Oct. 20, 1953 P. HODSON ET AL 2,656,158

PLATE TYPE HEAT EXCHANGER AND METHOD OF MANUFACTURING SAME

Filed July 23, 1948 2 Sheets-Sheet 1

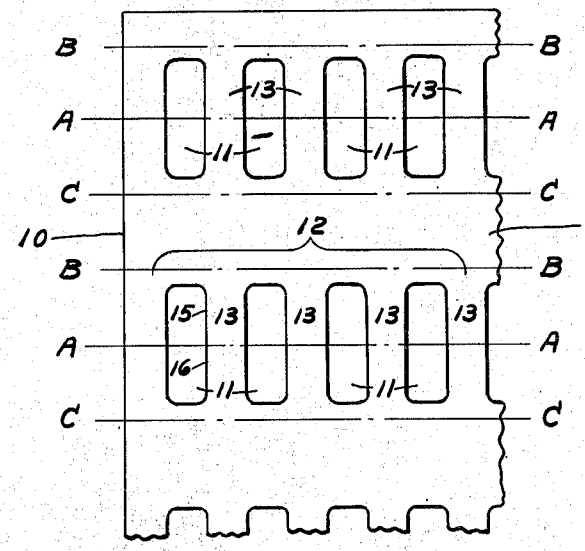


Fig. 1.

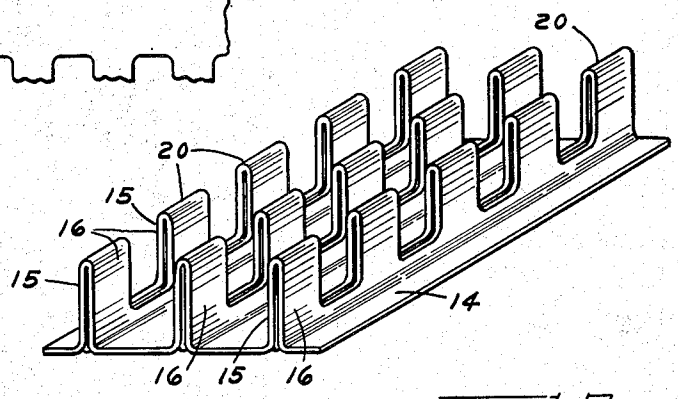


Fig. 2.

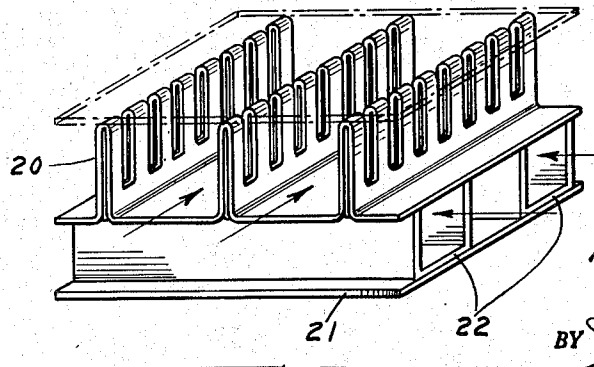


Fig. 3.

ERNEST A. LUNDSTROM
AND PETER HODSON
INVENTORS

BY James J. Whaley

Oct. 20, 1953

P. HODSON ET AL
PLATE TYPE HEAT EXCHANGER AND
METHOD OF MANUFACTURING SAME

2,656,158

Filed July 23, 1948

2 Sheets-Sheet 2

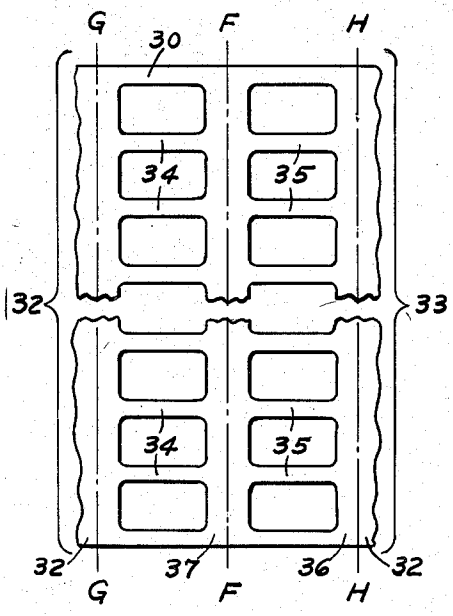


Fig. 4.

