July 23, 1963 J. B. THOMAS ET AL 3,098,290

METHOD OF EXPANDING PASSAGEWAY PANEL ON ONE SIDE

Filed April 27, 1954 2 Sheets-Sheet 1

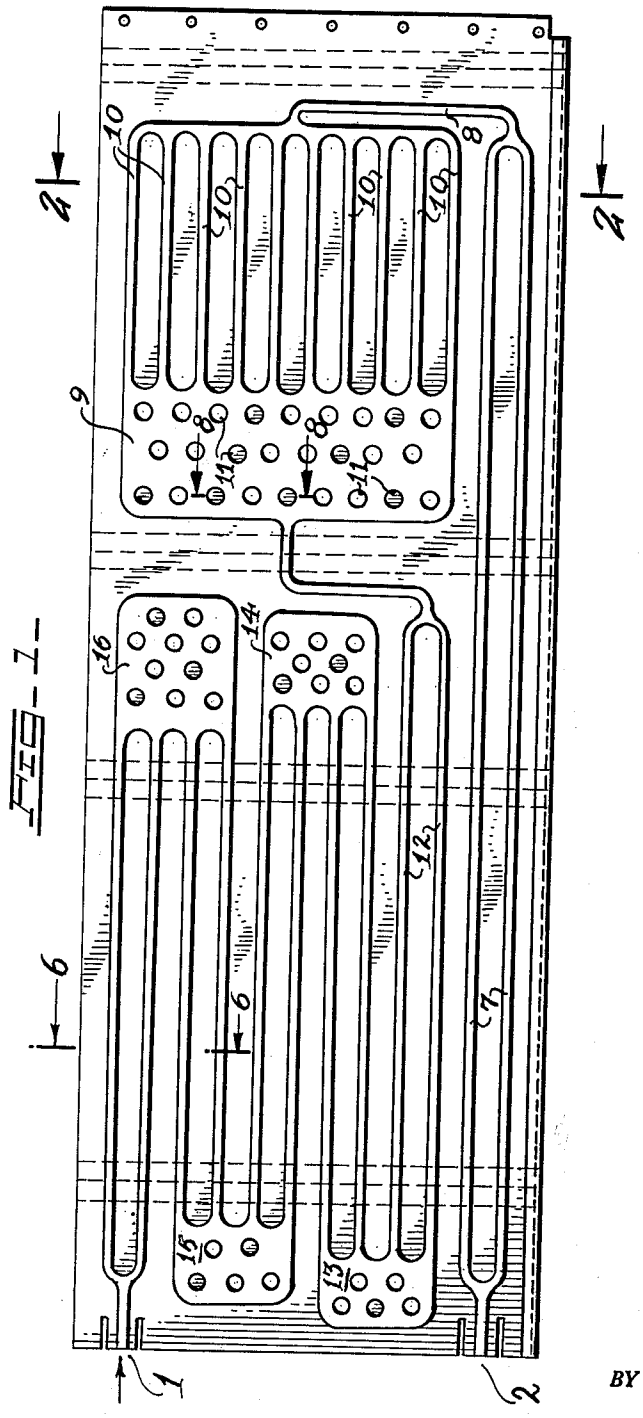


FIG. 7

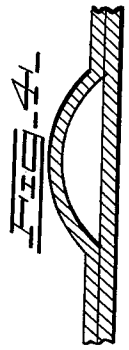


FIG. 4



FIG. 3

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Fig. 2.

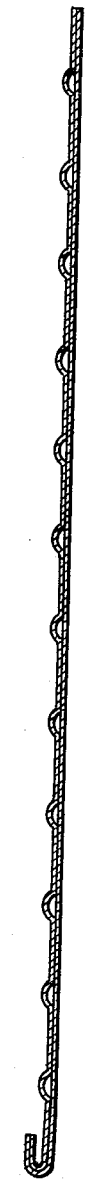


Fig. 5.

