March 20, 1951 F. BERRY 2,545,600

FLUID COMPRESSOR AND THE LIKE

Filed Aug. 21, 1946 5 Sheets-Sheet 1

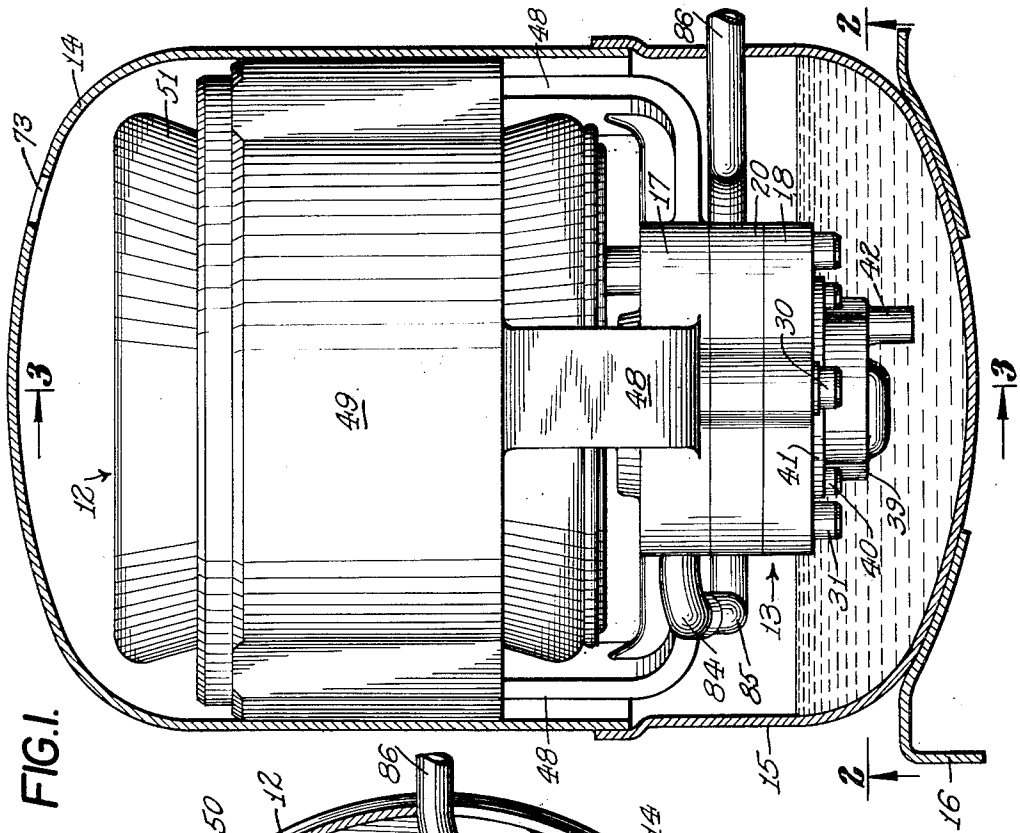

FIG. 1.

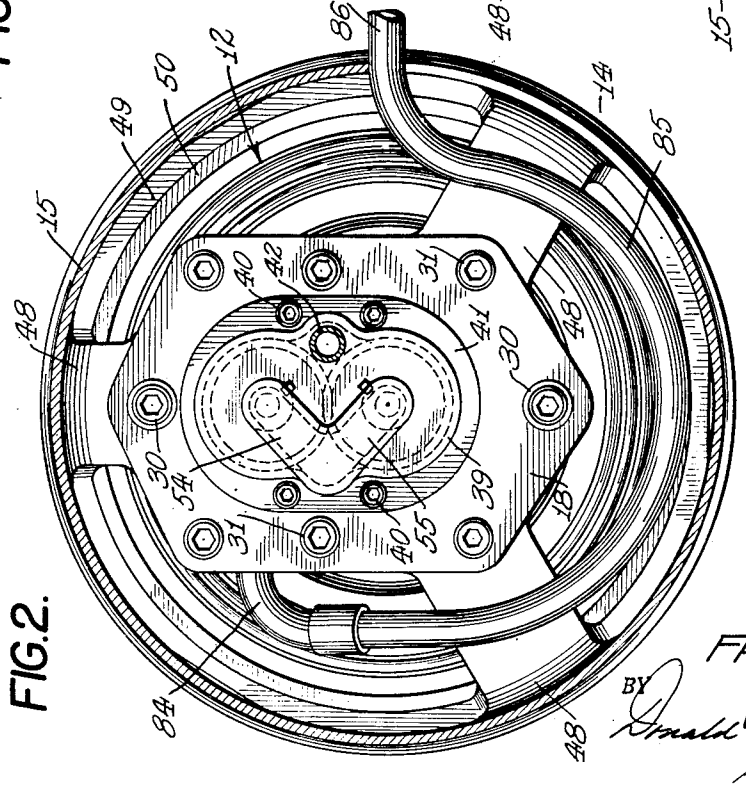

FIG. 2.

