A. E. MOORHEAD.

VALVE.

APPLICATION FILED APR. 26, 1911.

1,020,922.

Patented Mar. 19, 1912.

5 SHEETS—SHEET 1.

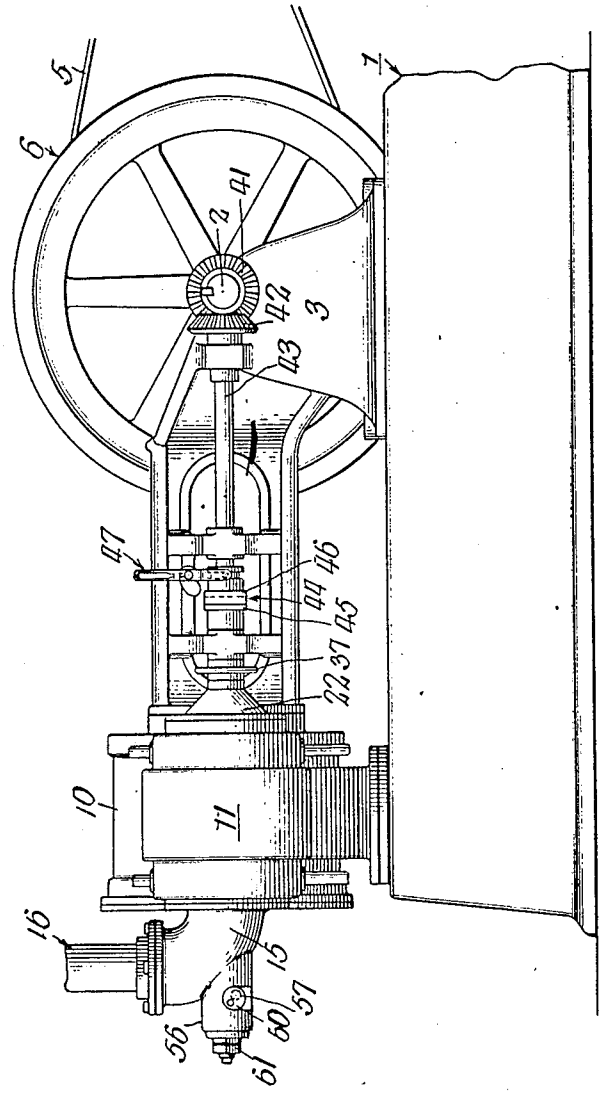


Fig. 1.

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5 SHEETS—SHEET 2.

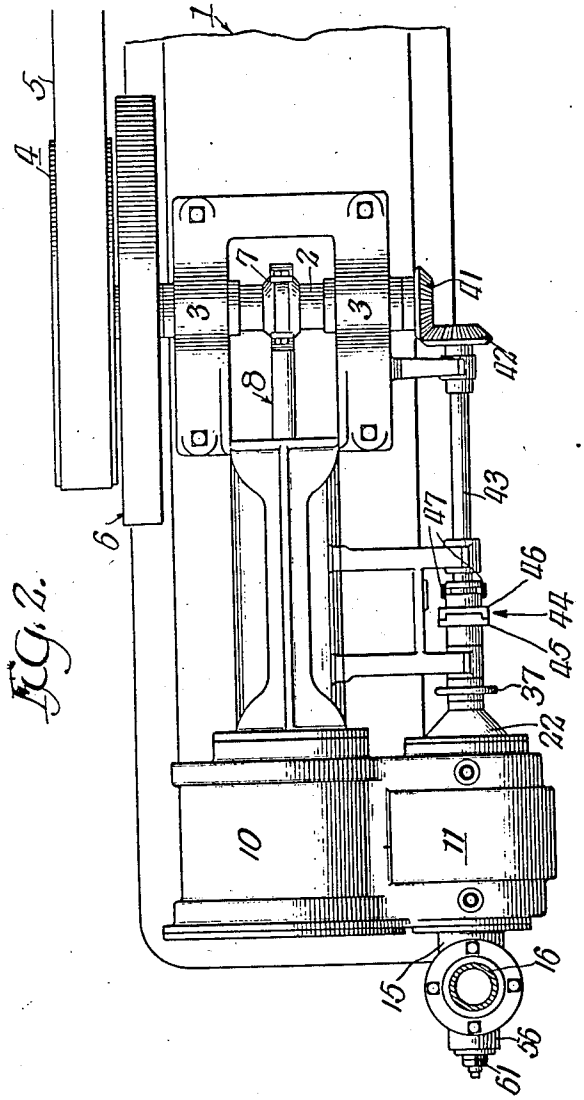


FIG. 2.

