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ROTARY COMPRESSOR LUBRICATING ARRANGEMENT

Filed Dec. 23, 1957

2 Sheets-Sheet 1

FIG. 1

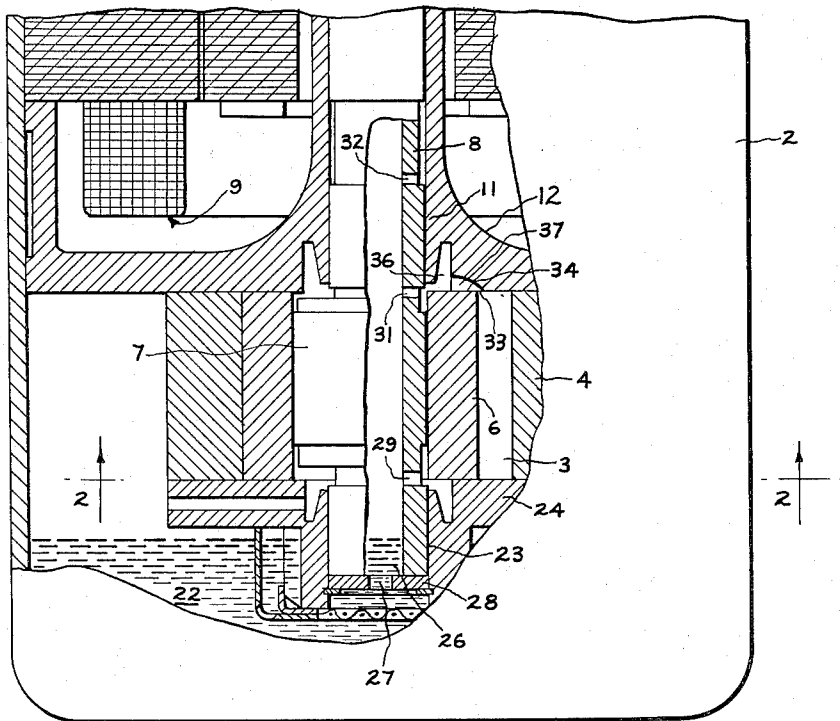
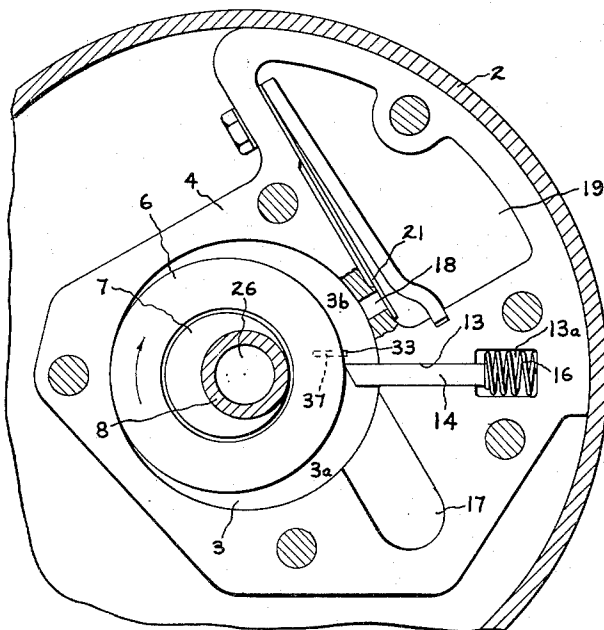


