B. O. GAGE.

PUMP.

APPLICATION FILED FEB. 18, 1910.

969,616.

Patented Sept. 6, 1910.

4 SHEETS—SHEET 1.

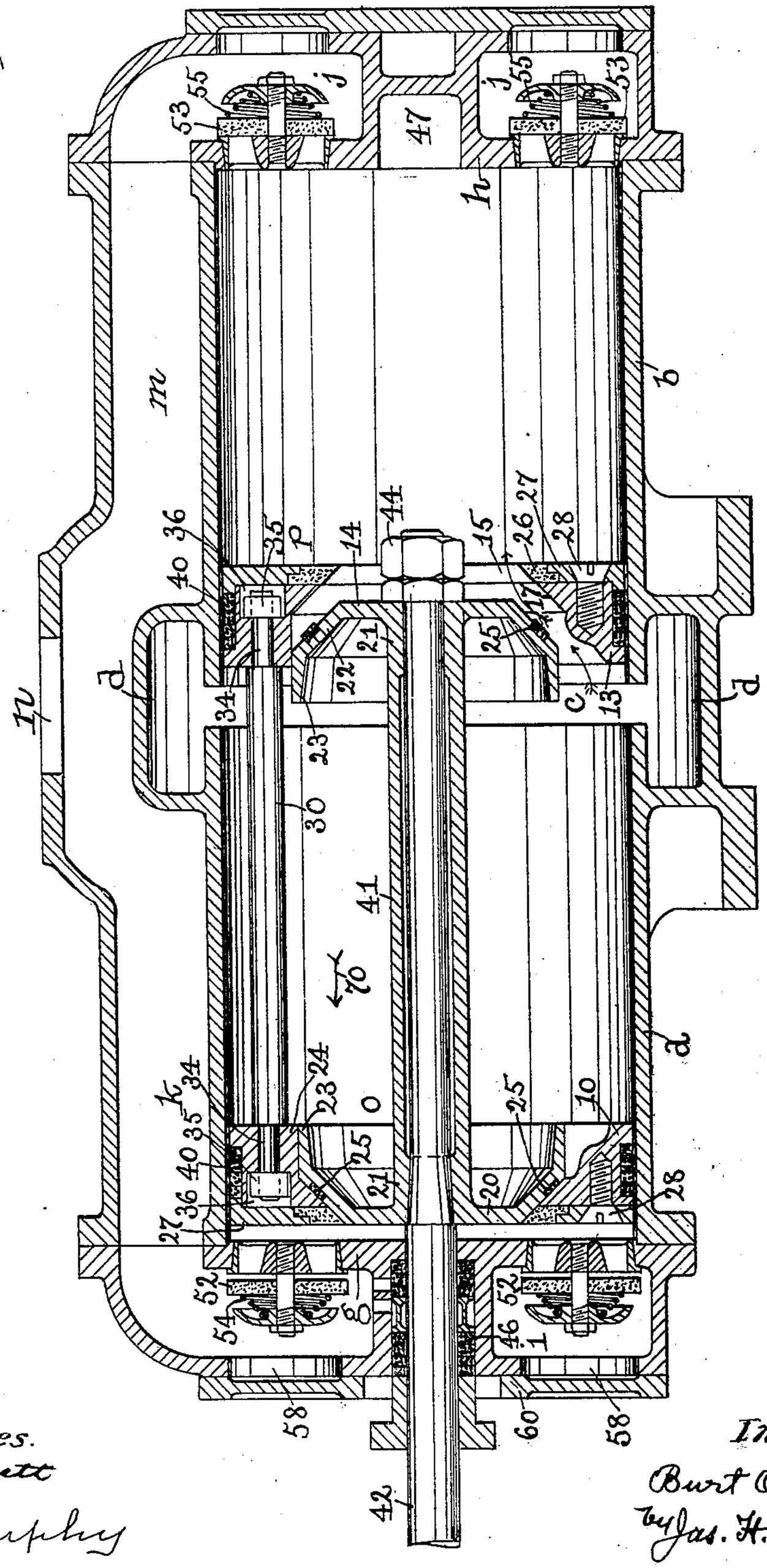

Fig. 1.

Witnesses.
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4 SHEETS—SHEET 2.

