May 13, 1952 F. BERRY 2,596,640

REFRIGERATOR COMPRESSOR

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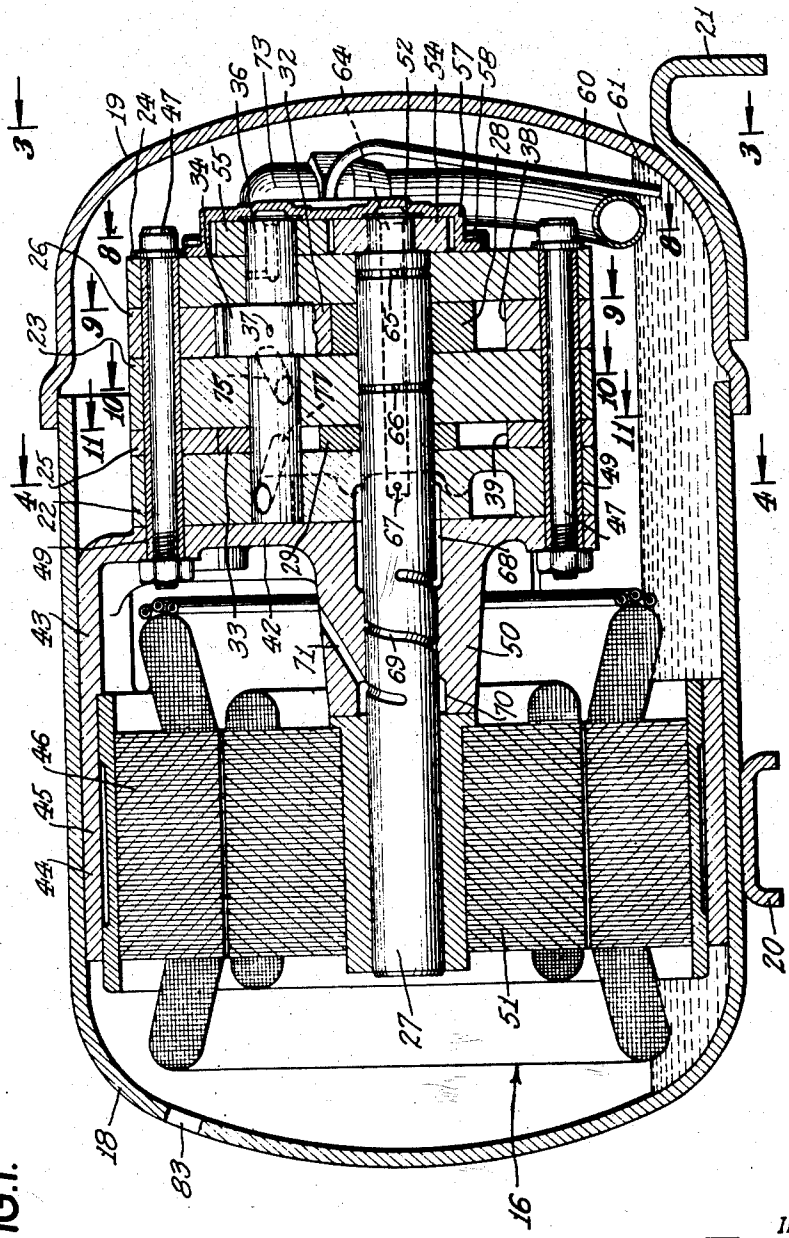


FIG. 1.

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FIG.2.

