

July 5, 1927.

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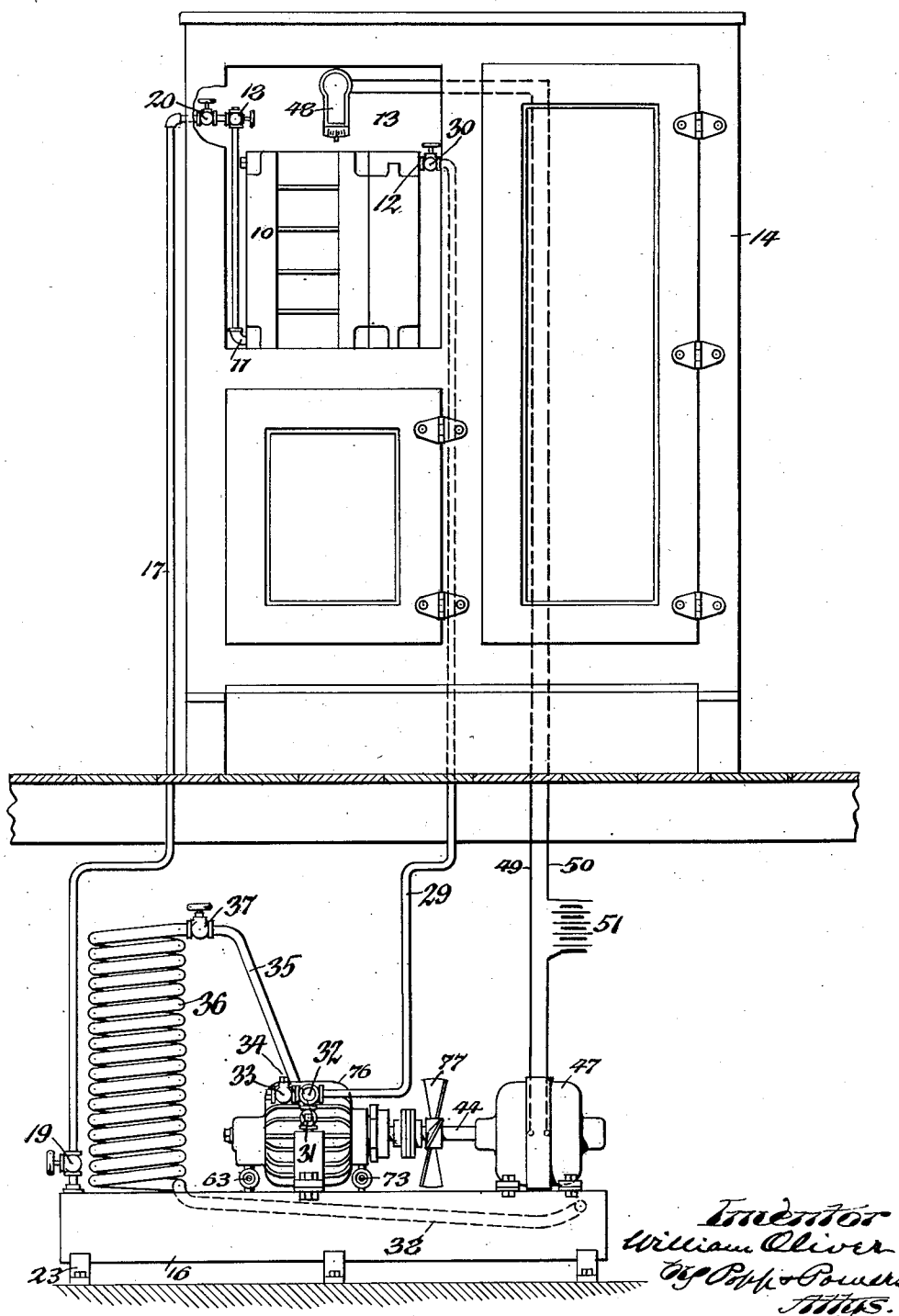
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Fig. 7.



