E. W. CHRISTIE.

PUMP.

APPLICATION FILED MAR. 22, 1909.

930,838.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

Fig: 1.

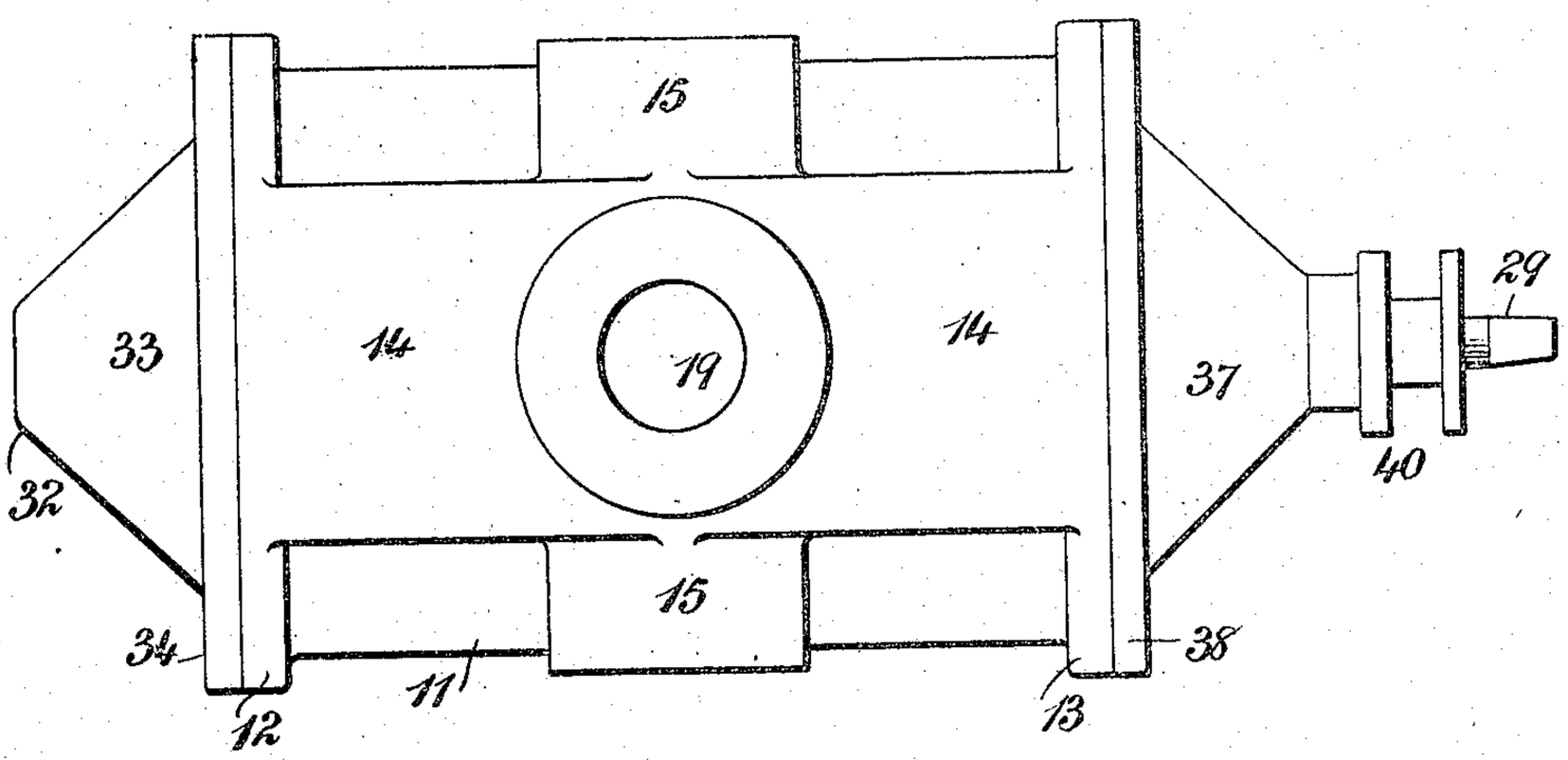
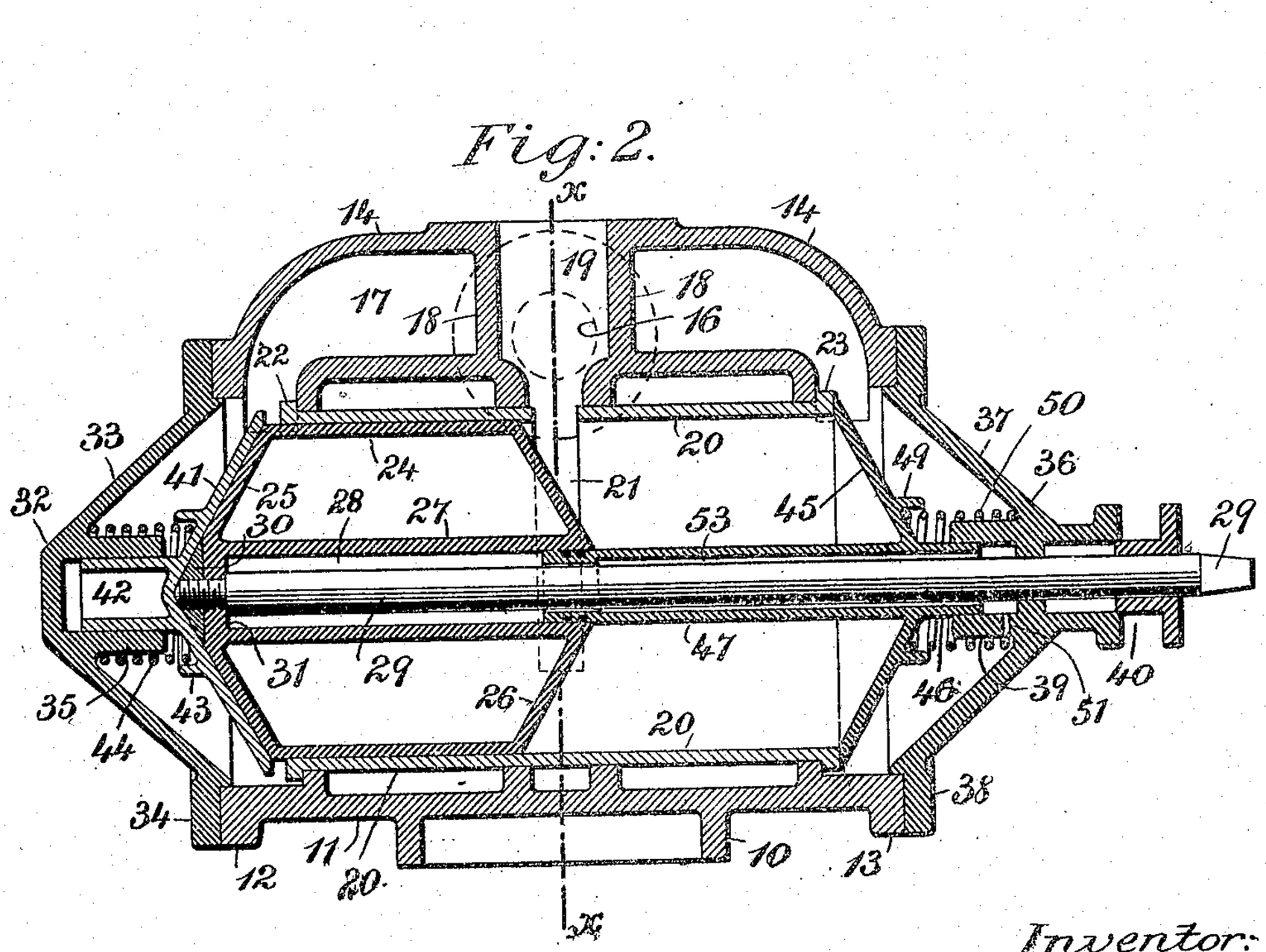



Fig: 2.




