Aug. 1, 1939. P. W. DES ROCHES 2,167,879

ELECTRIC REFRIGERATING COMPRESSOR

Filed Feb. 26, 1936 2 Sheets-Sheet 1

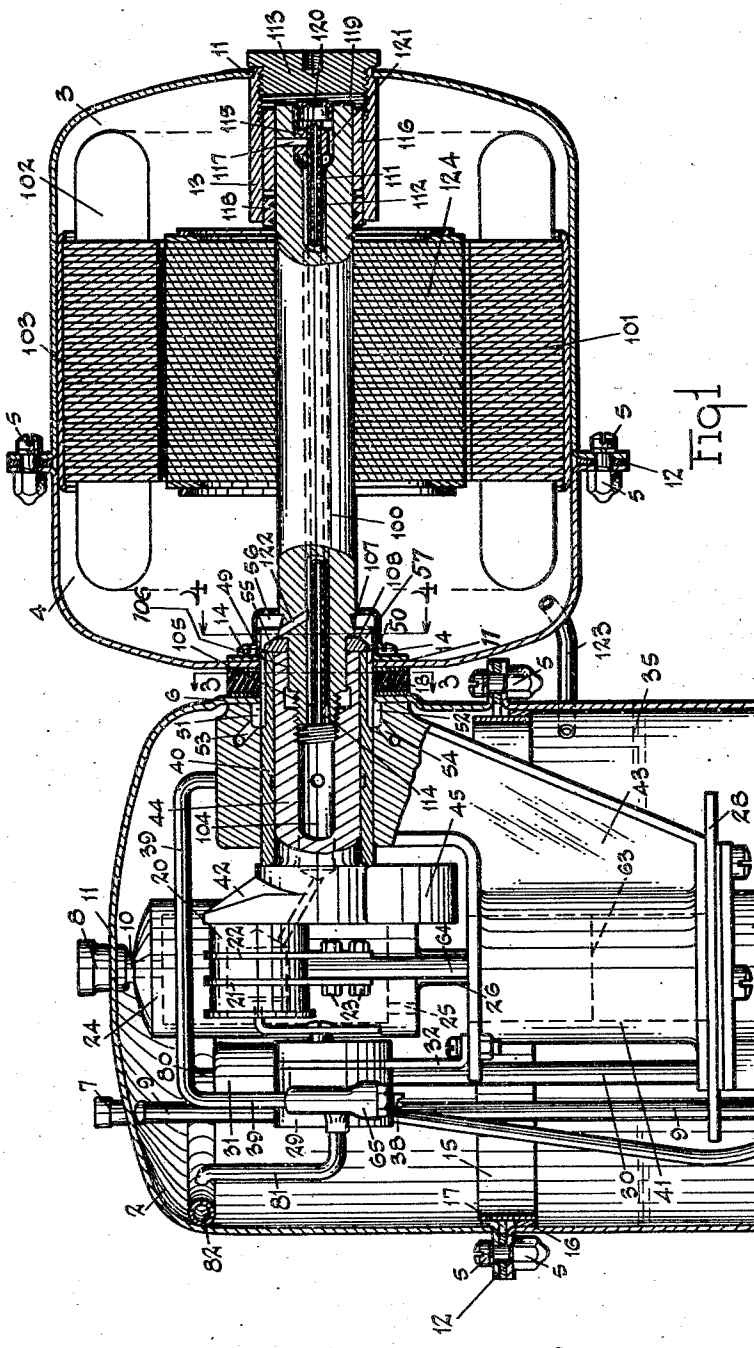


Fig 1

Inventor

Philip W. Des Roches

Aug. 1, 1939. P. W. DES ROCHES 2,167,879

ELECTRIC REFRIGERATING COMPRESSOR

Filed Feb. 26, 1936 2 Sheets-Sheet 2

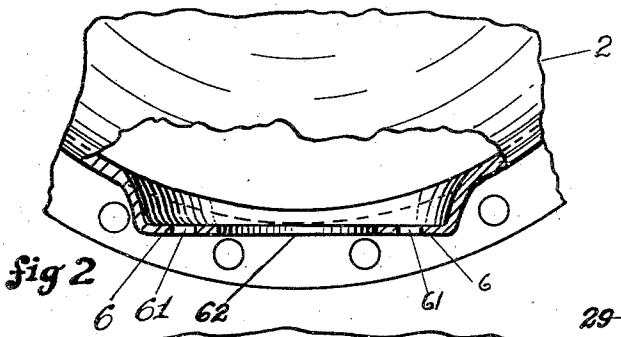


fig 2

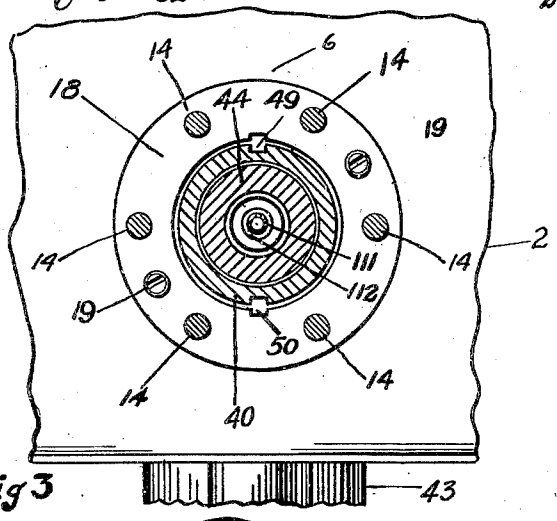


fig 3

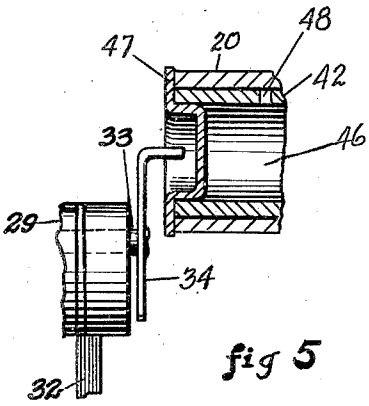


fig 5

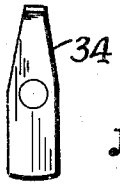


fig 6

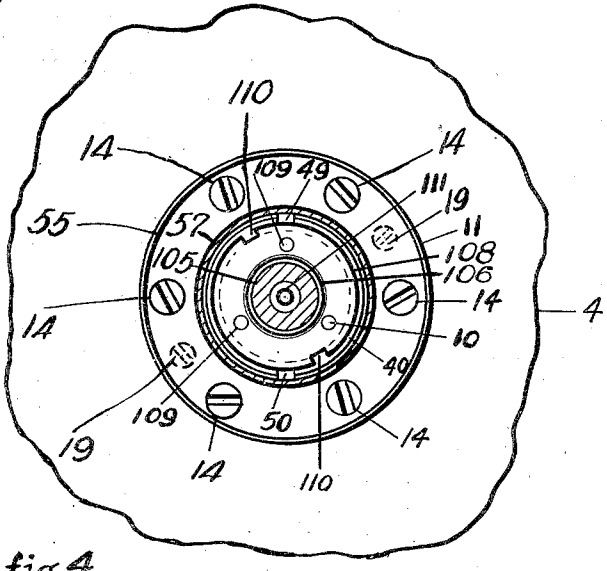


fig 4

Inventor

Philip W. Des Roches

Patented Aug. 1, 1939 2,167,879

UNITED STATES PATENT OFFICE

2,167,879

ELECTRIC REFRIGERATING COMPRESSOR

Philip W. Des Roches, Detroit, Mich.

Application February 26, 1936, Serial No. 65,892

23 Claims. (Cl. 230—58)

The subject matter is substantially disclosed but not claimed in my prior Patent No. 1,948,846 of February 27, 1934.

My invention has for its object to provide for gas tightly enclosing a compressor of a refrigerating system and an electric motor in similar sheet metal cup-like casings which may be readily connected together and in which the waste heat of the motor is prevented from being transmitted to the compressor and thus to the refrigerant vapor which is being circulated.

The invention provides a compressor frame, bearing and separate shell closure construction wherein the compressor may be secured to the side of a cylindrical shell by a heat insulating disc.

A further object of the invention is to enable the use of the compressor bearing as a motor bearing wherein the compressor and the motor are enclosed in separate contiguous housings and wherein the motor windings and the motor rotor may be readily assembled or disassembled without dismantling or disturbing the compressor.

