

Jan. 14, 1930.

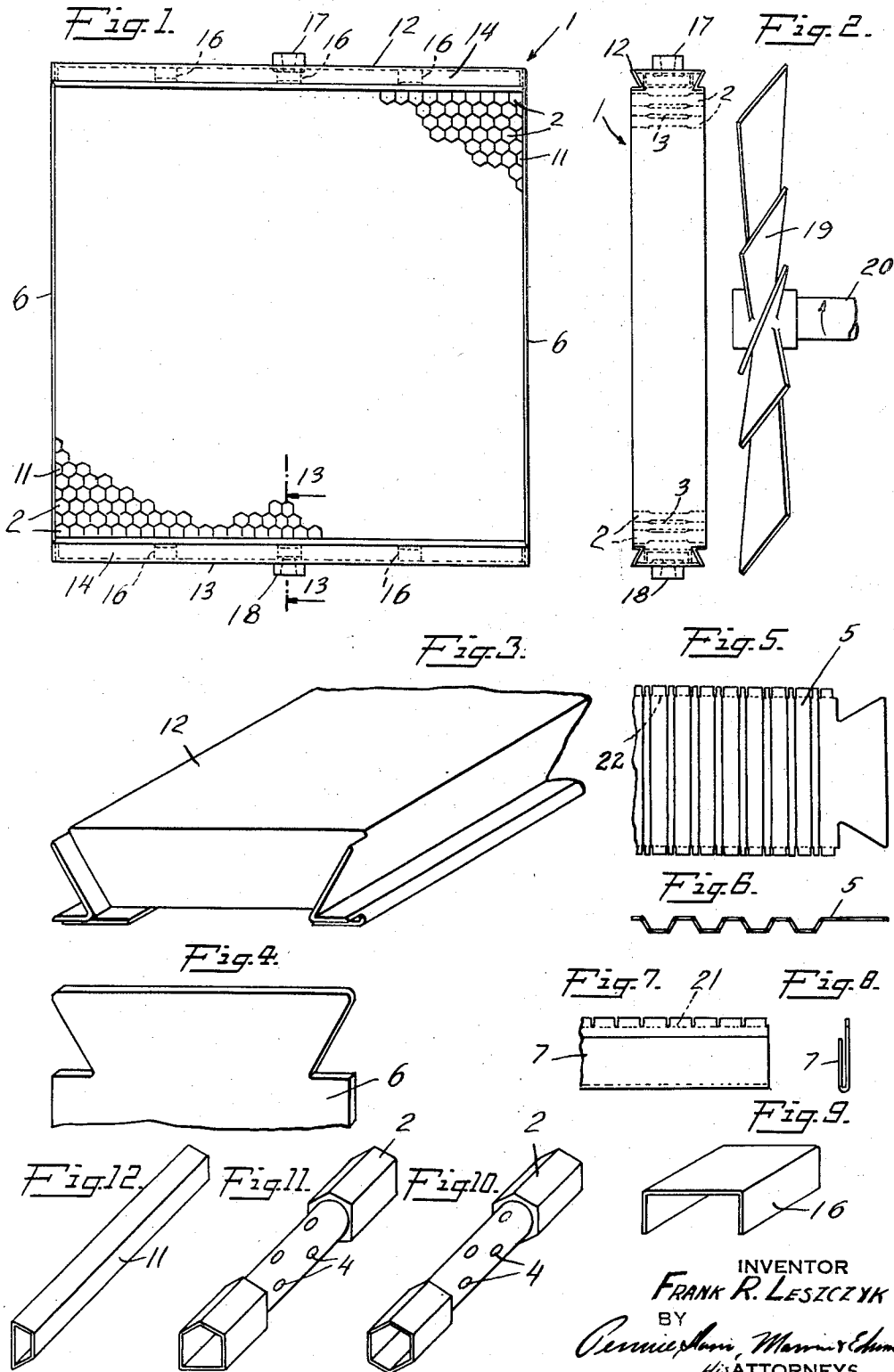
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1,743,785