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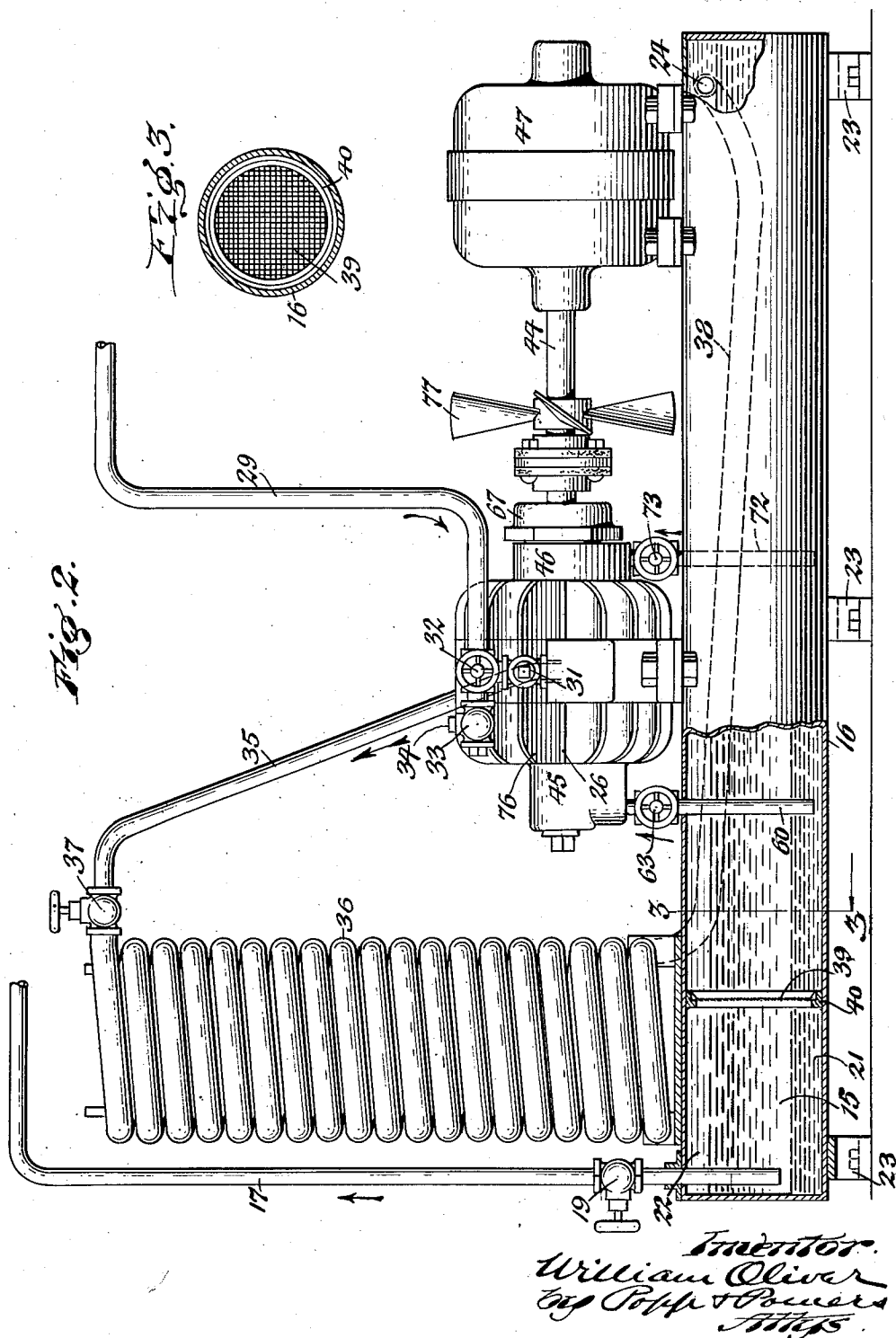
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Fig. 4.

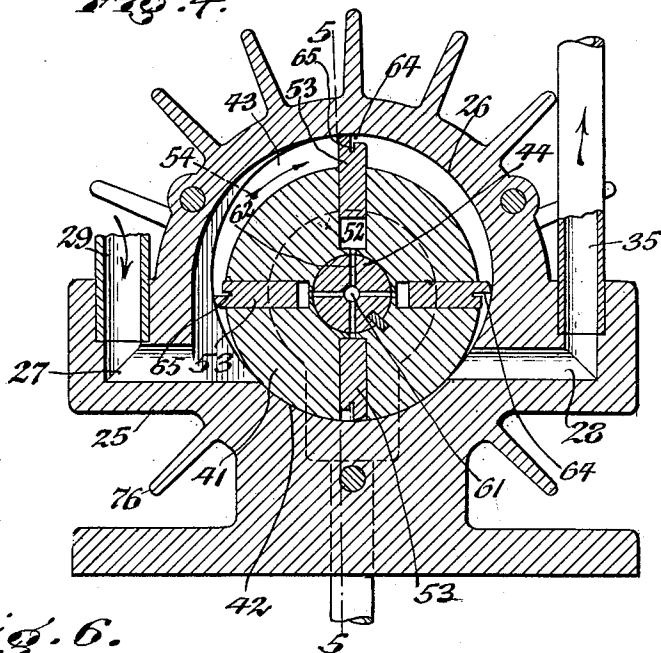


Fig. 6.