The invention also provides a means whereby lubricant may be supplied to the bearings of the motor and the compressor and the pressure adjustment between the motor and compressor will be maintained so as to enable the proper return of the lubricant to its sump and, at the same time, the warm gas inside the motor shell will not be added to the heat load of the circulating refrigerant.

The invention also has for its object to provide other advantages and features that will appear upon examination of the drawings and from the description of the invention as shall hereby be set forth. The invention may be contained in structures of different forms and, to illustrate a preferred form as an example of the various embodiments of my invention and I shall describe it hereinafter. The particular construction selected, as an example, is shown in the accompanying drawings.

Fig. 1 is a side view of the motor assembly and compressor assembly together with the enclosing shells, parts thereof being shown in full cross section and parts shown in broken section.

Fig. 2 is a top broken view of the upper compressor shell shown in Fig. 1 looking down on the top of the shell along the line 3—3 of Fig. 1 and shows the flat circular spot formed of the shell to which the motor and compressor parts may be secured.

Fig. 3 is a front view of the spot shown in Fig. 2 and is a section made on the line 3—3 of Fig. 1.

Fig. 4 is a section taken along the line 4—4 of Fig. 1 and is a broken view of the inside of the compressor end of the motor shell.

Fig. 5 shows the means of driving the oil pump by an end part of the crank-pin of the compressor.

Fig. 6 shows a front elevation view of the oil pump crank shown as a side view in Fig. 5.

