

April 14, 1942.

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2,279,740

PUMP, COMPRESSOR, OR THE LIKE

Filed June 19, 1939

3 Sheets-Sheet 1

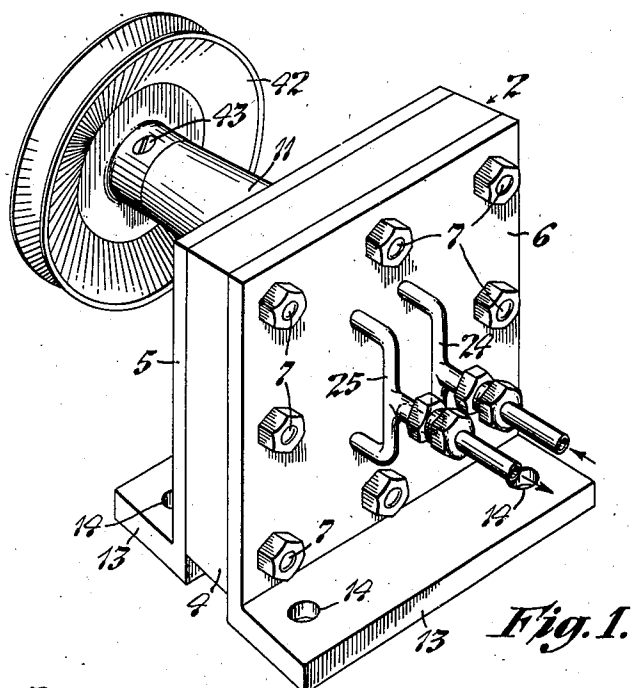


Fig. 1.

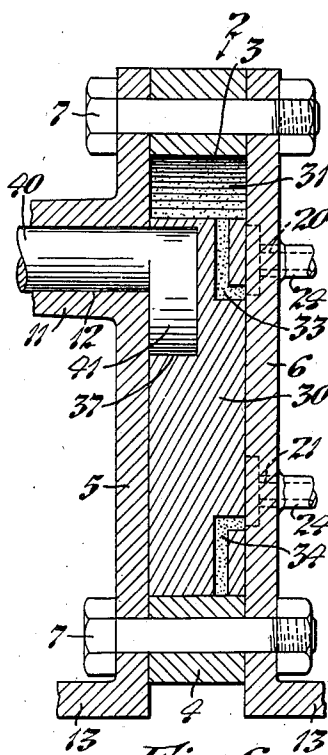


Fig. 6.

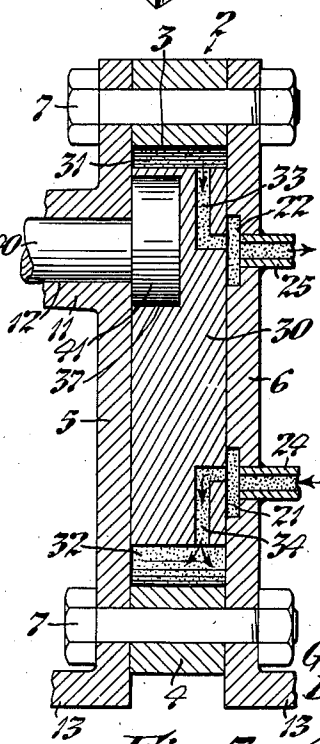


Fig. 7.

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3 Sheets-Sheet 2

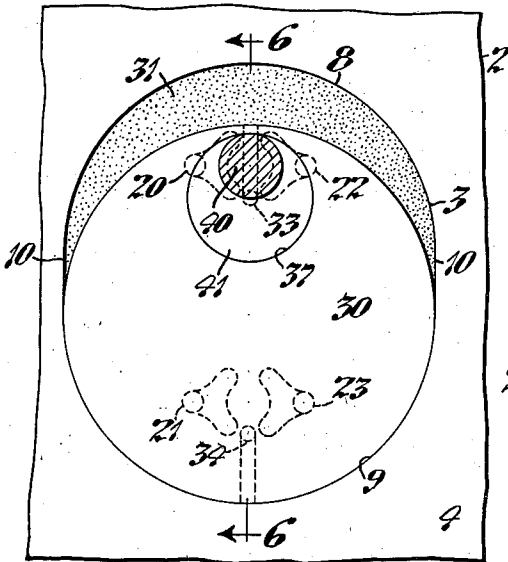


Fig. 2.

