Feb. 8, 1938. F. R. ERBACH 2,107,630

REFRIGERATING APPARATUS

Filed Sept. 21, 1932 5 Sheets-Sheet 1

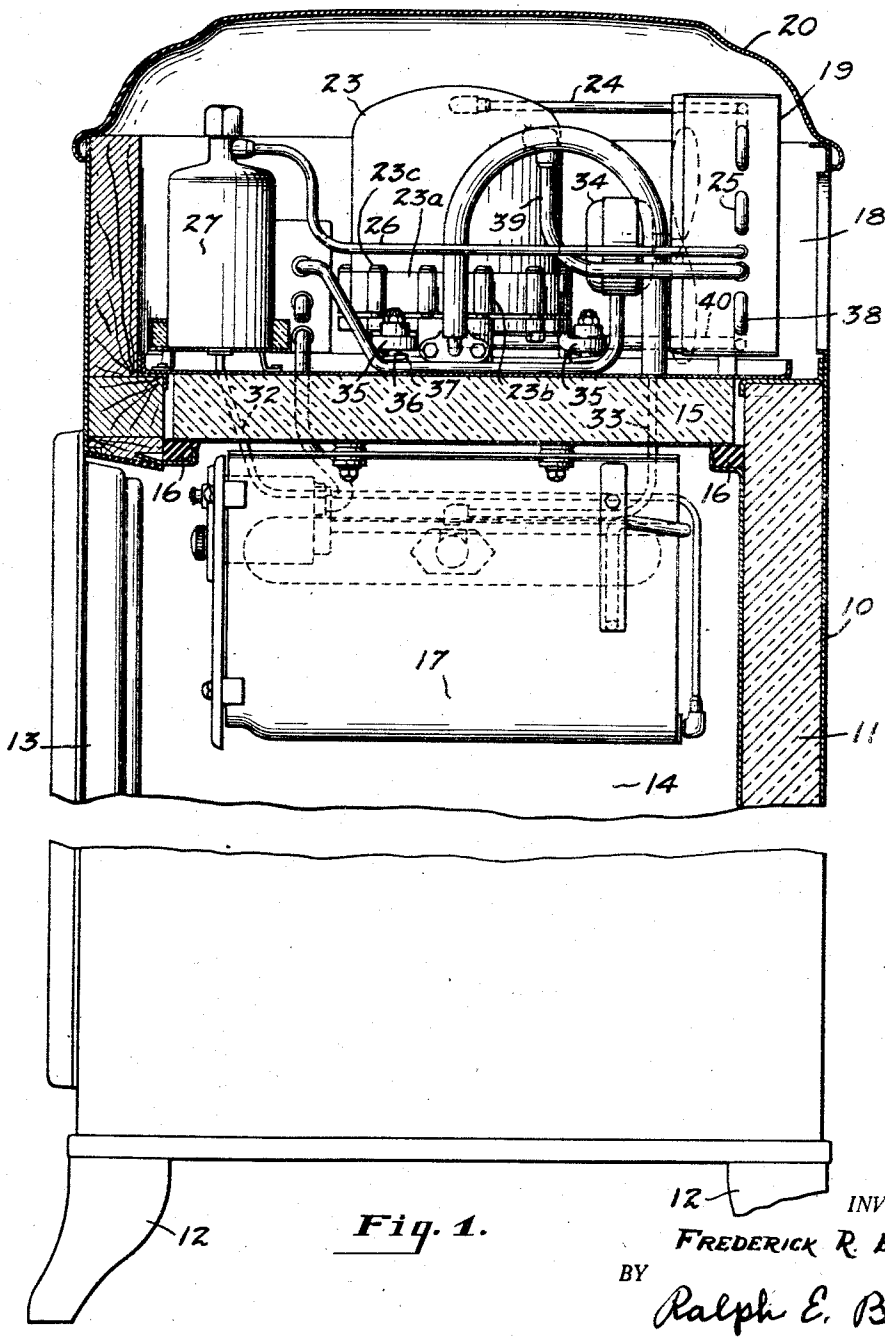

Fig. 1.

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Filed Sept. 21, 1932 5 Sheets-Sheet 2