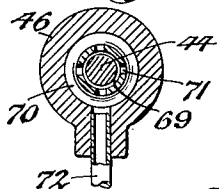
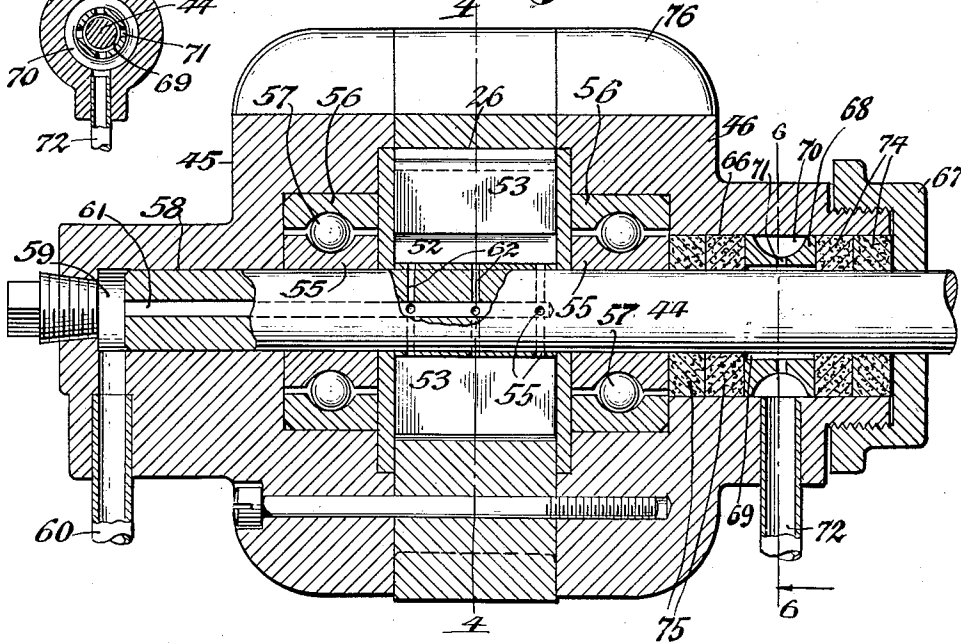


Fig. 5.



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PUMP.

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This invention relates to a pump for a refrigerating apparatus which is more particularly designed for domestic use in which a small amount of refrigeration is required as compared with large commercial installations.

In the forms of such apparatus as heretofore constructed it has been impossible to supply a refrigerating medium in a completely liquefied form to the cooling unit of the apparatus inasmuch as this liquid was always in a more or less foamy condition due to the admixture therewith of some of the unliquefied gaseous refrigerant medium which was mingled or suspended in the liquid body of the same. This is objectionable because when the refrigerating medium was subjected to pressure and is permitted to expand in the form of a gas in the cooling unit such gas does not yield the maximum amount of cooling effect and it also prevents perfect control of the apparatus under all conditions.

It is one of the objects of this invention to prevent delivery from the storage tank of the refrigerating medium which is in a more or less foamy condition but instead the foam has been broken down and the gaseous constituents thereof have been liquefied and therefore in the best condition for delivery under pressure to the cooling unit where it is expanded in the form of gas. The means for accomplishing this particular object of this invention consists generally in the interposition of a screen within the tank between its inlet through which the refrigerating medium in the form of mixed liquid and gas is returned thereto and the outlet of this tank from which the refrigerant in pure liquid form is conducted under pressure to the cooling unit.

An apparatus of this character as heretofore constructed has always been difficult to lubricate the compressor and maintain the same in a tight condition so as to render the same most effective.