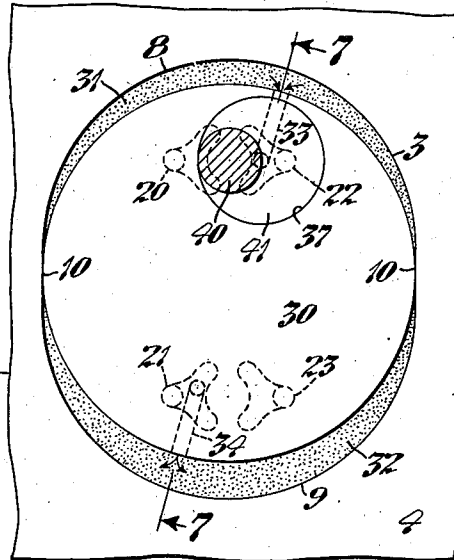


Fig. 3.

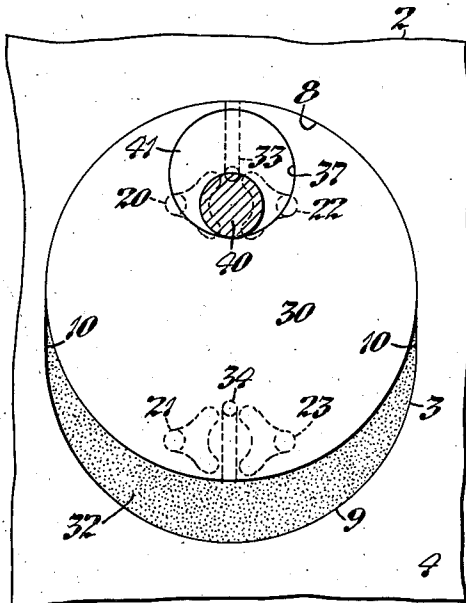


Fig. 4.

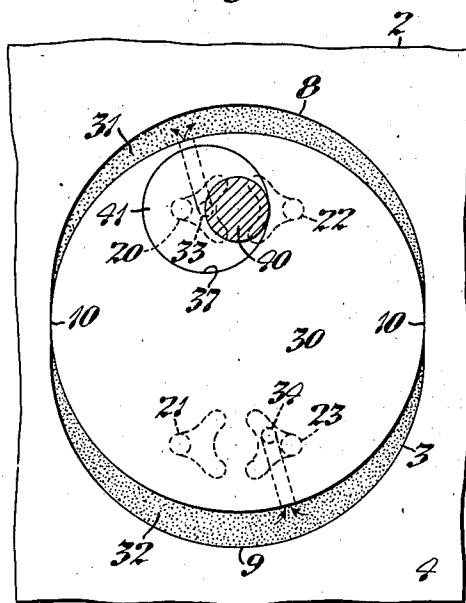


Fig. 5.

