March 14, 1939. C. S. SORENSEN 2,150,347

COMPRESSOR

Filed Jan. 18, 1937 3 Sheets-Sheet 1

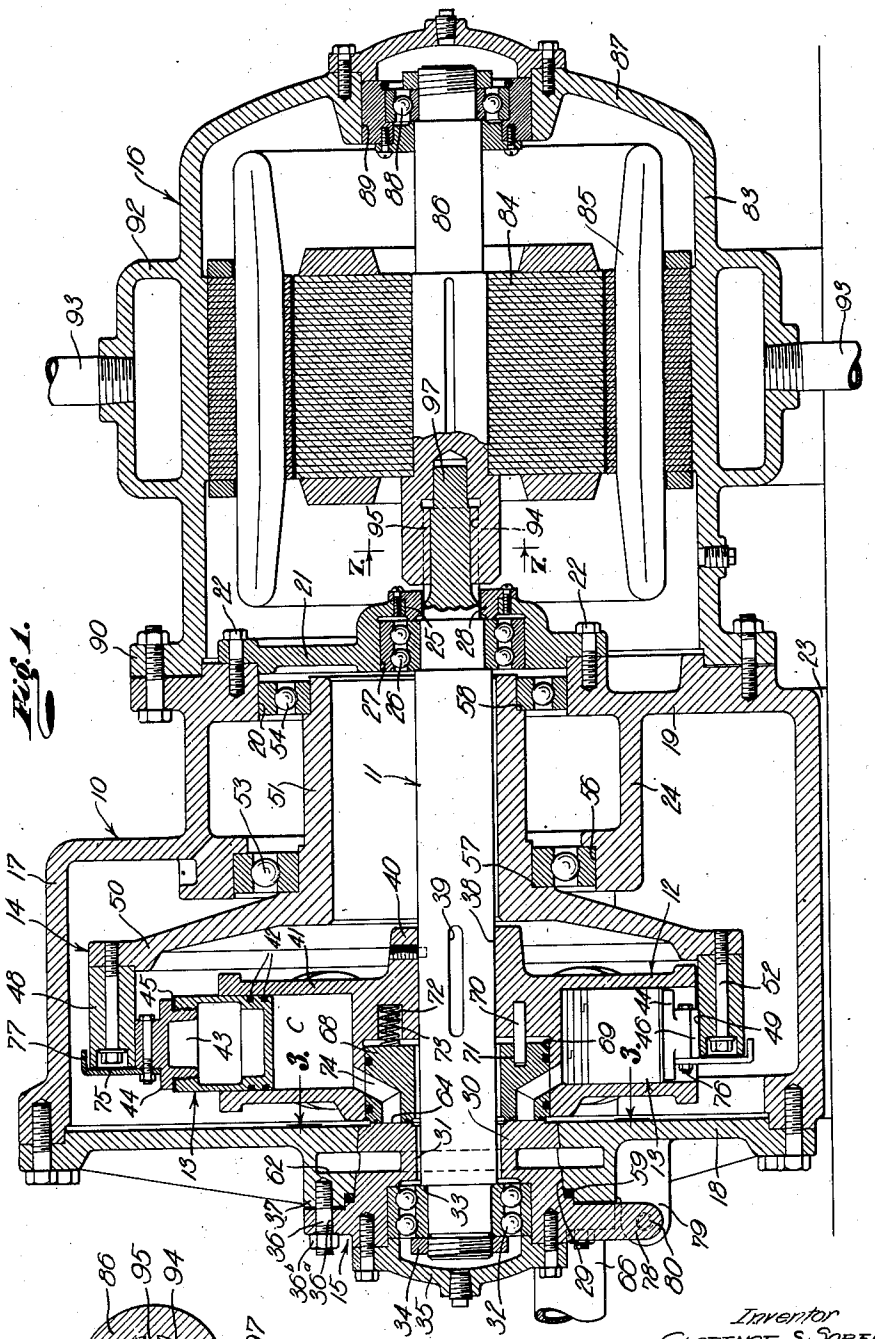


Fig. 1.

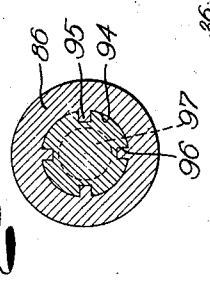


Fig. 2.

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Fig. 2.

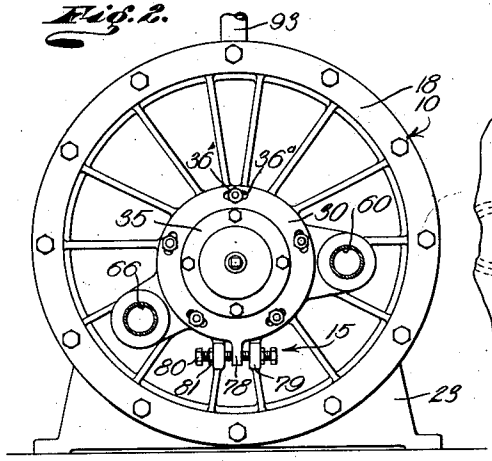


Fig. 3.

