for obtaining the stamping of Fig. 7 is set in position in the special frame after adjusting the latter to the form.

Fig. 6 is a perspective view of the part of the blank flexed as illustrated in Fig. 5 which is comprised between the clamping lines drawn on said blank, the frame and the means for flexing the blank having been omitted.

Fig. 7 is a perspective view of the same part of the blank after the stretching step giving the stamping to be obtained, the flanged edges having been cut out.

Fig. 8 is a diagrammatical illustration of the method of determining the angle made by the flanged edges with the blank flexed as illustrated in Fig. 5 at a given point of the clamping lines drawn on the blank.

Fig. 9 is a central transverse section of the jig used for

forming the flanged or clamping edges of the blank on the developed blank used for obtaining the stamping of Fig. 7 with a flanged developed blank removed from the jig.

Fig. 10 is a diagrammatical central part section of the hydraulic double-acting press of a type suitable for stretch-bending metal sheets or blanks, said press being equipped with a flanged blank submitted to a second flexing by clamping its flanged edges on the clamping jaws illustrated in Fig. 2 and with a shaping die used for obtaining the stamping illustrated in Fig. 7.

Fig. 11 is a perspective view of the blank pre-forming jig illustrated in Fig. 9.

In view of stretch-bending a sheet metal blank according to the characteristic features of this invention, the continuous holding edge for each longitudinal side of the blank consists of a clamping bead 1, preferably of steel, having a diameter of 5/16" to 7/16" for example and curved according to the contour of the shaping die which reproduces the contour of the longitudinal trim lines of the stamping to be obtained. This curved clamping bead is held in position by a set of supporting members 2, for example four inches wide, disposed on the bed plate of a stretch-bending press and arranged according to said contour. Each supporting member is formed with a groove 3 in which the curved clamping bead 1 is laid, and a pair of deeper grooves 4, 5 receiving corresponding ribbed rollers 6, 7 respectively. The blank 8, as explained hereinafter with reference to Figs. 9 and 11, is formed with flanged edges 11 which are placed upon the curved clamping beads 1 and rollers 6, 7, so that their inner edges coincide with said beads 1, whereby, as explained with reference to Fig. 10, the part of said blank disposed between said flanged edges assumes a curved shape. In this position, the blank is clamped by means of upper jaws 9 through the intermediary of rubber strips 10 whereby the flanged edges 11 of blank 8 will be pressed against rollers 6, 7. When the blank is thus positively held against movement, its part contained between said flanged edges 11 is shaped by lowering the shaping die 12 equipping the stretch-bending press and which acts in the direction of the arrow F.

As illustrated in Fig. 2 the supporting members 2 for the continuous curved beads 1 are grouped in threes on intermediate supporting blocks 13 displaceable and orientable on the bed plate of the press so that the continuous curved beads 1 are properly positioned on curves corresponding to the contour of the longitudinal trim lines of the stamping to be obtained.

If sheet elements having a small transverse curvature are contemplated, that is to say elements in which the difference between arc and chord is of from 3% to 5%, a flat blank can be used initially for the stretch-bending operation, without prior formation of any flanged edge.

If the curvature is more pronounced, it is necessary to provide the blank with flanged edges for positively holding the same against movement by jaws 9 when the shaping die is moved in the direction of arrow F. For this purpose, with a view to determine the clamping lines of said flanged edges 11 and to decrease the tensile stress which will be applied to the blank when mounted on the press at a value less than the elastic limit of the metal forming said blank, according to the present invention, the blank lying on the curved beads 1 is submitted to flexing in order to attain end heights with respect to said beads at the most equal to those of the transverse trim lines of the stamping to be obtained, the clamping lines being drawn along said beads while the blank remains in its flexed state. In most instances and particularly when thin sheet metal is used, the free flexing of the sheet under its own weight obtained by laying the blank on the curved beads may be sufficient to attain said end heights.

