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FLUID COMPRESSOR UNIT

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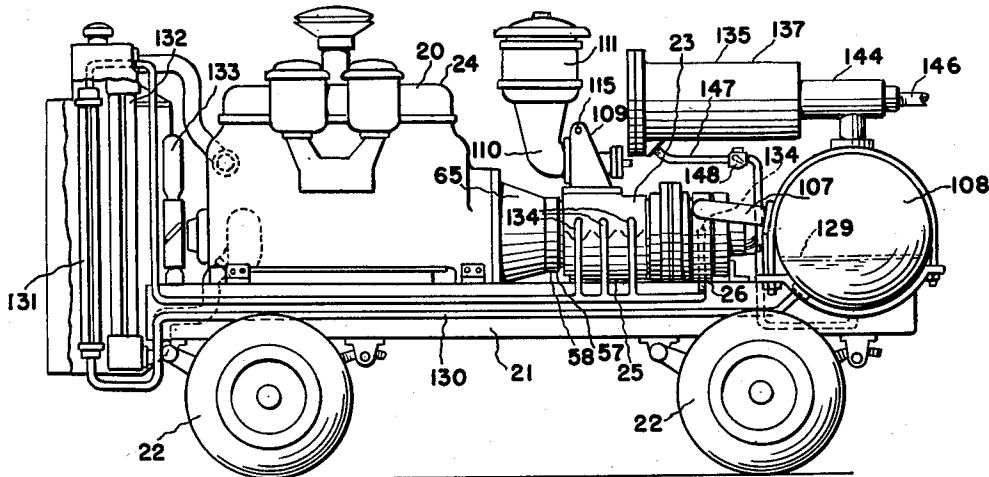


FIG. 1.

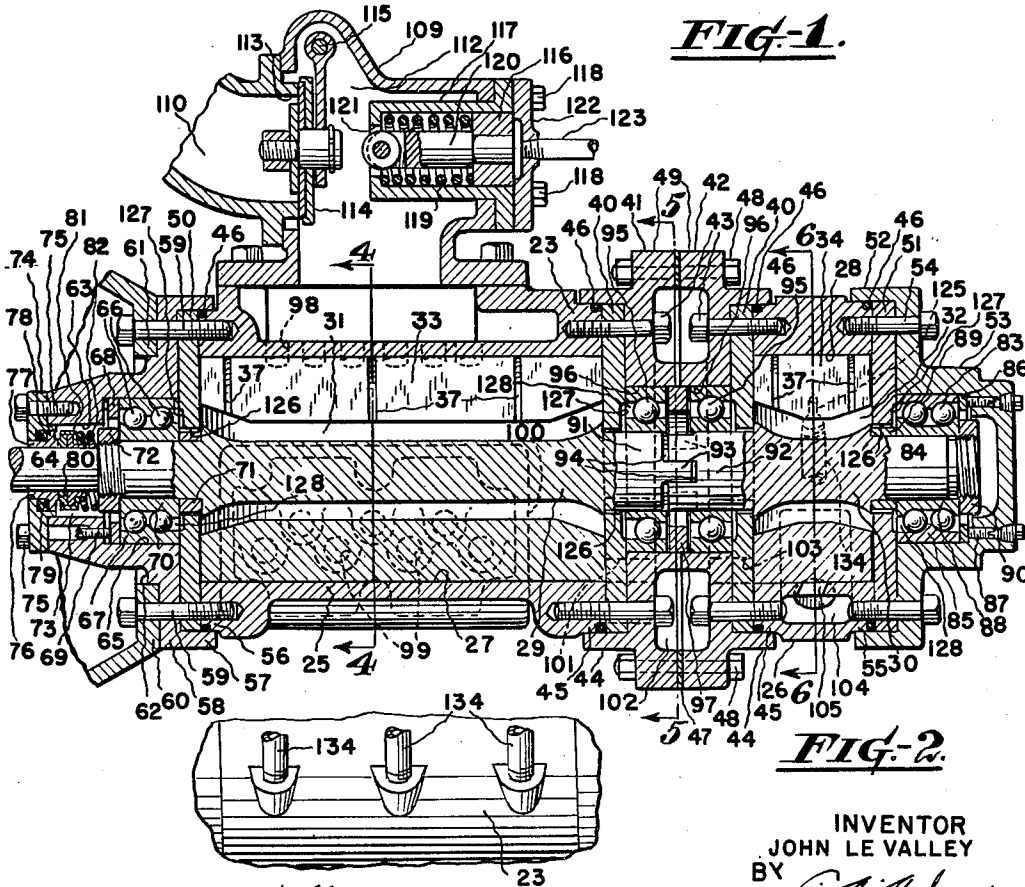


FIG. 2.

