

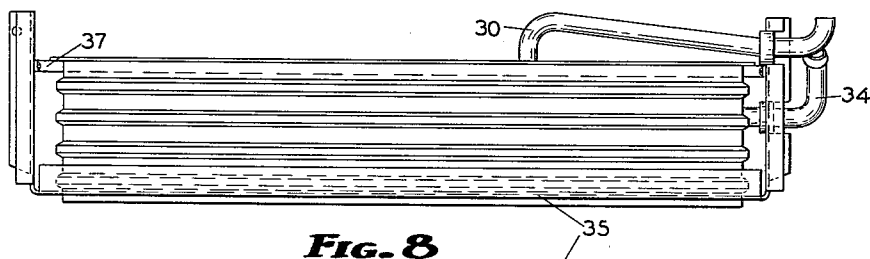
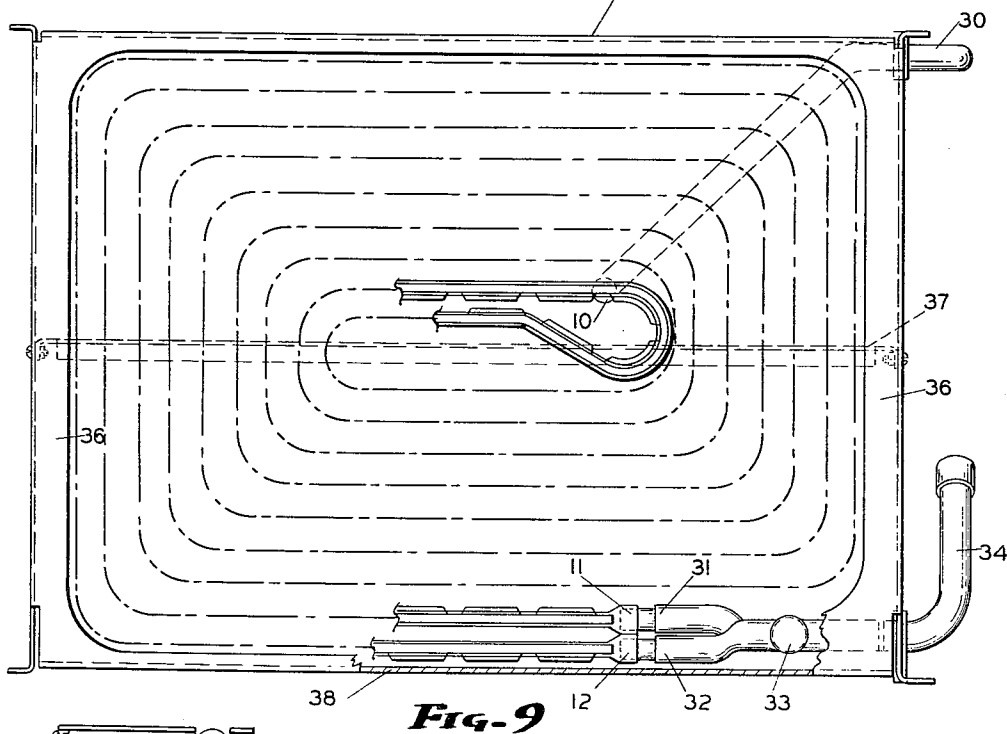
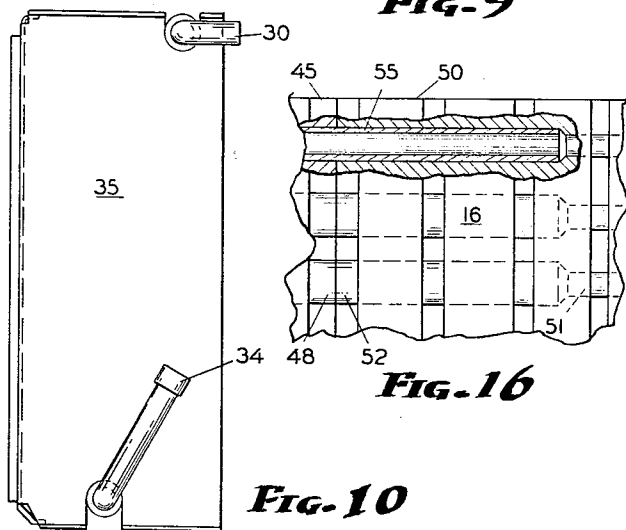
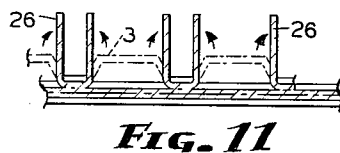
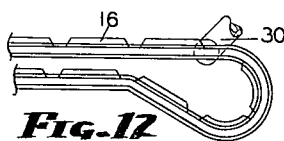
Sept. 12, 1961