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March 20, 1951 F. BERRY 2,545,600

FLUID COMPRESSOR AND THE LIKE

Filed Aug. 21, 1946 5 Sheets-Sheet 2

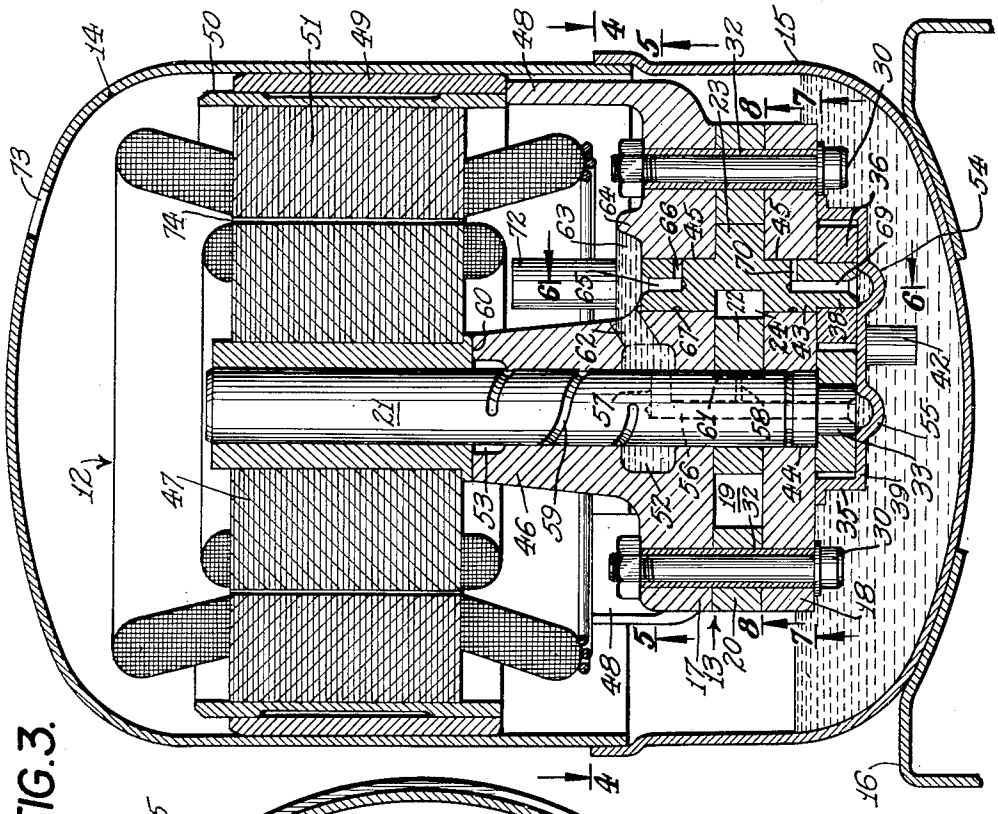

FIG. 3.

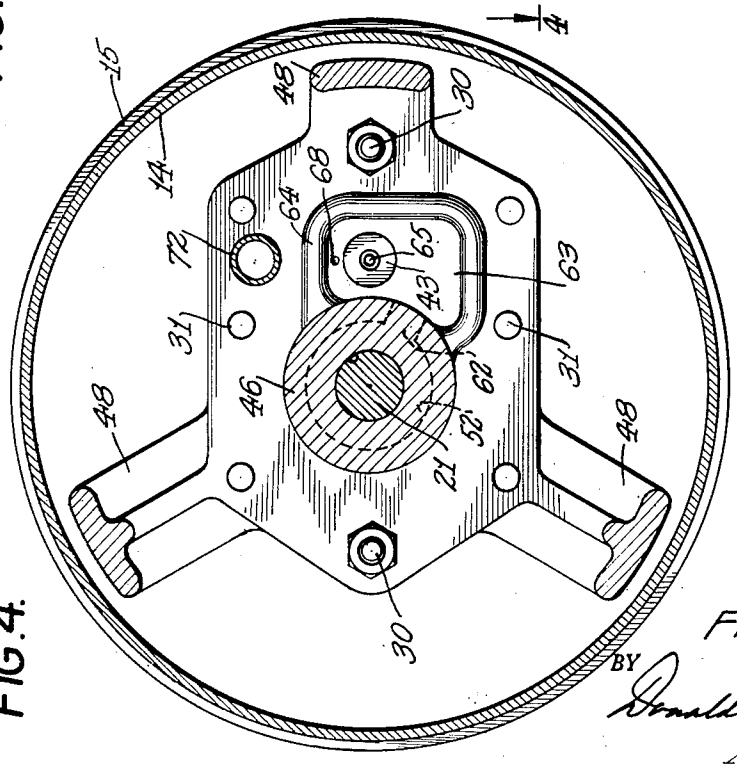

FIG. 4.

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March 20, 1951 F. BERRY 2,545,600

FLUID COMPRESSOR AND THE LIKE

Filed Aug. 21, 1946 5 Sheets-Sheet 3

FIG. 6.