FIG. 3.

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FLUID COMPRESSOR UNIT

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9 Claims. (Cl. 230—158)

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This invention relates to compressor units, and more particularly to a fluid compressor unit of the portable type.

It is one object of the invention to minimize the development of heat in the compressor.

Another object is to obviate leakage of fluid medium across the cooperating surfaces of the vanes and the surfaces defining the bounding surfaces of the compression chambers of the compressor.

Further objects will be in part obvious and in part pointed out hereinafter.

In the drawings accompanying this specification and in which similar reference numerals refer to similar parts,

Figure 1 is a side elevation of a fluid compressor unit constructed and arranged in accordance with the practice of the invention,

Figure 2 is a longitudinal elevation, in section, of the fluid compressor of the unit,

Figure 3 is an enlarged fragmentary side view of the low pressure cylinder of the compressor,

Figures 4, 5 and 6 are transverse views taken through Figure 2 on the lines 4—4, 5—5 and 6—6, respectively, and looking in the direction indicated by the arrows,

Figure 7 is an enlarged view, in elevation, partly broken away, of a container serving as a reservoir for coolant and as a receiver for the final discharge output of the compressor and having a strainer superimposed thereon for filtering the coolant from the pressure fluid stream, and

Figure 8 is an elevation, partly broken away and somewhat enlarged, of a detail.

Referring more particularly to the drawings, 20 designates, in general, a fluid compressor unit which is mounted upon a frame 21 having wheels 22 to enable the unit 20 to be conveniently transported from place to place.

In the form of the invention shown, the compressor unit includes a compressor 23 of the rotary vane-type shown disposed endwise of the mounting 21 in tandem with an internal combustion engine 24, whereby it is driven, and has low and high pressure cylinders 25 and 26 positioned in end to end relation with respect to each other.

The cylinders 25 and 26 have cylindrical bores 27 and 28, respectively, for the accommodation of rotors 29 and 30, and in said rotors are radially extending slots 31 and 32 having, respectively, vanes 33 and 34 slidable therein to divide the bores 27 and 28 into compression chambers 35 and 36. The vanes 33 and 34 are provided on

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their leading surfaces with grooves 37 that extend from their outer to the inner edges to admit fluid medium beneath the vanes 33 and 34 for preventing the entrapment of fluid in the slots and to assure adequate lubrication of their surfaces and those of the vanes.

As a preferred arrangement, the bores 27 and 28 are located abaxially with respect to each other in the horizontal plane of the rotors. The rotors, on the other hand, are arranged coaxially with each other and the portions 38 and 39 of the bores 27 and 28 wherewith the rotors 29 and 30 have sealing engagement, are described on radii equal to those of the rotors plus running clearance and are of an extent approximately equal to the space between adjacent vanes.

Closures are provided for the inner ends of the bores 27 and 28 in the form of cylindrical plates 40 that seat flush against the ends of the cylinders and are pressed thereagainst by heads 41 and 42 which are, respectively, secured to the ends of the cylinders 25 and 26 by bolts 43. In order to preclude leakage of fluid along the cooperating surfaces of the plates 40 and the ends of the cylinders and at the same time minimize the use of sealing members in the assembly, the plates 40 are disposed within cylindrical skirts 44 at the outer ends of the heads 41 and 42. These skirts 44 also encircle the adjacent cylinder ends 45 which have packing members 46 arranged in their peripheral surfaces for sealing engagement with the inner surfaces of the skirts 44.

By reason of this arrangement, only one packing member is required at each cylinder end to preclude the leakage of fluid along the cooperating surfaces of the plates 40 and the cylinders and the inner heads to the atmosphere. A sealing member 47 is interposed between the heads 41 and 42 at their outer marginal portions, and the heads are secured together by bolts 48 extending through flanges 49 on the peripheries of the heads.