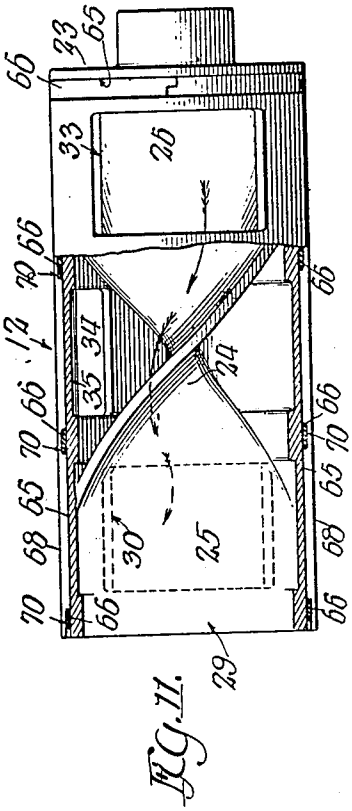


FIG. 11.

Witnesses:
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5 SHEETS—SHEET 3.

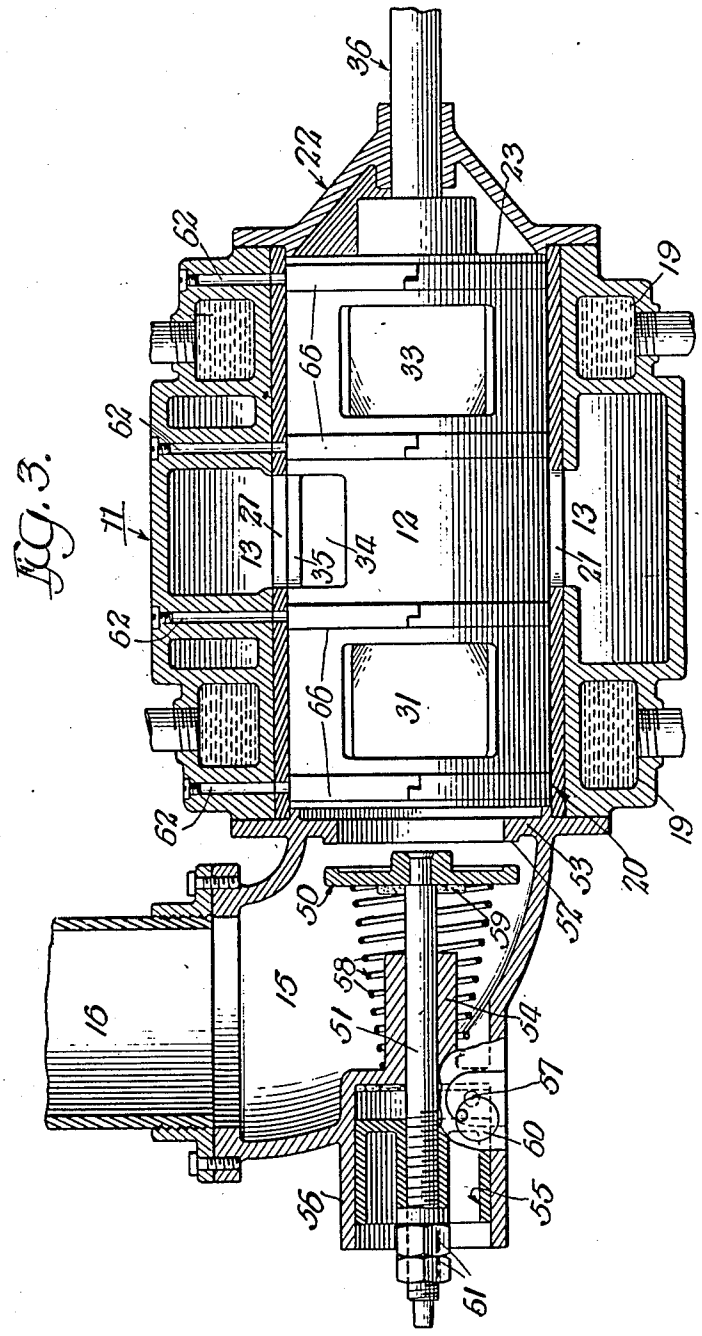


Fig. 3.

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5 SHEETS—SHEET 4.

