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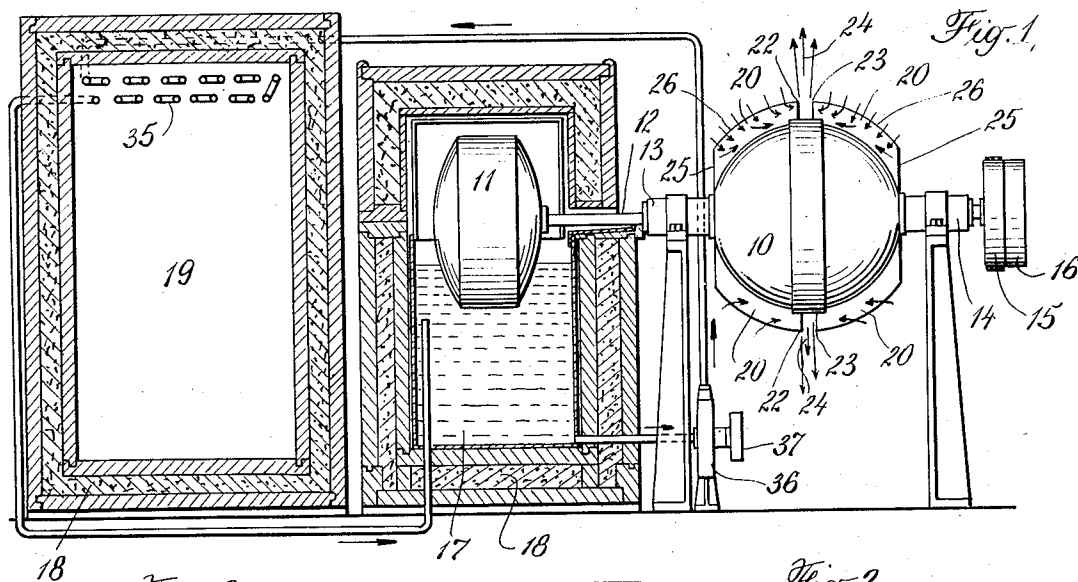
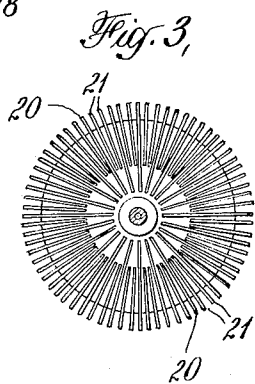
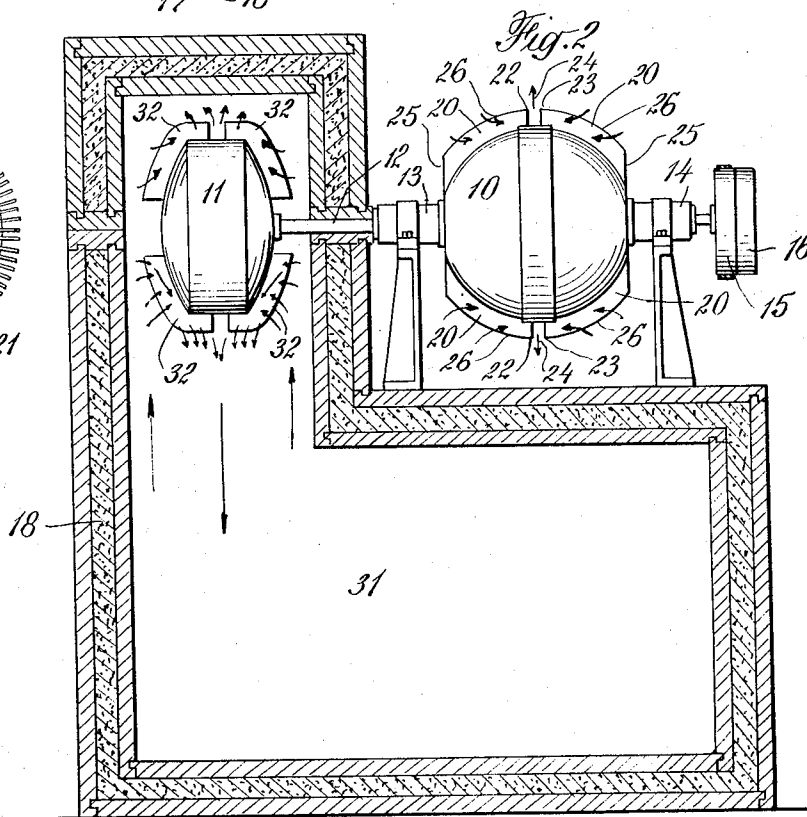
1,559,883

