Nov. 8, 1932. G. H. PHELPS 1,886,498

HEAT INTERCHANGER

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Fig. 1.

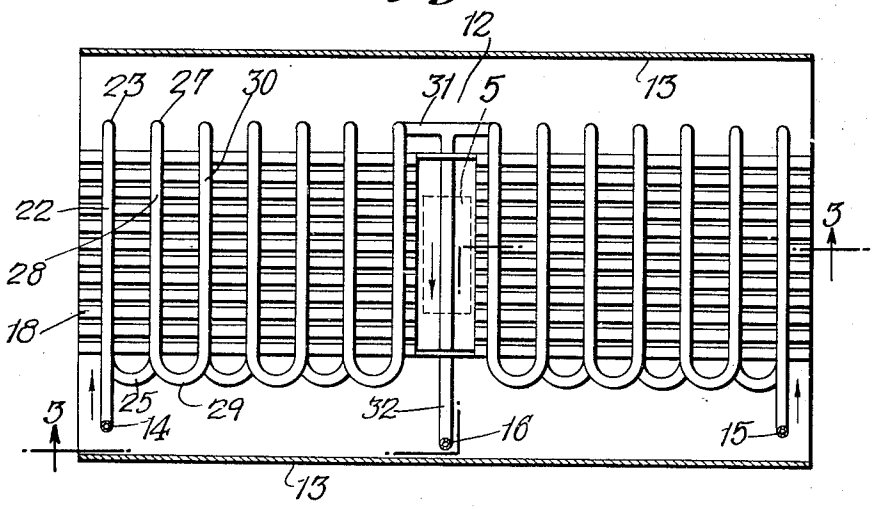


Fig. 2.

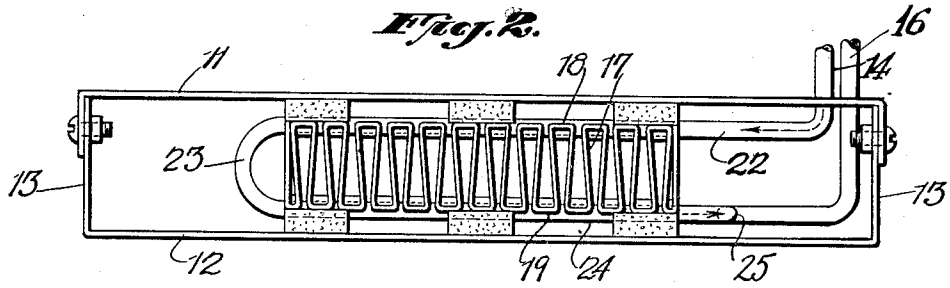


Fig. 3.

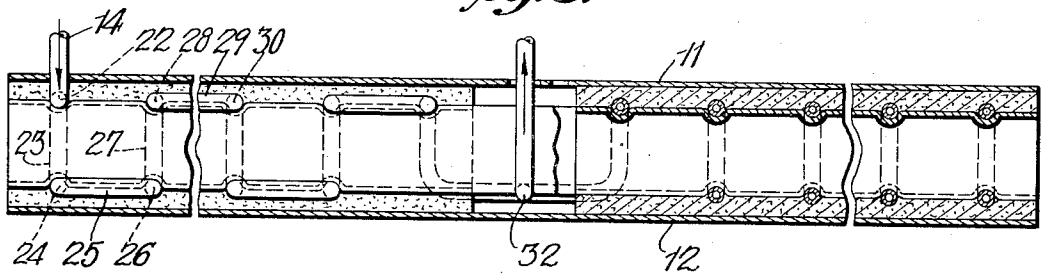
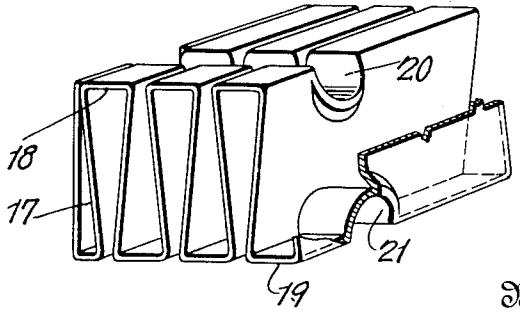


Fig. 4.