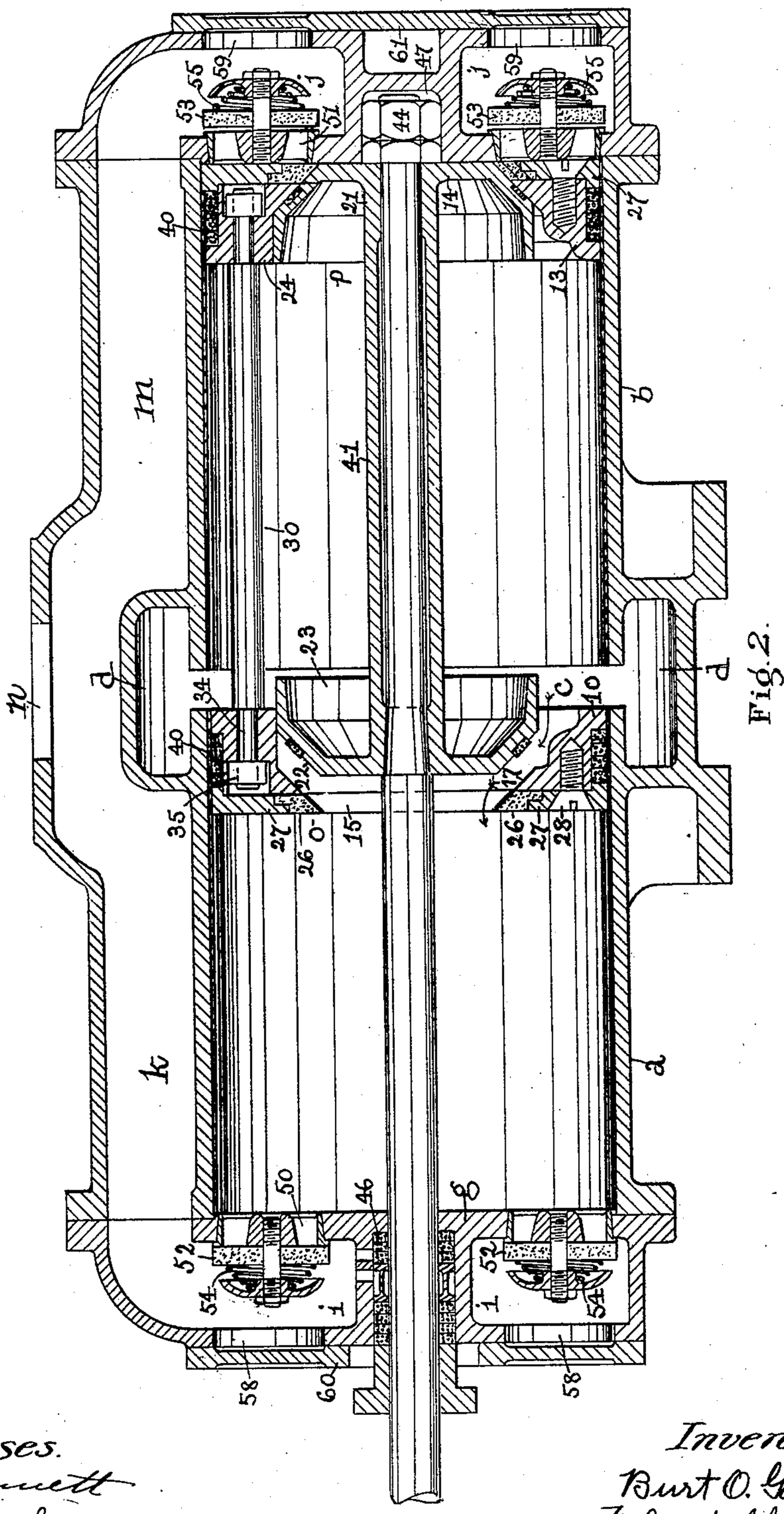

Fig. 2.

Witnesses.
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4 SHEETS—SHEET 3.

