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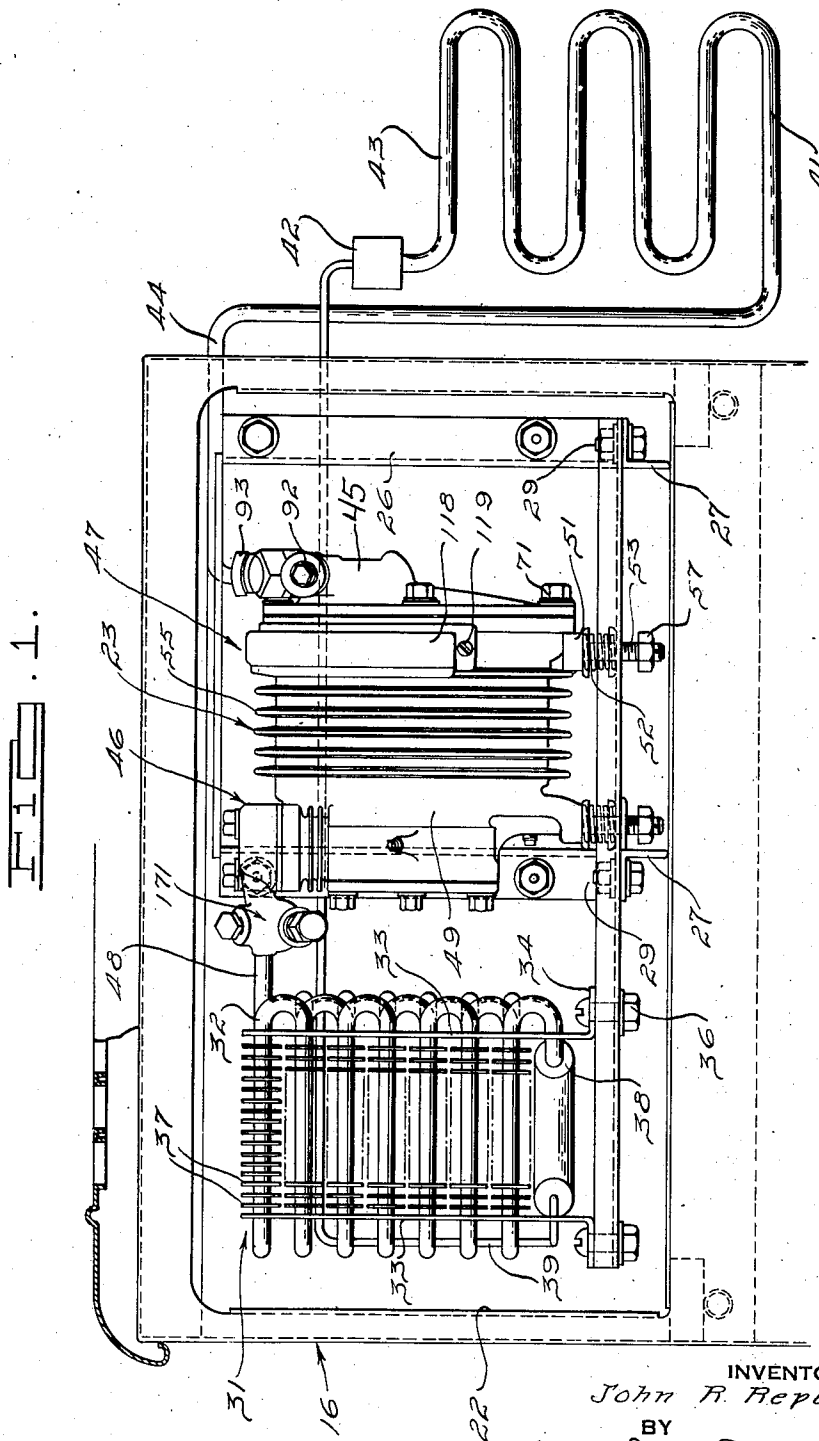
J. R. REPLOGLE

2,035,276

REFRIGERANT COMPRESSING UNIT

Filed May 5, 1932

5 Sheets-Sheet 1



INVENTOR  
John R. Replogle.  
BY  
Harnes Dickey Pierce & Harnes  
ATTORNEYS.

March 24, 1936.

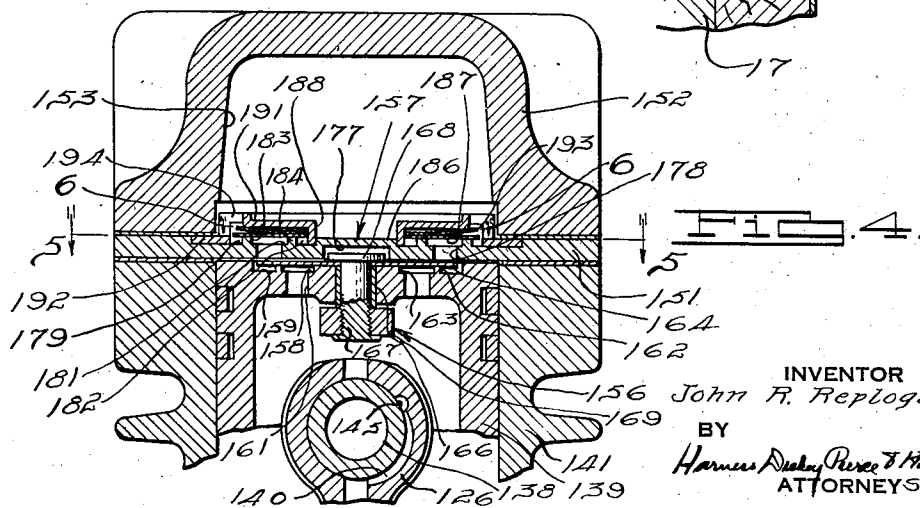
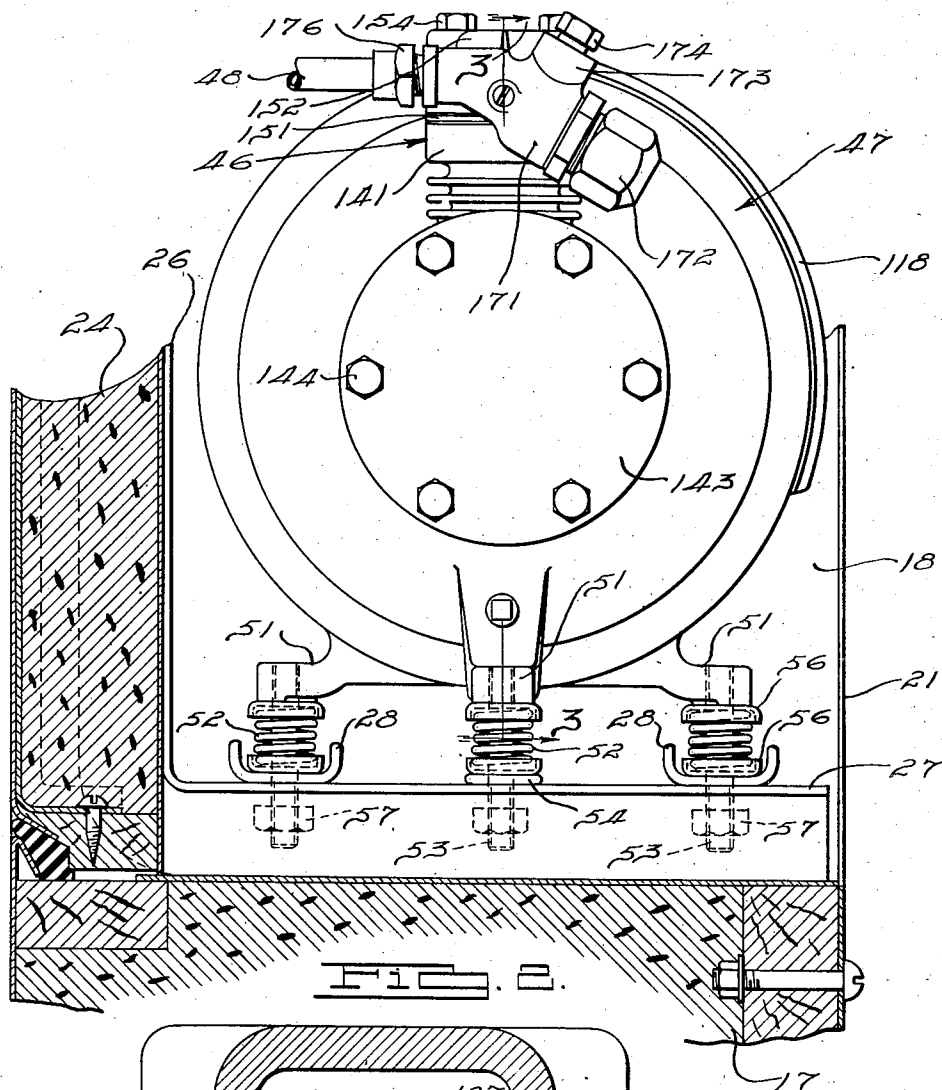
J. R. REPLOGLE