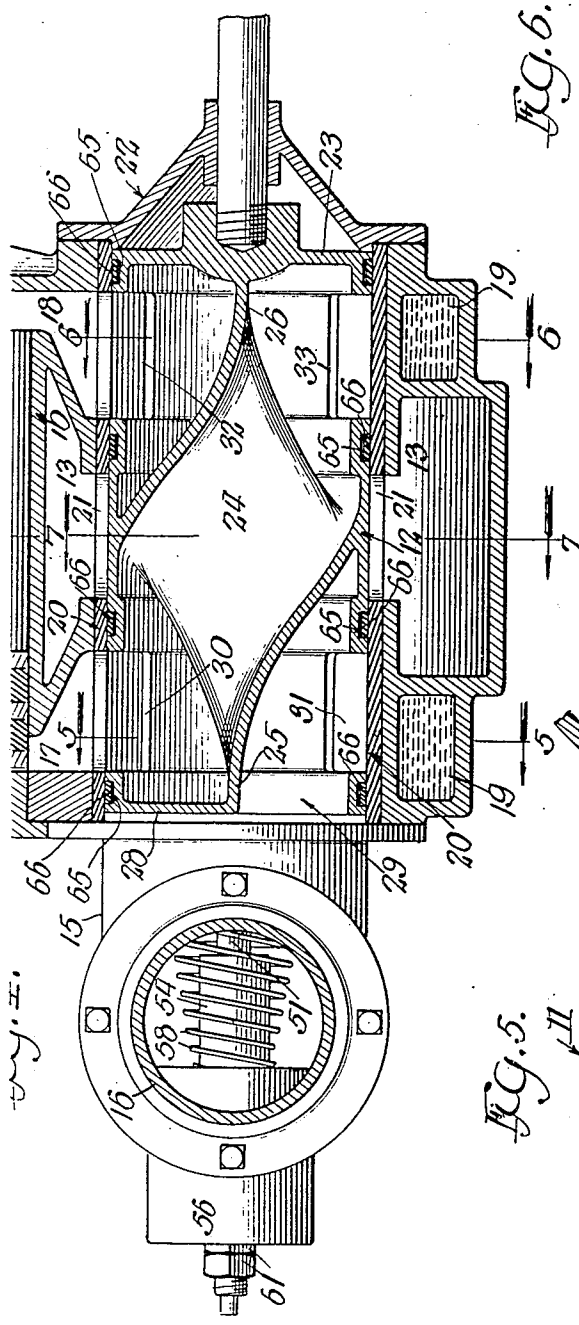

Fig. 4.

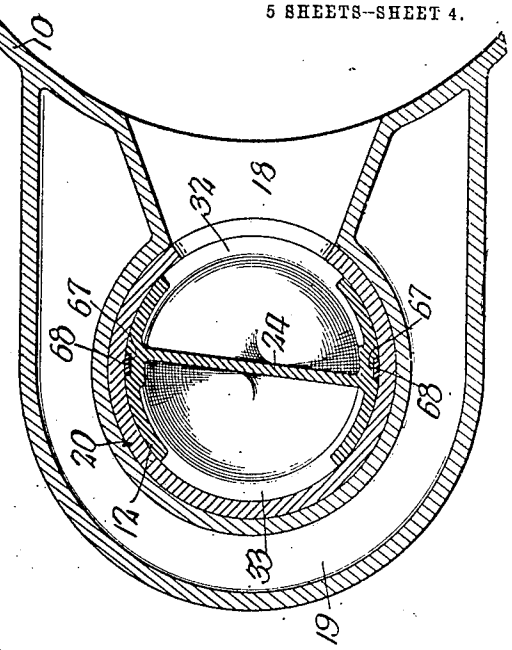

Fig. 6.

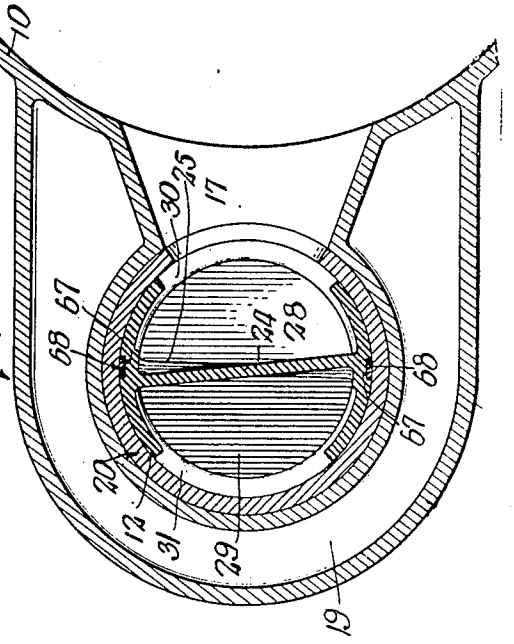

Fig. 5.

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5 SHEETS—SHEET 5.

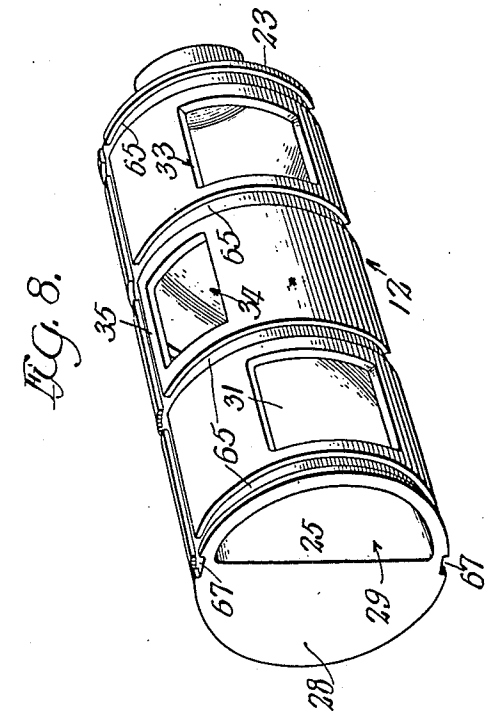


FIG. 8.