Similar closures are provided for the outer ends of the cylinders, that for the bore 27 being designated 50 and the one for the bore 28 being designated 51. The latter plate lies within a skirt portion 52 of a head 53 which is clamped against the plate 51 and the plate, in turn, is clamped against the outer end of the cylinder 26 by bolts 54. A sealing ring 46 in the periphery of the end 55 of the cylinder lying within the skirt 52 engages the inner surface of the skirt

to preclude the leakage of fluid from the outer end of the bore 28 to the atmosphere.

A sealing ring 46 performs a like function at the outer end of the cylinder 25. It encircles the end portion 56 of the cylinder 25 and is in sealing engagement with the inner surface of a skirt portion 57 carried by a head 58 bearing against the outer surface of the plate 50. The plate and the head 58 are fastened to the cylinder 25 by bolts 59 which also secure the adjacent end portion 60 of the casing of the engine 24 to the low pressure cylinder 25. The casing 60 is held coaxial with the compressor by an introverted flange 61 on the casing and a cylindrical boss 62 on the head 58 lying within the flange 61.

The head 58 is hollow having a bore 63, and a shaft portion 64 on the rotor extends through the bore for connection with the crankshaft (not shown) of the engine 24. The inmost portion 65 of the bore 63 is enlarged for the accommodation of an anti-friction bearing 66 the outer race 67 of which seats at one end against the plate 50, and an annular plate 68 is pressed against its opposite end by screws 69 threaded into the head 58 for holding the outer race 67 fixedly in position.

An additional function of the anti-friction bearing 66, apart from acting as a support for the rotor 29, is that of holding the rotor against axial movement. The inner race 70 of the bearing is accordingly attached fixedly to the shaft portion 64. It encircles the shaft portion in the usual manner and abuts, at one end, an annular spacer 71 that encircles the shaft portion 64 and seats against the end of the rotor 29. A nut 72 threaded onto the free end of the shaft presses the inner race 70 fixedly against the spacer 71 and the spacer 71, in turn, fixedly against the end of the rotor. The width of the spacer exceeds the width of the plate 50 by the sum of the clearances required at the ends of the rotor, and these clearances will remain as initially established for the reason that the outer race 67 is held immovable axially and the inner race 70 is restrained against such movement by the anti-friction members of the bearing.

The outer portion 73 of the bore 63 is covered by a plate 74 secured to the end of the head 58 by screws 75 and having a hole 76 to permit the shaft portion 64 to extend therethrough. The hole 76 contains an annular member 77 having a radial flange 78 at its inner end to overlie a packing ring 79 seated in the inner surface of the plate 74. Leakage along the shaft 64 is also prevented by the inner end of the member 77 which constitutes a sealing surface 80 and cooperates with a sealing ring 81 on the shaft 64. The sealing ring 81 is rotatable with the shaft and is urged into sealing engagement with the sealing surface 80 by a spring 82 encircling the shaft 64 and bearing against the nut 72.

The rotor 30 is held against endwise movement in the same manner as the rotor 29. The anti-friction bearing 83 for the shaft portion 84 of the rotor has its outer race 85 clamped fixedly against the side of the plate 51 by a ring 86 seating against the race 85, and screws 87 in the head 53 bearing against the ring 86. The inner race 88 of the bearing 83 also seats against a spacer 89 which determines the clearances at the ends of the rotor 30 and, with the inner race 88, is secured fixedly to the shaft by a nut 90.

As will be apparent, by providing the cylinders of the compressor with individual inner heads

41—42 and securing them together in the manner described, the several stages may be conveniently separated from each other for the purpose of inspection and repairs, if required. It is, accordingly, desirable that the rotors be also readily detachable from each other. To this end the inner shaft portions 91 and 92 of the rotors 29—30, respectively, are provided with clutch members 93 that are slidably interlocked with each other, so that each can be readily disengaged from the other, and serve to transmit rotary motion from the rotor 29 to the rotor 30.

Suitable clearances 94 may be provided between the opposed end surfaces of the shaft extensions 91 and 92 since, owing to the manner in which the rotors are held against endwise movement by the anti-friction bearings 82 and 83, it is not essential that the inner ends of the rotors abut each other to hold them against relative endwise movement.