Witnesses:
Chas. H. Smith
A. H. Ferrell

Inventor:
Evi W. Christie
By Harold Ferrell
His Attorney.

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2 SHEETS—SHEET 2.

Fig: 3.

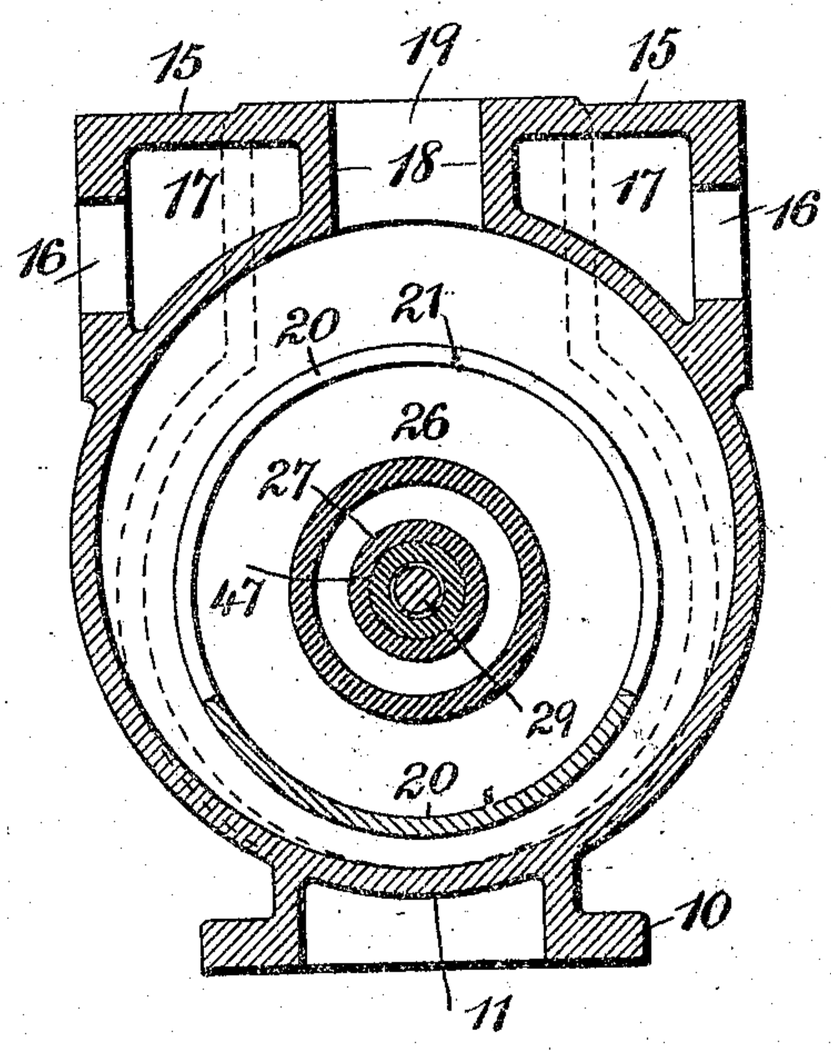
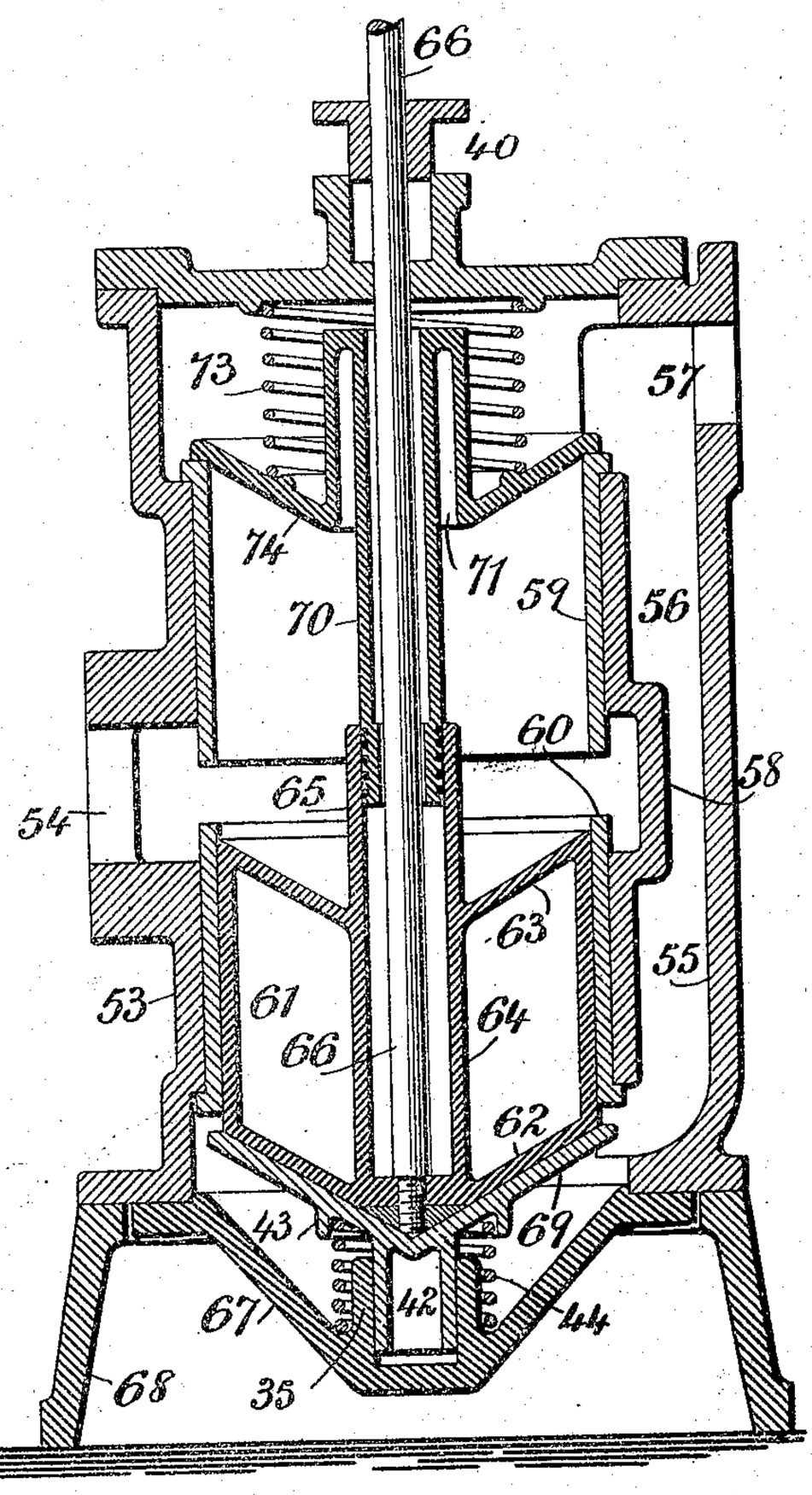