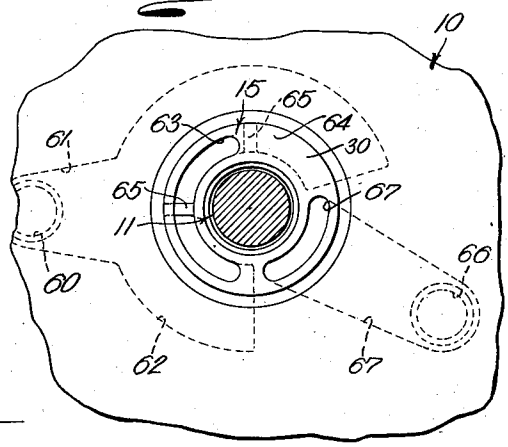
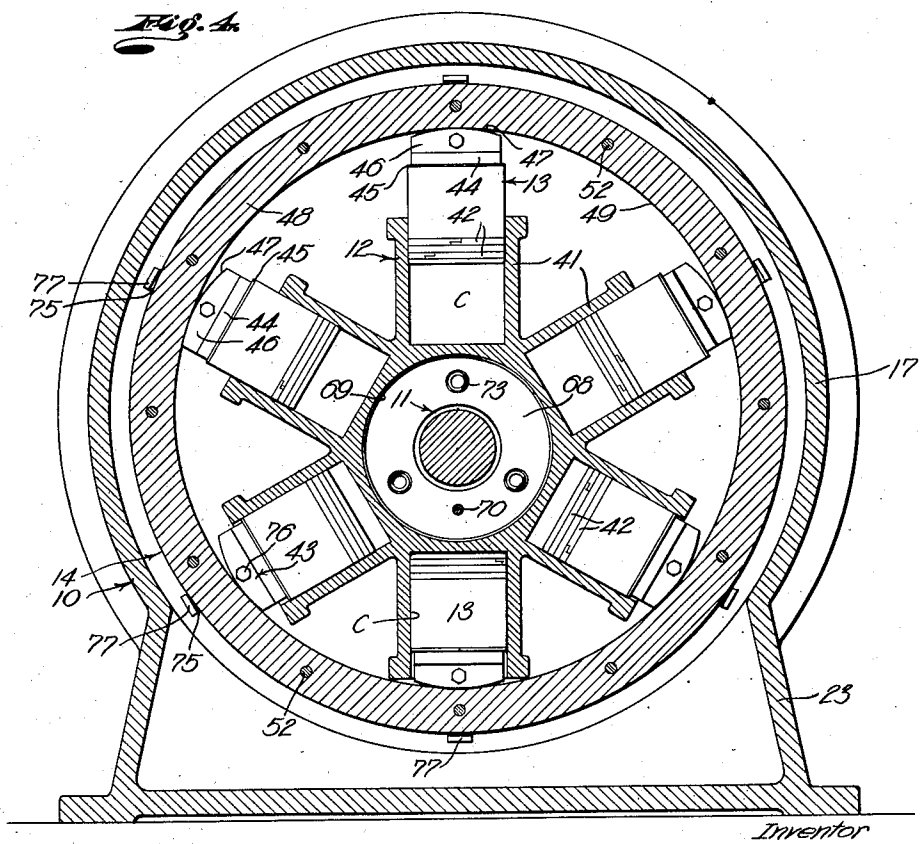


Fig. 4.



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Fig. 5.