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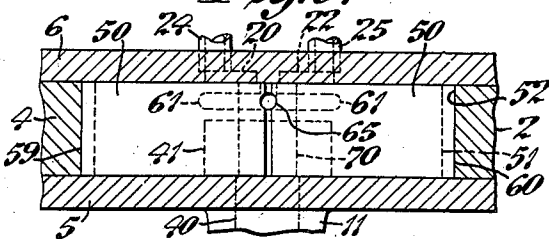
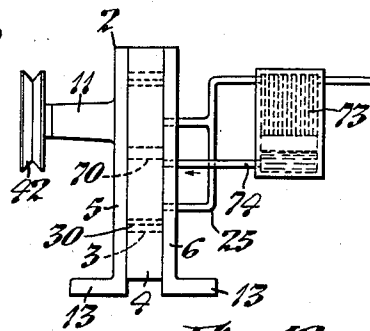
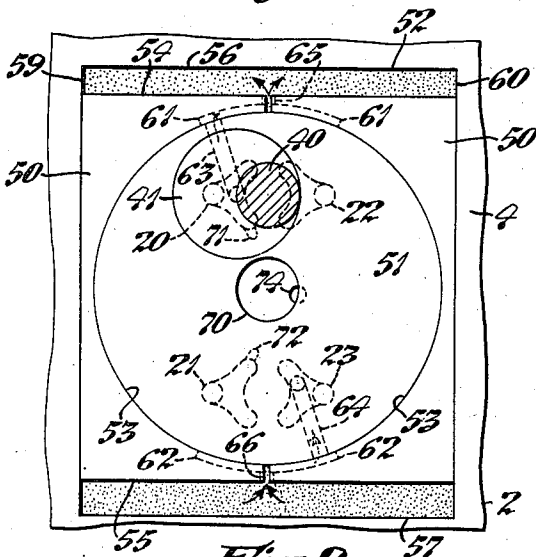
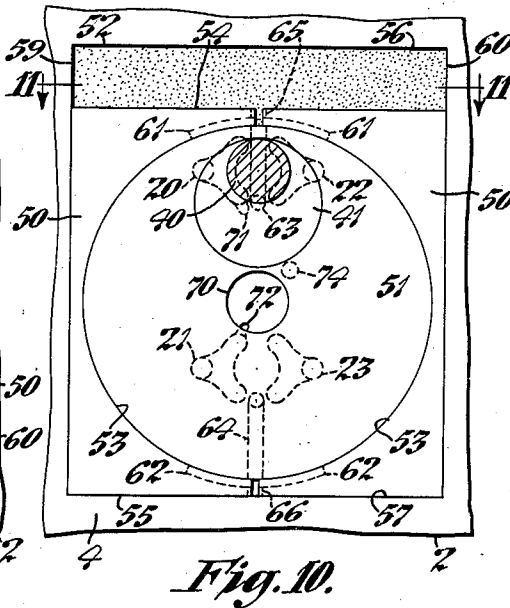
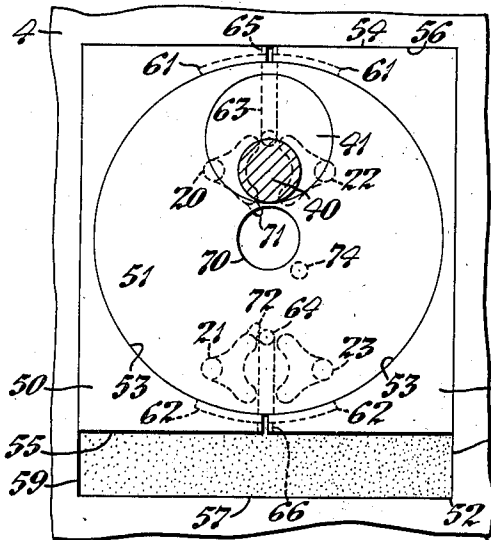
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PUMP, COMPRESSOR, OR THE LIKE

Filed June 19, 1939

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,279,740

PUMP, COMPRESSOR, OR THE LIKE

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Application June 19, 1939, Serial No. 279,924

16 Claims. (Cl. 103—145)

The present invention relates to a device for compressing or pumping fluids. It is to be understood, however, that the invention is not limited to such uses as a pump or compressor but may also be employed as an engine, meter or the like.

One of the objects of the present invention is to provide a device of the type indicated having a piston in the form of a disk adapted to oscillate as it reciprocates in a work-chamber.

Another object of the invention is to provide a device of the type indicated wherein the oscillation of the piston controls the intake and exhaust of fluid to and from the work-chamber.

Another object of the invention is to provide a device of the type indicated in which the piston-disk is directly driven by eccentric means to cause it to oscillate about its center as it reciprocates along the axis of the chamber.

Another object of the invention is to provide a device of the type indicated wherein ports in the piston-disk move in closed orbits and register with intake and exhaust ports arranged in said orbits on the casing to control the intake and exhaust of fluid to and from the work-chamber.

Another object of the invention is to provide a device of the type indicated which is double-acting in that the piston is adapted to pump and compress fluids in the work-chamber during its movement in either direction.

Still another object of the invention is to provide a device of the type indicated which is of extremely simple construction and comprising few parts to adapt it for economical manufacture while at the same time being efficient in performing its intended functions.

Further objects of the invention are set forth in the following specification which describes a preferred embodiment of the invention, by way of example, as illustrated by the accompanying drawings. In the drawings:

Fig. 1 is a perspective view of a pump incorporating the novel features of the present invention;

Fig. 2 is an enlarged sectional view through the pump illustrating the piston at one end of the work-chamber and showing the valve-ports in the piston positioned between the intake and exhaust ports in the casing;

Fig. 3 is a view similar to Fig. 2 illustrating the eccentric driving means for the piston rotated 90° from the position illustrated in Fig. 2 and indicating the combined reciprocation and oscillation of the piston-disk to register the ports in the piston-disk with the intake and exhaust ports at opposite ends of the casing;

Fig. 4 is a view similar to Fig. 2 showing the relative position of the piston and valve-ports after the eccentric driving means has been rotated 180° from the position illustrated in Fig. 2;

Fig. 5 is a view similar to Fig. 2 illustrating the combined reciprocation and oscillation of the piston-disk in a reverse direction by rotation of the eccentric driving means 270° from the position illustrated in Fig. 2 and showing the ports in the piston in registry with the intake and exhaust ports opposite from those illustrated in Fig. 3;

