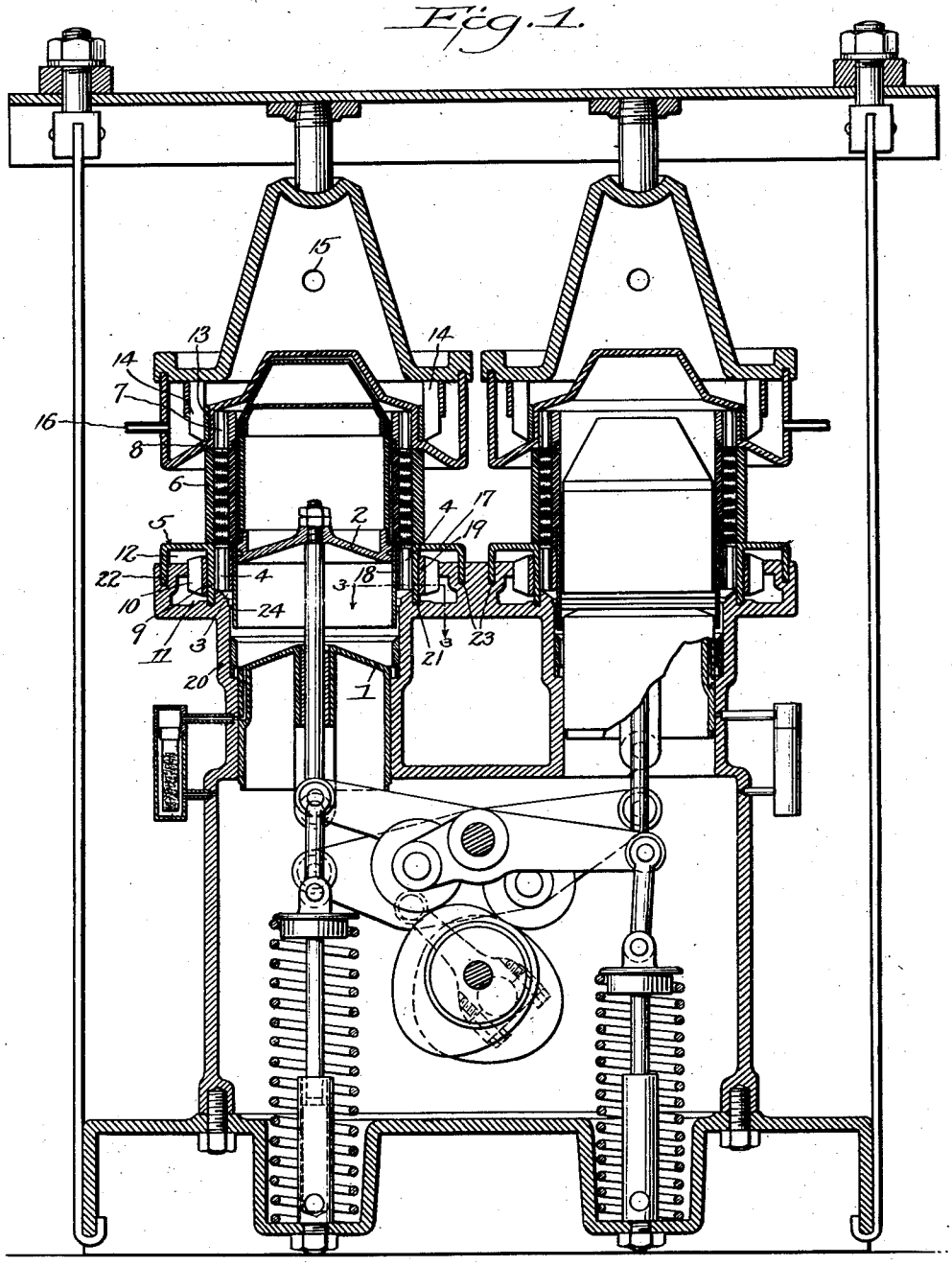
April 21, 1925. 1,534,794

I. LUNDGAARD

HEAT EXCHANGER

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Fig. 1.



WITNESSES

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Fig. 2.