It is a further object of this invention to provide a compressor for this purpose in which the blades of the pump are well lubricated and a reliable seal is formed between the outer end of each pump blade and the periphery of the pump cylinder by utilizing the film of the lubricant itself for this purpose, this object being arranged by

providing the outer front corner of each blade with a recess or groove whereby this blade during its forward movement while in engagement with the bore of the cylinder will pick up the lubricant and carry the same in the form of a comparatively thick film along the bore of the cylinder and the advancing outer front corner of the same whereby a perfectly tight joint is produced between each pump wing and the cylinder of the pump which permits of operating this pump constantly at a maximum efficiency and with the minimum of wear and great economy.

Leakage through the joint between the shaft and the bearing in which the shaft is journaled has also been a cause of constant trouble in a refrigerating apparatus as heretofore constructed and it is another object of this invention to so pack and mount the bearing of the rotary compressor pump used in this refrigerating apparatus that leakage from the interior of the pump to the exterior thereof is positively prevented, thereby avoiding loss of the refrigerating medium and effecting a considerable economy in operation. To that end the bearing of the compressor pump in which that end of the shaft opposite to its suction end is located, is packed by means of an oiling ring which is in constant communication with the refrigerant tank so as to be between the pressure therein and this bearing being packed on opposite sides of this oil ring so as to positively prevent any oil from escaping therefrom either to the atmosphere or to the interior of the pump.

In the accompanying drawings:—

Figure 1, is an elevation of an installation of a refrigerating apparatus embodying an improved form of my invention.

Figure 2, is a side elevation of the compressor, condenser, refrigerant tank, motor and associated parts, on an enlarged scale, the storage tank being shown partly in section.

Figure 3, is a vertical cross section taken on line 3—3, Fig. 2.

Figure 4, is a vertical cross section of the compressor pump taken on line 4—4, Fig. 5.

Figure 5, is a vertical longitudinal section taken on line 5—5, Fig. 4. Figure 6, is a fragmentary vertical cross section on a reduced scale taken on line 6—6, Fig. 5.

Similar characters of reference indicate like parts throughout the several views of the drawings.

The numeral 10 represents the cooling unit of the refrigerating apparatus which is adapted to be placed in the space which is to be cooled and which has an inlet 11 through which the refrigerant is introduced in gaseous form for the purpose of enabling the same to most efficiently absorb the heat in the surrounding space and it is also provided with an outlet 12 through which the heat laden refrigerant vapors are delivered from the cooling unit. In the particular installation of this invention shown in Fig. 1, this cooling unit is located within a compartment 13 of a refrigerator 14 such as are now in common use in households for storing and preserving family supplies of food. The refrigerating medium for this purpose is preferably drawn from a source of supply of pure liquid refrigerant 15 which is contained within one end of a tank 16, in this case the left end thereof as shown in Fig. 2. The liquid refrigerant is conducted from this source of supply to the inlet 11 of the cooling unit by means of a delivery pipe 17 which latter was provided with an expansion valve 18 of any suitable and well known character such as those now in common use and which operates to convert into gaseous form a refrigerating medium which has been discharged from the tank 16 in liquid form so that this gaseous refrigerant upon entering the cooling unit 10 will absorb the heat in the respective compartment. For convenience in making repairs and also when installing this apparatus a cut-off valve 19 is preferably arranged in the delivery conduit 17 adjacent to the tank 16 and for a similar purpose a valve 20 is arranged in this conduit 17 adjacent to the expansion valve 18.

In the present case the lower or inlet end of the liquid refrigerant delivery pipe or tube 17 projects downward through the top of the tank 16 and terminates at its lower end at a point between the top and bottom of this tank so that the inlet end of this pipe is at all times within the zone or layer of pure liquid refrigerant 15 and above the layer or zone 21 of lubricant which lies in the bottom of this tank for a purpose which will presently appear, and the inlet of this pipe also is arranged below the zone 22 of gaseous refrigerant which lies in the tank 16 between the top thereof and the other side of the layer 15 of liquid refrigerant. Although this refrigerant may be of any suitable character it is preferable to provide ethylchloride, and the lubricant may also be of any approved character but preferably glycerine which is now commonly used in refrigerating apparatus for lubricating the bearing surfaces and other parts which re-

quire lubrication to prevent undue friction and wear.

In the present case the storage tank 16 is represented in the drawings as located in the basement of the building and in the present case is supported on the floor of the basement by means of legs 23.