For mass production, instead of using the curved beads 1 mounted on the bed plate of the press, it is preferable to use a special frame in order to avoid an undue stopping in the operation of the stamping device.

A practical example will be considered in which stampings having a symmetrical double convexity as illustrated in Fig. 7 are to be obtained.

Fig. 3 illustrates a special frame for drawing the clamping lines on the blank used for obtaining the stamping illustrated in Fig. 7. This device consists of a rectangular bottom frame 16 having columns 17 connected through transverse elements 18. On the bottom frame 16 is fixed a longitudinal beam 19 carrying lateral slideways 20. A pair of transverse beams 21, 22 contained in a common horizontal plane are carried in an adjustable or fixed manner by columns 17 and provided in turn with slideways 23, 24. The form 25 reproducing the shape of the stamping to be obtained or of the shaping die is mounted in the special frame with the assistance of a hoisting-conveying machine such as a travelling-crane or hoist and of a beam 26 which is fast with the form. In Fig. 3, the curves which form the upper contour of form 25 and which correspond to the longitudinal trim lines *a'b'c'* and *d'e'f'* of the stamping corresponding to form 25 are assumed to be contained in a common plane. With the assistance of legs 27 mounted for sliding vertical adjustment on the aforesaid slideways 20 and fast with a perpendicular element 28, on the one hand, and similar members 29 positioned at the rear of the frame on the same slideways 20, the upper plane contour of the form is brought to the horizontal position. Then, on each side of form 25, movable beams 30 are mounted on transverse beams 21 and 22, said movable beams being respectively inclined in their common horizontal plane substantially parallel to the average inclination of the curves forming the upper contour of form 25. On each movable beam 30 carrying a slideway 31 a series of adjustable supporting members 32 are mounted. These members are formed with an end groove in which a continuous drawing bead 33 is located. The beads 33 are caused to take the shape of the curves forming the upper contour of form 25, i. e. the shape of the longitudinal trim lines of the stamping, or at least to be placed in positions tangent with the surface of this form, as illustrated in Fig. 6. The assembly consisting of members 27, 28, on the one hand, and members 29 interconnected through a member similar to member 28, on the other hand, defines the end heights or depths of form 25 in relation to the place of its upper contour, i. e. the heights of the transverse trim lines *a'g'd'* and *c'i'f'* of the stamping.

After the members 28 indicating the extreme or end heights of the form and supporting members 32 are adjusted, so as to properly position the continuous drawing beads 33, form 25 is removed from the special frame and replaced with a sheet or blank sunk under free flexing into the aperture provided between the drawing beads 33 down to the level of the members 28 indicating the extreme or end heights. Then, this sheet metal blank is held in position in a state of constrained flexing by loading it with a cylindrical bar 35 bearing on the pair of members 28 which serve for determining the heights at both ends as shown in Fig. 5, while said blank remains flexed under constraint. This causes the part of the blank comprised between the drawing beads 33 to assume the shape of a composite regulated developable surface of the type illustrated in Fig. 6.

When the blank is held in this position a marking tool is utilized for marking on the blank clamping lines corresponding to the position of the continuous marking beads 33. Then, with the assistance of special devices 36 formed with recesses for housing the drawing beads 33, as illustrated in Fig. 8, inserted on the continuous drawing beads 33 between the supporting members 32 thereof and by applying the face 37 of these devices against the sheet material 34, horizontal lines, illustrated in dotted line on Fig. 8, are drawn on said devices 36.

At each point of said drawing beads **33** the angle α, which is the definite angle at which the blank will be clamped in the machine jaws, is determined as the supplement of the angle existing between the horizontal line drawn on the corresponding device **36** and the face **37** of said device.

