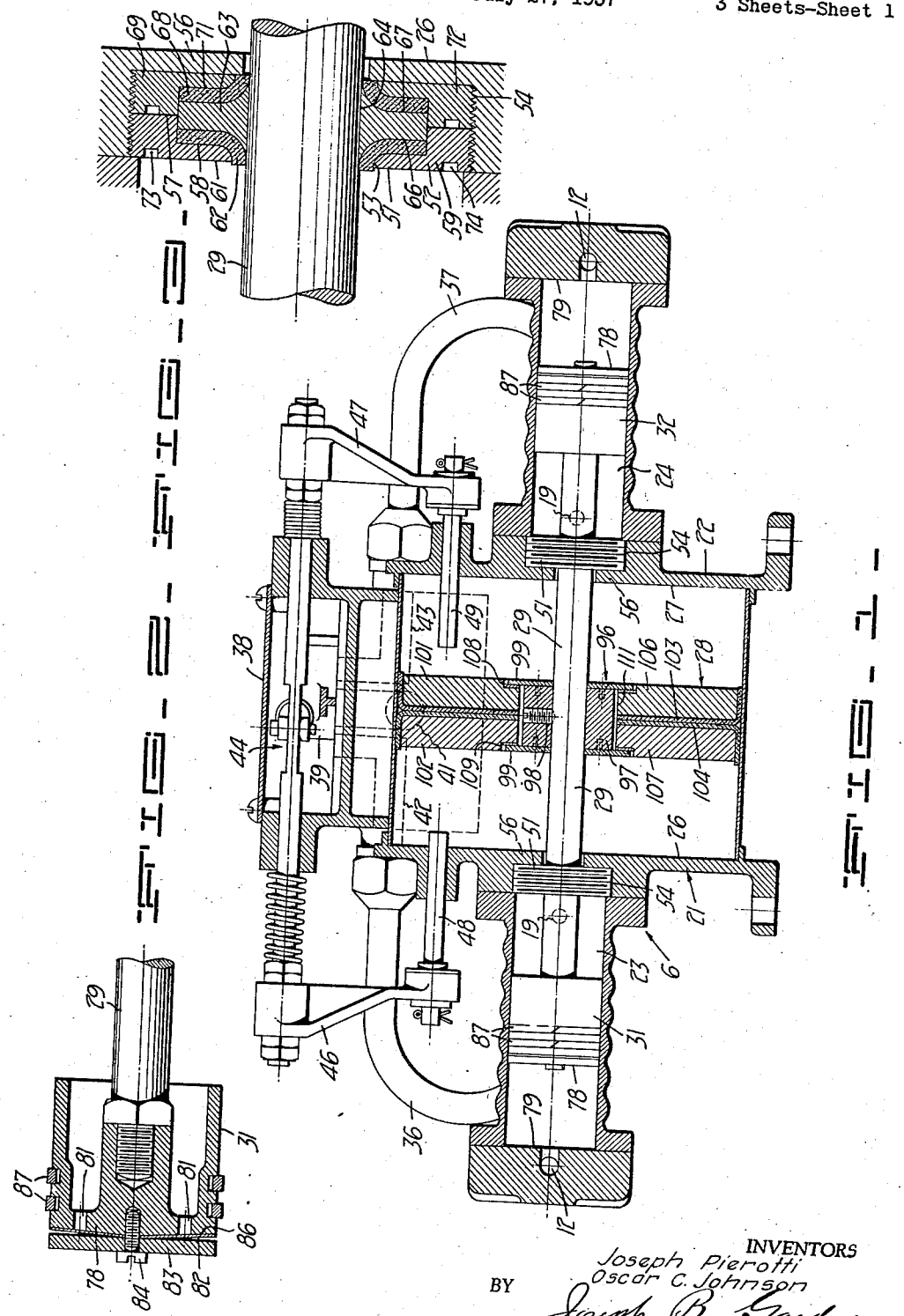
July 23, 1940. J. PIEROTTI ET AL 2,209,090

REFRIGERANT COMPRESSOR

Filed July 27, 1937 3 Sheets-Sheet 1



INVENTORS
Joseph Pierotti
Oscar C. Johnson
BY Joseph B. Gardner
ATTORNEY.