As the heat laden gaseous refrigerant issues from the outlet 12 of the cooling unit the same is taken up by a compressor which operates to force the same through a condenser and then delivers the same into the inlet 24 of the tank 16 which inlet in the preferred construction is arranged at the right hand end of the tank, or opposite to that end in which the outlet or delivery pipe 17 is arranged, and this inlet 24 is also arranged above the zone of pure liquid refrigerant and within the zone of gaseous liquid refrigerant, as shown in Fig. 2. The compressor for this purpose may be variously constructed but in the present case the same is preferably constructed in the form of a rotary pump, having its body 25 provided with a horizontal cylinder 26 one side of which is provided with a refrigerant inlet 27 and on its opposite side with a refrigerant outlet 28. The refrigerant inlet 27 is connected by means of a conduit or pipe 29 with the outlet 12 of the cooling unit which pipe is preferably provided adjacent to this outlet 12 with a valve 30 for convenience in cutting off the cooling unit in case repair of the same or adjustment thereof is required without disturbing the remaining parts of the apparatus. This pipe 29 is also provided adjacent to the pump inlet 27 with a check valve 31 which will only permit the liquid to flow into the pump but not back out of the same, it is also provided with a valve 32 whereby the flow of liquid through this pipe may be regulated or the pump may be cut off from the remaining apparatus in case of necessity for making repairs, the same is also provided with a filling fitting 33 which is normally closed by means of a plug 34 which filling fitting permits of introducing the ethyl-chloride originally into the apparatus and also replenishing the same from time to time when required.

The outlet 28 of the compressor pump is connected by means of a conduit or pipe 35 with the inlet or upper end of the condenser 36 which in the present form is constructed of a coil of tubing. Between the upper end of this coil and the conduit 35 is arranged a cut-off valve 37 for convenience in cutting off these members from each other when this becomes necessary when erecting or dismantling the apparatus or making any adjustment or repairs on the same. The lower or outer end of the condenser coil 36 is connected by means of a return pipe 38 with the inlet 24 of the storage tank or chamber 16. The refrigerant upon entering the inlet of

the compressor pump is partly in a gaseous and partly in a liquid form but in passing through the compressor it is subject to pressure so that the greater part of the same is reduced to liquid form and as the refrigerant passes through the condenser 36 which is exposed to the external atmosphere the bulk of the remaining gaseous constituents in the refrigerant are condensed so that this refrigerant upon entering storage tank 16 through the inlet 24 thereof is nearly all of liquid form with only part of the refrigerant still in a gaseous or uncondensed form. This admixture of liquid refrigerant and gaseous refrigerant in the storage tank produces a foamy mass on top of the liquid portion of the refrigerant which foamy mass if permitted to be discharged from the tank through the delivery pipe 17 to the cooling unit 10 would seriously interfere with obtaining the maximum efficiency in the cooling effect of the refrigerant and also prevent proper regulation of the cooling effect of the apparatus. Means are therefore provided for breaking down the foamy mass of refrigerant within the storage tank 16 after the same enters through the inlet 24 thereof and before escaping through the outlet at the lower end of the delivery pipe 17. This is accomplished most effectively by the arrangement of a screen 39 of a suitable small mesh of woven wire fabric which is arranged vertically across the space within the tank at a point between the inlet 24 and the lower opening of the delivery pipe 17, this screen in the present case being mounted at its margin on a frame 40 which is secured in the bore of the tank 16 in any approved manner.

As the foam laden liquid refrigerant passes from the inlet 24 through the screen 39 the bubbles of the foam are broken down and converted into liquid form which passes through the screen to the opposite side thereof and into that end of the tank into which the lower end of the delivery pipe 17 dips. Only the clear or pure liquid refrigerant is therefore present between this screen 39 and the delivery pipe 17 so that the latter draws off only pure liquid unmixed with any foam and delivers this pure liquid refrigerant to the expansion valve 18 where it entire mass is expanded into the form of a gas preparatory to entering the cooling unit 10, thereby exerting the maximum cooling effect in the respective compartment.

Within the cylinder 26 of the pump is arranged a rotor or piston 41 which is mounted eccentrically therein so that one side thereof engages with a curved surface 42 of the pump cylinder while its opposite side is spaced therefrom by an intervening pump chamber 43 which is of crescent-shape form and extends from the inlet 27 to the outlet 28 of the compressor pump, as shown in Fig.