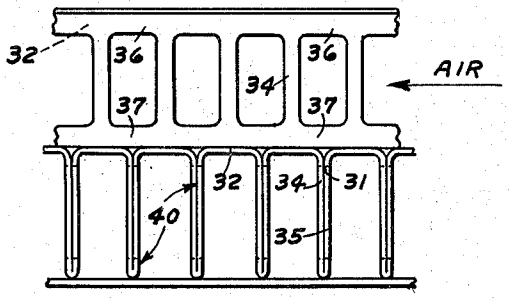


Fig. 5.

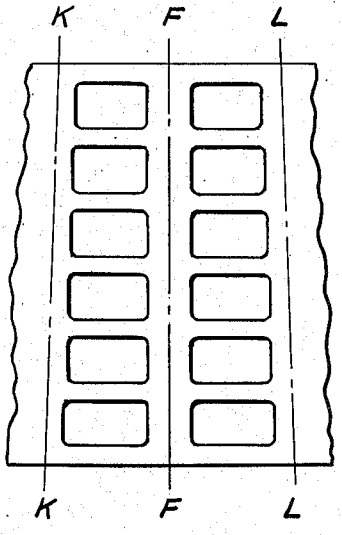


Fig. 6.

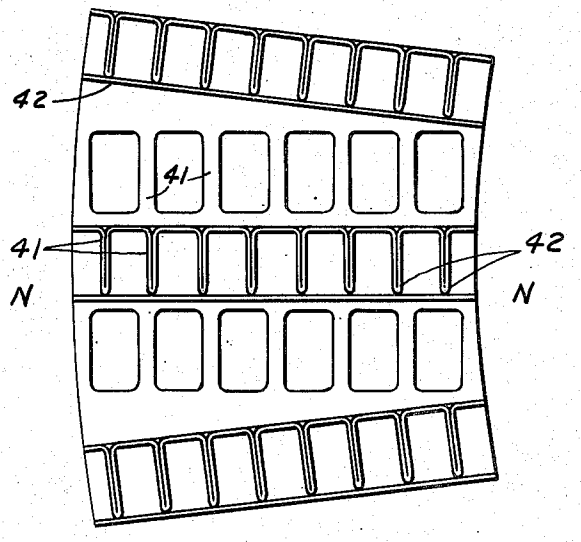


Fig. 7.

ERNEST A. LUNDSTROM
AND PETER HODSON
INVENTORS

BY James J. Whalen

Patented Oct. 20, 1953

2,656,158

UNITED STATES PATENT OFFICE

2,656,158

PLATE TYPE HEAT EXCHANGER AND METHOD OF MANUFACTURING SAME

Peter Hodson, Wellsville, and Ernest A. Lundstrom, Valley Stream, N. Y., assignors to The Air Preheater Corporation, New York, N. Y.

Application July 23, 1948, Serial No. 40,336

10 Claims. (Cl. 257—245)

1

The present invention relates to heat exchange apparatus and particularly to a method of manufacturing heat exchanger components provided with extended surface in the form of pin-like fins or interrupted strip fins.

Various types of heat exchangers particularly those of the envelope type having passages formed by spaced plates for confining the fluids in heat exchange relationship are frequently provided with extended surface in the form of fins intended to increase the efficiency of heat transfer from a heated fluid on one side of the passage wall to a cooler fluid on the other side of the wall. The present invention contemplates the provision of finned components for use in heat exchangers either as a plate to form the walls of a fluid passage or as a member to be inserted in the passages of a regenerative exchanger to provide greater efficiency in heat exchange. Specifically, the invention involves methods of first forming perforations in a plate and then bending it to form projections from its surface which will function as heat exchange fins.

The invention will be best understood upon consideration of the following detailed description of illustrative methods when read in conjunction with the accompanying drawings in which:

Figure 1 is a plan view of a perforated plate from which a heat exchange component is formed;

Figure 2 is a perspective view illustrating the manner in which the plate is bent to provide the heat exchange fins;

Figure 3 is a fragmentary perspective view illustrating the use of the heat exchange components to form envelopes for a two fluid heat exchanger.

Figures 4 and 6 are plan views of sheets perforated for forming alternative arrangements of the fin surface;

Figure 5 is a fragmentary sectional view through part of a heat exchanger embodying finned surface formed from the plate shown in Figure 4; and

Figure 7 is a sectional view through part of a heat exchange core of annular form embodying finned surface created from the plates illustrated in Figures 4 and 6.

