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COMPRESSOR UNLOADER

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Fig.1.

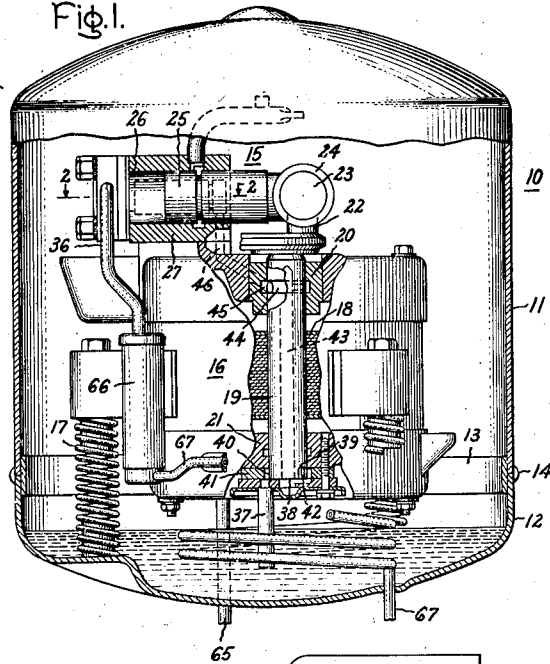
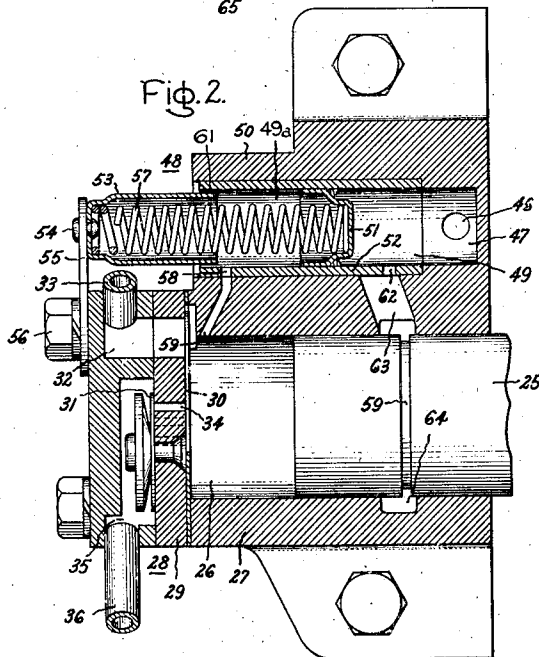


Fig. 2.



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COMPRESSOR UNLOADER

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7 Claims. (Cl. 230—24)

My invention relates to refrigerating machines and more particularly to unloading mechanisms for refrigerant compressors.

Refrigerating machines of the compression type include a compressor for compressing a gaseous refrigerant, the compressor being driven by an electric motor or the like. It is desirable to provide some means for unloading the compressor during the starting period of the driving motor in order that the motor may be subjected only to a light starting load and hence draw a relatively low starting current. It is also desirable that the unloading means should be so arranged as to unload the compressor during the period following cutting off of electric current to the motor when the compressor is coasting to a stop. It is still further desirable to provide an arrangement in which the compressor is unloaded when, for any reason, the supply of lubricant to the compressor is inadequate.

It is an object of my invention to provide a new and improved unloading mechanism for refrigerant compressors or the like.

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

For a better understanding of my invention, reference may be had to the accompanying drawing in which Fig. 1 is a side elevation partly in section illustrating a casing enclosing a motor driven compressor and Fig. 2 is a partial sectional view of the valve assembly and unloader mechanism incorporated in the unit of Fig. 1.

Referring to the drawing, in Fig. 1 there is provided a refrigerating machine having a hermetically sealed casing 10 of any suitable construction. There is illustrated an upper casing section 11 and a lower casing section 12, the adjacent edges of these sections being welded together over a reinforcing ring 13 as indicated by the numeral 14. The casing sections are preferably made of steel and mounted in any suitable position with respect to a refrigerator cabinet, not shown. A refrigerant compressor 15 and an electric driving motor 16 therefor are suitably supported within the hermetically sealed casing 10 as by means of a plurality of suitably secured vertical helical springs 17. The driving motor 16 is provided with a rotor 18 which is mounted on a hollow, vertical shaft 19 within a stator. The shaft 19 is supported in suitable upper and lower bearings 20 and 21, respectively.