A. D. KARR ET AL

AIR COOLED REFRIGERATING MACHINE

Filed March 7, 1923

3 Sheets-Sheet 1



INVENTORS

A. D. Karr and H. D. Perkins

BY

Permie, Davis, Marvin and Edmunds
ATTORNEYS

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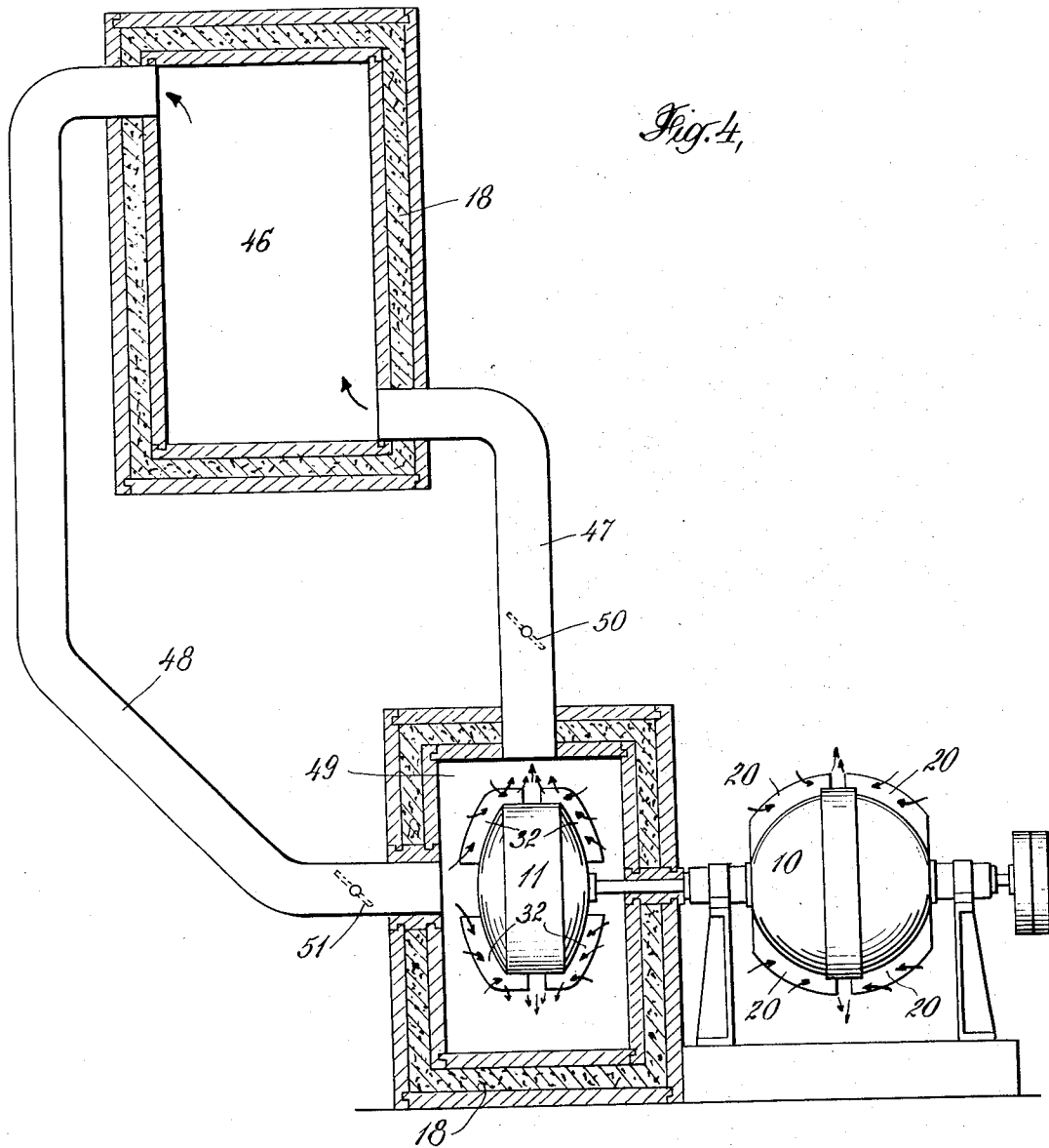
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AIR COOLED REFRIGERATING MACHINE