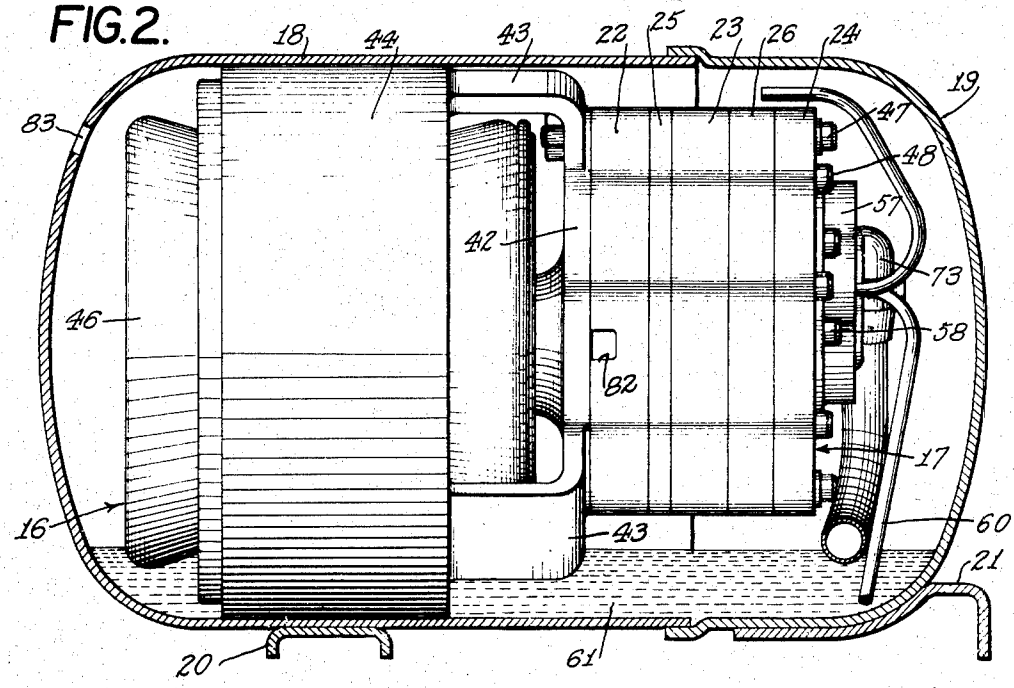
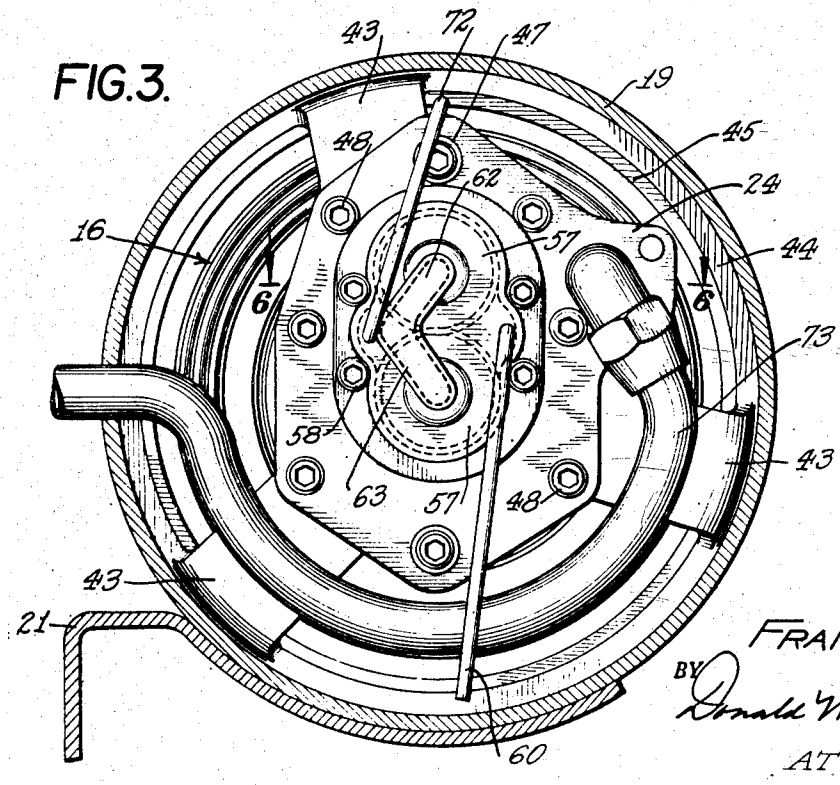


FIG.3.



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FIG.4.