Fig. 6 is a transverse sectional view on line 6—6 of Fig. 2 showing the eccentric driving means seated in a circular recess in the piston;

Fig. 7 is a transverse sectional view on line 7—7 of Fig. 3 showing the ports in the piston in registry with one of the pairs of intake and exhaust ports in the casing;

Fig. 8 is a view similar to Fig. 2 showing a modified form of construction incorporating shoes at the opposite sides of the piston-disk;

Fig. 9 is a view similar to Fig. 8 illustrating the eccentric driving means rotated 90° from the position illustrated in Fig. 8 and showing the fluid being compressed and exhausted from the compartment at one end of the chamber and entering the compartment at the opposite end of the chamber;

Fig. 10 is a view similar to Fig. 8 illustrating the eccentric driving means rotated 180° from the position illustrated in Fig. 8 and showing the piston at the opposite end of the chamber;

Fig. 11 is a transverse sectional view on line 11—11 of Fig. 10 showing the rectangular form of the ends of the shoes and the fluid-port therebetween; and

Fig. 12 is a diagrammatic view illustrating a lubrication system for the pump.

The present invention comprises in general an elongate chamber and a piston of disk form adapted to reciprocate and oscillate in said chamber. The disk may engage directly with the side walls of the chamber or shoes may be provided between the disk and casing, but in either case the piston means is in sealing engagement with the walls of the chamber to divide it into separate compartments. An eccentric driving means is seated in a circular recess in the piston-disk and when rotated it simultaneously reciprocates and oscillates the piston. Valve-ports in the piston-disk communicate with the compartments at opposite ends of the piston and terminate in openings at one side of the disk which alternately register with intake and exhaust ports in the

casing. In other words, the piston itself constitutes the valves for controlling the intake and exhaust of fluids to and from the chamber.

The embodiment of the invention illustrated in Figs. 1 to 7 of the drawings comprises a casing 2 having a work-chamber 3 formed therein. Preferably, the casing 2 consists of a body-member 4 having a central opening therein of the desired contour to form the chamber 3 and closure plates 5 and 6 at the opposite sides of the body-member. The body-member 4 and closure plates 5 and 6 are held in assembled relationship by means of bolts 7 extending through the parts adjacent their marginal sides. It will be understood, however, that the body-member 4 and one closure plate 5 may be made integral and the chamber 3 formed therein by a routing or other machining operation. As illustrated in Figs. 2 and 6, the chamber 3 has semi-circular walls 8 and 9 connected by parallel walls 10 in the body-member 4 and parallel side walls formed by the closure plates 5 and 6. A tubular bearing 11 is provided on the closure plate 5 having a central bore 12 therein. The casing 2 may be supported in any suitable manner and, as herein illustrated, the closure plates 5 and 6 have lateral feet 13 with holes 14 therein for adapting the casing to be bolted to any suitable support. The body-member 4 and closure plates 5 and 6 may be cast and machined, but preferably they are manufactured from sheet-metal with the feet 13 and bearing 11 welded thereto.

The closure plate 6 has opposite pairs of intake ports 20, 21 and exhaust ports 22, 23 formed therein. As illustrated in Figs. 2 and 7 the ports 20, 21, 22 and 23 are in the form of recessed slots with the pair of intake ports 20 and 21 arranged on one side of the longitudinal axis of the chamber 3 and the pair of exhaust ports 22 and 23 arranged on the opposite side of said axis. The intake and exhaust ports 20 and 22 are arranged opposite each other adjacent one end of the chamber 3, while the intake and exhaust ports 21 and 23 are similarly arranged adjacent the opposite end of the chamber. The opposite intake and exhaust ports 20, 22 and 21, 23 are located in the orbit of movement of ports in a piston, to be later described, and may vary in shape and size for any particular design of pump. The intake ports 20 and 21 are connected to a common supply by the branched ends of a substantially Y-shaped conduit, or pipe fitting 24, see Fig. 1, extending through holes in the closure plate 6 and welded or soldered thereto and the exhaust ports 22 and 23 are similarly connected by a Y-shaped conduit 25.

The piston 30 is in the form of a disk mounted in the chamber 3 and having a radius equal to the radius of the semi-circular end walls 8 and 9 and a width or thickness equal to that of the body-member 4. Thus, the periphery of the piston 30 closely fits against the walls 10 and inner faces of the closure plates 5 and 6 to divide the chamber 3 into separate compartments 31 and 32. The piston-disk 30 is provided with ports 33 and 34 communicating with the opposite compartments 31 and 32 and terminating in spaced relation on one flat side of the disk. As illustrated in Figs. 2 and 7, the ports 33 and 34 are arranged at diametrically opposite points on the periphery of the piston-disk and extend radially inwardly and then outwardly to the side of the disk. A circular recess 37 is formed in the disk 30 on the opposite side from the ports 33 and 34.