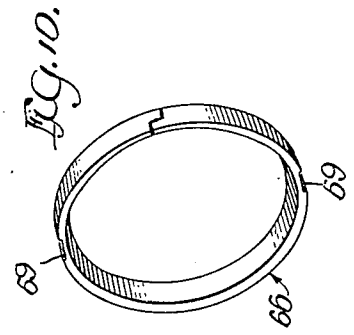


FIG. 10.

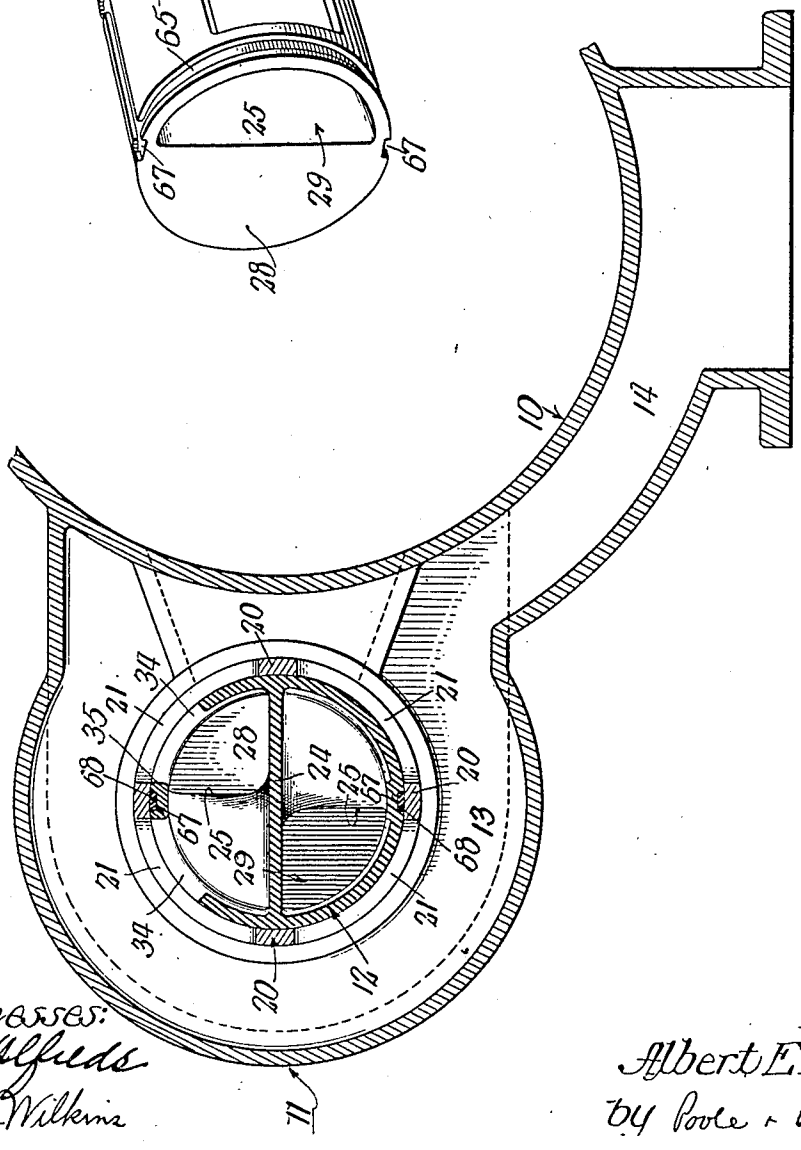


FIG. 11.


FIG. 9.

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# UNITED STATES PATENT OFFICE.

ALBERT E. MOORHEAD, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ROTARY VALVE COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

## VALVE.

1,020,922. Specification of Letters Patent. Patented Mar. 19, 1912.

Original application filed October 28, 1908, Serial No. 459,945. Divided and this application filed April 25, 1911. Serial No. 623,293.

*To all whom it may concern:*

Be it known that I, ALBERT E. MOORHEAD, a citizen of the United States, and a resident of the city of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Valves; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to valve mechanism adapted for use in connection with a pump or engine having a cylinder and a reciprocating piston therein, and which embraces a rotative valve member operating to control the entrance of fluid to and its exit from the opposite ends of the cylinder.

A valve mechanism embodying my invention is shown in the accompanying drawings as applied to the cylinder of a power-operated air exhaust pump or compressor, but such mechanism is applicable to pumps for other purposes, as well as to the power cylinders of engines or motors.