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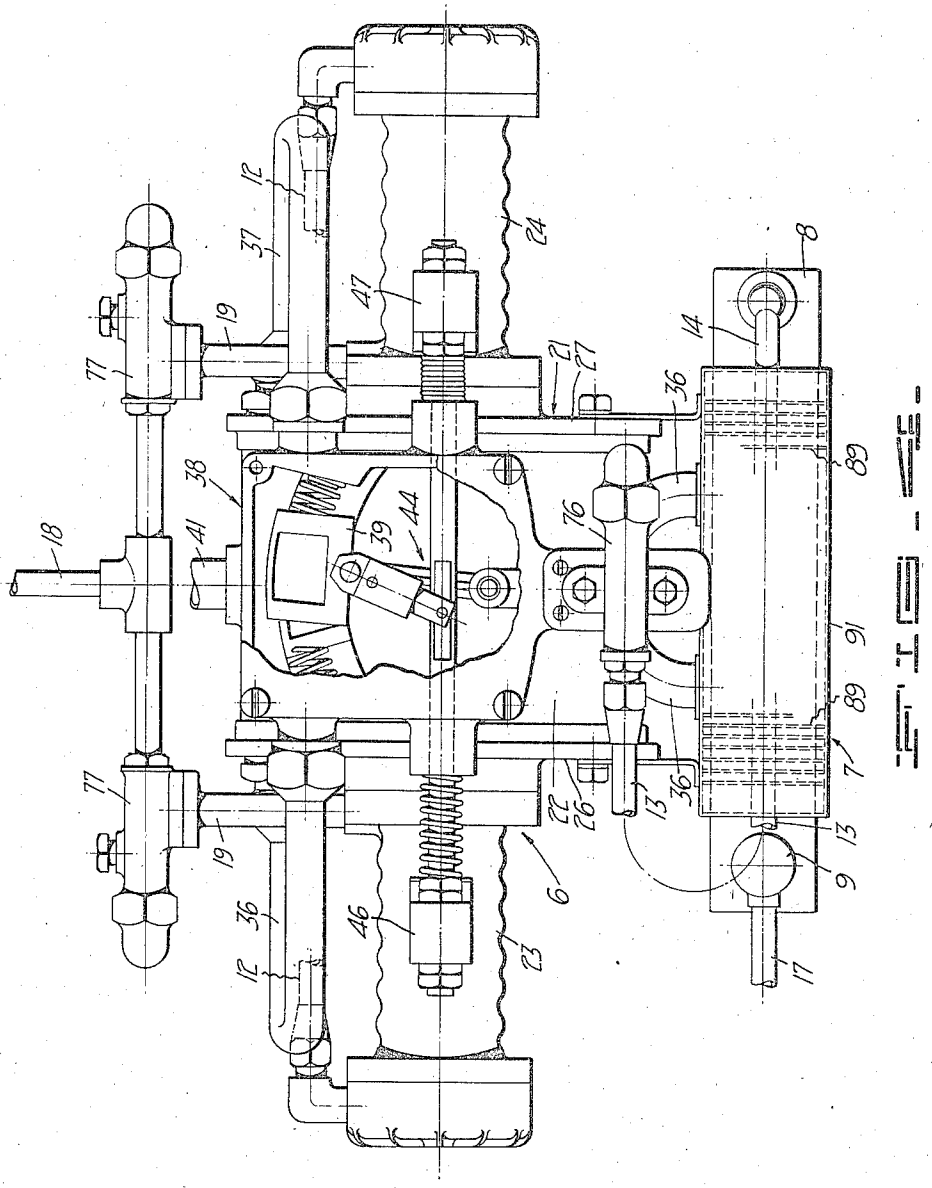


FIG. 5.

INVENTORS
Joseph Pierotti
Oscar C. Johnson

BY Joseph B. Gardner
ATTORNEY.