HEAT EXCHANGER

Filed Oct. 11, 1928

2 Sheets-Sheet 1



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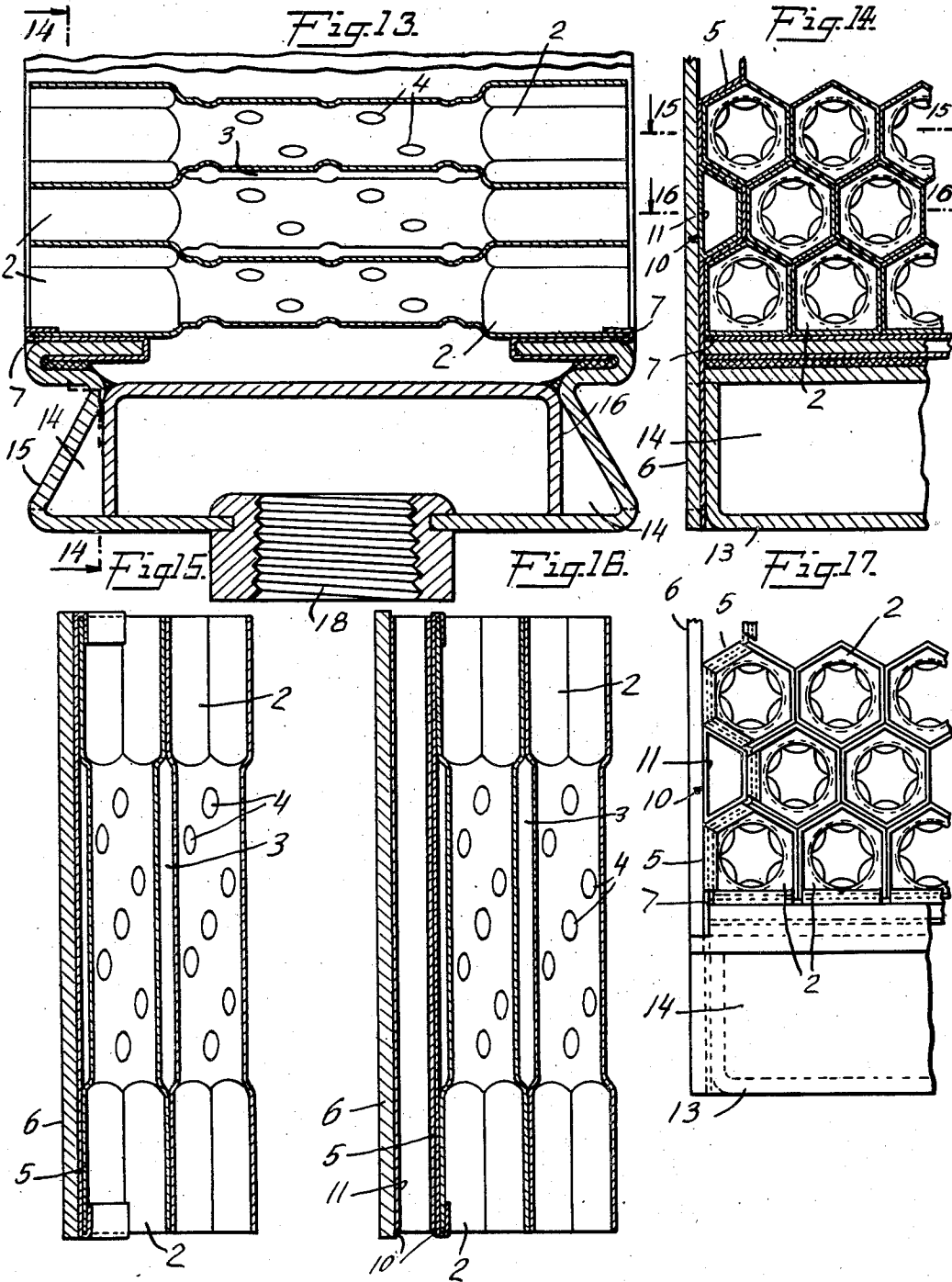
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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Application filed October 11, 1928. Serial No. 311,815.

This invention relates to heat exchangers and more particularly to improvements in the construction thereof. My invention is particularly applicable to that type of heat exchanger which may be used in cooling or heating buildings, such as moving picture theatres, auditoriums or dwellings. This invention may also be used in cooling an internal combustion engine such as that of an automobile, aeroplane, motorboat or similar engines in which radiator cooling systems are used. This invention comprises certain improvements in the construction of heat exchangers and the manner in which the apparatus is assembled.

