June 27, 1933. L. L. TORREY 1,916,130

COMPRESSOR

Filed Dec. 29, 1928 3 Sheets-Sheet 1

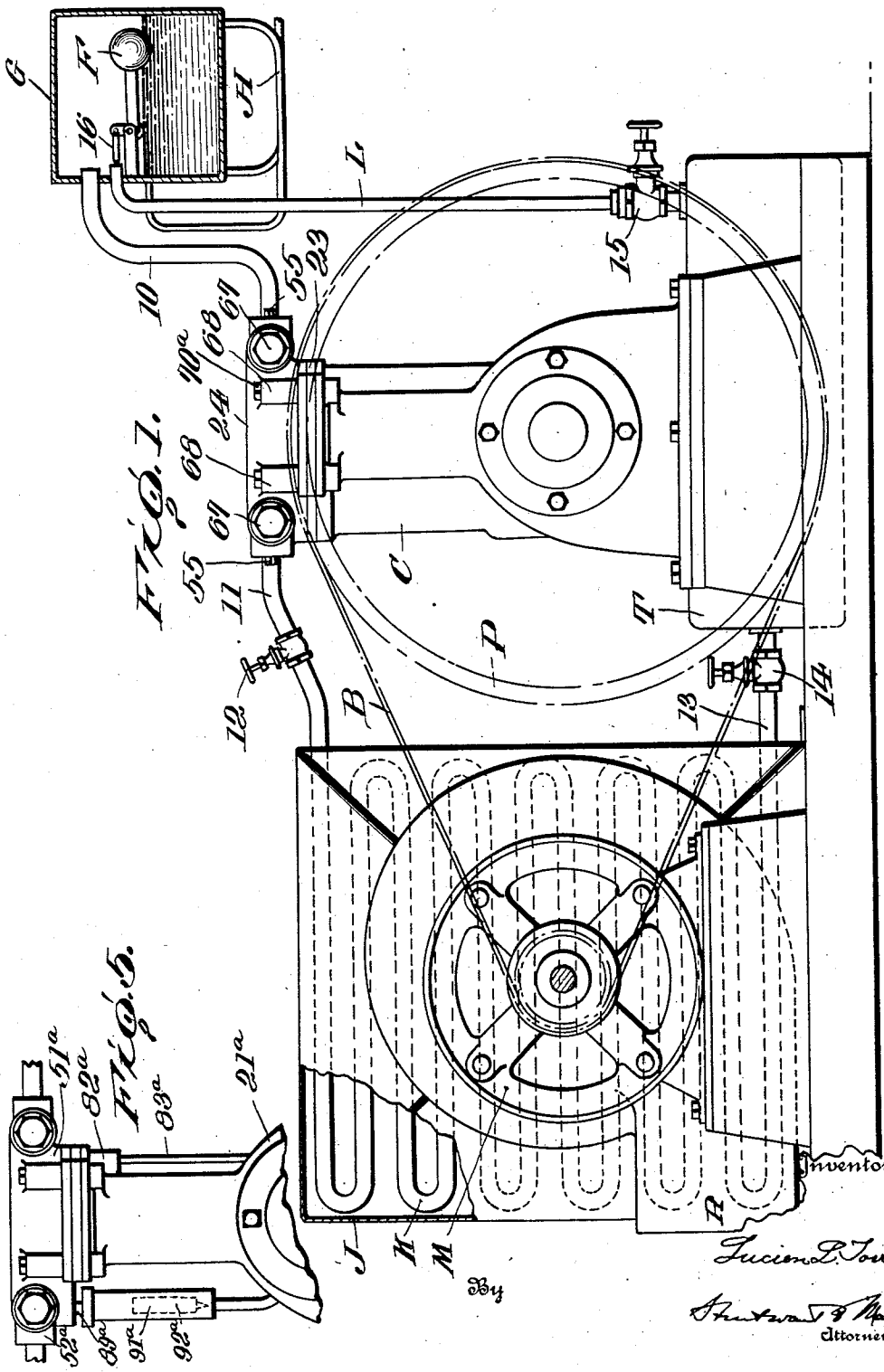


Fig. 1.