2,035,276

REFRIGERANT COMPRESSING UNIT

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5 Sheets-Sheet 2



INVENTOR  
John R. Replogle.  
BY  
Harris, Dickey, Pierce & Howe  
ATTORNEYS.

March 24, 1936.

J. R. REPLOGLE

2,035,276

REFRIGERANT COMPRESSING UNIT

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5 Sheets-Sheet 3

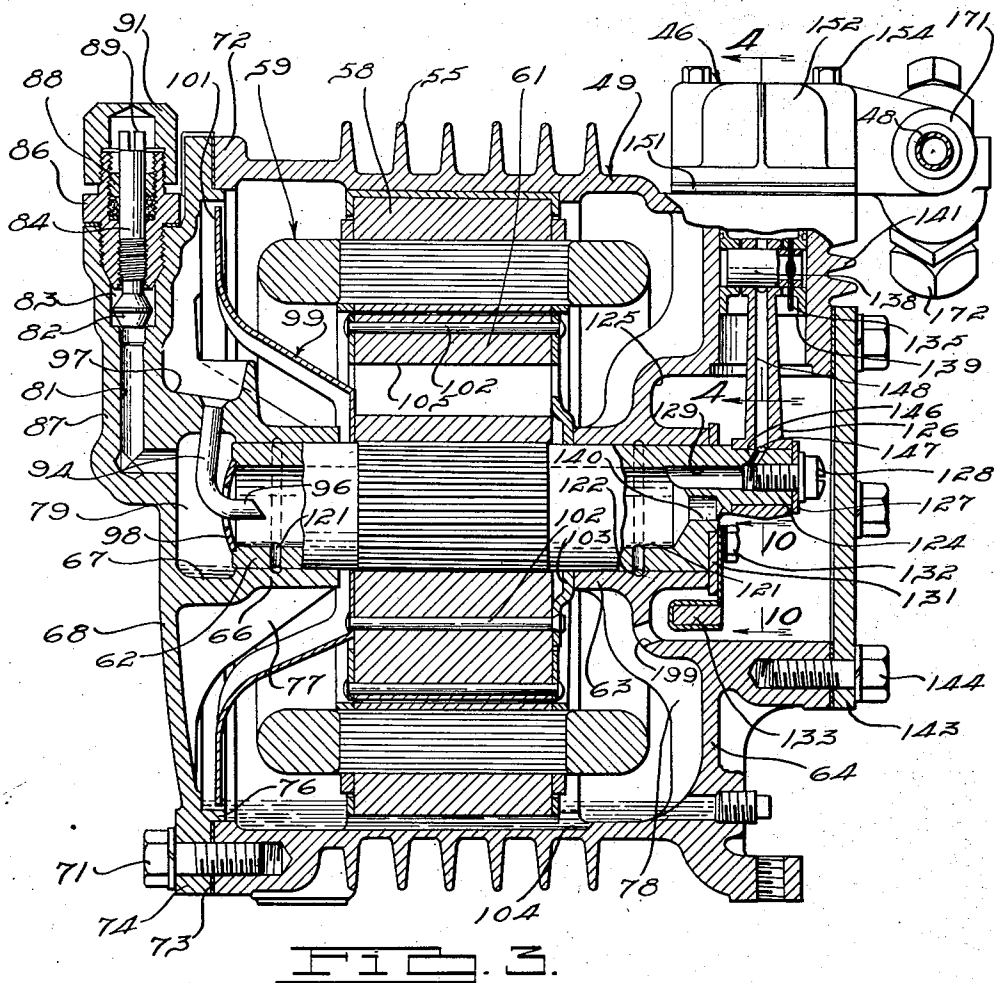


FIG. 3.

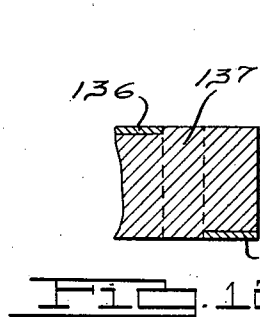


FIG. 12.

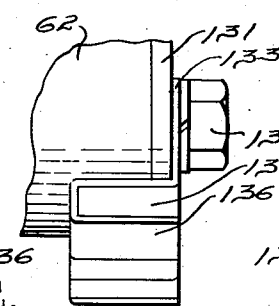


FIG. 11.

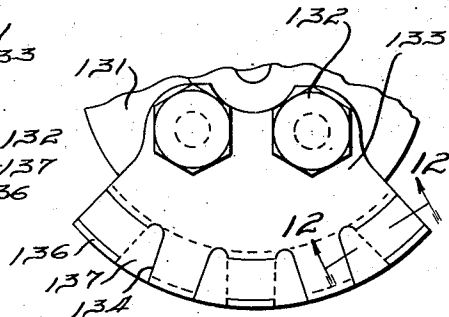


FIG. 10.

INVENTOR  
John R. Replogle.

BY

Hammer Decker Pusey & Ham  
ATTORNEYS.

March 24, 1936.