In accordance with the invention the first step in the process of making finned heat exchange components is to punch or otherwise form in a plate 10 (Fig. 1) a plurality of perforations 11 disposed in parallel rows 12 with the perforations alined from row to row or offset if it is desired to stagger the pin-fins. The plate is then creased on the lines A—A extending along the axis of the rows 12 of openings and bent in what may be termed an upward direction along the lines B—B and C—C located at either side of each row 12 at perforations 11 to raise the ligaments 13 that remain after punching the openings 11 above the surface of the unbent portions 14 of the plate. Thus, the halves 15, 16 of each ligament 13 at either side of the crease line A—A are raised from the surface 14 of the plate and drawn together to create a series of projecting tabs or fins 20 alined in a plurality of parallel rows extending transversely of the plate, the perforations 11 becoming notch-like spaces between the fins. The erection of the ligament portions 13 to form the tab-like fins 20 results in the fins automatically alining with each other in rows extending transversely of the plate. This produces interrupted strip-fins extending in one direction on the plate. By narrowing the width of the ligaments 13 the tabs 20 become more and more pin-like. The ligament portions 15, 16 are then brazed together. When a fin is bonded to a plate that separates passages the heat to be transferred must traverse a double thickness of metal, i. e. the piece forming the fins and the wall itself. This increases the resistance to heat flow which is proportional to the thickness. Furthermore, it is difficult to assure that each fin is perfectly bonded to the wall separating the passages and lack of metal to metal contact in this region seriously affects heat flow. By forming the fins integral with the plate and using brazing or welding as a seal to prevent flow through the perforations made in the plate, one also assures perfect contact between the fins and plate without double thicknesses of plate being required.

2

When used in a heat exchanger a number of complete elements 21 each having a multiplicity of tab-like fins 20 may be stacked upon each other or with intervening plates 21 have channel fins 22 as illustrated in Figure 2 and then brazed together so that the portions 14 form walls of the fluid passage having the fins 20 extending therefrom. Alternatively, complete elements 21 stacked together (with or without brazing) into a unitary mass may be inserted in the fluid passages of a regenerative heat exchanger, for example, to absorb and temporarily store heat from gases before imparting to air or other fluids.

The plate 30 illustrated in Figure 4 has rows of perforations 31 disposed in pairs separated by a portion 32 of the plate which becomes part

of the passage wall. In this alternative method the plate **30** is creased on the lines F—F lying between the two rows of a pair. Thus the bend line is at the base of the ligaments **34, 35** between the perforations in the various rows. The plate **30** is then bent in an upward direction on the lines G—G and H—H so that entire ligaments **34** between the perforations in the row **32** are brought into contact with entire ligaments **35** between the perforations in the row **33**. The double thickness fins **40** thus raised from the surface of the plate when viewed in side elevation present the appearance of a perforated strip as appears in the upper part of Figure 5 while in end elevation each double thickness fin **40** is spaced from the adjacent fins and connected thereto by portions **32** of the plate.

This form of finned plate is particularly adapted for use in a heat exchanger wherein the core is of annular cross section as illustrated in Figure 7, since by slanting the bend lines K and L with respect to the axes of the row of perforations as indicated in Figure 6 the plate portion **32** between the rows **34, 35** of perforations will in effect be progressively wider along the core radius with one side **42** of the finned strip tapered to accommodate the radial flow passages of the annular core while the distal ends **42** of the pin-fins will lie in a common plane N—N coinciding with the radius on the opposite wall of the passage. Fig. 7 shows a portion of a core of annular shape in which one fluid flows parallel to the center of the core in the passages **43** while the other fluid flows radially in the passages **44**. This type core is made by alternating plates **32** bent as shown in Fig. 4 for the passages normal to the radius with plates **46** bent as shown in Fig. 6 for the radial passages. The progressively longer fins **41** will allow these latter passages to taper toward a common center resulting in a core having an annular shape.

What we claim is:

1. The method of forming a finned heat transfer element of plate form for use in a heat exchanger which comprises; forming in the surface of a plate of heat exchange material a plurality of spaced perforations alined in parallel rows; creasing the plate along lines parallel to one edge of said plate for raising the ligaments remaining between perforations from the surface of the plate; squeezing the raised ligament portions of the plate into contact; and welding or brazing the ligament portions together for forming unitary fins and sealing off fluid flow through said perforations from one side of the plate to the other.

