Sept. 27, 1960 C. A. HEUER 2,953,843

FABRICATION OF HOLLOW ARTICLES

Filed Nov. 6, 1956

FIG. 1

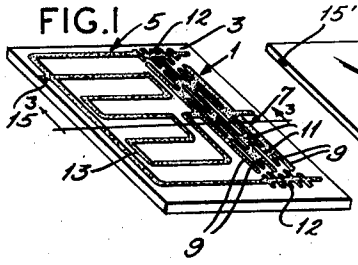


FIG. 2

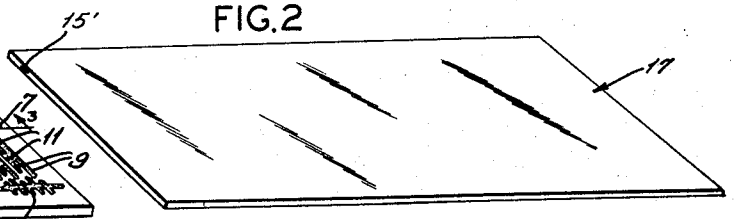


FIG. 3

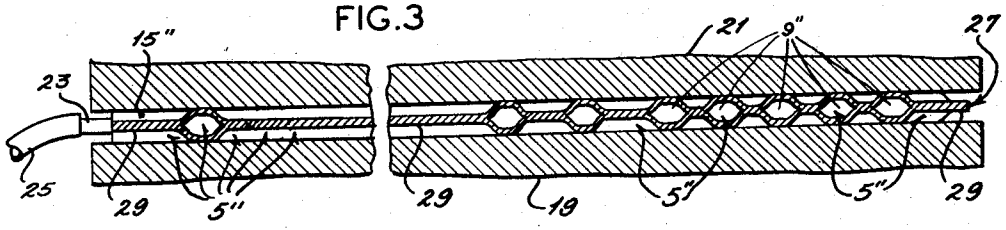


FIG. 4

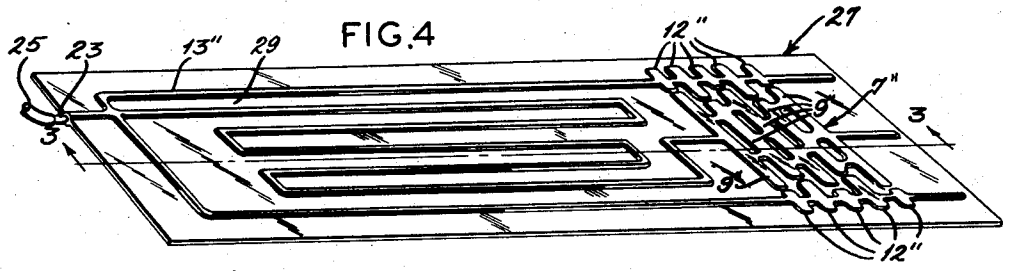


FIG. 5

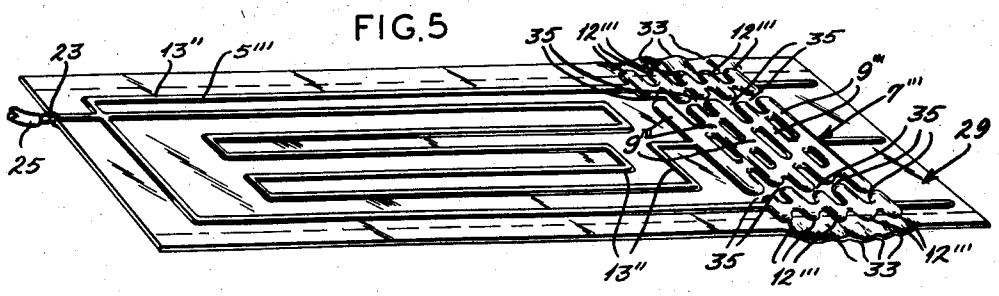
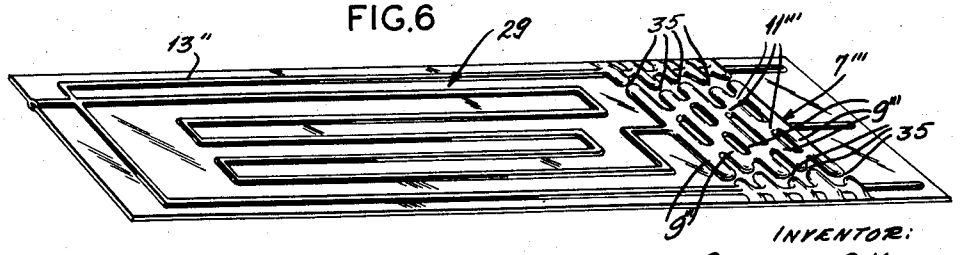


FIG. 6



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FABRICATION OF HOLLOW ARTICLES

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2 Claims. (Cl. 29—157.3)

This invention relates to the fabrication of hollow articles and more particularly to forming the hollow in such articles.