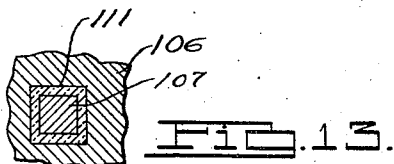
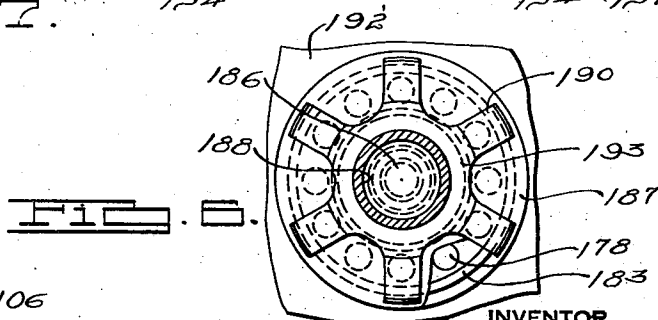
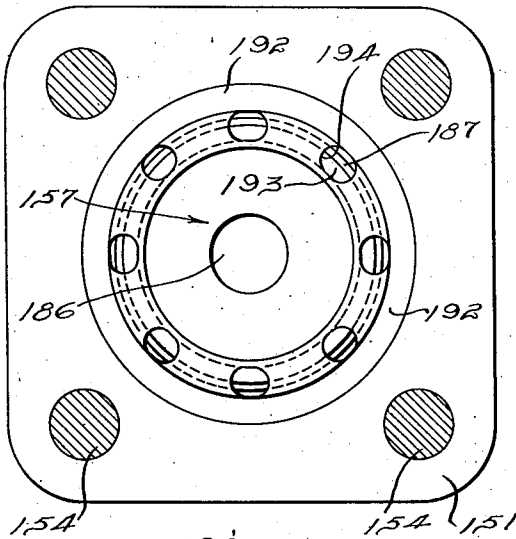
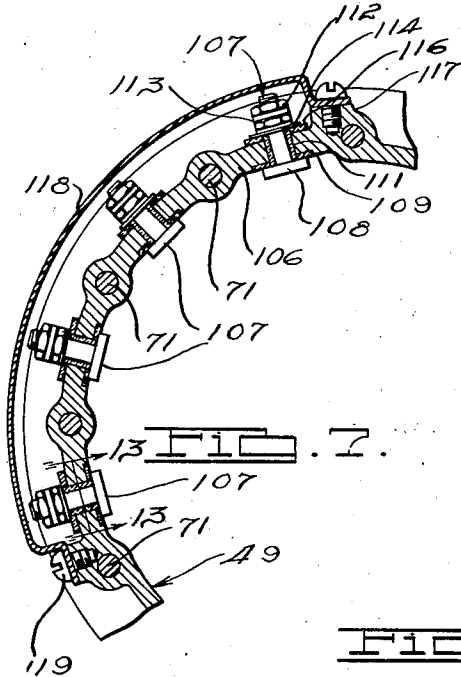
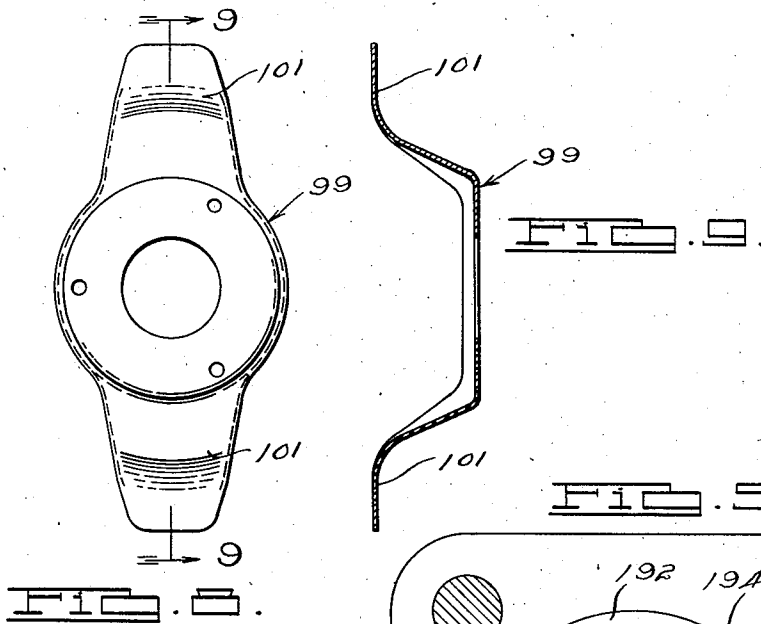
J. R. REPLOGLE

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REFRIGERANT COMPRESSING UNIT

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5 Sheets-Sheet 4



INVENTOR  
John R. Replogle.

BY  
Hamm, Diehl, Pierce & Hamm  
ATTORNEYS.

March 24, 1936.

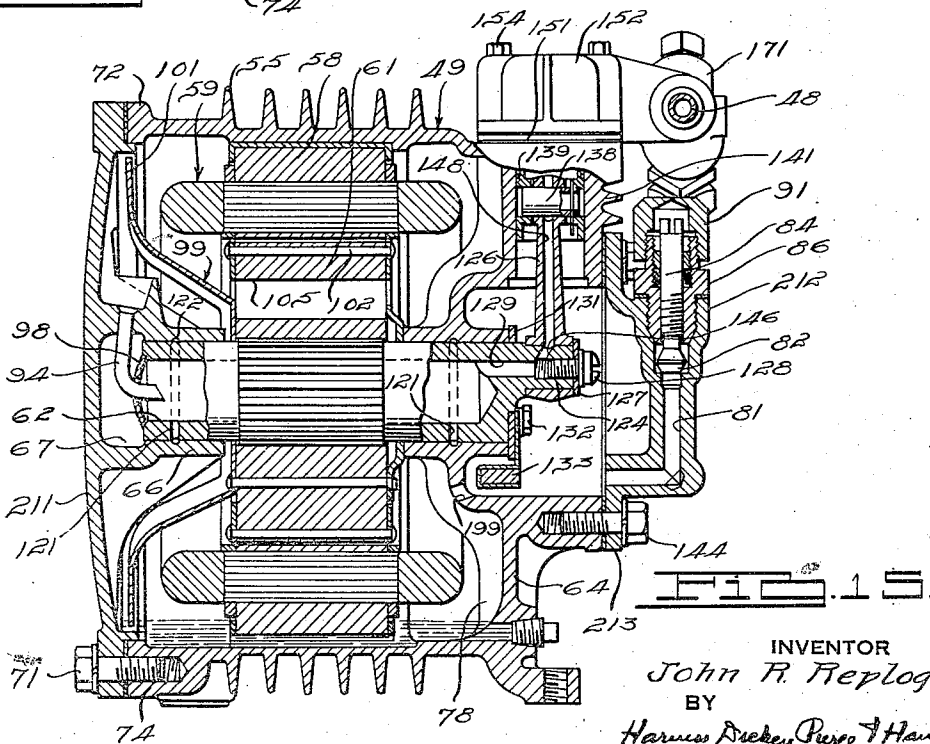
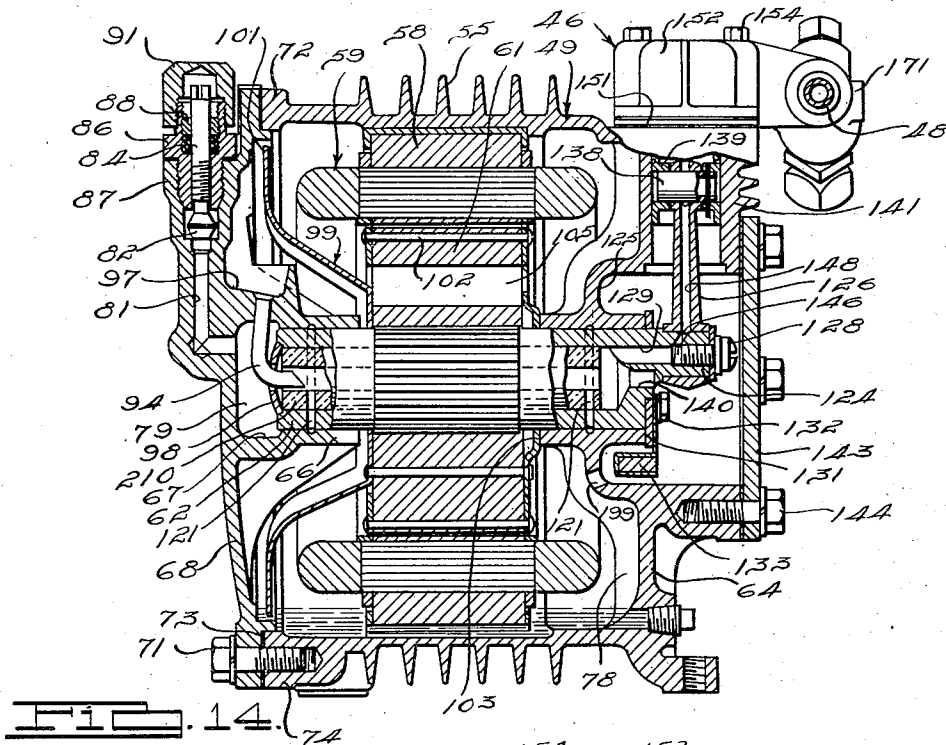
J. R. REPLOGLE