The driving means for the piston-disk 30 may

comprise a drive-shaft 40 journaled in the bore 12 of the bearing 11 on the closure plate 5 and having an eccentric disk 41 formed on or secured to the inner end of the shaft. Preferably the eccentric disk 41 is made integral with the drive-shaft 40 and is adapted to seat in the circular recess 37 in the piston-disk. A pulley 42 may be connected to the drive-shaft 40 at its outer end, as by a set-screw 43, or any other suitable means may be used to turn the shaft.

The construction and relationship of the parts may be varied through a wide range to effect different conditions of operation. For example, a relatively slight eccentricity of the disk 41 with respect to the drive-shaft 40 will provide a greater mechanical advantage to drive the piston with relatively small side pressures thereon. Such an arrangement would have the limitation of relatively small capacity and a relatively small orbit of movement of the ports 33 and 34 in the piston 30. A relatively great eccentricity of the disk 41 with respect to the drive-shaft 40 will give a greater capacity and a larger orbit of movement of the valve ports 33 and 34 but with a reduction of the mechanical advantage to drive the piston-disk 30 and an increase in the side pressure on the piston-disk. The advantage and disadvantages approach each other to give an optimum average of capacity, mechanical advantage and valve-port movement when the eccentricity of the disk 41 with respect to the drive-shaft 40 is midway between its opposite limits. It will be understood, however, that for a particular condition of use of the device a particular relationship of the parts would be desirable. If the device were to be used to compress gases at low pressure a relatively large eccentricity would be desirable, but if the device were to be used to compress gas at a high pressure a relatively small eccentricity would be preferable.

The eccentricity of the disk 41 with respect to the drive-shaft 40 may be varied from zero, as one limit, to a value approaching the distance between the center of the disk 41 and the center of the piston-disk 30 as the other limit. If the eccentricity of the disk 41 with respect to the drive-shaft 40 is equal to the distance between the center of the eccentric disk and the center of the piston-disk 30 the latter will rotate instead of oscillate and if the eccentricity is greater the piston-disk will jam against the side walls 10 of the chamber 3. Between these limits of eccentricity the piston-disk 30 will simultaneously reciprocate and oscillate and the relative movement varies directly with the eccentricity.

The ends of the valve-ports 33 and 34 in the piston-disk 30 may be located at any point on the side thereof and their orbits of movement will vary in shape and size depending upon their particular location. When the end of the port 33 is located on the piston-disk 30 between the center of the eccentric disk 41 and the center of the piston-disk its orbit will be egg-shaped and flattened in the direction of longitudinal movement of the piston-disk. When located between the center of the eccentric disk 41 and edge of the piston-disk 30 the orbit will be a distorted oval flattened in the direction of oscillation of the piston-disk. As illustrated in the drawings the end of the port 33 is located on the piston-disk 30 at a point coincident with the center of the eccentric disk 41 and moves in a circular orbit. The end of the port 34 is arranged on the side of the piston-disk 30 at a point diametrically opposite the end of the port 33 but does not move in a true

circle due to the combined harmonic and reciprocatory motion of the latter. The distortion of the orbit of movement of the end of the valve-port 34 from a true circle is so slight, however, as to be practically negligible. As stated above the intake and exhaust ports 20, 21, 22 and 23 in the cover-plate 6 of the casing 2 are arranged in the orbits of movement of the ends of the valve-ports 33 and 34 in the piston-disk 30 and the ports 21 and 23 are made slightly wider than the width of the port 34 in the piston-disk to compensate for the slight variation of its orbit of movement from a true circle. One embodiment of the pump having now been described in detail its mode of operation is explained as follows:

Assuming the parts of the device to be in the relationship illustrated in Fig. 2, upon rotation of the drive-shaft 40 to the position illustrated in Fig. 3 the crank-arm between the centers of the drive-shaft and the eccentric disk 41 moves from a vertical to a horizontal position. The shifting of said crank-arm with the rotation of the eccentric disk 41 in the circular recess 37 of the piston-disk 30 moves the latter upwardly and simultaneously rocks it about its axis in a clockwise direction, see Fig. 3. At the beginning of the movement of the piston-disk 30 the inner ends of the ports 33 and 34 are brought into register with the exhaust port 22 and intake port 21, respectively, and due to the shape of said ports they continue to register as the piston-disk is simultaneously reciprocated and oscillated. During the upward movement of the piston-disk 30 the fluid in the compartment 31 is compressed and forced outwardly through the port 33 in the piston-disk, exhaust port 22 in the casing and conduit 25 connecting the exhaust ports to a suitable receiver. Simultaneously, fluid is drawn into the compartment 32 below the piston-disk 30 through the conduit 24, intake port 21, and port 34 in the piston-disk, the opposite intake and exhaust ports 20 and 23 of each pair being in sealing engagement with the side of the piston-disk.