Fig: 4




Witnesses:

Chas. H. Smith

C. L. Serrell

Inventor:

Evi W. Christie

By Harold Serrell

His Attorney.

# UNITED STATES PATENT OFFICE.

EVI WILLSON CHRISTIE, OF SEWAREN, NEW JERSEY.

## PUMP.

No. 930,838. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed March 22, 1909. Serial No. 485,086.

*To all whom it may concern:*

Be it known that I, EVI W. CHRISTIE, a citizen of the United States, residing at Sewaren, in the county of Middlesex and State of New Jersey, have invented an Improvement in Pumps, of which the following is a specification.

This invention relates to pumps and particularly to that class of pumps commonly designated vacuum pumps of the valveless suction type.

It has long been recognized in pump design and in the art relating to pumps, that in order to produce a high vacuum or as complete an exhaustion of the air cylinder in an air pump as is possible, the clearance spaces between the piston or plunger device and the valves or other discharge devices must be as nearly the zero percentage of the pump cylinder volume as is possible, and heretofore it has been sought to accomplish this by using a crank to drive the piston with a very small clearance at the end of the stroke. In the driving of an air-pump as heretofore constructed by a direct acting steam cylinder however, it is mechanically impossible to effect a very close clearance, because the stroke varies more or less, due to the action of the steam gear.

Now the object of my invention is the provision of an air pump in which the clearance spaces are positively eliminated whereby the vacuum is increased for the reasons hereinbefore stated and a maximum efficiency obtained in the pump, and furthermore the inevitable variations in the stroke of a pump of this type would not affect the operation of a pump constructed in accordance with my invention.

In carrying out my invention, my improved pump preferably comprises a base, a pump body having suction and discharge ports, a piston, means whereby the same is actuated, a discharge valve operated in one direction by direct contact with and the movement of the said piston, and means for operating the discharge valve in the other direction,—as will be hereinafter more particularly described.

In the drawing, Figure 1 is a plan of my improved vacuum pump. Fig. 2 is a central longitudinal vertical section of the pump. Fig. 3 is a cross section on line $x$, $x$, Fig. 2, and Fig. 4 is a central vertical section of a modification of the invention as illustrated in Figs. 1 to 3 inclusive.

Referring particularly to the drawing, in constructing my improved air pump, I preferably provide a base 10, and a pump body 11 to which the base may be suitably attached or with which the base may be made integral as shown in Figs. 2 and 3. The pump body 11 is open ended and at one end thereof there is a flange 12, and at the other end a similar and corresponding flange 13.

Extending from one end of the pump body to the other and preferably in the upper central portion thereof and running longitudinally is a wall 14, and extending preferably at right angles from the central portion of the longitudinal wall 14 and in diametrically opposite positions, there are transverse walls 15. In the transverse walls 15 there are discharge ports 16 communicating with the discharge chambers 17 provided by the longitudinal wall 14. Extending preferably through the center of the discharge chambers 17 is a wall 18 which is circular or of other configuration communicating with the suction connection 19.

Within the pump body 11 I employ a lining 20 comprising the pump cylinder which, as will be understood, may be made of any suitable material. Approximately centrally this cylinder 20 is provided with a recess forming a port 21 providing for communication between the interior of the cylinder 20 and the suction connection 19. At one end the cylinder 20 is provided with a flange 22 forming a valve seat and at the opposite end the cylinder 20 is provided with a similar flange 23 also forming a valve seat. Within the cylinder 20 there is a piston 24 and this piston 24 is preferably so constructed as to have outwardly extending conical end walls 25, 26, respectively, and centrally the piston is provided with a wall 27 which is preferably circular in section forming a central bore within the piston which is open at one end. 29 indicates the piston rod which extends through the said bore provided by the wall 27 and at one extremity the piston rod 29 is provided with a reduced screw threaded end which passes through the end wall 31 of the piston and is secured thereto by the nut 30 or otherwise, the said rod passing through the bore in the piston so that there is an annular space formed between the same and the circular wall 27.

On one end the pump is provided with a cover 32 so constructed as to have outwardly

extending conical walls 33 and a flange 34 adapted to abut against the flange 12 and to be connected to the pump body in any suitable manner known to the art. Interiorly the cover 32 is provided with a centrally disposed annular wall 35. The other or rod end of the pump is similarly provided with a cover 36 also having outwardly extending conical walls 37 and a flange 38, which latter flange is adapted to abut against the flange 13 and be connected to the pump body by any suitable means. This cover member 36 is also provided interiorly with a centrally disposed annular wall 39. There is also provided with this cover member 36 a suitable gland or stuffing box 40 through and in which, as will be understood, the piston rod 29 passes and operates.