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REFRIGERANT COMPRESSING UNIT

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5 Sheets-Sheet 5



INVENTOR  
John R. Replogle  
BY  
Harnes Dickey, Perez & Harnes  
ATTORNEYS.

## UNITED STATES PATENT OFFICE

2,035,276

## REFRIGERANT COMPRESSING UNIT

John R. Replogle, Detroit, Mich., assignor, by  
mesne assignments, to Copeland Refrigeration  
Corporation, Mount Clemens, Mich., a corpo-  
ration of Michigan

Application May 5, 1932, Serial No. 609,480

17 Claims. (Cl. 230—206)

This invention relates generally to motor compressor units and has particular relation to motor compressor units for refrigeration purposes.

An object of the invention is to provide a simple, compact and efficient refrigerating apparatus power unit embracing a compressor having a crankcase provided with an extension for the reception of a motor for driving the compressor and with both the compressor casing and the extension provided with removable end walls for rendering the power unit parts accessible.

Another object of the invention is to so construct a refrigerating mechanism power unit that all of the working parts thereof will be automatically lubricated by circulating oil within the system and without the necessity for the employment of special oil pumping mechanism ordinarily required for this purpose.

Another object of the invention is to provide for the dissipation of the heat generated by the working parts of a motor compressor unit without materially superheating the circulating working fluid employed in the refrigerating system and thereby increasing the volume of the latter before it has reached the compressing mechanism of the unit.

Another object of the invention is to provide a plurality of zones in the interior of a motor compressor unit in one of which a relatively stagnant body of refrigerating fluid is maintained in a highly superheated state for conducting away the heat generated by the electrical energy dissipated within the motor of the unit but, by reason of the relative isolation of such fluid from the other zones, the superheating and condensing of working fluid does not materially interfere with the operation of the system.

The particular embodiment of the invention disclosed herein for the purpose of illustration comprises a refrigerant compressor having a finned extension formed on the casing thereof in which is contained an electric motor separated from the compressor by an end wall of the crankcase of the latter. This separating end wall and an end plate secured removably upon the finned extension are provided with bearings for supporting a hollow shaft on which the rotor part of the motor is journaled between the bearings. This shaft constitutes an extension of the compressor shaft which is rotatably supported in the compressor crankcase in one of the aforesaid bearings formed therein. The interior of this shaft is connected directly with the refrigerant evaporating unit of the system in which the pow-

er unit is employed and also with the suction side of the compressor. Also the interior of the shaft is connected with the motor containing compartment of the extension for the purpose of admitting the oil collected within such compartment to the fluid circulating part of the system and for equalizing the pressure of the compartment with the system. This connection, however, is such that there is only a small quantity of working fluid conducted therethrough. The oil collected within the shaft is automatically distributed and supplied by the operation of the mechanism for lubricating and cooling the working parts in the interior of the casing and the extension.

An eccentric crank, formed on the compressor shaft, supports a connecting rod for operating a piston which is mounted for reciprocation in the compressor cylinder and this crank and other moving mechanism of the compressor is balanced by a weight secured on the end of the shaft in opposite relation thereto. The compressor is provided with a valve plate and a head, the valve plate having a discharge valve arranged therein which cooperates with a suction valve arranged in the piston for effecting the operation of the compressor.

The electric motor within the extension embraces a main winding, a starting winding and a generator winding the latter of which generates the current as the motor attains its normal speed for operating a switch to open the starting winding circuit. The conductors for these various windings pass through terminals formed in spaced relation along one edge of the extension and between the bolts by which one of the heads is attached. These terminals are provided with a casing or cover which prevents their being injured or short-circuited by contact with anything capable of accomplishing this undesirable result.

In the drawings:

Figure 1 is a fragmentary side elevational view taken from the rear of a refrigerator employing a motor compressor unit embracing the principles of this invention;

Fig. 2 is a cross-sectional view of a portion of the refrigerator structure disclosed by Fig. 1 and illustrating particularly an end elevational view taken from the left hand side of the motor compressor unit disclosed by that figure;

Fig. 3 is a longitudinal sectional view through the motor compressor unit of the refrigerating mechanism disclosed by Figs. 1 and 2 and is taken substantially on line 3—3 of Fig. 2;

Fig. 4 is a transverse sectional view through the compressor portion of the motor compressor unit;

Fig. 5 is a horizontal sectional view of the compressor taken substantially on line 5—5 of Fig. 4;

Fig. 6 is a fragmentary horizontal sectional view of the compressor taken slightly below the plane of Fig. 5 on line 6—6 thereof and illustrating particularly the discharge valve of the compressor;

Fig. 7 is a fragmentary cross-sectional view of the motor compressor unit casing showing particularly the terminals by which electrical energy is supplied to the electrical motor therein;

Fig. 8 is an end elevational view of an oil distributing element employed in the motor compressor unit;

Fig. 9 is a vertical sectional view through the oil distributing element taken substantially on line 9—9 of Fig. 8;

Fig. 10 is an elevational view of a compressor balancing element employed in the motor compressor unit as it might appear looking in the direction of the arrows from line 10—10 of Fig. 3;

Fig. 11 is a fragmentary side elevational view of the balancing element shown by Fig. 10;

Fig. 12 is a cross-sectional view through the balancing element as it might appear in the plane of line 12—12 in Fig. 10.

Fig. 13 is a fragmentary cross-sectional view on line 13—13 of Fig. 7.

Figs. 14 and 15 are illustrations of slightly different forms of motor compressor units embracing the principles of the invention.

Referring particularly to Figs. 1 and 2, the invention is embodied in a refrigerator 16 embracing a heat insulating cabinet 17 outside of which is formed a machine compartment 18 which occupies the upper region in the rear of the refrigerator and is surrounded by an exterior lining 21 which also surrounds the cabinet 17. Along the rear of the refrigerator 16 the lining 21 is provided with an opening 22 through which a refrigerant condensing unit 23 located in the machine compartment is inserted and removed.