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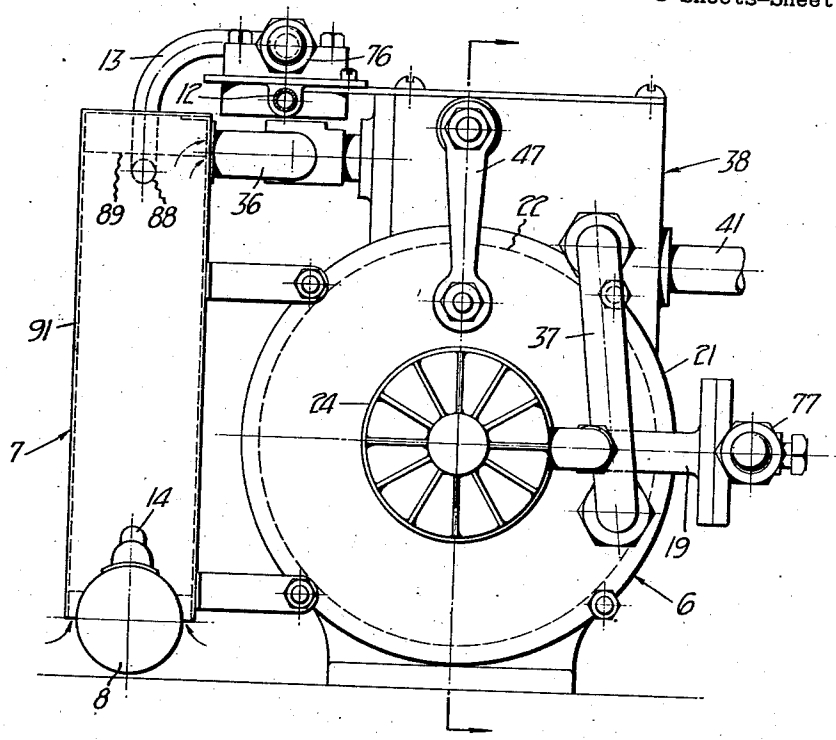


FIG. 5.

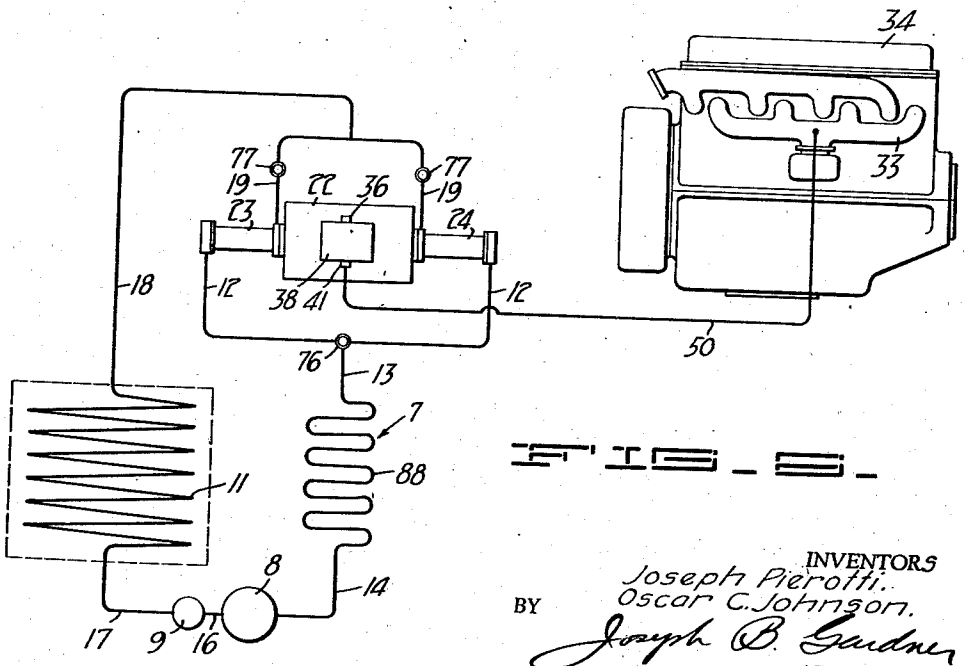


FIG. 6.

INVENTORS
Joseph Pierotti.
Oscar C. Johnson.

BY Joseph B. Gardner

ATTORNEY.

