

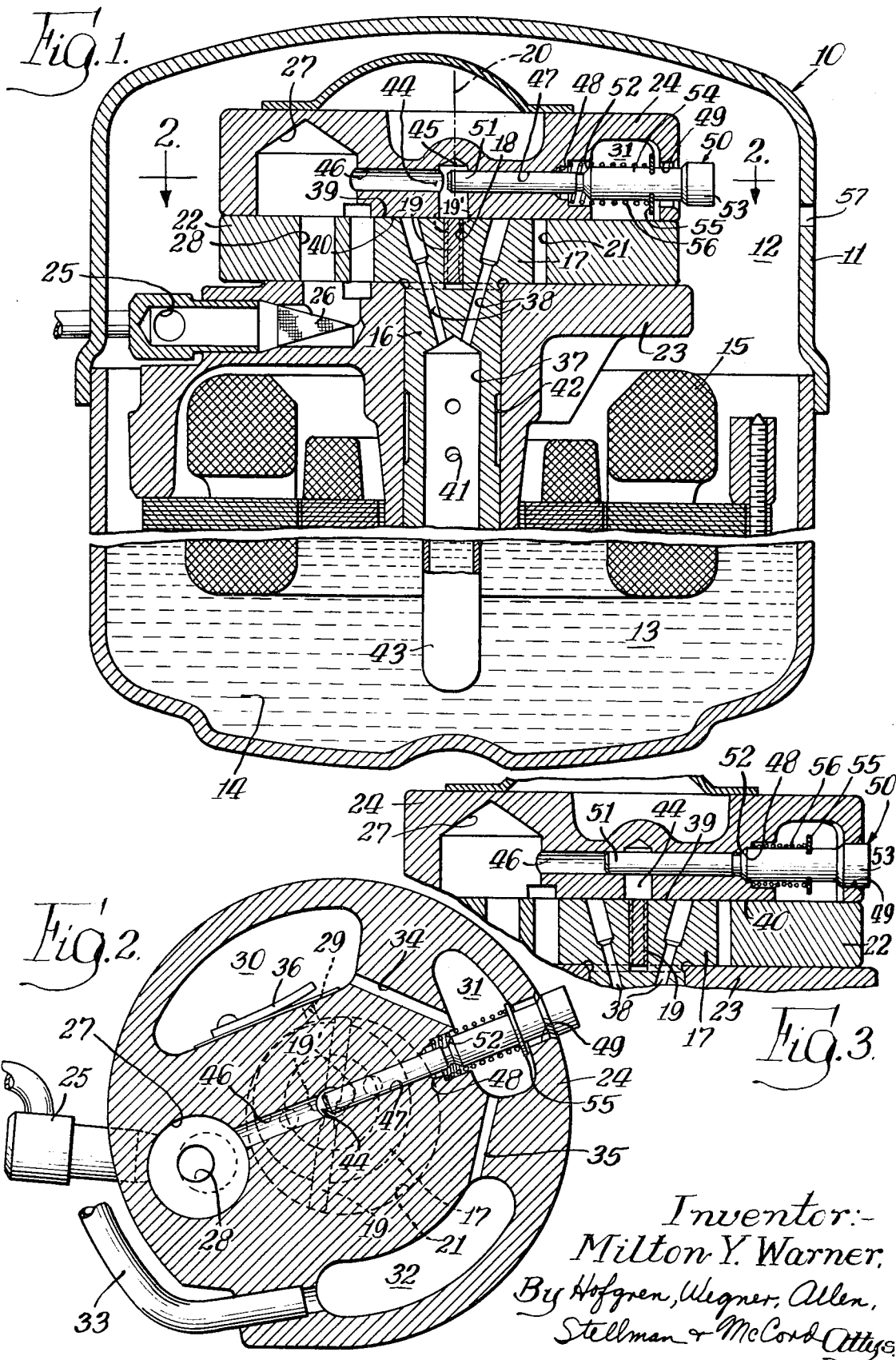
July 11, 1972

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3,676,021

RADIAL UNLOADER VALVE FOR THRU-SLOT ROTARY COMPRESSOR

Filed Oct. 9, 1970



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**RADIAL UNLOADER VALVE FOR THRU-SLOT
ROTARY COMPRESSOR**Milton Young Warner, Evansville, Ind., assignor to
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Filed Oct. 9, 1970, Ser. No. 79,399