The shaft portions 91—92 are also supported by anti-friction bearings designated 95. These bearings are disposed in bores 96 in the heads 41 and 42 and bear at their outer ends against the adjacent plates 40. They are suitably spaced with respect to each other to accommodate therebetween a ring 97 that has a close fit within the opposed ends of the bores 96 to assure the correct axial relationship of the bearings 95 and thereby maintain the rotors in coaxial alignment.

The inlet ports 98 through which the fluid medium enters the initial stage cylinder are arranged in rows extending endwise along the upper side of the cylinder 25, and on the side of said cylinder are discharge ports 99 that open into a manifold 100 which communicates through ports 101, in the plate 40 and the head 41, with a low point of a chamber 102 in the opposed surfaces of the heads 41—42. The chamber 102 is of annular shape, being defined by recesses in the opposed surfaces of the heads 41 and 42, and communicates, through ports 103 in the head 42 and the adjacent plate 40, with a partly annular chamber 104 in the cylinder 25 beneath the bore 28, and communication between the chamber 104 and the adjacent side of the bore 28 is afforded through ports 105 in the cylinder. The fluid discharged from the high pressure cylinder passes therefrom through discharge ports 106 and through a conduit 107 leading to a container 108 secured upon the frame 21, immediately adjacent the rearward end of the compressor.

The fluid medium intended to be compressed passes to the compressor through a casing 109 which is seated upon the cylinder 25 and has an inlet conduit 110 provided with a suitable filter 111 for preventing the entrance of solids into the compressor. The conduit 110 opens into a chamber 112 wherewith the inlet ports 98 communicate, and its outlet end 113 is controlled by a valve 114 in the form of a plate which is suspended from a pivot 115 so positioned that the valve will normally tend to overlie the outlet end 113, for closing it, but will be readily swung away and held unseated by the current of fluid flowing into the chamber 112.

To the end that the valve 114 may be forcibly placed and held in its closed position, as when the discharge pressure reaches a certain predetermined value, and in which case it is desirable that the compressor be unloaded, the casing is provided with actuating means comprising a piston 116 that is reciprocable in a cylinder 117 secured to the casing 109 by bolts 118. The pis-

ton 116 lies coaxial with the outlet 113 and is normally held out of engagement with the valve by a spring 119 interposed between the piston and the bottom of the cylinder 117.

The piston 116 carries an extension 120 that moves through an opening 121 in the bottom of the cylinder 117 for engagement with the valve 114. The bolts 118 securing the cylinder 117 to the casing 109 also serve to secure a plate 122 against the outer end of the cylinder, and a conduit 123 is threaded to said plate for conveying pressure fluid at the final discharge pressure to the piston 116 from a suitable source, as for example, the container 108. The flow of fluid through the conduit 123 may be controlled by any suitable device (not shown) capable of effecting its controlling functions in response to predetermined maximum and minimum pressures within the container 108.

Means are provided for introducing pre-cooled oil into the compression chambers 35 and 36 for cooling the fluid during compression and to cool and lubricate the surfaces of the rotors and the cylinders as well as the anti-friction bearings supporting the rotors. To these ends the cylinders 25 and 26 are provided with orifices 124 and 125, respectively, from which the oil issues in the form of a mist into the zones of maximum clearance between the rotors and the walls of the bores 27 and 28.

The orifices 124 are arranged in a row along the length of one side of the low pressure cylinder 25 and one orifice 125 is indicated on the opposite side of the high pressure cylinder 26. Any suitable number of orifices may be provided to assure the desired cooling effect and the delivery of an ample supply of oil to the anti-friction bearings which flows, in the present instance, from the ends of the bores through the apertures 126 in the plates 40, 50 and 51 through which the shaft portions of the rotors extend, these apertures being sufficiently larger than the shafts to provide the necessary flow areas. The clearances thus provided communicate, through recesses 127 in the outer surfaces of the end plates, with the spaces 128 between the inner and outer races of the bearings.

The supply of oil 129 used for this purpose is stored in the container 108. It is, therefore, subjected to the final discharge pressure of the compressor and is conveyed from the container by a conduit 130 leading to the lower end of a vertical cooler 131 at the front end of the frame 21 and closely adjacent the radiator 132 containing the cooling water for the engine 24. Owing to this arrangement, the air circulated by the engine fan 133 normally provided for cooling the water for the engine will also be circulated over the surfaces of the cooler 131 for cooling the oil flowing to the compressor.

