Dec. 31, 1957 L. A. PHILIPP 2,818,210

REFRIGERATING APPARATUS

Filed March 27, 1956 2 Sheets-Sheet 1

Fig. 1

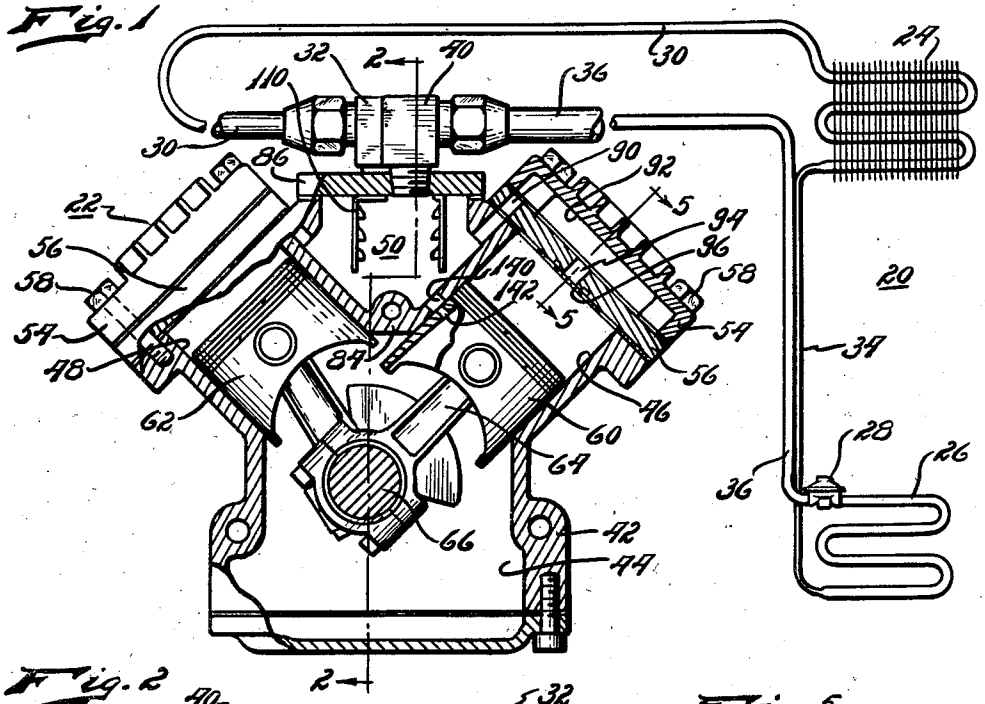


Fig. 2

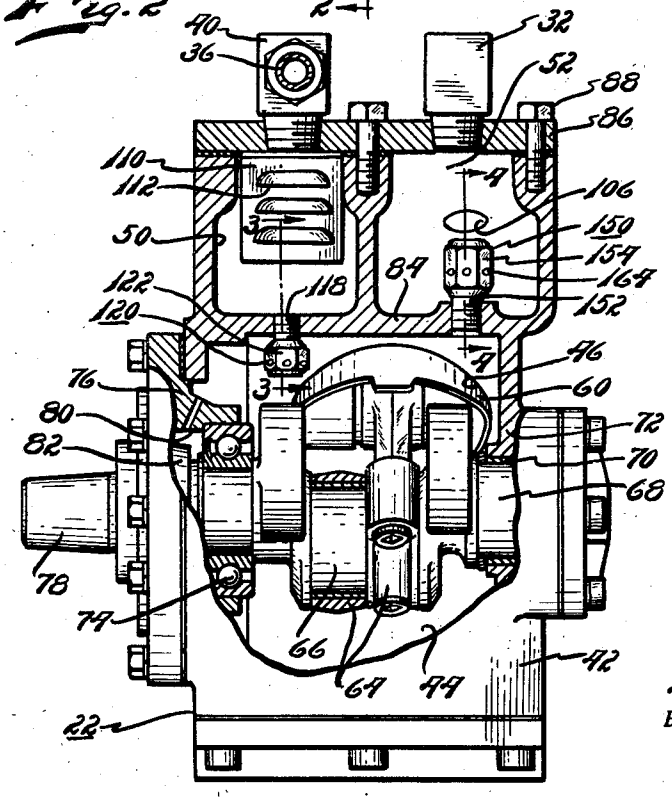
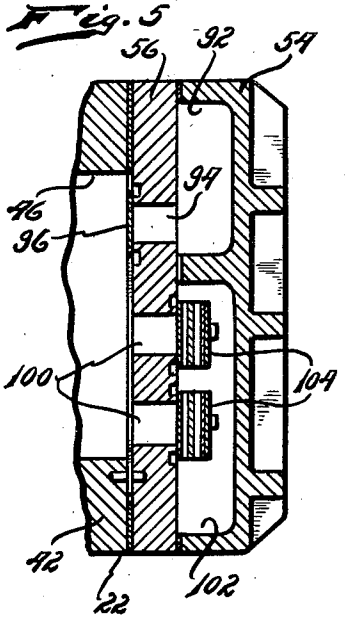