In the particular construction selected as an example of the various embodiments of the invention, the compressor and the motor are each located in pairs of individual sheet metal cups or shells, that completely surround the compressor in the one case, and the motor, in the other case. The use of sheet metal shells prevents the leakage of gases, which leakage renders such systems inoperative over a period of time. Castings in general, and die-castings in particular, are invariably subject to the likelihood of small leaks of a gas under pressure, which may not be readily detected even under inspection or test and such castings for pressure sealing are either unreliable or may not even be of practical use. The use of sheet metal enclosures eliminates the sealing difficulties of ordinary castings and makes feasible the use of die-castings for various parts which otherwise could not be satisfactorily used at all. Thus by my invention I avoid the difficulty of insidious leaks and justify the use of die-castings for parts of the structure confined within the shells.

The shells that enclose the motor and compressor are basically three identical flanged cups that may be formed from sheet metal and thus start from the same die. The fourth shell, of which the first two are used to house the compressor and the third to house the motor windings, is a more shallow cup which is similar to the other three cups and may be formed from modified parts of the dies used to form the first named three shells. To adapt one basic cup form and size to the purpose of enclosing both the motor and compressor certain additional forming or punching operations are done on the basic cup, which set up is an important production advantage.

The shells or cups are so connected together as to permit the movement of the lubricant between the compressor and the motor for lubricating their bearing parts and also to maintain a lubricating circuit as between the compressor and the motor, notwithstanding the pressure changes as they occur within the compressor shells in the operation of the compressor. The

shells of the motor prevent the escape of refrigerant that may enter with the lubricant and the same time separately encloses the motor to enable the removal of the heat of the motor to the outside atmosphere and thus prevent the heat of the motor from heating the refrigerating gas in the refrigerating circuit. The shells of both the motor and compressor are located in the low pressure side of the refrigerating circuit and thus such refrigerant that enters the shells of the motor has the pressure of the low pressure side of the compressor or refrigerating circuit, thus avoiding the condensation of refrigerant in the motor shells. The shells of the motor are maintained at said pressure, without being in the stream of the refrigerating system and yet are allowed to communicate with the refrigerating system sufficiently to maintain pressure equalization therewith for the purpose of positive lubricant circulation, in connection with the compressor.

Referring to Fig. 1 the lower shell 1 may be taken as the basic shell or cup form. Shell 1 encloses the lower part of the compressor assembly and contains the lubricant used for the apparatus. It consists of a domed cylindrical cup having flat side flanges which are adapted to admit the retaining screws and nuts 5. The screws and nuts 5 are gasketed and the fact that the nuts have closed ends makes them gas-tight. The holes in the side flanges are shown in Fig. 2. At the bottom of the shell 1 the flat circular spot 11 is formed by the die although this spot is used fully only when the shell 1 or modification thereof is used as a motor enclosing cup. See Figs. 1 and 4.

The upper compressor shell 2 is similar to 1 excepting that it is provided with a flat spot 6 formed on the cylindrical side of the cup, with the plane of the spot tangent to the side of cylindrical walls in which it is formed. The spot 6 is circular and of the same approximate diameter as the spot 11 formed on the end of the shell 1. Fig. 2 shows the spot 6 in part section with the crank-bearing hole 62 formed in its center together with the holes for the motor screws at 61. Openings are punched in 2 also to admit the welding of inlet and outlet passages as at 8 and 7 in the upper part of the dome. The compressor discharge tube 9 and the inlet pipe 10 communicate with these openings. The hole 62 in the spot 6 is of such diameter as to readily admit the compressor crank bearing 40 therethrough as shown in Fig. 3.

Shell 3 is again similar to shell 1 with an additional opening punched in its flat spot 11 to admit and locate the outer motor bearing sleeve 13, the latter being welded or otherwise secured to the spot 11. Shell 3 encloses the stator part of the motor which is pressed therein.

Shell 4 which forms the inner closure for the motor is similar to shell 1 and is shorter. Shell 4 is provided with a hole at the center of its dome which accurately locates the shell 4 on the outside of the compressor bearing 40. The flat spot which is shown as 11 on shell 1 thus appears on shell 4 as the surface for securing the motor to the compressor. The end of shell 4 also has the openings required to pass the screws 14 shown in Fig. 3 and Fig. 4.

As shown in Fig. 1 shells 1 and 2 entirely surround the compressor 41. At the juncture of the shells 1 and 2 there is provided a metal ring 15 which is held to the inside of the shell 1 by means of gasket 16. This forms the annular chamber 17 which is filled with a supply of oil when the compressor operates and serves as an aid in preventing leaks by keeping oil at the juncture of the shells 1 and 2. Thus a leak will be shown by the escape of oil and the oil will tend to prevent small leaks. It is assumed that an adequate gasket 64 may be used between the shells, also, at other points throughout the structure where its use is required. Thus by my invention I provide an additional oil sealing means at a sealing surface which would not otherwise be maintained with such an oil supply.