The cooler 131 is shown as being of approximately the same height as the radiator 132. Its upper or outlet end lies at a higher elevation than the oil level in the container 108 so that the oil will normally tend to drain from the cooler back to the container and is connected to a continuation of the conduit 130 extending to the compressor 23 and having branches 134 leading to the orifices 124 and 125. In this connection it should be explained, moreover, that owing to the fact that the container 108 is in constant communication with the compressor, through the conduit 107, it is essential that the oil in the system be of such volume as to preclude the rising of its level within the container

to the height of the conduit 107 in order to prevent flooding of the compression chambers. Normally, during the operation of the compressor, the level of the oil in the container will be about midway between the conduit 107 and the bottom of the container, but this level will, of course, rise by reason of the difference in static heads in the cooler 131 and the container 108 when the compressor is idle.

In order to effect the removal of oil from the compressed fluid a strainer 135 is disposed over the discharge opening 136 of the container 108. The discharge opening 136 is located at the top of the container and opens into the casing 137 of the strainer to deliver the oil-laden compressed fluid to a series of discs 138 of suitable filtering material arranged in face-to-face relation throughout the major portion of the casing 137 but terminating near the free end of the casing 137 to define a spaced 139 therein for the reception of oil-free compressed fluid.

The discs 138 are held in the assembled position within the casing 137 by a conduit 140 that extends axially of the discs to convey the compressed fluid from the space 139. The conduit 140 has a flange 141 at one end to overlie the adjacent disc 138 and is threaded at its other end into a boss 142 in the casing 137 to hold the opposite end member of the disc assembly against an extension 143 of the portion 144 of the casing defining the passage 145 through which the fluid flows from the container 108 to the filter. The conduit 140 constitutes a portion of the discharge line for conveying the filtered pressure fluid from the strainer and communicates with a main discharge conduit 146 also threadably connected to the boss 142.

Any of the oil filtered from the compressed fluid that may find its way along the bottom of the casing 137 to the space 139 is returned to the container 108 by a conduit 147. This conduit leads from the bottom of the space 139 to the lowermost portion of the container 108. Owing to this arrangement, the difference in the static heads of the oil in the conduit 147 and the container 108 will be sufficient to assure the return of oil from the space 139 to the container, even though the pressure existing within the space 139 may be of a slightly lower value than that in the container 108, a condition that may be brought about by the slight resistance afforded by the filtering discs 138 to the passage of compressed fluid therethrough.

Preferably, a check valve 148 is arranged in the conduit 147 to prevent the injection of oil from the container through the conduit 147 into the space 139 by the pressure of the compressed fluid within the container.

Inasmuch as the oil is delivered to the compression chambers, and thus to the bearings, by the pressure existing within the container 108 it is essential that means be provided to assure the immediate creation of a pressure therein capable of promptly inducing oil flow when starting the compressor against an empty system, otherwise the bearings may become seriously damaged. In furtherance of this end, the discharge line of the container 108, in the present instance the outlet and of the conduit 140, is in the form of an orifice 149 through which the oil-free fluid passes from the conduit 140 to the discharge conduit 146.

The restriction imposed upon the pressure fluid by the orifice 149 need be of only small degree to assure a moderate pressure within the

container capable of causing the circulation of oil through the cooler 131 and the associated conduits to the compression chambers, whence it will be delivered to the anti-friction bearings. In actual practice it has been found that a pressure of approximately eight pounds at little or no discharge of fluid through the discharge line 146 is ample for forcing the oil through the system when the engine is accelerating to the normal speed, and that an orifice capable of producing this result will cause only a negligible pressure drop when the compressor is operating at the normal rate.

In the operation of the device, the fluid medium intended to be compressed and entering the low pressure cylinder through the inlet conduit 110 and associated channels, passes through the exhaust ports 99 into the manifold 100, thence through the ports 101, the annular chamber 102, the ports 103 into the chamber 104 and through the ports 105 into the high pressure cylinder. There it is compressed to a higher value and discharged through the conduit 107 into the container 108.