Int. Cl. F04b 49/02, 49/08

U.S. Cl. 417—299

17 Claims

ABSTRACT OF THE DISCLOSURE

A rotary compressor such as for use in refrigeration apparatus having a vane-type rotor. Means are provided for alleviating liquid fluid ingestion in the compressor during start-up including valved passage means for returning high pressure liquid fluid from the compression chamber to the suction inlet during start-up. The passage means includes means for passing liquid fluid from a muffler chamber into the head space during start-up. The valve means is responsive to the pressure conditions within the compressor to substantially throttle such liquid fluid transfer during normal operating conditions of the compressor.

BACKGROUND OF THE INVENTION**Field of the invention**

This invention relates to rotary compressors and in particular to rotary compressors for use in refrigeration apparatus and the like.

Description of the prior art

A serious problem arises in the operation of conventional rotary compressors having vane-type rotors during cycling thereof such as in response to thermostatic controls or manual operation. At such times, surges of liquid fluid refrigerant from the evaporator of the refrigeration system may pass into the compression chamber. Such liquid refrigerant in the compression chamber causes a severe pressure increase causing a corresponding severe rise in bearing pressure. Further, the high pressure liquid refrigerant tends to pass through the running clearances of the compressor into the lubrication system. The resultant washout of lubricating oil from the bearing presents a serious problem.

Further during start-up of the compressor, a substantial increase in the discharge pressure above the compressor head pressure tends to aggravate this bearing load problem.

Still further in such known rotary compressors, refrigerant vapor tends to accumulate at the center of the vane slot during normal operation thereby tending to displace lubricant therefrom.

SUMMARY OF THE INVENTION

The present invention comprehends a rotary compressor having new and improved means for alleviating the problem of liquid fluid ingestion such as during start-up of the compressor thereby providing improved lubrication of the bearing and rotor faces during the start-up period. The rotary compressor structure is further arranged to alleviate gaseous refrigerant collection at the center of the rotor during normal operation. Thus, the present invention broadly comprehends an improved rotary compressor structure eliminating the disadvantages of the conventional rotary compressor structures as discussed above in a novel and simple manner.

More specifically, the invention comprehends providing a passage for conducting fluid from adjacent the axis of the rotor to the suction inlet thereby effectively preclud-

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ing washing out of the lubricant from the motor bearing means by pressurized liquid fluid delivered to the compression chamber during start-up. The passage means is further arranged to conduct a small flow of gaseous refrigerant from adjacent the axis of the motor during normal running conditions thereby to provide further improved lubrication of the compressor.

A further flow passage is provided between at least one muffler chamber and the space within the compressor housing communicating with the oil sump for maintaining the muffler pressure substantially at the housing space pressure during start-up.

Valve means are provided for controlling the passages so as to effectively throttle fluid flow therethrough during the normal operation of the compressor.

BRIEF DESCRIPTION OF THE DRAWING

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. 1 is a fragmentary diametric section of a rotary compressor structure embodying the invention;

FIG. 2 is a horizontal section taken substantially along the line 2—2 of FIG. 1; and

FIG. 3 is a fragmentary diametric section illustrating the control valve means in the closed arrangement.

**DESCRIPTION OF THE PREFERRED
EMBODIMENT**

In the exemplary embodiment of the invention as disclosed in the drawing, a rotary compressor generally designated 10 is shown to comprise a rotating vane compressor such as for use in refrigeration apparatus and the like. As shown in FIG. 1, the compressor includes an outer housing 11 defining a space 12. The lower end of housing 12 defines a sump 13 in which lubricating oil 14 is collected for use in lubricating the running parts of the compressor.

The compressor includes an electric motor 15 driving a shaft 16 which carries at its upper end a rotor 17 provided with a diametric through slot 18. The pumping vane of the rotor herein comprises a one-piece blade 19, it being understood that a split vane utilizing a pair of radially outwardly biased blades may be utilized in slot 18 within the scope of the invention. The rotor blade 19 is provided with undercut portions 19' on each side of the blade at the center thereof. These undercut portions 19' provide a passageway from the bottom of the blade slot 18 to the top thereof. Where the rotor vane 19 comprises a pair of radial vanes (rather than the single diametric blade illustrated), the gap between the inner ends of the blades provides the passageway. Rotor 17 is rotatable about its vertical axis 20 in a compression chamber 21 of a cylinder 22 disposed between a front head 23 and a rear head 24.