2. The method of forming a finned heat transfer element of plate form for use in a heat exchanger which comprises; forming in the surface of a plate of heat exchange material a plurality of spaced perforations alined in parallel rows; folding the ligaments remaining in the plate between perforations upwardly along lines parallel to the axis of the rows and at either side thereof to raise the ligaments from the surface of the plate; creasing the raised ligaments along lines corresponding to the axis of the rows of apertures and squeezing together the up-folded ligament portions to create tab-like fins of double thickness projecting from the surface of the plate; and welding or brazing the thickness of the tabs to each other to form unitary fins.

3. The method of forming a finned heat transfer element of plate form for use in a heat exchanger which comprises; forming in the surface of a plate of heat exchange material a plurality of spaced perforations alined in parallel rows; creasing the ligaments remaining in the plate between perforations along lines corresponding to the axis of the rows of apertures and bending the plate upwardly along lines parallel to the axis of the rows and at either side thereof to raise the ligaments from the surface of the plate; squeezing together the up-folded ligament portions to create tab-like fins of double thickness projecting from the surface of the plate; and welding or brazing the thicknesses of the fin to each other to form unitary fins.

4. The method of forming a finned heat transfer element of plate form for use in a heat exchanger which comprises; forming in the surface of a plate of heat exchange material a plurality of spaced perforations alined in parallel rows; bending the plate along lines parallel to the rows of perforations to raise the ligaments between the latter from the surface of the plate as spaced fins; squeezing the raised ligament portions of the plate into contact and welding or brazing them together.

5. The method of forming a finned heat transfer element of plate form for use in a heat exchanger which comprises; forming in the surface of a plate of heat exchange material a plurality of spaced perforations alined in parallel rows; creasing the plate along lines extending between two contiguous rows of perforations and bending the plate upwardly along fold lines at either side of said pair of rows of perforations to raise the ligaments remaining between perforations from the surface of the plate; squeezing the creased ligaments in contact and bonding them together to form fins projecting from the plate surface.

6. The method of forming a finned heat transfer element of plate form for use in a heat exchanger which comprises; forming in the surface of a plate of heat exchange material a plurality of spaced perforations alined in parallel rows; bending the plate in an upward direction along parallel fold lines lying at either side of each contiguous pair of rows of perforations to raise the ligaments between perforations from the surface of the plate; creasing the plate along lines parallel to said fold lines to bring the ligaments between the perforations of one row into contact with those between the locations of the contiguous row; and welding or brazing the raised ligaments together for forming unitary fins projecting from the plate surface.

7. The method as recited in claim 5 wherein the plate is bent along divergent fold lines.

8. In a heat exchanger; a wall member separating passages for two streams of fluid between which heat is to be exchanged consisting of a plate member having a plurality of rows of closely spaced narrow tab-like fins projecting from its surface, said tab-like fins comprising doubled ligament portions of the plate located between perforations spaced in rows therein, abutting faces of said doubled ligament portions being bonded together so as to prevent leakage of fluid from one side of said plate wall to the other side thereof.

9. In a heat exchanger; a wall separating the passages for two streams of fluid between which heat is to be exchanged consisting of a plate member having a plurality of rows of closely spaced narrow tab-like fins projecting from its surface and made up of half-parts of narrow plate ligaments between perforations spaced in

rows therein, said half parts of plate ligaments in an abutting relation and bonding material joining said ligament portions to form integral narrow fins thereof to prevent leakage from one side of said plate wall to the other side thereof.

10. A heat exchanger made up of a plurality of wall members formed as recited in claim 9 stacked upon each other so as to provide a core in which all of the walls separating passages for fluid flow are formed from plate members with fins integral therewith located in the passages.

PETER HODSON.
ERNEST A. LUNDSTROM.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
349,060	Serve	Sept. 14, 1886
1,037,754	Gildersleeve	Sept. 3, 1912
1,048,107	Stolp	Dec. 24, 1912
1,057,294	Streichert	Mar. 25, 1913
1,369,806	Hanmer	Mar. 1, 1921
1,797,030	Steenstrup	Mar. 17, 1931
1,927,329	Whitlock	Sept. 19, 1933
1,960,510	Ridgway	May 29 1934
2,222,721	Ramsaur	Nov. 26, 1940
2,291,945	Bowers	Aug. 4, 1942
2,386,159	Elder	Oct. 2, 1945
2,429,508	Belaieff	Oct. 21, 1947

FOREIGN PATENTS

Number	Country	Date
14,904	Great Britain	of 1901
510,206	Great Britain	Sept. 14, 1886
574,949	Great Britain	Jan. 28, 1946
573,873	France	of 1924