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STRETCH FORMING OF METAL SHEETS PROVIDED WITH REENFORCING RIBS

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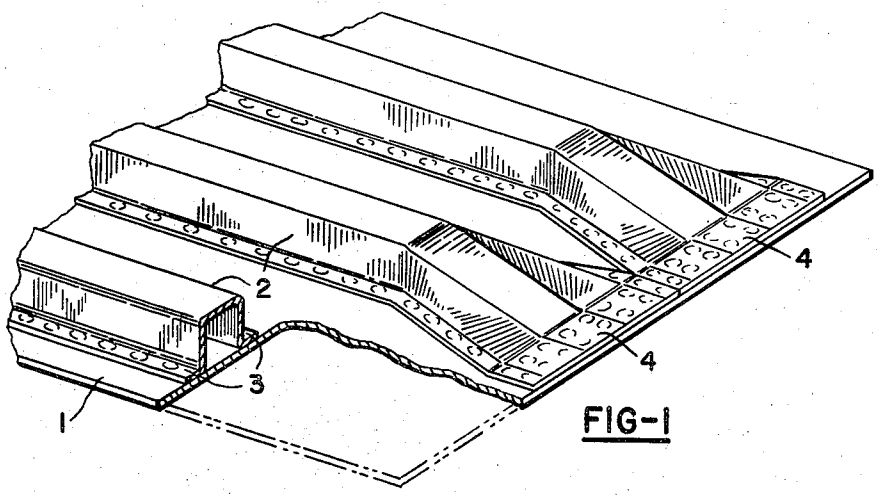


FIG-1

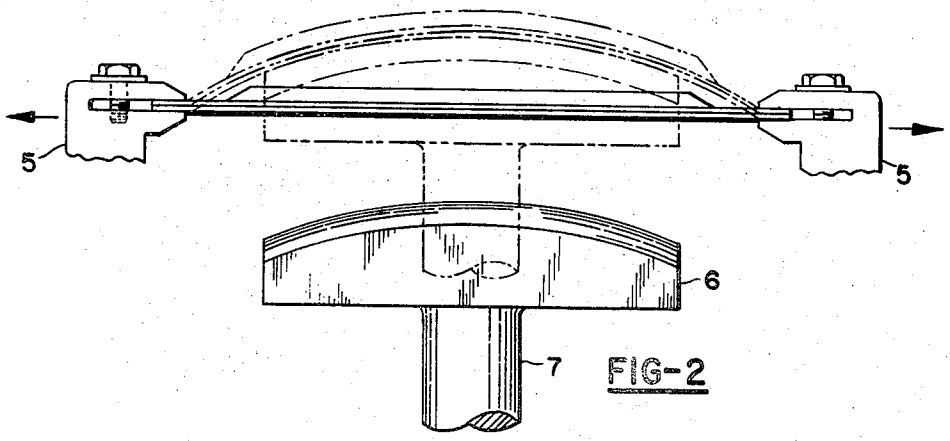


FIG-2

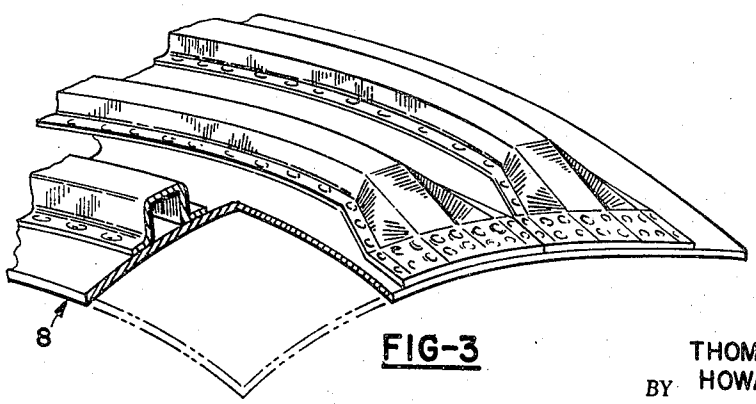


FIG-3

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4 Claims. (Cl. 29—428)

This invention relates to the provision of arcuately contoured reenforced metal sheets, especially to a method of stretch forming initially flat metal sheets having a series of reenforcing ribs thereon.

Heretofore there have been many articles made wherein it is necessary to provide a contoured metal sheet that has reenforcing ribs applied to local areas thereof. Normally these contoured metal sheets have been shaped to a desired contour, such as a single or double curvature form. Then reenforcing ribs are separately contoured to a shape complementary to that of the metal sheet and are secured thereto by means of special assembly jigs, fixtures or the like. Of course, the initial sheets and the separately formed reenforcing ribs can each be shaped by stretching, rolling, hydropress, or equivalent shaping operations.