Numerous types of radiators or cooling devices have been used in connection with automobile cooling systems, and since the more recent demand has been made for cooling systems in moving picture houses and theatres, certain types of heat exchangers have been devised for this purpose. In many types of automobile radiators a plurality of hollow metal tubes nested together and soldered in place in honey-comb or similar fashion have been used. The assembled tubes of the radiators now in use are usually soldered together around the exterior end surfaces and also soldered into their respective frames or containers. In the ordinary construction of radiators or heat exchangers the use of a large quantity of solder has been necessary to attach the assembled tubes to their supporting frames, this extensive use of solder resulting in an expensive and difficult apparatus to construct.

One of the objects of my invention is to eliminate the use of solder for attaching the assembled tubes of a heat exchanger to their encasing frame or container. A further object of this invention is to provide side walls with corrugated edges which may be folded into and securely attached to the heat exchanger tubes in an inexpensive, quick and advantageous manner.

This invention also provides a heat exchanger which may be used either for cooling hot air or for heating cool air, as the situation may demand, and may also be used for cooling liquids and condensing gases.

Further objects, advantages and distinct features of this invention will become apparent upon considering the detailed description which is to be taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a front elevation of my assembled heat exchanger;

Fig. 2 is a vertical side view of the heat exchanger shown in Fig. 1, with a fan mounted adjacent thereto;

Fig. 3 is a perspective view of the top section of my heat exchanger;

Fig. 4 is a side view of an end section of one of the side walls;

Fig. 5 is a plan view of one of the side walls before folding or shaping it to fit the side of the nested tubes;

Fig. 6 is a side view of one of the folded sides of the side wall shown in Fig. 5;

Fig. 7 is a detail sectional view of one of the top and bottom strips;

Fig. 8 is a detail view of one of the overlapping members of the top and bottom strips shown in Fig. 7;

Fig. 9 is a perspective view of one of the tube supporting members;

Fig. 10 is an enlarged view of one of the tubes showing the hexagonal ends of the tubes forming the central portion of the nest.

Fig. 11 is a view similar to Fig. 10 of one of the tubes showing the end construction of the tubes of the top and bottom rows;

Fig. 12 is a view of one of the tubes which is placed into the cavities between the corrugated side strip and the radiator frame;

Fig. 13 is a sectional elevation of the heat exchanger taken along line 13—13 of Fig. 1, showing the arrangement of the tubes, and the construction of the liquid or steam chamber;

Fig. 14 is an enlarged front elevation of the heat exchanger tubes taken along line 14—14 of Fig. 13;

Fig. 15 is a sectional plan view of the heat exchanger tubes taken along line 15—15 of Fig. 14;

Fig. 16 is a view similar to Fig. 15 taken along line 16—16 of Fig. 14; and

Fig. 17 is a view similar to Fig. 14 showing the corrugated side strips in detail.

Referring to the drawings, reference numeral 1 represents the assembled heat exchanger as shown in Fig. 1. The heat exchanger 1 contains a plurality of open-ended hollow metal tubes 2 arranged in parallel relation to each other with the peripheral surface of their open ends soldered together, giving the front of the assembled tubes 2 a honeycomb appearance. The ends of the metal tubes 2 are of a greater diameter than the remaining portion of the tubes, thus forming a space 3 between the tubes 2, in which liquid or steam may circulate. The circulating space 3 is increased by the indentions or depressions 4 in the surface of the tubes 2. Mounted on each side of the assembled tubes 2, perpendicular to the openings therein, is a corrugated strip 5 the surface of which is so disposed as to fit the configurations of the tubes 2 which contact therewith, and which is adapted to be folded along its edge at the point indicated by the line 22. An outer side member 6 is placed over the strips 5 and forms the outside wall or side frame of the heat exchanger unit. Across the top and bottom of the assembled tubes 2 over the enlarged surface at each end thereof is placed a metal strip 7 having a folded edge indicated by the line 21. The body portion of these strips may be U-shaped in cross section as shown in Fig. 8. The width of the body portion of the strips 7 corresponds to the length of the enlarged portion of the tubes 2 at each end thereof. The top and bottom strips 7 are suitably connected to the side strips 5 thus forming a frame for the tubes 2. The ends of the tubes 2 adjacent to and contacting with the top and bottom strips 7 are pentagonal in shape as shown in Fig. 11 and the ends of the tubes 2 adjacent the corrugated side strips 5 are hexagonal in shape, as are all of the tubes 2 except those contacting with the top and bottom strips 7 as best shown in Figs. 1, 14 and 17. The edges of the side strips 5 and of the top and bottom strips 7 are folded over and securely crimped into the adjacent tubes 2; the edges of the side strips 5 being folded into the hexagonal tubes contacting therewith and the edges of the top and bottom strips 7 being folded into the pentagonal tubes which are employed only along the top and bottom strips 7. In placing the outside cover strip 6 over the corrugated strip 5 a space 10 is formed between the cover strip 6 and the corrugated strip 5 in each place where the strip 5 is indented to conform with the configuration of the hexagonal tubes 2, as best shown in Figs. 16 and 17. Into each of the spaces 10 is inserted a hollow metal tube 11 whose shape corresponds to that of a half hexagonal tube. The tube 11 may be formed of the same material as that used in the formation of tubes 2 although their surface remains the same