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HEAT INTERCHANGER

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Fig. 5.



Fig. 6.

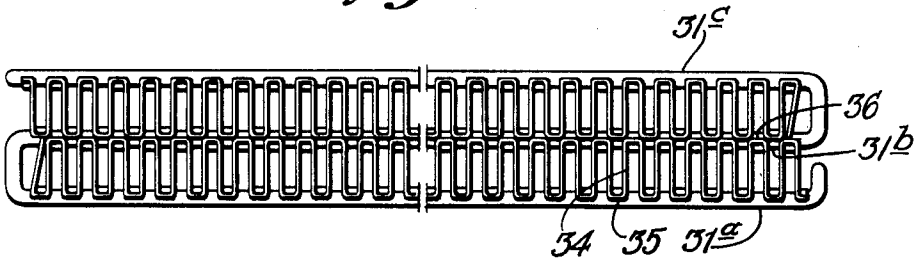


Fig. 7.

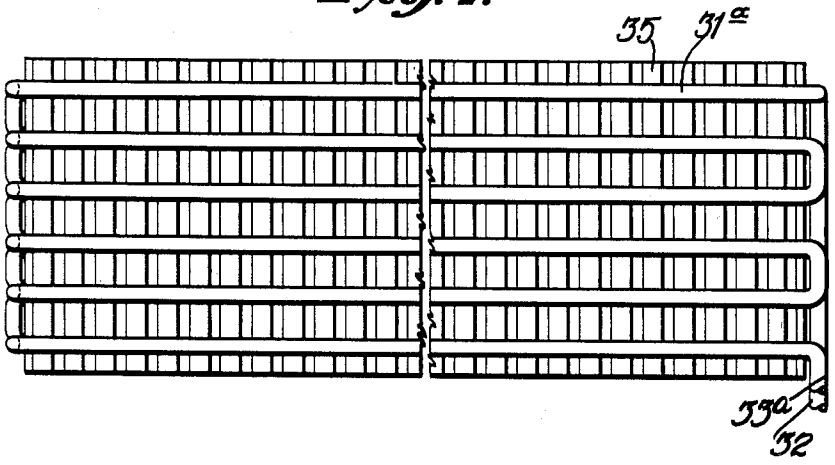
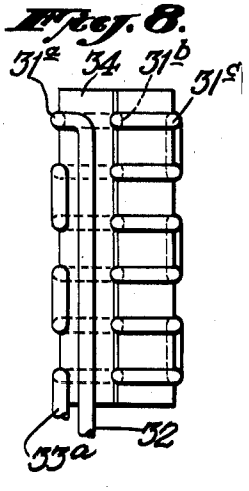


Fig. 8.



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Fig. 9.



Fig. 10.

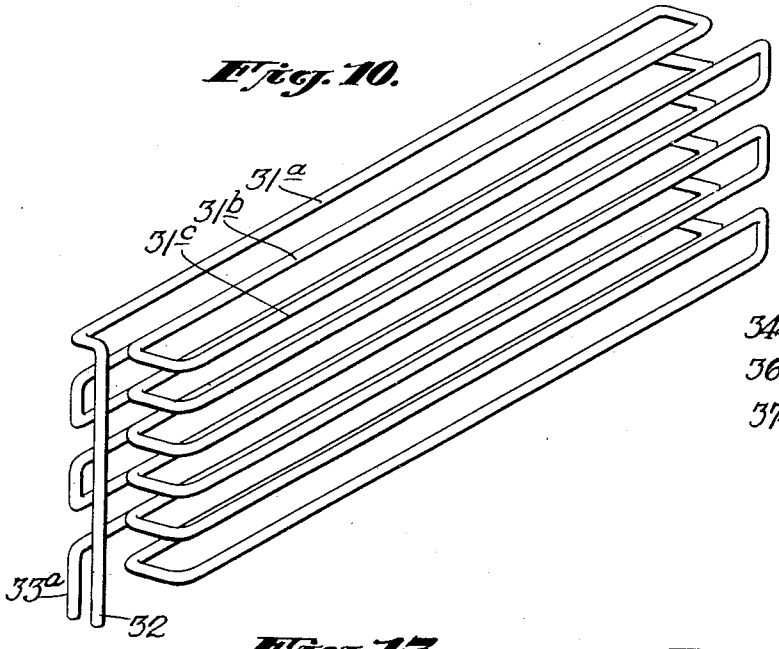


Fig. 11.