At the front of the machine compartment 18 the insulating cabinet 17 is provided with an outwardly removable vertically disposed wall section 24 arranged on one side of the cabinet and to the opposite vertical edges of which are secured corresponding sides of vertically disposed portions of angle members 26. Horizontally disposed portions 27 of the angle members 26, formed by bending the members rearwardly at an angle of approximately 90 degrees, extend outwardly along the upper surface of the wall of the cabinet 17 forming the lower limit of the machine compartment 18. The laterally projecting portions of the vertical portions of the angle members 26 extend oppositely from the removable wall section 24 and thus provide abutments engaging the adjacent edges of the cabinet 16 for limiting the inward movement of the wall section 24.

Extending in spaced relation across the upper surfaces of the angle members 27 and substantially from one end of the compartment 18 to another is a pair of channel members 28 which are secured to the laterally extending portions of the angle members 27 by bolts 29. On the ends of these members remote from the removable wall section 24 is secured a refrigerant condenser 31 embracing a plurality of sinuously wound and interconnected conduit sections 32 disposed one above another and supported adjacent the op-

posite ends thereof by a spaced pair of supporting plates 33. The lower ends of the supporting plates are bent laterally as is indicated at 34 and are there secured to the channel members 28 by bolts 36. On the conduit sections 32 are secured a plurality of vertically disposed and spaced fins 37 to provide a sufficient amount of surface for the cooling of the condenser by natural draft circulation of air. It is to be understood, however, that this condenser or one of any other suitable type may be cooled by forced circulation of air or other cooling fluid by the employment of a fan or other suitable device as is customary in the art.

The lower end of the condenser 31 is connected to one end of a U-shaped refrigerant receiver 38, the parallel ends of which lie alongside of the supporting plates 33 in order to minimize the interference with the circulation of air through the condenser. The opposite end of the receiver is connected by a liquid line 39 to any suitable refrigerant evaporating unit 41 normally located within the heat insulated cabinet 17 and in the present instance comprising an expansion valve 42 which discharges refrigerant liquid into a refrigerant evaporating conduit 43. The suction line end of the evaporating conduit 43 is connected by a suction line 44 to the low pressure side of a refrigerant compressor 46 embraced in a motor compressor unit 47 of the refrigerating mechanism. The high pressure side of such compressor is connected to the inlet end 48 of the condenser 31.

The motor compressor unit 47 comprises a compressor casing 45 and an integral cylindrical extension 49, the latter having three outwardly projecting legs 51 formed on the lower side thereof which are resiliently mounted on springs 52 having threaded bolts 53 projecting downwardly therethrough from the legs. Two of the springs 52 are supported at their lower ends upon the upper surfaces of the channel members 28 while the remaining one is similarly supported upon a washer 54 disposed upon the upper surface of one of the angle members 27 and adjacent the middle thereof.

In order to prevent the springs 52 from becoming improperly positioned between the legs 51 and the channel members 28 and washer 54 the opposite ends thereof are supported in cups 56 which in turn are seated against the aforesaid legs and supporting members. Beneath the springs 52 the studs 53 project through openings formed in the channel members 28 and have loosely disposed upon the lower ends thereof nuts 57 which may be tightened to prevent the operation of the springs 52 when the refrigerating apparatus is not being employed.

Around the middle portion of the exterior surface of the cylindrical extension 49 are disposed a plurality of spaced fins 55 for increasing the heat exchanging surface of the extension and immediately inside thereof is secured the stator 58 of an electric motor 59. The rotor 61 of the motor 59 is rigidly secured upon a knurled surface 60 formed on a continuation of a hollow shaft compressor 62 projecting from the compressor casing 45. The shaft is supported at one end in a bearing 63 formed in an end portion of a compressor crankcase 64 while the opposite end thereof is supported in a bearing 66 formed at the inner extremity of a hollow part 67 projecting inwardly from and formed integrally with a removable end wall or head 68 of the cylindrical extension. The knurled exterior surface of the

shaft 62 provides a minimum amount of contact with the rotor 61 for restricting the flow of heat between such elements. In order to provide means for supporting the removable head 68, the extension 49 is provided with an integral annular flange 72 which supports a compressible gasket 73 against which the outer flanged edge 74 of the head 68 is retained by studs 71. The inner periphery of the flanged edge 74 of the head 68 is provided with a laterally extending flange 76 which slidably and tightly engages the smooth inner edge of the annular end 72 of the extension 49 for centering the head 68 relative thereto. The head 68 is provided with radially extending webs 77 for reinforcing the bearing 66 while the end of the crankcase 64 of the compressor casing 45 is provided with similar radially extending webs 78 for reinforcing the bearing 63.

Beyond the end of the shaft 62 but within the part 67, is located a refrigerant inlet chamber 79 communicating with the interior of the shaft and with a duct 81 formed in the head 67 and controlled by a valve 82 which controls the flow of fluid to the duct from a passage 83. The valve 82 embraces a stem 84 which is threaded in the interior of a packing gland 86 in turn threadably engaging an opening formed in an enlarged portion 87 of the casing head 68. The upper end of the stem 84 is surrounded by packing material 88 and is provided with a squared end 89 for operation by a wrench or other suitable tool (not shown). In order to insure against leakage of the valve 82 and to protect the stem 84 from external injury, the upper end of the packing gland 86 is threaded for receiving a cap 91 which completely encloses the upper end of the packing gland and valve stem. The passage 83 communicates at one end with a gauge coupling 92 while the opposite end thereof communicates with a coupling 93 to which the suction line 44 is secured.

Secured in an opening formed in an upper wall of the inlet chamber 79 is a short pipe or conduit 94, the lower end of which is curved laterally as is indicated at 96 and projects internally into the hollow shaft 62. This conduit is employed for the purpose of conducting oil to the interior of the hollow shaft from a sump 97 formed inside the head 86 and about the part 67. In order to prevent such oil from again flowing outwardly from the hollow shaft 62 into the inlet chamber 79, the end of the shaft 62 is partially closed by an annular disc 98 through the center of which the conduit 96 projects. The sump 97 normally is supplied with oil by an oil distributing member 99 having a pair of blades 101 which rotate around the inside of the extension 49 and become coated with oil collecting in the bottom thereof. This coating of oil is thrown from the blade by centrifugal force and is distributed around the inside of the extension beyond the ends of the blades and upon the exterior surfaces of the electric motor. Such of the oil as may collect upon the walls of the casing above the sump 97 will drain downwardly into the sump and be conducted by the conduit 94 into the hollow shaft 62. Such oil as is splashed upon the motor, later is also splashed against the interior walls of the extension, where the heat absorbed thereby while in contact with the motor is dissipated.

The oil distributing member is secured intermediate its ends to the rotor 61 by rivets 102 projecting through the rotor for securing the elements thereof together and the opposite ends of such rivets also engage and secure to the rotor an annular thrust plate 103 which engages the ad-

jacent end of the bearing 63 for limiting the movement of the rotor in such direction.