In a process for fabricating hollow expanded sheet metal articles described in U.S. Patent No. 2,690,002, granted September 28, 1954, a pattern of weld-inhibiting material is applied to a clean surface of a sheet of metal and a clean surface of a second sheet of metal is superimposed on the first surface to which the pattern has been applied. The superimposed sheets are then tacked together as by spot welding to prevent relative slippage between the sheets while they are being welded together in their adjacent areas not separated by the weld-inhibiting pattern by hot rolling, to form a blank. During the rolling operation, the sheets are elongated in the direction of rolling and it is, therefore, necessary to foreshorten the pattern of weld-inhibiting material in the intended direction of rolling. An opening is then formed into the unjoined portion of the blank defined by the weld-inhibiting pattern and a fluid pressure is injected therein to permanently distend the metal of the blank in the area of the weld-inhibiting material and form a hollow article having hollows of any desired plan configuration with a solid web of metal between the hollows. The pattern of weld-inhibiting material may assume any desired configuration. For example, the pattern may be such as to define a fluid conveying circuit as in a refrigerator evaporator, after expansion of the blank.

It is often necessary or desirable that hollow articles of this type have relatively large hollow portions. An accumulator in a refrigerator evaporator panel is an example of such a large hollow portion. Expansions of a relatively large hollow normally tends to warp the web of the panel adjacent the large hollow section.

This invention is directed to the control of such distortion by forcing any buckling or warping toward a desired portion of the blank, for example, the outer edges thereof which may subsequently be trimmed from the panel. To accomplish this the metal adjacent a large hollow is caused to draw in an equal amount immediately adjacent the large hollow and outwardly from the large hollow toward the outer edges of the panel.

It is therefore an object of this invention to fabricate an improved hollow expanded article.

Another object of this invention is to control the ultimate location of distortion, such as warping or buckling, of a hollow article during expansion of an unjoined inner portion of a blank to form the hollow panel.

Another object of this invention is to force any distortion, such as warping or buckling, to a desired portion of a hollow article, such as outer edge portions of the article, during fabrication of the article by expansion of an unjoined inner portion of a blank to form the hollow article.

Additional objects and advantages will be apparent in the following description and drawings in which:

Figure 1 is a perspective view of a sheet of metal having applied to a surface thereof a pattern of weld-inhibiting material;

Figure 2 is a perspective view of a blank incorporating the sheet of metal shown in Figure 1 and having an unjoined inner portion defined by the pattern of weld-inhibiting material;

Figure 3 is a schematic sectional view of the blank shown in Figure 2 positioned between a pair of rigid restraining pads and with the unjoined inner portion of the blank expanded to form a hollow article, the section of the blank being illustrated by the line 3—3 in Figure 4 and the pattern of weld-inhibiting material being illustrated by the line 3—3 in Figure 1;

Figure 4 is a perspective view of the expanded hollow article shown in Figure 3;

Figure 5 is a perspective view of the hollow article shown in Figure 4 after the article has been additionally expanded without external restraint on the hollow portion thereof; and

Figure 6 is a prespective view of the hollow article of Figure 5 with the edges trimmed therefrom.

Referring to Figure 1, a sheet of metal 1 has applied to a clean surface 3 a pattern of weld-inhibiting material 5. The pattern of weld-inhibiting material 5 includes a relatively wide and long area 7 consisting of a plurality of relatively wide strips 9 inter-connected by longitudinal strips 11. The area 7 will ultimately form an accumulator 7''' in a refrigerator evaporator panel 29, as shown in Figures 5 and 6.