FIG. 2



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FIG. 3

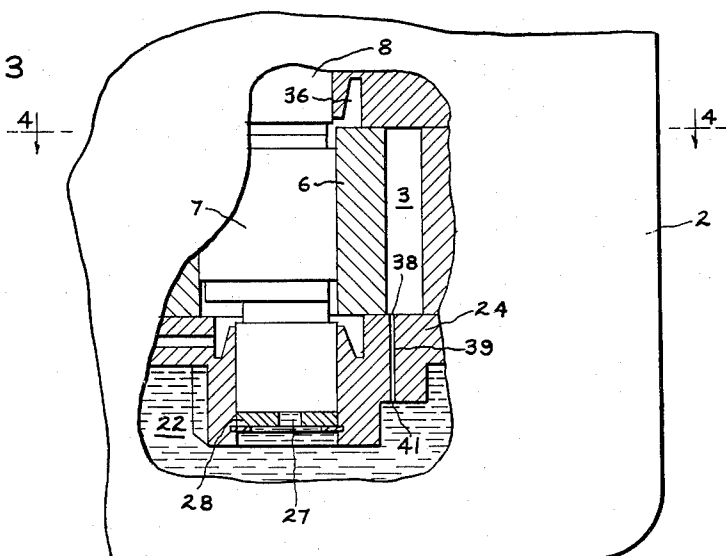


FIG. 4

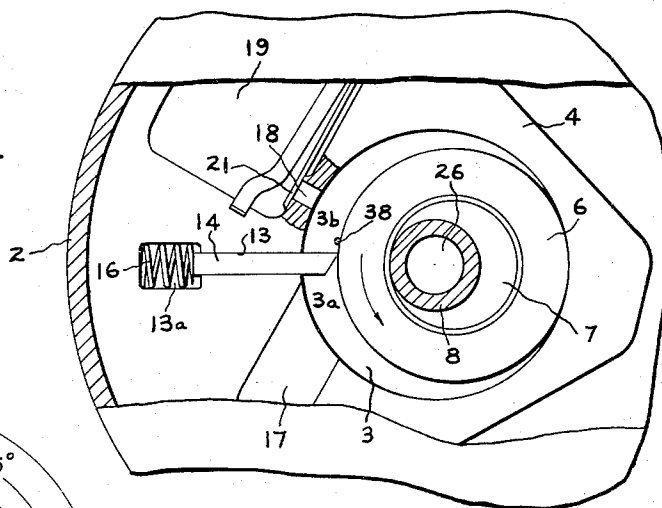
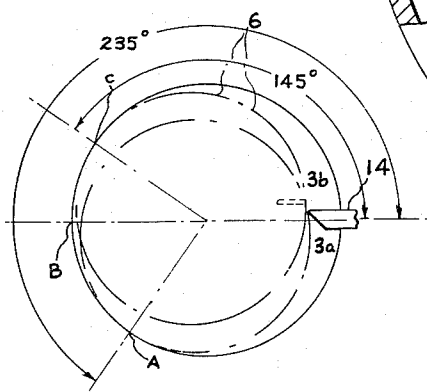


FIG. 5



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ROTARY COMPRESSOR LUBRICATING ARRANGEMENT

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5 Claims. (Cl. 230-207)

The present invention relates to rotary compressors and more particularly to an arrangement for supplying lubricating oil to the compression chamber of a rotary compressor.

One form of a rotary compressor commonly used in refrigeration systems includes a hermetic casing housing the compressor and an annular compression chamber within which there is disposed a rotor driven by an eccentric. Rotation of the eccentric is provided by a rotary drive shaft supported by at least one bearing which forms a portion of one of the end walls of the annular chamber. A slot, formed in one side of the chamber, contains a blade, which is biased into engagement with the periphery of the rotor, and which cooperates with the rotor to divide the chamber into high and low pressure sides. Rotation of the rotor within the chamber effects compression of a vaporous refrigerant which is drawn into the chamber through a suitable intake port on the one side of the blade and discharged through a discharge port on the opposite side of the blade directly or indirectly to the case. Such a compressor is commonly known as a "high side case" or "high side compressor" referring to the fact that the case is at discharge pressure.

A body of lubricating oil is generally provided in the bottom portion of the case for lubricating the moving components of the compressor and for sealing purposes between the high and low pressure sides of the compressor. In a "high side compressor," where the pressure of the refrigerant gas within the case is very substantial, great quantities of refrigerant gas are absorbed by this body of oil. For a representative operating condition under the pressures normally encountered in a "high side case," the volume of refrigerant absorbed in the lubricating oil may be as much as 20% of the total volume of the oil. This absorbed refrigerant expands approximately 50 times its original volume when changing from the high pressures of the case to suction pressure. Therefore, for every volume of oil in the "high side compressor" there are about 10 volumes of gas after expansion.