For more readily understanding the particular features of the invention, Fig. 6 represents the part of the blank, flexed as illustrated in Fig. 5, which is comprised between the clamping lines drawn on said blank in correspondance to the drawing beads **33**. In this position, the sheet material between the clamping lines is submitted only to flexing and has a regulated developable surface. The clamping lines *abc* and *def*, drawn on the blank and which are coincidents with the drawing beads **33** and the shaping die contour, and the depths *pg* and *qi* of said blank with respect to said clamping lines, respectively coincide with the longitudinal trim lines *a'b'c'* and *d'e'f'* of the stamping (Fig. 7) and with the heights *p'g'* and *q'i'* of its transversal trim lines *a'g'b'* and *c'i'f'*. On the contrary, the lengths of the intermediate longitudinal sectional lines in said part of the flexed blank, such as *ghi* (Fig. 6), are shorter than the corresponding longitudinal sectional lines of the stamping, such as *g'h'i'* (Fig. 7), because the height or depth of said part of the flexed blank is the same throughout its length with respect to the clamping lines, the line *ghi* being a straight line.

The longitudinal elongation is given by the ratio between the lengths of curve *g'h'i'* and straight line *ghi*.

The maximum transverse elongation is given by the ratio between the respective lengths of curves *b'h'e'* and *bhe*.

The related part of the flexed blank has seven developable sections: one cylindrical portion *jklm*, two flat triangles *jbl* and *kem*, and four cylindrical elements *ajb*, *bcl*, *mfe* and *ekd*.

However, the accurate determination of these developable sections is not indispensable because the related part of the blank will take this form by itself when laid upon the drawing beads **33** (Fig. 5) which coincide with the clamping lines and flexed by bar **35**. The clamping contour of the sheet can be determined by merely measuring depths or heights *pg* and *qi* and determining lateral contours *abc* and *def*, which operation as hereinabove explained, may be carried out by utilizing either the clamping beads illustrated in Fig. 2 or the drawing beads illustrated in Fig. 3.

After drawing the clamping lines on the flexed blank with a marking tool and measuring the angle α along said lines, the bar **35** is removed and the blank is extracted from the drawing frame and is restored to a developed planar state by its own elasticity. From this developed blank a hard wood form of the kind illustrated in Figs. 9 and 11 is machined. This form consists of side members **38**, the outer edges of which have bevelled portions **40** the inner edges of which reproduce the developed clamping lines drawn on the developed blank. Said bevelled portions **40** make with the horizontal at each point of their inner edges **41** an angle equal to the angle α measured at the corresponding point of the clamping lines when the blank is placed on the drawing beads **33** in a flexed state as illustrated in Fig. 5. Said side members **38** are interconnected by cross ties **39** the length of which is determined in order that the inner edges **41** coincide with the developed clamping lines.

The blank in its developed planar state is mounted on said form so that the developed clamping lines drawn thereon coincide with the inner edges **41**. The edges of said blank are then bent on the bevelled portions **40** so as to flange the same along the developed clamping lines according to the angles α measured at each point of said lines, whereby a flanged planar blank is obtained.

As explained hereinabove, the flanged planar blank is mounted on a stretch-bending press equipped with a shaping die **12**. For this purpose the flanges are placed upon the curved clamping beads **1** (Figs. 1 and 10) so that their inner edges are substantially coincident with said beads **1**. Under the action of the clamping jaws **9** the flanges and the inner edges occupy the positions illustrated in Fig. 1, said inner edges coinciding with said clamping beads **1**. Simultaneously, owing to the fact that, on the one hand, the blank has been pre-formed with flanges at angles α with respect to the remaining part of said blank and, on the other hand, the clamping beads **1** are closer together than the developed clamping lines, a flexing of the part of the blank contained between the clamped flanges **11** is induced, as illustrated at **47** in Fig. 10, said part corresponding to Fig. 5. The thus obtained form differs from that illustrated in Fig. 5 by the fact that, on the one hand, a constraint has been applied during the flanging operation on the zone of the blank adjacent to the flanges and, on the other hand, any device like the bar **35** is omitted, whereby the end heights of the form illustrated in Fig. 10 are smaller than those of the form illustrated in Fig. 5. It is not necessary to have accurately flattened flanged edges, on the contrary, it is preferable to have them slightly corrugated so that a greater flexibility will be available when positioning the blank on the stretch-bending apparatus.