Upon continued rotation of the drive-shaft 40 and eccentric disk 41 from the position illustrated in Fig. 3 to that illustrated in Fig. 4 the crank-arm of the eccentric disk 41 moves from a horizontal to a vertical position causing the piston-disk 30 to continue its upward motion, but to rock in the opposite or counter-clockwise direction. During the continued upward movement of the piston-disk 30 the fluid in the compartment 31 continues to be exhausted and the compartment 32 continues to be supplied with fluid until the valve-ports 33 and 34 in the piston-disk move out of register with the exhaust-port 22 and intake port 21, respectively. The exhaust port 22 is preferably arranged to register with the port 33 until the piston-disk 30 has completed its upward stroke. Due to the circular form of the piston-disk 30 and the semi-circular end 8 of the chamber 3 a very close clearance is obtained. At the very end of the up-stroke of the piston-disk 30 the valve port 33 therein moves out of register with the exhaust port 22 as illustrated in Fig. 4.

As the eccentric disk 41 continues its rotation from the position shown in Fig. 4 to that shown in Fig. 5 the crank-arm of the eccentric moves from a vertical to a horizontal position, but on the opposite side of the longitudinal axis of the work-chamber 3 from that previously described to move the piston-disk 30 downwardly and continue to rock it in a counter-clockwise direction. Thus, the port 33 in the piston-disk 30 is brought

into register with the intake port 20 and port 34 is brought into register with the exhaust port 23 as shown in Fig. 5. Downward movement of the piston-disk 30 causes the fluid in the compartment 32 to exhaust through the port 34, exhaust port 23 and conduit 25 and the compartment 31 to be supplied with fluid through the conduit 24, intake port 20 and port 33 in the piston-disk. The exhaust and intake of fluid continues during the down-stroke of the piston-disk 30 in the same manner as explained above with respect to the up-stroke of the piston-disk until the latter returns to the position illustrated in Fig. 2.

By the above explained method of operation the device functions as a double-acting pump or compressor during each revolution of the drive-shaft 40 and the oscillation of the piston-disk 30 controls the intake and exhaust of the fluid. It will be noted that the piston has its greatest lateral or oscillatory movement and its least reciprocatory movement at the ends of its stroke in either direction due to the harmonic motion of any point on the periphery of the eccentric disk 41. The increased lateral movement of the piston-disk 30 at the time when the ports 33 and 34 in the latter are shifted out of registry with the exhaust ports 22 and 23 to register with the intake ports 20 and 21 in the casing 2, or vice versa, gives an optimum operating condition.

Figs. 8 to 11 of the drawings illustrate a modified form of construction of the device incorporating shoes 50 at each side of a disk 51 to provide a piston of rectangular outline. In this modified construction the work-chamber 52 is of rectangular form to accommodate the rectangular piston. Preferably, the shoes 50 have arcuate faces 53 of the same radius as the periphery of the disk 51 and extend throughout substantially the whole circumference thereof with only a slight clearance between their ends. The top 54 and bottom 55 of each shoe 50 is arranged parallel to the ends 56 and 57 of the chamber 52 to cooperate therewith with a close fit and the sides of each shoe are adapted to slide on the respective side walls 59 and 60 of the work-chamber 52. Arcuate recesses 61 and 62 are provided on the inside face of each shoe 50 adjacent its opposite ends for cooperation with the ends of the ports 63 and 64 in the periphery of the disk 51 and recesses 65 and 66 at the ends of the arcuate recesses provide for communication with the compartments at opposite sides of the piston.