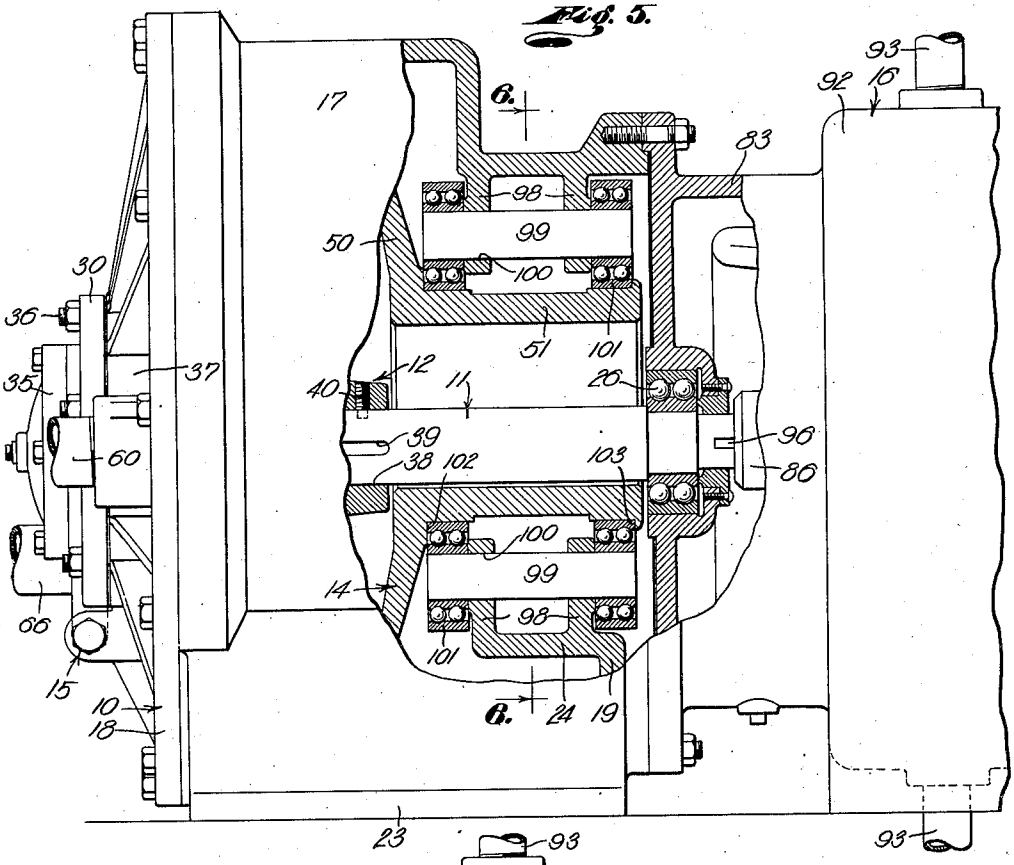
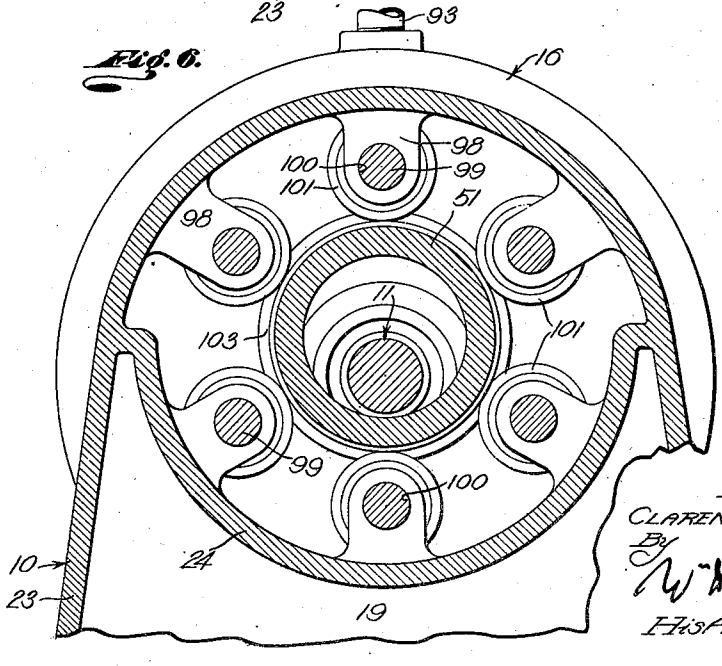


Fig. 6.



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UNITED STATES PATENT OFFICE

2,150,347

COMPRESSOR

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Application January 18, 1937, Serial No. 121,056

6 Claims. (Cl. 230—177)

This invention relates to fluid handling machines and relates more particularly to compressors. A general object of the invention is to provide a practical, improved and very efficient compressor of the rotary type.

Another object of this invention is to provide a compressor or like mechanism of the rotary type and embodying reciprocable pistons that is characterized by having all its rotating parts dynamically balanced whereby the inertia and forces set up by the rotation of the parts are all equalized or balanced.

Another object of this invention is to provide a compressor of the character mentioned in which the rotating cylinder block and the eccentric ring for effecting operation of the pistons in the cylinders are both dynamically balanced and are individually supported for rotation to rotate with a minimum of friction and expenditure of power.

Another object of this invention is to provide a compressor of the character mentioned embodying novel and very effective means for rotatably supporting the ring in eccentric relation to the axis of the cylinder block.

Another object of this invention is to provide a compressor of the character mentioned embodying novel and very simple means for associating the pistons with the eccentric ring that may allow relative turning between the ring and the pistons and yet retain the pistons in their proper relation to the ring.

Another object of this invention is to provide a compressor of the character mentioned embodying a practical and long wearing valve means for controlling the inlet and discharge of the fluid.

