No. 762,755. PATENTED JUNE 14, 1904.

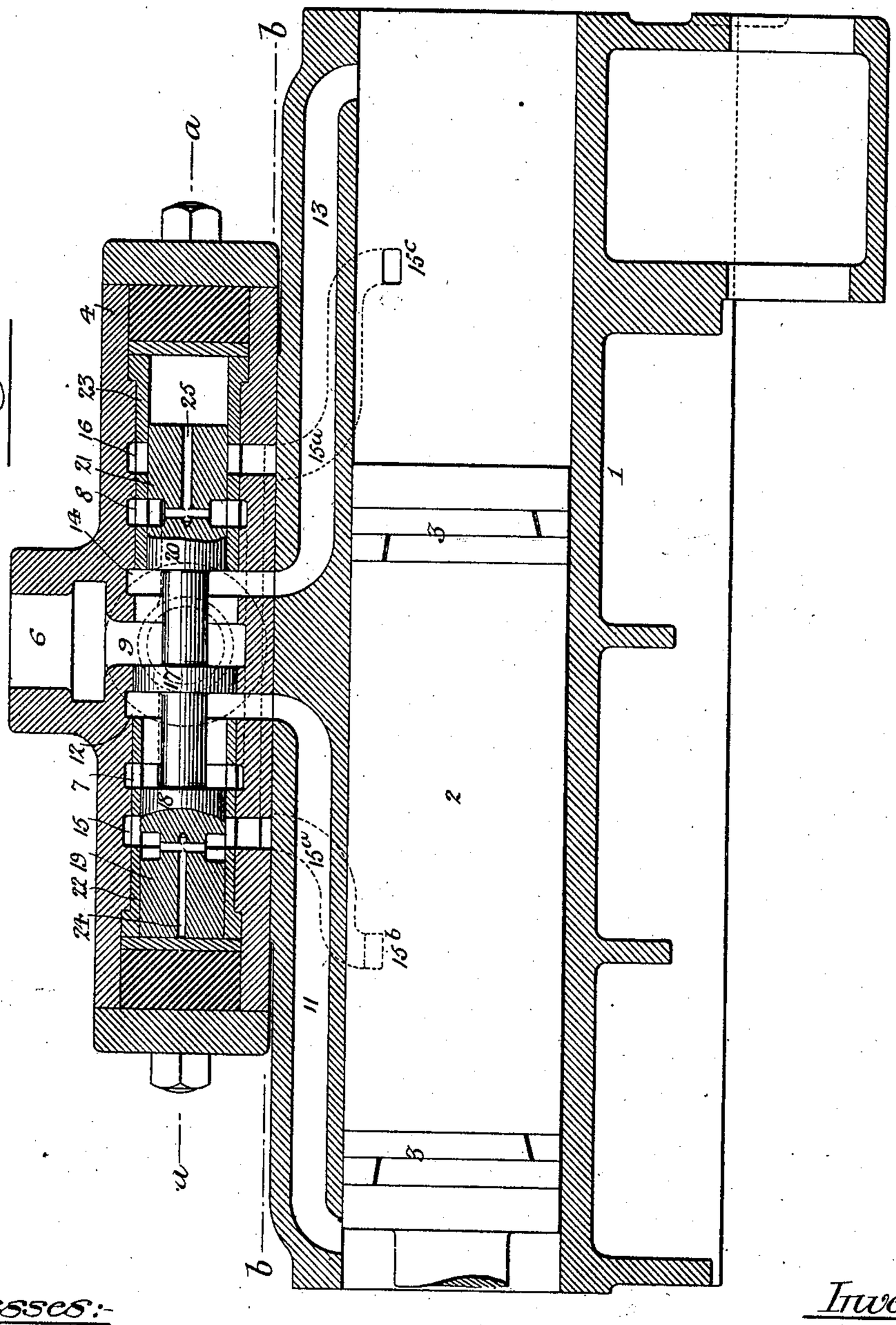
T. H. PHILLIPS.

RECIPROCATING ENGINE.

APPLICATION FILED DEC. 22, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



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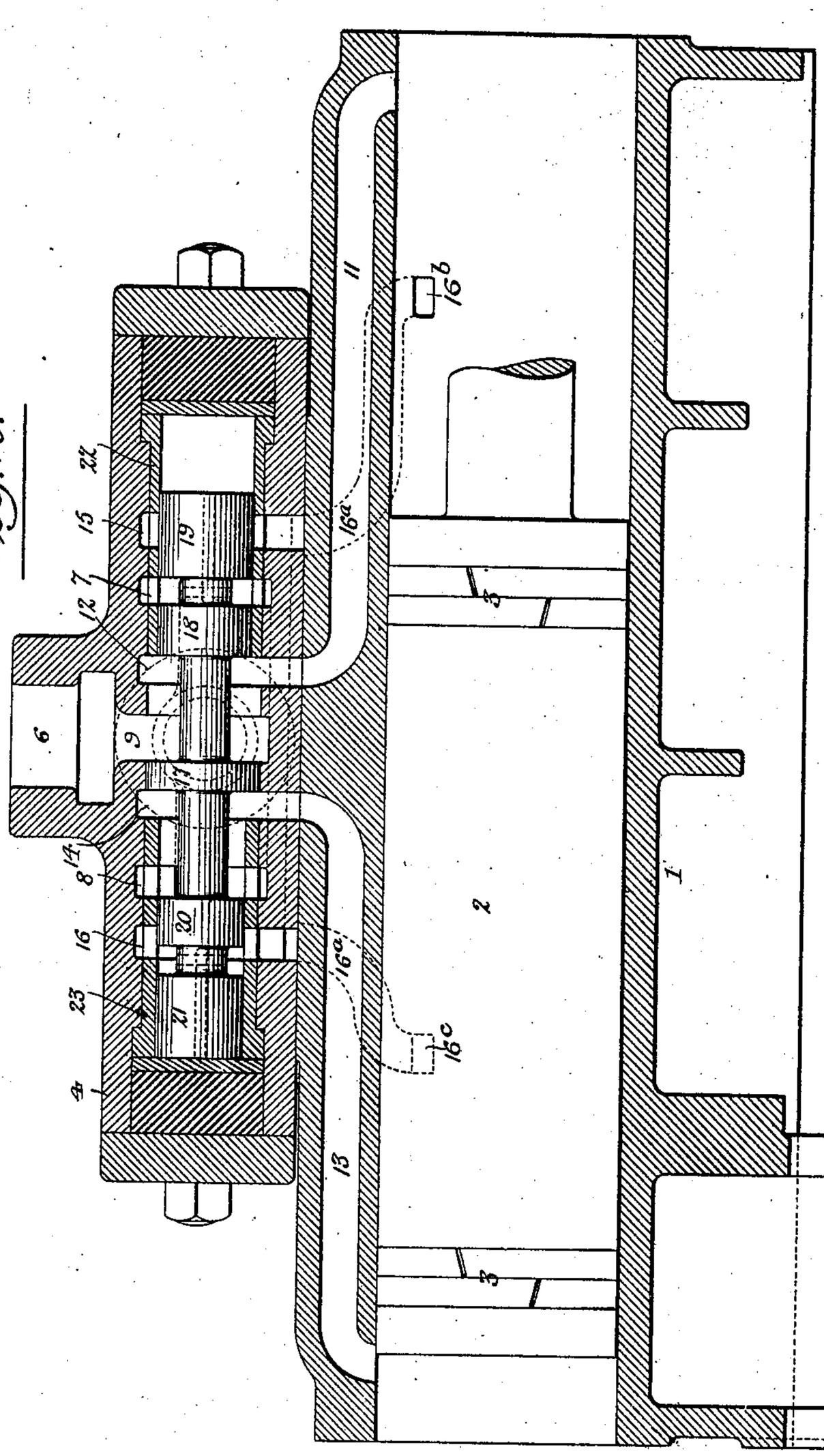
NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 3.

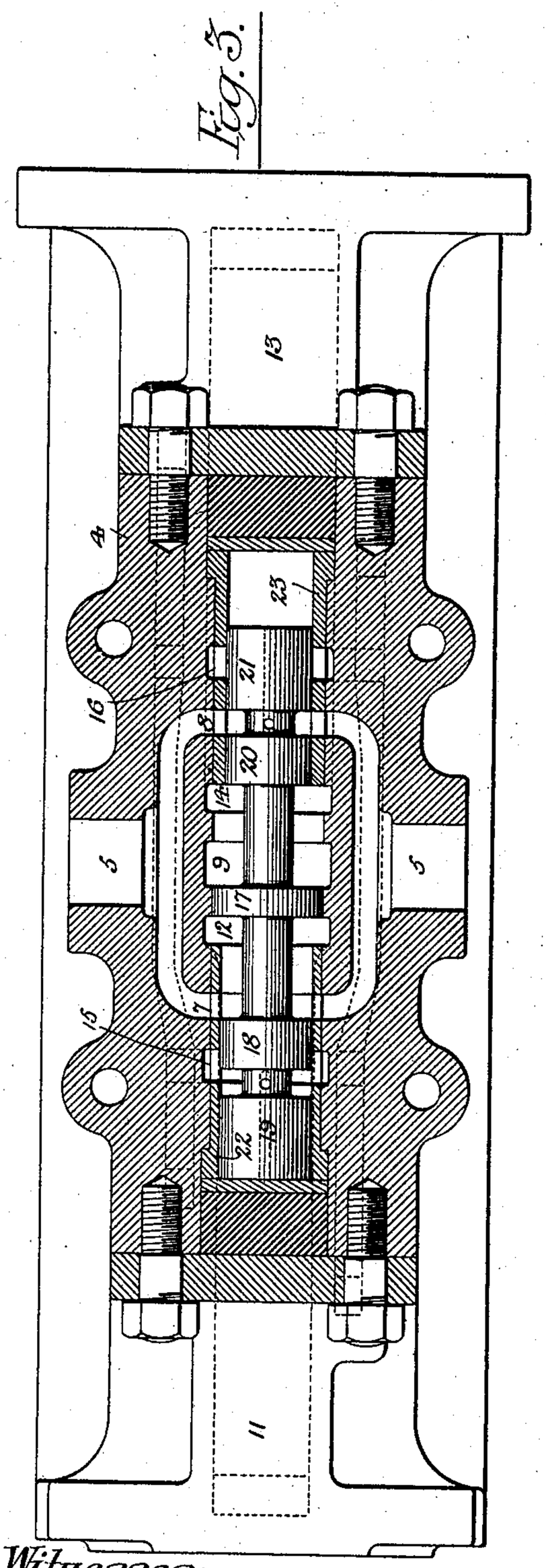
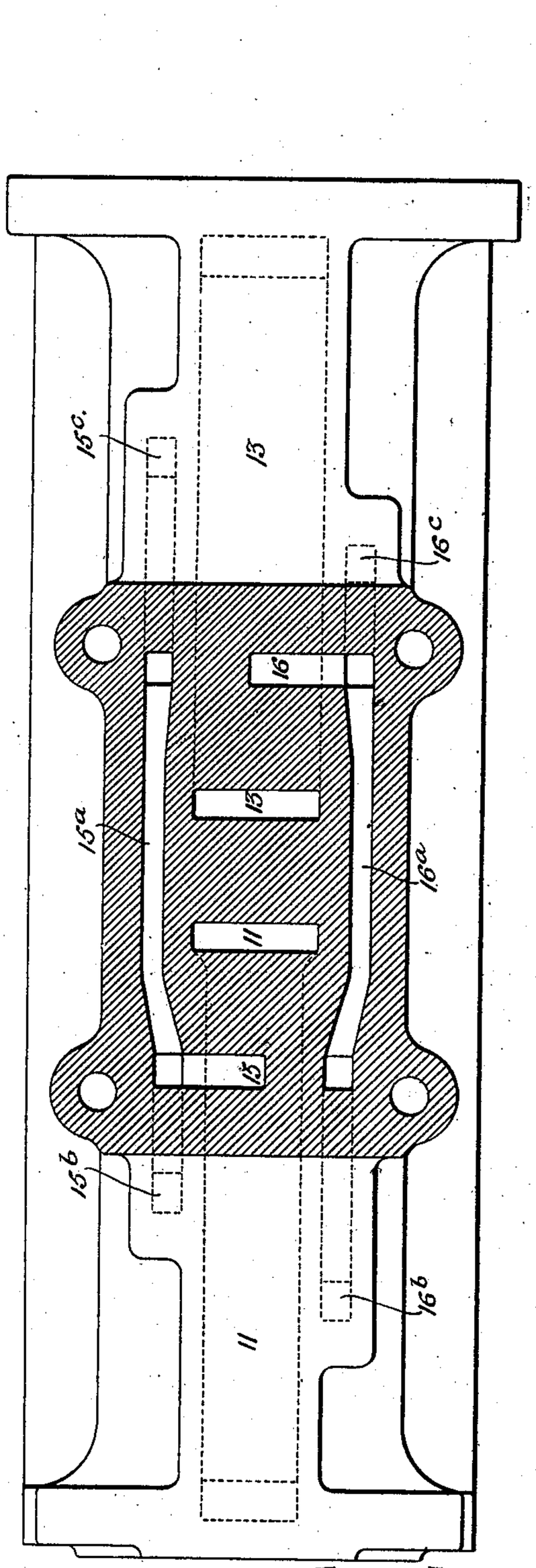


Fig. 4.



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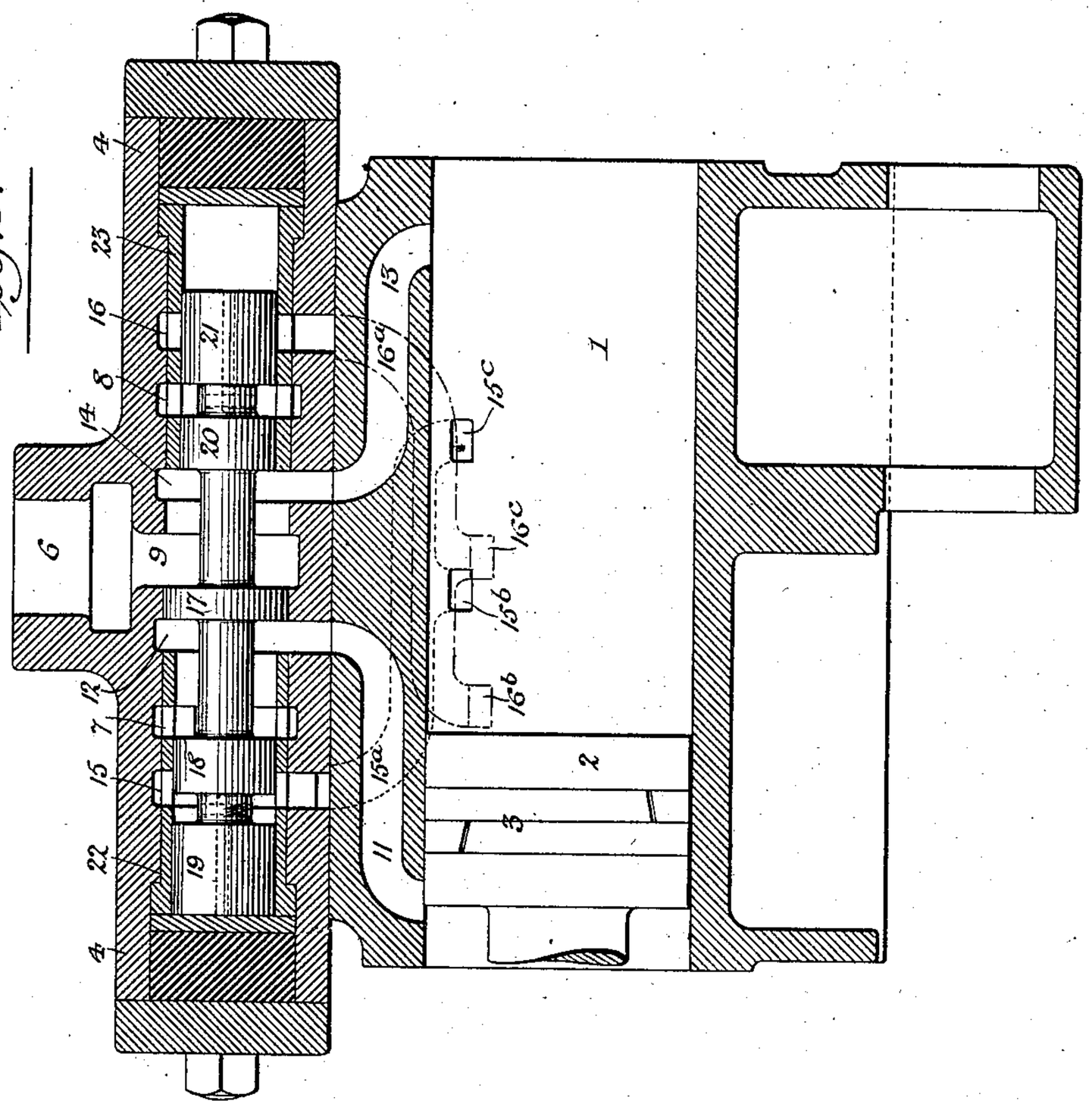
NO MODEL. 4 SHEETS—SHEET 4.

Fig. 5.



Witnesses:-

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No. 762,755. Patented June 14, 1904.

UNITED STATES PATENT OFFICE.

THOMAS H. PHILLIPS, OF ST. DAVIDS, PENNSYLVANIA.

RECIPROCATING ENGINE.

SPECIFICATION forming part of Letters Patent No. 762,755, dated June 14, 1904.

Application filed December 22, 1902. Serial No. 136,192. (No model.)

To all whom it may concern:

Be it known that I, THOMAS H. PHILLIPS, a citizen of the United States, residing in St. Davids, Delaware county, Pennsylvania, have invented certain Improvements in Reciprocating Engines, of which the following is a specification.

My invention relates to that class of reciprocating engines in which are combined a cylinder having a reciprocating piston or plunger and a valve-chest having a reciprocating valve, both piston and valve being moved by direct action of the steam, air, or other motive fluid employed. One type of engine of this class is an impact-tool, such as a rock-drill, and another type is a direct-acting pump. For convenience I will assume that it is an engine of the former class and is operated by steam.

The objects of my invention are to provide a simple and positive method of moving the valve at a predetermined point in the stroke of the piston, to provide an engine that with the same power and efficiency as compared with others of the same length of stroke is lighter and more easily handled, and to maintain the full length of stroke of the piston regardless of any wear that may take place on the piston or in the cylinder. These objects I attain in the manner hereinafter set forth, reference being had to the accompanying drawings, in which—

Figure 1 is a longitudinal section of the cylinder and valve-chest of a reciprocating engine constructed in accordance with my invention, showing the piston and valve in elevation and at the forward extremes of their movement. Fig. 2 is a longitudinal section looking in the opposite direction and showing the piston and valve at the rearward extreme of their movement. Fig. 3 is a sectional plan on the line *a a*, Fig. 1. Fig. 4 is a sectional plan on the line *b b*, Fig. 1; and Fig. 5 is a longitudinal section illustrating the application of my invention to an engine having a short piston.

In the drawings I have shown simply the cylinder and valve-chest structure, the piston, and the valve, omitting the heads of the cylinder and all other appurtenances not necessary to the proper understanding of my invention.

1 represents the cylinder, and 2 the piston contained therein, the latter being a solid piston—that is to say, a piston not having any central groove—and being provided with packing-rings 3 3, one near each end, the piston shown in Fig. 1 being a long piston of the type usually employed in connection with rock-drills or like impact-tools.

The valve-chest is represented at 4 and is suitably mounted upon the cylinder, said valve-chest having a steam-chamber 5 with opposite openings, either of which may be connected to the supply-pipe, the other being suitably plugged, thus permitting the tool to receive steam from a pipe either on the right-hand side or on the left-hand side of the same, as may be found most convenient in practice. In the top of the chest is another opening 6, which constitutes the exhaust-opening and is intended to receive a pipe for conveying the exhaust to any desired point, or it may discharge the exhaust directly therefrom, if desired, when compressed air is the motive fluid employed.

The steam-chamber 5 is continuously in communication with two chambers 7 and 8, which communicate with the bore of the valve-chest, and the exhaust-opening is continuously in communication with a central chamber 9, likewise communicating with the bore of the valve-chest.

Leading to the front end of the cylinder is a passage 11, which communicates with a chamber 12 in the valve-chest, and from the rear of the cylinder extends a passage 13, which communicates with a chamber 14 of the valve-chest.

The bore of the valve-chest at a point between the chamber 7 and the forward end of the chest is in communication with a chamber 15, which constitutes the valve-chest termination of a passage 15^a, and at a point between the passage 8 and the rear end of the valve-chest the bore of the latter is in communication with a chamber 16, which constitutes the valve-chest termination of a passage 16^a.

The passage 15^a is for convenience in construction formed partly in the valve-chest and

partly in the cylinder instead of being formed entirely in the cylinder, and it communicates with the bore of the cylinder through two ports 15^b and 15^c at one side of the cylinder, the port 15^b being located some distance inwardly from the forward end of the cylinder and the port 15^c being located some distance in advance of the rear end of the cylinder.

The passage 16^a resembles the passage 15^a and like it communicates with the bore of the cylinder through a forward port 16^b and a rear port 16^c, the port 16^b being some distance in advance of the port 15^b and the port 16^c being some distance in advance of the port 15^c, the ports 16^b and 16^c being on the opposite side of the cylinder from the ports 15^b and 15^c, as shown in Fig. 4, so that the two sets of passages will not interfere with each other.

The valve has five disks 17, 18, 19, 20, and 21, the disk 17 being centrally disposed on the valve-stem, the disks 18 and 19 being at the forward end of the stem, and the disks 20 and 21 being at the rear end of the same. The end disks 18 and 19 and 20 and 21 are separated from each other by narrow grooves, and the disks 18 and 20 are separated from the central disk 17 by wider grooves.

In the case of a steam-pump the pairs of end disks 18 19 and 20 21 may be of the same diameter, as in such case uniform forward and backward movement of the valve is required; but in the case of a rock-drill or other impact-tool it is preferable that the forward pair of disks 18 and 19 shall be of somewhat greater diameter than the rear disks 20 21 in order that the valve may have a quicker rearward than forward movement. The central disk 17 is of greater area than the end disks, the difference in area between said central disk and either end disk being less than the area of the opposite end disk. For convenience of manufacture and in order to insure accuracy in alinement the valve-chest is in the first instance bored out to the full diameter of the disk 17, and the desired reduction in diameter of bore at the ends of the chest is effected by the insertion of bushings 22 and 23.

In the stem of the valve at the forward end of the same is formed a passage 24, branched at its inner end, so as to communicate with the groove between the valve-disks 18 and 19, and a similar passage 25 at the rear end of the stem communicates with the groove between the valve-disks 20 and 21.

Supposing that the piston and valve are at the forward ends of their respective strokes, as shown in Fig. 1, the operation of the engine is as follows: The forward end of the cylinder is open to the steam-inlet chamber 7 through the passage 11, chamber 12, and the groove between the disks 17 and 18 of the valve, and the rear end of the cylinder is open to the exhaust-chamber 9 through the passage 13, chamber 14, and the groove between the disks 17 and 20 of the valve. The rear end of the valve-chest receives steam under pressure from the steam-passage 8 through the passage 25, while the forward end of the steam-chest is open to the exhaust through the passage 24, the chamber 15, the passage 15^a, the rear end of the cylinder, the passage 13, and the chamber 14. The rear face of the disk 18, the forward face of the disk 17, the rear face of the disk 20, and the forward and rear faces of the disk 21 are therefore subjected to steam-pressure. Hence the pressure to hold the valve in the forward position is that exerted upon the rear face of the disk 21 as against the backward pressure exerted upon that portion of the forward face of the disk 17, which is in excess of the area of the rear face of the disk 18. As the piston moves rearwardly in the cylinder its rear end first covers the port 16^c, and its forward end then uncovers the port 16^b; but as the valve-chest end of the passage 16^a is covered by the disk 21 of the valve this has no effect upon the movement of the valve. As the piston continues to move rearwardly its rear end covers the port 15^c, thereby cutting off the passage 15^a from communication with the exhaust, and still further rearward movement of the piston causes its forward end to uncover the port 15^b, thereby permitting flow of live steam from the forward end of the cylinder into the passage 15^a and thence through the chamber 15 and the passage 24 of the valve into the forward end of the valve-chest. The area of the forward end of the disk 19 is now added to the excess annular area of the disk 17 over that of the disk 18 in exerting pressure to move the valve rearwardly, and as this pressure is in excess of the pressure exerted upon the rear disk 21 of the valve said valve will be at once moved to the position shown in Fig. 2, thereby admitting steam to the rear end of the cylinder to cushion the piston on the back stroke and at the same time opening the front end of the cylinder to the exhaust, and consequently permitting the exhaust of steam from the rear end of the valve-chest through the passage 25, the chamber 16, passage 16^a, the front end of the cylinder, the passage 11, and the chamber 12. The disk 20 of the valve is wider than the chamber 8 or the space between the same and the chamber 16 or the groove between the disks 20 and 21, and in like manner the disk 18 is wider than the chamber 7 or the space between the same and the chamber 15 or the groove between the disks 18 and 19, and the disk 17 is narrower than the chamber 9. By reason of this construction the chamber 16 will in the backward movement of the valve be uncovered by the disk 21 before the disk 20 permits passage of live steam from the chamber 8 to the rear end of the cylinder through the passage 13 or subjects the rear face of the disk 17 to such live-steam pressure. At the time that the disk 21 uncovers the chamber 16 the disk 17 be-