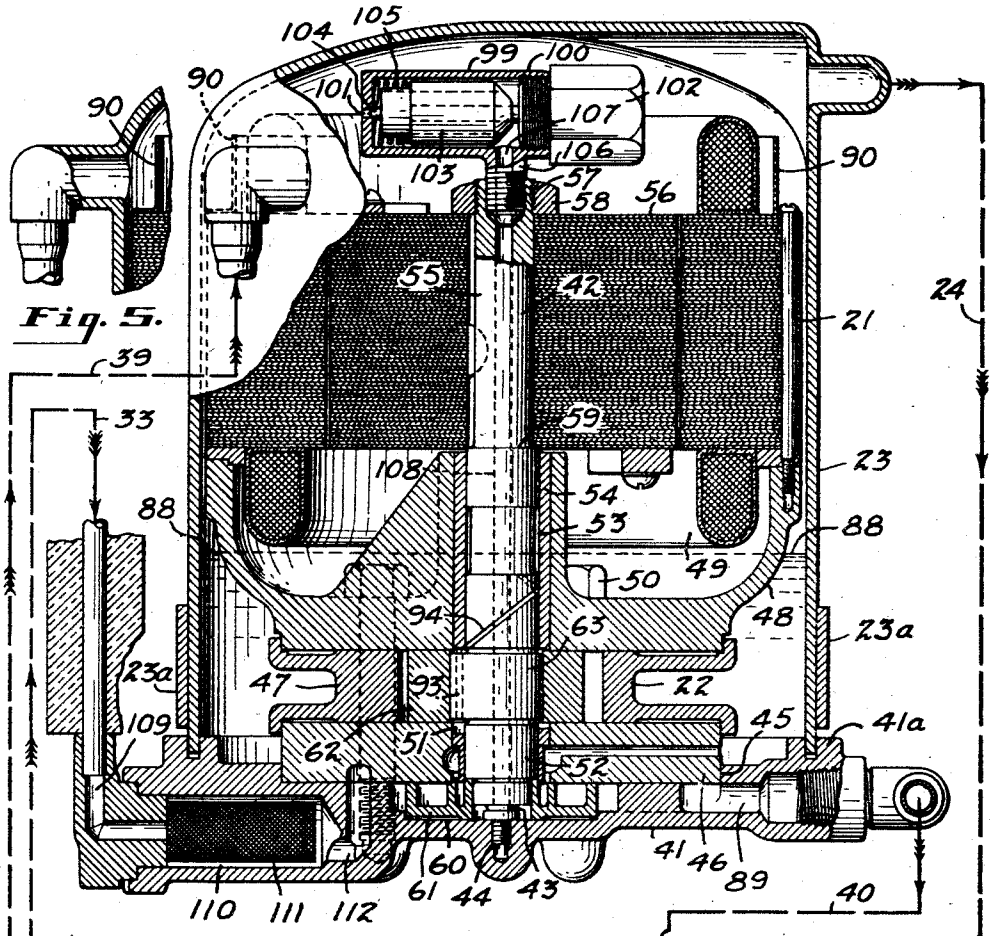

Fig. 5.

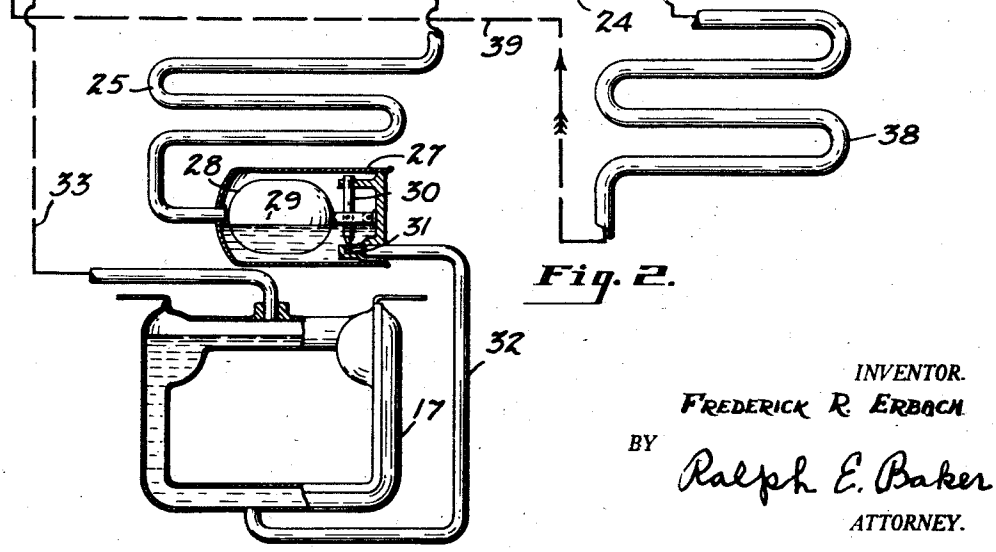

Fig. 2.