throughout their entire length, there being no depressions therein nor any space formed between the outer surface thereof and the adjacent side strips 5 and 6 as they are separated from the circulating chambers by the strips 5. Tubes 11 are inserted merely to give the construction greater strength and to complete the rectangular assembly. All of the tubes 2 and 11 assembled in this apparatus are hollow throughout their entire length in order to allow the free passage of air there-through.

Liquid or steam chambers 12 and 13, each of which comprises a tank 14 formed by an outer shell 15, are suitably attached to the top and bottom respectively of the assembled tubes 2 as shown in Figs. 1 and 13. The chambers 12 and 13 are provided with reinforcing members 16 disposed at intervals along the top and bottom of the assembled tubes 2. Chambers 12 and 13 are securely attached, as by soldering, to the supports 16 and to the top and bottom strips 7. Suitable threaded openings or couplings 17 and 18 are provided in chambers 12 and 13 respectively for the inlet and outlet of the material desired to be used in the heat exchanger. The tank 14 of chambers 12 and 13 has an opening therein (not shown) in direct relation to the passage space 3 around the tubes 2, so that steam or liquid injected into the tank 14 of chamber 12 passes immediately to the circulating space 3 or may be cooled or heated as desired, in its passage to the lower chamber 13. A fan 19 mounted on shaft 20 and driven by any suitable means (not shown) is situated on one side of the heat exchanger 1 for forcing air through the hollow tubes 2 and 11.

The heat exchanging operation of this apparatus is performed in the following manner: To cool air by the heat exchanger 1, brine or any suitable liquid refrigerant is inserted into the tank 14 through the opening 17 of chamber 12. As the refrigerating liquid reaches the tank 14, it passes immediately to the circulating space 3 between the tubes 2 through which it may circulate until it reaches the bottom chamber 13. If desired the liquid may be injected through the opening 17 until the tank 14 of the bottom chamber 13, the passage space 3 between the tubes 2 and the tank 14 of the top chamber 12 have become filled, after which the outlet 18 of the chamber 13 may be opened sufficiently to allow a portion of the liquid to pass out, and at the same time a stream of liquid may be continuously injected into inlet 17 corresponding to that which is passing off through the outlet 18, thus forming a continuous circulation of the liquid around the tubes 2. By means of the suction or blower fan 19 air is forced through the hollow tubes 2. In passing through tubes 2 the heat of the air is absorbed by the cold surface of the tubes 2 and transmitted to the circulating refrigerant

which is passing around the tubes. The degree to which the air is cooled by its passage through tubes 2, may be varied and regulated as desired by regulating the temperature of the refrigerating liquid, the degree of chill imparted to the air depending entirely upon the temperature of the circulating refrigerant and upon the amount of heat that must be absorbed or removed from the air. If it is desired to cool a hot liquid or to condense steam or gas in the heat exchanger 1, the operation may be performed in a manner similar to that employed for cooling hot air. The hot gas or liquid is introduced to the chamber 12 through the inlet 17, and is allowed to circulate through the passage space 3 to the bottom chamber 13. Air, which may have been previously cooled, is forced through the hollow tubes 2 to absorb and remove the heat transmitted to the walls of the tubes by the hot liquid or gas circulating in the passage 3. In condensing a gas by the heat exchanger 1 the gas is introduced into the opening 17 of chamber 12 and the condensate will collect in the bottom chamber 13 after having been condensed in its passage through the circulating space 3. The material collected in the bottom chamber 13 is then drawn off through the outlet 18.