Compressible fluid, such as refrigerant gas, is delivered to the compression chamber through an inlet 25 which may include an inlet filter 26. A recess 27 may be provided in rear head 24 communicating with the inlet chamber 28 in cylinder 22. As shown in FIG. 2, compressed fluid is delivered from compression chamber 21 through an outlet passage 29 into a series of muffler chambers 30, 31 and 32 to a discharge duct 33. As shown, chambers 30 and 31 may be interconnected by a small diameter passage 34 and chambers 31 and 32 may be interconnected by a small diameter passage 35. A reed-type check valve 36 may be provided in muffler chamber 30 for controlling the compressed gas delivery from the compression chamber in the conventional manner.

Lubricating oil is delivered from sump 13 upwardly through a central bore 37 in shaft 16 and outwardly through a pair of axial discharge passages 38 extending from the upper end of shaft 16 through the integrally joined rotor 17. Lubricant is delivered from passage 38 into the clearance space between the upper surface 39 of rotor 17 and the lower surface 40 of rear head 24. Lubricant is also delivered through a plurality of radial passages 41 to an annular space 42 in shaft 16 opening to front head 23 for lubricating the shaft therein. The lower end of shaft 16 carries a depending tube 43 for conducting the lubricant oil upwardly from sump 13 into bore 37.

As indicated briefly above, during start-up of the compressor, high pressure conditions may result from liquid refrigerant being ingested into the compressor from the refrigeration system evaporator (not shown). Such liquid refrigerant in the compression chamber causes a high pressure rise in the compressor producing a corresponding high pressure on the bearing surfaces of the compressor. The present invention alleviates this undesirable condition by providing means for conducting such high pressure liquid refrigerant substantially directly back to the suction space 28 during the start-up of the compressor and further reducing the pressure in the muffler means such as by providing a passage directly from muffler 31 to the housing space 12 during the start-up condition.

More specifically, a passage 44 is provided in rear head 24 leading from compression chamber 21 adjacent rotor axis 20 to rear head means 27. More specifically, passage 44 includes an axial bore 45 opening downwardly to compression chamber 21 and a radial bore 46 extending from portion 45 to recess 27. A second radial bore 47 is provided in rear head 24 opening from axial passage portion 45 radially opposite to passage portion 46 into communication with muffler chamber 31 through a frustoconical valve seat 48. A further passage 49 extending radially to axis 20 is provided in rear head 24 communicating between muffler chamber 31 and housing space 12.

Passage portion 46 and passages 47 and 49 are coaxially aligned and fluid flow therethrough is controlled by means of a valve member generally designated 50, having a first cylindrical portion 51 movably carried in passage 47 to be selectively received in and withdrawn from passage portion 46. Valve 50 further includes a frustoconical seating portion 52 selectively engageable with valve seat 48. An outer portion 53 of valve 50 comprises a cylindrical portion selectively receivable in passage 49. The valve further includes a portion 54 extending between seating portion 52 and outer portion 53 and carrying a split collar 55 within muffler chamber 31. A coil spring 56 extends coaxially about valve member 50 between the wall of rear head 24 and collar 55 in chamber 31 to urge the valve to the open position of FIG. 1 wherein cylindrical portion 51 is withdrawn from portion 46 of passage 44 and cylindrical portion 53 is withdrawn from passage 49.

Thus, at start-up, liquid refrigerant drawn into compression chamber 21 is caused to pass outwardly therefrom through passage 44 via the passageway formed by undercut portions 19' and rotor slot 18 rather than downwardly to the bearing surfaces thereby assuring maintained lubrication of the rotor faces and shaft bearing during the critical start-up period. At the same time, the opening of passage 49 from muffler cavity 31 effectively precludes an increase in the discharge pressure appreciably above the housing space pressure, further reducing the pressure rise in the compression chamber 21 and correspondingly reducing the bearing load.

Where the rotor vane 19 comprises a pair of radial vanes (rather than the single diametric vane illustrated), the low pressure maintained in the axis 20 of the rotor by the open passage 44 permits the vanes to move radially inwardly toward the axis away from the wall of compression chamber 21 thereby permitting some of the fluid to

remain uncompressed as the blades move through the chamber. Because of the reduced fluid compression, a reduced discharged pressure is provided during start-up thereby further tending to minimize the bearing load at that time.