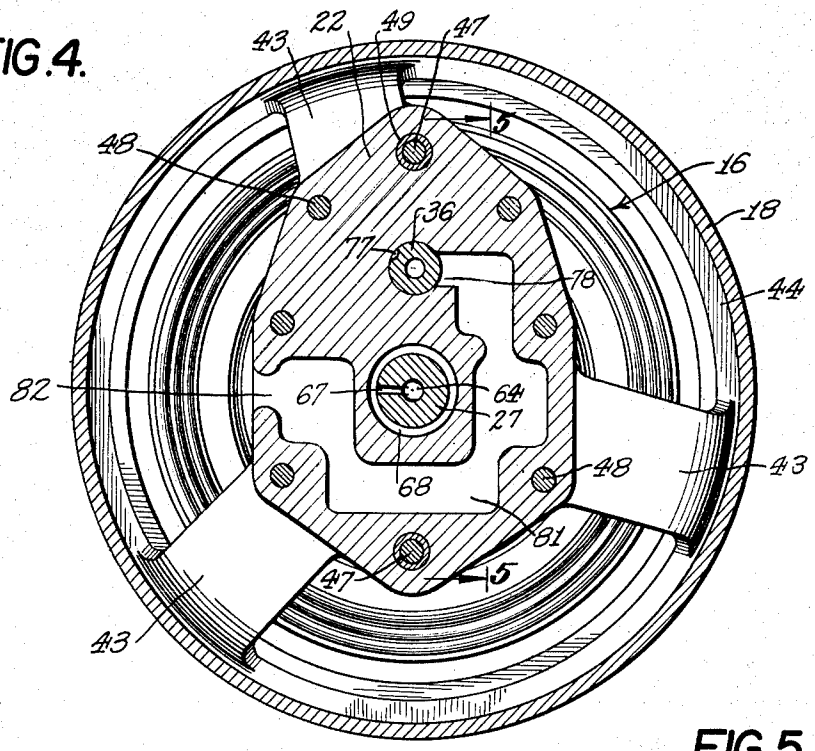


FIG.5.

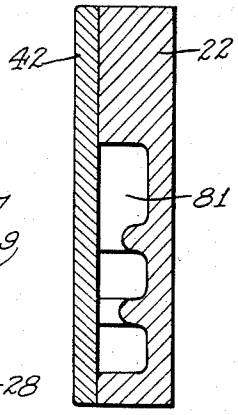


FIG.6.

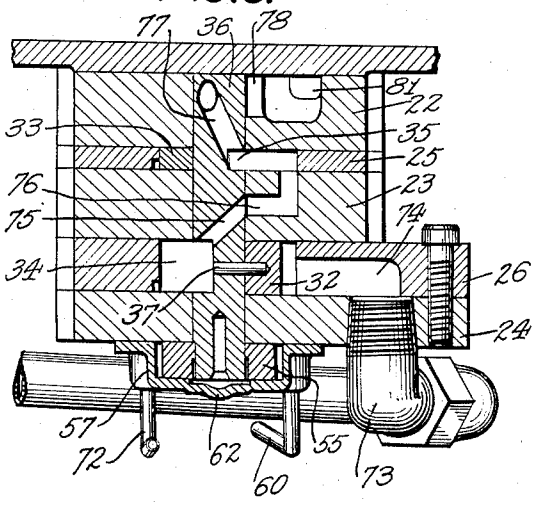
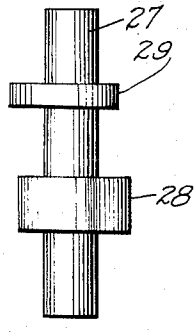


FIG.7.



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FIG.8.

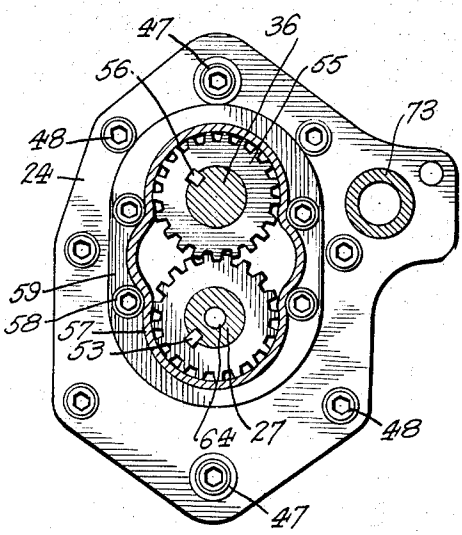


FIG.9.