The upper end of the shaft is provided with a crank arm 22. The rotary movement of the crank causes a reciprocatory movement of a slide member 23 in the crosshead 24, and a reciprocatory movement of the compressor piston 25 in the main cylinder bore 26 of the compressor cylinder 27 in a well-known manner.

One end of the bore 26 of the compression cylinder 27 is closed by a suitable valve assembly 28 including, for example, a valve plate 29 upon which are suitably mounted an intake valve 30 and an exhaust valve 31. The intake valve 30 is arranged to close an intake port 32 communicating with an intake conduit 33. The exhaust valve 31 is suitably constructed and arranged for closing a plurality of exhaust openings 34 communicating between an exhaust chamber 35 in the muffler box 28 and the interior or bore 26 of the cylinder 27. An exhaust 36 communicates with the exhaust chamber 35. The valve assembly herein illustrated and described is exemplary and any suitable desired means may be substituted.

I have provided unloading means for controlling the load and unloading of the compressor which is operated by lubricant circulating in a circuit including the contacting and moving surfaces of various compressor and motor parts and a lubricant reservoir contained within the hermetically sealed casing 10. In the illustrative arrangement shown, when the motor is in operation lubricant is drawn upwardly through a conduit 37 by a lubricant pump 38 which is driven by the shaft 19 of the motor. The pump is of the rotary type and includes a pair of oppositely extending blades 39 which are slidably mounted in suitable slots formed in the lower end of the shaft. The lower end of the shaft and the blades rotate in a chamber formed by a cylindrical bore 40 in a casing plate 41, the center of the bore being eccentric with respect to the center of the shaft. As the blades rotate in the chamber 40 lubricant is drawn into the chamber through the conduit 37 and expelled under pressure from the chamber through an outlet opening 42 and thence upwardly through the central axially extending passage 43 formed in the shaft 19 of the motor 16. A portion of the lubricant passing upwardly through the passage may be utilized for lubricating the upper and lower bearings 20 and 21 although details are not shown completely. A horizontal passage 44 communicating with the upper portion of the passage 43 communicates with an annular groove 45 formed in the upper bearing. A portion of the lubricant under pres-

sure in the passage 43 passes upwardly from the chamber 45 through a passage 46 to a chamber 47 disposed at one end of the unloader 48 and which opens into the unloader cylinder bore 49.

In the illustrative form of my invention, the compressor cylinder 27 and the unloader cylinder 50 are made as an integral structure, the axes of the bores 26 and 49, respectively, of the cylinders, being arranged in substantially parallel relationship. The unloader 48 includes an open-ended, preferably cylindrical, sleeve 52, and a generally cup-shaped partition member or means 51 transversely disposed with respect to the sleeve, and the member and sleeve being secured together in some suitable manner, as by welding, to form an open ended piston, the open end being directed toward the open end of the bore 49. The unloader 48 also comprises a second generally cup-shaped member 53 which is secured as by means of a rivet 54 to a bracket or arm 55, the latter being suitably secured as to the muffler box or cylinder head as by means of suitably threaded fastening means 56. The cup-like members 51 and 53 are biased apart as by a compression spring 57, the spring normally biasing the unloader mechanism to the unloading position. In this position an aperture 58 in the wall of the sleeve 52 is aligned with an opening 59 extending between the cylinders 27 and 50 so that in the unloaded position of the unloading mechanism there is provided communicating means, as a passage, between the high compression end of the cylinder bore 26 and the open end of the sleeve 52 in one predetermined position of the piston. The cup-like member 53 is constructed and arranged with its side walls in spaced apart relation with respect to the sleeve 52 to provide a suitably proportioned opening 61 therebetween. Thus, the open end of the unloader piston provides communication between the interior of the casing 10 exteriorly of the compressor and the high side of the compressor mechanism. The unloaded position of the mechanism is illustrated in Fig. 2.

In operation, gaseous refrigerant is drawn through a conduit 65 and discharged into the casing 10. Gas is drawn in the compressor through the conduit 33, compressed and discharged through the conduit 36, exhaust muffler 66 and conduit 67 to a suitable condenser (not shown).