W. G. REYNOLDS
SPIRAL HEAT EXCHANGER

2,999,305

Filed Dec. 27, 1955

3 Sheets-Sheet 2



INVENTOR.
WILLIAM G. REYNOLDS

BY

Arthur Robert

AT TORNEY

Sept. 12, 1961

W. G. REYNOLDS
SPIRAL HEAT EXCHANGER

2,999,305

Filed Dec. 27, 1955

3 Sheets-Sheet 3

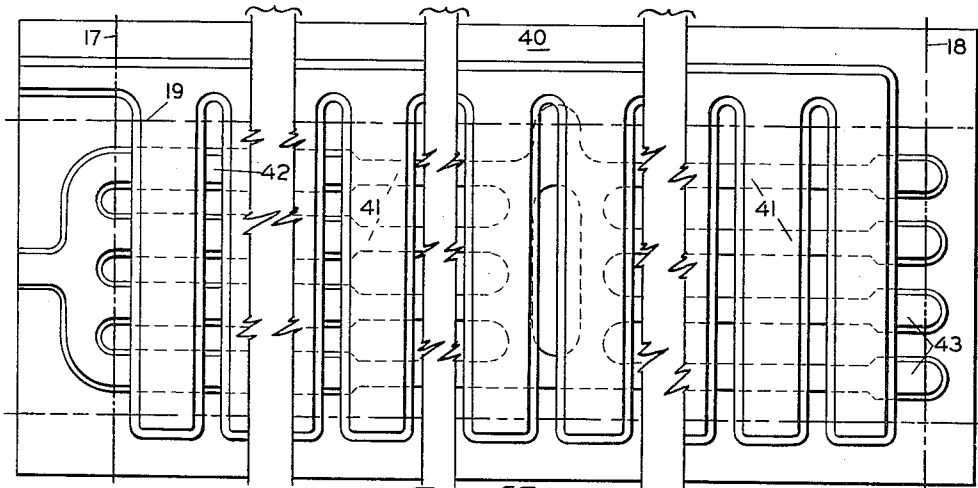


Fig. 13

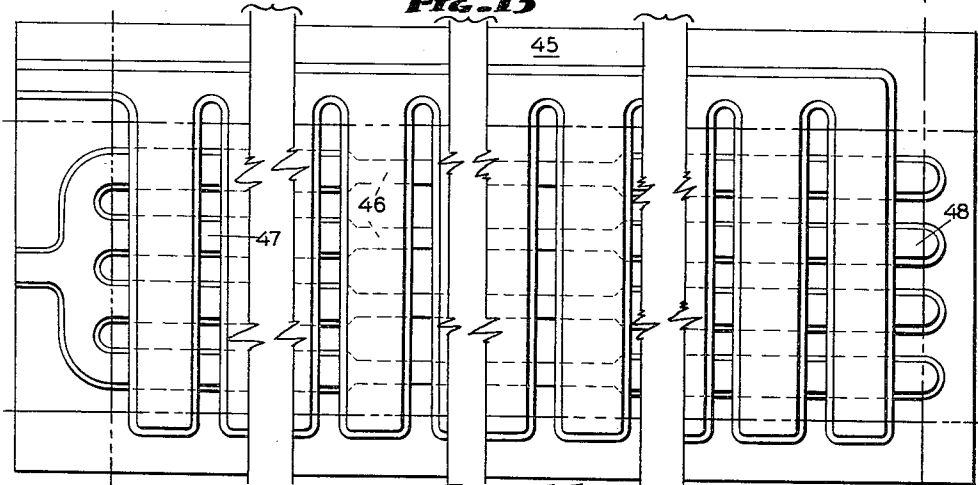


Fig. 14

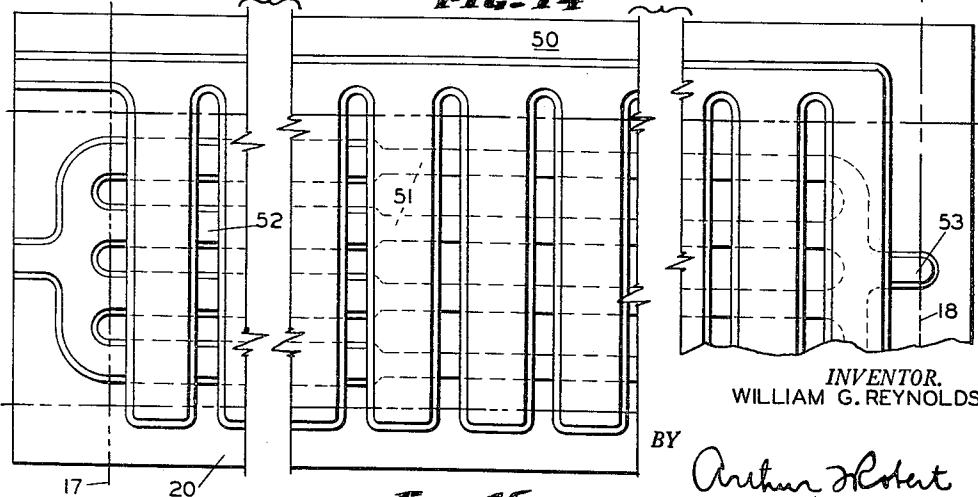


Fig. 15

INVENTOR.
WILLIAM G. REYNOLDS

BY

Arthur Robert

ATTORNEY

1

2,999,305

SPIRAL HEAT EXCHANGER

William G. Reynolds, Anchorage, Ky., assignor to Reynolds Metals Company, Louisville, Ky., a corporation of Delaware

Filed Dec. 27, 1955, Ser. No. 555,547

7 Claims. (Cl. 29-157.3)

The present invention relates to a roll-bonded heat exchanger.

It is an object of the present invention to provide a heat exchanger in the form of a spirally wrapped roll-bonded metal passageway panel incorporating one system of interior longitudinal channels or passages, which accommodate the longitudinal flow of one fluid along the panel and spirally through the heat exchanger, and another system of interior transverse channels or passages, which accommodate the transverse flow of another fluid across the panel and axially through the heat exchanger, these fluids being in heat transfer relationship with each other.

Another object is the provision of a heat exchanger, having spiral and axial fluid flows in heat exchange relation, which can be produced inexpensively.

Another object is the provision of a method of making a spiral heat exchanger in which the passageways and fins are integrally bonded together in a single operation.

According to the present invention, I provide a flat blank or panel by roll bonding together three sheets of metal, such as aluminum, in face-to-face relation, with a resist pattern between each pair of adjacent faces on opposite sides of the central sheet, each pattern defining a potential system of channels or passageways. The composite roll-bonded panel is expanded or dilated by internal pressure to form one system of longitudinally extending passageways and a second system of transversely extending channels connected together at one or both ends. By severing the end connections of the transverse channels, they may be converted into separate transverse passageways. When the flat panel is wrapped into a spiral, bonded portions of the panel, between passageways, act as fins joining the spiral passageways, and the walls forming the expanded transverse passageways may serve as spacers to hold the convolutions in proper relation. As the transverse passageways are open at the ends, they provide passageways or fins for guiding the transverse flow of fluid past the spirally directed tempering fluid.

If desired, these transverse passageways may have their outer walls split longitudinally and straightened to form fins extending axially and generally normal to the surface of the panel.