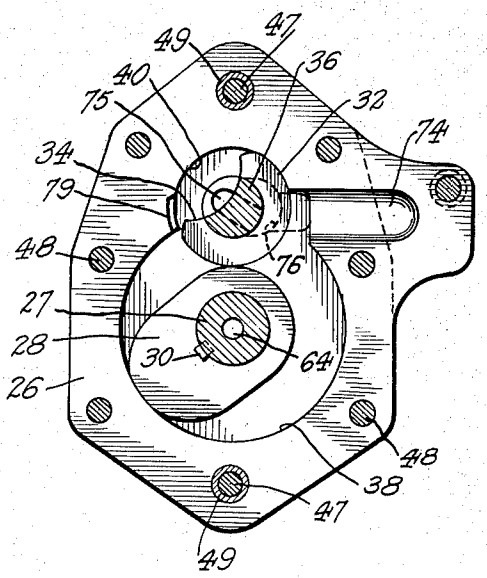


FIG.10.

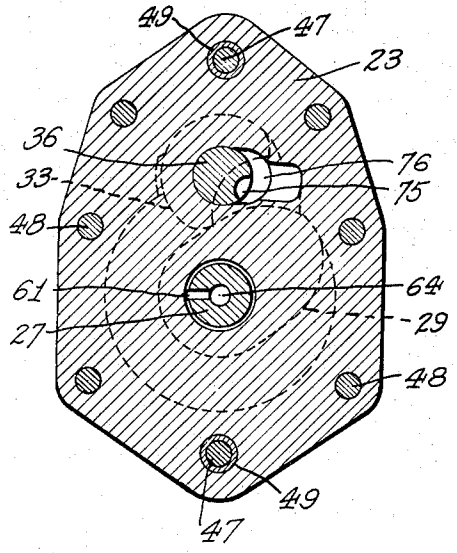
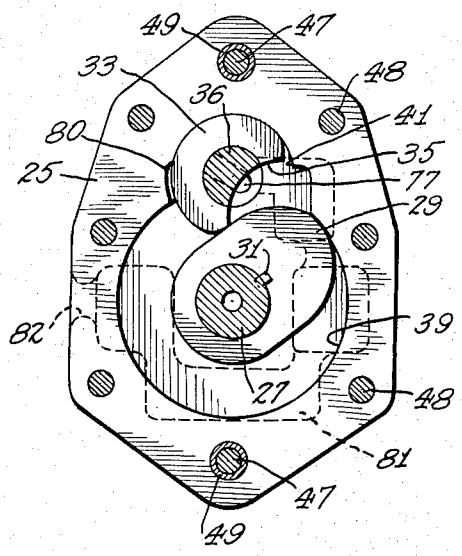


FIG.11.



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FIG.12.

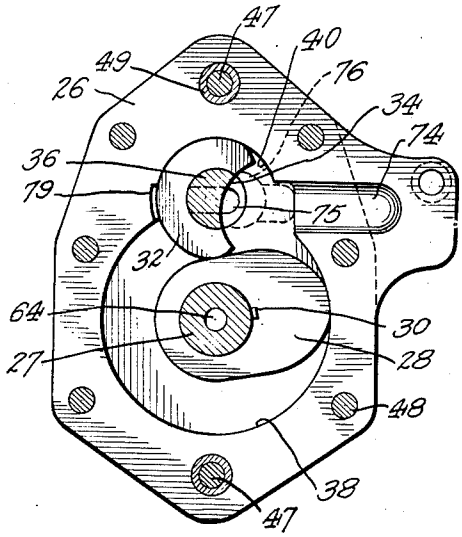


FIG.13.