The invention consists in the matters hereinafter set forth and pointed out in the appended claims.

In the accompanying drawings:—Figure 1 is a side elevation of a power-operated pump embodying my invention. Fig. 2 is a plan view thereof. Fig. 3 is a central longitudinal vertical section on an enlarged scale taken through the valve casing, showing the rotative valve member in side elevation. Fig. 4 is a central, longitudinal, horizontal section of the valve casing and rotative valve member. Fig. 5 is a transverse vertical section on the line 5—5 of Fig. 4. Fig. 6 is a transverse vertical section on the line 6—6 of Fig. 4. Fig. 7 is a transverse vertical section on the line 7—7 of Fig. 4. Fig. 8 is a perspective view of the valve, detached from other parts, the packing bar and rings being omitted; Fig. 9 is a detail perspective view of one of the packing bars; Fig. 10 is a detail perspective view of one of the packing rings; Fig. 11 is a view in side elevation of the rotative valve member with a portion of the side wall of the same broken away to show the interior construction thereof, showing the packing rings and bars in section.

Referring to the drawing, 1 indicates a rectangular hollow base, which forms a support for the pump, and in the case of an air-exhaust pump or compressor, may also form a receiver into which the air may be compressed or from which the air may be exhausted.

2 indicates a horizontal driving shaft mounted in bearings 3, 3, in the top of the base 1, and by which the pump is driven. Said shaft is provided with a belt pulley 4 over which is trained a driving belt 5, by which the shaft is driven, and also preferably with a fly-wheel 6. Said driving shaft 2 is provided with a crank 7, which actuates through the medium of a connecting rod 8 and a piston rod the pump piston 9 (Fig 4), which reciprocates in the main cylinder 10 of the pump. Said pump may be used, as desired, either as an air compressor to deliver air to the receiver, or as an air-exhaust pump to exhaust the air from the said receiver, dependently upon the adjustment of the controlling valve of the air pump.

Formed integral with the cylinder 10 is a valve casing 11 having a cylindrical valve chamber containing a cylindric, rotary valve member 12; these parts constituting a valve for controlling entrance of air to and its exit from the ends of the pump cylinder. Said valve casing is provided at its central part with an annular chamber 13, connecting by a conduit 14 with the interior of the receiver 1, and connected at its ends through ports 17, 18, with the ends of the cylinder 10. Connected with one end of the valve casing, by an elbow 15, is a pipe 16 adapted to form either an inlet or exhaust passage, according to whether the pump is acting to compress air into or exhaust air from the receiver, said pipe 16 being in communication with the interior of the valve casing through the adjacent open end thereof. The valve casing is shown as formed with annular water jackets 19, 19, arranged to surround its end portions, and as having a fixed cylindric bushing 20 forming the bearing surface for the valve 12; said bushing being provided centrally with a series of ports or openings 21, 21, (Fig. 7), communicating with the annular chamber 13, and near its ends with openings coinciding with the cylinder ports 17 and 18. The ends of said valve casing, opposite that to which the

pipe 16 is connected, is closed by an end wall or head 22. Said valve member 12 consists of a cylindric hollow shell or tube, the cylindric, exterior surface of which fits closely within the cylindric, inner surface of the valve casing. At the end of the valve casing, adjacent to the head 22, the end of said valve member 12 is closed by an end wall 23. Across the interior of said valve member extends diametrically a partition or web 24, the end or terminal portions 25, 26, (Figs. 4 and 11) of which lie in the same plane, but the intermediate portion of which is twisted through half a turn; said web being so formed that, when the valve is in the angular position shown in Figs. 3 and 4 of the drawings, the terminal portions 25, 26 of the web are vertical, but its central portion is horizontal; and the web being twisted from said central portion in each direction outward, from a horizontal to a vertical position. The said web extends longitudinally of the valve member from end to end thereof, and forms two longitudinal passages therein, one on each side of the said web. The other end of the valve or that adjacent to the open end of the valve casing with which is connected the inlet or outlet pipe 16, is closed on one side of the web 24 by an end wall 28, and is provided with an opening 29 at the other side of the web. Said opening 29 is always in communication with the pipe 16.

Adjacent to the partly open end of the valve member there are formed in the side wall thereof, on opposite sides of the web, and diametrically opposite each other, two ports 30, 31, and, in like manner, near the closed end of the valve member there are formed, on opposite sides of the web, two ports 32, 33. In its central part, the valve member is provided in its side wall with what is practically a single port 34, although the same is divided by a narrow, longitudinal bar or bridge 35. Said central port 34 is always open to the central annular chamber, which latter is connected with the receiver by means of the passage 14. The two end ports 30 and 33, at opposite sides and opposite ends of the valve member, are connected with each other and with the central port 34, by the longitudinal passage at one side of the web 24, while the end ports 31 and 32, at opposite sides and ends of the valve member are connected with each other and with the end port 29 by means of the longitudinal passage at the other side of said web. The valve member 12 is given rotary motion through the medium of a rotative valve-stem 36, rigidly attached thereto, and extending through one end of the valve casing. As shown in the drawings, said valve stem 36 is attached centrally to the end wall 23 of the valve member, and passes through and is adapted to turn in the end wall or head 22 of the casing. Said valve stem 36 is provided, outside of said head 22 with a rigidly attached hand-wheel 37.

