Dec. 24, 1935. W. W. HIGHAM 2,025,240

REFRIGERANT GAS COMPRESSOR

Filed Oct. 20, 1934 3 Sheets-Sheet 1

Fig. 1

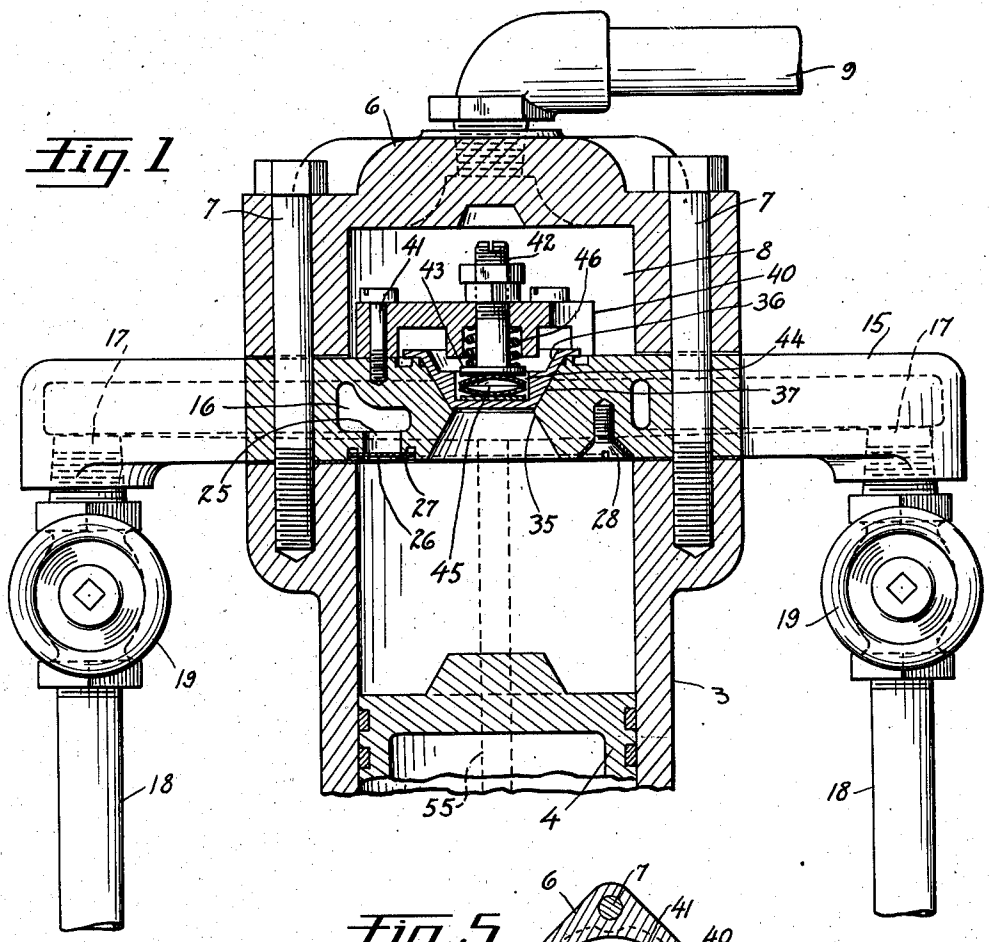
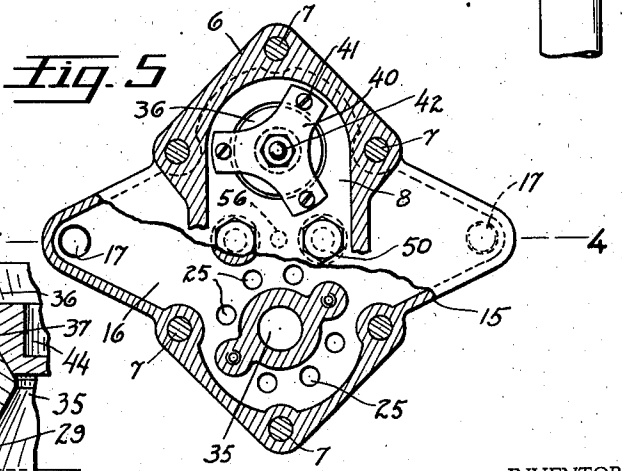