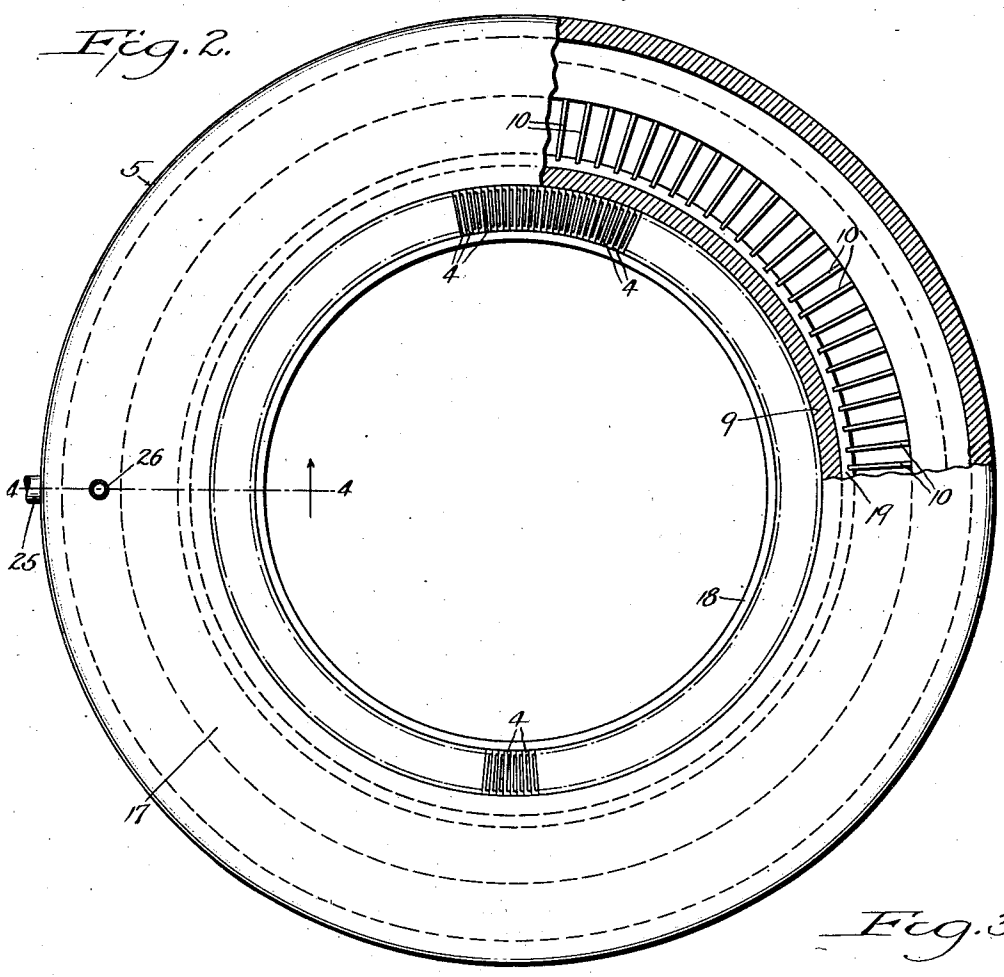


Fig. 3.

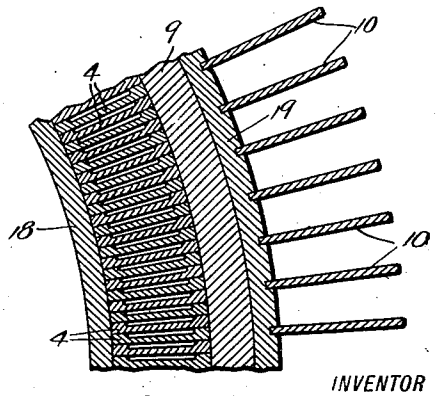
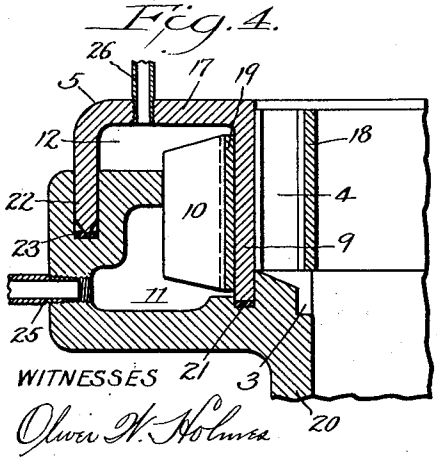


Fig. 4.



