

Feb. 12, 1952

R. A. SANDBERG

2,585,043

HEAT EXCHANGER

Filed July 2, 1948

2 SHEETS—SHEET 1

Fig. 1

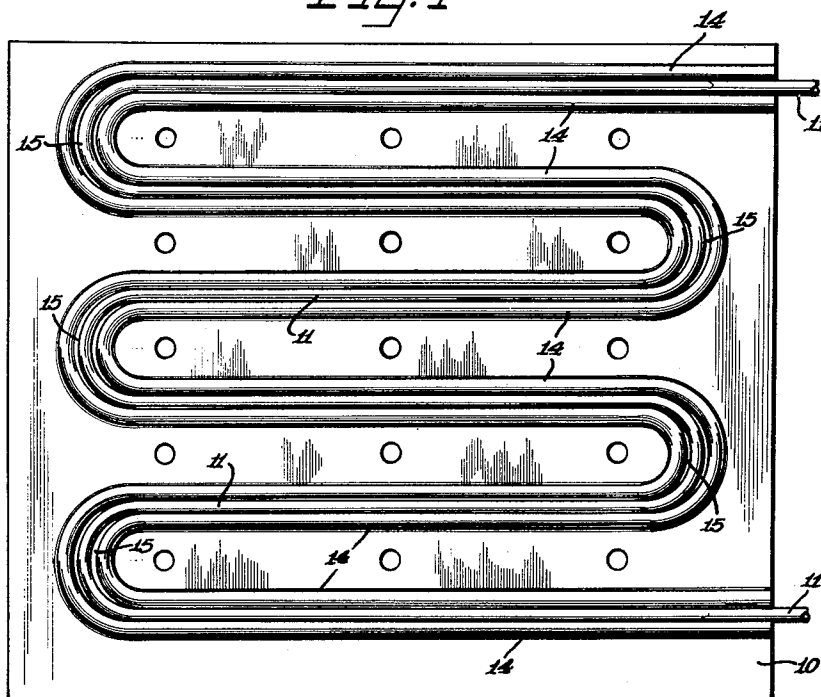
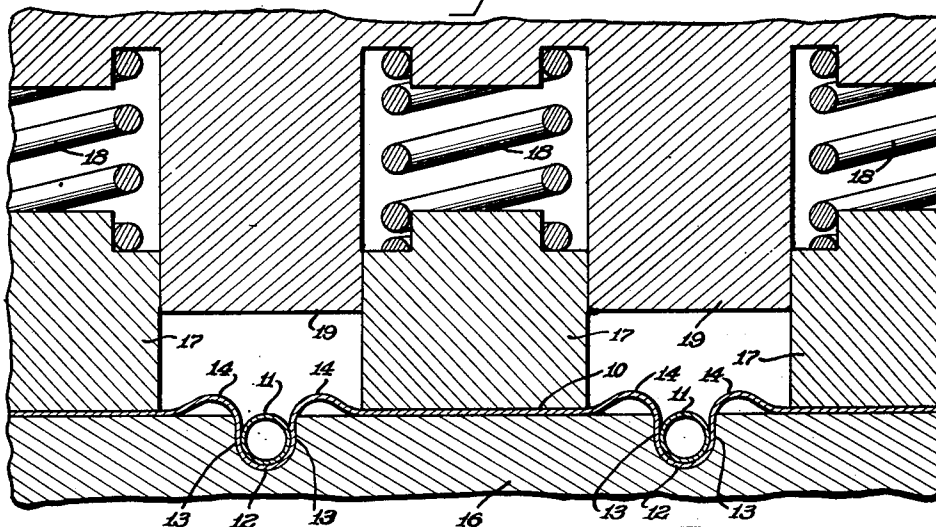