The absorbed gas in the lubricating oil of a "high pressure case" makes it very difficult to maintain an adequate supply of oil in the compression chamber without too greatly limiting the capacity of the compressor. That is, if lubricating oil is introduced at a point in the chamber and at a time when the pressure therein is low or at suction pressure, the volume of oil containing the absorbed refrigerant therein must necessarily be kept very small in order to maintain the capacity of the compressor since the gas absorbed in the oil immediately vaporizes in the chamber and reduces the amount of gas which can enter the chamber from the suction line. This absorbed gas affects the supply of oil to the chamber in a still further manner. Since the oil passage and port which feed oil to the chamber must be relatively small to prevent too much oil flow to the chamber, the differential in pressure between the oil and the compression chamber causes the gas absorbed in the oil to expand within this oil passage and restrict the flow of oil therethrough somewhat in the same manner as refrigerant gas in a capillary tube restricts the flow of liquid refrigerant therethrough.

It is an object of the present invention to provide an improved arrangement for introducing oil into the com-

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pression chamber of a rotary compressor such that there will be no appreciable decrease in volume of the oil after it has been introduced into the chamber.

More specifically, it is an object of the present invention to provide an arrangement for introducing oil into the high pressure side of a compression chamber only at such a time when the differential in pressure between the gas within the chamber and the gas within the casing is small enough to prevent revaporization of the refrigerant gas absorbed in the oil.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of the invention there is provided within a hermetically sealed casing having high pressure refrigerant vapor therein, a compressor unit having an annular compression chamber formed between spaced upper and lower end walls. A rotor having its peripheral surface arranged to move progressively into sealing engagement with successive portions of the annular chamber is provided for compressing gas within the chamber. A slot formed in one side wall of the annular chamber carries a reciprocable blade which is biased into engagement with the periphery of the rotor thereby dividing the chamber into high and low pressure sides. A vertical shaft, supported by bearings disposed in one or both end walls of the annular chamber, is provided for driving the rotor. In order to supply lubricating oil to the chamber there is provided an oil inlet port in one of the end walls of the chamber which communicates with the chamber adjacent the high pressure side of the reciprocable blade. The oil port is so disposed in one end wall of the chamber that the end of the rotor seals the port from the chamber at all times except for a short period during the rotation of the rotor when the pressure of the gas on the high pressure side of the chamber is equal to at least 50% of the pressure of refrigerant gas within the case.

As a further aspect of the present invention, by locating the oil inlet port to the chamber in the lower end wall of the compressor and by supplying oil to the port through a connecting passage having its opening submerged in the main body of lubricating oil in the lower part of the case, it is possible to assure a continuous supply of oil for the chamber and to take advantage of the differential in pressure between the case and chamber at the time the oil inlet port is uncovered by the end of the rotor to pump the oil upwardly into the chamber.

For a better understanding of the invention reference may be had to the accompanying drawings in which:

FIG. 1 is a side elevation view partially in section of a hermetic refrigeration compressor incorporating one embodiment of the present invention;

FIG. 2 is a partial plan view taken along line 2-2 of FIG. 1;

FIG. 3 is a partial side elevation view of the rotary compressor of FIG. 1 showing a second embodiment of the invention;

FIG. 4 is a partial plan view taken along the line 4-4 of FIG. 3; and

FIG. 5 is a schematic view illustrating the angular positions of the rotor when the oil inlet port is opened and closed by the rotor.

Referring to the drawings, there is shown a hermetic compressor including a hermetic casing 2 in which there is disposed a refrigerant compressor unit having an annular chamber or compression chamber 3 defined within a cylinder or housing 4. Disposed for rotation within the chamber 3 is a rotor 6 which is driven by an eccentric 7 formed as an integral part of a drive shaft 8 extending

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downwardly from the motor 9. A bearing 11, which with the supporting main frame 12, defines the upper end wall of the annular compression chamber 3, supports the shaft 8 above the eccentric 7 for rotation by the motor. The main frame 12 also supports the compressor unit within the casing.

As may better be seen in FIG. 2, within the cylinder 4 there is provided a radial slot 13 having slidably disposed therein a blade or vane 14 which is biased into engagement with the outer periphery of the rotor 6 thereby dividing the chamber 3 into low and high pressure sides respectively designated 3a and 3b. In the illustrated embodiment of the invention the end of blade 14 is biased against the periphery of the rotor by means of a spring 16, arranged within an enlarged opening 13a forming a part of the radial slot 13.