During this initial starting of the compressor, and while it is accelerating to normal speed, the resistance to flow of pressure fluid through the discharge conduit 146 afforded by the orifice 149 causes the prompt building up of a pressure within the container 108 capable of forcing oil from the container 108 through the conduit 130, the cooler 131, the branches 134 and the orifices 124 and 125 into the compression chambers of both the low and high pressure cylinders. A portion of this oil will immediately find its way from the compression chambers through the apertures 126 to the cooperating surfaces of the anti-friction bearings supporting the rotors.

The surfaces of the elements defining the compression chambers 35 and 36, as well as the surfaces of the slidable vanes 33 and 34 and those of the slots guiding them, will also be adequately lubricated so that no undue wear will be occasioned thereto. Thereafter, when the compressor reaches normal speed the higher pressure within the container 108 will continue to impel oil from the container and associated channels through the orifices 124 and 125 into the compression chambers in the form of a mist. The oil will be carried in that form by the compressed fluid through the channels connecting the discharge manifold of the low pressure cylinder with the high pressure cylinder and, owing to the arrangement of these passages and the fact that the fluid discharged by the low pressure cylinder remains in motion after being discharged from the low pressure cylinder, little or no oil will precipitate to collect as a liquid and be carried into the high pressure cylinder in that form.

Additional cooling oil is, of course, injected into the fluid medium in the compression chambers 36 and discharged, along with that previously entrained in the compressed fluid, through the conduit 107 into the container 108, whence it is carried by the compressed fluid through the passage 145 into the strainer 135. There, in passing through the filtering discs 138, the compressed fluid is freed of oil by the time it reaches the space 139. It then flows through the conduit 140, the orifice 149 and the discharge conduit 146 to the point of utilization or storage (not shown). Such oil as may precipitate through the filtering discs to the bottom of the strainer and find its way into the space 139 will drain through the conduit 147 into the bottom of the container 108.

The processes of spraying oil into the compression chambers and filtering the oil vapor from the compressed fluid will continue throughout the entire operating period of the compressor and whenever the compressor is brought to rest, and in which case the slidable vanes 33 and 34 will recede in their guide slots, pressure fluid will flow from the container 108 into the cylinders and the associated channels including the chamber 112 where it will act against the valve 114 and hold said valve in its closed position. The pressure fluid thus present within the compression chambers will equal that acting upon the oil 129 and will preclude the further injection of oil into the compression chambers.

If, on the other hand, the compressor is merely unloaded during operation, as by causing the piston 116 to move into engagement with the valve 114 and hold said valve in its closed position, the pressure fluid within the container 108 will continue to inject oil into the compression chambers. This is highly desirable since the first stage compressor then works at a high compression ratio which results in extremely high temperatures so that cooling is even more necessary than when the compressor is fully loaded.

I claim:

1. In a fluid compressor unit, low and high pressure cylinders arranged in end to end relation with respect to each other and each having inner and outer end heads, inlet and discharge passages for the cylinders, rotors in the cylinders for compressing fluid therein, means for introducing a cooling fluid into the fluid to be compressed in the cylinders, a chamber in the opposed surfaces of the inner heads to receive the cooling and compressed fluids from the low pressure cylinder and constituting a supply chamber for the high pressure cylinder, a container for cooling fluid to receive the cooling and compressed fluids discharged by the high pressure cylinder and having a discharge conduit, a conduit for conveying cooling fluid from the container to the cooling fluid introducing means, and means in the discharge conduit for straining the cooling fluid from the compressed fluid flowing therethrough.

2. In a fluid compressor unit, a compressor having low and high pressure cylinders and inlet and outlet passages for the cylinders, rotors in the cylinders, bearings for the rotors, a container for oil to receive the discharge output of the high pressure cylinder, a discharge conduit for the passage of pressure fluid from the container, conduit means for conveying oil from the container to the cylinders at the pressure existing in the container for cooling the fluid in the cylinders and for lubricating the bearings, and means in the discharge conduit for restricting the flow of pressure fluid from the container to assure a pressure therein of a value capable of forcing oil into the cylinders during the starting period of the compressor.

3. In a fluid compressor unit, a compressor having low and high pressure cylinders and inlet and outlet passages for the cylinders, rotors in the cylinders, bearings for the rotors, a container for oil to receive the discharge output of the high pressure cylinder, a discharge conduit for the passage of pressure fluid from the container, conduit means for conveying oil from the container to the cylinders at the pressure existing in the container for cooling the fluid in the cylinders and for lubricating the bearings, and an orifice in the discharge conduit for restrict-

ing the flow of pressure fluid from the container to assure a pressure therein of a value capable of forcing oil into the cylinders during the starting period of the compressor.