Fig. 5



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Fig. 3

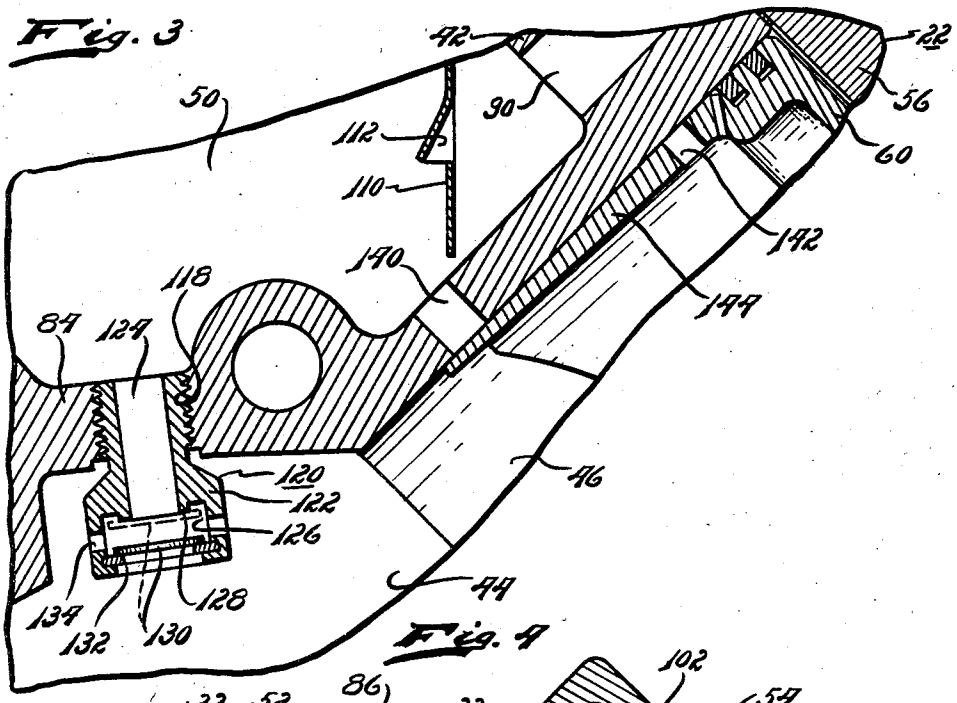
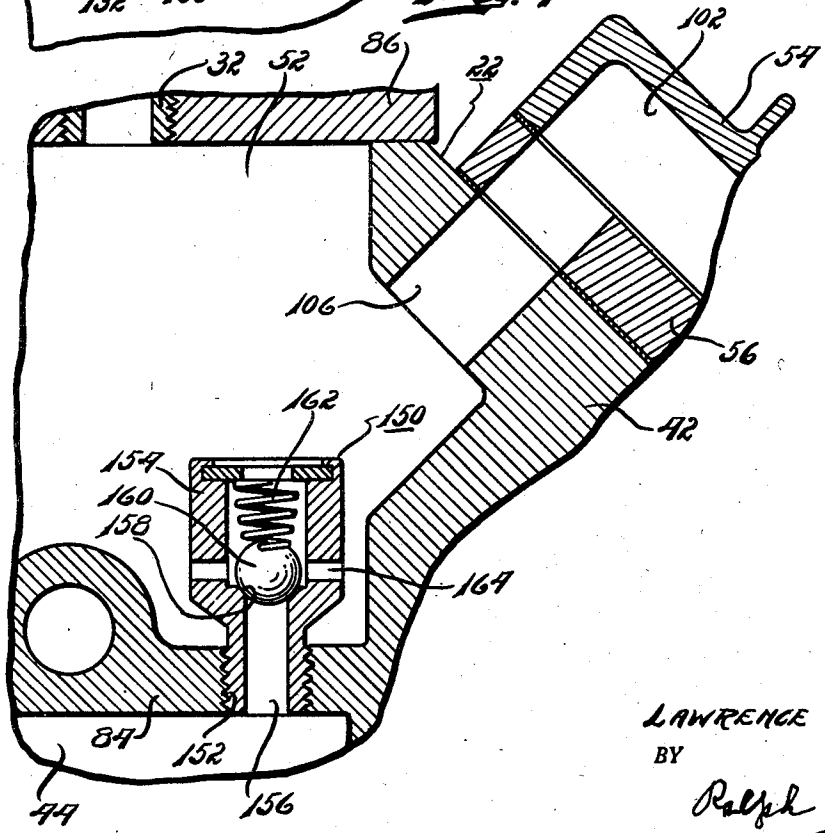