Either two panels may be spirally wrapped in interlocking relationship or, as preferred, one panel may be bent upon itself and wrapped double from the center outwardly, thus bringing the two outer ends into adjacent or proximate relationship. The inlet and outlet connections to the spiral passages can be made at the ends and the middle in any suitable manner. This double wrapped arrangement is specially suitable for a heat exchanger intended to carry volatile refrigerant.

The invention is illustrated in the accompanying drawings wherein:

FIGURE 1 is a plan view of a roll-bonded panel having two systems of expanded passageways;

FIGURES 2-7 are sectional views taken through FIGURE 1 along lines ranging from 2-2 to 7-7 respectively;

FIGURE 8 is a top plan view of a radiator incorporating a spirally wrapped panel in accordance with my invention;

FIGURES 9-10 are elevational views of the front face

2

and a side face of the heat exchanger shown in FIGURE 8;

FIGURE 11 is a detail showing one modification;

FIGURE 12 is a detail showing another modification;

FIGURES 13-15 are plan views, similar to FIG. 1, of three expanded panels which are to be joined in end-to-end relationship and which are modified to facilitate such joinder; and

FIGURE 16 is a detail showing a method of joining the ends of two panels together.

FIGURE 1 is a plan view of an intermediate product made in the form of an expanded roll-bonded sheet metal passageway panel composed of at least three elongate roll-bonded metal sheets 1, 2 and 3.

The unbonded areas in FIGURE 1 have been expanded to form a longitudinal system of channels between sheets 1 and 2, and a transverse system of channels between sheets 2 and 3. This intermediate panel, in its expanded form, was made by performing the following steps: assembling the original blank by superposing three foreshortened sheets, corresponding to the elongated sheets 1, 2 and 3, with foreshortened weld-resist patterns of appropriate design interposed between each pair of adjacent faces; roll-bonding this assembly not only to elongate the sheets and resist patterns, but also, at the same time, to weld the sheets together at all areas except those containing the resist material and thereby form a composite but unexpanded sheet metal panel; positioning the pressure-welded panel between flat expansion-limiting and flattening dies; adjusting the spacing of the dies pursuant to the Long Patent No. 2,662,273; introducing an expansion fluid under pressure (3000 p.s.i.) into the between-sheet space, extending along the unbonded areas of sheets 1 and 2, to stretch-expand said unbonded areas outwardly into flattening contact with the dies so as to form a longitudinal system of channels between sheets 1 and 2; locking the expansion fluid in the longitudinal system; adjusting the spacing of the flat dies to the wider spacing required by the next expansion operation; and introducing an expansion fluid under pressure into the between-sheet space, extending along the unbonded areas of sheets 2 and 3, to stretch-expand said unbonded areas outwardly into flattening contact with the dies so as to form a transverse system of channels between sheets 2 and 3.

The longitudinal system of channels, illustrated in FIGURE 1, comprises: a transverse end header 5; several parallel elongate passageways 6 extending longitudinally from one side of end header 5 to the adjacent side of the next adjacent transverse or central header 7; and several elongate passageways 8, extending longitudinally from the other side of central header 7 to the adjacent side of another transverse end header 9. The central header has a laterally directed protuberance 10, while the end headers 5 and 9, each have a longitudinally directed protuberance, one designated 11 and the other 12. The protuberances 10 and 12 stop short of the margin of the blank and are thus closed by dead ends. The resist pattern for the protuberance 11 was extended to the rim of the blank to facilitate access to the unbonded areas for fluid expansion purposes; hence the expanded protuberance 11 openly extends to the rim of the blank.

The transverse system of channels, illustrated in FIG. 1, comprises: an expansion fluid inlet 14 formed in the same manner and at the same (left) end of the blank as the open protuberance 11, which provides an expansion fluid inlet 11 for longitudinal systems; a side marginal header 15 extending from the expansion fluid inlet 14 longitudinally along one side margin of the blank up to a point short of the opposite end of the blank; and a series of longitudinally spaced, laterally extending cross channels 16 which, at one end, openly communi-

cate with the marginal header 15 at regular intervals along its length and which are closed by dead ends adjacent the opposite side margin of blank, these lateral or transverse channels 16 being individually designated by successive letters of a series running from "A" to "N."