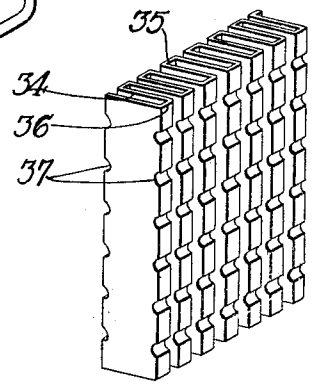


Fig. 13.

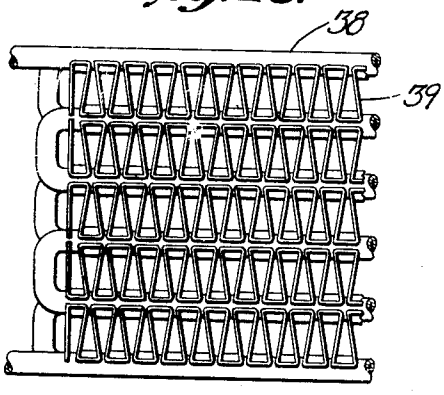
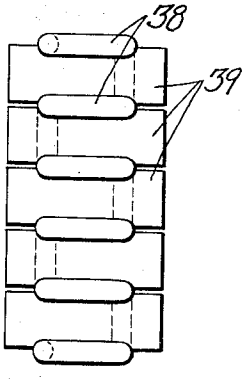


Fig. 12.



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UNITED STATES PATENT OFFICE

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HEAT INTERCHANGER

Application filed March 6, 1930. Serial No. 433,529.

My invention aims to provide an improved heat interchanger which is particularly useful as a condenser for refrigerating apparatus and which has also features of advantage for various other situations such as the heating or cooling of the air of a room: The accompanying drawings illustrate embodiments of the invention.

Fig. 1 is a plan of a condenser for a refrigerant.

Fig. 2 is an end view thereof.

Fig. 3 is a section on the line 3—3 of Fig. 1.

Fig. 4 is a detail in perspective.

Fig. 5 is an end view of an alternative style.

Figs. 6, 7 and 8 are respectively a plan and a front and an end elevation of an alternative design which is also specially useful as a condenser for a refrigerant.

Fig. 9 is a developed elevation of the tubing of Fig. 7.

Fig. 10 is a perspective of the same as it is bent in the condenser.

Fig. 11 is a separate perspective view of the corrugated plate forming part of the condenser.

Figs. 12 and 13 are diagrams in end and face elevation respectively illustrating an alternative arrangement.

In previous applications Serial Nos. 141,065 filed Oct. 12, 1926; 239,875 filed Dec. 14, 1927, and 311,292 filed Oct. 9, 1928, I have described certain improvements in refrigerating apparatus. The present application is a continuation in part of said prior applications, being based on certain heat interchangers disclosed therein.

Figs. 1, 2 and 3 illustrate a condenser designed for a horizontal position. It has a steel housing consisting of a top plate 11, a bottom plate 12 and side plates 13. The housing is open at opposite ends. There is a central opening in the top wall the location of which is indicated by the dotted rectangle 5, Fig. 1.

The refrigerant gas from the compressor, assuming the interchanger used as a condenser for a refrigerator, passes downwardly by pipes 14 and 15, thence through the coils of tubing indicated toward the center and finally out of the pipe 16 to the refrigerating cabinet. The tubing is in heat conducting engagement with a radiating structure which presents an extended area to the air blown through it and thus extracts heat rapidly from the refrigerant.

The radiating structure is made of a plate or plates of conductive metal, such for example as copper or tin plate. The tubing is also best made of thin seamless copper. But other metals may be used for the radiating structure and for the tubing.