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3 Sheets-Sheet 2



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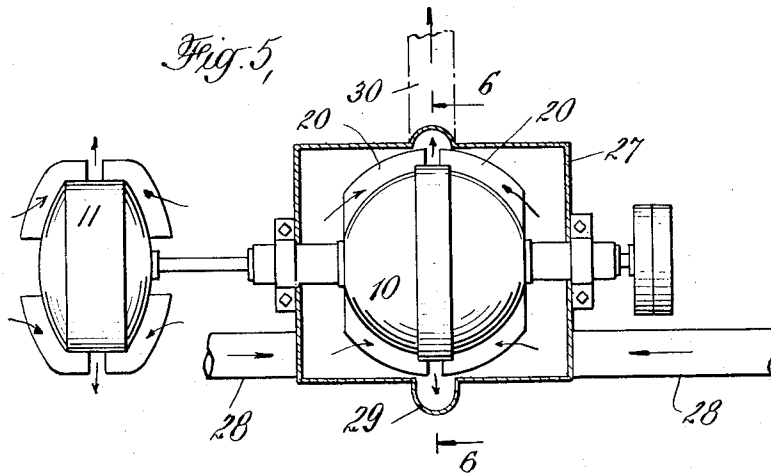
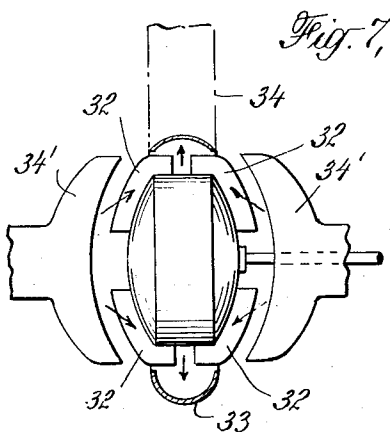
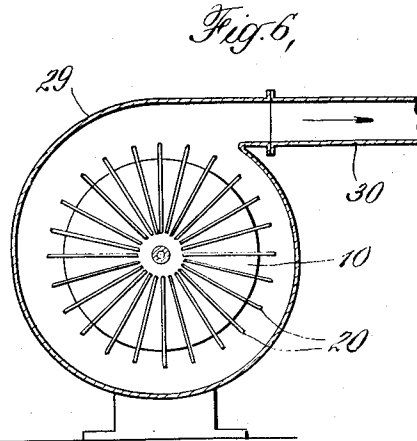
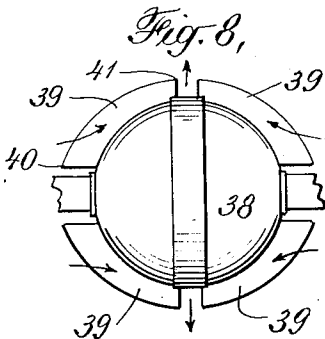
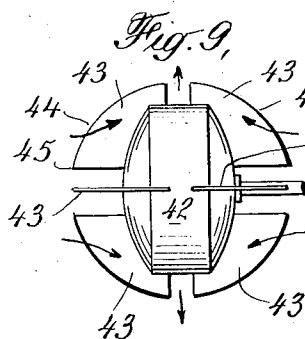
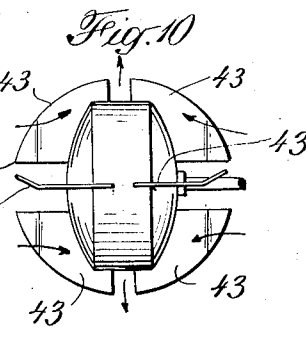
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AIR COOLED REFRIGERATING MACHINE

Filed March 7, 1923

3 Sheets-Sheet 3



INVENTORS

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UNITED STATES PATENT OFFICE.

ALFRED D. KARR, OF NEWARK, NEW JERSEY, AND KARL D. PERKINS, OF NEW YORK, N. Y.

AIR-COOLED REFRIGERATING MACHINE.

Application filed March 7, 1923. Serial No. 623,333.

To all whom it may concern:

Be it known that we, ALFRED D. KARR and KARL D. PERKINS, both citizens of the United States, and residing, respectively, at Newark, county of Essex, and State of New Jersey, and New York, county and State of New York, have invented certain new and useful Improvements in Air-Cooled Refrigerating Machines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Our invention relates to refrigerating apparatus, and particularly to refrigerating apparatus of the inclosed or hermetically sealed type. The object of our invention is to provide an improved refrigerating apparatus.