Fig. 4



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REFRIGERATING APPARATUS

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Application March 27, 1956, Serial No. 574,267

4 Claims. (Cl. 230—206)

This invention relates to refrigerating apparatus and more particularly to compressors for use in connection with such apparatus.

It is an object of the present invention to provide in a compressor an improved arrangement whereby the crankcase is in communication with the suction side of the compressor for the free return of lubricating oil that has passed into the refrigerating system, and to close this communication whenever the pressure within the crankcase substantially increases and open a second communicating arrangement to permit a slow or gradual reduction of the pressure in the crankcase to the suction side of compressor in such a manner as to prevent foaming of the lubricating oil, and after the pressure has been reduced the first communicating arrangement reopens with the closing of the second.

Another object of the present invention is to provide in a compressor an improved arrangement for relieving the crankcase of condensed liquid refrigerant accumulated during the period of the compressor's idleness by forcing, during the initial start of the compressor, the liquid refrigerant into the discharge side of the compressor to be conducted therefrom to the condenser.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view in cross section of a compressor embodying features of my invention with a refrigerating system shown diagrammatically therewith;

Fig. 2 is a view in cross section slightly enlarged and taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view in cross section slightly enlarged and taken along the line 3—3 of Fig. 2 illustrating the piston at the top of the cylinder;

Fig. 4 is a fragmentary view in cross section slightly enlarged and taken along the line 4—4 of Fig. 2; and

Fig. 5 is a view in cross section slightly enlarged and taken along the line 5—5 of Fig. 1.

Shown in the drawings is a refrigerating system, indicated in general by the numeral 20, comprising a compressor 22, a condenser 24, an evaporator coil 26 and a pressure regulating control valve 28. The refrigerant compressed by the compressor 22 is delivered by conduit 30, which is connected by a fitting 32 to the compressor, to the condenser 24 wherein it is cooled and liquified and from which it is delivered to the evaporator under the control of a small diameter conduit 34. The small diameter conduit 34 is bonded to a refrigerant return conduit 36 to prevent formation of vapor in the conduit 34 and to insure that only liquid refrigerant will enter the evaporator coil 26. The conduit 34 is of a small diameter to keep the pressure up so that the expansion will not take place at the outlet of the condenser but instead at the inlet of the evaporator. The vaporized or heat laden

refrigerant is withdrawn from the evaporator through the return conduit 36 under the control of the pressure regulating valve 28 by the compressor 22. The pressure regulating valve 28 is adjustable to maintain the operation of the evaporator coils 26 at the pressure temperature range to prevent the formation of frost thereon. The return conduit 36 is connected by fitting 40 to the compressor 22 to deliver the vaporized refrigerant thereinto.

The compressor 22 comprises a casting or outer casing 42 having formed therein a crankcase 44, cylinders or compression chambers 46 and 48, an inlet or suction muffling chamber 50, and an outlet or discharge muffling chamber 52. The compressor also includes for each cylinder 46 and 48 a head portion 54 and a valve plate 56 that is clamped between the head portion and the cylinder by screws 58.

The cylinders 46 and 48 extend in an angular opposed relation formed in a V arrangement with the crankcase section, and disposed in each cylinder for reciprocation are pistons 60 and 62, respectively. Each of the pistons are connected by a connecting rod 64 to a crank arm 66 of a crankshaft 68. The crankshaft 68 is journaled in a bearing 70 provided in end wall section 72 of the crankcase, and a bearing 74 mounted in an opposite removable end wall 76. The crankshaft 68 is formed with a shaft extension 78 that extends through an opening 80 formed in the removable end wall section 76 to project exteriorly of the crankcase for mounting thereon a suitable drive mechanism, such as a pulley sheeve (not shown), so that it may be operatively connected to a suitable source of driving power for operating the compressor. The opening 80 is sealed about the shaft extension 78 by a suitable seal 82 to prevent atmospherical air entering into the crankcase as well as preventing lubricant oil maintained in the crankcase from leaking out therethrough.