A compressor of this type is adapted to be connected into a refrigeration system to receive suction gas from an evaporator (not shown) through a suction line (not shown) connecting with the suction port 17. The suction port 17 delivers gas into the low pressure side 3a of the compression chamber 3 where it is compressed during rotation of the rotor 6 to a much higher pressure and is discharged through an outlet or discharge port 18 into a discharge chamber 19. Mounted within the chamber 19 is a suitable valve 21 for assuring proper compression of the gases issuing from the discharge port 18 and for preventing reverse flow of gases back into the compression chamber 3. The high pressure gas from the discharge chamber 19 flows into the hermetic casing 2 prior to its discharge into the refrigerating system. Sometimes, it is desirable to pass the discharge gas from the chamber 19 directly through a single de-superheater coil (not shown) over which outside air is blown and then to discharge this cooled compressed gas back into the casing. Regardless of the passage through which the high pressure gas flows, it is eventually directly into the casing and the pressure within the casing is only slightly below discharge pressure of the chamber 3b. In a tested compressor of the type illustrated in the drawings, when used in a refrigerating system of a self contained air conditioner for cooling an enclosure, the case pressure was approximately 300 p.s.i.g. and the pressure within the chamber was about 330 p.s.i.g. maximum. The suction pressure in such a refrigerating system normally runs approximately 225 p.s.i. less than discharge pressure, or about 75 p.s.i.g. and the temperature of the suction gas is approximately 60° to 70° F. Of course, the various applications of the above compressor and the particular design features of the refrigerating system all affect the pressure of the gas within the case, but as can be seen from the above representative figures, the pressure within the case is substantially above that of suction pressure.

In order to provide a source of lubricating oil for the various bearing surfaces and the other moving parts of the unit, there is employed a reservoir or body of oil 22 in the lower portion of the hermetic casing. This body of oil is of sufficient depth that the lower end of the shaft and a portion of the bearing 23 which forms a part of the lower end wall 24 of the annular chamber are substantially immersed in the oil. Means is provided for pumping lubricant to the various moving parts of the compressor unit. More specifically there is provided a relatively large axially extending passage 26 in the shaft 8. The axially extending passage is in communication with the reservoir through a hole 27 provided in the thrust plate 28. In the upper portion of the shaft 8 there is a passage (not shown) which connects the passage 26 with the casing thereby introducing casing pressure into the passage. Upon rotation of this shaft, lubricant entering the axial passage 26 is forced to quickly assume the rotational speed of the shaft 8. Centrifugal force then causes the lubricant to flow outwardly against the inner surface of the axial passage 26 and upwardly along the inner passage. Oil outlets 29, 31 and 32 in the circum-

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ference of the shaft transmit lubricant from the passage to the various bearing surfaces.

As thus far described, this compressor with its oil pumping arrangement for supplying lubricant to the various bearings forms no part of the present invention but is intended, rather, to be illustrative of the type of compressor to which the present invention may be adapted. As will now be explained, the invention deals with the introduction of lubricant into the compression chamber 3 for providing the necessary seal between the high and low pressure sides of the chamber or between the outer surfaces of the rotor and the surfaces of the chamber in order to assure proper compression of the refrigerant gas.

As stated previously, due to the high pressure within the case, a great deal of the vaporous refrigerant within the casing becomes absorbed in the body of lubricating oil in the lower portion of the case. Because of this gas absorbed in the oil it is difficult to supply a sufficient amount of oil to the compression chamber to attain the necessary sealing between the rotor and the chamber surfaces. It is not feasible to flood the chamber with oil since the gas in the oil expands to about 10 times the volume of the oil and gas mixture introduced and this would greatly reduce the capacity of the compressor. Referring to FIGS. 1 and 2 there is shown a means whereby the oil may be injected into the compression chamber only at such times when the pressure within the high pressure side 3b of the chamber is slightly below discharge pressure. More specifically, there is provided an oil inlet or injector port 33 arranged on the high pressure side 3b of the blade 14. This port is so arranged with respect to the high pressure side of the compression chamber and with respect to the rotor 6 that the end 34 of the rotor 6 completely covers the port 33 at all times during each cycle of the rotor, except when the gas within the compression chamber is only a small amount below discharge pressure.