Refrigerating apparatus of the inclosed type comprises a closed liquefying chamber, or condenser, and a closed vaporizing chamber, or evaporator, connected by a hollow shaft. The apparatus is arranged in the form of a "dumb-bell", one drum of which constitutes the condenser, and the other drum of which constitutes the evaporator. Within the condenser drum of this hermetically sealed, "dumb-bell" shaped, container, is placed a compressor member, and the complementary working parts of the compressor are respectively connected with a weight which does not revolve and with the container which is rotated from without. The general construction of the apparatus is similar to that described in Patent No. 1,155,780, issued October 5, 1915, to M. Audiffren and H. A. Singrun.

The apparatus contains a suitable material in the form of a saturated, or approximately saturated, vapor or gas, such as sulfur dioxide or the like, which is acted upon mechanically by the compressor to cause it to liquefy and lose energy in the form of heat, which is transmitted to and dissipated by a medium outside the condenser, in order that the material within the apparatus may effect the refrigeration of a medium surrounding the vaporizing chamber or evaporator by absorbing the heat therefrom as the compressed material vaporizes within the evaporator.

Difficulty has been experienced in such apparatus in obtaining an efficient transfer of heat into the evaporator from its surrounding medium, and from the condenser to the medium surrounding it. Heretofore, the condenser drum has been cooled, that is, the transference of heat from it has been effected by a liquid, usually water, or by a combination of water and air. In some cases the water has been brought into contact with the drum by partial submersion of the drum, and in other cases the water has been sprayed upon the drum in some manner and air caused to circulate through the spray to cause evaporation of a portion of the spray and further cool the drum.

The necessity of providing a water circulating system for cooling the condenser has many disadvantages. For example, it is sometimes desired to install a refrigerating plant in a locality where the water supply is limited, and the cost of obtaining sufficient water for cooling the condenser may be almost prohibitive. Again, in the ordinary domestic or household installation, a cooling system which must be connected with the water supply and drainage systems is expensive to install and maintain. It may freeze up in cold weather and is always liable to cause damage by leakage.

It has also been necessary heretofore to provide a brine circulating system associated with the refrigerating drum, or evaporator, which is quite evidently disadvantageous under many circumstances. In industrial installations, a brine circulating system is expensive to install and maintain, and in domestic installations such a system is liable to leak and cause damage, and when the brine evaporates, the housekeeper may inadvertently omit to replenish it. Added to these disadvantages, is the expense incident to installation and maintenance.

If the evaporator itself is placed directly in the compartment to be cooled, its smooth surface presents an insufficient area to permit as rapid an absorption of heat as is desired. The evaporator will therefore become progressively colder, become heavily coated with frost, which still further reduces the rate of heat absorption, and, in the case of an inclosed type of machine, it

may eventually be rendered inoperative from this reduction in capacity, because the resultant low evaporator temperature will congeal the lubricant which is sealed within the container for the purpose of lubricating the moving parts.

By our invention, we have overcome these difficulties by providing improved means for facilitating the transference of heat between the rotating condenser or evaporator drum of a refrigerating machine, and the fluid surrounding it. For this purpose we provide the surface of the drum (either the condenser or evaporator) with a plurality of vanes secured in heat-conducting relation to this surface and so disposed thereon that they will cause, when the drum is rotated, a flow of the fluid away from the drum in the region of a transverse plane, and toward the drum in substantially all other directions. The vanes themselves are constructed of material which possesses high heat-conducting properties and they are preferably so disposed on the surface of the drum that the peripheral speed of their edges progressively increases in a direction lengthwise of the vanes, the vanes being preferably arranged to extend from the region of the axis of rotation of the drum in a direction longitudinally of this axis to a region at a distance from the axis which is ordinarily the region of the equatorial plane of the drum.

When a rotating drum is thus provided with vanes of heat-conducting material intimately secured in heat-conducting relation to its surface and so disposed that the peripheral speed of their edges progressively increases and reaches a maximum in a single plane transverse to the axis of rotation, there is caused, first, a flow of the surrounding fluid away from the axis of rotation in this transverse plane, and, second, a flow of the fluid toward the drum in substantially all other directions. Simultaneously with the production of this flow of fluid, the vanes effect the transfer of heat between the drum and the fluid, the fluid being compelled to flow, by forces incident to the rotation of the drum and the disposition of the vanes thereon, into intimate contact with the surfaces of the vanes and the drum itself, some of the fluid travelling the full length of the vanes and additional fluid being brought into contact with them all the way up to the plane of discharge.