4. This rotor is mounted on a shaft 44 which extends lengthwise horizontally through the heads 45, 46, at opposite ends of the pump cylinder and may be driven by any suitable form of motor, for instance an electric motor 47 which is connected with one end of the shaft 44 and is mounted on top of the storage tank 16, as shown in Figs. 1 and 2. This motor is automatically controlled by means which are responsive to variations in the temperature within the compartment which is to be cooled and the means which are shown to this purpose in the drawings consist of a thermostatic switch 48 which is electrically connected by means of wires 49 and 50 with the battery 51 and the motor 47 and which is so organized that when the temperature in the cooling compartment 13 drops to a predetermined point the circuits through the motor will be open so that the compressor pump driven from the motor will cease to operate and therefore interrupt the circulation refrigerating medium through the system and prevent a further drop in the temperature in the cooling compartment, whereas if the temperature in the cooling chamber should rise up to a predetermined point the thermostatic switch 48 will close the electric circuit and cause the compressor pump to be operated for again circulating the refrigerating medium through the system so that the cooling effect of the same is again resumed and continues until the temperature in the cooling compartment 13 has dropped below the point at which the thermostatic switch has been set for high temperature and therefore opens said switch.

The particular form of compressor pump shown in the drawings best adapted for the present purpose has its rotor 41 provided with a plurality of radial pockets or guide ways 52 in each of which slides a radially movable piston wing or blade 53 which latter is generally the form of a flat plate and engages its outer end with the bore of the pump cylinder. When this pump is in operation the rotor turns in the direction of the arrow 54 in Fig. 4 and each of the piston wings or blades moves outwardly in its pocket so that the same engages the bore of the pump cylinder. As each piston engages with the curved abutment plates 42 on the cylinder between the inlet and outlet thereof each piston is moved into its innermost position in which it exerts no propelling effect upon the fluid within the pump cylinder but as each piston wing or blade reaches the inlet of the pump it gradually moves radially outward until it reaches its maximum projected position about half way around the cylinder of the pump and then is again retracted into its respective pocket on the rotor by the time it passes the outlet 28, thereby causing the liquid in the pump

cylinder to be moved through the crescent-shaped space within the cylinder from the inlet to the outlet thereof and produce the circulation of the refrigerating medium in the system.

This pressure of the pump is exerted in the first instance with the fluid which it receives from the outlet of the cooling unit through the pipe 28 and discharges the same through the pipe 35 into the condenser 36 and delivers the same into the right hand end of the storage tank 16 through the inlet 24 thereof so that a pressure is established within this tank which tends constantly to press the liquid therein downwardly toward the bottom of this tank and, as a result of this pressure, liquid taken from the central zone 15 of liquid ethyl-chloride will be pressed outwardly through the pipe 17 and delivered to the expansion valve 18 where the same is converted into a vapor preparatory to entering the cooling unit 10 and absorbing heat in the vicinity thereof.

This pressure upon the liquid within the tank 16 is utilized for lubricating the working surfaces of the compressor pump and also assisting in moving the piston wings or blades outwardly and holding the same reliably in engagement at their outer ends with the bore of the bore cylinder.

As shown in the drawings the pump shaft 44 is journaled in the pump casing on opposite sides of the rotor 41 by means of ball bearings each of which consists of an inner ball race 55 mounted on the shaft 44, an outer ball race 56 mounted on the adjacent head of the casing and an annular row of balls 57 interposed between the said inner and outer ball races. The inner end of the shaft 44 is also journaled in a bearing 58 which is arranged on the head 45 of the casing adjacent to the outer side of the respective ball bearing. At the outer end of the bearing 58 on the casing head 45 is formed an inlet chamber 59 which is connected with the upper end of a pressure tube or conduit 60 extending through the top of the tank 16 and terminating at its lower end within this tank adjacent to the bottom thereof so that the lower end of this tube communicates solely with the strata 21 of liquid lubricant previously referred to. The numeral 61 represents a conduit or passage arranged centrally within the shaft 44 and extending from that end thereof which faces the inlet chamber 59 to that part of the shaft which is arranged within the rotor of the pump, and 62 represents a plurality of branch passages or conduits extending laterally from the inner end of the longitudinal passage 61 to the inner ends of the several pockets 52 of the rotor in which the piston wings or blades 53 slide radially. It follows from this construction that the downward pressure upon the fluid within the tank 16 causes the liquid