Fig. 2



Inventor
Ray A. Sandberg

By The Firm of Charles H. Hellys
ATTY

Feb. 12, 1952

R. A. SANDBERG

2,585,043

HEAT EXCHANGER

Filed July 2, 1948

2 SHEETS—SHEET 2

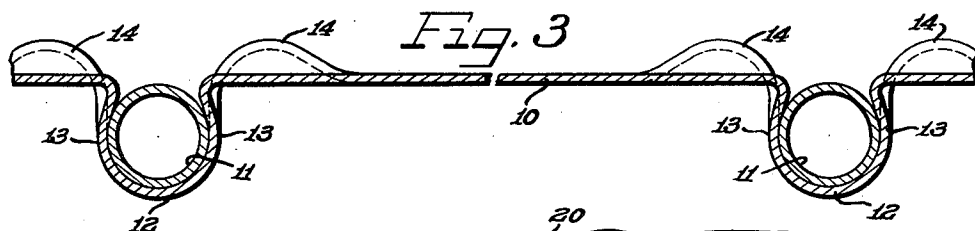


Fig. 4

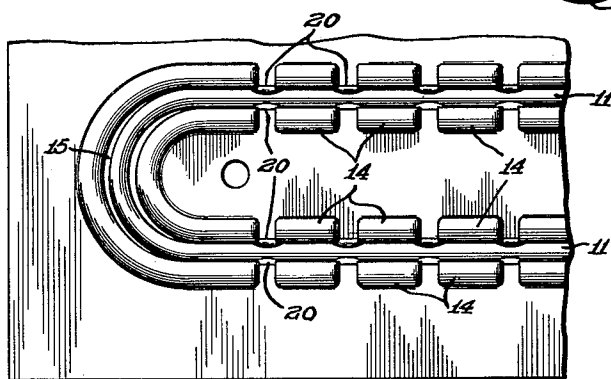


Fig. 5

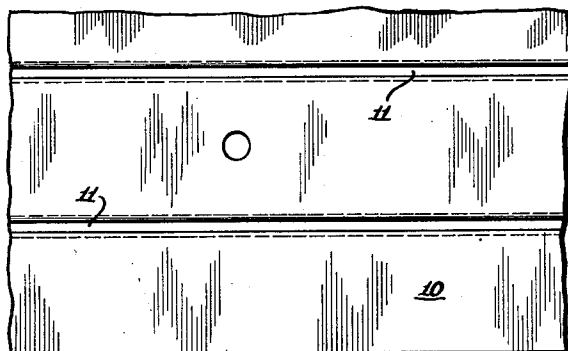
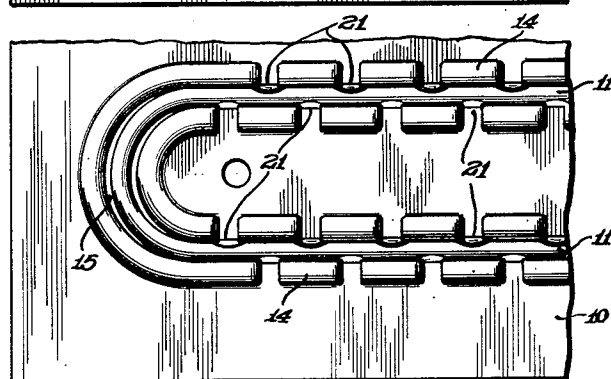


Fig. 6



Inventor
Ray A. Sandberg

By *John M. of Charles M. Hittys*

UNITED STATES PATENT OFFICE

2,585,043

HEAT EXCHANGER

Ray A. Sandberg, Waukegan, Ill., assignor to
Houdaille-Hershey Corporation, Detroit, Mich.,
a corporation of Michigan

Application July 2, 1948, Serial No. 36,598

2 Claims. (Cl. 257—256)

1

This invention relates to a heat exchanger and method of construction thereof and is specifically concerned with the provision of an efficient heat exchanger of the plate and tube type and a method whereby the same may be economically manufactured.

The present heat exchangers of the plate and tube type are of a construction wherein the tubes are welded or brazed to the surface of the plate, or in shallow depressions formed therein. These constructions are expensive and are subject to the further objection that the area of plate and tube contact is not sufficiently great to assure effective heat transfer. Increasing this area by flattening the tube involves an expensive operation that frequently results in weakening or rupturing the tube.

The present invention provides a method of construction wherein the plate is first embossed to provide a depression therein having an arcuate bottom surface corresponding to the outside diameter of the lower half of the tube and a depth sufficient to receive the entire tube. The metal of the plate is gathered during the embossing operation so that upwardly projecting ridges of metal remain along each side of the depression after the embossing is completed. The tube is then placed in the embossed depression. Thereafter with the bottom of the plate firmly supported by a suitable backing die and with the upper surface thereof also firmly held outside the ridges to prevent outward movement of the metal forming such ridges, a suitable movable die or punch is brought into pressure contact with the ridges to flatten the same or portions thereof sufficiently to close the open portions of the depression enough to tightly engage the tubes therein above the median diameter thereof and secure the same permanently in the plate. This inward working of the metal of the ridges causes the same to take a resilient set whereby the metal of the plate within the depression resiliently engages a large portion of the outer surface of the tube therein.