Another object of this invention is to provide a compressor of the character mentioned in which the valve means may be easily and quickly regulated.

Another object of this invention is to provide a compressor of the character mentioned embodying simple means for releasably connecting the main compressor shaft with the shaft of a motor or other power unit that permits the easy disconnection of the motor from the compressor proper.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a central longitudinal detailed sectional view of the compressor provided by this invention. Fig. 2 is a reduced end view of the compressor. Fig. 3 is a fragmentary vertical detailed sectional view taken as indicated by line 3—3 on Fig. 1. Fig. 4 is a transverse detailed sectional view illustrating the cylinder block and the pistons. Fig. 5 is a fragmentary side elevation with portions broken away to illustrate an alternative or modified mounting for the eccentric ring. Fig. 6 is a fragmentary vertical detailed sectional view taken as indicated by line 6—6 on Fig. 5 and Fig. 7 is a transverse sectional view of the connection between the main shaft and the motor shaft taken as indicated by line 7—7 on Fig. 1.

The compressor provided by this invention includes, generally, a housing 10, a shaft 11 extending through the housing 10, a cylinder block 12 on the shaft 11, pistons 13 operable in the cylinders C of the block 12, a ring 14 cooperating with the pistons 13 and supported in the housing 10 in eccentric relation to the cylinder block 12 to cause operation of the pistons, regulable valve means 15 for controlling the flow of fluid to and from the cylinders C and a power unit or motor 16 driving the compressor shaft 11.

The housing 10 is a hollow structure containing the cylinder block 12 and the ring 14 and supporting the shaft 11 and the valve means 15. The housing 10 in the preferred form of the invention includes a generally cylindrical main section 17 closed at one end by a bolted on plate 18 and having an end wall 19 at its other end. The end portion of the housing section 17 adjacent the end wall 19 is reduced in diameter or height as best illustrated in Figs. 1, 5 and 6. The housing of the motor 16 is secured to the end wall 19 as will be hereinafter described. A comparatively large opening 20 in the end wall 19 is closed by a plate 21. The plate 21 may be secured to the end wall 19 by suitable bolts or screws 22. The housing section 17 may have suitable base or standard flanges 23. An annular and substantially cylindrical flange 24 projects inwardly from the end wall 19. The upper portion of the flange 24 may merge with the upper wall of the housing section 17. The flange 24, the opening 20 and the plate 21 are offset or eccentric with relation to the longitudinal axis of the housing 10. The housing 10 is entirely closed and may contain a suitable lubricant.

The shaft 11 carries or drives the cylinder block 12 and extends longitudinally and centrally through the housing 10. The shaft 11 extends through an eccentric opening 25 in the plate 21 and projects from the housing 10 for connection with the shaft of the motor 16. A suitable bearing 26 is set in a socket 27 in the plate 21 to rotatably support the end por-

tion of the shaft 11. The bearing 26 may surround a reduced portion of the shaft 11 and may take end thrusts from the shaft in one direction. A ring 28 is secured in the opening 25 and engages against the outer end of the bearing 26. The shaft 11 extends completely through the housing 10 to project through the end plate 18. In accordance with the invention the end plate 18 has a central tapered opening 29 receiving a correspondingly tapered block 30 which in turn is provided with an opening 31 freely receiving the shaft 11. The shaft 11 has a reduced end portion rotatably supported by a bearing 32 in the block 30. The bearing 32 may engage against a shoulder 33 and a nut 34 on the shaft 11 to take end thrusts from the shaft. The block 30 carries a suitable cap 35 which closes the outer end of its opening 31 and retains lubricant for the bearing 32. The block 30 is an element of the valve means 15. At present it is believed sufficient to state that the valve block 30 is secured to the end plate 18 by studs or screws 36 threaded into openings in a hub or boss 37 on the end plate 18. It will be noted that the compressor shaft 11 is rotatably supported at its opposite ends by the bearings 26 and 32.

The cylinder block 12 is the principal rotating element of the compressor. The block 12 is preferably an integral member as illustrated. The cylinder block 12 rotates with the shaft 11 and is suitably fixed or keyed to the shaft adjacent the inner side of the end plate 18. A central opening 38 in the cylinder block 12 receives the shaft 11. In the arrangement illustrated the shaft 11 has longitudinal grooves 39 receiving threaded set pins 40 on the block 12 which fix the cylinder block to the shaft. The cylinder block 12 is bored to have the cylinders C. The cylinders C are radial openings being radial with respect to the longitudinal axis of the shaft 11. It is a feature of the invention that the cylinder block 12 is dynamically balanced. Further, the block 12 is preferably light in weight and formed to remain as cool as possible. The cylinder block 12 is provided with a multiplicity of circumferentially spaced parts 41 projecting radially outward relative to its axis of rotation. The radially projecting parts 41 are equally or symmetrically spaced and the cylinders C are provided in the parts 41. In the case illustrated there are six equally spaced cylinder parts 41 each provided with a cylinder C. The cylinders C extend into the outer ends of the cylinder parts 41 being in the nature of cylindrical sockets or bores closed at their inner ends and open at their outer ends to receive or carry the pistons 13. The cylinders C, of course, are of equal size. It will be noted that the cylinder block 12 is a simple light-weight member and is diametrically balanced so that its rotation imposes a minimum stress on the shaft 11 and the shaft bearings.