The stretch-bending device can be made either as a separate unit, or as a special attachment for a hydraulic press. When the hydraulic press is of the double-acting type the fitting of the device thereon is facilitated because the entire hydraulic equipment of the press is available. A typical example of a mounting of this kind is illustrated in Fig. 10 of the drawings.

The clamping action exerted by jaws **9** which support clamping beads **1** curved and disposed as drawing beads **33** may be assured through suitable push-rods **42** so arranged as to register with each bead supporting member **2**. These push-rods **42** are fixed beneath an intermediate plate **43** and adjustable thereon in the direction indicated by the arrows *f1* and *f2*. This intermediate plate **43** is controlled by the drivers **44** of the blank-pressing plate of the machine. The convex bottom surface of shaping die **45** has substantially the shape of the stamping to be obtained and this shaping die is fixed to the ram **46** passing with a free clearance through the intermediate plate **43**. When driven in the direction of the arrow F this shaping die will produce the permanent deformation by stretch-bending of the clamped blank **8** which was initially clamped by the action of jaws **9** on its flanged edges so that the stamping illustrated in Fig. 4 is obtained after the flanged edges have been cut out.

However, the arrangement illustrated is purely diagrammatical and given by way of example. Thus, the punch **45** may be driven from beneath, the press may be of the single-acting type and in this case the push-rods **42** are provided with resilient clamping means.

When utilizing the stretch-bending method forming the object of the present invention, the loss of blank material, after the stretching operation has been performed, is very small when compared with the loss of blank material in the conventional stretch-bending methods. In fact, when the blank is flexed as illustrated in Fig. 5, the angles made by said blank with respect to the plane of the drawing beads **33** are substantially equal to the angles formed by the stamping with the plane passing through its longitudinal trim lines along said lines. Consequently, during the stretch-bending operation performed on the press illustrated in Fig. 10, the part of blank close to the flanged edges is submitted only to a small tensile stress which avoids the formation of wrinkles or overstressed points, while in the conventional stretch-bending methods the part of the blank close to the flanged edges is submitted to a tensile stress which greatly exceeds the elastic limit and which generates wrinkles and overstressed points. In the conventional stretch-bending method, when the blank has been shaped in accordance with the stamping

to be obtained, the part of said blank formed with wrinkles and overstressed points must be cut out which corresponds for example, as illustrated in Fig. 1, to the loss of the flanged edges and of a part of the permanently deformed blank. In the stretch-bending method according to the invention, on the contrary, the corresponding portion of the permanent deformed blank is free of wrinkles and overstressed points and, therefore, may form a part of the stamping. Consequently, the loss of sheet material is limited to the loss of the flanged edges themselves which may range from 1⅛" to 2⅜" approximately for each flanged edge.

In case the construction of a separate machine is contemplated, this problem may be solved in various manners. It is also possible to carry out the conversion of an existing stamping machine having rectilinear clamping jaws into a machine having the characteristics set forth above.

Briefly, the successive steps for stretch-bending sheet metal according to the invention, in the case of a limited production of stamping, are as follows:

(*a*) Determination of the heights *p'g'—q'i'* of the transverse trim lines *a'g'd'—c'i'f'* of the stamping and formation of curved drawing beads **33** coincident with the longitudinal trim lines *a'b'c'—d'e'f'* of said stamping, by means of the frame illustrated in Fig. 3;

(*b*) Introduction of a metal sheet in said frame which metal sheet, while freely bearing on the curved drawing beads **33**, is submitted to a constrained flexing for attaining end heights *pg—qi* at the most equal to the determined heights *p'g'—q'i'*, as illustrated in Fig. 5, then drawing on the sheet which is maintained in said flexed state the position lines of curved drawing beads **33** which will be used as clamping lines and determination of angles α along said curved drawing beads **33**;