When one endeavors to rivet or weld contoured reenforcing ribs to a contoured or arcuate shaped metal sheet, frequently such securing actions produce localized distortions in the composite structure produced which is undesirable.

It is the general object of the present invention to avoid and overcome the foregoing and other difficulties with the above-mentioned processes and to find and provide a new method of stretch-forming metal sheets with separate reenforcing members secured thereto when the sheet is in the original flat condition and with the sheet and reenforcing members being stretched as an integral unit.

Another object of the invention is to provide an improved, low cost method of stretch-forming metal sheets to single or double curvatures and wherein the reenforcing ribs have a symmetrical section, such as a T or hat section.

A further object of the invention is the provision of a method of the character described wherein the reenforcing ribs have end portions which are flattened out and secured to the sheet. Preferably, but not necessarily, such ribs approximately equal in flattened width the width of the base sheet to which they are secured.

The foregoing and other objects and advantages of the invention will be made more apparent as the specification proceeds.

Reference now should be had to the accompanying drawings which illustrate the principles of the present invention and wherein:

Fig. 1 is a plan, partially broken away and shown in section, of a reenforced sheet of the invention prior to the contouring thereof;

Fig. 2 is a fragmentary side elevation indicating the first step of stretch-forming the reenforced sheet of Fig. 1, the sheet being partially shown in section; and

Fig. 3 is a fragmentary perspective of the sheet of Fig. 1 after being stretch-formed, a portion of the sheet being shown in section.

When referring to corresponding parts of the apparatus shown in the accompanying drawings and referred to in the specification, corresponding numerals are used to facilitate comparison therebetween.

The present invention, generally speaking, relates to a method of stretch-forming a metal sheet to a desired curved contour and includes the steps of securing a plurality of reenforcing ribs to one surface of the sheet, which ribs have center sections bridging over and spaced from parts of the sheet, but with the ribs being secured to the sheet at both lateral margins of the ribs, flattening the ends of the ribs against the sheet, which ribs are of such flattened length as to abut against the edges of adjacent ribs and with the ends of the ribs being secured to the sheet, and lastly stretching and forming the unit of a sheet and ribs so that the metal in the ribs and sheet is stretched beyond its elastic limit, but not beyond its ultimate tensile strength so that a unitary curved article of a desired contour is formed.

With reference to the details of the method of the present invention, attention particularly is directed to the drawings wherein a flat metal sheet 1 is shown which has a plurality of reenforcing ribs 2 secured thereto in parallel relation to each other. These ribs 2 are all of hat-shape in section, or they could be termed inverted U-shape in section. The ribs 2 have a pair of edges 3 provided thereon and suitable means secure the ribs 2 to the sheet 1 in substantially parallel but spaced relationship. Usually these edges 3 are provided with a plurality of spot welds or rivets at closely adjacent, longitudinally spaced portions thereof so that the ribs 2 for the purposes of the invention are made into a unit with the sheet 1 for stretching and forming operations as hereinafter described.

Either before the ribs 2 are secured to the sheet 1 or at least before the end portions thereof are secured to the sheet, these ribs are flattened or spread out laterally as indicated at 4 in Fig. 1 of the drawings. Such flattened ribs 4 are likewise secured, as by closely adjacent spot welds, to the sheet 1 and with the flattened ribs 4 abutting edges of adjacent ribs at the end portions of the sheet.

As the next operation is forming the desired contoured unit of the invention, the unit made from the sheet 1 and ribs 2 is secured in a pair of holding or clamping jaws 5 to secure or anchor the edge portions of the sheet 1 in a desired position. A suitable forming die 6, which is positioned on a ram 7, is connected to suitable means (not shown) for moving the die 6 longitudinally by means of the ram 7 to bring the die 6 into forming engagement with the sheet and rib unit. Thus such sheet and rib unit initially is in flat or planar form but the axial movement of the die 6 will deform such sheet to a double curvature shape, or otherwise as provided on the working surface of the die 6. This die 6 may have any conventional lubrication means associated with its working face before it is brought into engagement with the sheet 1. Also, minimum tensional forces are set up on the sheet and rib unit by the clamping jaws 5 to tension such sheet slightly and insure that it is in its flattened or straight condition before the die 6 is brought into engagement therewith.

After the die 6 has been brought into full working engagement with the sheet 1 and rib unit, the metal forming the sheet 1 and ribs 2 has been deformed to the desired contour. However, normally it is necessary to stretch the shaped metal to insure that the metal in the sheet and ribs is stretched beyond its elastic limit, but not beyond its ultimate tensile strength by the forming or shaping operations performed thereon. Hence, suitable pressures are applied to the clamping jaws 5 to move them apart in an axial direction and this stretches the metal, such as about 2½% of its original length, to insure that the metal in the sheets and ribs is deformed beyond its elastic limit and will maintain the desired contour or shape given to it.