A short time after the operation of the compressor is initiated, illustratively several seconds, the differential between the discharged pressure and the suction pressure approaches normal operating conditions. The pressure differential may then be sufficient to urge valve member 50 to the closed position of FIG. 3. Illustratively, spring 56 may be selected to require a pressure of approximately 50 p.s.i. to permit the valve member to move to the closed position. Conventionally in such rotary compressors, the pressure differential may rise to approximately 50 p.s.i. in approximately three to five seconds. Thus, the compressor is permitted to operate with passages 44 and 49 open to alleviate the liquid ingestion problem for a period illustratively of approximately three to five seconds, thereby minimizing wear of the bearing surfaces. When valve 50 moves to the closed position of FIG. 3, cylindrical portion 51 is slidably received within portion 46 of passage 44 and valve portion 53 is slidably received in passage 49. The clearance between the valve portions and the walls of the passages in which they are received may be approximately .001" to provide for ready movement of the valve member between the closed and open positions. Thus, a small leakage may continue through passage 44 during normal operation of the compressor to vent the compression chamber at the axis of the rotor so as to remove gaseous refrigerant which may tend to collect thereat and undesirably displace lubricant therefrom. As the refrigerant flow through passage 44 is at all times away from the center of the rotor through the passage formed by the undercut portion 19' and the rotor slot 18, it tends to draw the lubricant upwardly from sump 13 thereby abetting the normal lubricating operation to provide an improved lubrication of the compressor at all times.

Passage 47 is effectively closed upon completion of start-up of the compressor to prevent substantially all leakage between muffler chamber 31 and suction chamber 28 by the seating of valve member seating surface 52 on seat 48 as shown in FIG. 3. Thus, during normal operating conditions, the compressor functions substantially in the normal manner.

As is conventional in such rotary compressors, the high pressure fluid may be delivered to the system which, illustratively, may comprise a refrigeration system, through a suitable outlet such as opening 57 in the housing.

The start-up valve means provided in compressor 10 is extremely simple and economical of construction comprising a simple stepped movable valve member and a counterbored diametric bore in the rear head. Spring 56 may be inserted with the reduced diameter portions of the valve member through the passage 49 and collar 55 may comprise a conventional split washer insertable through the bottom surface 40 of the rear head to be locked to valve portion 54 after the valve member and spring are inserted and prior to the installation of the rear head on the cylinder.

Thus, compressor structure 10 provides a highly desirable alleviation of liquid ingestion during start-up of the compressor eliminating the disadvantages of the known compressors as discussed above.

The foregoing disclosure of specific embodiments is illustrative of the broad inventive concepts comprehended by the invention.

Having described the invention, the embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a rotary compressor having means defining a compression chamber, a low suction pressure inlet to said chamber, a high discharge pressure outlet from said chamber, a rotor provided with a diametric through slot

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carrying blade means, bearing means rotatably carrying the rotor for rotation in said chamber to compress gaseous fluid delivered thereto from said inlet and delivering compressed gaseous fluid therefrom to said outlet, and means for providing lubricant to the rotor surfaces and bearing means, means for relieving high pressure conditions in the compressor during start-up, comprising: means defining a passage from said chamber at the axis of said rotor to said inlet for conducting high pressure fluid from adjacent the axis of said rotor to the inlet during start-up of the compressor and thereby effectively preclude washing out of the lubricant from the rotor and bearing means by said pressurized fluid; and valve means for substantially closing said passage at a preselected normal running pressure differential between said suction and discharge pressures.

2. The rotary compressor means of claim 1 wherein said valve means comprises a valve member having a portion exposed to said inlet suction pressure and an opposite portion exposed to said inlet discharge pressure, and means biasing the valve member to a valve open condition.

3. The rotary compressor means of claim 1 wherein said valve means is arranged to permit a small flow of fluid and lubricant outwardly through said passage back to said inlet when the valve means is in the closed condition thereby to facilitate provision of lubricant from said providing means.

4. The rotary compressor means of claim 1 wherein said passage means includes a pair of angularly related portions and said valve means comprises a cylindrical member movable across one portion axially into the other portion to close the valve means.