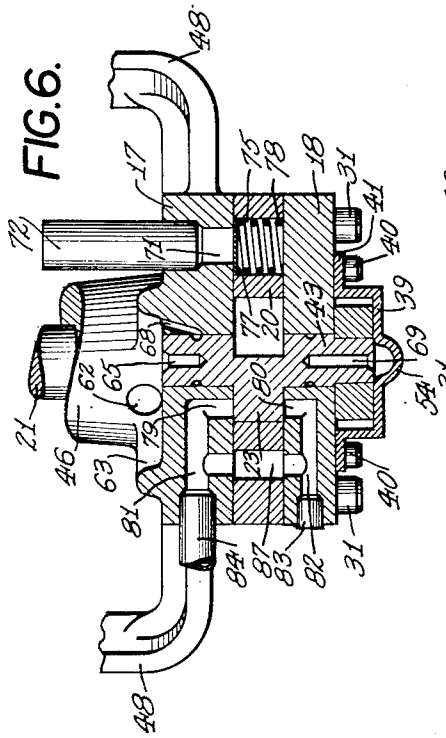


FIG. 7.

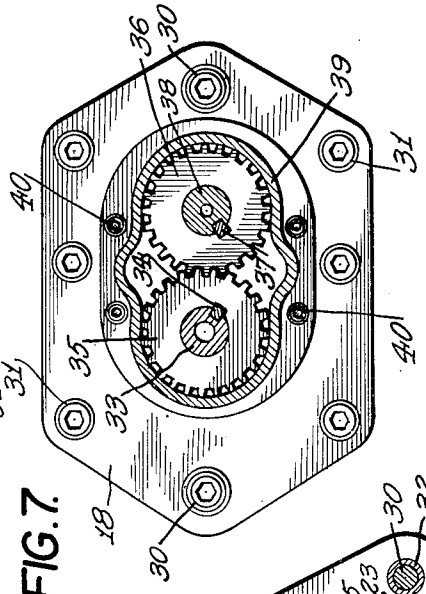


FIG. 8.

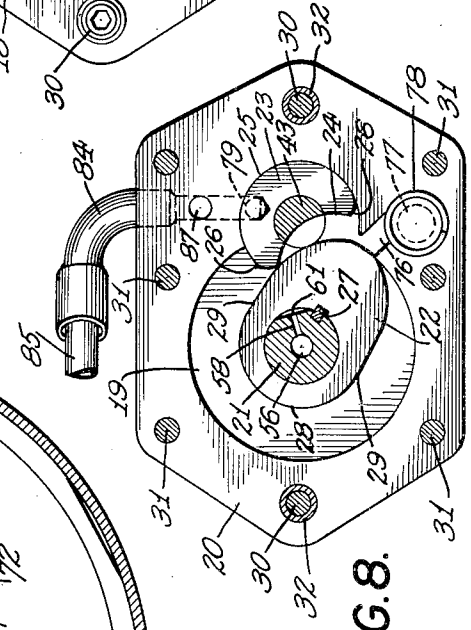
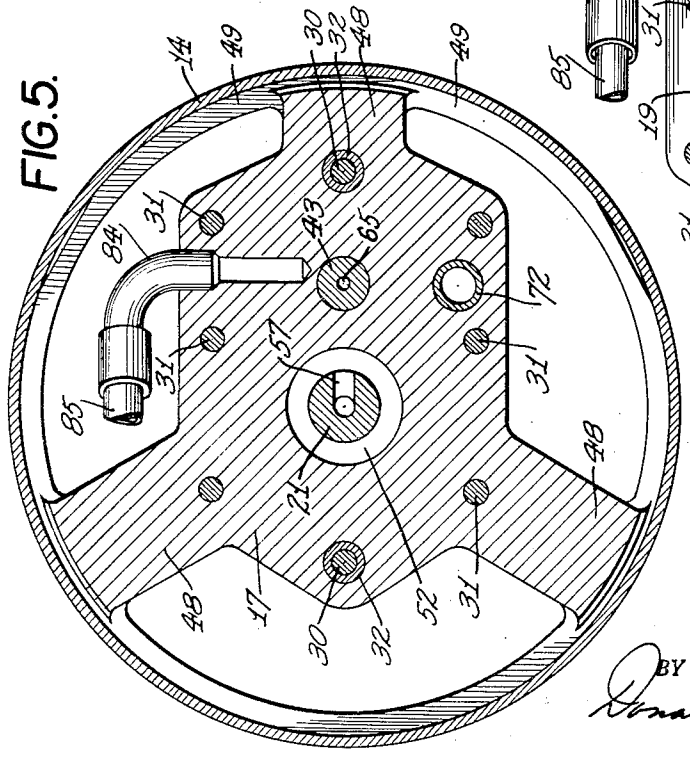


FIG. 5.