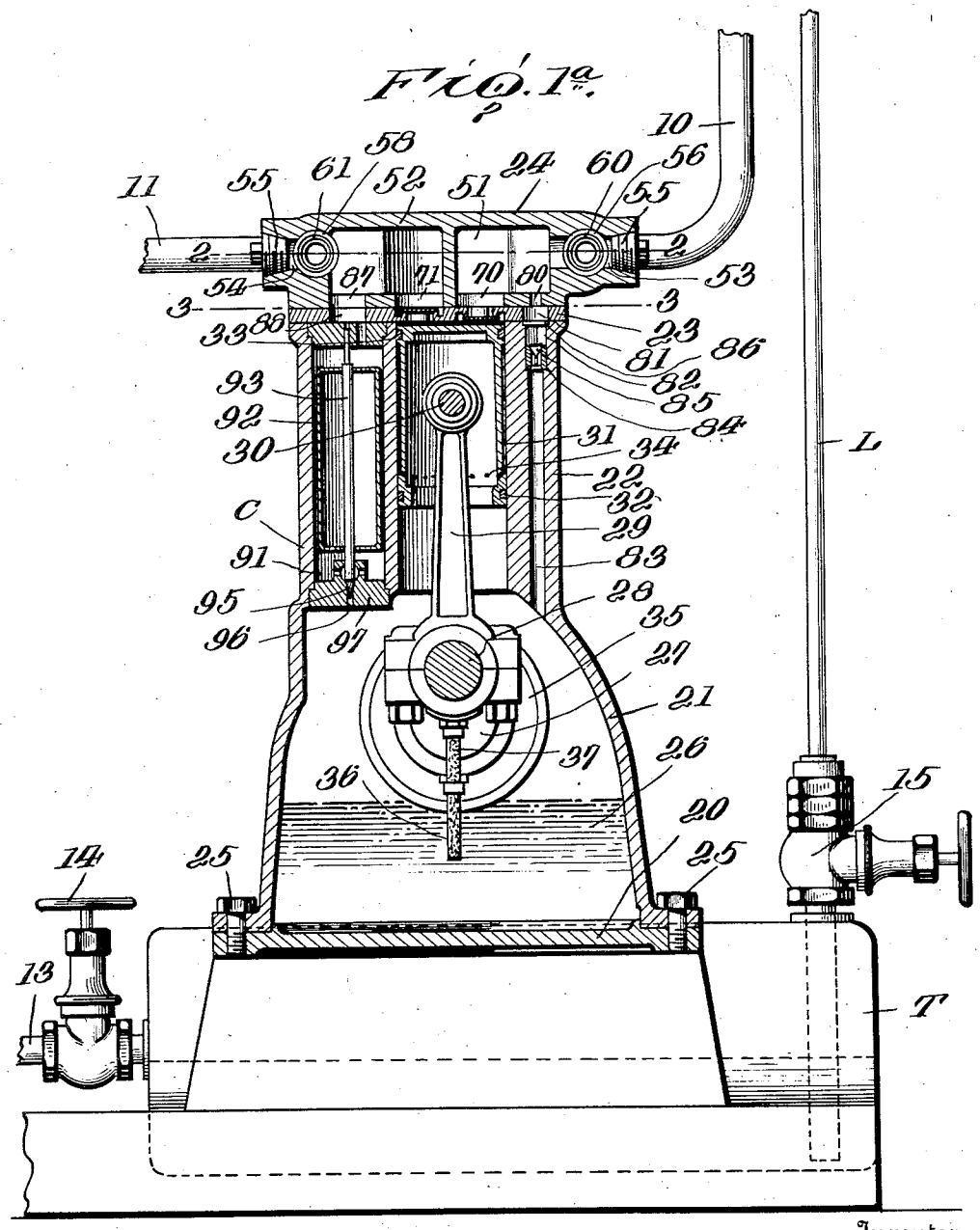
Fig. 5.

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COMPRESSOR

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FIG. 1a.



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COMPRESSOR

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Fig. 2.