On the blank or non-rod end of the pump I employ a cylinder cover valve indicated at 41. The walls of this valve are conical and the angle of inclination is preferably the same as that of the conical end wall 25 of the piston 24, the periphery or edge of the cylinder cover valve being adapted to seat against the valve seat 22. The cover valve 41 is provided with a stem 42 which is preferably hollow and open at one end and adapted to fit within the aperture provided in the annular wall 35 and on the exterior surface of the valve 41 I preferably provide a circular rib 43, the diameter of which is preferably slightly in excess of the outer diameter of the annular wall 35. Extending between the recess formed by the rib 43 and the adjacent outer surface of the valve 41 and the recess formed by the outer surface of the annular wall 35 and the adjacent inner surface of the conical wall 33 of the cover 32 is a helical spring 44. Similarly on the opposite or rod end of the pump I employ a cylinder cover valve 45. This valve similar to the valve 41, is conical and the inclination of the walls thereof is the same as that of the wall 26 of the piston 24 and the periphery or edge of the valve 45 is adapted to seat against the valve seat 23. The cylinder cover valve 45 is also provided with a tubular stem, one portion 46 thereof extending beyond the apex of the valve and adapted to fit and slide within the recess provided therefor in the annular wall 39 and the other portion 47 of the tubular stem extends inwardly from the valve 45 and into the annular space 28 provided between the piston rod 29 and the central wall 27 of the piston 24, fitting the same and is provided with a suitable packing 48 in order to form a tight joint between the outer surface of the inward extension 47 of this valve stem and the inner surface of the wall 27.

The piston rod 29, as will be understood, extends through the stem of the valve 45 from one end to the other thereof. At the inner extremity of the portion 47 of this valve stem which surrounds the piston rod 29 as indicated, there are scored portions so as to provide a communication between the annular space 28 and the annular space 53 between the piston rod 29 and the inner surface of the inward extension 47, the annular wall 39 being provided with an aperture 51, so that there is free communication between the discharge chambers and these annular spaces so that no unnecessary power in driving the pump will be consumed in either creating or tending to create a vacuum or a compression of any gases or vapors within the said annular spaces. The valve 45 is also provided with a circular rib 49 whose diameter is slightly in excess of the outer diameter of the annular wall 39 and extending between the recess formed by the rib 49 and the adjacent outer surface of the valve 45 and the recess formed by the outer surface of the annular wall 39 and the adjacent inner surface of the inclined walls 37 of the cover member 36, there is also a helical spring 50.

Now in the operation of the pump as hereinbefore described, assuming that the parts are at the end of a stroke from right to left, and at the beginning of the stroke from left to right, it will be apparent that the valve 41 is open; that the valve 45 is closed, and that the right hand portion of the cylinder 20 is opened by way of the port 21 to the suction connection 19. After the piston has started its travel from left to right, the valve 41 following up the piston, will be returned therewith by the action of the spring 44 until this valve is seated on its valve seat 22; thereafter and after the forward edge of the piston 24 has passed over the port 21, the gases and vapors contained in the right hand portion of the cylinder will be compressed under the continued movement of the piston from left to right, the piston, as will be understood, passing over the inward extension 47 of the valve 45. The pressure exerted by the piston on the gases and vapors contained in the cylinder, will force the valve 45 open, permitting the gradual escape of the gases and vapors. This condition maintains until the contents of the right hand end of the cylinder are entirely discharged, when the wall 26 of the piston 24 contacts directly with the conical walls of the valve 45. These juxtaposed conical walls coming into contact with each other before the end of the stroke squeeze out all the intervening gases and vapors, thereby eliminating all clearance spaces, and causing a complete discharge of the cylinder. The contact relationship between the conical end wall of the piston and the walls of the discharge valve maintains from the moment it is effected until the end of the stroke and until the piston has traveled sufficiently far in its return stroke to permit the valve to

reseat, and manifestly the same operation takes place at the other end of the pump.