Fig. 5



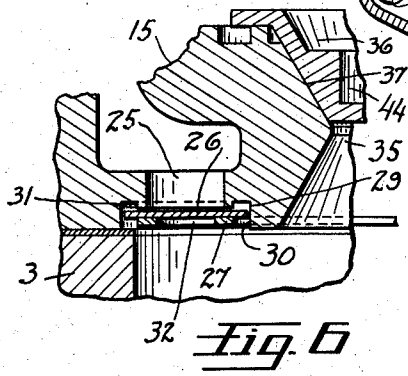


Fig. 6

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REFRIGERANT GAS COMPRESSOR

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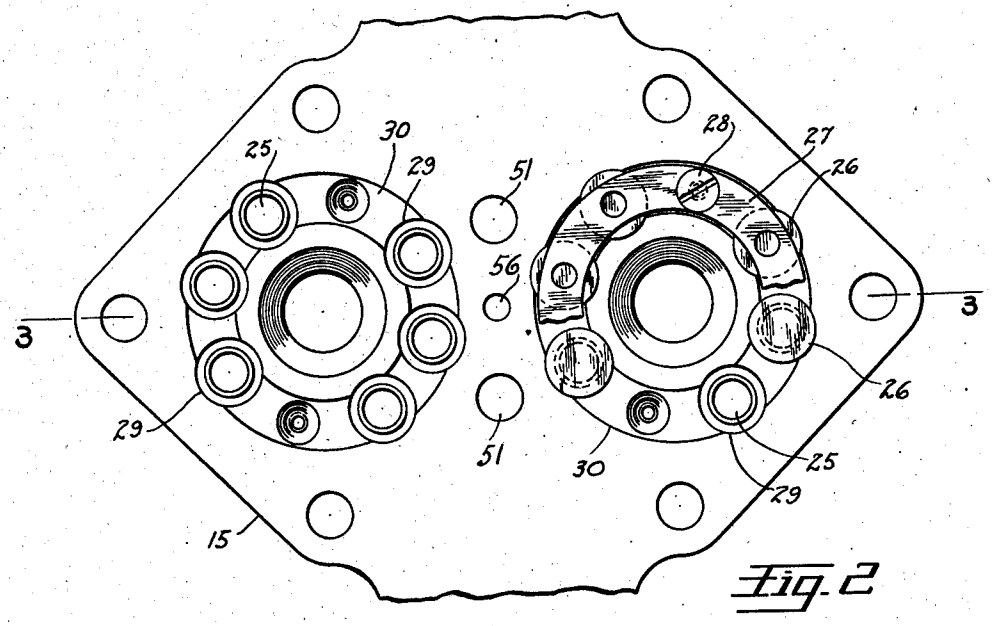