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UNITED STATES PATENT OFFICE.

IVAR LUNDGAARD, OF HARTFORD, CONNECTICUT, ASSIGNOR TO THE AUTOMATIC REFRIGERATING COMPANY, OF HARTFORD, CONNECTICUT, A CORPORATION OF NEW JERSEY.

HEAT EXCHANGER.

Application filed March 30, 1922. Serial No. 548,219.

To all whom it may concern:

Be it known that I, IVAR LUNDGAARD, a citizen of the United States, and a resident of Hartford, county of Hartford, State of Connecticut, have invented certain new and useful Improvements in Heat Exchangers, of which the following is a specification.

My invention relates to refrigerating machines wherein a body of air acting as a mediating fluid is subjected to alternate compression and expansion in a closed cycle. Such a machine includes a chamber wherein the air is compressed and a chamber wherein the air is expanded. Between these two chambers the air is passed through a heat exchanger for transferring heat from the compressed air to a body of cooling fluid, a regenerator for maintaining a difference of temperature between the air entering it and the air leaving it and a heat exchanger for transferring heat from a fluid to be cooled to the expanded air. In my Patent No. 1,240,862, I have described a machine of this type.

As the volume of the air spaces in the heat exchangers and regenerator is constant and as this volume is interposed between the compression and expansion chambers, it comprises what might be considered a clearance volume and it is obvious that to obtain any great amount of refrigeration this volume must be small as compared to the piston displacement. Further a large surface area must be presented to the air to transfer the heat to or from it.

The object of my invention is to produce a heat exchanger that will contain a small volume of air, that will present a large surface to the air, that will be easy and cheap to manufacture and that will effectively transfer the heat from one fluid to the other, and which, at the same time, will have a minimum number of joints to be kept tight between the two fluids.

I accomplish this object by constructing my heat exchangers with two annular chambers having one wall in common. In each chamber, I provide a number of metallic leaves which extend away from the wall across the chambers. In this way a large surface is presented by the extended surfaces of the leaves and heat is readily absorbed from the fluid while at the same time heat is conducted through the leaves to the wall, through the wall, and into the leaves on the other side of the wall, where it is given up to the other fluid circulating over those leaves.

In order that my invention may be readily understood, it is described in connection with the accompanying drawings, in which—

Figure 1 is a vertical, longitudinal section of my air refrigerating machine, of which heat exchangers according to this invention form a part.

Figure 2 is a plan view of the member containing the heat exchanger for removing heat from the compressed air, with the upper part broken away for part of the circumference.

Figure 3 is an enlarged horizontal fragmental section of the heat exchanger taken on lines 3—3 of Figure 1.

Figure 4 is an enlarged vertical section taken on lines 4—4 of Figure 2.

Referring to Figure 1, the operation of the machine is as follows for one revolution of the crank shaft, the movements of the pistons being controlled by the mechanism in the crank case.

The air is compressed between compression piston 1 and shifter piston 2. It is then transferred through annular port 3, the spaces between leaves 4 of heat exchanger 5, the regenerator 6 and the spaces between leaves 7 of heat exchanger 8 to the space above the piston 2 where it is expanded. The air is then transferred back again at the lower pressure to the space between the two pistons 1 and 2 through the heat exchanger 8, regenerator 6 and heat exchanger 5.

In the heat exchanger 5, the warm compressed air gives up its heat to the leaves 4 which convey the heat to the wall 9 through which it is transmitted to the leaves 10. Leaves 10 are surrounded by a cooling fluid such as water, which circulates from the annular chamber 11, over the leaves 10 and into the annular chamber 12. Pipe connections 25 and 26 (Figure 4) serve to carry the cooling fluid to and from the chambers 11 and 12. In the heat exchanger 8, the cold expanded air absorbs heat from the leaves 7, to which the heat has been brought through the wall 13 from the leaves 14, which in turn have been heated by the fluid circulating over them. This fluid may be any fluid as for example brine, which it is desired to refrigerate and it may enter the

space above the cylinder through the port 15, circulate around the leaves 14 and pass out of the machine through pipe 16 to some chamber (not shown) which it is desired to cool.