In order to prevent the accumulation of oil on the side of the motor opposite the blades 101, the interior of the extension is provided with a channel 104 extending from one side of the motor to another for collecting and draining the oil away from such region. Also extending through the rotor 61 of the motor 59 are a plurality of openings 105 which are formed therein in parallel relation to the axis of the motor for permitting circulation of gas from one side thereof to another. For supplying electrical energy to the motor 59 the extension 49 is provided with an arcuate portion 106 of somewhat greater diameter than the remainder of the extension and which extends a short distance around the extension between the flanged end 72 thereof and the adjacent one of the fins 55.

Extending across this enlarged portion and between the studs 71 by which the head 68 is secured in position, are a plurality of electrical terminals 107 embracing bolts 108, the heads of which abut washers 109 at the inner ends of insulating sleeves 111 surrounding the middle portions of the bolts. The heads of the bolts 108 are disposed inside the extension 49 and the conductors from the motor 59 are soldered or otherwise secured thereto. Outside the enlarged portion 106 of the extension 49 are pairs of nuts 112 engaging the bolts 108 and between which are confined washers or spacers 113 having laterally projecting portions to which the electrical conductors outside the extension are secured. The inner nuts of the pairs 112 are supported on washers 114 which in turn engage electrically insulating washers 116 abutting the outer surface of the enlarged portion 106 of the extension and cooperating with the sleeves 111 to prevent the conduction of electrical energy elsewhere than through the bolts 108. The middle portions of the bolts 107 are square in cross-section as likewise are the sleeves 111 and washers at the opposite ends of the latter. The extension 49 around the outer limits of the enlarged portion 106 thereof is provided with a continuous bead 117 on the outer surface of which a terminal cover 118 is secured by screws 119. The cover, of course, is provided with a suitable opening for the projection therein of the conductors to which the terminals 107 are attached.

The hollow shaft 62 within the bearings 63 and 66 is provided with transverse openings 121, the outer ends of which communicate with oppositely disposed annular grooves 122 formed in the inner surfaces of the bearings. These openings conduct the oil from the interior of the hollow shaft for lubricating the bearings.

Formed on the end of the compressor shaft 62 within the compressor casing 45 is an eccentric pin or crank 124 on which one end of a connecting rod 126 is secured by a washer 127 and a stud 128, the latter being threaded in an opening 129 formed axially of the pin 124 and communicating at its inner end with the interior of the hollow shaft 62. The pin 124 also projects through an eccentric opening formed in a plate 131 secured on the end of the shaft 62 by a plurality of studs 132. The plate 131 projects outwardly from the shaft 62 and abuts the adjacent end of the bearing 63 to provide a thrust bearing which, together with the annular ring 103, tends to limit movement of the motor shaft 62 in either direction. Between the heads of the studs 132 and the plate 131 and arranged to rotate in a cavity

125 formed in the crankcase 64, is secured an edge portion of an arcuate balancing element 133, the outer edge of which is provided with radially disposed slots 134 forming tongues 136 which are bent backwardly and forwardly in opposite directions around an arcuate segment 137 formed of lead or some other heavy metal. This balancing element compensates for the eccentric weight of the pin 124, the connecting rod 126 and piston of the compressor and tends to pick up any oil with which it comes in contact and to distribute it around the surface of the cavity 125.

The opposite end of the connecting rod 126 is provided with a bearing engaging a central portion of a pin 138 the opposite ends of which are secured by a key 135 in internally disposed bosses formed in diametrical relation across the central portion of a piston 139. Formed in the compressor casing 45 above the crankcase 64 is an externally finned cylinder 141 in which the piston 139 is mounted for reciprocatory movement.

The crankcase 64 enclosing the rotating parts for driving the compressor is closed by a removable plate 143 secured to the open end thereof by studs 144. The crank casing communicates with the interior of the shaft 62 by an opening 140 formed axially thereof through the closed end of the shaft.

In order to provide lubrication for the connecting rod 126 and piston 139 the crank pin 124 is provided with an opening 146 communicating at opposite ends with the passage 129 formed longitudinally thereof and with an annular groove 147 formed in the surface of the connecting rod bearing. This groove is formed directly opposite and in communication with a passage 148 formed longitudinally of the connecting rod 126 for conducting oil to the pin 138 through intersecting circumferential and transverse grooves 140 and 145 formed in the connecting rod bearing with which the opposite end of the passage communicates. The lubrication for the piston 139 is provided by oil in suspension in the working fluid of the refrigerating system upon which the compressor operates and by oil thrown from the weight 133.

Adjacent the upper limit of travel of the piston 139 the cylinder 141 is provided with a flat surface for supporting a valve plate 151 having disposed on the upper surface thereof a head 152, in the interior of which is formed a gas collecting chamber 153. The head and valve plate both are secured rigidly to the cylinder 141 by cap screws 154. In order to provide for the operation of the compressor 46, the piston 139 and valve plate 151 are provided with suction and discharge valves 156 and 157 respectively.

The suction valve 156 is formed by providing the head end of the piston 139 with a pair of annular and concentric recesses 158 and 159, the inner one of which communicates with a circular row of openings 161 which provide communication between the regions in the cylinder 141 above and below the piston. An annular seat 162 formed between the recesses 158 and 159, and a boss 163 formed at the center of the piston head are reduced in depth to a slight extent to provide seats for an annular disc 164 which is disposed in the head of the piston 139 within the limits of the upper surface thereof. In order to provide means for securing the disc 164 in position, the head of the piston 139 is provided with an axial opening having a bushing 166 disposed therein which is somewhat longer than the thick-

ness of the piston head. Within this sleeve is received a bolt 167 having a head 168 which engages the upper surface of the disc 164 and retains the latter against the upper end of the bushing 166. These parts are secured in such position by a nut 169 engaging the lower end of the bolt 167 and tightened against the lower end of the bushing 166. The lower end of the bolt 167 is upset against the lower surface of the nut 169 in order to prevent any of the parts from becoming loosened.

In the operation of the compressor when the direction of motion of the piston 139 is reversed adjacent its upper limit of travel, the inertia of the parts of the suction valve 156 tends to slide the bushing 166 in the opening in the piston head until the nut 169 engages the lower surface of the latter, thus opening communication between the regions above and below the piston 139 through the opening 161 and between the annular seat 162 and the lower surface of the disc 164. The valve remains in this position during the downward movement of the piston 139 and the cylinder thereabove is filled with the working fluid within the refrigerating system which is supplied to the crank case 142 by the hollow shaft 62. When the piston 139 reaches its lower limit of travel the reverse in the motion thereof seats the valve 156 upon the seats 162 and 163 and thereafter during the upward movement of the piston the working fluid of the system previously admitted through the valve 156 is compressed within the cylinder 141 between the piston 139 and the valve plate 151.

When the pressure in the cylinder has reached a predetermined value the discharge valve 157 will operate and permit the compressed gas to be expelled from the cylinder 141 into the gas collecting chamber 153 in the interior of the head. This chamber is in open communication with the condenser 31 through a fitting 171 embracing a valve 172 and a nipple 173 closed by a plug 174 for the attachment of a gauge and which fitting is attached to the condenser by a coupling 176.

The valve plate 151, embracing the discharge valve 157 and having an opening 177 in the lower surface therefor for receiving the head 168 of the bolt 167, is provided with a circular row of spaced and transversely disposed openings 178 extending from one surface thereof to another in a region directly above the outer extremity of the suction valve disc 164. The upper surface of the plate is provided with three concentric and annular recesses 179, 181 and 182 between which are formed a pair of annular seats 183 and 184 and a centrally located boss 186. The openings 178 communicate with the central one of these annular recesses 181.