Fig. 2

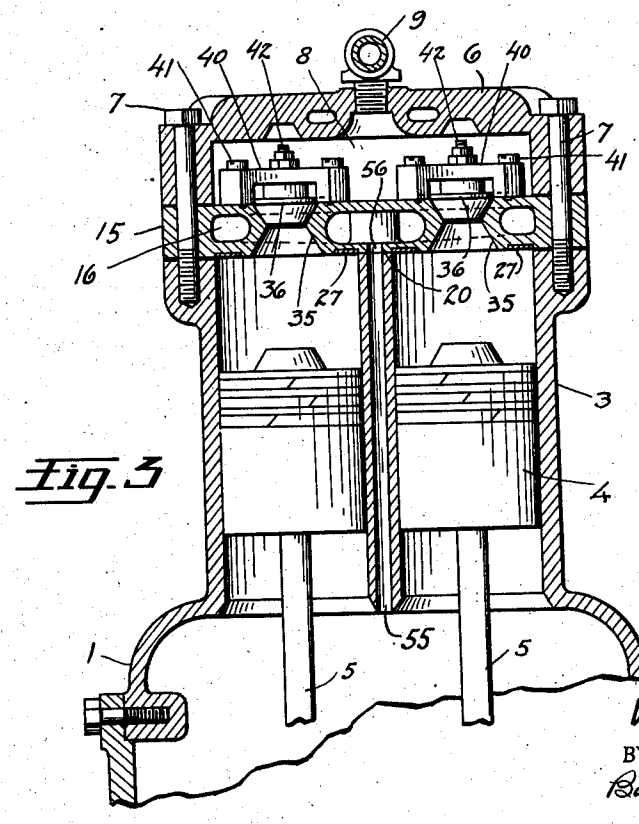

Fig. 3

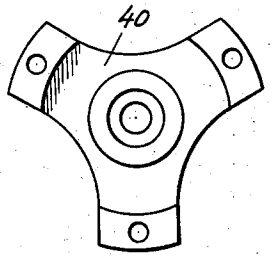

Fig. 8

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REFRIGERANT GAS COMPRESSOR

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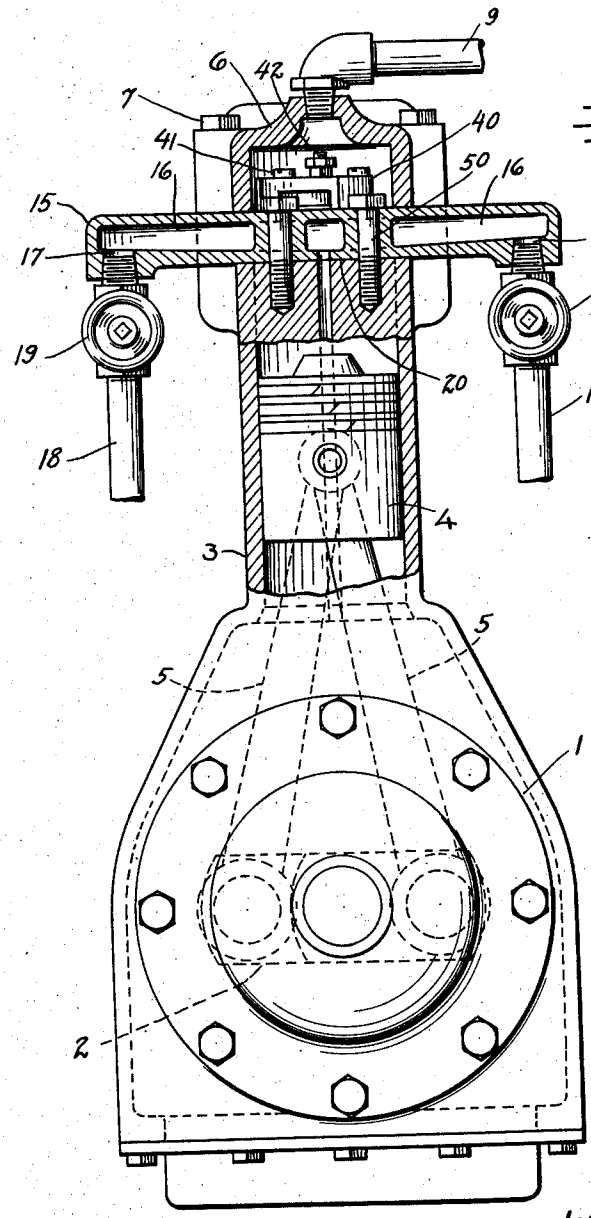

Fig. 4

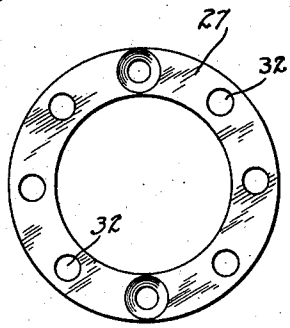

Fig. 7

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UNITED STATES PATENT OFFICE

2,025,240

REFRIGERANT GAS COMPRESSOR

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Application October 20, 1934, Serial No. 749,137

9 Claims. (Cl. 230—231)

This invention relates to refrigerant compressors, and has to do particularly with a valve assembly for the entrance of expanded refrigerant into a compressor and for the discharge of the compressed refrigerant therefrom.

Heretofore it has been largely the practice with compressors of the type employing reciprocating pistons, to draw the expanded refrigerant into the crank case of the compressor, passing the same through a valve in the piston head, then compressing the gases in the cylinder and discharging the same from the cylinder. Such a compressor employs lubricating oil in the crank case, with the result that the refrigerant at times carries slugs of oil through the valve in the piston into the compressing chamber above the piston, and such oil passes through the refrigerant lines. This is undesirable from a number of standpoints, and notably the fact that such slugs of oil are forced through outlet valves which must be constructed to handle such slugs, and resulting in undesirable valve noise. There is always the possibility of the refrigerant mixing with the hot lubricating oil and creating an effervescing of the oil, thus increasing the tendency of the refrigerant to carry the oil with it into the compressing chamber.

This invention provides a valve assembly for use with a compressor of the piston type wherein refrigerant is drawn directly into the compressing chamber, compressed therein and discharged therefrom without passing through the crank case. This structure positively eliminates slugs of oil getting into the refrigerant lines. The invention further contemplates a structure for the draining of any oil which may get into the refrigerant back to the crank case, it being understood, of course, that in the normal operation of such a compressor there may be some oil leakage past the piston and piston rings. Still further, the invention aims to provide a unit valve assembly where, in one assembly, both the intake and discharge valves are included. This assembly is arranged so that the entire assembly may be quickly and easily removed and a new assembly installed, thus materially facilitating repair and reconditioning work, and requiring no tearing down of the compressor as a whole and requiring no access to the crank case.