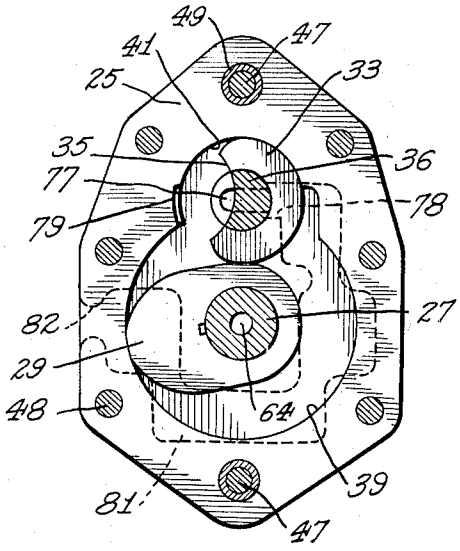


FIG.14.

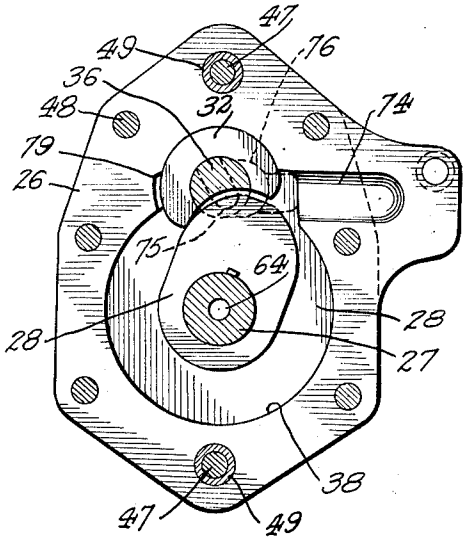
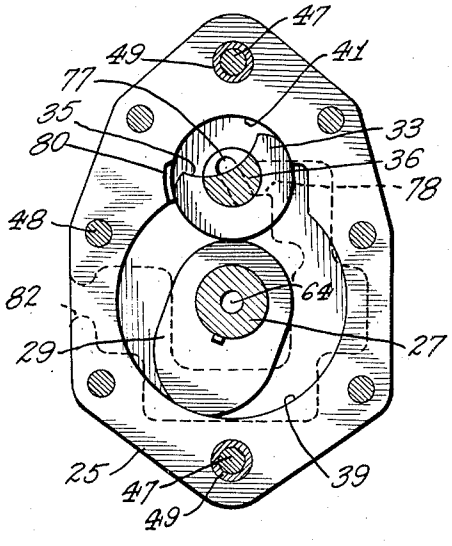


FIG.15.



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UNITED STATES PATENT OFFICE

2,596,640

REFRIGERATOR COMPRESSOR

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Application August 21, 1946, Serial No. 692,003

1 Claim. (Cl. 230—150)

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The invention relates to rotary fluid compressors such as air or freon compressors for use in refrigeration systems and the like. It has special application to multistage rotary compressors of the rotary abutment type.

A rotary fluid compressor if operated in reverse is a fluid motor. Consequently, if the motor which drives the compressor is turned off or disconnected, the compressed fluid will drive the compressor in reverse as a prime mover, or motor, dissipating the compressed fluid. At least this normally will be the case in the absence of check or unloader valves to prevent the fluid from flowing through the unit in reverse. Therefore, it is quite customary to provide spring or gravity operated check and unloader valves at the low pressure fluid intake or at the high pressure outlet, or both, so that when the motor which drives the compressor is cut off, reverse flow of the compressed fluid is prevented.

I have discovered, however, that by a special construction and interrelation of the fluid passageway between stages and of the fluid outlet, controlled by the rotary abutment, a pressure balance can be achieved which will effectively lock the compressor against operation in reverse as a motor. I have discovered, further, that this special construction and arrangement makes it possible to dispense entirely with the use of check and unloader valves without sacrificing the functions formerly served by such valves. Consequently I have been able to eliminate a number of parts while retaining the same operational characteristics with respect to locking against reverse flow. The elimination of these parts leads to a simpler construction which can be manufactured at lower cost and which is easier to maintain.

Thus a primary object of my invention has been to eliminate the use of check and unloader valves in multi-stage fluid compressors while retaining the principal advantages of such valves.

In the drawings:

Fig. 1 is a central vertical cross sectional view of a preferred form of multi-stage refrigerator compressor constructed in accordance with my invention.

Fig. 2 is a side elevational view of the same compressor with its encasing hermetic shell shown in cross section.