The pistons 13 are provided to reciprocate in the cylinders C to pump or compress the fluid handled by the machine. In practice the pistons 13 may be simple structures as illustrated. The pistons 13 are closed at their inner ends by integral imperforate heads and suitable rings 42 are provided on the pistons 13 to slidably seal with the walls of the cylinders C. The outer ends of the pistons 13 are closed by plug-like heads 43. The heads 43 have radial annular flanges 44 opposing the outer ends of the pistons 13. In accordance with the invention the heads 43 are adjustably secured to the pistons 13. The heads 43 are threaded into the pistons 13 and laminated shims 43 are provided between the flanges 44 and the outer ends of the pistons 13. The pistons 13 and their heads 43 may be adjusted with respect to one another by varying the thickness of the shims 45. Shoes 46 are provided on the piston heads 43 for cooperating with the ring 14. The shoes 46 may be integral with the piston heads 43 and have curved convex outer surfaces 47 for cooperating with the interior of the ring 14 as will be subsequently described.

The ring 14 is provided to cooperate with the shoes 46 of the pistons 13 to effect the operation of the pistons. The active portion of the ring 14 surrounds the cylinder block 12 while the supporting portion of the ring 14 extends into the internal housing flange 24 to be supported therein. The ring 14 includes a cylindrical tubular section 48 surrounding the cylinder block 12 and having a finished cylindrical internal surface 49 for slidably cooperating with the surfaces 47 of the shoes 46. The ring 14 further includes a disc-like section 50 having a cylindrical tubular sleeve 51 extending axially into the housing flange 24. The ring section 48 may be attached to the section 50 by suitable screws 52.

As described above, the flange 24 is eccentric relative to the axis of the housing 10 and the sleeve 51 is rotatably supported in the flange 24 so that the ring 14 is rotatable about an axis parallel with and spaced from the axis of rotation of the cylinder block 12 and the shaft 11. In the construction illustrated in detail in Fig. 1 the sleeve 51 is rotatably supported by an antifriction bearing 53 in the inner portion of the flange 24 and a somewhat smaller bearing 54 in the opening 20 in the housing end wall 19 at the outer end of the flange 24. The inner end portion of the flange 24 may have an inwardly extending rim provided with a groove 56 carrying the bearing 53. The bearings 53 and 54 may cooperate with shoulders 57 and 58, respectively, of the sleeve 51 to receive end thrusts from the ring 14.

It will be observed that the ring 14 just described is supported in the housing 10 for free rotation and has its cylindrical internal surface 49 engageable by the shoes 46 of the pistons 13 which engagement may cause rotation of the ring 14 when the cylinder block 12 is rotating. It is believed that it will be apparent how the ring 14 having its axis of rotation spaced from the axis of rotation of the cylinder block 12 cooperates with the piston shoes 46 to successively cause inward movement of the pistons in the cylinders. The outward movement of the pistons is caused by centrifugal force or fluid pressure in the cylinders, or both. It will be seen that by varying the thickness of the shims 45 the innermost positions of the pistons 13 relative to the bottoms of the cylinders C may be adjusted or regulated as found most desirable. It is important to note that the above described ring 14 is symmetrical and dynamically balanced and rotatably supported in such a manner that it imposes a minimum of stress on the bearings and housing parts.

The invention provides simple means for loosely connecting the pistons 13 with the ring 14 to prevent the pistons from falling inwardly in the cylinders C when the operation of the compressor is suspended. This means includes a hook-like

member 75 attached to the outer end of each piston shoe 46 by a screw or bolt 76. The members 75 extend outwardly at the end of the ring section 48 and each has a finger 77 projecting axially at the outer periphery of the ring section. The members 75 do not engage the end of the ring section 48. The fingers 77 are normally clear of the periphery of the ring section 48 but may engage against the ring section to prevent the pistons 13 from falling or moving inwardly in the cylinders C when the compressor is stopped.