Referring particularly to Fig. 4, the pump illustrated therein embodies my present invention as incorporated in a vertical pump in which the body of the pump is indicated at 53, wherein is provided a suction 54 and a longitudinal wall 55 providing for a discharge chamber 56 from which at the upper end of the pump there is a discharge connection 57. The cylinder or lining in this construction is preferably made in two parts indicated at 59, 60, respectively, the adjacent ends of which extend into the space provided by the wall 58 forming a suction chamber. In this construction the piston is illustrated at 61 and the end walls 62, 63, thereof are preferably inclined in the same direction and at the same angle. This piston is also constructed with a central circular wall 64 and at its upper end this wall is continued to form a stem as indicated at 65. 66 represents a piston rod which passes into the bore formed by the wall 64 and is suitably connected to the piston. The lower end of the pump is provided with a cover 67 and the pump is mounted on a suitable base 68 or otherwise. At this end of the pump there is a valve 69 which is conical in configuration, the walls thereof being at the same inclination as the wall 62 of the piston and the other associated parts at this end of the pump are in all respects similar to those described in connection with the blank or non-rod end of the pump shown in Figs. 1 to 3 inclusive. The valve 74 at the upper end of the pump is also conical, the walls thereof extending inwardly or downwardly instead of outwardly as described in connection with Figs. 1 to 3 inclusive and the inclination of the conical walls of this valve 74 is the same as that of the end wall 63 of the piston. The valve 74 is provided with a stem 70 through which and spaced apart therefrom the piston rod 66 passes, this stem passing into and sliding within the annular space formed between the piston rod and the stem 65 in the central wall 64. In the other or upper side of the valve 74 the stem is provided with an annular recess 71 into which as will be understood, the stem 65 passes in the upward stroke of the pump and the valve 74 is normally maintained against its seat on the end of the cylinder 59 by means of a spring 73 which extends between the upper or outer surface of the valve and the inner face of the cover 72, which in this instance is made flat and which construction, as will be understood, necessitates the downward inclination of the walls of the valve 74 and the end walls 63 of the piston. The operation of this modification of the invention is in all respects similar to that hereinbefore described in connection with the preferred form of pump illustrated in the horizontal type as shown in Figs. 1 to 3 inclusive.

I claim as my invention:

1. In a vacuum pump, a cylinder having suction and discharge ports, a valve seat in the end of said cylinder, a piston within said cylinder, a piston rod, a valve adapted to seat on the seat at the end of said cylinder, a valve stem passing into said piston and upon which the same slides, and means for returning the said valve to its seat and normally maintaining the same in position thereon.

2. In a vacuum pump, a cylinder having a central intake and a valve seat on each end thereof, a piston having a tubular center movable through said cylinder and having inclined heads, valves having walls at the same inclination as the inclined piston heads and adapted to seat on the ends of the cylinder, a tubular member formed with one of said valves and passing into the tubular center of the piston, guides for said valves, and means for normally maintaining said valves on their seats.

3. A vacuum pump comprising a base, a pump body having suction and discharge connections, end or cover members for the said pump body having outwardly extending conical walls, an open ended cylinder in said pump body having a port therein in communication with the said suction connection, a piston in said cylinder, means whereby the piston is actuated, a discharge valve adapted to seat against the end of the said cylinder and to be opened by the action of the said piston, a stem connected to the said discharge valve, an annular wall within one of the said cover members and within which the said valve stem operates, a circular rib on the outer surface of the said valve and a spring fitting within the said circular rib and extending between the same and the inner surface of the conical walls of the said end member.