(*c*) Extraction of the sheet from the frame, said sheet recovering a planar shape by its own elasticity, and formation of side flanged edges along the thus developed drawn clamping lines by means of the form illustrated in Figs. 9 and 11 and which reproduces the angles α;

(*d*) Mounting and clamping of the thus flanged sheet on the stretch-bending device, the inner limits or clamping lines of the clamped flanged edges **11** coinciding with the holding or clamping beads **1** curved and disposed as the drawing beads **33**, i. e. with lines reproducing the longitudinal trim lines *a'b'c'—d'e'f'* of the stamping to be obtained (Fig. 10);

(*e*) Stretch-bending of the metal sheet for obtaining under permanent deformation the stamping (Fig. 7) after the flanged edges **11** have been cut out.

For mass production, the first metal sheet only is submitted to all steps (*a*) to (*e*). The following metal sheets are only submitted to steps (*c*), (*d*) and (*e*), so that the steps of preliminary determination (*a*) and clamping line drawing (*b*) are made only once for a large number of identical elements.

What I claim is:

1. A method of stretch-bending plane sheet metal blanks, more particularly to obtain double-curved stampings from thin sheet metal, which comprises laying freely the plane sheet metal blank on a contour which reproduces the contour of the longitudinal trim lines of the stamping to be obtained, flexing said sheet metal blank lying on said contour by the application along a substantially longitudinal line thereof of a uniformly distributed stress less than the elastic limit of the material forming the blank so as to attain end heights with respect to said contour at the most equal to those of the transverse trim lines of the stamping, drawing on said sheet metal blank maintained in flexed state clamping lines exactly reproducing the curves forming said contour, determining the angle of said blank maintained in flexed state with a horizontal transverse line at each point of said drawn clamping lines, removing said stress whereby said sheet metal blank springs back to planar shape by its own elasticity, forming along the developed clamping lines drawn on the plane metal sheet blank flanged edges usable for clamping said blank during the stretch-bending step whereby the inner edges of said flanged edges coincide with the developed drawn clamping lines, the angle of said flanged edges with the remaining planar part of the developed blank being equal at each point of their inner edges to the angle determined at the corresponding point of said clamping lines when the blank was flexed, clamping the flanged edges of the thus pre-formed blank so that their inner edges coincide with the contour of the longitudinal trim lines of the stamping to be obtained whereby the blank part comprised between said clamped flanged edges is flexed, stretch-bending said part around a shaping die the shape of which reproduces that of the stamping to be obtained, and cutting out the flanged edges alone.

2. Method of stretch-bending plane sheet metal blanks, according to claim 1, adapted for mass production of double-curved stampings from a lot of plane sheet metal blanks, wherein, after drawing of the clamping lines on the first sheet metal blank of the lot maintained in flexed state and determination of the angle of said first blank maintained in its flexed state with a transverse horizontal line at each point of said drawn clamping lines and after said first blank has sprung back to its planar state, each plane sheet metal blank of the lot is formed along lines reproducing the developed clamping lines drawn on the first blank in planar state with flanged edges usable for clamping said blank during the stretch-bending step whereby the inner edges of said flanged edges coincide with the developed drawn clamping lines, the angle of said flanged edges with the remaining planar part of the blank being equal at each point of their inner edges to the angle determined at the corresponding point of the clamping lines drawn on said first blank when the latter was flexed, then the flanged edges of the thus pre-formed blank are clamped so that their inner edges coincide with the contour of the longitudinal trim lines of the stamping to be obtained whereby the blank part comprised between said clamped flanged edges is flexed, afterwards said part is stretch-bent around a shaping die the shape of which reproduces that of the stamping to be obtained and finally the flanged edges alone are cut out.

References Cited in the file of this patent

UNITED STATES PATENTS

1,216,396	Avery et al.	Feb. 20, 1917
2,119,630	Williams	June 7, 1938
2,251,477	Wiseman	Aug. 5, 1941

FOREIGN PATENTS

543,040	Great Britain	Feb. 6, 1942