The valve means 15 is provided to control the admission and exhaust of the fluid from the cylinders C. It is a feature of the invention that the valve means 15 includes a minimum number of simple parts. The means 15 includes the valve block 30 mentioned above. The tapered block 30 is tightly clamped in the tapered opening 29 by the studs or bolts 36 to tightly seal with the wall of the socket. A sealing washer or ring 59 may be clamped between opposing shoulders of the block 30 and the socket 29 to assure a perfect seal. A suction or inlet line 60 communicates with a port 61 extending radially into the boss 37 of the end plate 18. A curved or circumferential port 62 extends through the engaging telescoping portions of the boss 37 and the block 30 and has communication with the radial port 61. The port 62 is curved concentric with the axis of the shaft 11 and is of substantial length and radial extent so that the fluid flowing therethrough serves to cool the valve means 15. A curved concentric port 63 of reduced width and length is provided in the inner face 64 of the valve block 30 and has extensive communication with the port 62. The port 63 is preferably slightly less than 180° in circumferential extent. The inner surface or face 64 of the valve block 30 is finished and smooth. Webs 65 may extend through the port 62 to connect the parts of the block 30 separated by the port.

An outlet or discharge line 66 communicates with a radial port 67 extending into the boss 37. The port 67 continues through the boss 37 and the block 30 to have its inner end at the inner surface 64 of the valve block. The inner end of the port 67 is of the same width as the port 63 and has the same curvature as the port 63. The discharge port 67 is somewhat shorter than the inlet port 63 being only substantially 90° in circumferential extent at the inner surface 64 of the valve block 30. The discharge port 67 does not occur in opposite relation to the port 63 but has one end in spaced adjacent relation to an end of the port 63. This relationship is clearly illustrated in Fig. 3 of the drawings.

The valve means 15 further includes a valve block or member 68 arranged in a socket 69 in the cylinder block 12 to have its outer end oppose the inner surface 64 of the block 30. In accordance with the invention the member 68 has limited axial movement in the socket 69 but is made to turn with the cylinder block 12. One or more pins 70 project from the inner wall of the socket 69 and slidably fit openings 71 in the member 68 to cause the member to turn with the cylinder block. Spring means is provided to urge the member 68 outwardly to have its outer end in sealing contact with the surface 64 of the valve block 30. In the preferred construction illustrated a plurality of spaced bores 72 is provided in the bottom of the socket 69. The bores 72 receive coiled springs 73 which engage against the inner end of the valve member 68 to hold the member outwardly so that its outer end seals against the surface 64 of the block 30. Ports 74 extend from the inner ends of the cylinders C to the outer face or end of the valve member 68. A single port 74 communicates with each cylinder C. The ends of the ports 74 at the face of the block 68 are in the same rotative positions as their respective cylinders C and are in a circumferential series to successively register with the ports 63 and 67 in the valve block 30.

The rotative positions of the ports 63 and 67 in the face 64 of the valve block 30 are related to the eccentricity of the ring 14 in such a manner that the port 74 of a cylinder C communicates with the inlet port 63 during the out stroke of the piston 13 in the cylinder and comes into communication with the outlet port 67 when the piston is in the major final portion of its inward stroke after the gas has been compressed the desired extent. The invention provides novel and very effective means for regulating the valve means 15, that is for adjusting the rotative position of the block 30 relative to the eccentricity of the ring 14 so that the above described relationship between the cylinder ports 74 and the inlet and outlet ports 63 and 64 may be varied to effect the desired operation of the machine.

The valve adjusting means includes an abutment 78 on the block 30. The abutment 78 may project outwardly from the block 30 adjacent the boss 37. Spaced lugs 79 project outwardly from the end plate 18 to be in spaced relation from the opposite sides of the abutment 78. A screw 80 is threaded through an opening in each lug 79 and the screws are adapted to engage against the abutment 78. The screws 80 engaging against the abutment 78 normally prevent turning of the valve block 30 and thus retain the valve block in its adjusted position. Lock nuts 81 may be provided on the screws 80 to set the screws in their adjusted positions. The openings 36^a in the block 30 which receive the studs 36 are in the nature of slots or curved openings whereby the block 30 may have limited turning movement when the nuts 36^b on the studs 36 are loosened.

It will be apparent how the valve block 30 may be turned or adjusted following the loosening of the nuts 36^b by backing off one screw 80 and tightening in the other screw 80. After such adjustment the lock nuts 81 may be employed to lock the screws 80 in place and the nuts 36^b may be tightened down. Turning or adjustment of the valve block 30 by the adjustment means just described changes the rotative position of the ports 63 and 67 and therefore changes the times during which the cylinder ports 74 communicate with the ports 63 and 67. The ports 63 and 67 are, of course, related or spaced so that the cylinder ports 74 are out of communication with both of them at the ends of the piston strokes.