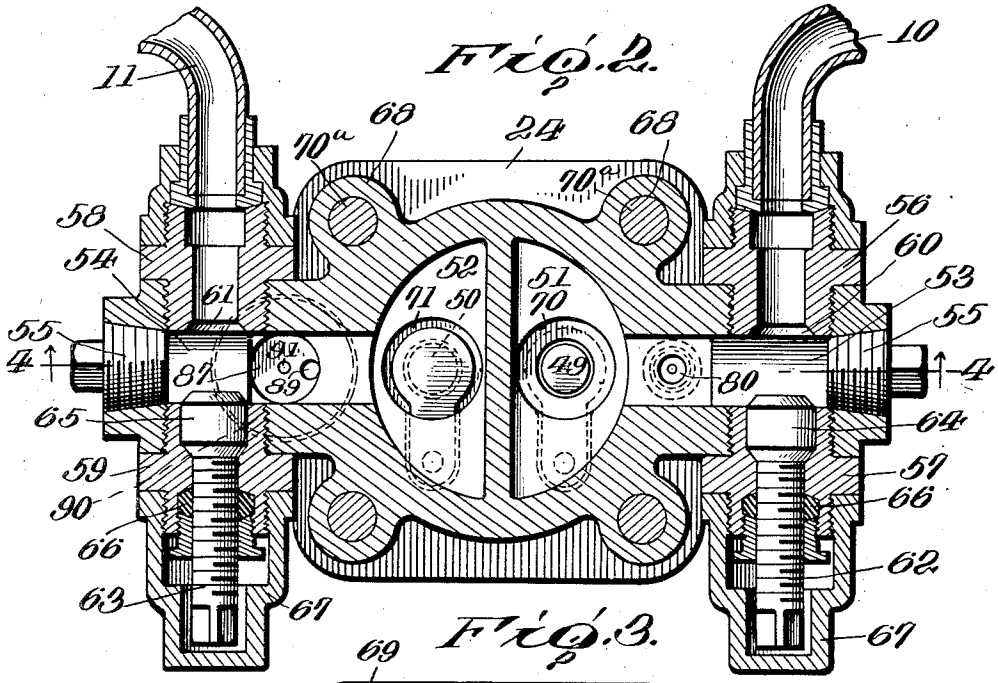


Fig. 3.

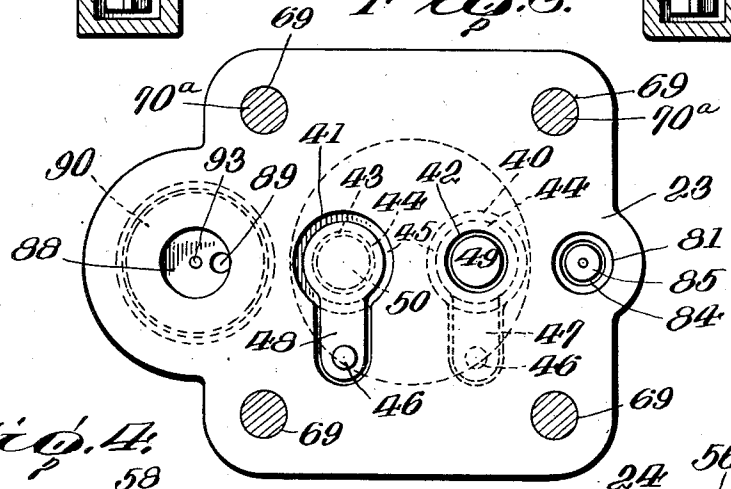
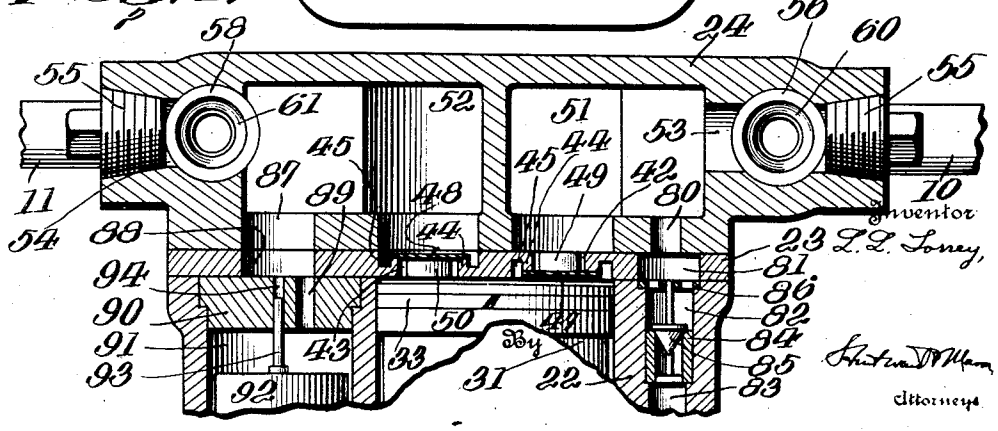


Fig. 4.