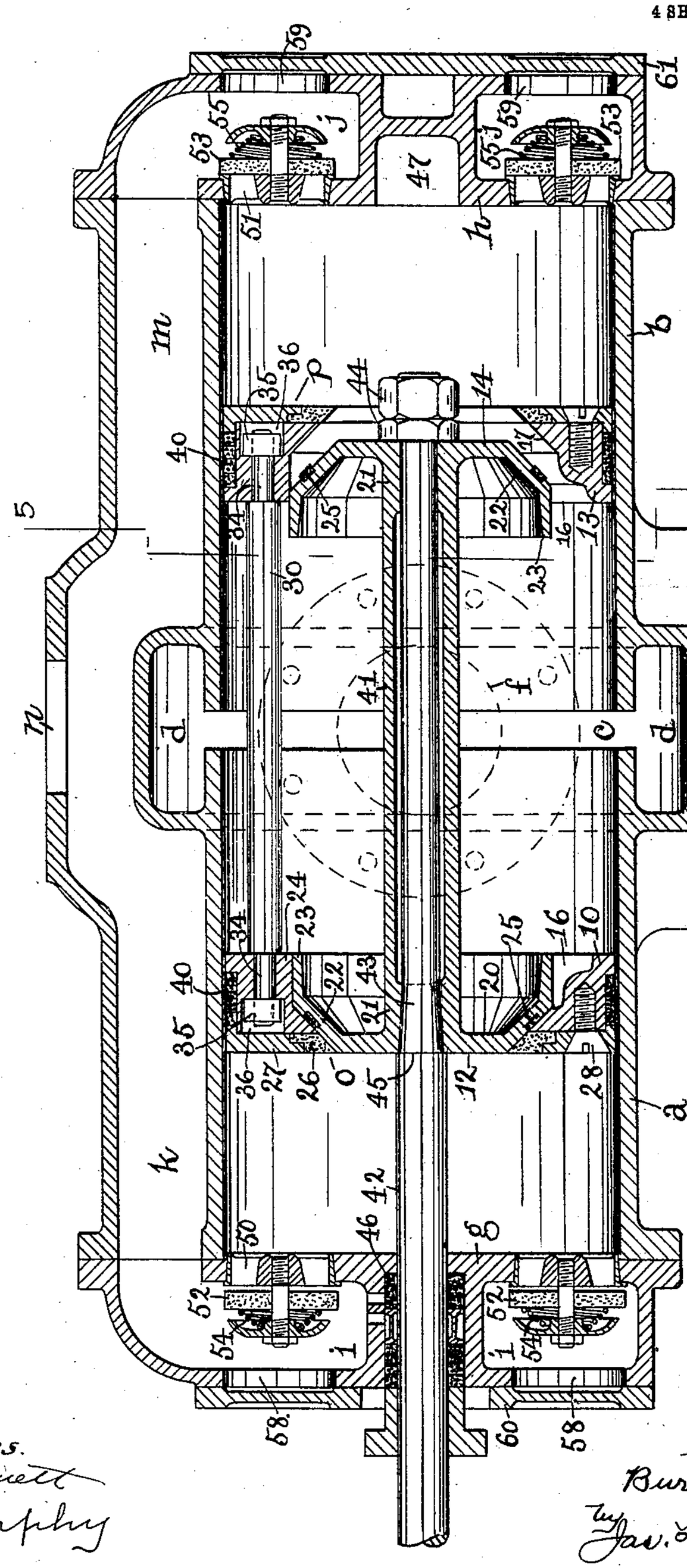

Fig. 3.

Witnesses.
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4 SHEETS—SHEET 4.