The devices employed to actuate the rotative valve member 12 are so constructed that the same is given a half rotation with each half stroke of the piston. In the position of the parts shown in Figs. 3 and 4, the pump is acting to exhaust air from the receiver and the piston 9 has just completed its stroke toward the left and the valve member has completed a half turn, by which the valve ports 30 and 32 have been brought into communication with the cylinder ports 17 and 18, the central cylinder port 34 at this time being directed upwardly and above the central, horizontal part of the web 24. The central valve port 34 being always in communication with the central passage 13, and the said valve port 29 having constant communication with the pipe 16, it follows that when the piston makes its stroke toward the right, air from the right-hand end of the cylinder will pass from the port 18 downwardly beneath the horizontal central part of the web 24, and outwardly through the end port 29 to the pipe 16; the valve port 31 being at this time closed by the wall of the valve casing. At the same time, as the piston moves toward the right, air will be drawn into the left-hand end of the cylinder from the receiver, through the passage 13, the central valve port 34, over the central horizontal part of the web 24 and through the valve port 30 and cylinder port 17; the valve port 33 at this time being closed by the valve casing. When the piston completes its stroke toward the right, the relative valve member will have made a half rotation from the position shown, and in the subsequent stroke of the piston toward the left, air will be expelled from the left-hand end of the cylinder through the cylinder port 17, and passing through the valve port 31 (which will then register with said port 17), will pass from said port 31 directly out through the end port 29; the port 32 at the opposite end and opposite side of the valve member being then closed by the valve casing. At the same time, the valve port 33 will be in register with the cylinder port 18, and air will be drawn into the right-hand end of the cylinder, the air at this time passing from the receiver through the central port 34 (which will then be directed downwardly) and beneath the central part of the web 24 to the said port 33.

If the valve member be given a half rotation, or reversed in position relatively to the actuating devices by which it is turned or driven, the pump will act as a compressor. Such reversal of the valve is accomplished by disconnecting the valve-stem 36 from its actuating devices, giving it a

half turn by the use of the hand-wheel 37, and then again connecting it with its said actuating devices. When the valve member is so reversed, the piston still being in the left hand end of the cylinder, movement of said piston toward the right will expel the air from the right hand end of the cylinder through the cylinder port 18 and valve port 33, from which it will pass to the chamber 13 and the receiver, while air will be drawn inwardly to the left hand end of the cylinder, from the pipe 16, through the end port 29 and valve port 31. Likewise, in the subsequent stroke of the piston toward the left, air will be expelled from the cylinder through the cylinder port 17 and valve port 30, and, passing above the web 24, will pass to the receiver through the central port 34 and chamber 13, while air will be drawn into the right hand end of the cylinder, from the pipe 16, through the port 29, beneath the central part of the web 24 and through the valve port 32; the valve member in this latter case being in the same position shown in Figs. 3 and 4, but the piston being at the right hand end of the cylinder and about to make or making its stroke toward the left.

From the above it will be seen that, by reason of the twisted form of the web 24, said web forms in effect two longitudinally extending, spiral passages in the valve member, one of which is in communication with an inlet or outlet passage at the end of the valve casing, and the other of which is in communication with an inlet or outlet passage at the central part of the valve casing, and that, by reason of the arrangement of the end valve ports, at opposite sides of the end portions of said web, the said central inlet or outlet passage is in constant connection, through one of said spiral passages, with two of said end ports, as 30 and 33, which are located at opposite ends as well as at opposite sides of the valve member, while the inlet or outlet passage at the end of the valve casing is constantly in connection, through the other of said spiral passages, with the two other valve ports, as 31 and 32, which are located, relatively to each other, at opposite ends and opposite sides of the valve member.

While the central ports 21, 21 of the valve casing are shown in the drawings as so made as to form in effect an annular port extending entirely around the valve chamber, so that the central valve port 34 is in communication with the chamber 13 in all positions of the valve member, yet this particular construction is not essential, it only being necessary that said central port 34 should be in communication with said chamber 13, during the time the end ports 30 and 32, in one instance, and the opposite end ports 31 and 33, in the other instance, are in communication with the cylinder ports 17 and 18.