4. In a fluid compressor unit, a compressor having low and high pressure cylinders and inlet and discharge passages for the cylinders, rotors in the cylinders for compressing fluid therein, a container for oil to receive the discharge output of the high pressure cylinder and having a discharge conduit, conduit means connected between the cylinders and said container for conveying oil from the container to the cylinders for cooling the fluid therein, a strainer in the discharge conduit for straining oil from the pressure fluid and being located at a higher elevation than the oil in the container, and a conduit leading from the strainer to the container for returning thereto oil filtered from the pressure fluid by the strainer.

5. In a fluid compressor unit, a compressor having low and high pressure cylinders and inlet and discharge passages for the cylinders, rotors in the cylinders for compressing fluid therein, a container for oil to receive the discharge output of the high pressure cylinder, means communicating the interior of the cylinders with said container at a point below the liquid level therein, an outlet at the top of said container for the passage of pressure fluid and entrained oil from the container, a strainer superposed upon the container to receive the pressure fluid flowing through the outlet opening and to strain oil from such pressure fluid, and a conduit leading from the strainer to a low point in the container for the oil filtered from the pressure fluid by the strainer.

6. In a fluid compressor unit, a compressor having low and high pressure cylinders and inlet and discharge passages for the cylinders, rotors in the cylinders for compressing fluid therein, means for introducing oil into the cylinders for cooling the fluid being compressed, a container for oil to receive the compressed fluid and entrained oil from the high pressure cylinder and having an outlet opening at the top thereof, conduit means for conveying oil from the container to the oil introducing means, a strainer above the container to receive the pressure fluid flowing through the outlet opening and to strain oil from such pressure fluid, a conduit leading from the strainer to a low point in the container for conveying thereto by gravity flow the oil filtered from the pressure fluid by the strainer, a conduit for conveying pressure fluid from the strainer, and an orifice in the last-mentioned conduit for restricting the flow of pressure fluid from the container to assure a pressure therein of a value capable of forcing oil through the oil introducing means into the cylinders during the starting period of the compressor.

7. In a fluid compressor unit, a compressor having low and high pressure cylinders arranged in end to end relation with respect to each other and having inlet and discharge passages, heads for the cylinders, rotors in the cylinders for compressing fluid therein, inner and outer shaft portions on the rotors, means on the inner shaft portions slidably interlocked with each other for transmitting rotary motion from one rotor to another, antifriction bearings on the outer shaft portions having inner and outer races, spacers

interposed between the rotors and the inner races, means on the shaft for clamping the inner races firmly against the spacers and the spacers against the rotors, and means for clamping the outer races fixedly against the outer heads to prevent longitudinal movement of the rotors.

8. In a fluid compressor unit, a compressor having low and high pressure cylinders arranged in end to end relation with respect to each other and having inlet and discharge passages, heads for the cylinders, rotors in the cylinders for compressing fluid therein, inner and outer shaft portions on the rotors, means on the inner shaft portions slidably interlocked with each other for transmitting rotary motion from one rotor to another, antifriction bearings on the outer shaft portions having inner and outer races, means for holding the inner races fixedly upon the outer portions of the shaft in spaced relation with respect to the rotors, and means for clamping the outer races fixedly against the outer heads to prevent longitudinal movement of the rotors.

9. In a fluid compressor unit, a compressor having low and high pressure cylinders arranged in end to end relation with respect to each other and having inlet and discharge passages, rotors in the cylinders having inner and outer shaft portions, means on the inner shaft portions slidably interlocked with each other for transmitting rotary motion from one rotor to another, heads for the outer ends of the cylinders having cavities to receive the outer shaft portions, walls in the heads between the cavities and the cylinders having apertures to permit the outer portions to extend therethrough into the cavities, spacers on the shaft portions lying within the cavities and exceeding the walls in width in the sum of the clearances at the ends of the associated rotor, anti-friction bearings on the shaft portions lying within the cavities having inner and outer races, means on the shaft for clamping the inner races firmly against the spacers and the spacers firmly against the rotors, and means for clamping the outer races firmly against the walls to prevent longitudinal movement of the rotors.

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