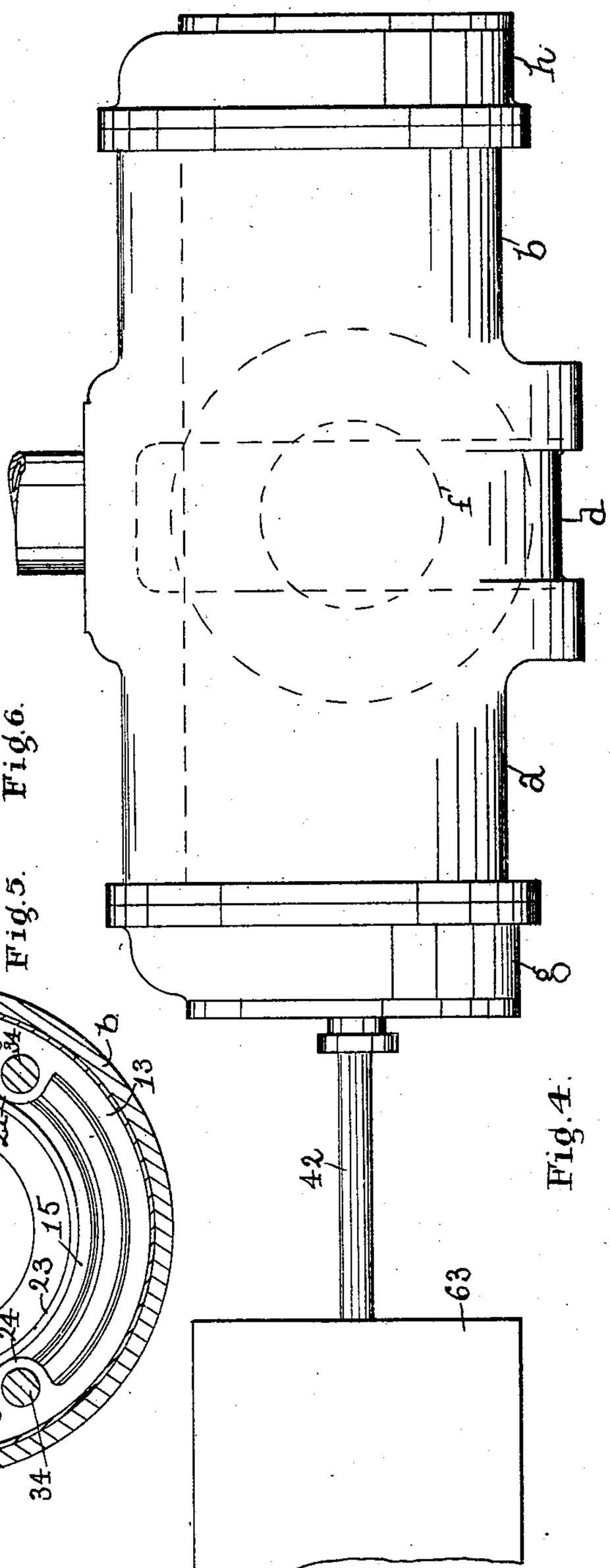

Fig. 4.

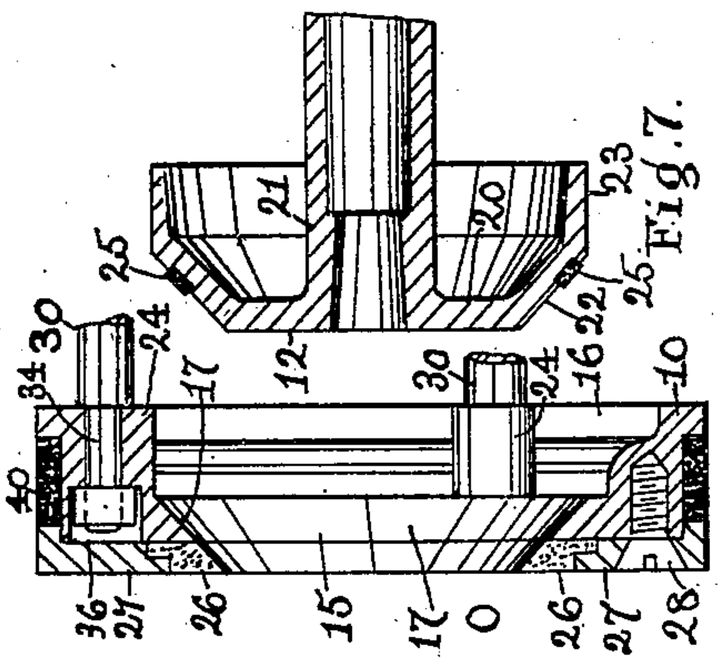

Fig. 7.

Fig. 6.