The area 7 may alternatively be a large solid area of weld-inhibiting material in the shape of an oval, circle, rectangle, square, or the like. Adjacent opposite ends of the accumulator pattern 7 are other patterns 12 which will provide hollow dummy sections 12'' and 12''' as shown in Figures 4 and 5, respectively, and serve to force distortion of the blank away from the accumulator upon subsequent expansion of the blank. The patterns 12 should have the same configuration as the accumulator pattern 7. More particularly, if the accumulator pattern 7 consists of a plurality of relatively wide strips 9, the dummy area 12 should also consist of a plurality of relatively wide strips and preferably each strip of the dummy area should be of the same width as the strips 9 and should be in general axial alignment with strips 9. If the accumulator area 7 is solid, as in the event of an oval, rectangle, and the like, then the dummy section should be a solid area of approximately the same width as the average width solid accumulator area 7. Distortion of the finished panel will be forced outwardly of the dummy section and toward the edges of the panel if the dummy is positioned outwardly toward the edge of the blank with respect to the accumulator area 7 as will be more fully described hereinafter. The pattern of weld-inhibiting material may, if desired, also include a coil-like portion 13 and an inlet portion 15. A clean surface of a second sheet of metal is superimposed on the surface 3 of the sheet 1. The two sheets are tacked together in any appropriate manner, as by spot welding, to prevent relative slippage between the sheets, and the sheets are then welded together in their adjacent areas not separated by the weld-inhibiting material 5 in any appropriate manner as by being passed through a rolling mill to form a blank 17 shown in Figure 2, having an unjoined inner portion and a solid web. Inlet 15' opens through an edge of the blank 17. In welding two sheets of metal together in this manner, the rolls reduce the thickness of the sheets and elongate the sheets in the direction of rolling. It is, therefore, necessary that the pattern of weld-inhibiting material 5 be foreshortened in the intended direction of rolling as indicated in Figure 1. This process of fabricating blanks having an un-

joined inner portion is fully described in the aforementioned patent U.S. 2,690,002.

As shown in Figure 3, the blank **17** is positioned between a pair of fixed rigid restraining pads **19** and **21** spaced apart a predetermined distance equal to the desired total outward distention of the blank. A nozzle **23**, connected to a fluid pressure supply in any appropriate manner as by a hose **25**, is sealed in the inlet portion **15''** of the blank **17**. A fluid pressure is injected through the nozzle **23** and into the unjoined portion of the blank, defined by the pattern **5** of weld-inhibiting material, causing the metal of the blank adjacent the weld-inhibiting material to distend outwardly into firm engagement with the rigid pressure pads **19** and **21**, thereby forming a hollow article **27** having hollow portions **5''**. The hollow portions are separated by a solid web portion **29**. The fluid pressure is then released from the hollow portion **5''** through the nozzle **23** and the pads **19** and **21** are spaced apart an additional amount. The expanded panel **27** may now be removed from between the pads, or the pads may be spaced apart an amount sufficient to permit further expansion to a predetermined height of the hollows **9''** forming the hollow accumulator areas **7''**. Referring to Figure 4, with the panel removed from between the pads, a greatly reduced fluid pressure is now injected into the hollow portion **5''** through the nozzle **23**. The coil-like hollows **13''** are substantially narrower than the tubes **9''** forming the accumulator portion **7''** so that upon injection of a relatively low fluid pressure into the hollow portion **5''** the relatively wide hollow tubes **9''** will expand outwardly forming arched hollow portions **9'''** whereas the tubes **13''** of the hollow coil portion retain their flat outer surfaces resulting from their being expanded into firm engagement with the restraining pads **19** and **21**. If the hollow panel **27** is retained between the spaced apart rigid pads **19** and **21** during the second expansion, the pads should be spaced apart just sufficiently to be lightly engaged by the additional expanded tubes **9'''**. By restraining tubes **9'''** between the pads, warping of the panel will be lessened through engagement of the tubes **9'''** with the pads. Also, less production time is required if the panel **27** is retained between the pads **19** and **21** during the secondary expansion.

Immediately adjacent the ends of the hollow accumulator portion **7''** are the hollow dummy portions **12''**. These hollow dummy portions draw in metal in the web **29** of the hollow article **27** approximately the same as the amount drawn in by accumulator tubes **9''** to prevent excessive warping or buckling of the web adjacent the accumulator. As will be noted in Figure 5, the edges are warped as indicated at **33**. However, the inner portion **35** of the web **29** is not warped or buckled as would result if the dummy hollow portion **12'''** had not been provided. The warped edges of the hollow article **27** are now trimmed, as by a shear, resulting in a hollow article having a substantially flat web **29** throughout as shown in Figure 6.

The hollow portion **5'''** of the panel may assume any desired configuration. For example, the coil portion **13''** may be a plurality of straight tubes entering into end headers, and the accumulator section **7'''** may be one large expanded area rather than a plurality of tubes. However, the accumulator section **7'''** must be substantially wider than the coil or other tubes **13''** in the same fluid expansion circuit to permit the wider accumulator section **7'''** to expand outwardly at a low pressure if the coil portion **13''** is to retain its flat outer configuration. It is not necessary that the coil portion **13''** and the accumulator portion **7'''** be in the same fluid expansion circuit. It is, however, desirable that the dummy portions **12'''** be in the same fluid circuit as the accumulator **7'''** and so positioned and designed as to force distortion of the web **29** away from the accumulator **7'''**. Part of the dummy portion **12'''** is trimmed from the hollow article and the dummy portion may be so designed that all of this portion may be removed from the finished trimmed hollow article. When the dummy portions **12'''** are in the same operating fluid circuit as the accumulator **7'''** or the coil portion **13''**, the exposed trimmed ends of the dummy must be sealed to prevent escape of the fluid.