In Fig. 3 a Bakelite fabric washer 18 held by the screws 14 joins the upper compressor shell 2 to the motor shell 4. This material, or a similar material, is selected because it is a thermal insulator, it acts as a sound deadener and it is strong enough to stand the pressure of a tight seal. The washer 18 is provided with a central opening to admit and pass easily the outer diameter of the crank-bearing 40 and also the screws 14. The screws 14 draw the motor shell 4 tightly to the spot 6 on the side of the upper compressor shell 2, the screws 14 extending into an end, circular, flat bolting surface surrounding and at right angles to the crank-bearing 40 on the compressor frame 43. The compressor holding screws 19 have their heads recessed in the washer 18 and secure the compressor 41 in place to the shell 2 and to the washer 18 when the screws 14 are for any reason removed. Thus I have provided for the compressor assembly to be secured as a unit in and to its casing shells 1 and 2 without regard to presence of the motor shells 3 or 4, for purposes of separate assembly, disassembly, replacement of the motor, test, etc. The Bakelite washer 18 is of such a diameter as to clear the crank-bearing freely therethrough, and provide a sealing area around the screws 14. Preferably the screws 14 and 19 are heat treated alloy steel which will stand severe tightening without letting go and occupy a small amount of space.

Thus the heat of the motor does not carry across into the compressor shells as is the case with other constructions wherein a large part of the motor end closure is bolted, or is otherwise secured, to the compressor housing, or worse, as in those constructions in which the entire motor and compressor are located in a common shell or housing. Only a sufficient connection is utilized in my invention to provide a tight bolting means and to enable the motor to drive the compressor. The shaft of the motor is drilled and the motor bearing is large at its outer end which tends to carry the heat of the stator to the end of the motor away from the compressor shell. Thus by my invention I obtain advantages hitherto incident to the belt-driven motor compressor type in which the motor heat is quite removed from the refrigerating circuit, and I obtain the sealing advantages of the totally enclosed hermetically sealed motor-compressor type.

The compressor 41 may be of any type but I have selected a single, fixed-cylinder, reciprocating piston type with an overhanging crank. The main crank-bearing and cylinder are either cast in or pressed into a die-cast frame structure 43. It is preferably a die-casting in order that the parts may be properly formed to produce the desired chambers and passages with accuracy at low cost. Being a die-cast structure the problems of porosity in the compressor casting as they relate to leakage do not arise as the shells 1 and 2

prevent the escape of any gas to the outside atmosphere. The crank 42 is a forging or high-grade iron casting and formed integral with the crank-shaft 44 and counterweight 45. The inside of the crank-pin is bored out as shown in Fig. 5 at 46 and is provided with a flanged closure cap 47 pressed in its end to close the end thereof and to locate the connecting rod big-end bearing 20. A drilled hole 48 supplies the crank-pin and connecting rod bearing with oil.

The crank-shaft 44 runs in the crank-bearing 40, which is preferably a hardened and ground steel or cast-iron material. The bearing 40 is held tightly in the frame 43. The end of the frame 43 surrounding the bearing 40 is finished flat, square with the crank-shaft axis, and provides a bolt circle as shown in Fig. 3. The screws 14 and 19 engage threaded holes in the end of the frame 43, by which the entire compressor assembly may be secured to the spot 6 and connection made through the Bakelite washer 18 to the inside of the motor shell 4.

To equalize the pressures between the motor casting and the compressor casing and allow the return of the lubricant to the compressor base, the bearing 40 is provided with top and bottom axial slots at the motor end, 49 and 50. These bearing slots or longitudinal grooves communicate with mating slots 51 and 52 formed in the end of the compressor frame 43. These in turn are connected by the drilled holes 53 and 54 to the interior of the compressor casing. A cylindrical chamber 57 to receive the oil which escapes along and out of the motor end of the crank-shaft bearing is formed in the flanged washer 55 which is secured under the screws 14 inside the motor shell 4. See Fig. 4 and Fig. 1. The flanged washer 55 is closed by the washer cap 56 which is oil-tightly but removably pressed over the outside end of 55. The center of 56 is stamped out or otherwise sized to just clear slightly the motor shaft 100 and the pressure between the motor and the compressor may equalize past this annular space for clearance through the passages 49, 51, and 53. The oil which has escaped along the motor end of the compressor bearing 40 will fall by gravity through slots 50, 52, and the drilled hole 54 and back to the compressor oil base in the bottom of shell 1. The vapor which flows in and out around the annular clearance space between motor shaft 100 and the hole in cap 56 is very small owing to the small cross area of the clearance thereof and to the small volume change per stroke in the compressor 41, in view of the large clear volume in the compressor housing shells 1 and 2. Thus an orderly and gradual adjustment of the pressure between the motor and compressor casing is effected as the pressure rises and falls with the temperature in the evaporative side of the system and the waste heat of the motor transmitted into the vapor in the motor shell is held there as in a dead chamber.

The compressor 41 is directly connected to the motor and therefore operates at motor speed. The piston shown only by a dotted line as 63 in Fig. 1 is secured to the crank pin 42 by the articulated connecting rod 64, which is joined to the unbroken cylindrical connecting rod bearing 20 by a pair of stamped circular metal eye members having depending ears, 21 and 22, by means of through bolts and nuts 23.