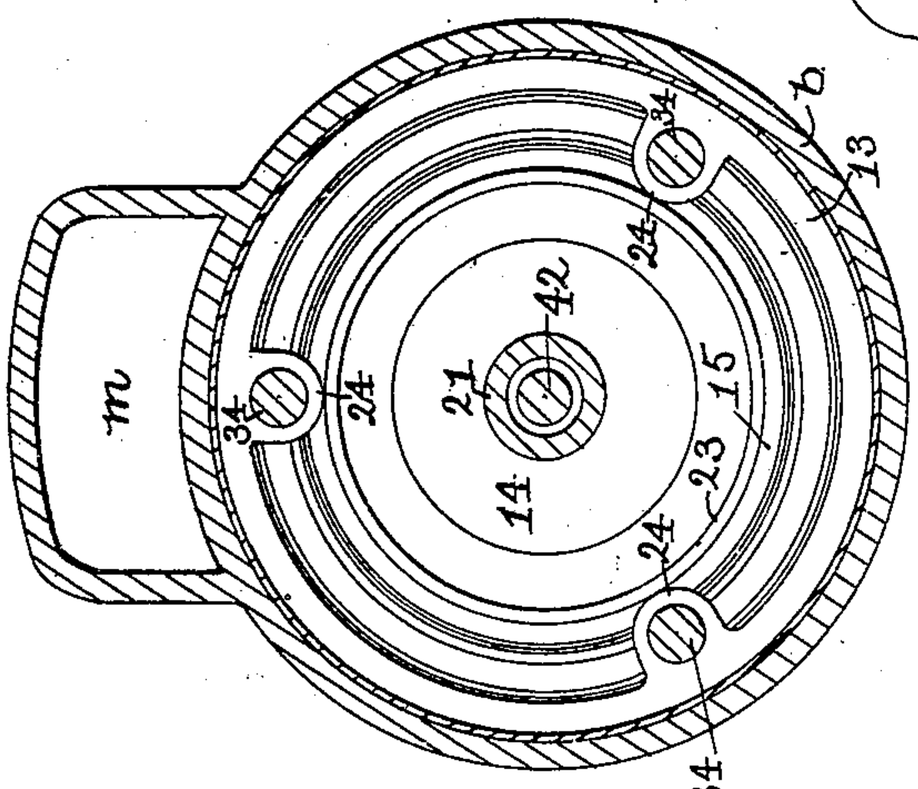

Fig. 5.

Witnesses.
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UNITED STATES PATENT OFFICE.

BURT O. GAGE, OF WARREN, MASSACHUSETTS, ASSIGNOR TO WARREN STEAM PUMP COMPANY, OF WARREN, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

PUMP.

969,616. Specification of Letters Patent. Patented Sept. 6, 1910.

Application filed February 18, 1910. Serial No. 544,599.

To all whom it may concern:

Be it known that I, BURT O. GAGE, a citizen of the United States, residing in Warren, county of Worcester, and State of Massachusetts, have invented an Improvement in Pumps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to pumps and is herein shown as embodied in an air pump of that class commonly known as a suction valveless pump, and has for its object to provide a pump of maximum efficiency, which may be used either as a compressor or as a vacuum pump, and with which, when used as a vacuum pump, a vacuum substantially close to the barometric pressure may be produced, whereby the pump is especially adapted among other uses to be employed for producing a high vacuum in condensers employed with turbine engines. For this purpose, the pump is provided with a piston composed of members, which may be designated the seat and valve members. The seat member is of substantially the internal diameter of the cylinder to make contact therewith and is provided with a substantially central port or opening with which coöperates the valve member, which is attached to or connected with the piston rod. The valve member is arranged to be moved independently of the seat member and also simultaneously therewith, as will be described.

The invention is especially applicable to a double acting pump having opposing cylinders with a common inlet between them and with independent outlets, and containing pistons whose seat members are connected together, and whose valve members are connected with the piston rod to move simultaneously, and which are arranged with relation to the seat members, so that both seat members are moved by the valve member of each piston, and so that when one valve member is seated, the other valve member is removed from its seat for a purpose, as will be described.

Provision is made for obtaining a fluid-tight joint between each valve member and its coöperating seat member, whereby fluid is prevented from passing through the port in the seat member of the piston, when the valve member is seated. Provision is also made for enabling fiber or other non-metallic packing to be used on the exterior of the seat members, as will be described.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a longitudinal section of a double acting pump, showing the pistons near the end of their stroke in one direction; Fig. 2, a section like Fig. 1 with the pistons at the end of their stroke in the opposite direction; Fig. 3, a section like Fig. 1 with the pistons at an intermediate position; Fig. 4, a side elevation of the air cylinders shown in Fig. 1 and a portion of a steam pump for actuating the pistons therein; Fig. 5, a detail in cross section on the line 5—5, Fig. 3, and Figs. 6 and 7, details of the parts comprising one of the pistons.

In the pump herein shown as embodying this invention, *a*, *b*, represent two cylinders arranged in line with each other and having their inner or adjacent ends separated by an annular space *c* forming a fluid inlet for both cylinders and which communicate with an annular chamber *d* whose walls are herein shown as integral with the walls of the cylinders *a*, *b*. The annular chamber *d* is provided with a fluid inlet port *f*. The cylinders *a*, *b*, are provided at their outer ends with suitable heads *g*, *h*, having chambers *i*, *j*, which communicate with passages *k*, *m*, extended longitudinally of the cylinders on the exterior thereof and provided with a common substantially central outlet *n*. The cylinders *a*, *b*, contain within them two reciprocating pistons *o*, *p*, of like construction and each comprising a seat member and a valve member.