In the drawings, the dummy portion **12'''** comprises hollow tubes which are in general alignment with the tubes **9'''** of the accumulator **7'''** but with a small portion of web **29** separating the dummy portion from the accumulator. The length of the dummy tubes and the accumulator tubes vary as indicated in the drawings to provide more uniform drawing of metal in the edge of the web and prevent warping in the inner portion of the web.

The particular location of the dummy section will be determined by the location in the web at which distortion is permissible. In certain installations, portions of the hollow article are concealed from the user or for other reasons may be warped or otherwise distorted, however, other sections of the hollow article may necessarily be required to be free of distortion. The dummy sections serve to provide a means of drawing metal in particular areas of the web of the hollow article thereby preventing distortion in these areas. The dummy section should, therefore, be designed to force this distortion into a suitable area of the web such as toward edges which may be trimmed from the hollow article.

The blank **17** may be fabricated from 1100 or 2S aluminum sheets of the same thickness, with a finished thickness of .060 of an inch. The unjoined strips **13** of the blank which will form tubes **13''** are approximately ⅜ of an inch wide and the strips **9** which will form accumulator tubes **9'''** are approximately $1\frac{1}{16}$ of an inch wide. The strips of dummy section **12** are also approximately $1\frac{1}{16}$ of an inch wide. When fully annealed, the blank is positioned between rigid pressure pads **19** and **21** spaced apart .180 inch and a fluid pressure of 3000 p.s.i. is injected into the unjoined portion of the blank **17** resulting in a hollow article substantially as shown in Figures 3 and 4. After this expansion, the edges of the hollow article **27** are still substantially straight. With the hollow article removed from between the pads, a fluid pressure of approximately 400 p.s.i. is injected into the hollow portion **5''**. This pressure is not sufficient to further deform the coil tubes **13''** because of their narrow width. However, such a pressure is entirely adequate to cause the accumulator **9''** to further expand and form substantially arched hollow areas **9'''**. Alternatively, the hollow article shown in Figure 4 may again be positioned between rigid pressure pads spaced apart approximately ¾ of an inch and a pressure of 400 p.s.i. injected into the previously expanded portion **5''**. By spacing the pressure pads apart just slightly less than the normal expansion of the accumulator tubes, warping of the web of the panel is further prevented. However, in order to obtain an adequate cross sectional area in the tubes **9'''**, the restraint cannot be too great and the restraining pads must, therefore, be spaced apart almost the full amount of the anticipated expansion of the accumulator portion of the hollow article.

This invention is directed primarily to expanding hollow metal blanks fabricated in the manner of the aforementioned patent. However, it is equally applicable to the expansion of any blanks having unjoined inner portions, but fabricated by other methods as well as to blanks fabricated from other materials such as plastics or combinations of metal and plastic.

Although this invention has been described with reference to certain embodiments, materials, and details, various changes will be apparent to one skilled in the art, and the invention is therefore not to be limited to such

embodiments, materials, and details except as set forth in the appended claims.

I claim:

1. In the fabrication of a hollow article by expansion of a blank having a relatively large unjoined area, a method for preventing distortion of said blank caused by contraction of said blank during expansion of said hollow comprising interposing a first pattern and a second pattern of weld-inhibiting material between superposed metal sheets, said first pattern defining a relatively large first area of a desired passageway system having a relatively large volumetric capacity, said second pattern defining a second area of a dummy passageway system disposed between said first area and a pair of adjacent edges of said sheets and spaced in close proximity to said first area throughout the marginal portions within said sheets between said first area and said pair of adjacent edges, welding said sheets into a relatively thin solid sheet in all the areas bounding said material whereby a first unjoined area and a second unjoined area corresponding respectively to said first and second patterns of weld-inhibiting material are formed internally within said sheet, simultaneously expanding said first and said second unjoined areas without restraining said sheet against contraction whereby any distortion which otherwise forms in the welded portions of said sheet adjacent said first unjoined area is directed away therefrom by said second unjoined area, and trimming said sheet to remove the distorted portions of said sheet.

2. The method of claim 1 wherein said pattern of weld-inhibiting material is interposed between said sheets to define within said first area a plurality of interconnected unjoined portions forming said desired fluid passageway system.

References Cited in the file of this patent

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