The resulting structure is one wherein the plate and the tube embedded therein are permanently held in associated relationship and wherein a large area of efficient heat transfer contact between the tube and plate is established and maintained.

It is therefore an important object of this invention to provide an efficient plate and tube type of heat exchanger which may be economically manufactured in accordance with the methods herein disclosed.

2

Other and further important objects of the present invention will be apparent from the disclosures in the following specification and in the accompanying drawings.

5 The invention in a preferred form is shown on the drawings and hereinafter more fully described.

On the drawings:

Fig. 1 is a plan view of a plate condenser unit constructed in accordance with the method of this invention showing the condenser tubes in position within the embossed depressions prior to performance of an operation which permanently affixes the tubes in the plate.

15 Fig. 2 is an enlarged fragmentary sectional view showing the arrangement and relative positions of the holding dies, backing die and punches which are used in flattening the ridges adjacent the embossed depressions for securing the tubes within such depressions.

20 Fig. 3 is an enlarged fragmentary sectional view showing the relative relationship of the plate and tube after portions of the ridges have been flattened to secure the tubes within the depressions in the plate.

25 Fig. 4 is a fragmentary plan view showing one method of securing the tubes within the embossed depressions.

30 Fig. 5 is a view similar to Fig. 4 showing another method of securing the tubes within the depressions which involves flattening of the entire projecting ridges.

35 Fig. 6 is a view similar to Fig. 4 showing another method of securing the tube within the depression in the plate by alternate flattening of portions of the upstanding ridges on either side of the depression.

As shown on the drawings:

The reference numeral 10 indicates a usual backing plate which has a continuous depression formed therein as by stamping, such depression being of suitable configuration to receive a condenser tube 11. As shown in Fig. 1 the depression formed in the plate is of serpentine configuration in order to accommodate a greater length of tube and the tube 11 is ordinarily preformed so that it may be readily engaged within the embossed depression.

45 The embossed depression within the plate consists of a bottom portion 12 which corresponds to the outside diameter of the tube 11 and engages the outer half of the lower wall of the tube to approximately its median diameter. The metal forming the bottom portion 12 of the depression 50 has side walls 13 which extend upwardly and

3

terminate in ridges 14 projecting above the surface of the plate at either side of the depression (see Fig. 2). These ridges 14 result from a gathering of the metal of the plate during the embossing operation.

In order to accommodate the depression for certain irregularities in the formation of the tube 11 which as above noted is preformed to the serpentine configuration shown in Fig. 1, the depression formed in the plate is preferably made wider at the curved ends of the serpentine path to allow a clearance as shown at 15. This clearance permits of easy positioning of the serpentine tube within the preformed depression despite slight irregularities in dimensions.

Permanent anchoring of the tube 11 within the depression in the plate is accomplished by use of apparatus such as is shown diagrammatically in Figure 2. This apparatus involves a backing die 16 which has suitable depressions formed therein to receive the depressed embossed portions of the plate 10 as clearly shown in Fig. 2. A movable die assembly shown positioned above the plate 10 in Fig. 2 consists of holding dies 17 which are backed by compression springs 18 within the movable die block and which are adapted to engage the upper face of the plate 10 between ridges 14 of adjacent depressions. These holding dies 17 prevent a flow of the metal away from the depressions and cooperate with punches 19 which are forced downwardly following the engagement of the holding dies 17 with the upper face of the plate, such downward movement of the punches 19 serving to flatten the ridges 14 or portions thereof so as to cause the metal of the plate to tightly engage about the tube 10 as shown in Fig. 3. This action of the punches not only closes the top of the depressions above the median diameter of the tube but also causes the upstanding portions 13 of the depressions to tightly engage the wall of the tube above such median diameter. A cold working of the metal involved in this operation causes the same to take a permanent resilient set, which due to the holding of the metal by the holding dies 17, is inwardly toward the tube effecting a resilient gripping thereof.

The configuration of the punches or movable dies 19 and the extent thereof determines the portions of the upstanding ridges 14 which will be deformed and flattened by the downward movement of such punches against the backing dies 16.