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REFRIGERATING APPARATUS

Filed Sept. 21, 1932 5 Sheets-Sheet 3

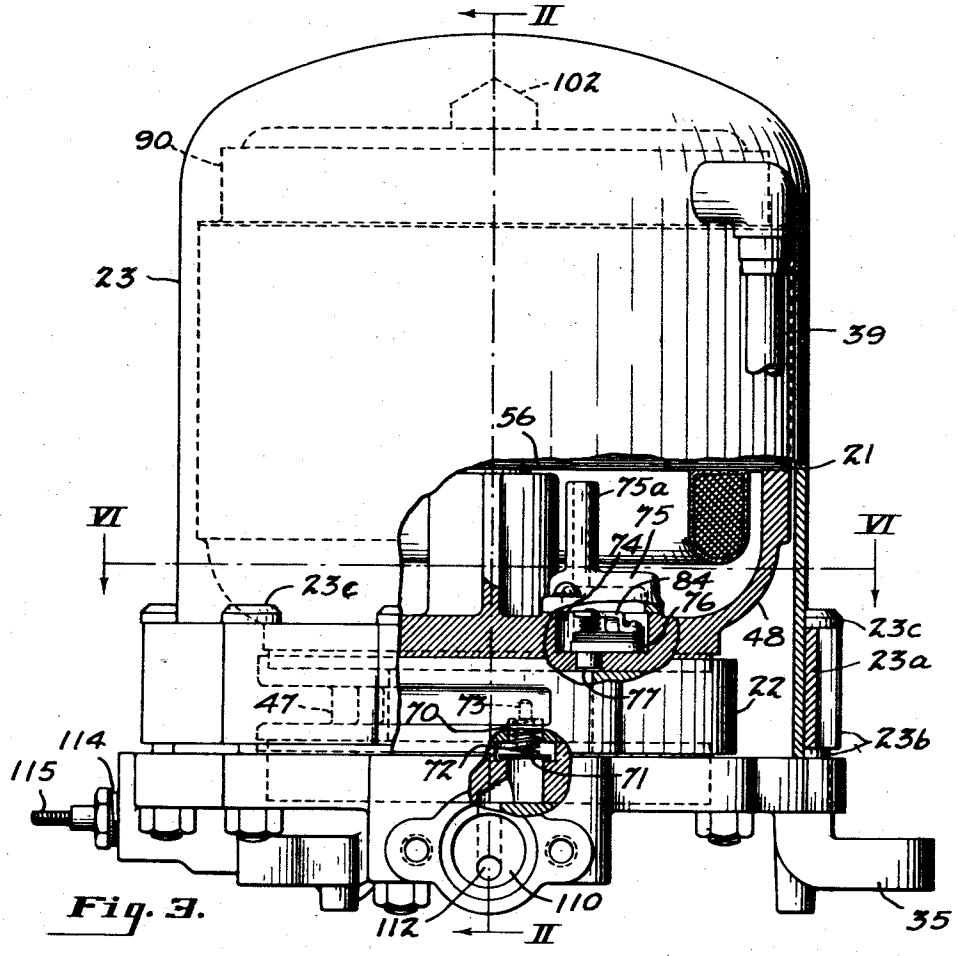

Fig. 3.

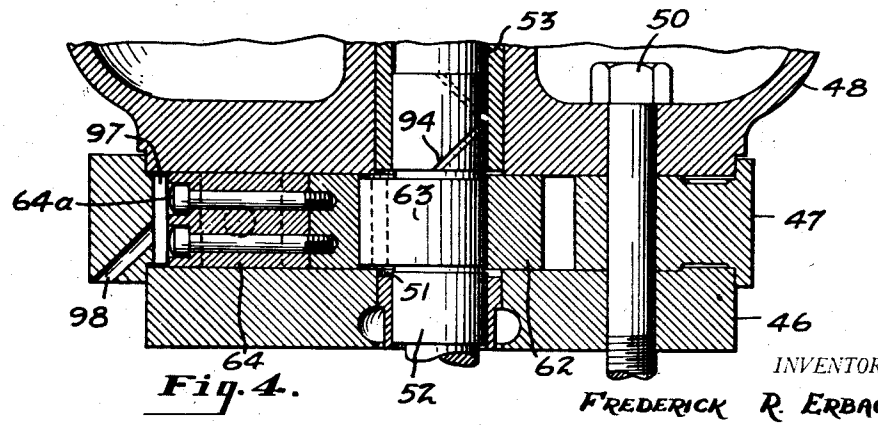

Fig. 4.