In the preferred construction illustrated the valve actuating devices are connected as follows: A miter-gear 41 is secured upon the transverse driving shaft 2, and meshes with a miter-gear 42 upon a longitudinal shaft 43 arranged in alinement longitudinally with the valve stem 36. Said shaft 43 is connected with the valve stem 36 through the interposition of a clutch 44 which permits the valve to be reversed in its relation to the shaft 43, in order to change the operation of the pump from an exhaust pump to a compressor. The said clutch 44 consists of two parts that are adapted to be interlocked with each other in two diametrically reversed positions of one of them, and one of which is movable in a direction endwise of the shaft 43. As shown, said clutch consists of two clutch members 45 and 46. The clutch-member 45 is secured to the outer end of the valve stem 36 and is provided on its end face with a transverse rib adapted to engage a transverse groove in the clutch member 46. The clutch member 46 is mounted and adapted to slide endwise, without rotation, on the shaft 43, so that it may be moved on the said shaft toward and from the clutch member 45. A hand-lever 47 is pivoted on a fixed support and has a forked end, the arms of which engage an annular groove in the clutch member 46, in a familiar manner. When it is desired to reverse the operation of the valve, the clutch member 46 is actuated to release the shaft 43 from the valve stem 36 and the latter is turned through half a revolution by means of the hand-wheel 37 on the valve stem, and the parts of the clutch are again interlocked so as to connect the valve stem with the shaft 43.

The passage from the valve casing to the pipe 16 is controlled by means of an outwardly opening check-valve, embracing a valve disk 50 (Fig. 3) carried by a stem 51 and adapted to close against an annular seat 52, formed on a flange 53 at the inner end of the elbow 15. Said stem 51 slides in a fixed guide-sleeve 54 on the elbow 15. Upon the outer end of said stem 51 is secured a piston 55, which slides in a cylinder 56 formed on the elbow 15. The inner end of said cylinder is provided with a restricted air opening or vent 57, so that the cylinder and piston constitute a dash-pot adapted to cushion the valve disk in its closing movement. The inner end of said cylinder 56 is closed by an integral head on which is formed the guide sleeve 54. Said valve disk 50 is pressed toward its seat by means of a helical spring 58 interposed between the said valve disk and the head of the cylinder 56. A disk 59, of felt or the like, surrounds the stem 51 and is

interposed between the outer side of the valve disk 50 and the inner end of the guide-sleeve 54 to cushion the impact of the valve disk against the end of said guide-sleeve in the outward movement of the said disk.

In order to afford adjustment of the vent 57, or for the purpose of regulating the rate of flow at which the air passes through said vent, the latter is provided with a pivoted door 60. It is necessary to limit the amount of air which is drawn into the pump when using it as a compressor, for if the full volume of air were drawn into the cylinder, the power required to compress the entire volume of air so admitted might be too great. In order to so limit the amount of air thus admitted, an adjustable connection is provided between the valve stem and the piston 55, so that the parts may be so adjusted that the closing movement of the valve disk will be arrested when the same is at a short distance from its seat. For this purpose, set-nuts 61 are applied to the valve stem in contact with the outer face of the piston 55. When the pump is used as a compressor, the air being then drawn into the pump cylinder through the pipe 16, the inward movement of the valve disk 50 will be arrested when it reaches a position as close to the seat as permitted by the said set-nuts. When the pump is used as an exhaust pump, the nuts will be so adjusted as to permit the valve disk to close fully against its seat.

In order to provide packing means on the exterior of the valve 12 to prevent the passage of air or other fluid between the bearing faces of the valve casing and valve member, in such manner as to avoid leakage from one to the other of the ports 30, 31, 32, 33, and 34, and from said ports to the ends of the valve casing, a construction is provided as follows: In the surface of said valve member are formed four circumferential grooves, indicated by 65, 65, two of said grooves being located adjacent the ends of said valve member exterior to the end ports and two of said grooves extending between the central port 34 and the said end ports. Within each of said grooves is located a packing ring 66, which is severed or split at one point to permit the same to expand into close contact with the inner surface of the valve casing. Said valve member is also provided in its exterior surface with two longitudinally extending grooves 67, 67, which are located midway between the end ports at each side of the valve member, and one extends over the bar or bridge 35. In said longitudinal grooves are seated packing bars 68 (Fig. 9), which extend across the packing rings outside of the same, so that the expansive action of said rings tends to press said bars against the cylindric inner surface of the valve casing. The rings 66 and bars 68 are provided respectively with notches 69 and 70, at their intersecting points, the notches being interlocked with each other and the parts being so arranged that the outer surfaces of the bars are flush with the outer surfaces of the packing rings. The valve casing is shown as provided with oil passages 62, 62, terminating in discharge openings located opposite or over the packing rings 66, 66. The packing rings, arranged as described, separate the surface of the shell longitudinally into three sections, while the packing bars divide said surface circumferentially into two sections. Moreover, the said packing rings and bars not only serve to prevent leakage between the ports and at the ends of the valve member, but the particular arrangement thereof by which the longitudinal bars extend over or outside of the rings has a special advantage that may be understood from the following: By reason of the continued rotary motion of the valve member, if the packing rings alone were used, the same, being pressed outward by their resiliency, would tend to wear grooves into the inner surface of the valve casing, but by reason of the presence of the longitudinal bars, the outer surfaces of said rings are always held flush with the outer surfaces of said bars, and as the bars are pressed against and moved along the inner surface of said casing, they distribute the outward pressure produced by the rings along the entire length of the cylindric bearing surface of the casing and thereby afford a uniform wear on all parts of said bearing surface.