After the formed article, indicated at 8 in Fig. 3 of the drawings, has been removed from engagement with the clamping jaws 5, it may be desirable to trim off the flattened end portions 4 of the ribs 2. Thus the unit 8

could be cut off or have the end sections removed as indicated in the vertically sectioned portion of the unit 8 of Fig. 3.

By practice of the present invention, relatively large structures can be formed to a desired contour and such articles will retain their given shapes within reasonable limits, such as ⅛ inch or less.

While the present invention has been shown with the use of a so-called "hat" shaped reenforcing rib therein, it will be realized that any suitable type of a reenforcing rib can be used wherein some type of a bridged or overhanging center portion is provided in the rib and with the two edge portions on each rib being secured to the base sheet by either cementing, welding, riveting or other similar operations.

Preferably when providing the reenforcing ribs for the base sheet in the unit to be stretched, it is desirable that the rib have slightly thinner gauge metal used therein inasmuch as such rib portion of the metal unit must be stretched or pulled farther than the base sheet and will thus yield a little more readily than if the base sheet and reenforcing ribs were all made of the same thickness. The use of unsymmetrical reenforcing angles of L or Z shape, for example, wherein only one edge of the reenforcing member is secured to the base sheet of the unit is possible, particularly if the curved contours are not severe. However, it is generally preferable to use symmetrical reenforcing shapes of T or hat shape, for example.

It also should be noted that the present invention can be used with any conventional ductile metal such as aluminum, stainless steel, or other conventional materials. It should be realized that the ultimate use of the contoured metal unit provided by the invention will determine the particular shape and size of the reenforcing ribs used thereon and the gauge of material therein with relation to the gauge of the metal in the base sheet. Thus for stiffening action, a light, but relatively high crowned or center portion should be provided on the reenforcing rib to provide the desired result. For other installations, it may be desired to use a relatively wide, low height reenforcing rib.

It also will be realized that the present invention particularly lends itself to the production of quite large metal units such as large metal reflectors for use in radar apparatus and in the telephone industry. These reflectors may be 7, 8 ft. or more long and may be 2, 3 ft. or more wide. These units normally must be held to a tolerance of plus or minus ⅛ inch, for example.

While a certain representative embodiment and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

What is claimed is:

1. A method of stretch forming a flat metal sheet unit to a desired curved contour comprising securing a plurality of substantially parallel straight reenforcing ribs each having pairs of parallel continuous attaching flanges for engagement with the sheet and continuous spaced standing flanges substantially normal to one surface of the sheet with the ribs extending in a direction of desired curvature, each rib having a center section spaced from and bridging over a part of said sheet and secured to said flanges that are substantially normal to said sheet at the edges thereof remote from said sheet, the ends of such ribs being flattened against said sheet and substantially abutting against the edges of adjacent ribs, the ends of such ribs being secured to said sheet, gripping opposite ends of the assembled members at the flattened rib ends, tensioning the flat assembly in a direction parallel to the reenforcing ribs to stretch the unit by about 2½% and forming the unit of said sheet and ribs to a double curvature form to a degree so that the metal in the ribs and in the sheet is stretched beyond its elastic limit and to the desired curvature but not beyond its ultimate tensile strength and without collapse of said ribs.

2. A method of stretch forming a flat metal sheet unit to a desired curved contour comprising securing a plurality of substantially parallel straight reenforcing ribs each having pairs of continuous attaching flanges for engagement with the sheet and continuous standing flanges normal to the sheet to one surface of the sheet with the ribs extending in a direction of desired curvature, said ribs having center sections spaced from and bridging over parts of said sheet and being secured to said sheet at both of the lateral margins of such ribs, the ends of such ribs being flattening against said sheet, said ribs being made from thinner gauge material than said sheet, gripping opposite ends of the assembled members at the flattened rib ends, tensioning the flat assembly in a direction parallel to the reenforcing ribs to stretch the assembled unit, and forming the unit of said sheet and ribs to a double curvature so that the metal in the ribs and in the sheet is stretched by the tensioning and forming beyond its elastic limit to the desired curvature but not beyond its ultimate tensile strength.

3. A method as in Claim 2 where said sheet and rib unit is stretched by about 2½% by the tensioning step.

4. A method as in claim 1 where the flattened ends of said ribs and the portions of said sheet thereadjacent are trimmed from the unit after the forming thereof.

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