In the operation of the compressor the vapor is drawn through inlet pipe and passage 10 into the insulated chamber 24 whence the oil entrained with the incoming refrigerant vapor is separated and allowed to pass into the compressor base through the hole 25 in the base of 24. The oil-free, cold, vapor is then drawn down the pipe 26 and into the valve head member 27 and upwardly through the cylinder head plate 28 and into the cylinder.

The compressed vapor leaves the compressor through the pipe 9 and the discharge connection, 7, gas-tightly secured to the upper surface of shell 2.

Thus the motor compressor shell interiors are subject to the low pressure side of the evaporative system through the passage 25 in chamber 24 and thence to the low pressure inlet pipe 10 and the inlet 8 from the evaporator.

Compressor valves for the inlet and outlet to the compressor cylinder are automatic and are operable with the compressor piston and mounted on and in 20.

Lubrication of the motor and compressor is obtained by pressure from the oil pump 29. The pump pressure which builds up as soon as the compressor rotates is also used to cool the compressor and further to load the compressor through an unloader device, the unloader being operated by spring pressure. When the oil pressure falls with the stopping of the compressor, a spring acting on a suitable linkage opens a small passage in the cylinder head plate 28 and allows the pressure in the cylinder to be released and short-circuit through a pipe 30 to unloader 31, and from the unloader 31 into the compressor casing interior and thence back into the inlet side pipe 26 after passing through the hole 25 in the bottom of chamber 24. When the oil pressure is built up after the motor comes up to speed the oil pressure is sufficient to overcome the force of the unloader spring by the application of the oil pressure to the upper side of a piston located in unloader 31. Thus as the unloader piston is moved under the re-established oil pressure the small passage is again closed in the cylinder head 28 and the compressor begins to function normally.

The oil pump may be of any type but I have selected a twin-gear pump whose driven shaft axis approximately coincides with that of the crank-shaft axis. It is mounted on the oil pump standard or support 32 secured to the left side of the frame casting 43 about the open end of the cylinder. Fig. 1 shows this, however, Fig. 6 is a side view of the overhung crank which affords the driving connection between the pump shaft 33 and the inside of the cupped washer 47 which encloses the end of the crank pin 42. The driving crank 34 is of such a length as to rest in the end of the cup 47 and be driven thereby. When the compressor is in rotation the end of crank 34 rests in 47 on the circumference of the circle described by the center of the crank pin. Thus even though the crank 34 engages the inner side walls of the cup 47 the transmission of motion from the compressor crank pin is angularly uniform and there is negligible sliding back and forth of the end of the crank 34 within the cup 47. Thus a simple and inexpensive drive is afforded for the pump, in which the need for extreme accuracy of alignment is avoided.

A level of oil is established in the lower portion of compressor shell 1 at the level of the line 35. The oil is drawn by the operation of the pump through the pipe 36 after passing strainer 37. On the discharge side of pump 29 the pressure is controlled by spring-loaded oil pressure regulator 65 through oil pressure regulator screw

38. The oil under pressure is delivered through pipe 39 to crank bearing 40 where the oil flow divides, oil going to the left to the crank-pin 42, oil flowing to the right to the outer motor bearing in sleeve 13, and some flowing along and over the crank-shaft journal. The compressor is oiled by spray from the crank-pin ends for the piston part.

The unloader receives its oil pressure from pipe 39 through the interconnected pipe 80. The excess oil pressure released from the regulator valve flows into pipe 81 and thence to oil ring 82 which is provided with a number of openings which direct the oil over the inside of the compressor shells 2 and 1 and back to the sump in 1. Thus, heat which the oil may have taken from the cylinder head 28 and other compressor parts is rejected to the air through shells 2 and 1.

The motor 101 is of the alternating current type requiring neither brushes nor commutator. Stator winding 102 is in the stator block 103 pressed into motor shell 3. Thus the stator block may be replaced in event of service failure by undoing the bolts 5, 5, etc., which secure shell 3 to 4 and substitute another shell 3 with its wound stator and use the same rotor 124. It would be of course necessary to first block off the compressor refrigerating circuit connections by valves that may be provided at 7 and 8 on the compressor shell 2 or elsewhere in the refrigerating circuit before opening the motor shells.

Driving connection between the motor shaft 100 and the crank-shaft 44 is so arranged as to overcome difficulties in assembly and disassembly in the field which has been characteristic of the enclosed motor compressor types of refrigerating compressors, and have militated against the use of this type of apparatus.

Crank-shaft 44 is provided with two bores at the motor end and are shown in Fig. 1 and Fig. 4 at 104 and 106. The compressor end of the smaller of these bored out portions 104 constitutes a distributing pipe to supply crank-pin 42 with lubricant; and at the same time a threaded portion on this bore engages a correspondingly reduced and threaded end portion of the motor shaft 100. Threads on the ends of motor shaft 100 are indicated at 105. The threads are fine pitch so that screwing up will unite the parts firmly even as against the reverse torques of the piston. The larger bore 106 on the inside of the crank-shaft is accurately ground as to size and concentricity with the axis of rotation of its outer diameter and this larger bore is a pilot (shown at 106 in Fig. 4) so that the crank shaft and the motor shaft, when screwed together will assume coaxial alignment independent of the threads which are formed loosely enough to admit of such alignment by the pilot.