lubricant 21, consisting preferably of glycerine to be forced upwardly through the pipe or tube 60 into the chamber 59 where a part thereof passes inwardly through the opposing surfaces between the bearing 58 and the adjacent part of the shaft 44 thence past the respective roller bearing and thence through any available joints to the pump cylinder where it joins the fluid drawn by the pump from the pipe 28 and is discharged through the pipe 35. Some of this liquid also passes from the chamber 59 through the longitudinal conduit 61 thence through the branch passages 62 and into the inner ends of the pockets 52 where this liquid lubricant serves to force the piston blades or wings outwardly against the bore of the pump cylinder, any liquid leaking past the joints between these blades and the rotor being conducted to the inside of the pump cylinder and joining the fluid which is being propelled by the pump from the inlet to the outlet thereof. The pipe 60 is preferably provided with a cut-off valve 63 whereby the pump and tank may be disconnected when this is required during installation, inspection or repairing the apparatus.

As each piston wing or blade moves forwardly in engagement with the bore of the pump cylinder a film of liquid is gathered on each blade at the outer front corner thereof which is scraped from the bore of the cylinder. At the outer front corner of each wing the same is cut away so as to form a pocket 64 which extends across the entire width or face of each blade at its outer end and a longitudinal radial groove 65 is arranged in each wing and extends for a short distance inwardly from the bottom of the pocket 64, as shown in Fig. 4. As each wing or blade moves forwardly in engagement with the bore of the pump cylinder and scrapes a film of liquid therefrom this film is caused to pile up in the form of a mass within the pocket 64 of the groove 65 and held there so as to form a seal in the joint between the respective piston blade and the bore of the pump cylinder which prevents any leakage between these relatively moving surfaces thereby causing the pump to operate more effectively and insure reliable circulation of the refrigerating medium through the system. In addition to the ball bearing between the opposite head 46 of the pump casing and the adjacent part of the pump shaft 44 means are provided on this head of the casing whereby a liquid lubricant is conducted to this ball bearing from the lubricant zone 21 of the tank 16 and a tight joint is formed between this part of the bearing and the pump casing which prevents any part of the lubricant or refrigerating agent to escape to the exterior of the pump at this end of the casing. The preferred form of the means which are shown

in the drawings for accomplishing this purpose are constructed as follows:—

The numeral 66 represents a cylindrical chamber arranged in the outer part of the head 46 around the shaft 44 and extending from the outer end of the head 46 inwardly to the respective ball bearing. Secured to the outer end of the head 46 by means of a screw joint and surrounding the adjacent part of the shaft 44 is a cap 67. The numeral 68 represents an oil ring arranged in the packing chamber 66 midway between its inner and outer ends and bearing with its periphery against the bore of this packing chamber while its inner side or bore is separated by an annular space 69 from the periphery of the shaft 44. On its periphery this oil ring is provided with an annular groove 70 and at intervals in its circumference the same is provided with a plurality of radial openings 71 extending from the bore of this ring to the bottom of the groove 70.

The numeral 72 represents a conduit or tube 72 secured at its upper end to the casing head 46 and communicating with the bore of the chamber 60 opposite the groove 70 in the oil ring 68, and extends with its central part through the top of the storage tank 60 and terminates at its lower end a short distance above the bottom of this tank and within the zone 21 of liquid lubricant, as shown by dotted lines in Fig. 2. This pipe is provided with a valve 73 whereby communication between the pump and the tank 16 may be cut off whenever it is desired to do so, for instance, when dismantling more or less of this apparatus when making repairs and thereby preventing the fluids from passing from the tank to the pump at this time.

Between the outer side of the oil ring 68 and the cap 67 a packing is arranged consisting preferably of a plurality of metal packing rings 74 which engage their bores with the periphery of the shaft 44 while their peripheries engage with the bore of the chamber 66. Similar packing rings 75 of metal are arranged between the periphery of the shaft 44 and the bore of the chamber 66 and between the inner side of the oil ring 68 and the outer side of the inner ball race forming part of the adjacent ball bearing.