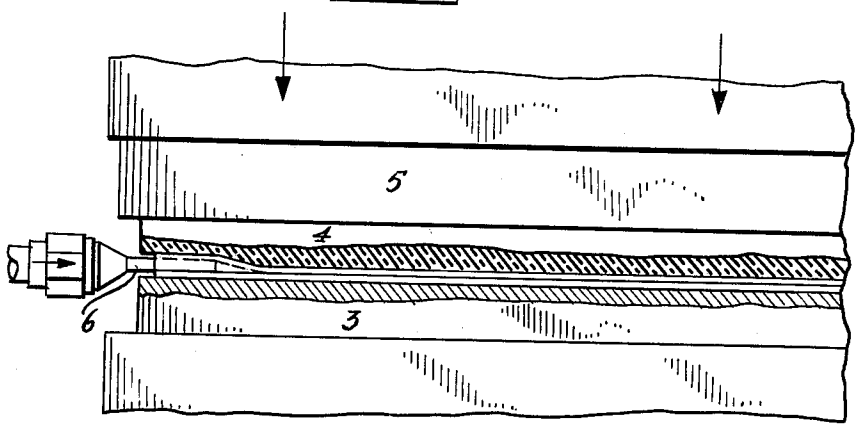


Fig. 6.

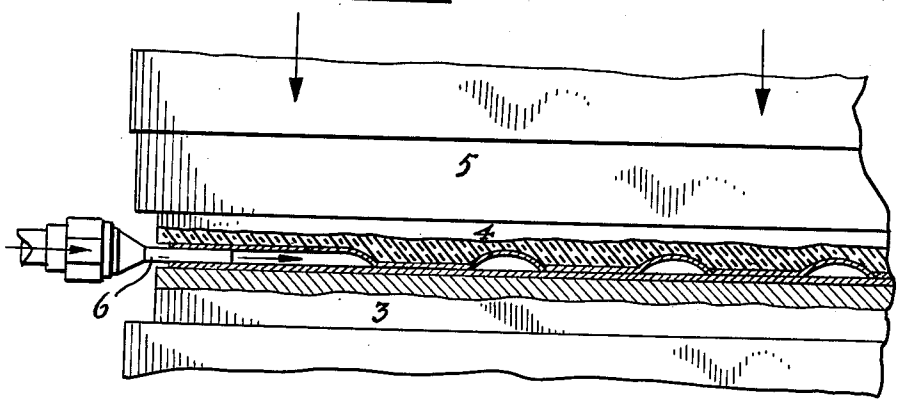


Fig. 7.

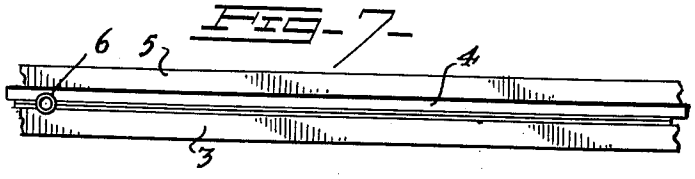


Fig. 8.



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3,098,290

Patented July 23, 1963

3,098,290
METHOD OF EXPANDING PASSAGEWAY PANEL ON ONE SIDE

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Filed Apr. 27, 1954, Ser. No. 425,926
8 Claims. (Cl. 29—157.3)

The Long U.S. Patent No. 2,662,273 discloses a method for making an unexpanded pressure-welded passageway panel and for simultaneously expanding both sides of that panel. It is desirable to expand some pressure-welded passageway panels on one side only, leaving the other side in a flat unexpanded condition but, up to the present time, the one-side expansion methods proposed have been too unsatisfactory for commercial use.

The principal object of the present invention is to provide a simple and relatively superior one-side expansion method, which is much better suited for commercial use.

Another important object is to provide a simple and relatively inexpensive method of expanding an expandable portion of one side or face of a passageway panel while leaving the corresponding portion of the other side or face thereof in a flat unexpanded condition.