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REFRIGERATING APPARATUS

Filed Sept. 21, 1932 5 Sheets-Sheet 4

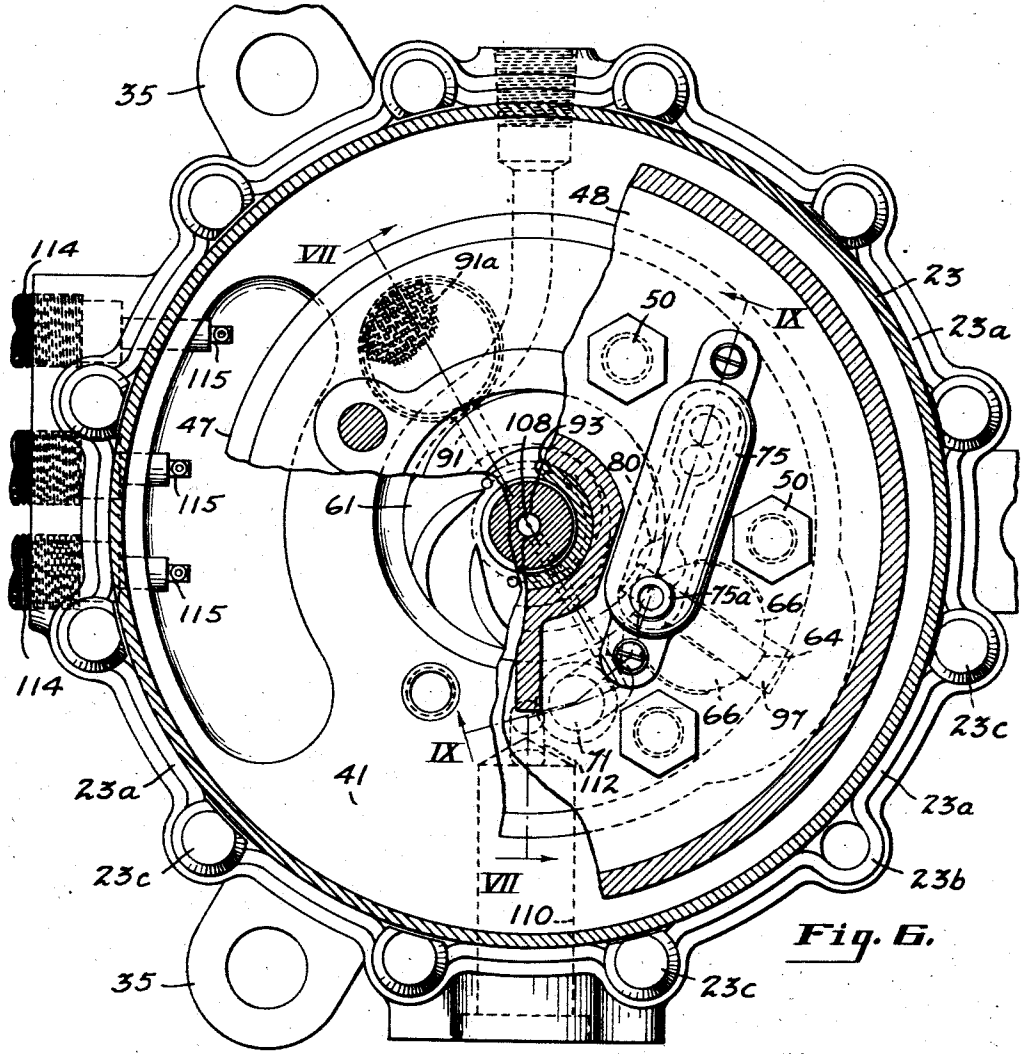

Fig. 6.

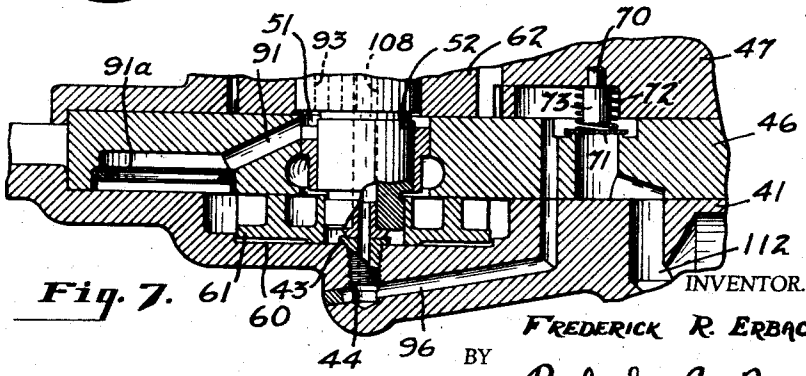

Fig. 7.

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REFRIGERATING APPARATUS

Filed Sept. 21, 1932 5 Sheets-Sheet 5

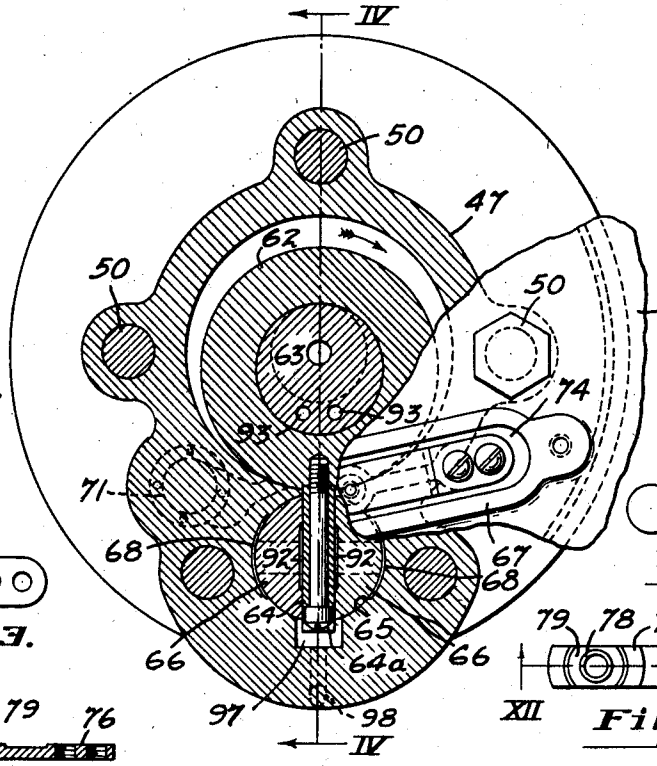

Fig. 8.

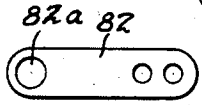

Fig. 13.

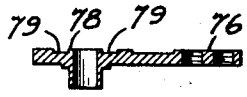

Fig. 12.

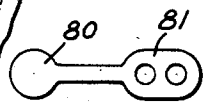

Fig. 10.

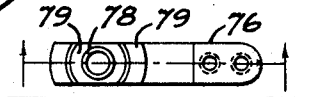

Fig. 11.