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COMPRESSOR

Application filed December 29, 1928. Serial No. 329,105.

This invention relates to improvements in compressors, and more particularly concerns a compressor which is excellently adapted for employment in a refrigerating system.

One of the objects of the invention is to provide a compressor in which a type of valve is employed that is substantially noiseless in operation and permits the operation of the compressor with a minimum clearance and so that the valves open and close automatically and at times when the pressure differences thereon are substantially balanced.

Another object of the invention is to provide means whereby the lubricating oil and the moving parts in the crank case, and especially the inner ends of bearings for the main shaft, shall be kept during operation at a pressure slightly less than atmospheric, so that the crank case gases shall not escape into the atmosphere.

A further feature of the present invention is the provision of a compressor in which the compressor structure may be shut off from the rest of the refrigerating system for the purpose of repairs to the compressor, so that substantially no refrigerant will escape into the atmosphere during repairs.

Still another object of the invention is the provision of the compressor valves in a simple removable unitary structure which may be easily placed and removed, and which is of simple and cheap construction of itself.

A further object is to provide a compressor having an automatically sealed trap in the outlet or high pressure conduit, so that lubricating oil entering this conduit is separated and immediately returned to the oil supply sump.

Another object of the invention is the provision of a compressor especially adapted for a refrigerating system, in which all possible means are provided to prevent intermingling of lubricating oil and refrigerant, to which end only minor contacts are permitted between the oil and the refrigerant, and then only when the latter is in the gaseous stage; and further means are provided for removing the refrigerant from the oil, and the oil from the refrigerant.

With these and other objects in view as will appear in the course of the following specification and claims, illustrative forms of the invention have been represented on the accompanying drawings, in which:

Figure 1 is a side elevation of a compressor of the present type, shown in conjunction with a refrigerating plant.

Fig. 1*a* is a vertical sectional view on a somewhat larger scale, showing the compressor arrangements.

Fig. 2 is a horizontal sectional view on an enlarged scale substantially on line 2—2 of Fig. 1*a*.

Fig. 3 is a plan view of a replaceable valve plate, substantially on line 3—3 of Fig. 1*a*.

Fig. 4 is a vertical sectional view, substantially on line 4—4 of Fig. 2.

Fig. 5 shows a modification of the float valve housing.

The compressor according to the present invention comprises a crank case having an oil supply sump, and a cylinder with a piston operating therein for compressing the returning gaseous refrigerant and delivering it for condensation. On top of the cylinder is mounted a valve plate containing automatically operating reed valves designed for providing a very small clearance within the cylinder, so that the compression of the gas, portion by portion, may be obtained without the necessity of raising large volumes to the requisite pressure, and then permitting the reduction of such pressure on the portion of the gas which has not passed through the outlet valve. Mounted over this valve plate is the cylinder head proper, which is provided with enlarged chambers for equilibrating the pressures at the low and high portion sides. The compressor employs the low pressure chamber, which during the operation of the compressor may be brought to a pressure below atmospheric, as a means of maintaining the crank case and associated parts at a pressure less than atmospheric, whereby the lubricating oil may be freed from refrigerant. The high pressure chamber is employed as an oil trap to separate any oil, and permit it to return by gravity to the crank case, past a pressure sealing float. The cylinder head is provided with shut-off valves

for permitting the repair of the compressor without entire drainage of the system.

In the drawings, in Fig. 1, the compressor is shown as applied in a refrigerating system, in which the compressor C has a driving pulley P operated from an electric motor M by a belt B. The compressor receives the returning gaseous refrigerant under low pressure from a pipe 10 and delivers it under increased pressure through a pipe 11 passing shut-off valve 12 into the condenser coil K where it is cooled and brought to liquid condition so that it flows through the outlet conduit 13 past a shut-off valve 14 into a liquid refrigerant tank T, from which it passes by the liquid refrigerant conduit L having the shut-off valve 15 back to the evaporating coil, which is illustrated as comprising the float chamber G having the float F therein to control a valve 16 in the liquid refrigerant conduit, as well as the suction of evaporating coils H connected to the tank G, in which the liquid refrigerant is evaporated as usual and returns through the pipe 10. The conduits and structures between the compressor including the outlet of the compressor, the pipe 11, the condensing coil K, the delivery conduit 13, the liquid refrigerant tank T, and the liquid refrigerant conduit L, constitute a high pressure portion of the system, while the evaporator chamber G, evaporator coils H, and gas return conduit 10 and the inlet side of the compressor, constitute a low pressure portion of the system. The condenser coil K is preferably surrounded by a jacket J and a fan R is directly driven from the motor M and serves to force air over the condensing coil K whereby to absorb the heat of compression of the high pressure gaseous refrigerant, and cause it to condense to form the liquid refrigerant.