Shoulder 107 formed on the motor shaft engages tightly, by friction incidental to initial screwing up by hand as well as that produced by the direction of torque or rotation, the slotted thrust washer 108. Fig. 4 shows that the thrust washer 108 is smaller in diameter than the outer diameter of the crank-shaft bearing 40 in order that the pressure equalizing passages and oil return passages 49 and 50 respectively are not masked.

Washer 108 abuts squarely against the end of crank-shaft 44 and by the insertion of thin annular metal spacer shims between the shoulder 107 and 108 adjustment for crank-shaft end-play may be provided. These shims are not shown as I assume that the crank-shaft is of the proper length in relation to the crank-shaft bearing 40 to have the proper end clearance. If the crank-shaft is too long a shorter one should be assembled or else the end shoulder ground off further. If the crank-shaft is too short its adjustment may be effected by the use of such spacing shims as desired. End play gives rise to noise and this is important to compressor quietness.

The washer 108, see Fig. 4, is secured to the crank-shaft end by three small axial pins 109 which engage small drill holes in 44. Pins 109 do not extend beyond the motor face of the washer 108 and serve to hold crank-shaft 44 against rotation when disassembly in the field is to be accomplished.

The method of using the washer 108 may be taken from Fig. 4 and Fig. 3. Assume that the compressor assembly is mounted on its frame 43 and secured to the side of shell 2 by the two auxiliary holding screws 19 recessed in the counter-bores provided for them in the washer 18. Shell 4 and flanged washer 55 are brought up and the screws 14 inserted and tightened through the inside of shell 4, and threaded into the tapped holes in frame 43. Washer 108 is then located against the exposed end of crankshaft so that pins 109 will engage the drilled holes provided for them in 44. Flanged washer cap 56 is then slipped over the threaded end of motor shaft 100 and the latter is inserted into the larger bore 106 of shaft 44. If the lower shell 1 of the compressor is off, the rotation of the crank-shaft may be prevented by the insertion of a screwdriver under the counterweight 45 and between the counterweight and the top of the cylinder end portion of the frame 43. Rotor 124 is then rotated by hand and a positive and quick assembly is effected. Cap 56 is then slid towards the compressor end and fits oil-tightly over the outside of flanged washer 55.

When the compressor is enclosed by its lower shell 1, disassembly is the reverse of the above steps excepting that a special two prong spanner wrench may be inserted in the open end of washer 55 and the slots 110 be grasped thereby in order to prevent the crank-shaft 44 from rotating. This is due to the pins 109 which engage the end of the shaft as shown in Fig. 4. Thus by my invention I provide means whereby the advantages of a belt driven compressor obtain with the hermetically enclosed type in respect to repair in the field.

A preferred form of supplying lubricant to the outer motor bearing which is housed in the oil tight bearing sleeve 13, which has been welded or otherwise secured to the spot 11 in shell 3, is provided by the small tube 111 which is fitted in the drilled center of the motor shaft as indicated by 112. Bearing closure sleeve 13 is closed by the threaded hex nut 113. Tube 111 receives its oil under pressure from the inside of the crank-shaft. The oil may not enter directly into the annular space between tube 111 and 112 because of the annular soft metal closure sleeve 114. A similar but larger soft metal closure sleeve 115 is provided at the motor bearing end and this supports the tube 111 in the center of the shaft. Plug 115 is drilled through with hole 117 into tube 111 whence oil flows to the main outer motor bearing bushing 116. Tube 111 is closed at this end.

The oil which works along the inside of the bushing towards the compressor end is prevented from coming out and dropping into the motor

shell by the motor bearing bushing 118. Bushing 118 has reversed screw threads formed along parts of its inner bearing surface whereby the oil is screwed back into the annular space between the bushings 118 and 116.

Slots are provided axially on the outside of the bushing 116 forming longitudinal passages between the outside of bushing 116 and the sleeve 13 thus connecting the annular chamber formed between bushings 118 and 116 with the chamber 119. Chamber 119 is the disc space between the closure hex nut 113 and the end of the bushing 118.

From chamber 119 the oil flows into the drilled center of a centrally perforated flanged cup 120 which catches the oil by the rotation of the motor shaft and by means of centrifugal force passes slot 121 in plug 115, and is carried between the tube 111 and the drilled inside 112 of the motor shaft 100. The oil then escapes out of the angularly drilled hole 122 in the motor shaft 100 where it enters the chamber within the flanged washer 55 and thence back into the compressor base.

If in time, due to wear, oil may escape past retaining bushing 118 it may be advisable to provide the small tube 123 which connects shell 4 to shell 1 at a point above the liquid level 35 therein. However with the proper functioning of the seal at 118 the tube 123 may be omitted. Oil seal bushing 118 may be of any type of oil seal as desired. It is not limited to an internally threaded bushing.