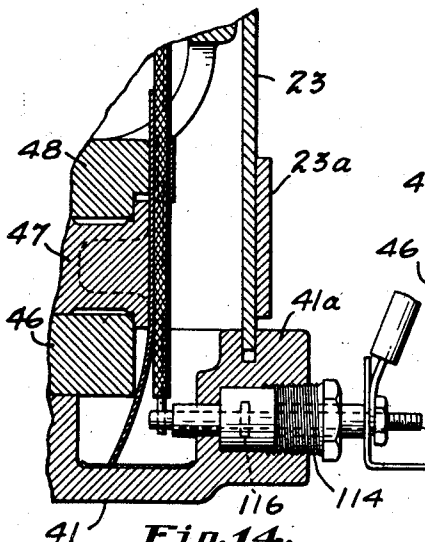

Fig. 14.

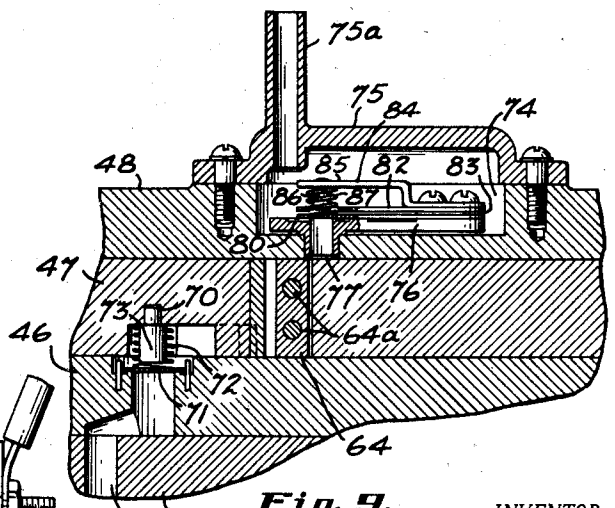

Fig. 9.

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Patented Feb. 8, 1938 2,107,630

UNITED STATES PATENT OFFICE

2,107,630

REFRIGERATING APPARATUS

Frederick R. Erbach, Beloit, Wis., assignor, by mesne assignments, to Nash-Kelvinator Corporation, Detroit, Mich., a corporation of Maryland

Application September 21, 1932, Serial No. 634,129

1 Claim. (Cl. 230—139)

This invention relates to refrigerating apparatus and particularly to refrigerating apparatus of the compression type.

It is an object of the invention to provide a compression mechanism for refrigeration purposes in which the gas pump or compressor is enclosed with its driving motor in a fluid tight casing, the relative parts of the mechanism being so constructed and arranged as to insure adequate lubrication of the moving parts and to utilize the lubricating medium as a cooling agent for the heat-generating compression mechanism and motor.

A further object is the provision of a simple and effective device for permitting the driving motor to substantially reach its normal operating speed before any material load is placed on it.

Still another object of the invention is to provide a compressor of the pendulum rotary type having a radial abutment member rigidly attached thereto, which abutment member reciprocates between two oscillating members during the operation of the compressor, the relation and operation of the parts and their coordination being such that a compressor of high efficiency for gas compressing purposes is provided.

My invention also includes improved intake and discharge valve structures particularly designed for use with a compressor of the type before mentioned.

By this invention there is also provided an improved lubricating system for an enclosed motor-compressor unit in which the lubricating medium is positively circulated through the moving parts of the mechanism, circulated outside the enclosing casing and then cooled, and then returned to the casing in its cooled state to assist in removing the heat generated by the motor and compressor during their operation.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawings wherein:

Fig. 1 is a vertical view, partly in section, of a refrigerator cabinet showing my improved refrigerating mechanism in operating relation thereto.

Fig. 2 is a vertical view partly in section through the compression mechanism taken on the line II—II of Fig. 3 and showing diagrammatically its relation to the other parts of the refrigerating system.

Fig. 3 is a vertical view partly in section of the compression mechanism and taken at a displacement of substantially 90° from the view in Figure 2.

Fig. 4 is a vertical sectional view on an enlarged scale of the compressor proper, taken on the line IV—IV of Fig. 8.

Fig. 5 is a detailed view partly in section showing the connection of the oil return conduit to the compressor housing.

Fig. 6 is a plan view partly in section, taken on the line VI—VI of Fig. 3 and showing details of the compressor base and oil pump.

Fig. 7 is a fragmentary vertical sectional view taken on the line VII—VII of Figure 6 and showing further details of the oil pump and lubrication features.

Fig. 8 is a plan view partly in section of the compressor per se.

Fig. 9 is an enlarged vertical section taken on the line IX—IX of Figure 6 and showing details of the inlet and discharge valve mechanisms for the compressor.

Figs. 10, 11, 12, and 13 are detail views of component parts of the discharge valve mechanism, and

Fig. 14 is a vertical view, partly in section, and showing a preferred structure for making an electrical connection through the casing to the enclosed motor.