As shown in Fig. 1*a*, the compressor C comprises a bottom plate 20, a body casting having the crank case portion 21 and the cylinder portion 22, a unitary valve plate structure 23, and a cylinder head 24. The bottom plate 20 and the crank case 21 are held together in sealed relationship by the bolts 25, and provides a crank case sump for a supply of lubricating oil 26. The main shaft 27 of the compressor is provided with one or more offset cranks 28 to operate the connecting rods 29 connected to the pins 30 of the respective pistons 31. It will be understood that any desired number of cylinders may be provided, and that the following description applies to each such cylinder. The piston is provided at its top with the bearing and compression ring 32, and at the bottom with the bearing and oil scraper ring 33, while between these rings the body of the piston is cut away to form a chamber to receive and catch lubricating oil, which is permitted to return by suitable apertures 34 to the interior of the piston, and thence to the oil supply sump 26. The main bearings 35 for the main shaft 27 are provided with wick oilers 36 to suck up lubricating oil by capillary attraction from the sump 26 and maintain these bearings under proper lubrication. The bearing on the shaft crank 28 is likewise lubricated by a wick 37 which dips into the oil supply sump 26 during the rotation of the main shaft 27.

The unitary valve plate 23 is provided with two cavities 40, 41 on opposite sides of the plate, and each being of substantially key-hole shape, and provided at the enlarged end with an aperture 42, 43 passing through the plate and serving for the passage of gas to and from the compressor cylinder. An axially directed flange 44 extends around each aperture to form a valve seat, while an annular groove 45 provides a free passage for gas adjacent this seat.

Fixedly secured to this valve plate by clamping screws 46, and respectively located in the key-shaped cavities 40, 41 are the reed valves 47, 48, which respectively serve as the intake and discharge valves of the compressor. These valves are usually made of sheet metal about 1/64th of an inch in thickness, which is tempered and ground down to about one-half of such thickness, whereby to form a light resilient valve having definite plane surfaces to cooperate with the valve seats 44. The discharge valve 48 has fixed thereto a plug member 50 which serves substantially to fill the respective passage 43 through the valve plate, for establishing minimum clearance and uniform operation of the valve, as will be pointed out hereinafter.

The cylinder head 24 is provided with the inlet chamber 51 and the outlet chamber 52 of substantial size, which serve to compensate differences in pressure arising from friction in the pipes 10 and 11 and the parts connected thereto, so that the relative back and head pressures upon the compressor are kept at a low level. The cylinder head 24 is preferably formed of a body casting having the alined inlet passage 53 and outlet passage 54, which are respectively closed at their outer ends by the plugs 55. Threaded sleeves 56, 57, 58 and 59 are screwed into cross passages opening into the passages 53 and 54 (Fig. 2), and of these the sleeves 56 and 58 are respectively provided with means for connecting and sealing the gas return pipe 10 and the compressed gas outlet pipe 11 for communication with the respective inlet and outlet passages 53 and 54. The inner ends of the bushings 56 and 58 are formed as valve seats 60, 61. The bushings 57 and 59 are provided with threaded valve stems 62, 63 passing therethrough, and adapted upon rotation to present their respective heads 64, 65 into sealing relationship with the valve seats 60, 61. Suitable packing means are provided for these valves, including the stem packings 66 and the

safety closing caps 67. The cylinder head 24 and the valve plate 23 are provided with apertures 68, 69 to receive the clamping bolts 70*a* which pass down into the cylinder block 22, and serve to clamp the members together. Thin paper or lead gaskets may be employed to establish the seals between the several members. It will be noted that the intake and exhaust chambers 51, 52 have flat bottoms except for the openings 70, 71 through which the gas passes into and out of the compressor cylinder, so that a very firm seat is provided for the gasket between the cylinder head and valve plate: and correspondingly a large area is provided between the valve plate and the end of the cylinder block, even though the parts are made of small dimensions and close together and exposed to pressure differences of several atmospheres.