A lubricating system is preferably provided in the device for supplying lubricant to the relatively movable parts and to further act as a seal between the piston and the side walls of the chamber 3 or 52. As illustrated in Fig. 9, an oil-well in the form of a bore 70 is provided at the center of the disk 51 and the intake ports 20 and 21 in the casing have oil-grooves 71 and 72 adapted to overlie the edge of the oil-well during the combined reciprocation and oscillation of the disk. Thus, small amounts of lubricant are supplied to the compartments at opposite sides of the piston which are distributed by the movement of the piston-disk 51. It will be understood that oil-grooves (not herein shown) may be provided in the side of the piston-disk 51 to extend radially from the oil-well 70 to the bearing surfaces of the shoes 50. In Fig. 12 an oil separator 73 is illustrated in the line on the high pressure side of the device for separating the lubricant from the fluid and returning it to the oil-well 70 in the piston-disk 51 through a pipe 74 con-

necting the separator with the interior of the chamber.

The device of modified construction illustrated in Figs. 8 to 11 operates in the same manner as that illustrated in Figs. 1 to 7. Rotation of the eccentric disk 41 causes the piston-disk 51 to reciprocate and oscillate simultaneously to compress or pump fluid and control the opening and closing of the intake and exhaust ports. The periphery of the piston-disk 51, however, bears against the shoes 50 throughout substantially its whole circumference to provide a tight seal and the shoes reciprocate on the side walls of the chamber 52. It is to be noted that the pressure of the fluid acting against the ends of the shoes 50 tends to wedge them between the disk 51 and the side walls of the chamber 52 to provide an effective seal therebetween. During the combined reciprocation and oscillation of the disk 51 lubricant is distributed from the oil-well 70 to lubricate the relatively movable parts and it further helps to seal the points of contact between the piston and the side walls of the chamber 5 in the casing.

It will be observed from the foregoing description that the present invention provides a device particularly well adapted for compressing or pumping fluids and which has a minimum number of parts of simple and compact construction. It will be observed further that the invention provides a construction wherein a single element constitutes both a piston and the valves for controlling the intake and exhaust of fluid to and from a work-chamber.

While two embodiments only of the present invention are herein shown and described, it is to be understood that various other modifications may be made in the structure and arrangement of the elements without departing from the spirit or scope of the invention.

Therefore, without limiting myself in this respect,

I claim:

1. In a device of the type indicated, a casing having a chamber therein with parallel side walls, a disk having its opposite flat faces engaging the parallel side walls of the chamber, and means for reciprocating and oscillating the disk in the chamber, said casing having inlet and outlet ports and said disk having a port communicating with the chamber and cooperating with the valve ports in the casing during its reciprocation and oscillation.

2. In a device of the type indicated, a casing having a chamber therein, a piston in said chamber comprising a disk dividing the chamber into separate compartments, said disk having parallel flat faces and a cylindrical periphery, means for reciprocating and oscillating said disk in the chamber in a plane parallel to the flat faces of the disk, and valve-means communicating with the separate compartments.

3. In a device of the type indicated, a casing having an elongate chamber therein with inlet and outlet ports, at the side of the chamber, means in sealing engagement with the walls of said chamber to divide the latter into separate compartments comprising a disk having ports adapted for communication with the inlet and outlet ports in the casing and the compartments, and means for reciprocating and oscillating said disk in said chamber in a plane normal to the axis of the disk.

4. In a device of the type indicated, a casing having a chamber with parallel side walls and

valve ports therein, means in sealing engagement with the parallel side walls of the chamber comprising a disk having a port therein communicating with the chamber and one side of the disk, and means for simultaneously reciprocating and oscillating said disk, the port in the disk moving into and out of register with the ports in the casing during the oscillation of the disk to control the flow of fluid to and from the chamber.

5. In a device of the type indicated, a casing having a chamber therein with parallel side walls, a disk in said chamber, said disk having its opposite faces in sealing engagement with the parallel side walls of the chamber, means for simultaneously reciprocating and oscillating said disk in a plane normal to its axis, inlet and outlet valve ports in the casing, and a valve port in the disk communicating with the chamber and adapted to move into and out of registry with the inlet and outlet ports in the casing during the reciprocation and oscillation of the disk.

6. In a device of the type indicated, a casing having a chamber therein, means in sealing engagement with the walls of the chamber comprising a disk and shoes at opposite sides of the disk having bearing surfaces engageable with the disk and the side walls of the chamber, and means for reciprocating and oscillating said disk in the chamber, said casing having inlet and outlet ports and said sealing means having a port communicating with the chamber and the inlet and outlet ports in the casing during reciprocation and oscillation of the disk.

7. In a device of the type indicated, a casing having a rectangular chamber therein with inlet and outlet ports in one of the side walls thereof, means in sealing engagement with the walls of the chamber and dividing the latter into separate compartments, said means comprising a disk and shoes at opposite sides thereof to provide a rectangular piston, and eccentric means for reciprocating and oscillating the disk, said disk having ports communicating with the separate compartments and adapted for registry with the inlet and outlet ports in the wall of the casing as the disk is reciprocated and oscillated.