Referring to the drawings wherein is shown a specific embodiment of the invention, 10 designates a refrigerator cabinet supported by legs 12 and provided with insulated walls 11 which together with a swinging insulated door 13 form a food storage compartment 14. The refrigerating apparatus comprises generally a heat insulated base 15 which is removably supported, as by members 16 and thus forms a removable top wall for the food storage compartment 14. A heat-absorbing unit 17 is fixedly secured to and suspended from the base 15 within the food compartment. The heat-absorbing unit may be of any suitable construction but is here shown as a sheet-metal evaporator of the type described and claimed in the co-pending application of Ransom H. Beman, Serial No. 556,420 filed Aug. 11, 1931, and assigned to Kelvinator Corporation.

Mounted on the upper side of the base 15 and located within a machine compartment 18 formed integrally with the cabinet above the food compartment, but heat-insulated therefrom, is the heat dissipating mechanism 19. A removable cover 20 is provided for the machine compartment, and when this cover is removed the base 15 and the refrigerating apparatus attached thereto may be bodily removed from the cabinet in a vertical direction.

The heat dissipating unit, the operation of which will be later described in detail, comprises generally a motor 21 and a compressor 22 enclosed within a fluid tight casing 23. The casing 23 is connected by conduit 24 to a condensing coil 25 wherein the compressed gaseous refrigerant discharged from the compressor and the casing 23 is condensed to a liquid. The liquid refrigerant is delivered from the condenser through a conduit 26 to a casing 27 containing a float valve mechanism 28.

Referring to Figure 2 wherein the float valve mechanism is shown diagrammatically, it will be noted that the said mechanism comprises the casing 27 within which is located a hollow float member 29 operatively connected to a valve member 30, which valve member cooperates with a seat 31. The construction is such that when a predetermined quantity of liquid refrigerant is present within the casing 27, the float will lift the valve 30 from its seat and allow liquid refrigerant to flow at a reduced pressure through a conduit 32 to the cooling unit or evaporator 17. Here because of its relatively low pressure the liquid refrigerant boils and in so doing absorbs heat from the food compartment 14. The gaseous refrigerant is then drawn through a conduit 33 to the compressor where it is recompressed and the cycle repeated. A motor driven fan 34 may be provided to force air over the condenser coils 25 and thus assist in removing heat from the compressed refrigerant.

Preferably, the base of the compressor unit is provided with a plurality of flanges 35 having openings through which project bolts 36, and springs 37 are located around these bolts between each flange and the base 15 whereby to resiliently support the encased motor-compressor unit.

An oil cooling coil 38 similar in construction to the condenser coil 25 is disposed beneath the condenser coil and in the path of air circulated by the fan 34. This cooling coil is connected to the upper part of the casing 23 by a conduit 39 and to the lower part of the casing by a conduit 40, for a purpose to be hereafter described.

Referring to Figure 2 wherein is shown in more detailed form the compressor and motor operatively assembled, 41 designates generally a base of relatively heavy material upon which are supported the compressor and its driving motor together with the surrounding casing 23. The casing 23 may be sealed to the base in any desired manner but is here shown as provided with a strap 23a welded thereto and in which strap are provided at spaced intervals a plurality of loops 23b through which bolts 23c may be inserted and screwed into the base 41 so as to maintain the casing 23 in fluid tight contact with the base 41, a grooved flange 41a being provided in the upper surface of the base 41 for receiving the lower edge of the casing 23. The base 41 is substantially circular and the compressor shaft 42 extends vertically upward substantially at the center of the base. The lower end of the shaft runs on a thrust bearing 43 extending into a recess 44 formed in the base. The base is also provided with a recess 45 for receiving a plate 46 upon which plate rests the compressor cylinder 47. The opposite side of the compressor serves as a support for a substantially U-shaped member 48 which in turn supports the motor stator 49. When these parts are assembled, the compressor cylinder 47 is rigidly fastened between the members 46 and 48 by means of bolts 50, which in turn secure the whole assembly to the base 41.

The lower member or plate 46 is provided with a recess 51 which receives a bearing 52 formed on the lower end of the shaft 42, and the upper or U-shaped member 48 has formed therein, at its central part, a somewhat elongated recess 53 which serves as a surface for an upper bearing 54 also formed integrally with the compressor shaft. The portion 55 of the shaft extending upwardly from the second main bearing is somewhat reduced in diameter and has keyed thereto the rotor 56 of the motor 21. The extreme upper end of the shaft is screw-threaded as indicated at 57 and a nut 58 engages the threaded portion to securely clamp the rotor 56 between nut 58 and a shoulder 59 formed above the upper bearing 54.

Immediately below the recess 45, formed in the base 41 for receiving the plate 46, there is a smaller recess 60 within which is located a centrifugal oil pump 61 rigidly attached to and driven by the shaft 42.

Referring to Figures 4 and 8 wherein are shown details of the compressor construction, it will be noted that the piston 62 for the compressor is circular in cross-section, and that it is eccentrically mounted on the shaft 42, through the intermediary of an eccentric member 63 formed integrally with the shaft. A radial abutting member or blade 64 is rigidly attached to the piston 62 by means of bolts 64a, whereby this member and the piston move as a unit. The radial member extends into a cylindrical recess 65 between two substantially semi-cylindrical oscillating portions 66. The construction is such that when the shaft 42 is rotated, the piston 62 will nutate and thus its outer surface will always have one point in contact with the wall of the cylinder, thereby squeezing any gas which may be ahead of the point of contact and compressing the same until it is discharged through the valve 67.