A compressor constructed in accordance with the invention, due to this valve arrangement, is capable of more universal use in that it will satisfactorily perform its work under varying loads. In other words, a compressor of constant speed and of constant displacement will satisfactorily take care of operations where the loads on the compressor vary. For example, such a compressor may be switched from an ice cream freezing system to a hardening system where there is a large differential in the temperatures maintained. To further exemplify this thought it may be pointed out that with some freezers, for example, the pressure in the refrigerating system may be about 10 pounds, while, for example, in some hardening units the pressure may be about minus 10 inches of mercury. This represents a total difference of about 30 pounds, yet the compressor will satisfactorily perform its function under such varying conditions.

In the accompanying drawings:

Fig. 1 is a sectional view taken through a compressor cylinder illustrating the cylinder structure and some of the valve assembly.

Fig. 2 is a plan view with some parts removed showing what may be termed the under side of the valve plate and illustrating valve structure.

Fig. 3 is a sectional view taken through the cylinder block of a compressor showing the valve plate assembly substantially on line 3—3 of Fig. 2.

Fig. 4 is a view of a compressor showing the cylinder and valve plate in cross section, the section of the valve plate being substantially on line 4—4 of Fig. 5.

Fig. 5 is a detail view partly in section and with parts cut away, illustrating the valve plate structure.

Fig. 6 is an enlarged detail view showing some of the valve plate structure and valve arrangement.

Fig. 7 is a detail view illustrating a valve retaining member.

Fig. 8 is a detail view of a cage structure for a discharge valve.

The compressor, as shown herein, has the usual crank case 1 with a crank therein as shown at 2, designed to be driven by suitable means. The compressor has a cylinder block 3 which has two cylinders, as shown herein, and pistons 4 operate in the cylinders and are connected to the crank shaft by conventional connecting rods 5. The invention is not limited to a compressor with two cylinders, as the valve assembly may be used with a compressor having but a single cylinder. The cylinder head is illustrated at 6 and this may be suitably fastened to the cylinder block by cap screws 7. The cylinder head is fashioned to provide an outlet compartment 8 and connecting into this compartment, as for example through the cylinder head, is an outlet conduit 9 for the compressed refrigerant.

The valve assembly includes a valve plate 15 which may be in the form of a casting, cored out to form a refrigerant return chamber 16. The plate may be shaped as illustrated in Fig. 5, and provided with apertures 17 into which connect refrigerant return pipes 18. These two pipes may be branches of a single return pipe or may each constitute a separate return from the cooling unit or units. A shut-off valve 19 may be provided in each return line of desired. The

valve plate is apertured as shown so that the cap screws 7 may pass therethrough, thus to hold the valve plate securely positioned and sealed between the cylinder block and the cylinder head. Suitable gaskets may be used for this purpose.

In the form shown the valve plate has two complete valve arrangements, each embodying intake and outlet valves, there being a complete valve arrangement for each cylinder. The valve plate is preferably sealed as by means of a gasket against the wall of the cylinder block which divides the cylinders, as illustrated at 20 (Fig. 4).

The inlet valve arrangement advantageously comprises a plurality of circularly arranged ports 25 in the valve plate and connecting into the chamber 16. A floating valve may be provided for each port, and such valves may take the form of light metal discs 26. A holding ring 27 may be positioned over the several discs 26 and secured to the plate by screws 28. The valve body is suitably machined to provide recessed curved walls 29 so that each valve member is held positioned over its port and the valve body may have a circumferential groove 30 in which the valves are located and in which the holding ring 27 is located. The valves 26 fit rather loosely relative to the said curved walls, as illustrated in Fig. 6, for the free passage of refrigerant. A slight clearance is provided so that the valves may shift axially, seating against the valve seat 31 around each port in one extreme position and resting against the holding ring 27 in another extreme position. The holding ring may be provided with an aperture 32 adjacent each valve.

It will be noted that this structure forms a check valve arrangement in that when a suction occurs in the cylinder gases may flow from the chamber 16 through the several valves and into the cylinder above a piston. When compression occurs in the cylinder the valves 26 are caused to seat against the valve seats 31, thus closing the ports and preventing the refrigerant returning to the chamber 16. As will be noted by reference to Fig. 2, such a valve arrangement is provided for each cylinder.