To facilitate description, the seat member of the piston *o* is marked 10 and the valve member is marked 12, while the seat member of the piston *p* is marked 13 and the valve member 14. Inasmuch as the pistons *o*, *p*, are of like construction, a detailed description of one will suffice for both.

The seat member 10 of the piston *o* is of substantially the full internal diameter of the cylinder *a* and is provided with a substantially central opening or port 15 extended through it, and having its walls of different diameters. In the present instance, the walls of the port or opening 15 comprise

a substantially large cylindrical portion 16 (see Figs. 2 and 6) extended from one side of the seat member toward the center thereof, and an inclined or frustum-shaped portion 17 extended from the cylindrical portion 16 to the other side of the seat member. The inclined portion 17 forms a seat for the valve member 12, which comprises a disk or circular central portion 20 provided with a central hub 21 and from which extends a frustum-shaped portion 22 having a cylindrical extension 23.

The inclined portion 22 of the valve member coöperates with the inclined portion 17 of the seat member, and the cylindrical portion 23 coöperates with lugs or projections 24, which extend radially inward from the cylindrical wall 16 of the port or opening 15 and form guides for the valve member. The disk portion 20 of the valve member, when the latter is seated, fills the portion of the opening in the rear face or side of the seat member, as represented at the left in Fig. 3. A fluid-tight joint between the valve member and the seat member may be effected in different ways, as for instance by packing 25 set into the inclined portion 22 of the valve member so as to contact with the inclined wall 17 of the seat member, or by a ring 26 of fibrous material secured to the seat member by a follower ring 27, which is secured to the seat member by screws 28 or otherwise. The packing ring 26 is provided with an opening having inclined walls to correspond to the inclined portion 22 of the valve member.

From the above description of the valve and seat members of the piston *o*, it will be seen that a practically solid piston is obtained when the valve member is seated on the seat member as represented in Fig. 2, and passage of fluid from one side of the piston to the other through the opening in the seat member is prevented. On the other hand, when the valve member is moved off or away from its seat, passage for the fluid is afforded between the valve member and seat member through the port or opening 15 in the latter, as represented at the right in Figs. 1 and 3.

The seat members 10, 13 are connected together to move simultaneously in their respective cylinders *a*, *b*, and in the present instance, said seat members are connected together near their outer circumferences by tie rods 30, only one of which is shown in Figs. 1, 2 and 3, said tie rod having reduced end portions 34, which form shoulders, against which the front faces or sides of the seat members are held by nuts 35, which engage screw-threads on the end portions 34. The nuts 35 are located in pockets 36 in the rear sides of the seat members, said pockets being closed by the follower ring 27.

The reduced end portions 34 of the tie rods 30 are shown as extended through the guiding lugs or projections 24, and the tie rods are made of the proper length to space or separate the seat members, so that the latter on their strokes toward the inner ends of their cylinders will stop substantially flush with the inner ends of the cylinders and will not pass over and close the annular inlet port *c*, whereby the latter is open at all times and the packing 40 on the exterior of each seat member is not uncovered by the inlet port but is confined between the seat member and its cylinder. This enables a fibrous or other non-metallic or soft packing to be used, whereby a superior joint is obtained between the seat member and its cylinder, and leakage of fluid between the seat member and its cylinder is avoided, which is an important feature in a pump of this class.

The valve members 12, 24 are connected together to move simultaneously, and in the present construction, the hubs 21 of said members are joined by a sleeve 41 integral therewith. The sleeve 41 and hubs 21 are made of a length less than the distance between the rear faces or sides of the seat members, so that when either valve member is seated, the other is opened.

The valve members 12, 14, are mounted upon a common piston rod 42 and are secured thereon as herein shown by providing the hub of the valve member 12 with a tapered bore which engages a tapered portion 43 of the piston rod, and by means of nuts 44 which engage the threaded outer end of the piston rod and coöperate with the valve member 14 to force the tapered hub upon the tapered portion 43 of the piston rod and against an annular shoulder 45 formed on the piston rod by said tapered portion 43. The piston rod 42 extends through the head *g* for the cylinder *a* and through a suitable stuffing box 46 therein, and the end of the piston rod which projects beyond the valve member 14 is adapted to enter a recess 47 in the head *h* of the cylinder *b*. The pistons are designed and adapted to be moved into contact or substantially into contact with the heads *g*, *h* of the cylinders *a*, *b*, so as to eliminate clearance space between the pistons and the said heads, or at least reduce the clearance to a minimum, so that it can practically be disregarded. The heads *g*, *h*, of the cylinders are provided as herein shown with outlet ports 50, 51, with which coöperate valves 52, 53, normally seated by springs 54, 55, and automatically opened by the pressure of the fluid in the cylinders when the pistons therein are moved toward said heads.