The blank of FIG. 1 is processed to form the composite panel used in the radiator of FIGS. 8-10 by severing its marginal end portions along marginal end lines 17 and 18 and its marginal side portions along marginal side lines 19 and 20. The longitudinal system is thus trimmed at protuberance 11 by severing along end line 17 and provided with a side central opening 10 and an end opening 12 at side and end protuberances 10 and 12 by severing along the side and end of lines 19 and 18 respectively. The transverse system is simultaneously converted, from a comb-like system of interconnecting channels into a series of separate open-ended longitudinally-spaced, transversely-extending channels 16, by the severance operations along the marginal side lines 19 and 20.

The sheet 3 which forms the outer wall of the transverse channels, may, if desired, be made relatively thin since it does not have to confine any great pressure except for the expansion. Because it is thin, the expansion pressure may be lower. Also, it may be duplicated on the other side of the blank to provide cross channels on that side also. We have omitted any disclosure of cross channels on the opposite side but this has been done solely for the sake of clarity.

The trimmed panels may now be wound from end to end to form a spiral heat exchanger. If desired, a pair of panels (not shown) may be placed one upon the other and wound end-to-end into a spiral heat exchanger. Preferably, however, a single panel is doubled back upon itself at a point adjacent its side marginal connection 10 and then spirally wound to form the desired exchanger. This heat exchanger will have one fluid connection 10 at its center and two fluid connections 11 and 12 at its periphery. The connections 10, 11 and 12 are provided with terminal tubes 30, 31 and 32 respectively, the tubes 31 and 32 connecting into a single header 33 having an outlet terminal tube 34. While the center terminal tube 30 may function as an outlet and the peripheral terminal tube 34 as an inlet, I prefer the reverse arrangement; hence, shall hereinafter refer to tube 30 as the inlet tube and 34 as the outlet tube.

The spiral heat exchange panel is now inserted within the perimeter of a shroud 35 and is held therein by the endless marginal flange 36 at the front face of the shroud and the brace bar 37 across the rear face of the shroud. The central opening of the spiral may be obstructed or closed in any suitable way. This will complete the construction of the radiator.

FIG. 11 illustrates a change in which the outer walls of the transverse channels 16 are split centrally, in a direction extending across the panel, and then bent outwardly to form straight fins 26. The walls forming the transverse passages 16 or the fins 26 may serve as spacers when spirally winding the panel. However, other spacers may be provided wherever desirable or necessary.

FIGURE 12 shows a modification in which the transverse passageways 16, located on one side of inlet tube 30, are along one outer face of the panel, say between sheets 2 and 3, while on the other side of inlet tube 30, these transverse passageways are along the other outer face of the panel between sheets 1 and 2. The location of the longitudinal system on one side of inlet tube 30 is likewise the reverse of that which occurs on the other side of inlet tube 30. The passageways of one half of the longitudinal system are preferably connected to the passageways of the other half thereof through suitable openings (not shown) in the center sheet. Of course, there is no such reversal where two systems of transverse channels are employed, one along each outer face of the panel.

The spiral heat exchanger may, where desired, be made

of a series of separate panels suitably joined together. For example, I illustrate in FIGURES 13-15, a center panel 40, an intermediate panel 45 and an end panel 50. Each of these panels is made in the same general way as FIGURE 1. Each, when trimmed along lines corresponding to lines 17-20 of FIGURE 1, has a longitudinal system of passageways and a series of open ended passages. These trimmed panels are general similarly to the panel of FIGURE 1, except that: the center panel 40 has its longitudinal passageways 41 cross-sectionally enlarged at opposite ends to provide terminals 42 and 43; the intermediate panel 45 similarly has its longitudinal passageway 46 terminate, at the opposite ends, in enlarged terminals 47 and 48; while the end panel 50 has its longitudinal passageways 51 terminate at one end in a series of enlarged terminals 52 and, at its opposite end, in an enlarged outlet terminal 53. The enlarged terminals are not enlarged outwardly at right angles to the major plane of the sheet but they are enlarged in the direction of the major plane thereof. In other words, they are made wider in the plane of the panel.