4. A vacuum pump comprising a base, a pump body having suction and discharge connections, end or cover members for the said pump body having outwardly extending conical walls, an open ended cylinder in said pump body having a port therein communicating with the said suction connection, a piston in the said cylinder having an outwardly extending conical end wall, means whereby said piston is actuated, a conical discharge valve adapted to seat against the end of the said cylinder, and the inclination of the walls of which are at the same angle as that of the said conical end wall of the piston, a tubular stem extending outwardly from the apex of the said conical discharge valve, an annular wall extending inwardly from the conical wall of one of the said end members and within which the said stem

is adapted to operate, a circular rib on the outer surface of the said discharge valve and a spring extending between the outer surface of the said discharge valve within the said circular rib and the inner surface of the conical walls of the said end member and by which the said discharge valve is closed.

5. A vacuum pump comprising a base, a pump body having suction and discharge connections, ends or covers for the said pump body, a cylinder within the said pump body and having a port therein in communication with the said suction connection, a piston within the said cylinder and having a conical end wall and a central circular wall forming a longitudinal bore therein, a piston rod extending through the said bore and connected to the said piston so that there is an annular space between the said central circular wall and the said piston rod within the piston, a conical discharge valve adapted to seat against the end of the said cylinder and the inclination of the walls of which are at the same angle as that of the said conical end wall of the said piston, a stem connected to the said discharge valve surrounding the said piston rod and extending into the said annular space between the said piston rod and the said circular wall in the piston, and means for closing the said discharge valve.

6. A vacuum pump comprising a base, a pump body having suction and discharge connections, ends or covers for the said pump body, a cylinder within the said pump body and having a port therein in communication with the said suction connection, a piston within the said cylinder and having a conical end wall and a central circular wall forming a longitudinal bore therein, a piston rod extending through the said bore and connected to the said piston so that there is an annular space between the said central circular wall and the said piston rod within the piston, a conical discharge valve adapted to seat against the end of said cylinder and the inclination of the walls of which are at the same angle as that of the said conical end wall of the said piston, a tubular stem connected to the said discharge valve and extending both forwardly and rearwardly thereof, the rearwardly extending portion passing into the said annular space between the piston rod and the circular wall of the piston, an annular wall extending inwardly from one of the said end members and adapted to receive the forwardly extending portion of the said tubular valve stem, a circular rib on the outer surface of the said valve and a helical spring extending between the recess formed by the said circular rib and the adjacent outer surface of the said discharge valve and the recess formed by the said annular inwardly extending wall and the adjacent inner surface of the said end member.

7. A vacuum pump comprising a base, a pump body having suction and discharge connections, end or cover members for the pump body, each having outwardly extending conical walls, an open ended cylinder within the said pump body and having a port therein providing communication between the interior of the said cylinder and the said suction connection, a piston within the said cylinder and having outwardly extending conical end walls and a central longitudinal circular wall providing a bore therein, a piston rod extending through the bore formed by the said central wall of the piston and secured thereto, whereby there is provided an annular space between the said piston rod and the said central wall of the piston, a conical discharge valve at the non-rod end of the pump, the walls of which are at the same inclination as the adjacent end wall of the piston with which the said discharge valve is adapted to contact, means in which the said discharge valve operates, means for closing the said discharge valve and for normally maintaining the same against its seat, a conical discharge valve at the rod end of the pump, the walls of which are at the same inclination as those of the adjacent end wall of the piston, with which the same contacts, a tubular valve stem connected to the last aforesaid discharge valve extending both inwardly and outwardly of the said discharge valve and surrounding the said piston rod, the said inwardly extending portion of the said tubular stem passing into the said annular space between the said piston rod and the said central wall of the piston, an annular wall extending inwardly from the cover at the rod end of the pump and in which the said outwardly extending portion of the valve stem operates, and means for closing the last aforesaid discharge valve and normally maintaining the same against its seat.

Signed by me this 13th day of March, 1909.

EVI WILLSON CHRISTIE.

Witnesses:
ARTHUR H. SERRELL,
BERTHA M. ALLEN.