In the form shown in Fig. 4 flattened portions of the ridges which are designated by the reference numeral 20 are in alignment.

In the form shown in Fig. 6 the flattened gripping portions are staggered as designated by the reference numeral 21.

In both of these forms the resilient "set" given to the metal intermediate these depressed or flattened portions of the ridges 14 is transmitted along the wall 13 of the depression so that such wall, intermediate such flattened portions, firmly grips the tube above the median diameter thereof.

Although this gripping or flattening operation is not ordinarily effected at the curved ends of the depression, it has been found in practice that performing of such operation on the straight runs of the tube serves to hold the tube in firm and rigid permanent association with the plate and since such a large area of the outer surface of the tube is maintained in intimate contact with the metal of the plate due to the flattening operation and the resulting gripping of the tube, an efficient heat transfer unit is thereby provided.

4

In the form of plate condenser shown in Fig. 5, an operation has been performed whereby the upstanding ridges 14 have been flattened throughout their length so that there is a continuous gripping of the tube by the inwardly formed portions of the metal resulting from such flattening. It will be appreciated that this complete flattening of the ridges 14 also effects a resilient set of the metal and causes the portions 13 of the embossed depressions in the plate 10 to continuously engage along surfaces of the tube above a median diameter thereof. In other words, although the intermittent flattening of the ridges 14 effects a generally continuous engagement due to the resilient "set" of the metal, such engagement is enhanced by flattening the ridges throughout their length as shown in Figure 5. Furthermore, the construction shown in Figure 5 results in a smooth surface so that when the heat exchanger is used, for example as a part of a refrigerator evaporator, it may comprise a shelf over which sliding movement of articles placed thereon may be readily effected.

The surfaces of both the plate and the tube may be coated with any desired non-corrosive coating, applied either mechanically or electrolytically, such coating being preferably applied before the tube is positioned in the depression and prior to the flattening of the ridges 14.

It will be apparent that the heat exchanger provided by this invention is one where intimate contact with relatively large surface areas of the plate and tube respectively is assured and wherein the tube and plate are securely retained in fixed association.

While a plate type of condenser has been chosen as illustrative of an embodiment of this invention, it will be apparent that the plate and tube assembly of this invention may be used in a variety of heat exchangers, such for example as evaporators and radiators.

The method of construction inherent in this invention lends itself to economical manufacture in that welding or brazing and the expensive apparatus necessary for the commercial carrying out of such operations is eliminated.

I am aware that various details of construction and modifications of the method herein disclosed may be changed without departing from the principles of this invention and I, therefore, do not purpose limiting the patent granted hereon otherwise than indicated by the scope of the appended claims.

I claim as my invention:

1. A heat exchanger comprising a plate having a depression therein of serpentine form consisting of straight portions and joining curved portions, the curved portions of the depression being of greater width than the straight portions, a raised ridge formed integrally with said plate immediately contiguous to and coextensive with said groove, a preformed serpentine tube positioned within the depression, irregularities in the formation thereof and differential thermal expansion of the plate and the tube being accommodated by the greater width of the curved portions of the depression, and localized depressions in said ridge causing portions thereof adjacent the straight portions only of said depression to engage corresponding straight portions of the tube above a median diameter thereof to snugly bottom said tube in said groove.

2. A heat exchanger comprising a plate having a groove of serpentine configuration formed

5

therein, said groove consisting of straight portions and curved portions joining said straight portions, said curved groove portions being of greater width than the straight portions thereof, ridges projecting upwardly from the plate on either side of said groove and following the contour thereof, a preformed serpentine tube positioned within the groove in seated engagement therewith, said greater width curved groove portions accommodating any irregularities in said tube and any thermal expansion of the tube relative to the plate when in use, and a plurality of individual spaced deformations in said ridges adjacent the straight portions only of said groove and overlying a portion of the exterior surface of said tube for holding the same in said groove. 15

RAY A. SANDBERG.

6

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
795,479	Svenson	Nov. 15, 1910
2,091,584	Brown	Aug. 31, 1937
2,190,288	Higham	Feb. 13, 1940
2,281,299	Steenstrup	Apr. 28, 1942
2,306,772	Benson	Dec. 29, 1942
3,311,579	Scott	Feb. 16, 1943
2,456,506	Henchert	Dec. 14, 1948