More specifically, as may best be seen from the schematic diagram in FIG. 5, for the compressor of the type illustrated in the drawings, the oil inlet port 33 is closed at all times during each cycle of the rotor 6 except for the period when the contacting or peripheral surface of the rotor moves from point A to point C of the annular chamber 3. At point A the end of the rotor is just beginning to open the oil port 33 and at point C it has completely closed the port. The location of the point A is approximately 235° in advance of the completion of the compression stroke or in advance of the center line of the blade 14. When the motor is in this position, the pressure of the gas within the high pressure side 3b is approximately 170 p.s.i.g. or approximately 56% of the pressure of the gas within the case. Point C is located 145° in advance of the completion of the compression stroke or in advance of the center line of the blade. When the rotor is in the position indicated at point C, the pressure within the high pressure side 3b of the chamber is approximately 275 p.s.i.g., which is about 91% of the pressure of the gas within the case. In order to prevent reverse flow through the port, point C should in no circumstances be located such that the port 33 is still unsealed when the pressure within the chamber exceeds that of the case. The average pressure of the gas within the side 3b of the chamber is about 225 p.s.i.g. during that portion of the cycle when the oil port 33 is unsealed. This is only an average of 75 p.s.i. below discharge pressure and the absorbed gas in the oil expands very little, when introduced into the chamber at this pressure. Thus, during the time the oil port is unsealed the average pressure within the high pressure side of the chamber 3b is approximately 75% of case pressure. At no time, during the period that oil is introduced to the chamber is the pressure within the high side 3b of the chamber lower than 50% of the pressure of the gas within the case.

In order to supply oil to the oil port 33, it is connected

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by a passage to the trepan section 36 in the lower portion of the bearing section 11 which forms a small reservoir or chamber between the bearing and the rotor for collecting a small amount of oil. More specifically, in the embodiment of the invention shown in FIGS. 1 and 2, the oil port 33 and its supply passage form one continuous groove 37 in the upper end wall 12 of the chamber. Since the oil within the axial passage 26 is at the same pressure as the case, the oil within the trepan section or reservoir 36 is at substantially the same pressure. In the illustrated compressor, the differential in pressure between the case and the high pressure side 3b of the compression chamber 3 averages about 75 p.s.i. during the short period that the port 33 is open. This differential in pressure forces the oil from the trepan section 36 through the groove 37 thereby supplying oil under pressure to the oil inlet port 33. Since the rotor is operating at very high speeds, the oil inlet port 33 is open only a very short instant. Therefore, although there is 75 pound per square inch average pressure differential between the high pressure side 3b of the compressor chamber and the pressure within the case, only a very small amount of oil is introduced into the chamber during each rotation of the rotor. Because the high pressure side 3b of the compression chamber 3 is almost up to discharge pressure when the rotor opens the port 33, or as explained above, because the pressure within the high side 3b of the chamber only averages about 75 pounds per square inch below the pressure within the case, the total expansion of the refrigerant gas absorbed in the oil as it enters the compressor chamber is relatively small as compared with the volume to which it would expand if the oil were introduced at suction pressure. Because the differential in pressure is relatively small as compared to the pressure differential between the case and suction pressure, the groove 37 can be made relatively small, without danger of the gas expansion therein which would greatly restrict the flow of oil through a small groove.

Referring now to FIGS. 3 and 4, there is shown a second embodiment of the invention in which an oil injector port 38 is located in the bottom end wall of the annular chamber. In this embodiment of the invention, oil is introduced to the oil port in a somewhat different manner than that shown for the embodiment of FIGS. 1 and 2. More specifically, there is provided a passage 39 extending downwardly through the lower end wall or bearing plate 24 and having its other opening 41 submerged in the body of oil 22 which covers at least a portion of the bearing plate 24. The pressure difference between the case and the compression chamber at the time the oil port 38 is uncovered is sufficient to cause lubricating oil to flow through the opening 41 into the passage 39. Oil is then introduced into the high pressure side 3b the compression chamber 3 in the same manner as explained above for the oil port 33 of the compressor of FIGS. 1 and 2. An advantage of the arrangement shown in FIGS. 3 and 4 is that there is a supply of lubricating oil from the main reservoir 22 at all times while there is a possibility that the oil supplied to the trepan section or oil reservoir 36 may be inadequate at times, particularly when the compressor is first started.