The motor 16 is provided to drive or rotate the compressor shaft 11. The particular motor 16 illustrated is a sealed induction motor comprising a housing 83, an armature 84 and a field 85. The present invention is not primarily concerned with the armature 84 of the field 85 of the motor. The armature 84 is carried by a shaft 86. The motor housing 83 is substantially cylindrical and is entirely closed or sealed. An integral wall 87 closes the outer end of the housing 83. A suitable bearing 88 is carried in a socket 89 in the housing wall 87 to rotatably support the end of the motor shaft 86. The inner end of the motor housing 83 is connected with the end 19 of the compressor housing 10 by a flange and bolt con-

nection 90. The motor housing 83 is in concentric or aligned relation to the shaft 11 of the compressor. A manifold 92 extends around the motor housing 83 and is adapted to carry water or other cooling medium to cool the motor. The cooling medium may be supplied to and carried from the manifold 92 by suitable lines 93.

The invention provides an effective readily releasable connection between the compressor shaft 11 and the motor shaft 86. The motor shaft 86 is provided with an axial socket 94 in its inner end which receives the end portion of the compressor shaft 11. The socket 94 is provided with longitudinal splines 95 which cooperate with grooves 96 in the compressor shaft 11. The shaft 11 may have a reduced pilot portion 97 fitting a correspondingly reduced portion of the socket 94. The shafts 11 and 86 may be quickly connected by sliding the shaft 86 onto the end portion of the shaft 11 so that the splines 95 are received in the grooves 96. The splines 95 cooperating with the grooves 96, of course, transmit rotation between the shafts. The connection just described permits the entire motor 16 to be easily removed from the compressor without disturbing any parts of the compressor. In the event that the motor 16 requires replacement or repair the flange and bolt connection 90 may be released whereupon the entire motor 16 may be bodily moved away from the housing 10. The splines 95 slide out of the grooves 96 allowing the shaft 86 to freely disconnect from the shaft 11. In this manner the motor 16 may be disconnected from the compressor proper without disturbing any parts of the compressor.

Figs. 5 and 6 of the drawings illustrate a form of the invention embodying an alternative or modified means for rotatably supporting the ring 14. In this form of the invention the tubular internal flange 24 of the housing 10 is provided with a plurality of pairs of spaced ears 98. The ears 98 project inwardly in the flange 24 and are spaced apart axially with respect to the axis of the machine. The pairs of ears 98 are preferably equally spaced about the interior of the flange 24. A shaft 99 is carried by each pair of ears 98. The shafts 99 may be pressed or otherwise secured in openings 100 in the ears 98 and are parallel with the axis of the ring sleeve 51. Suitable anti-friction bearings 101 are carried by the end portions of the shafts 99 to have supporting cooperation with the sleeve 51. The bearings 101 may engage against the outer sides of the ears 99 and shoulders 102 and 103 on the sleeve 51 for the transmission of end thrusts. It is believed that it will be apparent how the spaced sets or pairs of anti-friction bearings 101 support the ring 14 for free independent rotation.

It is believed that the operation of the compressor will be understood from the foregoing detailed description. The motor 16 drives or rotates the shaft 11 which in turn rotates the cylinder block 12. The cylinder block 12 is symmetrical and dynamically balanced so that its rotation imposes a minimum of stress on the shaft 11 and its bearings. As the cylinder block 12 rotates within the eccentrically disposed ring 14 the shoes 46 cooperating with the interior of the ring cause the pistons 13 to be successively moved inwardly in the cylinders C. The centrifugal force on the pistons 13 and perhaps the fluid pressure in the cylinders C successively move the pistons outwardly in the cylinders C. In actual operation the members 75 do not cooperate with the ring section 48 to cause the outward movement of the pistons in the cylinders. When operation of the compressor is commenced the engagement of the shoes 46 with the internal surface 49 of the ring 14 may be in the nature of a sliding engagement and the ring may tend to remain stationary. However, the engagement of the shoes with the interior of the ring 14 will ultimately result in rotation of the ring 14 with the cylinder block 12. However, as the ring 14 is independently supported for rotation about an axis spaced from the axis of rotation of the cylinder block 12 its operation remains the same irrespective of whether it rotates or remains stationary. The ring 14 is a symmetrical dynamically balanced structure and its rotation imposes a minimum of stress and strain on its bearings 53 and 54 and the housing parts.

The valve member 68 turns with the cylinder block 12 and the cylinder ports 74 successively move across the inlet port 63 and discharge port 67 in the end face 64 of the block 30. As described above, the ports 63 and 67 are related to the position of the ring 14 so that the cylinder ports 74 are in communication with the inlet port 63 during substantially the entire out strokes of the pistons 13 and come into communication with the discharge ports 67 when the pistons 13 have completed a portion of their inward strokes and remain in communication with the discharge port 67 during the remainder of the stroke so that the fluid under pressure is discharged through the port 67 and the line 66. The screws 80, may upon loosening of the nuts 36^b and 81 be employed to change the rotative position of the valve block 30 and thus adjust the rotative position of the ports 63 and 67 to properly regulate the action of the compressor.