The suction muffling chamber 50 and the discharge muffling chamber 52 are formed in the casing between and above the cylinders 46 and 48 and are separated from the crankcase by a partitional wall 84. A closure plate 86 is secured by screws 88 to the casing to close the top opening to the suction and discharge muffling chambers. Threaded into openings formed in the closure plate 86 are the fittings 32 and 40, the fitting 32 communicates with the discharge muffling chamber 52 for conducting compressed refrigerant into the conduit 30, while the fitting 40 connected to the return conduit 36 delivers therefrom vaporized refrigerant into the suction muffling chamber 50.

The suction and discharge muffling chambers serve both cylinders or compression chambers, and the communicating passages to and from each cylinder together with control valves are the same so that a description of the course of flow of the refrigerant to and from one of the cylinders is believed sufficient. Refrigerant is conducted from the suction muffling chamber 50 through a passageway 90 that extends through a wall of the casing and through the valve plate 56 to deliver the refrigerant into a chamber 92 formed in the head section 54. From the chamber 92 refrigerant is admitted into the cylinder or compression chamber 46 through port 94, formed in the valve plate 56, under the control of reed type valve 96. The refrigerant is compressed by the piston 60 to pass outwardly from the compression chamber through ports 100, formed in valve plate 56, into a chamber 102 under the control of discharge valves 104. The compressed refrigerant is conducted from the chamber 102 formed in the head section 54, through a passage 106 that extends through the valve plate 56 and through a wall of the casing to be delivered into the discharge muffling chamber 52 from which it may pass outwardly through fitting 32, conduit 30, to the condenser 24.

During the operation of the compressor some lubricant oil is withdrawn or passes from the crankcase past the pistons to be discharged into the refrigerating system where it will circulate to eventually return with the refrigerant to be separated therefrom in the suction muffling chamber 50. To further aid in the separation there are provided within the chamber 50 a pair of opposed baffle plates 110 positioned so that each lies between the outlet of fitting 40 and the inlet to the passageway 90 leading to a respective compression chamber. Each baffle plate 110 is constructed with louvered openings 112 for the passage of vaporized refrigerant therethrough while the lubricant carried by the refrigerant will condense out on the surface of the baffle to drain therefrom as droplets and to collect on the bottom of the chamber 50.

The partitional wall 84 of the casing is the bottom wall of the chambers 50 and 52 and the upper wall of the crankcase. Extending through the wall 84 from the suction chamber 50 to the crankcase is a threaded hole 118 in which is threadably secured an oil return valve 120 which extends into the crankcase 44. The valve 120 comprises a body 122 having an axially directed passage 124 extending inwardly from one end of the body 122 to join a larger diameter passage 126 that extends to the opposite end of the body 122. At the juncture of passages 124 and 126 is formed a valve seat 128 over which is adapted to seat a valve disk 130 to close communication between the passages. The valve disk 130 when moved away from the valve seat 128 will rest upon a stop ring 132 carried by the valve body within the passage 126. The ring 132 is spaced from the valve seat 128 to limit the movement of the valve disk 130 from its seat. Openings 134 extend radially from the passage 126 through the body 122. When the valve 120 is opened, that is the disk rests upon the stop ring 132 (see Fig. 3) lubricant oil will drain from the chamber 50 flowing downwardly through passages 128, 130 and through openings 134 into the crankcase 44. The valve 120 is opened by the suction action on the upwardly moving pistons whereby the pressure in the crankcase 44 is reduced below the pressure in the suction chamber 50 and will remain open until the pressure in the crankcase exceeds that in the suction chamber. When the pressure in the crankcase is greater, the valve 120 will automatically close as the greater pressure in the crankcase will lift and hold the valve disk upon its seat 128. This arrangement prevents any sudden reduction of pressure on the lubricant oil within the crankcase and consequently eliminates any tendency of foaming of the lubricant.