As the radial member or blade 64 is rigidly attached to the periphery of the piston it will reciprocate between the semi-cylindrical members 66 and these members will in turn oscillate in the cylinder 65. It will be noted that the cylinder 65 is provided with narrow recesses 68 at diametrically opposite points so that there is a relatively small contact surface between each of the semi-cylindrical members 66 and the remaining portion of the cylinder wall 65. By this construction I have not only reduced the bearing surface and consequent frictional loss but have also provided a means for effectually reducing any tendency on the part of the members 66 to bind in the cylinder wall during the operation of the compressor. The blade 64 serves as a constant partition between the high and low pressure sides of the compressor and effectually prevents the escape of gas from one side to the other.

The intake valve 70 comprises a disc of spring steel 71, firmly maintained seated by the force of a spring 72 which surrounds a pin 73 rigidly fastened in the cylinder wall. The discharge or exhaust valve comprises a recess 74 formed in the upper member 48 and provided with a cover member 75 from which a relatively short conduit 75a extends vertically upward. This conduit should, however, be long enough to extend at all times above the highest oil level obtainable within the casing 23. The valve mechanism proper consists of an elongated seat member 76 shown in Figure 12 and provided with a downwardly depending hollow cylindrical portion projecting into the discharge port 77 in a tight relation. On its upper surface this member is provided with a relatively narrow upwardly projecting seat 78

and is then cut away as indicated at 79 to provide a groove for receiving a small quantity of oil which assists in quieting the action of the valve. The valve member which cooperates with the seat 78 comprises a flat leaf spring 80 shown in Figure 10. It will be noted from this figure that the portion of the spring engaging the valve seat is substantially circular in form and that from the circular portion a somewhat narrow neck extends to an enlarged portion 81. In Figure 13 there is shown a second leaf spring member 82 substantially rectangular in contour and provided at its outer end with an opening 82a for a purpose to be hereafter described.

Referring to Figure 9, it will be noted that the valve member 80 is mounted directly on the valve seat, that the member 82 is superposed thereon in a slightly spaced relation, and is so maintained by an interposed washer 83, and that a rigid Z-shaped member 84, is superposed on the member 82 with a portion 85 overhanging the valve seat and spaced some distance therefrom. A stud 86 is rigidly fastened to the underside of the portion 85 and about the stud is placed a coil spring 87 which passes freely through the opening 82a formed in the member 82 and presses against the portion of the valve member 80 which overlies the seat 78. In the normal operation of this valve, the gas discharged from the compressor has a pressure only sufficient to overcome the force of the spring 87 and the spring member 82 serves normally as a cushioning member to limit the upward movement of the valve member 80. However, should an abnormal pressure be exerted on the valve member 80 such as might be caused by the passage of a slug of oil, the construction is such that the member 80, the spring 86 and the spring member 82 will all yield and allow the pressure to be relieved.

The lubrication of the moving parts of the motor and the compressor is accomplished by a forced lubrication system in which the circulation of oil is maintained by the pump 61. As has been previously stated this pump is located in a recess 60 formed in the lowermost portion of the casing 41 and is directly attached to and driven by the main compressor shaft 42. The oil pump may be of any desired construction but as here shown, is a conventional centrifugal pump. Under normal operating conditions, the casing 23 contains a body of oil to a level indicated approximately by the line 88, Figure 2. Thus it will be noted that the compressor mechanism is completely immersed in an oil bath and that the level of the oil terminates just below the lower part of the stator windings. When the motor and consequently the oil pump is operated, a considerable portion of the oil circulates out through passage-way 89 and through the conduit 40 to the oil cooling coil 38, where its temperature is materially reduced, and then returns through conduit 39 to the upper part of the casing 23. As the cool oil comes into the casing it is deflected from the stator windings by means of a shield 90 rigidly attached to the stator and flows down through the space between the outer surface of the stator and the casing 23 and in so doing, absorbs a considerable portion of the heat generated in the motor. The oil then returns to the main body where it absorbs additional heat from the compressor and is then re-circulated through the cooling coil by the pump.

Another portion of the oil flows through filter 91a and passage-way 91, Figure 7, to the lower shaft bearing 52, and is then forced into the compressor where it effectually seals the moving parts including the piston 62, the partition member or blade 64 and the two rocker members 66. It will be noted that each of the flat surfaces of the two rocker members adjacent to the blade 64, is provided with a recess 92 for permitting the introduction of oil between the plate and the rockers. Some of the oil also passes through ports 93 drilled through the eccentric 63 and from there passes to the upper surfaces of the compressor and then through grooves 94 formed in shaft 42 so that the upper bearing 54 is effectively lubricated. The oil then passes out over the upper edge of the bearing and drops down to the main body of oil.

As has been previously stated, the conduit 75a leading from discharge valve chamber 74 is of sufficient height to extend above the oil level 88 under all conditions of operation whereby the compressed gas discharged from the compressor does not have to pass through the oil on its way to the condenser. Any particles of oil which may be commingled with the gas as it comes through the discharge valve and conduit 75a, will separate by gravity after they have passed through that conduit.