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2,209,090

REFRIGERANT COMPRESSOR

Joseph Pierotti, Oakland, and Oscar C. Johnson, Piedmont, Calif.; said Johnson assignor to said Pierotti

Application July 27, 1937, Serial No. 155,910

6 Claims. (Cl. 230—52)

The invention relates to air cooling and refrigerating systems and particularly of the type adapted for use in automotive vehicles and of the type disclosed in the co-pending application of Joseph Pierotti, Serial Number 97,937, filed August 26, 1936, now abandoned.

In the refrigerating system disclosed in the application aforesaid, the source of power for the refrigerant compressor is in the form of a vacuum motor which is adapted for connection to the intake manifold of an internal combustion engine for energizing by the source of low pressure thereat. Also in the refrigerating system disclosed in said application the refrigerant compressor is unitarily associated with the vacuum motor. Such an organization provides two outstanding advantages. One lies in the utilization of the large quantity of air at a reduced temperature in the vacuum motor for absorbing heat from the compressed refrigerant in the compressor and thereby reducing the amount of heat which must be dissipated in the cooler unit of the refrigerating system. Secondly, the use of a vacuum motor and the simple connection thereof with the engine by means of a conduit makes possible the positioning of the refrigerating unit substantially in any position in the body of the automotive vehicle and completely eliminates the relatively complicated drive mechanism heretofore required with other types of refrigerating systems in automotive vehicles. The present invention provides for substantial improvements in various features of the refrigerating system of the character described in affording improved fluid separation between the vacuum motor and the refrigerant compressor and an improved valve construction in the refrigerant compressor itself.

Another object of the present invention is to provide a further utilization of the air drawn into the vacuum motor for cooling the compressed refrigerant by causing such air to pass in thermal contact with the cooler unit of the refrigerating system.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings:

Figure 1 is a vertical sectional view of the motor and compressor unit forming part of the present refrigerating system.

Figure 2 is an enlarged cross sectional view of one of the compressor pistons.

Figure 3 is an enlarged cross sectional view of one of the packing glands of the compressor unit.

Figure 4 is a plane view of the motor and compressor unit with part of the top cover removed.

Figure 5 is an end view of the motor and compressor unit.

Figure 6 is a diagrammatic representation of the refrigerating system.

The refrigerating system of the present invention and as illustrated in the accompanying drawings, see Figure 6, comprises a compressor and vacuum motor unit 6 and a refrigerant circuit including a refrigerant cooler 7, a refrigerant reservoir 8, an expansion valve 9, and refrigerating coils 11, the different parts of the system being connected by the following conduits: conduits 12 conduct the compressed refrigerant from the compressor to conduit 12 leading to the cooler 7, conduit 14 connects the cooler 7 with the reservoir 8, conduit 16 connects the reservoir with the expansion valve 9, conduit 17 connects the expansion valve with the refrigerating coils 11, and conduit 18 connects the refrigerating coils with intake conduits 19 of the compressor.

The motor and compressor unit 6 is embodied in the unitary casing 21 having a centrally disposed vacuum motor cylinder 22 and aligned and connected cylinders 23 and 24 axially extending from the opposite ends 26 and 27 of the cylinder 22, the cylinders 23 and 24 here being of a reduced diameter from the vacuum motor cylinder 22 so as to enable the production of a greater pressure therein. Mounted for reciprocation in the cylinder 22 is a piston 28 and connected on a common shaft 29 therewith in each of the cylinders 23 and 24 are pistons 31 and 32 which reciprocate with and are driven by the piston 28 through the medium of the shaft 29.

In order to avoid wear on the pistons due to any slight misalignment of the cylinder axes, we prefer to connect the piston 28 to the shaft with a radial slip joint to permit radial movement of the shaft relative to the piston 28 during reciprocation of the pistons and shaft. This is shown by mounting the piston on a spool-like member 96 consisting of a central cylindrical body 97 which is fastened to the shaft by means of a set screw 98 and fastening to the opposite longitudinally spaced radial sides of the body a pair of discs 99 which are somewhat larger in diameter than the body 97 to provide an an-

nular channel about the periphery of the body. The piston 23 is made up of sections 101 and 102 between which are clamped a pair of sheets 103 and 104 of packing material, and the outer sides 106 and 107 of the sections are provided with annular recesses 108 and 109 to permit mounting of a central opening 111 through the sections about the body portion 97 of the spool with the discs 99 extending into the recesses 108 and 109. The diameter of the opening 111 and of the recesses 108 and 109 are somewhat larger than the diameters of the member 97 and the discs 99 so as to permit of a radial movement of the piston relative to the spool member.