I claim:

1. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, a shaft interconnecting the motor and the compressor, the walls of the shells each having openings approximating the size of the shaft through which the shaft extends, and means surrounding the shaft for connecting the interior of the shells gas-tightly through the said openings and forming a clearance space open to the atmosphere between the outside of the shells excepting at the point of connection between the shells.

2. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, a shaft interconnecting the motor and the compressor, the walls of the shells each having openings approximating the size of the shaft through which the shaft extends, and a collar having an inner diameter substantially that of the shaft and interconnecting the shells, the shaft located in the collar, the space around the collar open to the outside atmosphere to form a cooling passage between the shell housing the motor and the shell housing the compressor.

3. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, a shaft interconnecting the motor and the compressor, means for maintaining the pressures within the shells substantially the same and for removing the lubricant from the motor shell and directing it into the compressor shell by the varying pressures within the shells.

4. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, retaining screws for connecting the shells, a shaft interconnecting the motor and the compressor at an end part of the compressor, the walls of the shells each having openings approximating the size of the shaft, and a collar having an inner diameter substantially that of the shaft interconnecting the shells and an outer diameter large enough to enclose said retaining screws close to the circumference of the shaft to maintain a tight sealing relation between the shells and the outside atmosphere.

5. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, a plurality of retaining screws for connecting the shells, a shaft interconnecting the motor and the compressor at an end part of the compressor, the walls of the shells each having openings approximating the size of the shaft, and a heat insulating collar having an inner diameter substantially that of the shaft interconnecting the shells and an outer diameter large enough to enclose said plurality of retaining screws which pass through the collar close to and about the circumference of the shaft to maintain a tight sealing relation as between the shells and the outside and to check the flow of heat from the motor shell to the compressor shell.

6. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, the compressor having a rotatable member, a shaft interconnecting the motor and the compressor shells at an end part of the compressor and forming a bearing for the rotatable member of the compressor located within the shaft, the motor having a shaft in driving relation to the rotatable member of the compressor, an end part of the motor shaft located in the center of the rotatable member of the compressor whereby the first named shaft serves as a bearing for the motor, the walls of each of the shells having an opening approximating the size of the first named shaft, and sealing means located at an end part of the compressor to join the shells of the motor and the compressor to each other and gas-tight as against the outside air.

7. In a compression refrigerating system, a motor and a compressor, a pair of cup-like shells for enclosing the compressor and a pair of shells for enclosing the motor, the pairs of shells enclosing the compressor having the same basic form and size, and one of the shells enclosing the motor having the same basic form and size as the shells enclosing the compressor.

8. In a compression refrigerating system, a motor and a compressor, a pair of cup-like shells for enclosing the compressor and a pair of shells for enclosing the motor, three of the shells having the same basic form and the fourth shell having the same basic form excepting in respect to its depth, means for establishing a sealing relation as between pairs of the shells and a sealing and driving relation between the motor located in one pair of shells and the compressor located in the other pair of shells.

9. In a compression refrigerating system, a motor and a compressor, a shell housing the motor in a gas-tight chamber, a second shell housing the compressor in a similar gas tight chamber, the chamber of the motor connected to the chamber of the compressor to establish sealing relation between the motor chamber and the compressor chamber with respect to the outside atmosphere, each chamber adapted to have driving relation established between the motor and the compressor at the point of sealing connection between the chambers, means for slowly equalizing the pressures between the chambers by a small passage between the motor chamber

and the compressor chamber to prevent heat interchange between the compressor and the motor.

10. In a compression refrigerating system, a motor and a compressor, an enclosure for the motor and the compressor having surfaces joined together in sealing relation to enclose the motor and the compressor against the outside atmosphere, means for retaining a supply of lubricant about the sealing surfaces to assist in making the sealing surfaces gas-tight at a point not normally covered by the level of the body of lubricant in the enclosure.

11. In a compression refrigerating system, a motor and a compressor, a shell hermetically enclosing the motor and a second shell hermetically enclosing the compressor, the motor and the compressor connected together in driving relation at the juncture between the shell of the motor and the shell of the compressor and in a gas tight relation with respect to the outside air, means adapted to prevent the rotation of the compressor so that driving connection of the motor may be disconnected from the compressor without disturbing the operating relation of the compressor parts located in its shell.

12. In a compression refrigerating system, a motor and a compressor, a shell enclosing the motor and a second shell enclosing the compressor, driving connection adapted to be established between a motor part and a compressor part, a bearing of the compressor which has an end located at the motor shell and a compressor driving member located in the bearing having screw threads, means for driving the compressor by the motor through the threads located on one of the parts.

13. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, a shaft interconnecting the motor and the compressor, the walls of the shells each having openings approximating the size of the shaft through which the shaft extends, the shells at the openings hermetically joined together with respect to the outside atmosphere and in spaced relation with each other elsewhere, means for adjusting slowly the pressures within the shells through the point of connection between the shells to prevent heat interchange between the motor and the medium handled by the compressor in the compressor shell.