Fig. 3 is an end elevational view of the same compressor, taken as indicated at 3—3 in Fig. 1.

Fig. 4 is a vertical cross sectional view taken on the line 4—4 of Fig. 1.

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Fig. 5 is a detail section taken on the line 5—5 of Fig. 4.

Fig. 6 is a detail section taken through the center line of the rotary abutment shaft as indicated at 6—6 in Fig. 3.

Fig. 7 is a detail view of the rotary abutment member.

Figs. 8, 9, 10 and 11 are detail cross sectional views taken respectively on the lines 8—8, 9—9, 10—10 and 11—11 of Fig. 1. Fig. 8 shows the abutment drive and gear pump assembly, Fig. 9 the first stage cylinder, Fig. 10 the porting between first and second stage cylinders, and Fig. 11 the second stage cylinder.

Figs. 12 and 13 show the first and second stage cylinders, respectively, with the parts in a stopped position such as will initiate reverse operation of the unit as a motor.

Figs. 14 and 15 show the first and second stage cylinders, respectively, with the parts in a pressure balanced position, locked against further reverse operation.

The multi-stage refrigerator compressor illustrated in the drawings comprises an electric motor 16 direct-connected to a compressor 17, the unit being mounted in a two-part hermetically sealed shell 18, 19 carried by suitable mounting brackets 20, 21.

The compressor 17 comprises in its general arrangement spaced casing members 22, 23 and 24 forming the side walls of annular cylinder chambers and adjacent abutment chambers, spacer casing members 25 and 26 therebetween forming the outer peripheral walls 38, 39 of the cylinder chambers and 40, 41 of the abutment chambers, a piston rotor comprising a shaft 27 and pistons 28 and 29 fixed thereto as by keys 30 and 31, and rotary abutments 32 and 33 fixed to a shaft 36 as by means of pins 37 (Fig. 6), the rotary abutments having recesses 34 and 35 to clear the pistons as they pass the abutments. The abutment recesses 34, 35 may extend part-way into the shaft 36 as clearly shown in Figs. 9 and 11.

Casing members 22, 23 and 24 are bored to receive the abutment shaft 36 and rotor shaft 27. An end plate 42 adjacent the casing member 22 is formed with brackets 43 supporting an annular housing member 44 to receive the mounting ring 45 which carries the stator 46 of the motor. The stator 46 may have a press fit in the mounting ring 45 and the latter a press fit in the annular housing member 44. Further, the housing 44 may have a press fit in the shell 18.

The end plate 42 and the five casing members 22, 23, 24, 25 and 26 are secured together as by means of bolts 47 and machine screws 48 passing through aligned apertures therein, the latter having threaded engagement with the end plate 42. I prefer to employ, also, hollow tubes or dowel pins 49 to secure accurate alignment of the parts during assembly.

End plate 42 is formed with an extension 50 to support the armature 51 of motor 16.

The right-hand end of the motor-compressor shaft 27 (as viewed in Fig. 1) is of reduced diameter as at 52, and to it is keyed as at 53 (Fig. 8) a gear 54 meshing with a gear 55 keyed at 56 to the end of the abutment shaft 36. By this means the rotary abutment is driven at the same speed as the pistons but in the opposite direction. Thus as viewed in Figs. 9 and 11, the pistons 28 and 29 rotate in a clockwise direction and the abutments 32 and 33 in a counterclockwise direction.

The gears 54, 55 are enclosed by a cover plate or housing 57 secured to the casing member 24 as by means of screws 58 passing through flange 59 of the housing 57. The gears 54, 55 fit the housing in the manner shown in Fig. 8 to provide a gear pump lubricating the compressor as will be described further on. A tube 60 provides communication between the interior of the gear housing 57 and a point below the surface of the oil 61 contained in the hermetic shell 18, 19. The lubricating oil which is drawn in through tube 60 is forced by the gear pump 54, 55 through channelways 62, 63 of the pump housing (Fig. 3) to the ends of the rotor and abutment shafts 27 and 36. From the end of the rotor shaft 27 the oil is forced through a central bore 64 and thence through transverse bores 65, 66 and 67. Transverse bores 65 and 66 lead to circumferential grooves lubricating the bearings in the casing members 23 and 24. Transverse bore 67 leads to an annular chamber 68 formed partly in the casing member 22 and partly in the end plate 42. From chamber 68 the oil is carried by the spiral groove 69 to an annular recess 70 at the end of extension 50 for lubrication of the thrust bearing of the armature 51. Excess oil passes out through the opening 71 leading from the recess 70. Also there is an overflow tube 72 leading directly from the gear pump casing and which discharges over the top of the compressor, this overflow discharge preventing excess pressure from being built up by the gear pump, while assuring a steady flow of the lubricant. Oil passages are provided in the abutment shaft 36 similar to those described in connection with the rotor shaft 27.