While our invention is described herein in particular relation to a refrigerating machine of the inclosed, or dumb-bell, type, it may be advantageously employed in connection with any refrigerating apparatus which is provided with a rotating condenser or evaporator drum.

Our invention will be better understood by referring to the following description

of a specific embodiment of it, read in conjunction with the accompanying drawings. Certain other novel features contemplated will also appear in this more detailed description. In these drawings:

Fig. 1 is a view, partly in elevation, and partly in section, of an inclosed refrigerating machine, the condenser of which is cooled in accordance with our invention;

Fig. 2 is a view, also partly in elevation and partly in section, of a refrigerating machine in which both the condenser and the evaporator are provided with the heat transferring means of our invention;

Fig. 3 is a view in end elevation of one of the drums showing the arrangement of the vanes;

Fig. 4 is a view, partly in elevation and partly in section, of a modification of the refrigerating apparatus;

Fig. 5 is a more or less diagrammatical view illustrating an air cooled condenser equipped with a housing for leading in and conveying away the cooling fluid;

Fig. 6 is a view in transverse section taken on line 6—6 of Fig. 5;

Fig. 7 is a diagrammatical view of an arrangement of air-directing housing associated with the refrigerator drum; and

Figs. 8, 9, and 10 illustrate modified forms of vanes.

A dumb-bell shaped, hermetically sealed container has two enlarged end portions or drums 10 and 11, of metal, which are connected by a hollow shaft 12. The enlargement 10 is herein termed the condenser and the enlargement 11 the evaporator. The dumb-bell container is mounted to be rotated as a whole in bearings 13 and 14, located adjacent the walls of the condenser drum 10, in which bearings shafts secured to the condenser drum are journaled. The outer end of one of these shafts is provided with tight and loose pulleys 15 and 16, or an equivalent driving connection such as a coupling for direct drive, or a single pulley for belted motor drive.

Within the condenser drum, a suitable compressor actuated by the rotation of the container draws expanded vapor or gas, such as sulfur dioxide, from the evaporator 11 through the hollow shaft 12 and compresses it to cause it to liquefy and lose energy in the form of heat. After compression, the heat thus given off by the material is transmitted through the walls of the condenser drum 10 and dissipated by a medium outside the condenser. After the material is cooled and liquefied, it is again allowed to vaporize in the evaporator 11 and thus absorb heat from the medium surrounding the evaporator.

In Fig. 1, the hollow shaft 12 projects through an opening in the wall of a brine tank 17 and the evaporator, or vaporizing

drum, 11, of the container is rotated in this tank with a portion of its surface submerged in brine or other suitable liquid with which the tank 17 is filled to a level just below the aperture through which the shaft 12 enters the tank. Tank 17 is thoroughly insulated by walls packed with cork, mineral wool, or other suitable material, 18, against the conduction of heat to the brine from the surrounding air or objects. Absorption of heat from the brine by the evaporator 11 takes place through the smooth metal surface of the evaporator drum and the temperature of the brine is lowered to the desired point.

In order to utilize the cold brine thus produced for refrigerating purposes, it is customary to provide a system for circulating the brine to carry it to a storage chamber, ice-making tank, or other compartment which it is desired to cool. By way of example, a storage chamber 19 is illustrated, the walls of which are of the same general heat insulating construction as the walls of brine tank 17. The cold brine from tank 17 is circulated through coils 35, located at the top of chamber 19, by means of pump 36 and the connecting pipes. These pipes and pump must be insulated with a liberal thickness of some heat insulating covering (not shown). Also, some means must be provided for driving the pump, such as an electric motor (also not shown) operatively connected to the pump, as by means of driving pulley 37. The arrangement of the refrigerating end of the apparatus just described is similar to the ordinary practice of the prior art, and it should be noted that the circulation of the air in chamber 19 depends entirely on the thermo-siphon effect.

The condenser drum 10, however, is cooled in accordance with the means provided by our invention. A relatively large number of vanes 20 and 21 of a material which is an extremely good conductor of heat, preferably copper, are provided on the surface of condenser 10 which is preferably of bronze. These vanes extend in a direction longitudinally of the axis of rotation of the drum and are so arranged that, when the drum is rotated, the peripheral speed of their edges will progressively vary from one end of the vanes to the other. The vanes 20 extend along the surface of the drum 10, commencing at points as close as practicable to the shafts journaled in bearings 13 and 14 and terminate in transverse planes 22 and 23 in the region of the equatorial plane 24 of drum 10. The vanes 21 are somewhat shorter than vanes 20, as may be seen in Fig. 3, and are placed intermediate these vanes to further subdivide the channels between them in order to increase the radiating surface of the drum. These vanes are of relatively thin metal and are intimately

ly secured in good heat-conducting relation to the surface of condenser 10, as by brazing, or otherwise, so as to effect the transfer of the maximum possible amount of heat from the condenser 10 to the surrounding medium.