Generally speaking, the objects of my invention are achieved by clamping an unexpanded passageway panel between a pair of opposed rigid platens with one face of the panel in flat face-to-face contact with the one adjacent platen and with a yieldable blanket interposed or confined between the other face of the panel and the other adjacent platen; and then subjecting the panel passageway system to an internal expansion pressure high enough to expand said other face of the panel into said blanket while said blanket provides a yieldable counteracting pressure of lower magnitude, which is low enough that it yields to the expansion of said other face but high enough that it tends to hold said one face of the panel substantially in its flat face-to-face engagement with said one platen.

The invention will be described with reference to the accompanying drawings, in which:

FIG. 1 is a plan view of an evaporator structure illustrating one form of heat exchange device for which our method is adapted;

FIG. 2 is an enlarged transverse section on the line 2—2, FIG. 1;

FIG. 3 is an enlarged sectional view showing two metal sheets face to face prior to bonding;

FIG. 4 is a schematic view showing two metallic sheets bonded into virtually an integral structure except for an area which was provided with a resist between the sheets, this area of one sheet being shown expanded;

FIG. 5 is a schematic view in elevation and partly broken away showing two sheets bonded together except for areas to be expanded, as for example, of the pattern shown in FIG. 1, the sheets being between the platens of a press, with a blanket, and ready for expansion of the unbonded areas;

FIG. 6 is a view similar to FIG. 5 showing the structure expanded, the latter, in section, being on the line 6—6, FIG. 1;

FIG. 7 is a view in elevation showing two press platens, a blanket, and the bonded metallic sheets, taken substantially at right angles to FIG. 5, and broken away; and

FIG. 8 is a fragmentary section on the line 8—8, FIG. 1.

In describing our method, reference will first be made to a highly desirable heat exchanger form of passageway panel structure consisting of one flat wall and an opposite wall having protruding tubular areas which may be, for

an example, of the pattern shown in FIG. 1. Many attempts have been made to produce such heat exchangers by the roll bonding of two metallic sheets, aluminum for example, with the areas to be expanded covered with a resist at the meeting faces of the sheets, before rolling, and with subsequent expansion of the unbonded area. It has been shown by practice that hydraulic expansion of the unbonded areas between configurated dies, which are formed to the exact shape of the areas to be expanded, causes ruptures of the metal in such high percentage as to make the use of formed dies impractical. Therefore a later practice has been to lay the bonded sheets between heavy rigid flat dies which are spaced in accordance with the composite thickness of the metal sheets plus the degree of expansion. In the expansion the bonded structure was "floating," and while this was an improvement there still were serious difficulties, overcome by the present invention.

In our method for the production of a preferred heat exchanger with one flat wall and an opposite bulged wall, we employ, for example one sheet of the aluminum alloy 2S as the sheet to be bulged to form the tubular areas, and a hard strong aluminum sheet having a higher yield point, such as the aluminum alloy J51S, or 61S as an example of the non-bulged sheet. The sheet to be stretched or expanded may be in the dry annealed or "0" temper and the faces to be bonded are preferably prepared by a chemical etch, air blasting, or any other method which will insure that the said surfaces are free of contaminants. Usually, a light etch or roughening of the said surfaces is sufficient.

The pattern conforming to the areas to be non-bonded and subsequently expanded, is formed by applying a weld-resist which will successfully inhibit the welding at the pattern areas. The qualifications for the weld-resist are its ability to cling to the metal surface before and after a reheat of the metal, that it have stability at the relatively high reheating temperature (say 800–900° F.); that it is adequate to resist any substantial flow during the very high roll pressure used in bonding, and finally that it may be readily cleaned from within the resulting tubular areas, leaving no residue which might have corrosive or other bad effects.

As examples of the resist, molybdenum disulfide and colloidal graphite, or a larger particle size of graphite held in a resin binder, are satisfactory. The pattern may be applied by conventional methods, for example, the pattern may be applied by silk screen printing, spraying, or any conventional printing.

The pattern may be applied to the meeting surfaces of the two sheets, or where the pattern is homogeneous and sufficiently thick, to one sheet.