When the compressor starts up, oil is pumped to the bore 49 by the lubricant pump 38 and passes therefrom through a sharp-edged orifice 62 in the sleeve 52 to a passage 63 communicating with the cylinder bore 26. The lubricant passing through the matching openings 62 and 63 flows into an annular groove 64 disposed in the surface of the cylinder bore and an annular groove 59 in the surface of the piston for lubricating the piston. The pressure of the lubricant supplied to the unloader 48 varies directly as the speed of the lubricant pump and hence as the speed of the motor 16, and the amount of lubricant which is diverted from the bore 49 through the orifice 62 varies as the square root of the pressure. The area of the orifice is preferably proportioned so that it will divert all of the lubricant supplied to the unloader until the motor 16 reaches a predetermined speed, as about sixty per cent full running speed. After the motor 16 reaches such predetermined speed the lubricant in excess of the amount which may be diverted through the orifice is accumulated in the bore 49 and is effective to cause the piston 51 to move outwardly in the cylinder bore.

Therefore, the sleeve 52 is also moved outwardly and when the oil pressure builds up sufficiently the openings or apertures 58 and 59 will be moved with respect to each other to such an extent that the passage communicating with the cylinder bore 26 is closed and the compressor is then in condition to compress the refrigerant or other working fluid and the motor 16 will be loaded.

When the electric power to the motor is cut off, as when the refrigerating cycle is entering the "off" period, the lubricant pressure will decrease and the force stored in the spring 57 will become effective to urge the sleeve 52 inwardly to a position in which the opening or passage 59 matches with the opening or passage 58 and hence a by-pass around the intake valve 30 is provided by the establishment of communication between the main cylinder bore 26 and the intake side of the compressor, i. e., the interior of casing 10, thereby unloading the motor. This path of communication comprises the passages 59 and 58, portion 49a of bore 49 and opening 61 to the interior of the casing. There is also a path of communication between the interior of the casing 10 by means of intake conduit 33 and port 32 around the intake valve. Thus as long as the motor speed is less than the predetermined amount, communication with the interior of the casing 10 is maintained during both intake and exhaust strokes. Accordingly, the compressor cannot be loaded until the oil pressure acting on cup 51 causes sufficient movement of the sleeve 52 to move passages 58 and 59 out of alignment.

It will be seen that by reason of the above described construction, failure or lack of lubricant pressure at the unloading mechanism for any reason, will cause the motor to be unloaded.

Muffling means is provided for the gas discharged during the unloading period. When the passage 59 is valved off as the apparatus comes up to speed, the discharged working fluid, as refrigerant, will tend to cause undesirable noise. I have provided means establishing a restricted opening of predetermined area for such discharge fluid from the unloader bore to the interior of the compressor casing, the open end of the unloader bore acting as an exhaust muffler. In the illustrated form of my invention, the opening establishing means takes the form of the cup 53, as previously described. By providing the cup-like members disposed with the open ends opposite each other and a relatively long unloader cylinder bore, as shown, and by constructing the cup-like member 53 slightly smaller in external dimensions than the inner wall of the sleeve, as a few thousandths of an inch, there results an efficient muffling action. The parts can be constructed in other ways to form a muffler, however. If desired, guides may be provided on the outside of the member 53 or the inner wall of the sleeve to accurately locate the parts and insure uniform spacing. The guides may take the form of a plurality of outwardly directed projections.

While I have described a particular embodiment of my invention, I do not desire my invention to be limited to the particular construction shown and described, and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

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

1. In a compressor having a main cylinder bore in which a working fluid is compressed by a piston and an unloader cylinder bore, reciprocable

means disposed in said unloader bore, means providing communication between the high compression end of the cylinder bore and one end of the unloader bore at a predetermined position of the reciprocable means, means providing a restricted opening between said one end of the unloader cylinder and the intake side of the compressor, means biasing said reciprocable means to the predetermined position, and means responsive to compressor lubricant pressure for causing movement of the reciprocable means to cut off communication between the cylinder bores.