It will be noted that the valve means 15 embodies a minimum number of working parts. The member 68 engages against the surface 64 of the block 30 and is held in sealing contact therewith by the springs 73. The member 68 and the block 30 constitute the only engaging and moving parts of the valve means 15. The compressor shaft 11 is dependably supported at its opposite ends by the bearings 26 and 32 while the ring 14 is effectively supported at spaced points by the bearings 53 and 54. Thus the principal rotating elements of the compressor are effectively supported by sets of spaced bearings. The compressor is compact and yet has a substantial capacity. There are a minimum of wearing and working parts embodied in the machine. The shims 45 constitute an easy means of regulating contact between the pistons 13 and the ring 14 and for adjusting the clearance of the pistons in the cylinders C.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the folowing claims

Having described my invention, I claim:

1. A mechanism of the character described including a housing, a shaft extending through the housing, a tubular internal flange formed on the wall of the housing surrounding the shaft in spaced relation thereto, a cylinder block in the housing fixed to the shaft and having cylinders, pistons operable in the cylinders, valve means for controlling the fluid flow to and from the cylinders, a ring surrounding the block for cooperating with the pistons, a sleeve on the ring extending into said flange, an annular series of

circumferentially spaced bearing shafts in the said flange, and anti-friction bearings on the bearing shafts cooperating with the sleeve to support the ring for rotation about an axis spaced from the axis of the cylinder block.

2. A mechanism of the character described including, a housing having spaced opposite end walls, a rotatable shaft extending through the housing, bearing means carried by said end walls for rotatably supporting the shaft, a rotor fixed to the shaft in the housing and having radial cylinders and having cylinder ports communicating with the cylinders, pistons in the cylinders, a ring rotatably supported in the housing in eccentric relation to the shaft and cooperating with the pistons, two elements one a block supported by the housing and having an inlet port and an outlet port both extending to the exterior of the housing, the other a part carried by the rotor and having ports communicating with the cylinder ports and adapted to register with the said inlet during the out strokes of the pistons and adapted to register with the said outlet port during only portions of the in strokes of the pistons, both of said elements being in surrounding relation to the shaft, and means for urging one element against the other.

3. A mechanism of the character described including, two elements one a housing, the other a rotating rotor having radial cylinders, pistons in the cylinders, a ring rotatably supported in the housing in eccentric relation to the shaft and cooperating with the pistons, a block supported by one of the elements for limited turning movement and having an inlet port and an outlet port the outlet port being of less extent than the inlet port at a face of the block, the rotor having ports communicating with the cylinders, a member carried by the other element and having ports communicating with the cylinder ports, the member being pressed against said face so that its ports are adapted to successively register with the said inlet and outlet ports, and means for regulating the rotative position of the said block, the said means including a fixed abutment, and screw ports on the said block cooperating with the abutment.

4. A mechanism of the character described including, a housing, a rotatable shaft extending through the housing, a rotor fixed to the shaft in the housing and having radial cylinders, pistons in the cylinders, a ring rotatably supported in the housing in eccentric relation to the shaft and cooperating with the pistons, a block supported by the housing for limited turning movement and having an inlet port and an outlet port, said inlet and outlet ports extending to the exterior of the housing the rotor having ports communicating with the cylinders and adapted to successively register with the said inlet and outlet ports, and means for regulating the rotative position of the said block, the said means including an abutment on the housing, lugs on the said block at opposite sides of the abutment and screws on the lugs cooperating with the opposite sides of the abutment.

5. A mechanism of the character described including, a housing having an end wall with an opening, a rotatable shaft extending through the housing, a rotor fixed to the shaft in the housing and having radial cylinders, pistons in the cylinders, a ring rotatably supported in the housing in eccentric relation to the shaft and cooperating with the pistons, a block supported in said opening and having an inlet port and an outlet port, said ports extending to the exterior of the housing, and a part carried by the rotor to have engagement against said block, the rotor and said part having ports communicating with the cylinders and adapted to sucessively communicate with said inlet and outlet ports, the said inlet port being of large circumferential extent whereby the fluid therein serves to cool the block and the adjacent parts.

6. A mechanism of the character described including, a housing, a rotatable shaft extending through the housing, a rotor fixed to the shaft in the housing and having radial cylinders, pistons in the cylinders, a ring rotatably supported in the housing in eccentric relation to the shaft and cooperating with the pistons, the housing having a tapered socket co-axial with the rotor, a tapered block in the socket, means securing the block in the socket and allowing turning of the block, the block having an inlet port and an outlet port, a spring-urged member carried by the rotor and cooperating with the block, the rotor and member having ports communicating with the cylinders and adapted to successively communicate with the inlet and outlet ports, and means normally holding the block against turning and operable to turn the block.

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