As shown best in Fig. 4, a corrugated sheet is used with fins 17 converging alternatively at top and bottom and connected in pairs by longitudinal plates 18 and 19. The fins thus divide the space into a large number of small passages in which the streams of air are exposed to large areas of heated metal.

The tubing extends transversely across the plates which form the outer faces of the structure. These plates 18 and 19 are bent to form recesses 20 and 21. The tubing is embraced in these recesses so as to provide a wide area of contact and is intimately united or bonded thereto by heat or pressure or both; as, for example, by soldering, brazing or welding, or by dipping in molten zinc or tin or solder.

The corrugated sheet can be formed in dies, first bending the webs or fins to parallel positions and finally bending them by endwise pressure to the oblique positions shown.

The tubing is bent back and forth in successive looped sections at alternate sides of the corrugated sheet. Entering from branch 14, a length 22 crosses on top. At the end of 22 is a downward bend 23, then a return length 24 immediately below 22 (Fig. 3), a horizontal loop 25, a return length 26 parallel to 24, an upward bend 27 and a loop across the top comprising the length 28, bend 29 and length 30; and so on to the end, where it connects by a branch 31 with a cross pipe 32 leading to the outlet 16. The tubing at the other side leads in a similar way from the inlet 15 to the outlet 16.

Thus the tubing is in loops located on opposite faces of the corrugated sheet and connected by transverse bends like 23 and 27, all of which are at the same side. This is impor-

tant in the manufacture of the apparatus, permitting the insertion of the corrugated sheet between the loops of tubing by springing the latter slightly apart.

Where additional area is desirable, three radiating structures may be used as in Fig. 5. The central structure indicated as a whole at 33 carries the tubing in its top and bottom faces. And two additional radiating structures 34 and 35 of the same general design, though of less depth, are applied to the top and bottom and united by any of the methods above referred to.

For condensers of refrigerating machines it is advisable to arrange the fins or transverse portions of the corrugated plate closer together than in the case of radiators for heating the air. The tubing may be arranged in various other ways than those described. For example, instead of arranging it in two levels as shown, it may be arranged in any plurality of levels according to the total height required, and with any appropriate number of radiating structures arranged between the different levels of tubing and on top and bottom.

The heat exchanger is adapted also to various other uses; such for example as the heating of the air by circulating steam or other heating medium through the pipes or the cooling of the air by circulating cold brine through the pipes. Also the flow of air through the exchanger may be by means of a blower or by other positive means, or may be induced by setting the corrugated structure on edge with the air passages vertical to act in the manner of flues, as in certain radiators for heating the air in a room and circulating it.

The invention may be used with other heating elements; as by substituting for the tubing illustrated, elongated chambers or conduits of other shapes in cross section, or electric heating elements of the so called "strip" type. The finned radiating structure may be made of corrugated plates extending integrally throughout its full length, or it may be made in a plurality of separate sections or pieces, either spaced apart or arranged in a continuous structure.

The invention may be utilized also with a heating element extending along one side only of the radiating structure. And the fins may be united to the heating element in various mechanical ways instead of by the direct soldering and welding above referred to.

The lengthwise direction of the tubing is referred to as the longitudinal direction, and the direction of the air passages as transverse. But these terms are used only relatively. The apparatus may be arranged with the air flues in various horizontal directions or in a vertical direction, which has the advantage of acting like a flue or chimney and inducing a draft of air through the passages. Figs. 6 to 11 illustrate such an arrangement.

A long continuous tube 31, Fig. 9, is bent back and forth to form a number of parallel lengths in a vertical plane and connected end to end. The pipes 32 and 33*a* represent the inlet and outlet. With these fixed at one end, the assemblage is then bent horizontally back and forth so that each length is converted into three shorter lengths 31*a*, 31*b* and 31*c*, Fig. 10. We thus have a continuous tube assembled in lengths arranged close to each other in three parallel vertical groups. Initially the spaces between the vertical series 31*a* and 31*b* are made to diverge at the left, and the series 31*b* and 31*c* to diverge at the right so as to facilitate the insertion of the corrugated sheets between them.