When the pump is in operation and produces a downward pressure on the liquid within the tank 16 part of the liquid lubricant in the zone 21 is forced upwardly through the pipe 72 into the annular groove 70 of the oil ring 62, thence inwardly along the joints between the shaft 44 and the adjacent surfaces to the adjacent ball bearing and then joins the liquid within the cylinder of the pump which is being acted upon by the blades thereof. At this time the atmospheric pressure prevents any leakage from

the oil ring past the metallic packing rings 74 to the exterior of the pump and the constant suction effect of the pump on the joints between the inner metallic packing ring 75 operates to draw any oil from the ring 68 toward the cylinder of the pump, thereby preventing any of the lubricating agent or refrigerating medium from escaping to the exterior of the pump in the event that any looseness should develop in the joint between the casing head 46 and the shaft due to wear as the result of continued use of the pump.

Inasmuch as any excess lubricant taken up by the pump for lubricating its wearing surfaces are again discharged through the outlet of the same with the refrigerating agent this mixture of lubricant and refrigerating agent passes together through the condenser and back through the inlet 24 into the storage tank 16 where the difference in specific gravity between the lubricant and the refrigerant again separate into lower and upper stratas ready to be again circulated, it being understood, however, that only liquid refrigerant is withdrawn from the tank 16 and delivered to the expansion valve of the cooling unit and only liquid lubricant is withdrawn from the tank for use in lubricating the wearing surfaces of the pump inasmuch as the lubricant only passes from the tank 16 through the pump and coil 36 and back to the tank, while the refrigerant passes from the tank 16 through the pipe 17, expansion valve 18, cooling unit 10, pipe 29, compressor pump, pipe 35, coil 36 and back into the tank where it is separated from the lubricant with which it becomes mixed in the pump and condenser.

For the purpose of assisting in abstracting the heat from the refrigerant as the same passes through the cylinder of the pump and the coil 36 of the condenser the exterior of the pump cylinder is provided with a plurality of radiating fins 76 and the shaft 44 of the pump is provided with a rotary fan 77 which operates to deliver a blast of air against the fins 76 and the coil 36 and thus serve to carry off the heat contained within the refrigerant and lubricant, thereby reducing the temperature of the same and putting the same in condition for re-circulation in the system and again absorbing heat in the cooling chamber 13.

On the whole this refrigerating apparatus is very simple in construction, efficient in operation and capable of being manufactured and operated at a comparatively low cost inasmuch as it has no delicate parts which are likely to get out of order, the same can be run with a minimum expenditure of power and leakage of fluid refrigerant or lubricant is avoided so that replacement of these constituents or replenishing of the same are only required at long intervals,

By this means a reliable seal of oil is formed between the shaft and the casing in which it turns whereby external air is prevented from entering the compressor and building up a dangerous pressure in the compressor, and also preventing ethyl-chloride from escaping from the compressor and necessitating frequent replenishing.

I claim as my invention:—

10 1. In a refrigerating apparatus, a compressor pump provided with a cylinder having an inlet and an outlet, a rotor arranged within said cylinder and provided with a plurality of radial pockets, and a plurality
15 of piston blades one slidable radially in each of said pocket and each having its outer end engaging the bore of said cylinder and having its outer front corner removed to form a liquid film receiving pocket between the
20 outer front part of the respective blade and the bore of said cylinder.

2. In a refrigerating apparatus, a compressor pump provided with a cylinder having an inlet and an outlet, a rotor arranged
25 within said cylinder and provided with a plurality of radial pockets, and a plurality of piston blades one slidable radially in each of said pockets and each having its outer end engaging the bore of said cylinder and having
30 its outer front corner removed to form

a liquid film receiving pocket between the outer front part of the respective blade and the bore of said cylinder and each blade having a longitudinal groove extending inwardly from said pocket at the rear end of the same. 35

3. A compressor for a refrigerating apparatus comprising a cylinder having an inlet and an outlet, a closed bearing on one side, an open bearing on its opposite side, and a lubricant chamber surrounding said open
40 bearing, a shaft turning in said closed and open bearings and extending through said cylinder, but terminating at one end within said closed bearing and extending at its opposite end to the exterior of the cylinder, a
45 motor connected with that end of the shaft which extends to the exterior of the cylinder, a rotor mounted on said shaft within said cylinder, piston blades mounted on said rotor and engaging with the bore of said cylinder,
50 and a lubricant reservoir connected with said chamber and subjected to the pressure of the outlet of said cylinder for forcing lubricant from the lubricant reservoir into said chamber, thereby forming a seal between the shaft
55 and the open bearing to prevent liquid from escaping to the exterior and prevent external air from entering the cylinder.

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