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March 20, 1951 F. BERRY 2,545,600

FLUID COMPRESSOR AND THE LIKE

Filed Aug. 21, 1946 5 Sheets-Sheet 4

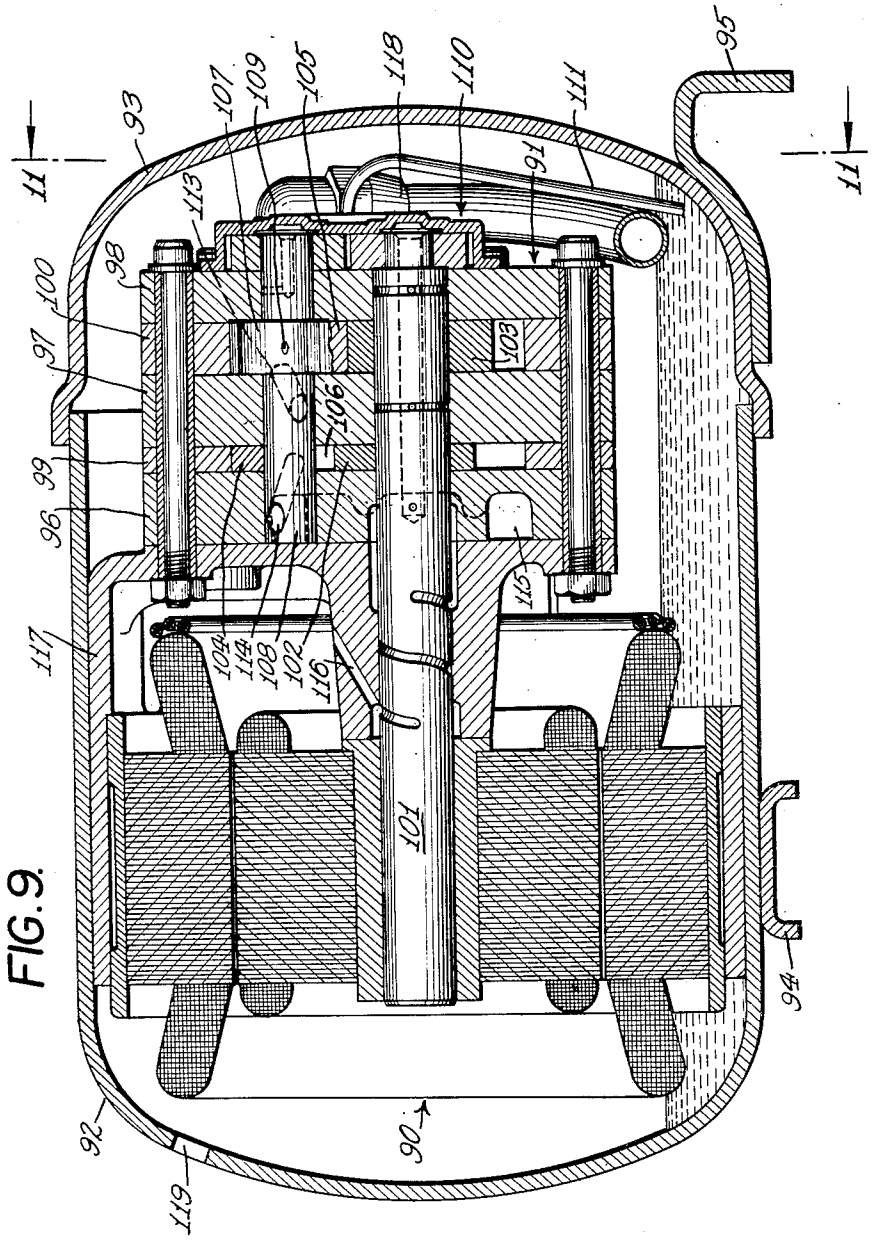

FIG. 9.

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March 20, 1951 F. BERRY 2,545,600

FLUID COMPRESSOR AND THE LIKE

Filed Aug. 21, 1946 5 Sheets-Sheet 5

FIG. 10.