Two such sheets are used, one located in each space as shown in Figs. 6, 7 and 8. The specific shape is shown in Fig. 11. The sheet is bent to form transverse walls or fins 34 connected at alternate ends by plates 35 and 36 in which are recesses 37 embracing the several lengths of pipe. After these radiating structures are applied, one in each of the spaces between the vertical groups of tubes, the latter are clamped closely against the sheets and the whole structure soldered by dipping, or otherwise united.

For such a dipped apparatus it is advantageous to have the successive plates, as 35 for example, separated by a space which is at least equal to the width of such plates (instead of being brought closer together like the plates 19 of Fig. 4). This is the design shown in Figs. 6 and 11. It facilitates the flowing of the molten soldering metal to the joints.

Figs. 12 and 13 show an arrangement in which the air passages and tubes are both horizontal. The tube is bent into a succession of horizontal loops 38, each consisting of two adjacent lengths; and the radiating structure is in a series of separate sections 39 between the horizontal loops. Each section 39 is corrugated like those of Fig. 4, or it may be in the manner of Fig. 11. The result is a series of short transverse air flues.

The modifications and different uses to which I have referred above in connection with Figs. 1 to 5 are applicable also to the subject-matter of Figs. 6 to 13. And those described in connection with Figs. 6 to 13 are applicable to the subject-matter of Figs. 1 to 5.

Various other modifications may be made by those skilled in the art without departing from the invention as defined in the following claims.

What I claim is:

1. A heat interchanger including a corrugated radiating structure forming channels for the passage of a draft of air and recesses transverse to said channels to receive

lengths of tubing and tubing for a heating medium passed alternately across the opposite sides of said radiating structure from one end thereof and received in said recesses.

2. A heat interchanger including a corrugated radiating structure forming channels for the passage of a draft of air and tubing in heat conducting contact therewith, said tubing being in successive loops engaging alternately the opposite faces of the radiating structure, with connections between the successive loops at one side only of the structure so as to leave space for introduction of the structure between the loops from the opposite side.

3. A heat interchanger including a corrugated radiating structure forming channels for the passage of a draft of air and tubing in heat conducting contact therewith, said tubing being in successive loops engaging alternately the opposite faces of the radiating structure, with connections between the successive loops at one side only of the structure so as to leave space for introduction of the structure between the loops from the opposite side, the radiating structure having recesses extending across the corrugations and embracing the tubing to provide a considerable heat transmitting area from one to the other.

4. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement with said tubing and comprising a succession of fins forming transversely extending channels for the passage of air, said fins being recessed at the opposite faces of the structure and said tubing being embraced by the recessed portions of said structure so as to provide a wide contact area.

5. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement with said tubing, said radiating structure comprising a sheet of metal corrugated to form transverse fins connected alternately at opposite edges by longitudinal portions forming opposite faces of the sheet, the opposite longitudinal portions being recessed and said tubing being embraced by such recessed portions so as to provide a wide contact area.

6. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement with said tubing, said radiating structure comprising a sheet of metal corrugated to form transverse fins connected alternately at opposite edges by longitudinal portions forming opposite faces of the sheet, the opposite longitudinal portions being recessed and said tubing being embraced by such recessed portions so as to provide a wide contact area, the spaces between longitudinal portions at the face of the sheet being at least equal to the width of such portions at said face.

7. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement therewith, said tubing comprising lengths extending serially end to end and arranged with several lengths in each of at least three spaced planes, and said radiating structure comprising two parts located respectively in the spaces between said planes.

8. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement therewith, said tubing comprising sections connected serially end to end and arranged in at least three planes with a plurality of lengths of tubing in each section.

9. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement therewith, said tubing being continuous, bent back and forth to form a number of substantially parallel lengths in one plane and bent transversely of such plane to form each length into a plurality of shorter lengths in planes transverse to the first plane.

10. A heat interchanger including in combination longitudinally extending tubing and a radiating structure in heat-conducting engagement therewith, said tubing comprising sections connected serially end to end and arranged in at least three planes with a plurality of lengths of tubing in each section, and said radiating structure comprising at least two corrugated plates located respectively in the spaces between said planes.

In witness whereof, I have hereunto signed my name.

GEORGE H. PHELPS.