By the present invention there has been provided a lubricating arrangement for the compression chamber of a rotary compressor having a "high side case" whereby oil is continuously supplied to the compression chamber at a time during each cycle of the rotor when the pressure within the chamber is equal to at least 50% of the pressure within the case and for a period during each cycle of the rotor when the average pressure within the chamber is at least 75% of the pressure of the case. Moreover, this arrangement takes advantage of the differential in pressure between the compression chamber and the case to force the oil into the chamber. Further, since the average difference in pressure between the case and the chamber is relatively small as compared to the

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difference in pressure between the case and suction pressure, there is very little expansion of the refrigerant gas absorbed in the oil to cause a reduction in the capacity of the compressor.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, the aim of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A hermetically sealed rotary refrigerant compressor comprising a hermetic casing containing a high pressure refrigerant gas, a body of lubricating oil in the lower portion of said casing, a compressor unit positioned in the lower portion of said casing above said body of oil and including a cylinder having an annular chamber, spaced parallel upper and lower end walls connecting with said cylinder and enclosing said annular chamber, a rotor eccentrically rotatable within said chamber with the peripheral surface of said rotor arranged to move progressively into sealing relation with successive portions of said annular chamber, a motor in the upper portion of said casing, said motor having a shaft thereon extending downwardly through said upper end wall into said cylinder for driving said rotor within said chamber, a radial slot in said cylinder communicating with said chamber, a blade slidably positioned in said radial slot, means biasing said blade against said rotor for following said rotor thereby to divide said chamber into high and low pressure sides, a gas suction port in said cylinder and connecting with said low pressure side of said chamber, a gas discharge port in said cylinder connecting with said high pressure side of said chamber, means leading from said discharge port into said casing for conducting high pressure discharge gas into said casing, means for introducing oil into said chamber including an oil injector port in one end wall of said chamber communicating with said high pressure side of said chamber, said oil injector port being entirely sealed from said chamber by the end of said rotor except at such times during the rotation of said rotor when the pressure of said refrigerant gas in said high pressure side of said chamber is equal to at least 50% of the pressure of said refrigerant gas in said case and means communicating with said body of lubricating oil and connecting with said oil injector port for introducing oil at case pressure into said oil injector port.

2. A hermetically sealed rotary refrigerant compressor comprising a hermetic casing containing a high pressure refrigerant gas, a body of lubricating oil in the lower portion of said casing, a compressor unit positioned in the lower portion of said casing above said body of lubricating oil and including a cylinder having an annular chamber, spaced parallel upper and lower end walls connecting with said cylinder and enclosing said annular chamber, a rotor eccentrically rotatable within said chamber with the peripheral surface of said rotor arranged to move progressively into sealing relation with successive portions of said annular chamber, a motor in the upper portion of said casing having a shaft extending downwardly through said upper end wall into said cylinder for driving said rotor within said chamber, a radial slot in said cylinder communicating with said chamber, a blade slidably positioned in said radial slot, means biasing said blade against said rotor for following said rotor thereby to divide said chamber into high and low pressure sides, a gas suction port in said cylinder connecting with said low pressure side of said chamber, a gas discharge port in said cylinder connecting with said high pressure side of said chamber, means leading from said discharge port into said casing for conducting high pres-

sure discharge gas into said casing, means for introducing lubricating oil into said chamber comprising an oil injector port in one end wall of said chamber, said oil injector port communicating with said chamber adjacent the high pressure side of said blade, said injector port being sealed from said chamber by the end of said rotor except at such times during the rotation of said rotor when the pressure of said refrigerant gas in said high pressure side of said chamber is within the range of 50% to 90% of the pressure of said high pressure refrigerant gas in said case and means connecting with said port for introducing oil at case pressure into said port.