Upon the upper surfaces of the annular seats 183 and 184 is disposed a relatively flexible annular disc 187 which covers the annular recess 181 and the central portion of which engages an inwardly flanged portion 188 of a discharge valve retaining cage 191. The flanged portion 188 of the cage projects within the annular recess 182 and there engages the outer surface of the centrally disposed boss 186 formed on the valve plate 151. The outer periphery of the cage is provided with a radially disposed flange 192 formed at one side thereof which is disposed within the annular recess 179 and is secured rigidly therein by engagement beneath the lower surface of the head 152.

Above the disc 187 is disposed an arcuate disc 75

193, the inner periphery of which rests upon the inner edge of the disc 187 while the outer periphery thereof is provided with a plurality of notches forming radially disposed spring segments 190 which extend away from the first disc and engage the lower surface of the cage 191 in a region directly above the annular seat 183. Beyond the outer extremity of the arcuate disc 193 the cage 191 is provided with a plurality of slots 194 through which gas or the working fluid of the system may escape from beneath the cage.

The segments 190 of the disc 193 exert a pressure upon the disc 187 which tends to retain the latter against the annular seats 183 and 184 although this pressure is overcome and the disc 187 is deflected off the annular seats when the pressure beneath the valve plate 151, caused by the upward movement of the piston 139, reaches a predetermined value. Thereafter the working fluid of the system is discharged through the space between the deflected disc 187 and the annular seat 183 until the piston reaches its upper limit of movement after which the disc again assumes its normal position upon the seat 183 and prevents the escape of the working fluid from the head 152 during the downward stroke of the piston.

In the operation of the refrigerating system disclosed herein the working fluid of the system which may be any suitable refrigerant liquid, is evaporated in the evaporating conduit 43 and such evaporated liquid or gas fills the suction conduit 44 and is drawn through the hollow shaft 62 into the interior of the crank case 64 at a relatively rapid rate by the reciprocation of the piston 139.

The region in the interior of the extension 49, occupied by the motor 59, is also filled with this gas by reason of the connection of such compartment or region with the interior of the hollow shaft 62 through the conduit 96. However, inasmuch as there is practically no variation in the size of this region during the operation of the mechanism, there is practically no tendency for gas to flow through the conduit 94; unless the pressure in the system changes, in which event enough gas will flow through the conduit 94 to permit the pressure to equalize. Generally speaking, then, the gas surrounding the motor 59 in the extension 49 remains in a more or less isolated region and is therein continuously and violently agitated by the rotation of the motor rotor 61 and the oil distributing member 99. The heat generated by the operation of the motor 59 is absorbed by this isolated quantity of gas and is conducted thereafter to the extension 49 from whence it is dissipated into the surrounding air.

When the motor is not running, the gas in the extension 49 will cool to a considerable degree and some of it may either condense or dissolve in the oil within the extension. When the operation of the motor is again continued the evaporation of the refrigerant will greatly expand the oil as a result of the formation therein of numerous bubbles or small quantities of gas surrounded by liquid. In view of the large volume of the interior of the extension 49, however, this expanded oil will have plenty of space to occupy without being discharged in large quantities through the pipe 94 into the hollow shaft 62, and, even though some of it did gain access to the hollow shaft 62, it would more than likely collect around the interior surface of the shaft due to the centrifugal force which the rotating shaft generates. In any event there would be little tendency of this oil

to flow outwardly through the axial opening 140 and into the crank case and thereafter to cause oil pumping by the compressor. While, during the operation of the motor, the stagnant gas in the interior of the extension 49 becomes heated to a relatively high degree, this condition does not materially affect the principal parts of the motor with which the gas is in contact other than to render possible the dissipation of a large quantity of heat through the relatively limited exterior surface of the extension.

It is desirable, however, to maintain the bearings of the motor at a considerably lower temperature than is permissible in the other parts thereof, and this result is accomplished by having the relatively small amount of heat generated by the bearings directly absorbed by the gas from the evaporating unit which passes through the hollow shaft 62. There is not enough of such heat to materially change the temperature of the gas or to cause any appreciable expansion thereof, by reason of the relatively limited space inside the shaft and the relatively large quantity of gas passing therethrough within such a short time and consequently only a small quantity of heat is absorbed by each unit of gas.

Inside the shaft 62 the particles of oil that may be carried by the gas are practically thrown out of suspension by the centrifugal force caused by the rotation of the gas within the rotating shaft. Such separated oil collects around the inside of the shaft and eventually flows either through the openings 121 to the bearings 63 and 66, or through the passage 129 to the connecting rod and piston bearings. The oil, however, will not flow outwardly through the axially formed opening 140 where the gas is exhausted from the shaft 62 by reason of its being held around the inner periphery of the shaft by the rotation thereof. In the event any oil should flow outwardly through the opening 140 it will collect in a small pool in the bottom of the crankcase 142 and from which it will again drain to the motor compartment through an opening 199 formed in the part of the crankcase 64 therebetween.

In the structure disclosed by Figs. 13 and 14 the principal elements thereof are substantially the same as the corresponding elements embraced in the preceding figures and, wherever applicable the same reference numerals are applied thereto.

In the structure disclosed by Fig. 14, there is employed inside the shaft 62 an insulating sleeve 210 for reducing the conductivity of heat from the motor and the bearings therefor to the refrigerant gas and oil during its passage through the shaft. The sleeve has openings communicating with the openings 121 in the shaft 62 to provide for conducting oil to the motor bearings, and terminates slightly inside the closed end of the shaft 62 in order to provide an annular space for separating the oil from the refrigerant vapor. Such separation, of course, will occur inside the insulating sleeve 210 although it will occur to a greater extent in the aforesaid annular space because of the greater diameter of the latter and the consequent development of a greater amount of centrifugal force therein. This insulating sleeve not only tends to reduce the conductivity of heat to the refrigerant and oil internally thereof but by reason of its greatly reduced internal diameter, as compared with the corresponding diameter of the shaft 62, refrigerant and oil will flow through the shaft at a much greater rate than were the sleeve not employed and hence the quantity of gas and the time available for the

absorption of heat is greatly reduced. In view of such fact and in view of the fact that the shaft 62 passes through the coolest part of the motor 59, it may be said for all practical purposes that the refrigerant and oil passing through the insulating sleeve 210 does not participate in cooling the motor.

In the structure disclosed by Fig. 15 the shaft 62 does not serve the purpose of conducting refrigerant vapor from one end of the motor to another, but merely is employed as an oil pumping and separating device. The motor compartment of the extension 49, in this instance, is entirely closed by an end plate 211 having no passage therethrough for the admission of refrigerant. Refrigerant and oil in suspension therein is admitted from the evaporator 41 through a valve 212 substantially identical to the valve employed on the end plate 68 and formed integrally with an end plate 213 for closing the crank case 64. When so admitted the refrigerant vapor and oil separate by gravity in the crank case wherefrom the refrigerant vapor flows directly to the compressor 46. The oil collects in the bottom of the crank case and flows therefrom through the opening 199 to the motor compartment. There the oil will be distributed by the oil distributing member 99 over the surface of the motor for cooling the latter and also collected in the sump 97 and circulated to the bearings of the motor and the compressor by the centrifugal force generated internally of the shaft 62. By reason of the opening 199 the motor compartment also will be filled with vaporized refrigerant from the crank case 64 but there will be no appreciable circulation of refrigerant continuously between the crank case and the motor compartment. In this structure the opening 140 to provide for the flow of refrigerant between the interior of the shaft 62 and the crank case is not essential to the operation of the unit and may be eliminated if desired. It will be observed in this unit that the refrigerant vapor flows directly from the evaporating unit to the compressor through the crank case of the latter, whereas the greater portion of the oil in the system flows in a shunt circuit between the various cooling surfaces and bearings of the motor compressor unit.