The casing member 24 is bored and tapped to receive the end of an intake conduit 73 (see Figs. 3 and 6) communicating with a transverse passage 74 in casing member 26 (Figs. 6 and 9) leading to the first stage cylinder at its junction with the abutment chamber.

An intermediate fluid passageway 75, 76 between the two cylinders is arranged to pass partially compressed fluid from one cylinder to the other during a selected portion of the rotation of the shaft and pistons. Portion 75 of the intermediate passageway leads from abutment recess 34 of the first stage cylinder diagonally through the shaft 36 to the outer periphery thereof where, during a selected portion of rotation of the shaft 36, it communicates with portion 76 of the intermediate passageway formed in the casing member 23. The interval during which such communication obtains will be understood from consideration of Fig. 10.

A fluid outlet passageway 77, 78 (Figs. 4 and 6) is arranged to pass fully compressed fluid directly into the shell 18, 19 or other high pressure container during a selected portion of rotation of the shaft and pistons. Portion 77 of the fluid outlet passageway leads from abutment recess 35 of the second stage cylinder diagonally through the shaft 36 to the outer periphery thereof where, during a selected portion of rotation of the shaft 36, it communicates with portion 78 of the outlet passageway formed in the casing member 22. The interval during which such communication obtains will be understood from consideration of Figs. 4 and 13. The opening and closing of the intermediate fluid passageway 75, 76 and fluid outlet passageway 77, 78 is controlled by the rotary abutment, the intermediate fluid passageway, fluid outlet passageway and abutment members being constructed and arranged so that when the compressor is stopped with the fluid outlet passageway open (Fig. 13), subjecting the compressor to being driven in reverse as a motor by the high pressure fluid in the shell 18, 19, the fluid outlet passageway 77, 78 will close and pressures on both sides of the piston 29 of the second stage cylinder (in this embodiment the final compression cylinder) will be equalized before the intermediate fluid passageway 75, 76 opens, whereby the compressor is locked against further operation in reverse.

The operation of the compressor may be summarized as follows:

Motor 16, through its rotor 51 fixed to the shaft 27, drives the pistons 28 and 29 in a clockwise direction as viewed in Figs. 9 to 15 inclusive, and through gears 54, 55, drives the rotary abutments 32, 33 in a counterclockwise direction. When the parts are in the position shown in Figs. 9, 10 and 11, the compression stroke of the first stage (Fig. 9) is partially completed and that of the second stage (Fig. 11) is about to begin. Low pressure fluid is drawn into the unit through the conduit 73 and passage 74 where it enters the first stage cylinder behind the piston 28. The fluid ahead of this piston is compressed until such time as the abutment 32 has reached a position where this abutment no longer seals off the cylinder from the abutment chamber as by uncovering the relief passageway 79. The compressed fluid ahead of the piston 28 then flows through passageway 75 which at this time is in communication with passageway 76. Also at this time the piston 29 of the second stage cylinder is in sealing engagement with the abutment 33 and the compressed fluid from the first cylinder flows between the piston 29 and the abutment. This piston, as it rotates, further compresses the fluid ahead of it (i. e. the fluid from the preceding cycle) against the rotary abutment 33 until such time as the latter uncovers the relief passageway 80 in casing member 25 permitting the fully compressed fluid to flow into the abutment recess 35 and through passageway 77 which will then be in communication with passageway 78 in casing member 22 as illustrated in Fig. 13, permitting the compressed fluid to flow through muffler 81 and out through opening 82 into the shell 18, 19 which is maintained at the discharge pressure, or approximately so. A suitable outlet for the compressed fluid is provided in the shell at 83 to which a fluid conduit may be connected as desired. The construction of muffler 81 formed in casing member 22 is plainly illustrated in Fig. 4 and consists of

a series of chambers joined by relatively narrow connecting passages.