Reciprocation of the piston 28 is effected as hereinbefore indicated by a source of reduced pressure which is preferably obtained from the intake manifold 33 of the internal combustion engine 34 of the vehicle although as will be understood other sources of reduced air pressure such as a pump may be used. Such source of reduced pressure and atmospheric pressure are communicated with the cylinder 22 at opposite sides of the piston 28 to produce a pressure differential for displacing the piston. The atmospheric and vacuum connections to the unit are made by way of conduits 36 and 37 connected to their respective sources and to a valve casing 38 provided on the unit and which is operative to alternately connect the vacuum and atmospheric pressures at opposite ends of the cylinder to cause a reciprocation of the piston 28. Any suitable valve mechanism appropriately timed in its operation to the movement of the piston 28 may be used. As here shown a sliding inverted cage type valve 39 is used to alternately communicate the vacuum passage 41 with passages 42 and 43 leading to the ends of the cylinder 22 and while connecting one of said passages to said vacuum passage leaving the other passage open to the atmosphere in the valve casing communicated thereto by the conduit 36. Operation of the slide valve 39 is here effected by a toggle mechanism 44 actuated by sliding arms 46 and 47 having portions 48 and 49 extended into the cylinder 22 through the opposite ends 26 and 27 thereof and engaged and displaced by the piston 28 upon movement thereof to the opposite ends of its stroke.

The operation of the motor unit in the manner described causes the passage of a relatively large quantity of air from the atmosphere through the valve mechanism and into the motor cylinder and then into the intake manifold of the engine. As will be understood, the air is subject to a substantial drop in pressure in the vacuum motor unit which cools the air and which, coupled with the relatively large volume of air drawn through the motor unit in thermal contact with the casing 21, enables a material absorption of heat by the air from the refrigerant cylinders 23 and 24. Also the operation of the unit from the source of vacuum at the intake manifold of the engine enables the necessary power for the plant to be communicated through a simple conduit 50 whereby the customary use of the drive means, pulleys, gears, and shafts, and the like heretofore associated with an automotive refrigerating system, is entirely avoided. Then, too, since the conduit 50 may be as long and flexible as desired, the motor compressor unit 6 may be positioned at substantially any desired portion of the vehicle without regard to the availability of a driving connection with the vehicle motor as has been heretofore necessary.

As an important feature of the present invention we provide an improved packing means 51 at the opposite ends 26 and 27 of the cylinder 22 for separating the air in this chamber from the refrigerant in the cylinders 23 and 24. As here illustrated, this packing means comprises a ring member 52 having a central opening 53 surrounding the shaft 29 and threaded into a socket 54 in the end walls 26 and 27 of the cylinder 22 against an inner shoulder or side 56 of the socket. The member is formed over its outer side 57 with an annular recess 58 extending from adjacent the outer peripheral portion 59 to the opening 53 and is beveled adjacent the opening towards the opposite side 61 of the member. Mounted in the recess 58 is a disc 62 of flexible, oil resistant material such as specially prepared rubber compounds and the like and which is held in closely engaged position against the base of the recess and extends through the opening 53 into a surrounding and sealing relation to the shaft 29 by means of a backing or supporting plate 63 which is also mounted on the shaft and fitted into the recess 58 and is widened or flared adjacent a central opening 64 therein and at the opposite sides 66 and 67 in substantial conformity with the bevel of the recess so as to hold the disc 62 snugly fitted against the shaft 29 and in a substantially parallel relation therewith at the contact of the disc with the shaft. A second disc 68 of a flexible, oil resistant material is mounted against the opposite side 67 of the supporting plate 63 and is held thereagainst and also against the shaft 29 by means of a second ring member 69 which is formed complementary to the member 52 and is threaded into the casing socket 54 with the recess 71 therein fitted over the disc 68 and a part of the periphery of the plate 63 and with the peripheral portion 72 thereof abutting the complementary peripheral portion 59 of the member 52. If desired, wrench openings 73 and 74 may be provided in the exposed sides of the ring members for threading the latter into and out of the sockets 54. An important feature of the packing means is the provision for supporting the flexible discs 62 and 68 with the central portions of such discs pressed firmly against the shaft and extending into substantially parallel relation with the shaft so as to insure the sealing of the motor and compressor cylinders from each other without undue friction on the shaft 29.