In roll bonding the two sheets it is desired that they enter into the hot mill at a temperature suitable for metallurgical bonding. Ordinary side edge guides at the hot mill, against which the edges of the two sheets will slide, are generally satisfactory without fastening the sheets in any way.

It is generally desirable that the roll bonding effect a reduction exceeding 55%. Thus, for example, in the composite thickness of two sheets amounting to 0.250" the composite was reduced 76%, which is adequate.

After the roll bonding of the two sheets they were annealed. Then a tube was welded into one entry port of the pattern as at 1, FIG. 1, the entry port 2 being closed. Of course, the hydrostatic expansion may be effected by hydrofluid admitted to both ports 1 and 2, FIG. 1.

The next step in our method is to place the bonded structure on a heavy platen 3, FIG. 5, with the stronger rigid sheet resting upon said platen. Thereupon a resilient blanket 4 is superimposed upon the opposite side of the

structure at which the tubular expansion is desired. Thereupon, a heavy platen 5 above the resilient blanket is brought down under pressure against the upper surface of the composite structure. Then the hydraulic fluid is introduced through the tube 6 and pumped into the pattern at a pressure 800–1000 p.s.i. to initially expand the pattern areas, under constant restraint by the resilient blanket. This initial expansion is approximately one-half the total expansion desired. At this point, when the resilient blanket is exerting counter pressure upon all surfaces which are under expansion, the pressure is increased well above 1000 p.s.i. and preferably more than twice that pressure. It is prfeerred that the final expansion pressure be 2500–3000 p.s.i. When this higher pressure was employed, it has been found that the tubular areas thus formed would withstand 3000 p.s.i. working pressures without breaking the bond or fracture.

For example, it is sufficient that the thickness of the resilient blanket, with a "hardness" by durometer test of 50–70, be not more than twice the degree of expansion of the tubular areas, the requirement being that a strong counter pressure by the rubber pad be maintained during the expansion, and particularly is this effective during the final expansion when the pressure rises to a very high degree. At the same time, satisfactory results have been secured with a blanket pressure not exceeding 2000 p.s.i. and as low as 500 p.s.i.

The purpose of the initial expansion is to completely open the areas defined by the resist pattern, and this occurs at about 1000 p.s.i.

The use of a hard wear-resisting flat sheet surface in an evaporator for household refrigerators, and many other uses, is desirable, because when formed up into box form the interior will have a smooth side without obstruction, and the evaporator will be of ideal durability. In some cases, however, both of the sheets, aluminum being preferred, may be of softer characteristic, as for example 2SO, and the same advantages but with lessened wear-resistance by the flat surfaces of the structure, will be obtained.

When it is desired, particularly in use of two bonded sheets of substantially equal physical properties, that the tubular areas extend at both sides of the structure, both sheets being expanded, this can be done, with great reduction of loss by defective production, through the use of a blanket such as shown at 4, FIGS. 5 and 6, at both faces of the bonded composite sheets. However, it is believed that the novel heat exchange structure exemplified at FIGS. 1 and 2, successfully produced by our method, is of very high utility and superior to those structures heretofore proposed in which the tubular areas are expanded at both sides of a composite structure in equal extent, this success being due to the lack of a commercial process capable of producing the said structure of FIGS. 1 and 2.

In FIG. 1 the evaporator has a refrigerant inlet at 2 and an outlet at 1. As the refrigerant passes through the tubular conduit communicating with inlet 2, the conduit consisting of the tubular areas 7, it passes to the rear conduit 8 and thence to the well 9 via the plural conduits 10. To strengthen this well 9 and the remaining wells, they may be bonded at spaced areas by a plurality of bar-like bonds. However, in FIG. 1, these bonded areas are disk-like in form and as indicated at 11. The refrigerant not evaporated passes through conduits 12 to accumulator well 13 and crosses to the accumulator well 14, thence to accumulator wells 15 and 16 and to the outlet at 1. It will be understood that the structure of FIG. 1 will be bent into box-like form as customary, at the appropriate bending or fold lines as shown by transverse broken lines in FIG. 1, and that the pattern may be widely varied. Also it will be understood that the invention is applicable to many heat exchange forms in addition to that illustrated in the drawings.