The discharge valve for each cylinder may advantageously be located centrally of the circularly arranged inlet valves. For this purpose the valve plate may have an aperture 35 extending therethrough, there being an aperture for each cylinder. A discharge valve controls each aperture. The discharge valve structure may take the form of a valve member 36 arranged to contact with a valve seat 37. A cage structure 40 may be fastened to the valve plate by cap screws 41. A guide stud 42 may be carried by the cage and provided with a head 43 for guiding the valve 36, the valve being formed with a suitably shaped recess 44 for receiving the head 43. The valve 36 is held normally seated advantageously by two spring structures, one of which is relatively weak to permit of normal valve movement in the discharge of refrigerant, the other of which is stronger and functions to permit the passage of a slug through the valve. The weak spring structure may take the form of spring metal discs 45 acting on the valve and reacting against the head of the stud 42. In normal valve action these spring discs flex to let the valve move from its seat. The stud 42 is preferably acted upon by a stronger spring which may be a coil spring, shown at 46, and if the presence of a slug requires additional movement in the opening of the valve, the spring 46 flexes.

It may further be pointed out that prior to the act of assembling the cylinder head to the cylinder block the valve plate may be attached to the cylinder block by cap screws 50 passing through apertures 51 in the valve plate, with the cap screws threaded into the block.

For the purpose of draining such lubricating oil as may be carried by the refrigerant, due to the leakage of the oil past the piston into the compressing chamber, the cylinder block is provided with a passageway 55 connecting into the crank case and extending through the cylinder block and opening in the top of the block. A port 56 is provided in the valve plate and the same communicates with the passageway 55, thus establishing a connection between the refrigerant return chamber 16 and the crank case. It will be also noted that a structure which is preferable embodies lower walls 57 of the chamber 16 which are inclined with the port 56 at the lowest portion thereof in order to provide for a draining action of lubricant to the port 56 for drainage back into the crank case through the passageway 55.

In the operation of the compressor downward movement of a piston creates a depression in the cylinder and expanded refrigerant is drawn into the cylinder through the inlet ports 25. Upward movement of the piston causes the valves 26 to close the ports 25, compresses the gases and forces the same out through the discharge valve 36. The refrigerant passes into the compartment 8 and then out through the conduit 9. Ordinarily, a relief valve arrangement such as provided by the spring 46 is unnecessary in this structure. However, some lubricating oil, as above mentioned, may leak past the piston ring, and if the same develops into a slug it may freely pass through the discharge valve by functioning of the spring 46. This relief valve arrangement is provided largely as a safety factor to take care of any unusual or unexpected conditions. The expanded refrigerant returns into the chamber 16, and due to the fact that this chamber is connected to the crank case the pressures are equalized. Accordingly, any lubricant which returns with the refrigerant may drain back into the crank case, the draining being facilitated by the inclined walls 57. It will be observed that each cylinder has its own valve assembly including both inlet and discharge valves and accordingly it is within the invention to employ a compressor with but a single cylinder, using one valve assembly. The action of the valve when relieved by the spring 46 for the passage of a slug therethrough creates the objectionable noise, as above alluded to, but with the present arrangement this action of the valve is practically eliminated.

Many times an installation develops an imperfect action, and many times this action is entirely due to inefficient or defective valve action. With the present structure a repair or conditioning job merely requires removal of the head, replacing the old valve plate assembly with a new valve plate assembly and then remounting the head. This is a simple operation which can be quickly and easily done and it requires no tearing down of the compressor as a whole, and requires no access to the crank case.

As above pointed out this structure is capable of functioning efficiently on varying loads even though the compressor be of a constant speed type and of constant displacement. This is facilitated by reason of the fact that the conditions of the returning refrigerant, the temperature and

pressure thereof, may vary, and such variation is not complicated by crank case conditions as would be the case if the refrigerant were drawn through the crank case. Substantially the only variation in the crank case condition resides in the fact that the pressures in the chamber 16 and crank case are balanced, with the result that the pressure in the crank case will vary with that in the chamber 16, but this variation has no substantial effect upon the operation of the compressor.

I claim:

1. In a refrigerant compressor, the combination of a compressor having a cylinder block and a crank case, a cylinder head attachable to the cylinder block and forming a discharge compartment, a valve plate having a chamber for expanded refrigerant, a valve controlled port in the plate connecting the chamber to the cylinder, a valve controlled discharge port in the plate connecting the cylinder with the discharge compartment, and a drain conduit connecting the said chamber with the crank case of a compressor.