It is to be understood that a valve mechanism embracing the features of construction hereinbefore set forth may be made in forms differing from that shown in the accompanying drawings, and I do not, therefore, desire to be limited to the specific structural forms and details illustrated in the accompanying drawings, except so far as the same may be specifically claimed in the appended claims.

I claim as my invention:—

1. The combination of a cylinder, a piston in the said cylinder, a valve casing provided at its ends with ports communicating with the opposite ends of the cylinder and with a central port, a rotative valve member, and means for turning the valve member a half rotation at each stroke of the piston, said valve member being provided at each of its ends with two lateral ports located at opposite sides thereof, and adapted for communication with the cylinder ports in alternation in the rotation of said valve member, in its central part with a lateral port adapted for communication with the central port of the valve casing, and in at least one of its ends

with an end port, the said valve member being provided with two passages connecting in one instance the central lateral port with two of the lateral end ports at opposite sides of the valve member and in the other instance the end port with the other two lateral end ports at the opposite sides of said valve member.

2. The combination of a cylinder, a piston in the said cylinder, a valve casing provided at its ends with ports communicating with the opposite ends of the cylinder and with a central port, a rotative valve member, and means for turning the valve member a half rotation at each stroke of the piston, said valve member consisting of a cylindric shell provided with a transverse web forming two longitudinal passages therein and also provided at each of its ends with two lateral ports located one at each side of the adjacent end of the web, and adapted for communication with their associated cylinder port in alternation in the rotation of the valve member, each of said lateral ports being connected by one of said longitudinal passages with the lateral port at the opposite end and side of the valve member, and said valve member having a central lateral port opening from one of said longitudinal passages and adapted for communication with the central port of the valve casing at times when either of the lateral end ports is in communication with its associated cylinder port, and said valve member also having in at least one of its ends an end port opening from the other of said longitudinal passages.

3. The combination of a cylinder, a piston in the said cylinder, a valve casing provided at its ends with ports communicating with the opposite ends of the cylinder and with a central port, a rotative valve member, and means for turning the valve member a half rotation at each stroke of the piston, said valve member consisting of a cylindric shell provided with a transverse longitudinal web, the end portions of which are in the same plane and the central portion of which is twisted a half turn so as to form two longitudinal, spiral passages in said valve member, and provided also, at each of its ends, with two lateral ports located at opposite sides of the adjacent end of the web, each of said lateral ports being connected by one of said spiral, longitudinal passages with the lateral port at the opposite end and side of the valve member, and said valve member having a central lateral port opening from one of said longitudinal passages, and also having in at least one of its ends an end port opening from the other of said longitudinal passages.

4. The combination of a cylinder, a piston in said cylinder, a valve casing provided with a cylindric valve chamber and with two cylinder ports each leading to one end of the cylinder, and having central and end passages each of which is to be brought by the action of the valve alternately into communication with each end of the cylinder, a cylindric valve member in said chamber provided at each of its ends with two lateral ports adapted to be brought alternately into communication with the associated cylinder port by the turning of the valve member, and with two longitudinal passages, each of which connects that one of the two lateral ports at one end of the valve member which, at any one time, is in communication with its associated cylinder port, with that one of the two lateral ports at the opposite end of the valve member which is at the same time cut off from communication with its associated cylinder port; one of said longitudinal passages having constant communication with the central passage of the valve casing and the other of said longitudinal passages having constant communication with the end passage of the valve casing, and means for turning said valve member to bring the two lateral ports at each end thereof alternately into communication with the cylinder port associated therewith.

5. The combination of a valve casing having a cylindric valve chamber, a rotative cylindric valve member, circumferential packing rings surrounding the valve member and packing bars extending longitudinally of the valve member exterior to said packing rings.

6. The combination of a valve casing having a cylindric valve chamber, a rotative cylindric valve member provided with circumferential and longitudinal grooves, packing rings inserted in the circumferential grooves and packing bars inserted in said longitudinal grooves and crossing the packing rings exterior to the latter.

In testimony, that I claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 18th day of April, A. D. 1911.

ALBERT E. MOORHEAD.

Witnesses:

C. CLARENCE POOLE,

GEORGE R. WILKINS.