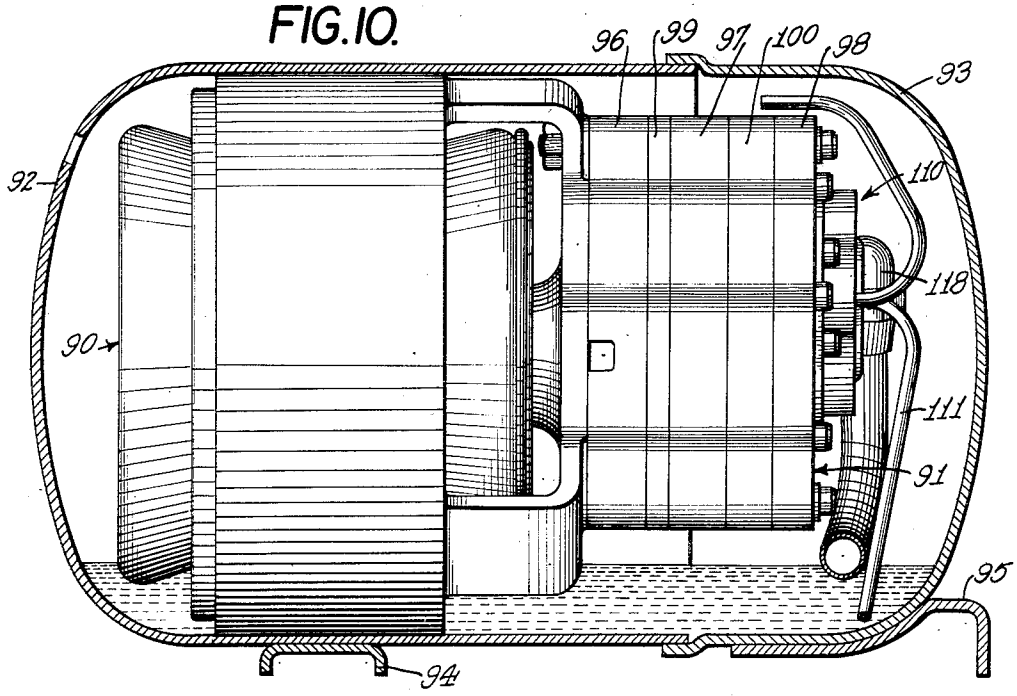
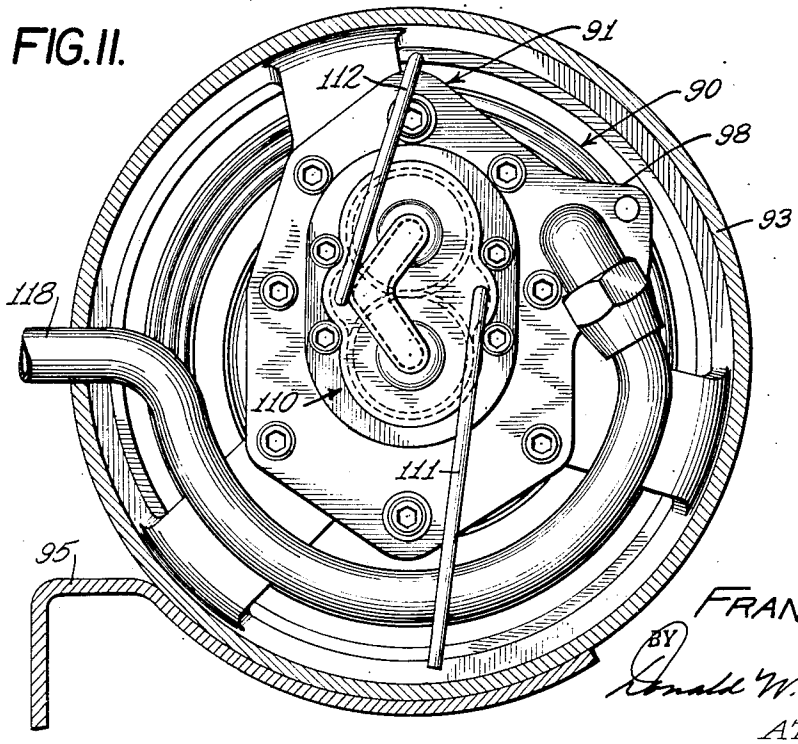


FIG. 11.



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Patented Mar. 20, 1951 2,545,600

UNITED STATES PATENT OFFICE

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FLUID COMPRESSOR AND THE LIKE

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Application August 21, 1946, Serial No. 692,002

5 Claims. (Cl. 230—150)

1

The invention relates to rotary fluid energy transforming devices such as air compressors or motors. It has special application to rotary compressors or motors of the rotary abutment type.

It is a leading object of my invention to provide an improved construction and arrangement of the pistons, rotary abutments and casing members of devices of the class described to secure high operating efficiency, simplicity of construction, and low manufacturing cost.

A further object is to provide a rotary compressor having a pressure-balanced discharge which will equalize pressure on both sides of the rotary abutment and thereby reduce end thrust.

Other objects and advantages of my invention will appear as the description proceeds.

In the drawings, which illustrate certain preferred embodiments of the invention:

Fig. 1 is a side elevational view of a single stage refrigerator compressor, and Fig. 2 is a bottom view thereof, taken as indicated at 2—2 in Fig. 1. In both of these views the hermetic shell in which the unit is encased is shown in cross section so as to reveal the general construction of the compressor and its operating motor.

Fig. 3 is a central vertical cross sectional view of the same unit, taken on the line 3—3 of Fig. 1.

Figs. 4, 5, 6, 7 and 8 are detail cross sectional views taken as indicated in Fig. 3 on the lines 4—4, 5—5, 6—6, 7—7 and 8—8, respectively.

Fig. 9 is a central vertical cross sectional view similar to Fig. 3, illustrating, as another embodiment of my invention, a multi-stage Freon compressor suitable for use in refrigeration.

Fig. 10 is a side elevational view of this multi-stage compressor with its encasing hermetic shell shown in cross section.

Fig. 11 is an end elevational view of the same unit, taken as indicated at 11—11 in Fig. 9.

The preferred form of my invention is well illustrated in its adaptation to single or multi-stage refrigerator compressors, so I have selected these for specific description. I have selected, further, refrigeration units in which the compressor and its operating motor are direct-connected and adapted for mounting in an hermetically sealed shell for dust-free operation either at atmospheric or superatmospheric pressures. This is by way of illustration only, and it will be understood that the invention is useful for many other applications.

The single stage compressor unit shown in Figs. 1 to 8, inclusive, comprises an electric motor

2

12 direct-connected to a compressor 13, the unit being mounted in a two-part shell 14, 15, carried by a suitable mounting bracket 16.