8. In a device of the type indicated, a casing having a chamber and inlet and outlet ports therein, a piston in sealing engagement with the walls of the chamber comprising a disk and bearing means embracing the disk with bearing surfaces engageable with the disk and side walls of the chamber, and means for reciprocating and oscillating said disk in the chamber, said piston having a valve port communicating with the chamber and cooperating with the inlet and outlet ports in the casing during the reciprocation and oscillation of the disk.

9. In a device of the type indicated, a casing having a rectangular prismoidal chamber with semi-cylindrical ends, a disk in sealing engagement with the walls of the chamber and dividing the latter into separate compartments, said disk having ports at one side communicating with the separate compartments, eccentric means for simultaneously reciprocating and oscillating the disk, and intake and exhaust ports in the casing adapted to cooperate with the ports in the disk during the oscillation of the latter.

10. In a device of the type indicated, a casing having a chamber and inlet and outlet ports therein, means in sealing engagement with the walls of the chamber comprising a disk having a circular recess in the side thereof, and a rotat-

able eccentric in the recess in the disk for reciprocating and oscillating the latter, said disk having a port communicating with the chamber and the inlet and outlet ports in the casing.

11. In a device of the type indicated, a casing 5 having an elongate chamber therein, said chamber having parallel side walls with inlet and exhaust ports therein, means in sealing engagement with the parallel side walls of the chamber comprising a disk having a port communicating with the chamber and adapted to alternately move into and out of register with the inlet and exhaust ports in the casing, and eccentric means for simultaneously reciprocating and oscillating the disk, the alternate registration of the port in the disk with the ports in the casing being controlled by the oscillation of said disk.

12. In a device of the type indicated, a casing 10 having an elongate chamber therein, means in sealing engagement with the walls of the chamber comprising a disk, said disk having a circular recess and a port in the side thereof communicating with the chamber, an eccentric rotatable in the recess in the disk for simultaneously reciprocating and oscillating the latter in the chamber, said compound movement of said disk causing the port in the side thereof to move in a predetermined closed orbit, and intake and exhaust ports in the side of the casing arranged in the orbit of movement of the port in the disk for registry therewith.

13. In a device of the type indicated, a casing 15 having an elongate chamber therein with parallel side walls and opposite pairs of intake and exhaust ports in one side wall thereof, means in sealing engagement with the parallel side walls of the chamber dividing the latter into separate compartments, said last-named means comprising a disk having ports communicating with the opposite compartments of the chamber and the intake and exhaust ports in the side wall of the chamber, and eccentric means for simultaneously reciprocating and oscillating the latter, the oscillation of said disk controlling the registry of the ports in the disk with the intake and exhaust ports in the chamber.

14. In a device of the type indicated, a casing

having an elongate chamber therein with inlet and outlet ports at the side of the chamber, means in sealing engagement with the walls of said chamber comprising a disk having a circular recess in one side thereof and a port adapted for communication with the inlet and outlet ports in the casing and the chamber, and a drive-shaft journaled in said casing and having a disk eccentrically mounted on the end thereof and seated in the recess in the first-mentioned disk, rotation of said eccentric disk causing said first-mentioned disk to simultaneously reciprocate and oscillate in the chamber.

15. In a device of the type indicated, a casing 20 having an elongate chamber therein, a disk having opposite parallel flat faces mounted in the chamber, the diameter of said disk being substantially equal to the distance between the lateral walls of the chamber and its cross-sectional dimension being substantially equal to the distance between the forward and rearward walls of the chamber to adapt it for sealing engagement with the sides of the latter, means for reciprocating and oscillating said disk in the chamber in a plane parallel to the flat faces of the disk, and valve-means communicating with the chamber.

16. In a device of the type indicated, a casing 25 having an elongate chamber therein, means in sealing engagement with the walls of the chamber dividing the latter into separate compartments, said means comprising a disk having a circular recess at one side of its center and opposite ports at one side thereof communicating with the separate compartments, an eccentric rotatable in the recess in the disk for simultaneously reciprocating and oscillating the latter in the chamber, said compound movement of said disk causing the ports in the side thereof to move in predetermined closed orbits, and a pair of intake ports in the side wall of the casing at one side of the longitudinal axis of the chamber and a pair of exhaust ports at the opposite side of said axis, said inlet and exhaust ports being arranged in the orbits of movement of the ports in the disk for registry therewith.

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