2. In a refrigerant compressor, the combination of a compressor having a cylinder block and a crank case, a cylinder head attachable to the cylinder block and forming a discharge compartment, a valve plate having a chamber for expanded refrigerant, a valve controlled port in the plate connecting the chamber to the cylinder, a valve controlled discharge port in the plate connecting the cylinder with the discharge compartment, said plate having an aperture therein connecting into said chamber, and drain conduit extending from said aperture to the crank case for draining lubricating oil to the crank case.

3. In a refrigerant compressor, the combination of a compressor having a cylinder block and a crank case, a cylinder head attachable to the cylinder block and forming a discharge compartment, a valve plate having a chamber for expanded refrigerant, a valve controlled port in the plate connecting the chamber to the cylinder, a valve controlled discharge port in the plate connecting the cylinder with the discharge compartment, said valve plate having an aperture therein connecting into said chamber, a passageway formed in the cylinder block and connecting at one end to the crank case and at its opposite end to said aperture for draining lubricant or the like into the crank case.

4. In a refrigerant compressor, the combination of a compressor having a cylinder block and a crank case, a cylinder head attachable to the cylinder block and forming a discharge compartment, a valve plate having a chamber for expanded refrigerant, a valve controlled port in the plate connecting the chamber to the cylinder, a valve controlled discharge port in the plate connecting the cylinder with the discharge compartment, said plate having a drain aperture therein connecting into the chamber, the lower walls of said chamber being inclined downwardly to said drain aperture to facilitate gravity flow, and a drain conduit associated with said aperture and running into said crank case.

5. In a refrigerant compressor, the combination of a compressor having a cylinder block and a crank case, a cylinder head attachable to the cylinder block and forming a discharge compartment, a valve plate having a chamber for expanded refrigerant, a valve controlled port in the plate connecting the chamber to the cylinder, a valve controlled discharge port in the plate connecting the cylinder with the discharge compartment, said plate having a drain aperture therein connecting into said chamber, and a drain passageway formed in the cylinder block and connecting at one end into the crank case and at its opposite end to said aperture for draining lubricant into the crank case.

6. A valve plate assembly for a refrigerant compressor comprising, a hollow plate for disposition between a cylinder block and cylinder head of a compressor, said hollow plate forming a chamber for expanded refrigerant, a valve controlled port in the wall of the plate connecting into said chamber, a discharge aperture extending through the plate, and valve means mounted on the plate for controlling said discharge aperture.

7. A valve plate assembly for a refrigerant compressor comprising, a hollow plate for disposition between a cylinder block and cylinder head of a compressor, said hollow plate forming a chamber for expanded refrigerant, a plurality of circularly arranged ports in the wall of the plate, a floating disc valve for each port, a holding ring positioned over the several disc valves, a discharge aperture extending through the plate, and valve means mounted upon the plate and controlling the opening and closing of the discharge aperture.

8. In a refrigerant compressor, in combination with a cylinder block having a cylinder with a piston therein, and a cylinder head forming a discharge compartment and which is removably attached to the cylinder block, and which has a discharge aperture; of a hollow valve plate positioned between the cylinder block and cylinder head, said hollow valve plate having an inlet aperture through one of its walls leading into the hollow interior for the passage of expanded refrigerant into the hollow interior of the plate independently of the cylinder block and cylinder head, a valve controlled inlet port in one wall of the hollow valve plate connecting the interior of the hollow head to the cylinder, and a valve controlled outlet port extending through the valve plate and connecting the cylinder and the said discharge compartment formed by the cylinder head.

9. In a refrigerant compressor, in combination with a cylinder block having a cylinder with a piston therein, and a cylinder head forming a discharge compartment, and which is removably attached to the cylinder block, and which has a discharge aperture; of a hollow valve plate positioned between the cylinder block and cylinder head, said hollow valve plate having an inlet aperture through one of its walls leading into the hollow interior for the passage of expanded refrigerant into the hollow interior of the plate entirely independently of the cylinder block and cylinder head, said valve plate having ports in one of its walls connecting the hollow interior of the valve plate to the cylinder for the inlet of gaseous refrigerant to the cylinder, valve means carried entirely by the valve plate and controlling said ports, said valve plate having a discharge port extending entirely through the valve plate which is separated from the hollow interior thereof and which connects the cylinder and discharge compartment, and a discharge valve carried entirely by the valve plate for controlling said discharge port.

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