After applying the final tube forming pressure, that pressure is maintained with slow reduction thereof to enable gradual release of the resilient blanket counter pressure. This can be done by simultaneously releasing the hydrostatic pressure and the upper platen of the assembly shown in the drawing. This is preferable because the time of release can be shortened.

Having described our invention, what we claim and desire to secure by Letters Patent is as follows:

1. A method of expanding an unexpanded pressure welded passageway panel on one side comprising: clamping the unexpanded passageway panel between a pair of opposed rigid platens with a yieldable blanket interposed between one face of the panel and the adjacent platen and with the other face of the panel engaged in face-to-face engagement with the other platen; and, while holding said panel and blanket in a clamped condition, subjecting the panel passageway system to an internal expansion pressure to expand said one face of the panel into the adjacent blanket.

2. A method of expanding a passageway panel composed of at least two superposed bonded metal sheets including a back sheet and a front sheet and having an internal system of unbonded areas between the sheets providing a potential passageway, comprising: positioning the panel between front and back rigid platens with the back platen in face-to-face relationship with the back sheet of the panel; interposing a yieldable blanket between the front platen and the front sheet of the panel; relatively moving said platens toward each other to an operative position wherein they cooperate to clamp the interposed blanket and panel together to force and hold the back sheet of the panel in flat face-to-face engagement with said back platen and to force and hold the blanket against the front sheet of the panel over the entire area of engagement therebetween so that said blanket is operative to resist the subsequent expansion of the front sheet with a substantial counter-pressure acting over said entire area of engagement; and introducing an expansion pressure into the internal unbonded areas of the panel to expand the unbonded areas of the front sheet outwardly into said yieldable blanket.

3. The method of claim 2 including: introducing said expansion pressure into the panel in a plurality of increasing pressure stages, the first stage using a low pressure sufficient to separate the sheets along the unbonded areas of the panel and a subsequent stage using a relatively higher pressure to stretch expand the unbonded areas of the panel front sheet.

4. The method of claim 3 wherein: after expanding the panel, said expansion pressure and the blanket counter-pressure are substantially simultaneously slowly released.

5. The method of claim 4 wherein: the back sheet of the panel is relatively harder than the front sheet of the panel.

6. The method of claim 5 wherein: both of the metal sheets are aluminum.

7. A method of fabricating a hollow panel which comprises a sheet of metal having an internal passageway pattern formed therein, comprising the steps of providing a composite sheet of metal which has layers bonded together throughout their contact surface except in a predetermined passageway pattern, providing an inlet connection to said passageway pattern, holding a first surface of said composite sheet against a rigid surface by means of resilient material brought to bear against the other surface of said composite sheet, applying sufficient expansion pressure through said inlet to cause metal adjacent said passageway pattern to expand outwardly from said rigid surface to form a hollow passageway in said composite sheet while applying sufficient force to said resilient material to maintain the first surface of said composite sheet against said rigid surface, whereby said metal only expands into said resilient material and the first surface of said composite sheet remains essentially free of deformation.

8. In a process for fabricating a hollow panel having a smooth side and an opposite side having protrusions formed by distentions conforming to the hollow portion of

said panel, the steps comprising forming a blank by superimposing a first sheet on a second sheet having an elastic limit different from the elastic limit of said first sheet, joining a portion of said sheets together to define an enclosed unjoined area between adjacent surfaces of said sheets, clamping said sheets between a compressible and a rigid pressure pad with the sheet having the lower elastic limit being plastically deformable and mounted adjacent the compressible pressure pad, and applying a force within said unjoined area to outwardly distend not substantially more than said unjoined area of the sheet having the lower elastic limit into said compressible pad, thereby producing a hollow article which is substantially unchanged on one side and permanently distended on the less elastic side.

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