Each of the compressor units 23 and 24 is provided with refrigerant intake and discharge passages 12 and 19 respectively adjacent the outer and inner ends of the cylinders and check valves 76 and 77 are provided at the joinder of the conduits 12 and 13 for limiting the passage of refrigerant through the discharge line in a direction away from the outer ends of the cylinders and at the joinder of the conduits 18 and 19 for restricting the refrigerant flow through such conduits to a direction to the inner ends of the cylinders. Thus on movement of one of the pistons 31 or 32 in its respective cylinder towards the outer end thereof, refrigerant is compressed between the head 78 of the piston and the outer end 79 of the cylinders while refrigerant is drawn into the inner end of the cylinder by the piston and the packing means 51. In the course of such movement both of the valves 76 and 77 are open. On the return movement of the piston both of the valves 76 and 77 close due to the reversal of pressure and passage of the refrigerant to the outer end of the cylinder is afforded through

openings 81 formed in the head 78 of the piston. These openings are covered by a flexible diaphragm 82 which is held by a retaining washer 83 secured to the piston by a screw 84 and is energized by the pressure differential at the opposite sides of the piston to cover and uncover the openings 81. Preferably the diaphragm 82 is in the form of a thin metal disc of conical form so as to normally cause the latter to lie in spaced relation from the openings 81. However on movement of the piston towards the outer end 79 of the cylinder and the building up of pressure at the head of the cylinder the diaphragm 82 will snap into a position against the surface 86 and seal off the openings 81 to thereby afford a compression of the refrigerant fluid contained between the piston and the outer end of the cylinder. Preferably each of the pistons is provided with a plurality of piston rings 87 for sealing the piston in the cylinder.

As another important feature of the present invention the air drawn into the vacuum motor during the operation of the unit is caused to pass in thermal contact over the cooler 7 so as to absorb heat from the compressed refrigerant therein. As here shown the cooler is in the form of a plurality of coils 88 which are wound in a sinuous manner and provided with radiating fins 89 and enclosed within a casing 91, the coil and casing assembly being mounted directly over the refrigerant reservoir 8 and the lower end of the casing being open so as to draw the air first over the reservoir casing and then through the casing in heat transfer relation with the coils and fins. The air is withdrawn from the top of the casing by means of the atmospheric air intake conduit 36 of the vacuum motor.

We claim:

1. In a refrigerating system of the character described an integral motor and compression unit comprising, a casing providing a plurality of aligned and connected cylinders, pistons mounted for reciprocation in said cylinders, a shaft connected to said pistons for simultaneous movement thereof, packing means surrounding said shaft and separating said cylinders and comprising, a ring surrounding said shaft and supported by said casing and provided with an annular recess extending to said shaft, a disc of flexible material mounted over said shaft and in said recess, a supporting plate surrounding said shaft and extending into said recess to hold said disc therein, a second disc of flexible material surrounding said shaft and mounted against said plate, and a second ring member surrounding said shaft and supported by said casing in abutting relation against said last named disc, means for alternately connecting the opposite ends of one of said cylinders with a source of reduced pressure and the atmosphere respectively to produce an oscillation of said pistons, and means for charging and discharging said other cylinder with a refrigerant fluid.