Instead of the particular form of outlet valve herein shown, I may employ any other suitable or desired construction.

The outer wall of the chambered heads *g*,

h, may be provided with suitable hand holes 58, 59 in line with the outlet valves, to render the latter accessible, and said hand holes are normally closed by covers 60, 61. The piston rod 42 may be operated in any suitable or desired manner, and in Fig. 4, I have represented the same as extended into the cylinder 63 of a steam engine of any suitable construction to whose piston (not shown) the piston rod 42 is connected.

The operation of the pump herein shown, may be clearly understood by reference to Figs. 1, 2 and 3. In Fig. 1, the pistons o, p, are represented as moving in the direction indicated by the arrow 70 and have reached nearly the end of their stroke in this direction.

It will be observed, that the valve member 12 is seated and coöperates with its seat member to form a practically solid piston, which cuts off or separates the portion of its cylinder a between the piston o and the head g of the cylinder, from the portion of the said cylinder between the piston o and the inlet port c, whereas the valve member 14 is removed from its seat, and the cylinder b is in open communication for its entire length with the fluid inlet c. As a result, fluid drawn into the cylinders through the inlet port c can pass freely through the port opening 15 in the valve p into the cylinder b behind the piston p, so that the pressure on both sides of the piston p is the same. It will further be noticed that when the piston o reaches the end of its stroke in the direction of the arrow 70, the seat member 13 of the piston p is substantially flush with the inner end of its cylinder b. When the piston o reaches the end of its stroke in the direction of the arrow 70, and is in contact or substantially in contact with the head g, of the cylinder a, the valve members 12, 14, are moved in the direction opposite to that indicated by the arrow 70 independently of the seat members 10, 13, and this movement closes or seats the valve member 14 to cut off the cylinder b for substantially its length from the fluid inlet c, while at the same time, the valve member 12 is unseated or opened so as to equalize the pressure of the fluid on both sides of the piston o. The two pistons are now in a condition to be moved simultaneously in the direction opposite to that indicated by the arrow 70, which condition is represented in Fig. 2. As the piston p is moved toward the head h of its cylinder b, the fluid between said piston and head is forced out through the ports 51, whose valves 53 are automatically opened.

It will be observed that the movement of the piston p toward the head h is not resisted by a vacuum behind the piston o, but is a free movement so far as the piston o is concerned, because the fluid is free to pass from the inlet end of the cylinder a to the outlet end of the latter through the port opening 15 in the piston o. In other words, the piston o is balanced. When the piston p reaches the end of its stroke toward the head h of its cylinder, the piston rod 42 starts on its stroke in the direction of the arrow 70 and first moves the valve members 12, 14, so as to close the member 12 and open the member 14, so that the pressure in the cylinder b on opposite sides of the piston p is equalized before the seat members are moved, and thereafter both pistons are moved simultaneously in the direction indicated by the arrow 70.

In Fig. 3, the condition of the pistons when moving in the direction of the arrow 70 is represented at substantially the middle of the stroke.

It will be observed, that the valve members of the piston are moved independently of the seat members to close one and open the other before the seat members are moved, and thereafter both valve and seat members in the condition just described, are simultaneously moved, which is a feature of great importance in an air pump, inasmuch as the movement of the piston in one cylinder on its compressing stroke is not pulling against a vacuum in the other cylinder. Furthermore, by providing the pistons with a seat member and a valve member movable independently of and then simultaneously with the seat member, the clearance between the pistons and cylinder heads may be eliminated or at least reduced to a minimum, so that, when the pump is used as a vacuum pump, a vacuum very close to the barometric pressure may be obtained.

I have herein described the pump as a vacuum pump, as it is superior for producing a high vacuum and thereby is especially adapted for use with the condensers of turbine engines, but it is not desired to limit the invention in this respect, as the pump can be used to produce a vacuum for other purposes and as a compressor with equal efficiency. Furthermore, one construction of pump embodying this invention is herein shown, but it is not desired to limit the invention to the particular construction shown.

Claims.