The compressor 13 comprises in its general arrangement longitudinally spaced casing members 17 and 18 (Figs. 1 and 3) forming the end walls of an annular cylinder chamber 19 and of an adjacent abutment chamber 25 (Fig. 8), and a spacer casing member 20 therebetween forming the outer peripheral walls of the cylinder and abutment chambers, a piston rotor comprising a shaft 21 and a piston 22 fixed thereto as by a key 27, and a rotary abutment 23 parallel to the shaft of the piston rotor having a recess 24 to clear the piston as it passes the abutment.

One of the important features of my construction is concerned with the form of the outer periphery of the rotary abutment 23 which, adjacent the edges of the piston recess 24 therein, is curved inwardly at 26 for sealing engagement with the piston. In my preferred construction the piston member surrounds the shaft 21 as shown clearly in Fig. 8, having a circular portion 28 and straight portions adjoining the circular portion. The rotary abutment 23 has a circular portion for rolling contact with the circular portion 28 of the piston rotor, and the inwardly curved portions 26 between the circular portion of the abutment and the piston recess 24 therein provide sealing engagement with the straight portions 29 of the piston member.

It will be observed that the spaced casing members 17 and 18 have opposed surfaces lying substantially entirely in a single plane and that the spacer casing member 20 has parallel surfaces lying substantially entirely in a single plane for engagement with the opposed surfaces of the spaced casing members 17 and 18; further, that the piston 22 and rotary abutment 23 have coplanar flat parallel ends lying adjacent the opposed surfaces of the spaced casing members. This arrangement makes it possible to machine and finish-grind the end walls of the piston and abutment chambers and the adjacent flat surfaces of the piston and abutment without the use of any special tools or fixtures because all the surfaces are perfectly flat and there are no projections on the piston or on any of the casing members 17, 18 and 20.

The three casing members 17, 18 and 20 are secured together, as by means of bolts 30 and machine screws 31 passing through aligned apertures therein, the latter having threaded engagement with the casing member 17. I prefer

to employ, also, hollow tubes or dowel pins 32 to secure accurate alignment of the parts during assembly.

The lower end of motor-compressor shaft 21 is of reduced diameter as at 33, and to it is keyed as at 34 (Fig. 7) a gear 35 meshing with a gear 36 keyed at 37 to the reduced end 38 of shaft 43 of rotary abutment 23. By this means the abutment 23 is driven at the same speed as the piston 22 but in the opposite direction. Thus as viewed in Fig. 8 the piston 22 rotates in a clockwise direction and the abutment 23 in a counter-clockwise direction.

The gears 35, 36 are enclosed by a cover plate or housing 39 secured to the casing member 18 as by means of screws 40 passing through the flange 41 of the housing 39. The gears 35, 36 fit the housing 39 in the manner shown in Fig. 7 to provide a gear pump lubricating the compressor as will be described further on. A short tube 42 projects from the end of the gear housing 39 to provide communication between the interior of the housing and a point well below the surface of the oil contained in the hermetic shell 14, 15.

Casing members 17 and 18 are bored at 44 and 45 to receive rotor shaft 21 and the shaft 43 of rotary abutment 23 respectively. Abutment 23 may be formed integrally with its shaft 43 or may be formed separately and fixed thereto as will be described more particularly with reference to the modified construction illustrated in Figs. 9 to 11. The top casing member 17 is formed with an extension 46 to support the armature 47 of motor 12. In my preferred construction, casing member 17 also is formed as an integral part of the housing for motor 12, having laterally and upwardly extending brackets 48 supporting an annular housing member 49 to receive the mounting ring 50 which carries the stator 51 of the motor. The stator 51 may have a press fit in the mounting ring 50 and the latter a press fit in the annular housing member 49. Further, the housing 49 may have a press fit in the upper shell 14.

The top casing member 17 and its extension 46 are provided with an annular oil chamber 52 surrounding the rotor shaft, and with an enlarged bore 53 at the upper end of the extension, also for lubricating oil. The lower part 15 of the shell serves as a reservoir for lubricating oil which is drawn in through the tube 42 at the bottom of the compressor by the gear pump 35, 36 from which it is forced through channelways 54, 55 of the pump housing (Fig. 2) to the lower ends of the rotor and abutment shafts 21 and 43. From the lower end of the rotor shaft 21 the oil is forced through a central bore 56 and thence through a transverse bore 57. Transverse bore 57 leads to the annular chamber 52 from which the oil is carried upwardly by a spiral groove 59 in the shaft 21. At its upper end spiral groove 59 discharges oil into the annular recess 53 for lubrication of the thrust bearing 60 of the armature. From the transverse bore 58, oil is discharged into depression 61 (Fig. 8) in the rotor shaft for lubrication between the ends of the piston 22 and side walls of the annular cylinder 19. Oil is discharged from the chamber 52 through an aperture 62 into a reservoir 63 at the top of the compressor formed by an upwardly extending rib 64 which at its ends adjoins extension 46 of the casing member. Oil from the reservoir 63 flows into a central bore 65 at the upper end of the rotor shaft 43 and thence through a transverse bore 66 to an annular groove 67 for lubrication of the upper end of the abutment shaft. Additional lubrication of the upper end of this shaft is provided by a bore 68 (Fig. 6). The lower end of abutment shaft 43 receives oil through the central bore 69 and transverse bore 70. Excess oil overflows from the reservoir 63 and runs back into the main reservoir at the bottom shell 15.