5. The rotary compressor means of claim 1 wherein said blade means comprises a pair of blades extending radially outwardly in said slot away from said rotor axis, said passage permitting the blades to move inwardly toward said axis during start-up of the compressor thereby to reduce the pumping rate and discharge pressure.

6. In a rotary compressor having a housing defining a sump space, means in said housing defining a compression chamber having a low suction pressure inlet and a high discharge pressure outlet, rotary means for compressing fluid in said compression chamber and delivering the compressed high pressure fluid to said outlet, and means defining a muffler cavity for conducting the compressed, high pressure fluid from said outlet, means for relieving high pressure conditions in the compressor, comprising:

means defining a passage from said muffler cavity to said sump space for discharging fluid from said muffler cavity and maintaining the muffler cavity substantially at the pressure of the sump space during start-up of the compressor; and

valve means for substantially closing said passage after start-up of the compressor at a preselected normal running pressure differential between said suction and discharge pressures.

7. The rotary compressor means of claim 6 wherein said valve means comprises a valve member having a portion exposed to said suction pressure and an opposite portion exposed to said discharge pressure, and means biasing the valve member to a valve open condition.

8. The rotary compressor means of claim 6 wherein said valve means is arranged to permit a small flow of fluid outwardly therethrough at all times.

9. The rotary compressor means of claim 6 wherein said valve means comprises a cylindrical element coaxially movable into said passage for substantially closing the passage.

10. In a rotary compressor having a housing defining a sump space, means in said housing defining a compression chamber, a low suction pressure inlet to said chamber, a high discharge pressure outlet from said chamber, a rotor

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provided with a diametric through slot carrying blade means, bearing means rotatably carrying the rotor rotatively disposed for rotation in said chamber to compress gaseous fluid delivered thereto from said inlet and delivering compressed gaseous fluid therefrom to said outlet, means for providing lubricant to rotor surfaces and bearing means, and means defining a muffler cavity for conducting the compressed high pressure fluid from said outlet, means for alleviating liquid fluid ingestion in the compressor comprising:

means defining a first passage from said chamber at the axis of said rotor for providing suction pressure to adjacent the axis of said rotor to cause pressurized liquid fluid to pass therefrom to the inlet and thereby effectively preclude washing out of the lubricant from the rotor to the lubricant providing means by said pressurized liquid fluid;

first valve means for substantially closing said first passage at a preselected normal running pressure differential between said suction and discharge pressures;

means defining a second passage from said muffler cavity to said sump space for discharging liquid fluid from said muffler cavity and maintaining the muffler cavity substantially at the pressure of the sump space during start-up of the compressor;

second valve means for substantially closing said second passage after start-up of the compressor at a preselected normal running pressure differential between said suction and discharge pressures; and

means for causing substantially concurrent operation of said first and second valve means.

11. The rotary compressor means of claim 10 wherein said first and second valve means are mechanically connected.

12. The rotary compressor means of claim 10 wherein said first and second valve means comprise integral first and second movable valve member portions.

13. The rotary compressor means of claim 10 wherein said valve means comprises a valve member having a portion exposed to said suction pressure and an opposite portion exposed to said discharge pressure, and means biasing the valve member to a valve open condition.

14. The rotary compressor of claim 13 wherein said first and second valve means comprise integral first and second valve member portions and said biasing means comprises a single spring means.

15. The rotary compressor means of claim 10 further including means defining a third passage interconnecting said first passage and said muffler cavity and said valve means includes means for closing said third passage.

16. The rotary compressor means of claim 15 wherein said valve means permits a small flow of fluid between said muffler cavity and said first passage during start-up of the compressor with said valve means disposed in the open condition.

17. The rotary compressor means of claim 16 wherein said first, second and third valve means comprises integral first, second and third valve member portions and said biasing means biases said third valve member to the open condition.

References Cited

UNITED STATES PATENTS

3,348,764 10/1967 Romerhaus ----- 417-299 X
3,499,600 3/1970 McGregor ----- 418-255

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U.S. Cl. X.R.

417-312, 902; 418-255

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,676,021 Dated July 11, 1972

Inventor(s) MILTON YOUNG WARNER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 2, line 20, delete "inlet" and insert in lieu thereof --outlet--.

Signed and sealed this 2nd day of January 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents