

No. 785,918.

PATENTED MAR. 28, 1905.

J. B. RHODES.  
FLUID ACTUATED VALVE.  
APPLICATION FILED MAY 12, 1902.

Fig. 2

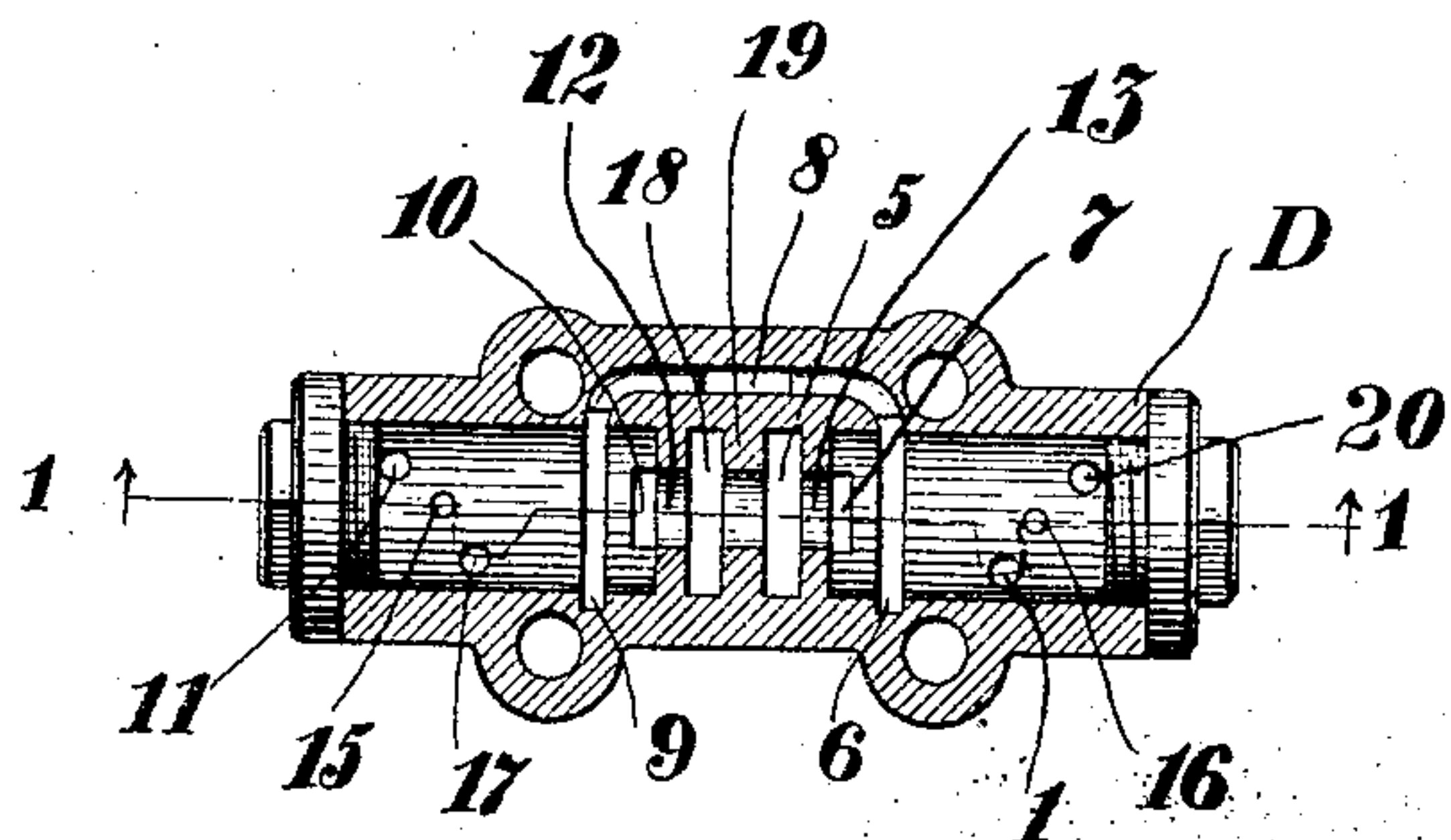


Fig. 3

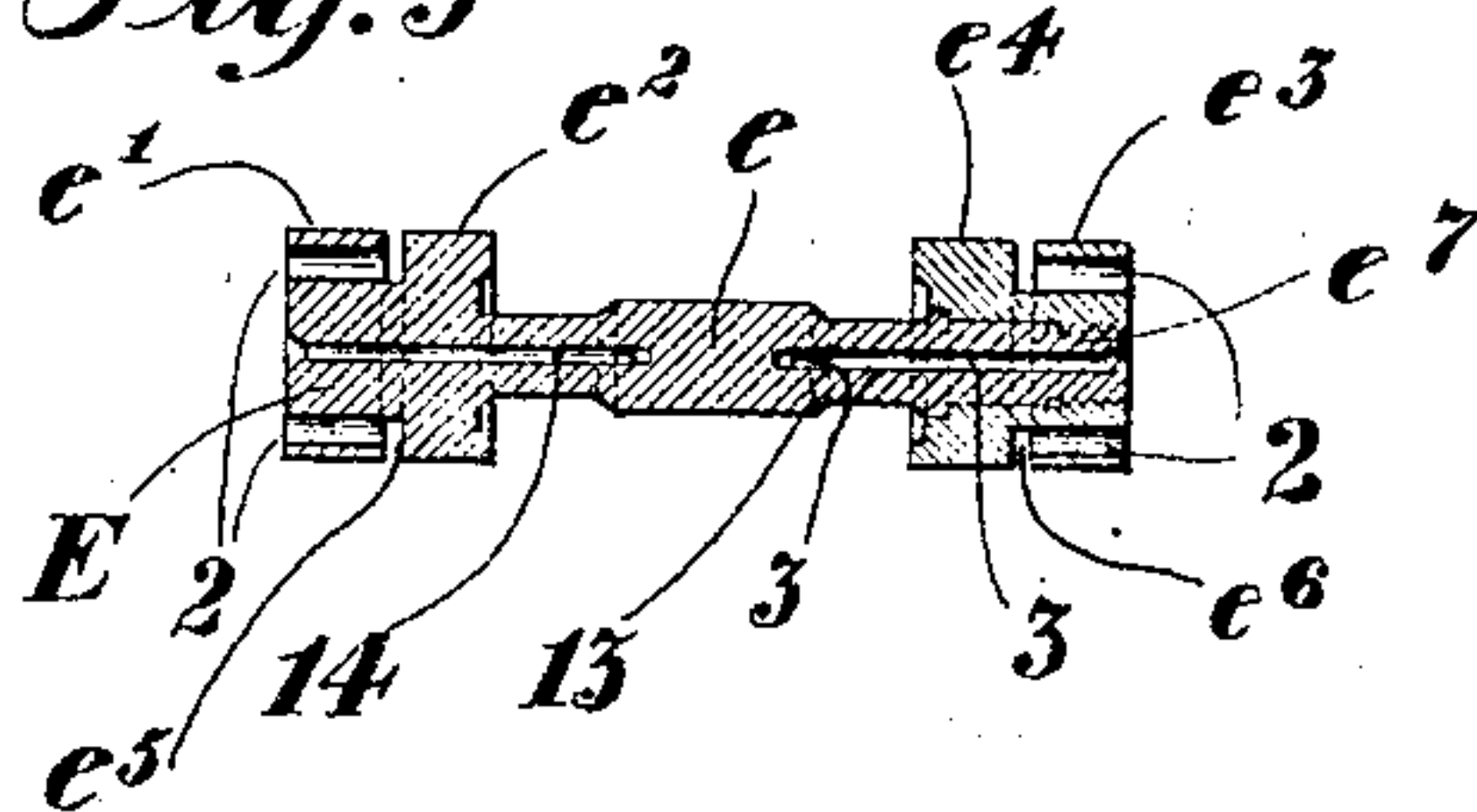
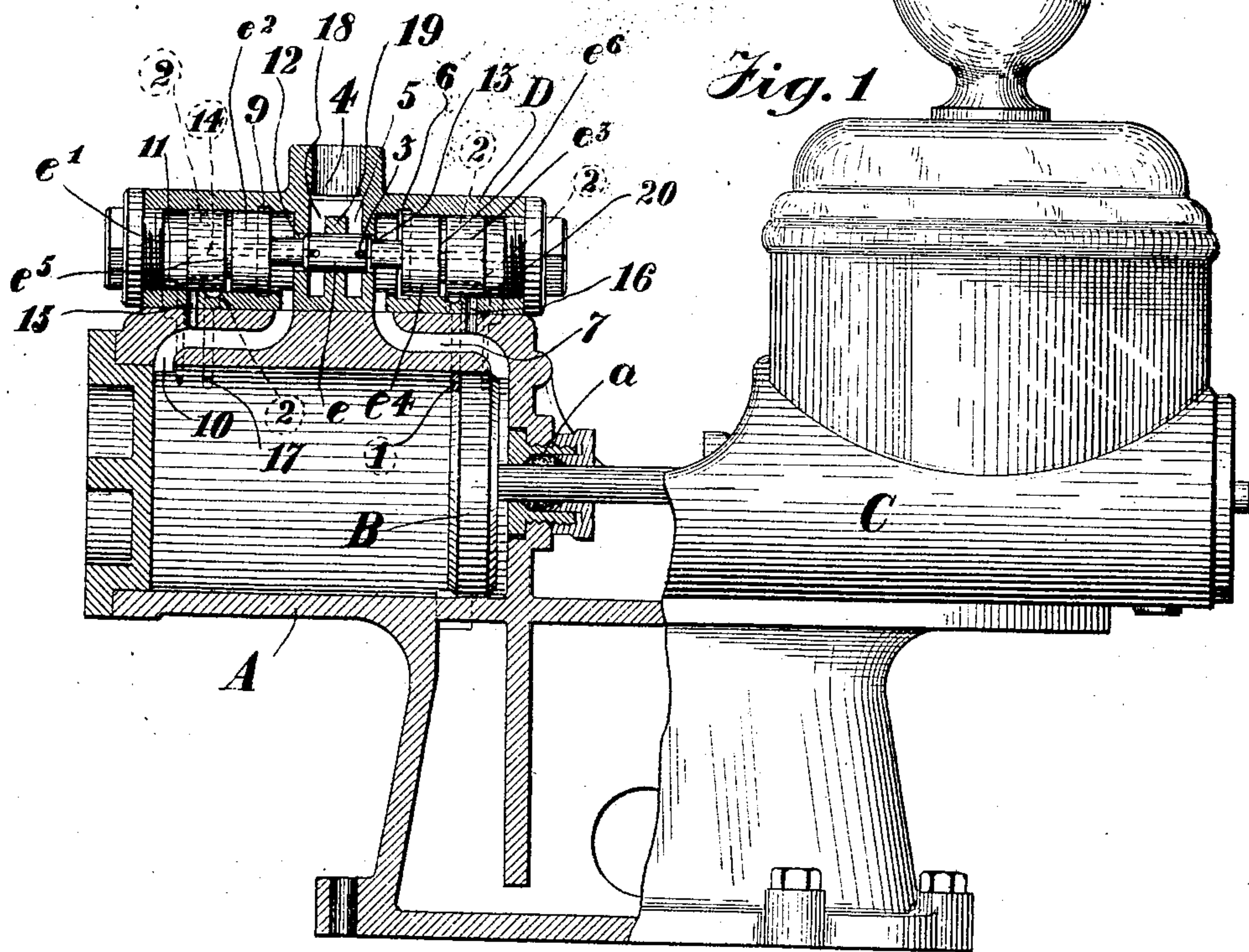


Fig. 1



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# UNITED STATES PATENT OFFICE.

JAY B. RHODES, OF HARVEY, ILLINOIS.

## FLUID-ACTUATED VALVE.

SPECIFICATION forming part of Letters Patent No. 785,918, dated March 28, 1905.

Application filed May 12, 1902. Serial No. 106,886.

*To all whom it may concern:*

Be it known that I, JAY B. RHODES, a citizen of the United States of America, residing at Harvey, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Fluid-Actuated Valves, of which the following is a specification.

My invention relates to reciprocating fluid-actuated valves adapted for use in various connections—as, for example, in reciprocating steam-pumps, steam-engines, or other like fluid-motors, wherein it is desirable to control the admission and exhaust of fluid to and from the cylinder by means of a valve of this character.

Generally stated, it is the object of my invention to provide a simple and efficient construction or form of fluid-motor involving in its construction a fluid-actuated valve for reversing the order of admission and exhaust.

A special object is to provide an improved construction whereby live steam may be taken from a cylinder and conducted to the valve-chamber for the purpose of initially shifting or actuating the valve.

Another object is to provide a construction and system of ports and passages tending not only to insure the desired action of the valve, but also to secure simplicity and compactness of construction.

A further object is to provide a construction and arrangement which will obviate the necessity of employing certain objectionable mechanical features heretofore considered necessary in fluid-motors having a valve operating on this principle.

It is also an object to provide certain details and features of improvement tending to increase the general efficiency and serviceability of engines having fluid-actuated valves.

To the foregoing and other useful ends my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings, Figure 1 is a side elevation, partly in section, of a steam-pump embodying the principles of my invention. Fig. 2 is a horizontal section through the valve-casing on line 2 2 in Fig. 1. Fig. 3 is a longitudinal section through the valve.

While I have thus shown and described my

invention as applied to steam-pumps such as shown in Fig. 1, it will be readily understood that the principles of my invention are applicable to all reciprocating piston-engines, and that for this reason I do not limit myself to the use of my invention in connection with steam-pumps. The system of ports and passages and the steam-actuated valve which I have shown and described can be employed in various connections and in various kinds of reciprocating piston-engines regardless of the work to be done by the engine. As thus illustrated, however, my invention comprises, preferably, an ordinary cylinder A, adapted to inclose a reciprocating piston B. The piston-rod of the said piston is arranged, preferably, to slide or work in an ordinary stuffing-box *a*. This piston-rod is in the present case connected with a pump-plunger in the pump-barrel C. This pump-plunger and the balance of the valve mechanism inclosed by the structure at the right of Fig. 1 can be of any suitable known or approved construction. For this reason only the portion of the pump at the left, or, in other words, the parts to which my invention relates, are shown in section. Upon the top of this cylinder is preferably mounted a valve-casing D. This valve-casing is adapted to inclose a reciprocating spool-shaped valve E, adapted to control the admission and exhaust of steam to and from the cylinder. As shown in Fig. 1, the piston has reached the end of its stroke to the right and has caused the initial actuation of the valve by admitting live steam from the cylinder to the valve-chamber. In other words, the piston has moved to the right sufficiently to uncover the port 1, so as to allow the steam driving the piston to pass through this port and thence through the valve-ports 2 to the right of the valve. This, it will be seen, causes the valve to shift to the left, and, as shown in Fig. 1, the movement of the valve has been sufficient to cover port 1, thereby cutting off the admission of steam from the cylinder. It will be seen, however, that the movement of the valve has also been sufficient to open the longitudinal port 3, thereby establishing direct connection between the right-hand end of the valve-chamber and the main steam-inlet 4. In this way the steam now



passes directly from the inlet 4 through the recess 5 and thence through the valve-passage 3 to the right of the valve. It will be observed at this juncture that the said passage 3 opens laterally through the middle portion of the valve. Thus the valve is initially actuated by an admission of working steam from the cylinder, and the stroke of the valve is then completed by a direct admission of steam from the main inlet. The valve, continuing in its movement to the left, closes the recess 6, thereby cutting off the exhaust from the right of the piston through the port 7, it being observed that this recess 6 communicates with the main or ultimate exhaust-passage 8. The valve in moving to the left also uncovers the annular recess 9, thereby allowing the exhaust from the left of the piston to pass out through the port 10 and recess 9 into the main exhaust-outlet. It will also be seen that the movement of the valve to the left closes the port 12, thereby cutting off the supply of steam to the left of the piston, and opens the port 13, thereby admitting steam from the main inlet through the valve-chamber and the port 7 to the right of the piston. In addition to this the further movement of the valve to the left from the position shown in Fig. 1 closes the valve-passage 14, which, it will be seen, corresponds to the previously-described passage 3. As shown in Fig. 1, the valve has moved sufficiently to cover the port 15, and in completing its stroke to the left it uncovers the corresponding port 16 at the right. The port 17, it will be observed, corresponds to the port 1, and the recess 18 corresponds to the recess 5. The proportion is preferably such that the valve can move sufficiently in either direction to have the part 19 cover either of the ports 3 and 14. In such case the proper amount of pressure will still be maintained on either end of the valve, according to the position it occupies by the admission of steam through either of the ports 15 and 16. For example, the valve in shifting to the left, as shown in Fig. 1, may cut off the admission of steam through the passage 3; but this will not interfere with the maintenance of the valve in its shifted position, inasmuch as the steam passing from the inlet 4 through the ports 13 and 7 is free to pass to the right of the valve through the port 16. Thus it will be seen that with the piston in the position shown in Fig. 1 the steam, which has driven the piston to such position, is free to enter to the right of the valve, so as to initially actuate the valve for the purpose of reversing the order of admission and exhaust, and that this admission is then cut off, so as to allow the stroke of the valve to be completed by a direct admission of steam from the main inlet. Now with steam entering the cylinder through port 7 and with the exhaust taking place through the port 10 the piston travels to the left. Upon reaching the limit of its stroke to the left the piston uncovers the port 17 in the same way that it is uncovering the port 1 in Fig. 1, and this, it will be seen, produces an admission of live steam from the cylinder through the said port 17 to the left of the valve, and the pressure thus established in the left-hand compartment of the valve-chamber operates to initially actuate the valve and cause it to move slightly to the right. The movement of the valve in this direction continuing, the steam then enters to the left of the valve through the port or passage 14, and at the same time the admission of steam from the cylinder is cut off. Thus the stroke or movement of the valve to the right is completed by a direct admission of steam from the main inlet in a manner similar to the way in which its stroke to the left was completed, as previously described. The movement of the valve to the right also opens the exhaust-passage 6, allowing the exhaust at the right of the piston to pass out through the port 7 and then into the main exhaust-outlet or ultimate exhaust-passage. If the movement is sufficient to cause the partition 19 to cover the passage 14, the pressure at the left of the valve is maintained by the admission of steam from the port 10 through the port 15. As soon as the valve shifts sufficiently to open the port 12 the live steam entering from the inlet 4 through the recess 18 and said port 12, thence through the valve-chamber and the port 10 to the cylinder, starts the piston to the right. Thus the operation is efficient and positive in character, and with the arrangement shown the valve in opening the exhaust-passage does not weaken the pressure which is driving it. In other words, before the valve opens the exhaust in shifting in either direction it first establishes direct communication between the main inlet and one end of the valve-chamber. In this way the valve, although initially actuated by the steam which is driving the piston, does not have any tendency to come to a standstill when it reduces the pressure in the cylinder by opening the exhaust. The direct admission from the main steam-inlet to the end of the valve has already been established when the pressure in the cylinder is thus reduced. Furthermore, it will be seen that although the passages 3 and 14 are for a brief instant both in communication with the main steam-inlet, as shown in Fig. 1, the valve nevertheless does not have any tendency to come to a standstill, inasmuch as the ports 11 and 20 serve as relief-ports to relieve the pressure opposing the desired movement of the valve. For example, with the relative position shown in Fig. 1 the steam from the main inlet is passing to the left of the valve through the passage 14, and thereby opposing the desired movement of the valve to the left. This does not, however, bring the valve to a standstill, inasmuch as the steam which thus enters to the left of the valve is free to escape to the



cylinder by way of the port 11, while the steam which passes to the right of the valve is confined in the right-hand compartment of the valve-chamber by reason of the port 20 being closed by the piston. Thus these ports 11 and 20 not only act as relief-ports, but also as exhaust-ports for exhausting the steam from in front of the valve as it advances one way or the other.

As to construction, it will be seen that the valve is preferably spool-shaped in form, and is provided at its left with a pair of disks  $e^1$  and  $e^2$  and at its right with a similar pair of disks  $e^3$  and  $e^4$ . The disks comprising each pair are, it will be seen, arranged far enough apart to provide the annular spaces or recesses  $e^5$  and  $e^6$ . Thus the valve consists of end disks, which control the various inlet and exhaust ports and passages, and of a central and relatively small portion, which controls the admission of steam to the cylinder and also the direct admission of steam to the ends of the valve. The system of ports and passages permits the initial actuation of the valve by live steam from the cylinder without the necessity of employing a special form of piston and also without employing a special form of stuffing-box. In other words, the valve, although actuated positively and efficiently in the manner described, does not necessitate any changes or alterations in the form of the cylinder and piston. Thus the cylinder and valve-casing may be of compact and simple form, the length of the piston and cylinder being reduced to a minimum. Preferably the valve is made in two pieces, as shown in Fig. 3, the two disks at one end being made integral and screwed onto the threaded portion  $e^7$ . It will be readily understood, however, that the valve can be constructed to suit the requirements of any particular case.

I claim, broadly, the feature of so arranging the live-steam ports relatively to the passages or ports for admitting working-cylinder steam to the valve-chamber that the live-steam ports must open just prior to the cutting off of the working steam from the cylinder. I also claim, broadly, the feature of so arranging the different ports and passages relatively to each other that the exhaust from the cylinder is established subsequent to the complete cutting off of working steam from the cylinder to the valve-chamber, or at least not earlier than contemporaneously with the cutting off of the admission of cylinder-steam to the valve-chamber, so as to prevent the exhaust from the cylinder from weakening the steam-pressure in the cylinder necessary for initially actuating the valve. As far as I know both these features are broadly new to me.

What I claim as my invention is—

1. The combination of a cylinder, a piston inclosed in said cylinder, a valve-casing, a live-steam port leading to the valve-casing, exhaust-ports, a reciprocating valve inclosed in

said valve-casing, ports connecting the interior of the valve-casing with that of the cylinder, passages through the reciprocating valve adapted to register with the live-steam port and the ports connecting the interior of the valve-casing with the cylinder, said ports and passages being so related and located that the valve is initially actuated by live steam taken from between the piston and one end of the cylinder at the end of each stroke, and by a partial movement in either direction to cut off the admission of the steam from the cylinder to the valve-chamber.

2. The combination of a suitable cylinder, a piston reciprocating therein, a suitable valve-casing having a centrally-arranged portion dividing the valve-chamber into two compartments, a valve having a reduced middle portion adapted to alternately close one and the other of two admission-ports formed in said central portion, said valve having a plurality of disks at each end, the cylinder and valve-casing being provided with a pair of ports adapted to be alternately covered and uncovered by the said end disks, one port being covered by one end disk while the other port is in communication with the space between the two disks at the other end of the valve, whereby the live steam driving the piston is admitted to the valve-chamber to initially actuate the valve at the end of each piston-stroke, and the said valve-casing being provided with a pair of annular grooves or recesses serving as exhaust-passages and controlled by the intermediate disks of said valve, one annular groove or recess being covered by one intermediate disk while the other groove or annular recess is uncovered by the other intermediate disk, and said valve being provided with passages adapted to open prior to the cutting off of steam from the cylinder, so as to admit live steam directly to the valve-chamber to complete the stroke of the valve.

3. In a steam-pump, the combination of a suitable cylinder, a piston reciprocating therein, a valve-casing mounted upon the cylinder, a reciprocating valve inclosed by the casing, said cylinder and casing having two admission-ports at opposite ends adapted to cooperate with two longitudinal ports in the opposite ends of the valve, so as to admit the live steam driving the piston into the valve-chamber to actuate the valve at the end of each piston-stroke, said valve having a central portion for controlling the admission of live steam through suitable ports both to the cylinder and to the ends of the valve, and said valve being provided with a pair of disks adapted to alternately cover and uncover exhaust-passages in the valve-casing, one exhaust-passage being covered while the other is uncovered.

4. The combination of a suitable cylinder, a single-headed reciprocating piston inclosed therein, a suitable valve-casing, a live-steam port leading to the valve-casing, an exhaust-



port, ports connecting the interior of the valve-casing with that of the cylinder, a reciprocating valve inclosed in said valve-casing provided at each end with disks and passages  
 5 and having a central portion adapted to control the admission of steam through the ports of the cylinder, the said disks being adapted to control the exhaust from the cylinder through the ports and passages, and the said ports and  
 10 passages being so related and located that the reciprocating valve is actuated at the end of each stroke by the live steam driving the piston.

5. The combination of a suitable cylinder,  
 15 a piston reciprocating therein provided with a single disk or head, a valve-casing, a reciprocating spool-shaped valve inclosed by said casing, said cylinder and casing being provided with a pair of ports adapted to admit  
 20 the live steam driving the piston into the valve-chamber to initially actuate the valve at the end of each piston-stroke, the valve being provided with a pair of end ports through which the steam is allowed to pass into the end of  
 25 the chamber, the said valve being also provided with a pair of longitudinally-extending ducts or passages, each pair of ducts opening laterally into the middle portion of the valve, whereby each stroke of the valve is completed  
 30 by direct admission of steam to the valve-chamber from the main inlet, and the cylinder and casing being constructed with a pair of ports connecting the extreme end portions of the valve-chamber with the cylinder.

35 6. The combination of a suitable cylinder and piston, a valve and valve-casing, the cylinder and casing being constructed with suitable ports and passages through which the steam driving the piston is admitted to the  
 40 valve-chamber to initially actuate the valve, the valve being constructed with passages through which steam is admitted directly from the main steam-inlet to the valve-chamber to complete the stroke of the valve, and the cylinder and casing being constructed with relief-ports to prevent the valve from centering.

7. The combination of a valve having a pair of disks at each end, and having also a middle portion, a cylinder and piston, a valve-casing  
 50 inclosing said valve, said casing being provided with a central portion having two recesses separated by a partition in which the said middle portion of the valve slides or reciprocates, suitable ports or passages for admitting live steam from the cylinder to the  
 55 valve-chamber to initially actuate the valve, suitable ports or passages for admitting steam directly from the main steam-inlet to the valve-chamber for the purpose of completing the stroke of the valve, and a pair of relief-ports for preventing the valve from centering.

8. In a steam-pump, the combination of a suitable cylinder, a piston, a suitable valve and valve-casing, the cylinder and valve-casing  
 65 having ports through which the steam driv-

ing the piston is admitted to the valve-chamber to initially actuate the valve at the end of each piston-stroke, the valve being provided with passages through which steam is admitted directly from the main steam-inlet to the  
 70 valve-chamber to complete the stroke of the valve, and the cylinder and valve-casing being also provided with suitable ports and passages through which the steam entering the valve-chamber directly from the main steam-inlet  
 75 may pass to the cylinder and thence back to the valve-chamber, thereby maintaining the preponderance of pressure on the valve in the desired direction.

9. In a steam-pump, the combination of a  
 80 suitable piston and cylinder, a suitable valve and valve-casing, the cylinder and valve-casing being provided with a pair of ports through which the steam driving the piston is admitted to the valve-chamber to initially actuate  
 85 the valve at the end of each piston-stroke, said valve being provided with a pair of passages through which steam is admitted directly from the main steam-inlet to the valve-chamber to complete the stroke of the valve, the  
 90 cylinder and casing being provided with a pair of main ports for admitting and exhausting the steam to and from the cylinder, and the cylinder and casing being further provided with a pair of ports through which the steam  
 95 entering the valve-chamber directly from the main steam-inlet passes into the piston-chamber and thence back to the valve-chamber through the said main ports, substantially as and for the purpose set forth.

10. In a steam-pump, the combination of a piston and valve, a cylinder and valve-casing, passages controlled by both the piston and said valve for admitting working steam from the cylinder to the valve-chamber to initially  
 100 actuate the valve at the end of each piston-stroke, the valve cutting off the admission of steam from the cylinder before it reaches the end of its stroke, passages in the said valve opening to admit steam directly from the main  
 105 supply-inlet to complete the stroke of the valve, a pair of ports for admitting and exhausting steam to and from said piston and cooperating with the valve to establish an exhaust from the cylinder subsequent to the cutting  
 110 off of the admission of working steam from the cylinder to the valve-chamber, said last-mentioned passages being each adapted to open just prior to the cutting off of steam from the cylinder.

11. In a steam-pump, the combination of a piston and valve, a cylinder and valve-casing, passages opened by the piston to admit working steam from the cylinder to the valve-chamber to initially actuate the valve at the end of  
 115 each piston-stroke, passages for establishing direct admission of steam from the main supply-inlet to the valve-chamber upon a partial movement of the valve in either direction, means for cutting off the admission of work- 120



ing steam from the cylinder to the valve-chamber subsequent to the said direct admission of steam and prior to the completion of the valve-stroke, suitable ports and passages for admitting and exhausting steam to and from the cylinder, and means whereby the exhaust from the cylinder is established subsequent to the cutting off of the admission of working steam from the cylinder to the valve-chamber.

12. The combination of a piston and cylinder, a reciprocating valve having each end provided with a head, a valve-casing inclosing said valve, said casing or cylinder being provided with suitable ports for admitting and exhausting motive fluid to and from said cylinder, and the said cylinder and valve-casing having also suitable ports or passages adapted to admit cylinder-steam to the valve-chamber to exert pressure upon one of said heads to initially actuate the valve at the end of each piston-stroke and while the other head of the valve is subject to motive fluid pressure in the same direction, and said valve having a pair of live-steam-admission ports each adapted to open just prior to the cutting off of steam from the cylinder, so as to complete the stroke of the valve in each direction.

13. The combination of a piston and cylinder, a reciprocating valve having each end provided with a head, a valve-casing inclosing said valve, said casing and cylinder being provided with suitable ports for admitting and exhausting motive fluid to and from said cylinder, and the said cylinder and valve-casing having also suitable ports or passages adapted to admit working cylinder-steam to the valve-chamber to exert pressure upon either one of said heads to initially actuate the valve at the end of each piston-stroke and while the other head of the valve is subject to motive fluid pressure in the same direction, the valve being adapted by a partial movement to cut off the admission of cylinder-steam, and said valve having a pair of live-steam-admission ports each adapted to open just prior to the cutting off of steam from the cylinder, so as to complete the stroke of the valve in each direction.

14. The combination of a piston and cylinder, a reciprocating valve provided at each end with a head, and a valve-casing inclosing said valve, said cylinder and casing being provided with piston-controlled ports for admitting working cylinder-steam to the valve-chamber to initially actuate the valve, in each direction, said casing having live-steam-admission ports adapted to maintain a direct live-steam pressure upon either head of the valve while the other head is subject to cylinder-steam pressure in the same direction, the direct and cylinder pressures exerted simultaneously on the two heads giving the necessary preponderance of pressure in the desired direction to initially actuate the valve at the end of each piston-stroke, in each direction,

means for cutting off the admission of cylinder-steam upon a partial movement of the valve in each direction, and means for admitting live steam to the valve-chamber before the cutting off of the cylinder-steam to complete the stroke of the valve, in each direction.

15. In a motive-fluid-actuated engine, the combination of a piston and cylinder, a reciprocating motive-fluid-actuated valve, and a casing inclosing said valve, said cylinder and casing being provided with piston-controlled ports for admitting working cylinder-steam to the valve-chamber to initially actuate the valve at the end of each piston-stroke, in each direction, means for cutting off said admission of cylinder-steam upon a partial movement of the valve, in each direction, the engine structure as a whole being provided with live-steam-admission passages adapted to open prior to the said cutting off of cylinder-steam and before the said valve completes its stroke, in each direction, and adapted to thus admit live steam directly to the valve-chamber to complete the stroke of the valve, in each direction.

16. In a steam-pump, the combination of a piston and cylinder, and a reciprocating valve and a valve-casing, the pump structure as a whole having suitable ports for admitting working steam from the cylinder to the valve-chamber to initially actuate the valve at the end of each piston-stroke, said ports being so located that said valve is adapted by a partial movement in each direction to cut off the admission of steam from the cylinder to the valve-chamber, the engine structure as a whole being also provided with suitable ports adapted to open just prior to the cutting off of steam from the cylinder, and adapted to thereby admit live steam to the valve-chamber to complete the stroke of the valve in each direction, and the pump structure as a whole being further provided with ports for admitting and exhausting steam to and from the cylinder for the purpose of actuating the piston, said last-mentioned ports being adapted to cooperate with the valve in establishing an exhaust from the cylinder just after the cutting off of the admission of cylinder-steam to the valve-chamber.

17. The combination of a cylinder, a reciprocating piston in said cylinder, a reciprocating valve provided at each end with a cylindrical head, said valve having also a reduced cylindric middle portion, and a valve-casing inclosing said valve, said cylinder and casing connected with piston-controlled ports for admitting the working cylinder-steam to the valve-chamber to initially actuate the valve in each direction, live-steam-admission ports adapted to maintain a direct live-steam pressure upon the heads of the valve, ports connecting the heads of the valve with the cylinder, the direct and cylinder pressures thus exerted simultaneously on the two heads giving



the necessary preponderance of pressure in the desired direction to initially actuate the valve at the end of each piston-stroke, the ports in the valve-casing, valve and to the cylinder being such that the stroke of the valve in each direction being completed by the admission of live steam to the valve-chamber just prior and subsequent to the cutting off of the admission of working steam thereto from the cylinder.

10 18. In a motive-fluid-actuated engine, the combination of a cylinder, a reciprocating piston in said cylinder, a reciprocating motive-fluid-actuated valve, and a casing inclosing said valve, said cylinder and casing being provided with piston-controlled ports for admitting working cylinder-steam to the valve-chamber to initially actuate the valve at the end of each piston-stroke, live-steam-admission passages connecting the cylinder with the valve-casing and adapted to open before the said valve completes its stroke in each direction, and adapted to thus admit live steam directly to the valve-chamber to complete each stroke of the valve, said passages being so arranged and constructed to also open just before the admission of cylinder-steam is cut off, whereby the stroke of the valve in each direction is completed by the admission of live steam to the valve-chamber just prior and subsequent to the cutting off of admission of working steam thereto from the cylinder.

19. A motive-fluid-actuated engine com-

prising a suitable cylinder, a live-steam connection, a reciprocating piston in said cylinder, a suitable valve-casing, reciprocating motive-fluid-actuated valve in the valve-casing, suitable ports connecting the cylinder with the valve-casing for admitting working steam from the cylinder to the valve-chamber to initially actuate the valve at the end of each piston-stroke, and whereby the admission of steam from the cylinder to the valve-chamber is cut off upon a partial movement of the valve in each direction, suitable ports and passages having a direct connection with the live-steam connection end of the casing to effect a direct admission of live steam to the valve-chamber to complete the stroke of the valve in each direction, the different ports and passages being so relatively disposed that the said direct admission of live steam to the valve-chamber is established just prior to the cutting off of steam from the cylinder, and suitable ports and passages adapted to cooperate with said valve in admitting and exhausting steam to and from the cylinder for the purpose of actuating the piston.

Signed by me at Chicago, Cook county, Illinois, this 5th day of May, 1902.

JAY B. RHODES.

Witnesses:

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