2. In a refrigerating system of the character described an integral motor and compression unit comprising, a casing providing a plurality of aligned and connected cylinders, pistons mounted for reciprocation in said cylinders, a shaft connected to said pistons for simultaneous movement thereof, packing means surrounding said shaft and separating said cylinders and comprising, a ring having a central opening surrounding said shaft and threaded in said casing between said cylinders and being provided on one side thereof with an annular recess extending from adjacent the outer periphery thereof to said opening and being beveled adjacent said opening towards the opposite side of said member, a disc of flexible material mounted in said recess and extending into said opening in surrounding and sealing relation to said shaft and in substantially parallel relation to said shaft, a backing plate having a central opening mounted over said shaft and fitted into said recess against said disc and being flared outwardly adjacent said opening on the opposite sides thereof in conformity with the beveled recess portion, a disc of flexible material having a central opening mounted over said shaft and against the opposite side of said plate, and a second ring member provided with a central opening surrounding said shaft and being threaded into said casing and having an annular recess in one side thereof fitted over said plate and second named disc and being beveled into said opening to conform to the flare of said plate and to surround and support said second disc against said shaft, means for alternately connecting the opposite ends of one of said cylinders with a source of reduced pressure and the atmosphere respectively to produce an oscillation of said pistons, and means for charging and discharging said other cylinder with a refrigerant fluid.

3. In a refrigerating system of the character described, a refrigerant compressor comprising, a casing providing a cylinder and having refrigerant inlet and discharge passages adjacent the opposite ends of said cylinder, a piston reciprocally mounted in said cylinder, a check valve in said discharge passage limiting the refrigerant flow therein to a direction away from said cylinder, a check valve in said inlet passage limiting the refrigerant flow therethrough in a direction to said cylinder, said piston being provided with passage means through the head thereof for connecting said cylinder at opposite sides of said piston, and a pressure responsive valve mounted in said passage means and flat conical diaphragm of thin resilient material fastened at its center to said piston generally across said passage means and being operative when subjected to opposite pressure differentials caused by movement of said piston towards and away from said discharge passage to spring to positions closing and opening said passage means respectively.

4. In a refrigerating system of the character described, a refrigerant compressor comprising, a casing provided with a cylinder having inlet and discharge passages opening through adjacent the opposite ends of the cylinder, check valves mounted in said passages for restricting the flow therein to and from said cylinder respectively, a piston reciprocally mounted in said cylinder and having a flat conical head portion and an opening through said head portion for communicating the cylinder portions at opposite sides of said piston, a rigid disc fastened to the center of the head of said piston, a flat conical diaphragm mounted between said disc and piston head and covering said opening and being responsive to the pressure differential at the opposite sides of said piston to close said opening upon movement of said piston in the direction of said discharge passage and to move against said disc to uncover said opening upon movement of said piston in the direction of said inlet passage.

5. In a refrigerating system of the character described, an integral motor and compressor unit comprising, a casing providing a central cylinder and aligned side cylinders connected therewith, pistons mounted for reciprocation in said

cylinders, a shaft connected to said pistons for simultaneous movement thereof, slip connection means between said shaft and piston in said central cylinder permitting small transverse movement of the piston relative to the shaft, valve means for alternately connecting the opposite ends of the central cylinder to a source of reduced pressure and the atmosphere respectively to produce an oscillation of the piston therein and of said other pistons, and valve means associated with said other cylinders for entering a refrigerant fluid into said cylinder for compression and discharge.

6. In a refrigerating system of the character described, an integral motor and compressor unit comprising, a casing providing a central cylinder and aligned side cylinders connected therewith, pistons mounted for reciprocation in said side cylinders, a shaft connected to said pistons for simultaneous movement thereof, packing means surrounding said shaft at opposite ends of said central cylinder and separating the latter from said side cylinders, a piston in said central cylinder adapted to move said shaft, means on said shaft including members extending radially from said shaft to opposite sides of said central cylinder piston to transmit power from said piston to said shaft, said central cylinder piston having sliding engagement with said means whereby small motion of said central cylinder piston is allowed transversely with respect to said shaft, valve means for alternately connecting the opposite ends of the central cylinder to a source of reduced pressure and the atmosphere respectively to produce an oscillation of the piston therein and of said side pistons, and valve means for entering a refrigerant fluid into said cylinders for compression and discharge.

JOSEPH PIEROTTI.
OSCAR C. JOHNSON.