The heat exchanger 1 may be used as a heating unit for heating buildings or auditoriums in a manner similar to that described in the cooling operation by circulating a hot liquid in the passage space 3 around the tubes 2 and forcing air through the tubes 2 by the fan 19. Suitable hot air pipes may be arranged to receive the heated air after it has passed through the tubes 2 to distribute it as desired for the heating purposes. The degree of heat imparted to the air will depend upon the temperature of the air when it contacts with the tubes 2 and also upon the amount of heat transmitted to the walls of tubes 2 by the hot liquid circulating in the passage 3.

One of the principal features in the construction of my heat exchanger is the manner in which the side strips 5 and the top and bottom strips 7 are attached to the tubes 2, forming a frame therefor, without the use of solder. The corrugated edges of the strips 5 and 7 are constructed in such a manner that they may be folded over on a line parallel to the edge as shown in Figs. 5 and 7 and crimped into the open ends of the tubes 2 forming a water-tight connection between the strips 5 and 7 and the tubes 2, thereby entirely eliminating the use of solder for attaching the tubes 2 to their frame container. This feature results in a great saving in the cost of construction of heat exchangers of this type and also provides a quick, easy and effective manner in which the tubes 2 may be attached to the container. The folded edges of the strips 7 are provided with slits 19 spaced from each other a proper distance to

align with the contacting walls of the nested tubes.

In assembling the heat exchanger, the side nest with the exception of tubes 11 is first formed, and strips 5 are placed in position. The body portion of these strips is equal to the length of the tubes, and after assembly the edges are folded over on lines 22 into the adjacent tubes as shown in Figs. 16 and 17. The tubes 11 and side frame members 6 may then be placed in position. Top and bottom strips 7 are first soldered to the top and bottom chamber, the U-shaped bottom portions being secured thereto as shown in Fig. 13. The upper and lower chambers are then placed in position and the foldable edges of strips 7 then folded into the tubes and crimped in place. As stated, this eliminates the necessity of solder around the edges of the nest, and the adjacent ends of the tubes away from the edges are soldered to each other in the usual manner.

When this heat exchanger is used in connection with an automobile cooling system, suitable additional connections for the inlet and outlet of the water to and from the engine may be added. In this embodiment water may be placed in the opening 17 until both chambers 12 and 13 and the circulating space 3 has been completely filled, after which the opening 17 is closed. The water may be supplied to the engine from a suitable connection to the bottom chamber 13 and after circulating through the water passage of the engine the water will be returned to the top chamber 12 through a suitable connection (not shown) thereto, and is cooled by passing through the circulating space 3 around the air cooled tubes 2.

The construction of the essential members of this apparatus can be varied within wide limits to suit the requirements of the particular circumstances; and in general all of the advantages of my invention can be used, even though the details of construction are modified to suit various conditions. My invention is accordingly not limited to the particular embodiment thereof specifically described, but includes such modifications thereof as fall within the scope of the appended claims.

I claim as my invention:

1. In a heat exchanger a plurality of hollow tubes nested together in a frame, each of said tubes having enlarged ends, and side strips having foldable edges attached to each side of the assembled tubes, said edges being folded perpendicular to the body portion of the strips, and said strips being attached by further folding and securely crimping the edges thereof into the enlarged ends of said tubes.

2. In a heat exchanger a plurality of open ended hollow metal tubes nested in a frame, said frame being formed by foldable strips

attached to all four sides of the assembled tubes, folding the edges of said strips perpendicular to the body portion of the strips and further folding said edges into the ends of the adjacent tubes, to attach said strips to said tubes.

3. In a heat exchanger a plurality of open-ended hollow metal tubes nested together in a frame, said frame being formed by attaching strips having foldable edges to the top and bottom sides of the assembled tubes with edges folded perpendicular to the body portion of the strips, said foldable edges being then folded and securely crimped into the open ends of said tubes, the tubes contacting with the top and bottom strips having enlarged ends of pentagonal shape, and the tubes contacting with said side strips having enlarged ends of hexagonal shape.

4. A heat exchanger comprising a plurality of hollow tubes nested together, and a frame surrounding said nest of tubes, the frame members being provided with foldable edges, said edges being adapted to be folded and crimped into the ends of the adjacent tubes to attach said frame to said nest of tubes.

In testimony whereof I affix my signature.
FRANK R. LESZCZYK.