3. A hermetically sealed rotary refrigerant compressor comprising a hermetic casing containing a high pressure refrigerant gas, a body of lubricating oil in the lower portion of said casing, a compressor unit positioned in the lower portion of said casing above said body of oil and including a cylinder having an annular chamber formed between spaced parallel upper and lower end walls, a rotor eccentrically rotatable within said chamber with the peripheral surface of the rotor moving progressively into sealing relation with successive portions of said annular chamber, a motor in said upper portion of said casing having a shaft extending downwardly into said compressor unit for driving said rotor in said chamber, bearing surfaces in said upper and lower end walls for supporting said shaft with respect to said compressor unit, a radial slot communicating with said chamber, a blade slidably positioned in said radial slot, means biasing said blade against said rotor for following said rotor thereby to divide said chamber into high and low pressure sides, a gas suction port connecting with said low pressure side of said chamber, a gas discharge port connected with said high pressure side of said chamber, means communicating with said gas discharge port for conducting discharge gas into said casing, said shaft having an internal passage communicating in the upper portion of said casing with said high pressure refrigerant gas within said casing and communicating in the lower portion of said casing with said body of oil whereby oil is centrifugally pumped during rotation of said shaft up the surface of said internal passage, oil passages connecting said internal passage with said bearing surfaces in said upper and lower end walls, a small oil chamber formed between said upper end wall and said rotor for collecting oil from said upper bearing, means for introducing oil into said compression chamber comprising a groove in said upper end wall of said chamber extending from said small oil chamber to a point in said compression chamber adjacent the high pressure side of said blade, said groove being arranged so that it is sealed from said chamber by the end of said rotor at all times except during the period of each stroke when the point of contact of said peripheral sealing surface of said rotor with said annular chamber is approximately between 235° and 145° in advance of the completion of the compression stroke.

4. A hermetically sealed rotary refrigerant compressor comprising a hermetic casing containing a high pressure refrigerant gas, a body of lubricating oil in the lower portion of said casing, a compressor unit positioned in the lower portion of said casing above said body of oil and including a cylinder having an annular chamber formed between spaced parallel upper and lower end walls, said lower end wall being at least partially submerged in said body of oil, a rotor eccentrically rotatable within said chamber with the peripheral surface of said rotor arranged to move progressively into sealing relation with successive portions of said annular chamber, a motor in said upper portion of said casing having a shaft extending downwardly into said compressor unit for driving said rotor in said chamber, a radial slot communicating with said chamber, a blade slidably positioned in said radial slot, means biasing said blade against said rotor for following said rotor thereby to divide said

chamber into high and low pressure sides, a suction port connecting with said low pressure side of said chamber, a gas discharge port connecting with said high pressure side of said chamber, means communicating with said gas discharge port for conducting discharge gas into said casing, means for introducing oil into said compression chamber comprising an oil injector port in said lower end wall of said chamber, said injector port being sealed from said chamber by the end of said rotor except at such times during the rotation of said rotor when the pressure of said refrigerant gas in said high pressure side of said chamber is within the range of 50% to 90% of the pressure of said high pressure refrigerant gas in said case, an oil passage in said lower end wall connecting with said oil injector port, said passage opening into said casing at a point beneath the level of said body of lubricating oil in the bottom of said casing whereby oil from the body of lubricating oil is forced through said passage and said oil injector port into said compression chamber during each cycle of rotor when the pressure in said compression chamber is between 50% and 95% of the pressure of the refrigerant gas in said casing.

5. A hermetically sealed rotary refrigerant compressor comprising a hermetic casing containing a high pressure refrigerant gas, a body of lubricating oil in the lower portion of said casing, a compressor unit positioned in the lower portion of said casing above said body of oil and including a cylinder having an annular chamber formed between spaced parallel upper and lower end walls, said lower end wall of said compressor being at least partially submerged in said body of oil, a rotor eccentrically rotatable within said chamber with the peripheral surface of said rotor arranged to move progressively into sealing relation with successive portions of said annular chamber, a motor in said upper portion of said casing having a shaft extending downwardly into said compressor unit for driving said rotor in said chamber, a radial slot communicating with said chamber, a blade slidably positioned in said radial slot, means biasing said blade against said rotor for following said rotor thereby to divide said chamber into high and low pressure sides, a suction port connecting with said low pressure side of said chamber, a gas discharge port connecting with said high pressure side of said chamber, means communicating with said gas discharge port for conducting discharge gas into said casing, means for introducing oil into said compression chamber comprising an oil injector port in said lower end wall of said chamber, said injector port being arranged so that it is sealed from said chamber by the end of said rotor at all times except during that period of each cycle when the peripheral surface of said rotor is between approximately 235° and 145° in advance of the completion of the compression stroke, said lower end wall having an oil supply passage connecting with said injector port, said passage opening into said casing at a point below the level of said body of lubricating oil in the bottom of said casing whereby oil from said body of lubricating oil is forced through said passage and said oil injector port into said high pressure side of said chamber during each cycle of said rotor at such times when said oil injector port is not sealed by said rotor.

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