The pressure within the crankcase 44 is increased as the pistons on each suction stroke move downwardly towards the crankcase to compress the gaseous refrigerant therein causing a corresponding rise in pressure upon the lubricant oil therein. In this V compressor both pistons are connected to operate from the same crank arm with both pistons moving simultaneously downwardly until one reaches bottom dead center. On such movement the pistons tend to compress the gases in the crankcase to greatly increase the pressure therein. As the pistons move downwardly causing an increase in pressure in the crankcase the oil return valve 120 will close and to gradually release the crankcase pressure there is provided a drilled orifice or opening 140 that extends through a cylinder wall providing communication from suction chamber 50 with the interior of the cylinder 46. The orifice or opening 140 is so located in the cylinder wall that it remains covered at all times by the piston 60. That is, the piston 60 whether it has traveled to the top of the cylinder 46 (see Fig. 3), or to the bottom of the cylinder 46 never bodily uncovers the opening 140. A hole or opening 142 is drilled through a wall 144 of the piston to communicate through the hollow interior of the piston with the crankcase 44. The opening 142 is of smaller diameter than the opening 140 and is sized to regulate and meter the flow of gaseous refrigerant therethrough to the opening 140

when it is in registration therewith so as to gradually relieve the pressure in the crankcase to the suction chamber 50. The hole or opening 142 in the piston 60 is so arranged therein that it begins to register with the opening 140 as the piston reaches a point approximately 51 degrees of crank arm travel from bottom dead center and remains in registration therefrom until the piston, that is the crank arm, has moved past dead center approximately 51 degrees. Thus during this period of 102 degrees of crankshaft rotation the openings 140 and 142 are in registration for refrigerant vapor to pass from crankcase to suction chamber to gradually relieve the pressure on the lubricant oil. During the remaining portion of the piston's travel the opening 140 remains covered and closed while communication between crankcase and suction chamber 50 is reopened through the oil return valve 120 which reopens upon the sudden reduction of crankcase pressure by the upward movement of the pistons. It has been found that one set of openings 140 and 142, as described above with piston 60, is adequate to effect the necessary gradual release of crankcase pressure and none need be provided in the piston 62.

During the shut down period of the system, that is, when the compressor has been idle for a considerable length of time, the crankcase begins to fill up with liquid refrigerant and should the pistons be stopped so that they are at the top of the cylinder allowing liquid refrigerant to fill up in the cylinders to the level of the pistons there will occur a hydraulic lock against piston travel. To break or relieve this hydraulic lock there is provided a blow off or check valve 150 to permit the forcing or blowing out the liquid refrigerant from the crankcase into the discharge muffling chamber 52. Extending through the partitional wall 84 from the discharge chamber 52 to crankcase 44 is a threaded bore 152 into which is threadably secured the check valve 150 to project into the chamber 52. The check valve 150 comprises a valve body 154 having an axially directed passageway 156 extended therethrough for communication between crankcase and chamber 52. Formed in the passageway 156 is a valve seat 158 upon which is adapted to seat a ball 160 adapted to close communication through the passageway 156. The ball 160 is held on its seat 158 by a coil spring 162. Provided in the valve body 154 between the valve seat and the passageway's outlet into the chamber 52 are a plurality of openings 164 to form radially extended outlets from the passageway 156 to the chamber 52.

During any period of idleness of the compressor the pressure in the system equalizes so that the pressure in the discharge muffling chamber is substantially equal with the pressure in any other part of system. Upon the initial start of the compressor with the crankcase substantially filled with liquid refrigerant the downward movement or stroke of the pistons will force the liquid refrigerant to open the check valve 150 as the liquid passes upwardly through the passage 156, unseating the ball 160, and passing outwardly into the discharge muffling chamber 52 and to the condenser. Once the crankcase has been relieved of a substantial portion of the liquid refrigerant the ball 160 will reseat by the action of the spring 162. As the piston 60 approaches the end of its initial downward stroke the openings 142 and 144 come into registration to aid in relieving the crankcase pressure to the suction chamber 50. Only when the crankcase pressure is greater than in the discharge chamber 52 will be the check valve 150 open. The valve 150 remains closed during normal cycling operation of the compressor as it is located in the high pressure side of the refrigerating system 20 which is from the compressor's discharge valve 104 to the inlet of the evaporator coil 26, and the low pressure side of the system is from the inlet of the evaporator to the reed valve 96 of the compressor, including the crankcase. The crankcase being normally balanced in pressure with the suction muffling chamber 52 by the alternate operation of the oil return valve 120 and the

registration of opening 142 with 140 through the operation of the piston 60.