1. In a pump, in combination, cylinders arranged in line with each other and separated at their adjacent ends to form a fluid inlet for both cylinders, an annular chamber about said adjacent ends and with which said fluid inlet communicates, said chamber having a fluid inlet, heads at the outer ends of said cylinders having fluid outlets, automatically operated valves coöperating with said outlets, pistons in said cylinders, each comprising a seat member of substantially the diameter of its cylinder and provided with a substantially central port or opening extended through it, and a valve mem-

ber coöperating with said seat member to form a substantially solid piston when said valve member is seated and to uncover said port or opening when unseated, means extended from one cylinder into the other for connecting said seat members together to move simultaneously and for obtaining a substantially long bearing for said seat members, a piston rod, and means for securing said valve members to said piston rod, said valve members being located between said seat members and separated from each other a distance less than the distance between the outer faces of said members, whereby either of the valve members is opened or unseated when the piston rod is moved to seat the other of said valve members, for the purpose specified.

2. In a pump, in combination, cylinders arranged in line with each other and separated at their adjacent ends to form a fluid inlet for both cylinders, an annular chamber about said adjacent ends and with which said fluid inlet communicates, said chamber having a fluid inlet, heads at the outer ends of said cylinders having fluid outlets, automatically operated valves coöperating with said outlets, pistons in said cylinders, each comprising a seat member of substantially the diameter of its cylinder and provided with a substantially central port or opening extended through it, a valve member coöperating with said seat member to form a substantially solid piston when said valve member is seated and to uncover said port or opening when unseated, means extended from one cylinder into the other for connecting said seat members together to move simultaneously and for obtaining a substantially long bearing for said seat members, a piston rod, means for securing said valve members to said piston rod, said valve members being located between said seat members and separated from each other a distance less than the distance between the outer faces of said seat members, whereby either of the valve members is opened or unseated when the piston rod is moved to seat the other of said valve members, and means for effecting a fluid-tight joint between said valve members and said seat members, substantially as described.

3. In a pump, in combination, two cylinders arranged substantially in line with each other and provided with a fluid-inlet common to both and in open communication therewith, pistons in said cylinders, each comprising a seat member of substantially the diameter of its cylinder and provided with a substantially central port or opening extended through it, and a valve member coöperating with said seat member, means extended from one cylinder into the other to connect the seat members together to move simultaneously and to obtain a long bearing for said seat members, a piston rod, means for securing said valve members to said piston rod, said valve members being located between said seat members and separated a distance less than the distance between the outer faces of the said seat members, whereby the valve members may be moved by said piston rod independently of said seat members and then simultaneously therewith, substantially as described.

4. In a pump, in combination, two cylinders arranged in line with each other, and provided with a fluid inlet common to both, two pistons located in said cylinders and each comprising a seat member having a port or opening extended through it, and a valve member coöperating with said port, means extended from one cylinder into the other to connect said seat members together to obtain a long bearing for said seat members, a piston rod, and means for securing said valve members to said piston rod in such relation to the seat members that one valve member is opened when the other is closed, substantially as described.

5. In a pump, two cylinders arranged in line with each other and provided with a fluid inlet common to both, two pistons located in said cylinders and each comprising a seat member having a port or opening and provided on its circumference with a packing and on its outer surface with a packing ring arranged about said port or opening and with a follower plate for retaining both packings in place, means extended from one cylinder into the other for connecting said seat members together and for obtaining a long bearing for said seat members, a piston rod, and means for securing said valve members to said piston rod between said seat members at a distance less than the distance between said seat members, substantially as described.

6. In a pump, a piston comprising a seat member having a substantially central port or opening through it, a valve member cooperating with said port or opening, a packing ring arranged about said port or opening and forming part of the seat for said valve member, a packing on the circumference of said seat member, a follower ring to secure said packing ring to said seat member, a piston rod connected with said valve member, means for operatively connecting said piston rod with said seat member to permit the piston rod to effect simultaneous movement of both members and independent movement of said valve member, substantially as described.

7. In a pump, a piston comprising a seat member having a substantially central port or opening through it, a valve member cooperating with said port or opening, a packing ring arranged about said port or opening and forming part of the seat for said

valve member, means to secure said packing ring to said seat member, a piston rod connected with one of said members, and means for operatively connecting said piston rod with the other of said members, substantially as described.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

BURT O. GAGE.

Witnesses:
L. G. KIBBE,
FRANK W. BLISS.