The locking action which prevents the compressor from being driven in reverse as a motor by the high pressure fluid in the shell 18, 19 without the use of auxiliary check valves or unloading valves will now be described in more detail with particular reference to Figs. 12 to 15 inclusive. Figs. 12 and 13 show the first and second stage cylinders with the parts in such a position as upon stopping would initiate reverse operation of the unit as a motor. Figs. 14 and 15 show the first and second stage cylinders with the parts in, or approaching, a pressure balanced position, locked against further reverse operation.

With the parts stopped as shown in Fig. 13, direct communication is afforded between the interior of the shell 18, 19 and the second stage cylinder via the opening 82 in the casing, muffler 81 and outlet passages 78 and 77. The compressed fluid thus flowing back into the second stage cylinder will produce rotation of the piston 29 in a reverse direction (counterclockwise as viewed in Fig. 13). As it rotates, the fluid at the other side of the piston 29 will be compressed against abutment 33. During this backward rotation of piston 29 there is no communication between portions 75 and 76 of the passageway between stages as will be understood from a comparison of Figs. 12 and 14. Consequently a certain amount of fluid is trapped between the first and second stages during reverse rotation from the position shown in Figs. 12 and 13 to the position shown in Figs. 14 and 15. Moreover, with the parts in the position shown in Fig. 15, communication has been closed between that part 77 of the fluid outlet which is in the abutment shaft and that part 78 which is in the casing member 22. Thus no more high pressure fluid can flow back into the second stage cylinder. At this moment the fluid trapped between the stages will have been compressed somewhat so that any further reverse movement of the piston 29 will be only such slight amount as will balance the pressures on both sides of this piston. In other words, at this point there is high pressure fluid locked on both sides of the piston 29 and the piston simply moves a sufficient amount to equalize these two pressures, and comes to a stop. This pressure balanced condition is due to the fact that communication between the abutment shaft and the casing in the fluid outlet is closed upon reverse rotation of the abutment shaft and a pressure balance obtained before communication between the casing and abutment shaft in the fluid passageway between stages is opened.

The pressure balanced interlock between stages, by preventing reverse operation of the unit as a fluid motor, makes it possible to eliminate the use of check and unloading valves without sacrificing the functions formerly served by such valves.

It will be understood that my invention is applicable to compressors having a greater number of stages than the one specifically illustrated, for, so long as there are two or more stages it is possible to bring about the pressure balanced interlock against reversal of the unit. The terms

and expressions which I have employed are used in a descriptive and not a limiting sense, and I have no intention of excluding such equivalents of the invention described, or of portions thereof, as fall within the purview of the claim.

I claim:

In a rotary fluid compressor, a casing having a plurality of annular compressor cylinders arranged side by side longitudinally along a common axis and rotary abutment chambers arranged longitudinally along a common axis and adjoining said cylinders, a piston in each cylinder fixed to a common shaft and a cooperating rotary abutment for each piston fixed to a common shaft, each abutment having a recess to clear its cooperating piston, an inlet through the casing to the first compression cylinder, an intermediate fluid passageway extending from one abutment recess through the abutment shaft to the casing and thence to the final compression cylinder, an outlet from the casing, and a fluid outlet passageway extending from the abutment recess of the final compression cylinder through the abutment shaft to said outlet, the opening and closing of said intermediate fluid passageway and fluid outlet passageway being controlled by the rotary abutment, and the intermediate fluid passageway, fluid outlet passageway, and abutment members being constructed and arranged so that when the compressor is stopped with the fluid outlet passageway open, subjecting the compressor to being driven in reverse as a motor by the high pressure fluid, the fluid outlet passageway will close and pressures on both sides of the piston of the final compression cylinder will be equalized before the intermediate fluid passageway opens, whereby the compressor is locked against further operation in reverse.

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