Heat exchangers 5 and 8 closely resemble each other in construction, so the details will be described in connection with one of them, heat exchanger 5. Between the vertical wall 9 of an annular inverted U-shaped member 17 and an inner cylinder 18 are arranged a large number of channel shaped leaves 4 so made that their sides are on radial lines (see Figures 2 and 3). The leaves 4 are preferably of copper or other good heat conducting metal and may be formed by rolling to shape and subsequently cutting off to the proper length. One edge of each of the leaves 4 contacts with the wall 9 and the other edge with the cylindrical member 18. The spaces formed in the leaves 4 afford the path for the mediating air, and in machines I have constructed the dimensions of these spaces, in cross-section, are not more than .015 inch by 9/32 inch, while the length of the channel shaped leaves in the direction of flow of the air is but one inch. As illustrated in Figure 2, there are three hundred and sixty leaves each covering one degree of the circumference.

On the outer side of wall 9, there is closely fitted a cylindrical member 19 preferably of brass or other good heat conducting material. Slots are milled vertically in member 19 and leaves 10 are secured in the slots by suitable means such as sweating them in with solder. Member 19 is used to facilitate construction, but it may be omitted and the leaves 10 be secured directly to wall 9. The number of leaves 10 and their size depend on the fluid used for cooling. If the fluid be water, an amount of surface relatively small compared to the surface of the leaves 4 is required. In any event, the required surface is easily attained as the limitations of fluid volume imposed in connection with leaves 4 do not apply to the spaces surrounding leaves 10. The thickness of leaves 4 and 10 is chosen so that their conductivity in proportion to their heat absorbing power is such that all parts of the leaves will be at approximately the same temperature.

When leaves 4 and leaves 10 are assembled on the wall 9, the heat exchanger 5 is ready to be placed on the machine. The wall 9 and the wall 22 of the heat exchanger 5 fit annular grooves formed in the crank-case 20 concentric with the cylinder. Packing rings 21 and 23 of suitable material such as rubber serve to make the joints between walls 9 and 22 and the crank-case 20 tight against leakage. The inner wall of the cylinder 18 fits snugly over the cylinder liner 24. The regenerator 6 is applied to the top of heat exchanger 5 in such a way that the opening into it registers with the leaves 4 and its walls make tight joints with the wall 9 and cylinder liner 24. The heat exchangers of the other cylinder of the machine of Figure 1 are the same as those of the cylinder described.

From the description it is seen that there is a wall separating the two fluids between which it is desired to exchange heat and that there are but four joints to maintain tight against leakage. These four joints are all circular and flat, hence easy to pack. It is also to be noted that a large area is presented to the fluids with a minimum volume of metal and fluid. As the speed of the machine may be as high as two hundred and fifty revolutions per minute, a complete cycle of operations takes place in less than one-quarter second, and the novel features of my invention render it possible to produce a commercial machine that is compact, efficient and economical to operate.

I claim:—

1. An annular heat exchanger adapted to be fitted onto a cylinder, comprising in combination a cylindrical wall of heat conductive material, heat conducting vanes extending outwardly from said wall, and heat conducting vanes having flanges laid against the inner surface of the wall and extending inwardly therefrom, the inner ends of the vanes provided with means for closing the spaces between them.

2. A heat exchanger comprising in combination a cylinder, a piston moving therein to compress a fluid at one end of the cylinder and rarefy it at the other end, annular heat exchangers, one at each end of the cylinder, each exchanger having a dividing wall forming interior and exterior annular spaces and conducting leaves in both spaces mounted on the common dividing wall, and an annular packing sealing the joints between the cylinder and the heat exchangers.

3. A heat exchanger comprising in combination a cylindrical wall enclosing an annular chamber forming a portion of the path for a mediating fluid, a second annular chamber surrounding said first cylindrical wall and adapted to contain a fluid with which heat is exchanged, a series of flanged metallic leaves disposed in contact with each other completely around said first named annular chamber and in heat conductive relation at their edges with the wall separating the two annular chambers and a plurality of metallic leaves in said second annular chamber in heat conductive relation at their edges with said wall.

IVAR LUNDGAARD.