While the structure as herein disclosed constitutes a preferred form and application of the invention, it is to be understood that there are numerous modified and equivalent structures also within the scope of the invention as defined by the appended claims.

I claim:

1. In a refrigerating system, a motor compressor unit comprising a fluid filled motor casing having a bearing formed therein, an electric motor therein, a shaft for said motor rotatably mounted in said bearing in said motor casing, and means for cooling the coating portions of said bearing and shaft to a greater extent than the remainder of said motor compressor unit comprising means for circulating refrigerant and lubricant through said shaft, and dam means in said shaft maintaining a material amount of lubricant in said shaft during normal operation.

2. In a refrigerating system, a motor compressor unit comprising a motor casing having a working fluid passage therein, a motor and a compressor in said casing operatively connected together, said casing being adapted for the collection of oil required for the lubrication of said motor and compressor, and oil displacing means

independent of said compressor and the suction effect thereof and driven by said motor for transferring the small quantities of said oil to said working fluid passage.

3. In a refrigerating system, a motor compressor unit comprising a motor casing having a working fluid passage therein and a compartment for the reception of an electric motor, said casing being adapted for the collection therein of oil required for the lubrication of said motor, means for transferring small quantities of said oil from said casing to said working fluid passage, and means within said passage for centrifugally separating said oil from the working fluid therein.

4. In a refrigerating system, a motor compressor unit comprising a casing having a refrigerant compressor therein and a working fluid passage for supplying refrigerant to said compressor and oil to the working parts of said unit, and means associated with said unit for centrifugally separating said oil from said refrigerant.

5. In a refrigerating system, a motor compressor unit comprising a casing having a pair of compartments formed therein, an electric motor in one of said compartments, a compressor in the other of said compartments, means operatively connecting said motor and said compressor, the compartment for said motor being adapted for the collection of oil therein required for the lubrication of said motor and compressor, and rotatable means independent of said compressor and operated by said motor for removing small quantities of oil from said casing.

6. In a refrigerating system, a motor compressor unit comprising a casing having a working fluid passage arranged therein and a pair of compartments for the reception of an electric motor and a compressor respectively, said compartment for said motor being adapted for the collection of oil required for the operation of said motor, an oil distributing member in said motor compartment associated with said motor for carrying away small quantities of said oil, a sump associated with said motor compartment for collecting some of the oil carried by said oil distributing member, and means for connecting said sump with said working fluid passage.

7. In a refrigerating system, a motor compressor unit comprising a casing having an electric motor mounted therein and a bearing for said motor, a hollow shaft journaled in said bearing to be operated by said motor, means for supplying working fluid with oil in suspension therein to the interior of said hollow shaft, and means associated with one end of said shaft for maintaining a body of oil in said shaft and preventing such oil from being discharged from the corresponding end of said shaft.

8. In a refrigerating system, a motor compressor unit comprising a motor having a hollow shaft, means for connecting said hollow shaft to a refrigerating system for receiving working fluid with oil in suspension therein from said system, means adjacent the inner periphery of said shaft for exhausting the oil from the interior thereof, and means adjacent the axis of said shaft for exhausting the working fluid of the refrigerating system therefrom.

9. In a refrigerating system, a motor compressor unit comprising a crank case extension having a bearing and an electric motor mounted therein, a shaft journaled in said bearing for supporting said motor, said shaft having an ec-

centric pin extending beyond said bearing, a plate having an eccentric opening therein surrounding said pin and secured to said shaft in abutting relation to the adjacent end surface of said bearing and a refrigerant compressor operated by said pin.

10. In a refrigerating system, a motor compressor unit comprising a crankcase having a relatively large extension forming a motor compartment on one side thereof, said crankcase being of smaller diameter and concentrically arranged relative to said motor compartment, an electric motor in said motor compartment, a shaft rotatably mounted in said crankcase and extending into said compartment for supporting said motor, a compressor cylinder formed in said crankcase associated therewith, a reciprocating piston in said cylinder and a connecting rod driven by said shaft for operating said piston.

11. In a refrigerating system, a motor compressor unit comprising a compressor casing having an extension and providing a motor compartment and a compressor compartment, an electric motor mounted in said motor compartment, a refrigerant compressor in said compressor compartment, said compressor comprising a shaft journaled in said casing and associated with said motor and compressor for operating the latter by the former, and a balancing element associated with said shaft and arranged in a cavity formed in said casing, the path of movement of said element being out of alignment with the cylinder of said compressor whereby oil collected by said element will be discharged against said casing but not in direct contact with said compressor cylinder.

12. In a refrigerating system, a motor compressor unit comprising a casing having an electric motor mounted therein and a detachable end plate for closing an open end thereof, a plurality of cap screws disposed around said end plate for securing the latter to said casing, a plurality of terminals extending through said casing for providing an insulated electrical circuit therethrough for operating said motor, said terminals being arranged in spaced relation around the periphery of said casing and extending therethrough in regions intermediate said screws.

13. In a refrigerating system, a motor compressor unit comprising a refrigerant compressor having an extension for receiving an electric

motor, a bearing formed in the casing of said compressor, a shaft mounted in said bearing and operatively associated with said motor and compressor, one end of said shaft having an eccentric pin projecting therefrom for operating said compressor and an arcuate balancing element secured to the end of said shaft adjacent said pin.

14. In a refrigerating system a power unit comprising an electric motor and a refrigerant compressor, said motor having a hollow shaft for the passage therethrough of the working fluid operated upon by said refrigerant compressor and an insulating sleeve inside said hollow shaft for restricting the flow of heat between said working fluid and said electric motor.

15. In a refrigerating system a power unit comprising an electric motor and a refrigerant compressor having compartments for said motor and compressor, means for admitting refrigerant vapor to be compressed to said compressor compartment and means independent of the aforesaid means for forcibly circulating oil throughout said two compartments for lubricating said motor and compressor and for cooling the heat dissipating elements thereof.

16. In a refrigerating system, a power unit including a compressor, a motor casing forming an extension of the casing for said compressor, a motor in said motor casing, a rotatable hollow shaft common to said motor and said compressor, means for introducing a refrigerant into one end of said shaft for passage therethrough to said compressor, and means for feeding a lubricant into the interior of said shaft whereby said lubricant in being acted upon by centrifugal force due to the rotation of said shaft will form an insulating layer between the walls of said shaft and said refrigerant passing therethrough to reduce the rate of heat transfer between said motor and said refrigerant.

17. In a refrigerating system, a motor compressor unit including an electric motor and a refrigerant compressor operatively connected together, said motor having a hollow shaft for the passage therethrough of the working fluid operated upon by said compressor, and said shaft being insulated against the flow of heat between said working fluid and said electric motor.

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