The floor of the inlet passage 53 in the cylinder head 24 is provided with a small aperture 80 communicating with an aperture 81 in the valve plate 23, and thence with a cavity 82 in the cylinder block 22, which is continued as a bore hole 83 of lesser diameter, which opens into the crank case chamber 21 of the compressor. A valve seat 84 is secured in the cavity 82 to cooperate with the valve member 85 having its stem guided in a spider plate 86 held in the cavity 82. This valve is a pressure relieving and suction valve for withdrawing gaseous refrigerant from the crank case 21.

The floor of the outlet or exhaust conduit 54 is provided with a hole 87 communicating with a similar hole 88 in the valve plate 23, and thence by a small orifice 89 through a closing plug 90 with an oil collection chamber 91 having a float 92 therein to be supported by the oil collecting in this chamber. This float has a guide stem 93 movable in a passage 94 in the closing plug 90, and is provided on its lower end with a needle valve 95 to be seated in the walls of a passage 96 of a bottom closing plug 97 when the float is in lowered position.

It will be noted that the head of piston 31 closely conforms to the bottom surface of the valve plate 23, and that a clearance of .002 or .003 of an inch may easily be provided in construction, without disadvantage or danger of breakage by reason of the circulation of oil or liquid refrigerant through the cylinder whereby to form a disrupting hammer.

The operation of the compressor in conjunction with a refrigerating system may be described as follows: The gaseous refrigerant returning under low pressure through the conduit 10 is received in the intake passage 53 and intake chamber 51. As the piston 31 moves downward, following the completion of a compression stroke, the pressure within the cylinder drops until it is substantially equal to or a little less than the pressure in the intake chamber 51. The reed valve 47 is then opened, at this balance of pressure, and gas flows downward through the aperture 42, the groove 45 and into the cylinder. The relatively large volume of the chamber 51 prevents wire drawing and assures that the cylinder shall have a substantial volume of gas refrigerant to operate upon.

During the up-stroke of the piston, the pressure in the cylinder rises until it is substantially equal to the low pressure in the intake chamber 51, whereupon the valve 47 closes by its resiliency, at the balance of pressures. Thereafter, the compression in the cylinder rises further in the usual manner, until a balance of pressure is established between that in the cylinder and that in the exhaust chamber 52, and then the exhaust valve 48 is opened, and the gas under high pressure is passed through the aperture 43 and the groove 45 into the chamber 52 whence it flows by the passage 54 to the high pressure gas line 11 and to the condenser in the usual manner, being cooled in the latter and delivered as liquid by pipe 13 into the liquid storage tank T, and then forced under the high pressure of the system by the high pressure liquid line L through the controlling and expansion valve 16 until the tank G is filled to the level determined by the float F. The coils H are constantly filled with liquid refrigerant, and by absorption of heat from the chamber which is being cooled, this liquid refrigerant is gasified and returned by the low pressure gas line 10 to the compressor for a further passage through the cycle.

It will be specifically noted that the head of piston 31 may be brought very close to the bottom surface of the valve plate 23 during compression, and that the very small clearance space is left in the cylinder, and especially that the valve 47 is located but slightly above the lower surface of this plate, while the valve 48 carries the filler member 50 to substantially fill the aperture 43. The flange 44 in each instance is made of substantial internal diameter so that a large area of flow for the gas is provided for a small movement of the respective valve 47 or 48.

Only the thin film of oil remaining on the cylinder walls during the downward stroke of the piston is exposed to the gaseous refrigerant in the compressor, and if any of this oil is carried along during the compression, it immediately collects on the wall of the exhaust chamber 52, and flows downward through the openings 87, 88 and collects in a pool in the chamber 91 until a sufficiency of this has accumulated to raise the float 92, and flow downward by gravity and under the differential of pressure between the high pressure portion of the system and the crank case, into the oil supply sump 26. It will be noted that the oil thus passing is exposed to the same high pressure as the refrigerant gas, and that

it is warmed by the compression, so that it contains substantially no refrigerant absorbed or dissolved therein.