When the drum 10 is rotated as in the normal operation of the apparatus, the fluid surrounding it will be caused to circulate in the manner shown generally by the arrows in Fig. 1. The fluid will be drawn into the channels between the vanes at the lateral ends 25 of the vanes, and as well along all points of their outer edges 26, all the way up to the ends 22 and 23 where the vanes preferably terminate substantially at the equatorial plane of the drum, and will be discharged from the vanes in the peripheral space between ends 22 and 23 substantially in a plane at right angles to the axis of rotation of the drum. The flow of fluid will be substantially the same, however, if the vanes are made to extend completely across the space between the ends 22 and 23 so that they are continuous from one side of the drum to the other. The fluid will thus be brought into intimate contact with the surfaces of the vanes as well as with the surface of the drum 10. The fluid which enters the outer ends 25 flows throughout the entire length of the vanes, this fluid being added to, or supplemented by, fresh fluid drawn in past the peripheral edges of the vanes and mixed with the original currents as they traverse these paths between the vanes and proceed toward the plane of discharge. In this way the entire surfaces of the drum and of the vanes are brought into contact with relatively cool air and the air passing through the channels between the vanes is caused to scour the surfaces of the vanes and the drum in such a manner as to absorb the heat therefrom with particular effectiveness and rapidity.

We have discovered that by providing a rotating body with vanes in this manner a remarkably high rate of heat transfer can be effected from the body to or from a surrounding fluid. In fact, the rate of heat transfer is sufficiently high that the condenser of an inclosed refrigerating machine, such as the condenser 10, may be successfully operated in air at ordinary room temperatures, and when thus operated, the amount of refrigeration produced by the evaporator drum 11 is substantially the same as when the condenser is water cooled in accordance with the methods in general use at present. If it is desired, other fluids than air may be used as the cooling medium surrounding the condenser and liquids even may be used, provided the speed of rotation is adjusted accordingly.

Under some conditions, it may be found advantageous to provide a casing 27, as illus-

trated in Fig. 5, for the purpose of surrounding the condenser drum 10 in order that the heat from the drum may not be given off into the room in which the apparatus is located. Air will then be drawn in through the conduits 28. It should be noted however that the casing 27 is spaced a relatively great distance from the vanes 20 and 21 and in no way assists these vanes in bringing the air into contact with them and with the surface of the drum. The casing merely acts to separate the atmosphere in which the drum is revolving from the atmosphere of the room. The revolving drum is freely exposed to the air immediately surrounding it. Such casing may be provided with an air collecting portion or scroll 29 (Figs. 5 and 6) opposite the annular fluid discharge space between the ends 22 and 23 of the vanes, so that the fluid discharged may be collected by the scroll. A conduit 30 serves to carry away this heated air.

The application of the means for effecting heat transfer to the refrigerating end of the machine, as well as to the condenser end, is illustrated in Figs. 2 and 4. In Fig. 2, instead of the brine circulated from tank 17 being used to cool the storage chamber 19, the evaporator drum 11 is placed directly in a similar storage chamber 31 which it is desired to cool. This evaporator drum 11 is provided with vanes 32 arranged upon the surface of the drum in a manner similar to the vanes 20 and 21 of the condenser 10. As the machine rotates, the air within the compartment 31 will be caused to circulate just as the air of the fluid surrounding drum 10 is caused to circulate, as is indicated generally by the arrows in Fig. 2. The circulation of the air in compartment 31 is not dependent upon the thermo-siphon effect as is the case with the air in compartment 19, as well as in all domestic refrigerators of which we are at present aware, and in many industrial installations. On the contrary, the air in compartment 31 is forced to circulate by means of the rotating drum 11, carrying the vanes 32, and it is an easy matter to so organize the apparatus that this circulation of the air may be made substantially uniform throughout the entire area of the chamber which it is desired to cool. Inasmuch as the air circulation in chamber 31 is not dependent upon the thermo-siphon effect, the evaporator drum may be located at any convenient place in the chamber. Accordingly, it may equally as well be located near the bottom as the top of the compartment.