2. In a compressor having walls defining a main cylinder bore in which a working fluid is to be compressed by a piston and an unloader cylinder bore, piston means reciprocably disposed in each of said cylinder bores, said walls having a first passage communicating between said bores, said unloader cylinder bore having a second passage communicating with the intake side of said compressor, movable means associated with the unloader piston means for closing said first passage in one position of said unloader piston means, means for biasing said last mentioned means to open said first passage for unloading said compressor, and means for supplying lubricant under pressure to said unloader cylinder for moving said movable means to close said first passage.

3. In a compressor having walls defining a main cylinder bore in which a working fluid is compressed by a piston and an unloader cylinder bore, a sleeve disposed in said unloader cylinder bore, said sleeve being open at one end, the open end of the sleeve communicating with the intake side of said compressor, said main cylinder walls having a passage communicating between the bores, said unloader sleeve being reciprocable from a position establishing communication through said passage between said main cylinder bore and the intake side of said compressor to a position cutting off such communication, means for biasing said sleeve toward the position in which said passage is open to the intake side of said compressor, and means supplying lubricant under pressure to said unloader cylinder for moving said sleeve in a direction to close said passage.

4. In a compressor having walls defining a main cylinder bore in which a working fluid is compressed by a main piston and an open-ended unloader cylinder bore, an unloader piston reciprocably arranged in the unloader cylinder bore, said walls having an opening communicating between the bores, said unloader piston having an opening adapted to be disposed in alignment with the first-mentioned opening in one position of the unloader piston, a member extending into the open end of the unloader bore, said member having its outer surface spaced from the inner surface of said unloader cylinder bore for providing a passage between the intake side of the compressor and the opening in the piston, means for biasing said unloader piston into the position in which the openings are aligned, and means responsive to compressor lubricant pressure for causing movement of the unloader piston to cut off communication between said openings.

5. In a compressor having a cylinder block including a main cylinder bore in which a working fluid is compressed by a main piston and an unloader cylinder bore spaced from said main bore,

an open-ended unloader piston reciprocably arranged in the unloader cylinder bore, the open end thereof communicating with the intake side of said compressor, said main cylinder bore having an opening in the wall thereof, said unloader piston having an opening through the unloader piston wall and communicating with the open end thereof and adapted to be disposed in alignment with the first-mentioned opening in the unloaded position of the unloader piston, an open-ended member extending into the open end of the unloader piston, the open end of said member being opposed to the open end of the unloader piston, said member being slightly smaller in external dimensions than the inner wall of the unloader piston in order to provide a passage between the unloader piston and the intake side of the compressor, means for biasing apart the unloader piston and the member for moving the unloader piston to the position in which the openings are aligned and means responsive to compressor lubricant pressure for causing movement of the unloader piston in opposition to the biasing means to close the opening into the main cylinder bore.

6. In a compressor having walls defining a main cylinder bore in which a working fluid is compressed by a piston and an open-ended unloader cylinder bore, a piston reciprocably arranged in the unloader cylinder bore, said walls having an opening communicating between said bores, said unloader piston having an opening adapted to be disposed in alignment with the first-mentioned opening in one position of the unloader piston, means closing the open end of the unloader bore, said means being arranged to provide communication between the intake side of the compressor and the opening in the piston, means for biasing said unloader piston into the position in which the openings are aligned, and means responsive to compressor lubricant pressure for causing movement of the unloader piston to cut off communication between said openings.

7. In a compressor having a cylinder block including a main cylinder bore in which a working fluid is compressed by a piston and an unloader cylinder bore spaced from said main bore, a cylindrical sleeve reciprocably arranged in said unloader bore, partition means transversely disposed with respect to said sleeve and secured thereto in order to provide an open ended piston, said open end thereof communicating with the intake side of said compressor, said main cylinder bore having an opening in the wall thereof, said sleeve having an opening through its wall and communicating with said open end of said piston, and adapted to be disposed in alignment with the first mentioned opening in the unloading position of the piston, an open-ended member extending into said open end of the piston, said open end of said member being opposed to the said open end of the piston, said member being externally shaped to provide communication between the unloader piston and the intake side of the compressor, means for biasing the piston and the member for moving said piston to a position in which the openings are aligned, and means responsive to compressor lubricant pressure for causing movement of the piston in opposition to the biasing means to close the opening into the main cylinder bore.

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