However, if any refrigerant is contained in the oil in the crank case sump 26, this, by its vapor tension, produces an atmosphere so to speak, of the refrigerant gas in the upper part of the crank case and beneath the piston. Such gas passes by the conduit 83 to the lower side of the valve 85, and during the suction of the compressor, the valve 85 will be raised whereby to draw off this gas from the crank case. It will be understood that normally the low pressure gas line 10 is operated by less than atmospheric pressure, in order to secure a proper efficiency in the evaporator G, H: and hence the pressure in the crank case 21 may be maintained at less than atmospheric, so that no gage pressure exists in the crank case during the actual operation of the compressor to force refrigerant vapors out of the main bearings, etc., thus further safeguarding these bearings against the passage of obnoxious refrigerant into the atmosphere of the room, in addition to siphon or like bearing seals.

Further, since the compressor is hotter while running than it is after a period of quiescence, owing to the heat of compression of the gas being delivered to the cylinder walls, and to these walls cooling off upon stoppage of the compressor, it is apparent that the crank case 21 will likewise have its contents cooled during a standstill, so that at such times there is even less tendency for refrigerant to escape from the compressor.

In the event of any disturbances in the system, the several parts may be shut off and disconnected. For example, if the valves or other parts of the compressor should be giving trouble, the valve caps 67 are removed, and valve stem 62 turned until the valve head 64 engages seat 60, and then the compressor is operated a moment or two to clear the chamber 51 and passage 53: and then the valve stem 63 is moved to close valve head 65 upon its seat 61. The conduits 10 and 11 are then each shut off from the atmosphere. The bolts 70 may now be removed, and the valve plate 23 slid out from beneath the cylinder head 24 and replaced by a new one if necessary. It will be noted that no parts interfere with the free sliding of the valve plate 23: and that there is at most only a slight springing of the cylinder head 24 with the pipes 10 and 11 during the removal of this plate and the insertion of a new one with the appropriate gaskets. It will further be noted that by a proper running of the compressor, and the employment of the further valves 12, 14 and 15, any part of the system may be charged with the refrigerant, while a remaining portion is substantially exhausted thereof: so that the parts of the system may be individually disconnected and repaired.

It is not necessary to form the passage 83 and chamber 91 integrally in the cylinder block 22: but these members may be located in separate structures as shown in Fig. 5 of the drawings, in which a top connection from the crank case 21*a* supports a vertical chamber 91*a* containing the float valve 92*a*, and communicating at its upper end by a nipple 89*a* with the outlet chamber 52*a*: while the inlet chamber 51*a* communicates with a valve chamber 82*a* having a valve therein to close the chamber 82*a* with respect to the communicating pipe 83*a* leading downward and opening into the crank case 21*a*.

It is obvious that the invention is not limited to the forms of execution shown, but that it may be modified in many ways and employed in many arts within the scope of the appended claims.

I claim:

1. In a compressor, the combination of a cylinder block, a cylinder head block having intake and exhaust chambers and inlet and outlet conduits extending respectively from said chambers, the mouths of said conduits at said chambers being formed as valve seats, a flat valve block including valves interposed between said cylinder head and cylinder blocks, and valve members mounted in the walls of said cylinder head block and movable across respective portions of the intake and exhaust chambers to establish respective sealing relationship with said valve seats whereby to block communication between said inlet and outlet conduits independently of said valve.

2. In a compressor, a crank case constituting a sump, a cylinder and a piston therein, a cylinder head having inlet and outlet chambers, and valves located between said chambers and said cylinder, the outlet chamber comprising an oil separating trap, and a gravity discharge conduit for separating oil from said outlet chamber and including a collecting chamber, a float in said collecting chamber, and a valve controlled by said float and opened when the said float rises upon the collection of oil in said collecting chamber whereby the oil may be returned to said sump.

3. In a compressor, a cylinder block, a cylinder head block, a flat valve block interposed between said cylinder and cylinder head blocks and means to clamp said blocks together in sealing relationship, said valve blocks having apertures therethrough to provide communication between said cylinder head block and the cylinder, a reed valve to each of said apertures, said reed valves being mounted on opposite sides of said valve block, and a filling plug carried by one of said reed valves to substantially fill the respective aperture whereby to reduce the clearance volume in the cylinder.

4. In a compressor, a cylinder block, a cylinder head block, a cylinder valve block interposed between said cylinder and said cylinder head block, and means to clamp said blocks together, said cylinder head block having inlet and outlet chambers therein, said valve block having apertures for providing communication between said chambers and the cylinder, each of said apertures having an annular groove surrounding the same at opposite sides of said valve block, recesses extending from said annular grooves, and reed valves located in said recesses and adapted to be seated against the internal flanges joining said annular grooves, whereby to seal the respective apertures.