It will be understood that these panels are assembled by connecting center panel terminals 43 to intermediate panel terminals 47 and intermediate panel terminals 48 to end panel terminals 52. These connections may be made in the manner indicated in FIG. 16 wherein the ends to be connected are brought into aligned abutting end-to-end relationship and each terminal on one panel is connected to the corresponding terminal of the next panel by an inner tube 55 which is welded or otherwise suitably secured to both panels.

Naturally, any desired number of intermediate sections can be interposed in end-to-end relationship between the center panel and the end panel while each panel may be of desired length. Ordinarily the length of the panel will be so chosen that the joints between panels do not coincide with any sharp bends which may be required in the panels of the ultimate product. By making the product in panel sections, the manufacturing procedures and equipment can be standardized whereby substantial reductions can be made in manufacturing costs.

Having described my invention, I claim:

1. A method of making a heat exchanger comprising: forge welding at least three sheets of metal into a composite panel with one resist pattern between one pair of adjacent faces to prevent welding along areas forming one potential system of passageways for the flow of fluid longitudinally along said panel and with another resist pattern between another pair of adjacent faces to prevent welding along areas forming another potential system of passageways for the flow of fluid transversely of said panel and across said one potential system of passageways; expanding one of said potential systems of passageways to one height; thereafter, expanding the other system of potential passageways to a relatively greater height; and spirally wrapping said panel about a transverse axis.

2. The method of claim 1 including: performing the second expansion operation while maintaining enough liquid in the earlier expanded system to prevent collapse under outside pressure while expanding the other system of passageways.

3. A method of making a heat exchanger comprising: forge welding at least three sheets of metal into a composite panel with one resist pattern between one pair of adjacent faces to prevent welding along areas forming one potential system of passageways for the flow of fluid longitudinally along said panel and with another resist pattern between another pair of adjacent faces to prevent welding along areas forming another potential system of passageways for the flow of fluid transversely of said panel and across said one potential system of passageways, said second resist pattern being designed to include a longitudinally extending marginal header section having, for said second system, transverse passageway-forming sections projecting transversely from it at intervals along its

5

length; expanding one of said potential systems of passageways to one height; thereafter, expanding the other system of potential passageways to a relatively greater height; after expansion, trimming said panel to remove said header section; and spirally wrapping said panel about a transverse axis.

4. The method of claim 3 wherein: after expansion, the transverse passageways are slit along their lengths to form fins.

5. The method of claim 1 wherein: after expansion, the walls of the transverse passageways are slit along their lengths to form fins.

6. In a method of making a heat exchanger: assembling at least three superposed foreshortened sheets with foreshortened weld resist patterns interposed between each pair of adjacent faces; roll bonding this assembly to elongate the sheets and resist patterns and simultaneously weld the sheets together at all areas except those containing the resist material; introducing a liquid under pressure into the between-sheet space extending along the unwelded portions corresponding to one resist pattern to expand such unwelded portions into passageways; locking the expansion liquid therein; and introducing an expansion fluid under pressure into the between-sheet space extending along the unwelded portions corresponding to the other resist pattern to expand such portions into passageways.

6

7. The method of claim 6 wherein: the liquid introduction step is performed with said sheets supported between expansion limiting dies having one spacing; and the expansion fluid introduction step is performed with said sheets supported between expansion limiting dies having a greater spacing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,712,085	Little	May 7, 1929
1,775,819	Fischer et al.	Sept. 16, 1930
2,088,391	Steinberg et al.	July 27, 1937
2,289,685	Schoen	July 14, 1942
2,312,451	Strike	Mar. 2, 1943
2,375,334	Valyi et al.	May 8, 1945
2,662,273	Long	Dec. 15, 1953
2,845,695	Grenell	Aug. 5, 1953
2,657,018	Simpelaar	Oct. 27, 1953
2,759,247	Grenell et al.	Aug. 21, 1956
2,766,514	Adams	Oct. 16, 1956
2,779,173	Wurtz	Jan. 29, 1957
2,859,509	Adams	Nov. 11, 1958

FOREIGN PATENTS

205,695	Australia	Nov. 1, 1956
---------	-----------	--------------