14. In a compression refrigerating system, a motor and a compressor, a pair of cup-like shells for enclosing the compressor and a pair of shells for enclosing the motor, the pair of shells enclosing the compressor having the same fundamental dome and flange form, and one of the shells enclosing the motor having the same fundamental dome and flange form as one of the shells enclosing the compressor.

15. In a compression refrigerating system, a motor and a compressor, a shell hermetically enclosing the compressor and a second shell hermetically enclosing the motor, one of the shells having a flat with an opening therethrough formed on a part of the surface of the shell, means for establishing a driving and sealing relation between the shell enclosing the motor and the shell enclosing the compressor through the flat formed on a part of one of the shells.

16. In a compression refrigerating system, a motor and a compressor having a reciprocable piston, shells for hermetically enclosing the motor and the compressor into separate contiguous chambers, connection established between the shells large enough to admit the passage therethrough of positive driving means for the compressor by the motor and establish adequate sealing means against the outside atmosphere, said connection also being small in cross section to allow a substantial air circulating passage to separate the motor and compressor shells where they are connected together to limit heat transference between the shells.

17. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor, a shaft interconnecting the motor and the compressor, the walls of the shells each having openings approximating the size of the shaft through which the shaft extends, and means surrounding the shaft for connecting the interior of the shells gas-tightly around the said openings and forming a clearance space open to the atmosphere between the outside of the shells excepting at the point of connection between the shells.

18. In a compression refrigerating system, a motor and a compressor, a pair of similar cup-like shells with domed bottoms hermetically enclosing the compressor, a pair of shells similar to the first named shells and differing in basic form only in respect to the depth of the shells enclosing the motor, the domed end on one of the shells having a flat surface thereon, means for establishing driving and sealing relation between the pair of shells enclosing the motor and the pair of shells enclosing the compressor through the flat surface formed on the end of one of the shells.

19. In a compression refrigerating system, a motor and a compressor, a pair of similar cup-like shells with domed bottoms hermetically enclosing the compressor, one of the pair of compressor shells having a flat spot with an opening therethrough formed on a part of the surface of the shell, a pair of shells similar to the first named shells and differing in basic form only in respect to the depth of the shells enclosing the motor, means for establishing driving and sealing relation between the pair of shells enclosing the motor and the pair of shells enclosing the compressor through the flat spot formed on a part of one of the shells.

20. In a compression refrigerating system, a compressor and a motor hermetically sealed in a chamber, a rotatable oil pump adapted to lubricate the motor and the compressor, the pump mounted on a part of the motor-compressor assembly with its driven shaft in approximate coaxial alignment with the axis of rotation of a rotatable part of the motor-compressor assembly and provided with a rotatable arm secured to its driven shaft, means whereby a rotating part will loosely engage a part of the rotatable arm of the pump and rotate the shaft of the pump with the said engaging part without binding notwithstanding small angular or lateral misalignments between the axis of rotation of the pump and the axis of rotation of the rotating part of the motor-compressor assembly.

21. In a compression refrigerating system, a motor and a compressor, shells for enclosing the motor and the compressor into separate contiguous chambers, the shell enclosing the motor adapted to reject the heat of the motor directly into the surrounding atmosphere, the shell of the compressor containing a body of lubricant and adapted to reject waste heat of the compressor by the lubricant to the surrounding atmosphere, a shaft interconnecting the motor and the com-

pressor, the walls of the shells each having openings approximating the size of the shaft through which the shaft extends, and means for slowly equalizing the pressures between the shells to maintain lubrication of the motor bearings and prevent waste heat of the motor from being added to the refrigerant vapor circulated by the compressor and prevent flooding of the motor with lubricant from the compressor shell.

22. In a compression refrigerating system, a motor and a compressor having a reciprocable piston, shells for hermetically enclosing the motor and the compressor into separate contiguous chambers, a connection established between the shells large enough to insure adequate sealing means against the outside atmosphere and passing therethrough a positive driving means for driving the compressor by the motor, said connection also being small in cross section to form a substantial air circulating passage between and around the connected parts of the shells, means for providing circulation of lubricant between the shells for the lubrication of the motor and the compressor, a small passage for equalizing the pressure between the shells, the clear volume in the compressor shell being large in relation to the displacement per stroke of the piston to minimize the extent of momentary pressure fluctuations in the shell enclosing the compressor and thus limit the transference of heated vapor in the motor shell to the compressor shell and allow the return of lubricant from the motor shell to the compressor shell.

23. In a compression refrigeration system, a motor and a compressor, the compressor having an open bracket frame, one end of the frame supporting a cylinder with a reciprocable piston located therein and operated by the crank, a shell forming a hermetically enclosed housing around the compressor for sealing the compressor from the outside atmosphere, a second shell forming a hermetically closed housing for the motor, means associated with the crank-shaft bearing end of the compressor frame whereby the frame may be secured to a wall of the compressor shell in sealing and driving relation with said second shell, and a connection between the crank and the motor passing through the sealed connection between the shells.

PHILIP W. DES ROCHES.