5. In a compressor, a cylinder block, a cylinder head block having inlet and outlet chambers therein, a flat valve block of uniform thickness interposed between said cylinder and said cylinder head blocks, and means to clamp said blocks together in sealing relationship, said valve block comprising a valve plate having apertures therethrough to establish communication between said chambers and said cylinder, said plate being cut away around each aperture and on opposite sides of said plate to provide a valve seat cavity having a lateral extension therefrom, reed valves fitted in said cavities to respectively close the same, and means to hold said valves on said valve plate, said means being located in said extensions.

6. In a compressor for refrigerating purposes, a cylinder having a cylinder head, a piston in said cylinder and a crank shaft to move said piston, a crank case providing means to support said crank shaft and having a closed chamber constituting a sump for lubricating oil, said cylinder head including inlet and outlet chambers, said crank case and cylinder being in communication so that the refrigerant may enter said crank case chamber, and valves to control the admission of gas from said inlet chamber to said cylinder and the discharge of compressed gas from said cylinder to said outlet chamber, said cylinder and cylinder head having a passage extending from the crank case to the inlet chamber, said conduit being enlarged near its upper end and provided with a valve seat, and a gravitationally closed valve in said enlargement, said valve being raised from its seat by and during the suction stroke of the piston whereby gas may be sucked from said crank case chamber into said inlet chamber.

7. In a compressor, a cylinder block, a cylinder head block, a crank case, a valve block interposed between said head and cylinder blocks, means for providing a conduit from the crank case to the valve block, a valve for closing said gas conduit when the pressure in said inlet chamber has greater than a predetermined ratio to the pressure in the crank case, said head block having inlet and outlet chambers and inlet and outlet connections to said chambers, said valve block having cylinder inlet and outlet ports for establishing communication between said conduit and said chambers and a port for establishing communication between said conduit and the inlet chamber, inlet and outlet valves mounted upon said valve block for controlling the said inlet and outlet ports, and clamping means for holding said blocks together whereby the valve block establishes sealed communications between said chambers and the cylinder and conduit.

8. In a compressor, a cylinder block having a flat end, a cylinder head block having a flat face opposite said flat end and inlet and outlet chambers, a flat valve block interposed between said flat end and flat face and having inlet and outlet ports for establishing communication between the cylinder and said inlet and outlet chambers, valves for closing said ports located wholly between the faces of the valve block, inlet and outlet connections to said inlet and outlet chambers, and releasable clamping means for holding said blocks together whereby the valve block may be slid out upon releasing said clamping means and without disconnecting said connections.

9. In a compressor for refrigerating purposes, a cylinder and a piston therein, a cylinder head having inlet and outlet chambers, a crank case providing a sump for lubricant, a gas conduit from said crank case to said inlet chamber, a valve for controlling said conduit and opened by and during the suction stroke of the piston whereby the crank case is maintained under evacuation during operation, a gravity drainage conduit from said outlet chamber to said crank case, and a float-controlled valve for normally closing said conduit and preventing passage of gas from said outlet chamber to said crank case, said gas conduit operating to draw off gas trapped in the oil and to maintain the crank case at low pressure during operation whereby to prevent the escape of refrigerant therefrom.

10. In a compressor for refrigerating purposes, a cylinder and a piston therein, a cylinder head having inlet and outlet chambers, a crank case providing a sump for lubricant, a gas conduit from said crank case to said inlet chamber, a valve for controlling said conduit and opened by and during the suction stroke of the piston whereby the crank case is maintained under evacuation during operation, a flat valve block interposed between said cylinder and cylinder head and having inlet and outlet ports for establishing communication between the cylinder and said inlet and outlet chambers and a gravity discharge port from said outlet chamber, inlet and outlet valves mounted on and located wholly between opposite faces of said valve

block, a gravity drainage conduit from said gravity discharge port to said crank case, a valve and a controlling float therefor located within said conduit below said valve block and operative for normally maintaining said conduit closed, and releasable clamping means for holding said cylinder, head and valve block together, whereby said block may be slid from between said cylinder and head without interference with or by said float and valve.

In testimony whereof I affix my signature.

LUCIEN L. TORREY.