During the operation of the blade member 64 it is inevitable that a quantity of oil will constantly be trapped between the end of this blade and the cylinder casing in the space 97. In order to prevent this trapped oil from exerting an increased pressure on the end of the blade and consequently adding to the load on the compressor a port 98 is drilled through the cylinder casing and connects the space 97 with the main body of oil. This port is made of relatively small diameter so that while oil may pass freely from the space 97 to the main reservoir because of the pumping effect of the blade 64, it will not readily flow in the reverse direction that is from reservoir toward the blade.

In order to permit the motor to attain approximately its normal operating speed before any load is imposed on it by the pumping action of the compressor, I provided an unloading device indicated generally by the numeral 99, and attached to the upper end of the compressor shaft. This device comprises a hollow cylindrical body 100 having a port 101 in one of its vertical end walls, and having an adjustable closure nut 102 screw-threaded into the opposite wall. A piston 103 is somewhat loosely mounted in the cylinder 100 and carries at its outer end a valve 104 adapted to cooperate with the port 101. A spring 105 is interposed between the wall carried port 101 and the piston 103, the arrangement being such that when the machine is at rest, the spring will unseat the valve 104. The unloading device 99 is attached to the compressor shaft by means of a screw threaded boss 106. This boss is provided with a hollow passageway 107 opening directly into a second hollow passageway 108 extending axially throughout the entire length of the compressor shaft 42.

A passage-way 109 is provided in the base 41 for the passage of low pressure gas from the cooling unit to the compressor. This passage-way opens into a chamber 110 in which is located a screen 111 which serves as a filter for the removal of foreign particles which may be entrained with the gas. After passing through the filter, the low pressure gas passes through a port 112 to the suction side of the compressor. A passage-way 96, is also provided to connect the suction side of the compressor with the passage-way 108

extending through the compressor shaft. Thus when the compressor is at rest, and the unloader valve 104 is unseated, there is an equalization of the pressure between the interior of the casing 23 when the pressure corresponds to that of the compressor discharge through the port 101, passage-ways 107 and 108, passage-way 96 and the suction side of the compressor. When the motor is started it is necessary for it to attain a speed sufficient to cause seating of the valve member 104 through the centrifugal force acting on the piston 103 and against the tension of spring 105 before this by-pass is closed, and as a result the motor will operate under a substantially "no-load" condition until it has substantially attained its normal operating speed.

In Figure 14 I have shown one arrangement for carrying the lead-in connections for the motor through the casing 23. The number of these connections will of course vary with the type of motor used. The connecting means here shown comprise a screw threaded bushing 114 of an insulating material such as phenolic condensation product, having an electrical conductor 115 passing axially through and maintained against axial movement in the bushing by means of a flange 116 securely embedded in the insulating material.

In the operation of my device the liquid refrigerant in the evaporator or cooling unit 17 being under low pressure, boils and absorbs heat from the food compartment 14. The gaseous refrigerant is then drawn through conduit 33, passage-way 109, filter 111, passage-way 112 and intake valve 70 to the suction side of the compressor. Here the gas is compressed by the rolling motion of the piston 62 against the cylinder wall, this motion being in a clock-wise direction as shown in Figure 8. As the volume of the gas is reduced its pressure is increased and it finally passes out through the passage-way 77, discharge valve 80, chamber 74 and conduit 75a to the interior of the casing 23. From this casing the compressed gas passes through the conduit 24 to the condenser coil 25 where it is cooled and liquefied by the air current created by fan 34. The liquefied gas then passes to the float valve assembly 27 from which place the liquid refrigerant is delivered at a reduced pressure through the conduit 32 back to the cooling unit 17. In the meantime, as has been previously explained in detail, a portion of the hot lubricating medium passes out through conduit 40, through the cooling coil 38 where a substantial portion of its heat is removed, and back through conduit 39 to the upper part of the casing 23. It is then deflected over the outer portion of the stator windings absorbing heat therefrom and then returns to the main oil reservoir where it absorbs further heat before being re-circulated outside the casing by the oil pump 61. Thus it will be seen that I have provided a unitary compact refrigerating system employing a compressor of the rotary pendulum type in which the parts are so correlated as to produce a maximum efficiency and simplicity of operation and which may be quickly and rapidly assembled or disassembled.

The lubricating system is both thorough and positive in its action, and in addition, the lubricating medium is used as a means to assist in removing the heat of compression outside the enclosed casing.

My unloading device as shown and described because of its simple construction, has proved to be very effective and positive in its action.

While I have shown and described a specific embodiment of my invention, it will be understood that other forms might be adapted by coming within the scope of the appended claim.

I claim:

A compressing system comprising a base, a compressor, a motor mounted thereon, a casing enclosing said compressor and motor secured to said base, a body of lubricant disposed in said casing, and adapted to function as a lubricant sealing means and cooling agent, and means for pumping and conducting said lubricant outside of said casing for cooling said lubricant and then conducting said lubricant to the upper portion of the region in said casing where a portion of said cooled lubricant is directed over the motor windings and the remainder of said lubricant along the inside surface of said casing.

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