Although only a preferred form of the invention has been illustrated, and that form described in detail, it will be apparent to those skilled in the art that various modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. A refrigerating system having a high pressure side, a low pressure side and a compressor for conducting refrigerant from said low pressure side to said high pressure side said compressor comprising a crankcase, a plurality of cylinders in communication with said crankcase, pistons for each of said cylinders and reciprocable therein, a crankshaft in said crankcase having a single crank arm, connecting rods for connecting each of said pistons to said crank arm, said cylinders being arranged relative to said crank arm so that during a phase of each revolution of the crankarm all of said pistons travel at times in the same direction to reduce the volume in the crankcase, a valve means for controlling communication between said low pressure side and crankcase, said valve means being operable to open position when the pressure is higher in said low pressure side than in said crankcase and to closed position when the pressure in said crankcase increases above the pressure in said low pressure side, a second communicating means comprising an opening through a wall of one of said cylinders from said low pressure side registerable with a restricted opening formed in the piston reciprocating in said cylinder leading to said crankcase, said openings being registerable with each other during the period the said piston is in the lower portion of said cylinder adjacent to said crankcase, said openings being arranged to control the flow therethrough to gradually release the pressure from said crankcase to said low pressure side, a second valve means operable to control communication from said crankcase to said high pressure side, and said second valve means operable to open position when the pressure in said crankcase exceeds the pressure in said high pressure side.

2. A refrigerant compressor comprising a casing having a crankcase, cylinders, a discharge muffling chamber, a suction muffling chamber, a crankshaft journaled in said crankcase having a single crank arm, pistons reciprocable in said cylinders and operably connected to said crank arm, said cylinders being arranged in said casing relative to said crank arm so that said crank arm during a phase of each revolution operably travels said pistons at times in the same direction towards said crankcase, and means for communication between said crankcase and said suction muffling chamber comprising a passageway normally open and a passageway normally closed, a valve means in said normally open passageway for closing said passageway when the pressure in said crankcase exceeds the pressure in said suction muffling chamber, and means operable by one of said pistons for opening said normally closed passageway during period said piston is in the lower portion of said cylinder, and said normally closed passageway being arranged with said last mentioned means for restricting the flow therethrough for a gradual equalization of pressure between said crankcase and suction muffling chamber, and a pressure responsive valve to control communication between said crankcase and discharge muffling chamber operable to open position when the pressure within said crankcase exceeds the pressure within said discharge muffling chamber.

3. A refrigerant compressor comprising a casing having a crankcase for the storage of lubricant oil, cylinders, a suction chamber, a discharge chamber, a crankshaft journaled in said crankcase having a single crank arm, pistons reciprocable in said cylinders and operably connected to said crank arm, said cylinders being arranged in said casing relative to said crank arm so that said crank arm during a phase of each revolution operably travels said pistons at times in the same direction downwardly towards said crankcase increasing the pressure on the lubricant oil in said crankcase, and means for communication between said crankcase and said suction chamber arranged for relieving and maintaining pressure on said lubricant oil to prevent foaming action of said lubricant oil comprising a passageway normally open and a passageway normally closed, a valve means in said normally opened passageway for closing said passageway as said pistons increase the pressure on said lubricant, and means operable by one of said pistons for opening said normally closed passageway as said piston nears the end of its downward travel and closing said opening as said piston has traveled a predetermined distance upwardly, and said normally closed passageway being arranged with said last mentioned means for a gradual release of pressure on said lubricant to said suction chamber, a third communicating passageway between said crankcase and discharge chamber, a valve means in said third passageway for controlling communication therethrough and operable to open position to relieve pressure within said crankcase when said first and second passages are closed.

4. A refrigerating system having a high pressure side, a low pressure side and a compressor for conducting refrigerant from said low pressure side to said high pressure side, said compressor having a first chamber for storage of lubricant oil therein and a second chamber in said low pressure side for separation of refrigerant from lubricant oil, said compressor having an operating characteristic of increasing periodically the pressure and alternatively decreasing the pressure in said first chamber, a pressure responsive valve interconnecting said chambers for conducting lubricant oil from said second to said first chamber during the periods the pressure in said second chamber equals or exceeds said first chamber, an operable valve controlling communication between said chambers to be alternatively opened and closed by the operation of said compressor, said compressor opening said valve in the periods when the pressure in said second chamber increases, a valve controlling communication from said first chamber to said high pressure side, said valve being responsive to the hydrostatic pressure in said first chamber when it exceeds the pressure in said high pressure side to open communication therebetween.

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