An important feature of the lubricating system I have disclosed is that it provides means for introducing oil at the inlet side of the cylinder and abutment chambers as at 61 so that oil is drawn into the compressor on the suction side, and effective lubrication of the piston and cylinder walls is secured notwithstanding the elevated pressures resulting from the action of the compressor.

Top casing member 17 is provided with an inlet passage 71 counterbored to receive an intake tube 72 extending within the field winding 51 of the motor (Figs. 3 and 6). The fluid to be compressed is drawn into the hermetic shell through an aperture 73 at its upper end, and on its way to the intake tube 72 passes through the clearance 74 between the rotor and stator of the motor, assisting in cooling the unit.

The spacer casing member 20 is apertured at 75 (Fig. 6) and is formed with a transverse passage 76 (Fig. 8) leading to the annular cylinder 19 at its juncture with the abutment chamber 25. A valve disc 77 is supported on the upper end of a coil spring 78 in aperture 75 and seals inlet passage 71 at such times as the fluid is not being drawn into the compressor.

The casing members 17 and 18 are provided with fluid outlets or exhaust ports 79, 80 leading from the abutment chamber 25 opposite each end of the rotary abutment in the opposed surfaces of the spaced casing members. These exhaust ports lead into transverse bores 81, 82. Transverse bore 82 in casing member 18 is stopped off by a plug 83, whereas transverse bore 81 in casing member 17 is counterbored to receive the end of a coupling 84 connected to discharge tube 85 for the compressed fluid. This discharge tube leads through an opening 86 in the shell (Fig. 2).

Aligned bores in the three casing members form a connecting passageway 87 between the transverse bores 81 and 82, connecting the fluid outlets 79, 80 at opposite sides of the abutment chamber to a common discharge. The provision of fluid outlets in the abutment chamber opposite each end of the rotary abutment in the opposed surfaces of the spaced casing members 17, 18 equalizes the pressure at the two ends of the abutment, thereby reducing end thrust.

It is believed that the operation of the compressor will be understood from the preceding description, but this may be further summarized as follows:

Motor 12, through its rotor 46 fixed to shaft 21, drives the piston 22 in a clockwise direction as viewed in Fig. 8, and through gears 35, 36 drives the rotary abutment 23 in a counter-clockwise direction. When the parts are in the position shown in Figure 8, the compression stroke begins. Fluid ahead of the piston is compressed against the abutment 23 which has sealing engagement with the piston as shown. Fluid to be compressed is drawn into the shell of the unit at 73, passes through the clearance between the rotor and stator of the motor at 74, intake tube 72, and passages 71, 75 and 76, where it is drawn into the space behind the piston. As the piston nears the end of its stroke, abutment 23 uncovers the fluid outlets 79, 80, and the compressed fluid passes out of the cylinder at each side of abut-

ment chamber 25 and flows through passages 81, 82, 87 into the discharge tube 85. The piston then passes through the clearance recess 24 of the abutment and a new stroke is begun. Sealing contact between the piston and abutment is maintained by contact between one of the straight side portions 29 of the piston and the corresponding inwardly curved portion 26 of the abutment until such time as the cylindrical portions of the piston and abutment are brought into rolling contact, and thereafter the other straight side portion 29 of the piston is brought into contact with the inwardly curved portion 26 at the other side of the abutment until the piston is ready to enter the recess 24 of the abutment.

Reference will now be had to Figs. 9, 10 and 11 illustrating, as another embodiment of my invention, a multi-stage Freon compressor suitable for use in refrigeration. The unit comprises an electric motor 90 direct-connected to a compressor 91, the unit being mounted in a two-part hermetically sealed shell 92, 93 carried by suitable mounting brackets 94, 95.

The compressor 91 comprises, in its general arrangement, spaced casing members 96, 97 and 98 forming the end walls of annular cylinder chambers and adjacent abutment chambers, spacer casing members 99 and 100 therebetween forming the outer peripheral walls of the cylinders and abutment chambers, a piston rotor comprising a shaft 101 and pistons 102 and 103 fixed thereto, and rotary abutments 104 and 105 parallel to the shaft of the piston rotor having recesses 106, 107 to clear the pistons as they pass the abutments. The abutments 104, 105 are secured to the abutment shaft 108 as by means of pins 109. The abutment recesses 106, 107 may extend part way into the shaft 108 as indicated in Fig. 9 for recess 107. Abutments 104 and 105 are each of the same thickness as the cooperating pistons 102, 103 and have coplanar flat parallel ends lying adjacent the opposed surfaces of the spaced casing members. As described in connection with the single stage compressor of Figs. 1 to 8, inclusive, this arrangement makes it possible to machine and finish-grind the end walls of the piston and abutment chambers and the adjacent flat surfaces of the pistons and abutments without the use of any special tools and fixtures because all the surfaces are perfectly flat and there are no projections on the piston or abutments, or on any of the casing members 96, 97, 98, 99, 100. In this embodiment, the motor housing member 117 is formed separately from the casing member 96 although this is not essential.