The distribution of the air discharged from evaporator drum 11 may be accomplished in a variety of ways, one of which is illustrated in Fig. 7, where a scroll or spiral casing 33 is disposed about the periphery of the vanes 32 opposite the plane of

discharge so as to collect the cooler air as it leaves the drum and distribute it to various parts of the chamber by means of conduits, such as conduit 34. Return ducts or baffles 34' may also be arranged to return air from relatively warm portions of the chamber to the general vicinity of the rotating cooling drum. These baffles are however spaced a relatively great distance from the rotating vanes and allow the vanes to be freely exposed to the fluid surrounding them so that the circulation of the fluid with respect to the drum is effected entirely by means of the vanes and not affected by the presence of the baffles 34'.

Simultaneously with the production of circulation within chamber 31, vanes 32 provide a greatly enlarged effective surface area for evaporator drum 11, and because of the peculiarly effective manner in which the air drawn in on both sides of the drum is caused to come into contact with and "scour" the surfaces of these vanes and the drum, the rate of heat transfer from the air to the drum is remarkably high.

As an indication of the efficiency of circulation of the air within chamber 31 compared with the efficiency of circulation in a refrigerator chamber of the ordinary type where circulation is produced by the thermo-siphon effect, it may be stated that in the latter type of refrigerating apparatus the rate of circulation of the air is not greater than one complete circuit about every fifteen minutes. However, in the refrigerating apparatus of our invention, it is perfectly feasible to cause a complete circulation of the air within the compartment several times a minute, and thus all parts of the chamber may be maintained at substantially the same temperature. Indeed, the amount of circulation produced is so great that it is sometimes desirable to reduce the circulation artificially.

Referring again to the combined air circulating and heat transferring vanes 20 and 21 of condenser drum 10, and 32 of evaporator drum 11, it will be noted that these vanes are all of substantially uniform width and that the progressively increasing peripheral speed of their outer edges from the vane ends nearest the axis of rotation to the ends farthest from the axis of rotation is a consequence of the shape of the drum bodies. Although, from a manufacturing standpoint, it is desirable to make these vanes of uniform width, from the standpoint of cooling, the width of the vanes may be varied in a variety of ways, some of which are illustrated in Figs. 8, 9, and 10.

In Fig. 8, the spherical rotating body 38, which may be a condenser or evaporator, or any other body to or from which it is desired to effect the transfer of heat, is provided with vanes 39 which are wider at the

ends 40, adjacent the axis of rotation, than they are at the ends 41, adjacent the plane of discharge.

In Fig. 9, the rotating body 42 is similar in shape to the evaporator drum 11, but the vanes 43 are so proportioned that when mounted upon the surface of the body, their outer edges 44 are circular in form.

By thus varying the proportions of the vanes, the distribution of the fluid surrounding the rotating bodies and flowing toward them may be varied to suit any particular set of conditions. As a further means of varying the distribution of the fluid flowing toward the rotating body, the ends 40 and 45 of vanes 39 or 43, respectively, may be bent forward in the direction of the rotation of the body, as shown in Fig. 10. Bending the vanes in this manner will tend to increase the amount of air gathered by the bent ends of the vanes.

Returning now to Fig. 4, a modification of our improved refrigerating apparatus is here illustrated, the purpose of which is to cool a chamber 46 by circulating chilled air therethrough. The chamber preferably has heat-insulating walls similar to those previously described and air ducts 47 and 48 serve to place chamber 46 in communication with a refrigerating chamber 49, also constructed with heat-insulating walls. An evaporating drum 11, constructed in accordance with our invention, rotates within refrigerating chamber 49, and serves to simultaneously cool the air contained in the chamber, and force it out through duct 47 to chamber 46, through which it is compelled to circulate and then return by duct 48 to refrigerating chamber 49. Dampers 50 and 51 may be provided for controlling the amounts of air circulated.

While we have illustrated the application of our invention to apparatus for cooling the air in a storage chamber in which, for example, food, furs, or other articles which it is desired to preserve, may be placed, it is obvious that the invention may be applied to many other uses. For example, freezing flasks may be placed directly in chamber 31 and ice produced by the direct circulation of air about the freezing flasks instead of by the circulation of brine, as is customary at present. Again, chamber 31 (or chamber 46), in place of being a storage chamber, may be an ordinary room, such as a dwelling room or office, which it is desired to cool.

Many advantages result from the use of our present invention, particularly in expanding the field of refrigerating machines of the inclosed or "dumb-bell" type, and in reducing the cost of installation, operation, and maintenance of such machines. The advantages resulting from the provision of an entirely air cooled condenser, thus dispens-

ing with the necessity for a water cooled system connected to a water supply, are obvious, especially in connection with domestic installations and installations under desert conditions where it is impossible to obtain cooling water. The provision of means for simultaneously producing an increased rate of heat transfer to the evaporator end of the machine and producing a forced circulation of the fluid within the compartment to be cooled, makes it unnecessary to use a brine circulating system to carry the heat from the objects to be cooled to the heat absorbing drum or evaporator.

We claim:

1. In a refrigerating apparatus, the combination with a compressor and an evaporator of a condenser comprising, a drum adapted to rotate with its entire surface in freely exposed relation to a body of cooling air, and vanes on said drum extending longitudinally of the axis of rotation of the drum and forming open channels between them, said vanes being so mounted that the distance of their peripheral edges from the axis of rotation increases from one end of the vanes to the other, the peripheral edges thereof from one end to the other being also unconfined and in freely exposed relation to the body of cooling air, whereby the rotation of said drum causes original currents of air to enter the channels at the ends of the vanes which are near the axis of rotation, and additional air to be drawn in past the peripheral edges into the open channels to supplement said original currents, the entire volume of air thus caused to flow through said channels being thrown away from the drum at the ends of the vanes which are remote from the axis of rotation.

2. In a refrigerating apparatus, the combination with a compressor and a condenser of an evaporator comprising, a drum adapted to rotate with its entire surface in freely exposed relation to a body of fluid to be cooled, and vanes on said drum extending longitudinally of the axis of rotation of the drum and forming open channels between them, said vanes being so mounted that the distance of their peripheral edges from the axis of rotation increases from one end of the vanes to the other, the peripheral edges thereof from one end to the other being also unconfined and in freely exposed relation to the body of fluid to be cooled whereby the rotation of said drum causes original currents of fluid to enter the channels at the ends of the vanes which are near the axis of rotation, and additional fluid to be drawn in past the peripheral edges into the open channels to supplement said original currents, the entire volume of fluid thus caused to flow through said channels being thrown away from the drum at the ends of the vanes which are remote from the axis of rotation.

3. In inclosed refrigerating apparatus having rotating liquefying and vaporizing drums, the liquefying drum rotating with its entire surface unconfined and freely exposed to a body of cooling fluid, means for transferring heat from said drum to said fluid including a plurality of vanes secured in heat-conducting relation to the surface of the drum longitudinally of its axis of rotation, the peripheral edges of said vanes being also unconfined and freely exposed to said body of cooling fluid.

4. In inclosed refrigerating apparatus having rotating liquefying and vaporizing drums, the vaporizing drum rotating with its entire surface unconfined and freely exposed to a body of cooling fluid, means for transferring heat to said drum from said fluid including a plurality of vanes secured in heat conducting relation to the surface of the drum longitudinally of its axis of rotation, the peripheral edges of said vanes being also unconfined and freely exposed to said body of fluid.

5. In inclosed refrigerating apparatus having rotating liquefying and vaporizing drums, both of said drums rotating with their surfaces unconfined and freely exposed to bodies of fluid, means for transferring heat between said drums and their respective bodies of fluid including a plurality of vanes secured in heat-conducting relation to the surfaces of the respective drums and extending longitudinally of the axis of rota-

tion thereof, the peripheral edges of said vanes being also unconfined and freely exposed to the bodies of fluid within which they respectively rotate.

6. In inclosed refrigerating apparatus having rotating liquefying and vaporizing drums, the liquefying drum rotating with its surface unconfined and freely exposed to a body of cooling fluid, means for transferring heat from said drum to said fluid including a plurality of vanes secured in heat-conducting relation to the surface of the drum and extending in a direction substantially longitudinal of the axis of rotation thereof, the peripheral edges of said vanes being also unconfined and freely exposed to said body of fluid.

7. In inclosed refrigerating apparatus having rotating liquefying and vaporizing drums, the vaporizing drum rotating with its surface unconfined and freely exposed to a body of cooling fluid, means for transferring heat to said drum from said fluid including a plurality of vanes secured in heat-conducting relation to the surface of the drum and extending in a direction substantially longitudinal of the axis of rotation thereof, the peripheral edges of said vanes being also unconfined and freely exposed to said body of fluid.

In testimony whereof we affix our signatures.

ALFRED D. KARR.
KARL D. PERKINS.