Means for lubricating the unit may be provided similar to the means described with reference to Figs. 1 to 8, inclusive, utilizing the gearing between the shafts 101 and 108 as a gear pump, indicated generally at 110, to draw oil from the reservoir provided by the bottom of the shell 92, 93 through tube 111. In the construction here shown the unit is mounted horizontally so that there is no overflow reservoir corresponding to the reservoir 63 shown in Fig. 3. However, excess oil passes out through the opening 116 between the motor and compressor. Also, there is a discharge directly from the gear pump casing through a tube 112 (Fig. 11) which discharges over the top of the compressor, this overflow discharge preventing the building up of excess pressure by the gear pump, while assuring a steady flow of the lubricant.

The casing members and motor housing are fastened together in any suitable manner such as by the means described with reference to the single stage compressor of Figs. 1 to 8, inclusive.

Operation of this unit is essentially the same as that described with reference to Figs. 1 to 8, inclusive, except, of course, that connecting passages must be provided between the two annular cylinders of the compressor. The fluid intake, shown at 118, communicates with the first stage cylinder in a manner similar to that illustrated in Fig. 8. The discharge from the first stage cylinder passes through outlet 113 in the abutment recess 107, flowing through the shaft 108 to a passage in the casing member 96, which in similar fashion communicates with the inlet of the second cylinder. From the second cylinder, the compressed gases are discharged from the abutment recess through an opening in the shaft 108 to an outlet 114 which in turn discharges into a passage in the casing member 96 through a muffler 115 therein, and finally is discharged to the space within the shell 92, 93 through a suitable opening in member 96. This particular unit is designed for operation at elevated pressures; i. e. the pressure within the shell 92, 93 is that of the compressed gases. A suitable outlet for the compressed gas is provided at 119, to which a fluid conduit may be connected as desired.

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 claims.

I claim:

1. A rotary fluid energy transforming device comprising longitudinally spaced casing members forming the end walls of an annular cylinder chamber and a spacer casing member therebetween forming the outer peripheral wall of said cylinder chamber, a piston rotor comprising a shaft and a piston member surrounding the shaft and fixed thereto, the piston member having a circular portion concentric with the shaft and straight portions tangent to said circular portion, a rotary abutment parallel to the shaft of the piston rotor having a circular portion for rolling contact with the circular portion of the piston rotor and a recess to clear the piston as it passes the abutment, the abutment also having inwardly curved portions between its circular portion and the piston recess therein, said inwardly curved portions providing sealing engagement with said straight portions of the piston member when the circular portions of the piston member and abutment are out of contact.

2. A rotary fluid energy transforming device comprising longitudinally spaced casing members forming the end walls of an annular cylinder chamber and a spacer casing member therebetween forming the outer peripheral wall of said cylinder chamber, a piston rotor comprising a shaft and a piston member surrounding the shaft and fixed thereto, the piston member having a circular portion concentric with the shaft and straight portions tangent to said circular portion, a rotary abutment parallel to the shaft of the piston rotor having a circular portion for rolling contact with the circular portion of the piston rotor and a recess to clear the piston as it passes the abutment, the abutment also having inwardly curved portions between its circular portion and the piston recess therein, said inwardly curved portions pro-

viding sealing engagement with said straight portions of the piston member when the circular portions of the piston member and abutment are out of contact, the piston member and rotary abutment having coplanar flat parallel ends lying adjacent the end walls of said casing members.

3. A rotary fluid energy transforming device comprising casing members forming adjacent cylinder and rotary abutment chambers, a piston rotor comprising a shaft and a piston member surrounding the shaft and fixed thereto, the piston member having a circular portion concentric with the shaft and straight portions tangent to said circular portion, a rotary abutment parallel to the shaft of the piston rotor having a circular portion for rolling contact with the circular portion of the piston rotor and a recess to clear the piston as it passes the abutment, the abutment also having inwardly curved portions between its circular portion and the piston recess therein, said inwardly curved portions providing sealing engagement with said straight portions of the piston member when the circular portions of the piston member and abutment are out of contact.

4. A rotary fluid energy transforming device comprising casing members forming adjacent cylinder and rotary abutment chambers, a piston rotor comprising a shaft and a piston fixed thereto, a rotary abutment parallel to the shaft of the piston rotor having a recess to clear the piston as it passes the abutment, a fluid inlet to the cylinder chamber at one side of the rotary abutment and fluid outlets in the abutment chamber opposite each end of the rotary abutment at the other side of the rotary abutment, and a bore positioned to introduce oil at a point between the ends of the piston and the end walls of the cylinder chamber toward the suction side of the cylinder and abutment chambers.

5. A rotary fluid energy transforming device comprising casing members forming adjacent cylinder and rotary abutment chambers, a piston rotor comprising a shaft and a piston fixed thereto, a rotary abutment parallel to the shaft of the piston rotor having a recess to clear the piston as it passes the abutment, a fluid inlet to the cylinder chamber at one side of the rotary abutment and a fluid outlet in the abutment chamber at its other side, and a bore positioned to introduce oil at a point between the ends of the piston and the end walls of the cylinder chamber toward the suction side of the cylinder and abutment chambers.

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