gins to uncover the exhaust-chamber 9. Hence there is free exhaust of steam from the rear end of the valve-chest through the passage 25, chamber 16, passage 16^a, the front end of the cylinder, the passage 11, and the chamber 12, and there is no risk of accidental reversal of the position of the valve before the piston has completed its designed stroke.

The purpose of making the disk 17 of less width than the exhaust-chamber 9 is to prevent pressure upon either face of said disk by steam leaking around the end disk which is in advance in the direction of movement of the valve and before said valve has moved so far that said end disk begins to uncover the steam-inlet chamber, as such leakage would in case the exhaust-chamber had been closed by the disk 17 exert such back pressure upon the latter as would render uncertain or actually prevent the desired movement of the valve. The piston now moves forwardly, first covering the port 15^b and then uncovering the port 15^c, which, however, has no effect upon the movement of the valve, owing to the fact that the valve-chest end of the passage 15^a is closed by the forward disk 19 of the valve. The port 16^b is next closed by the forward end of the piston, so as to cut off the passage 16^a from communication with the exhaust, and, finally, the port 16^c is uncovered by the rear end of the piston, so as to admit steam to the rear end of the valve-chest through the passage 16^a, chamber 16, and passage 25. The forward pressure upon the valve-disk 21 in addition to the forward pressure upon the central disk 17 overcomes the pressure upon the forward disk 19 of the valve and causes forward movement of the latter in the valve-chest to the position shown in Fig. 1, the exhaust from the forward end of the valve-chest taking place before the forward face of the disk 17 is exposed to the live-steam pressure from the chamber 7. When the piston of the engine is short, as in the case of a pump, the ports 15^b 16^b and 15^c 16^c are disposed closely to the center of the cylinder to compensate for this difference in the length of the piston, as shown in Fig. 5.

It will be observed that the valve is moved in each direction by full pressure upon one end disk, resisted by full pressure upon the other end disk, the pressure upon the central disk 17 being the dominating factor. Hence the valve will be moved positively in each direction, even though the end disks of the valve are of the same diameter. When the valve reaches its final position in the chest at either end, it is held in that position by full pressure upon one end disk, the opposite end disk being free from pressure, this condition being maintained until the piston has so far completed its stroke as to bring about the change in position whereby the valve is shifted. The valve moves forwardly when the piston approaches the forward end of its stroke and backwardly when the piston approaches the rear end of its stroke, following the movement of the piston. Hence the jarring of the piston, as in the case of a rock-drill, helps to hold in position rather than unseat the valve. The valve is moved forwardly by steam direct from the rear end of the cylinder and rearwardly by steam from the front end of the cylinder and after the movement in either direction is held in place by steam from the main inlet-supply, and the chambers in the valve-chest for the admission of steam from either end of the cylinder to the corresponding end of the valve-chest are never uncovered by either end of the valve, each chamber being first in communication with the exhaust from the opposite end of the cylinder, then receiving steam from the adjacent end of the cylinder to move the valve, and then being in communication with the exhaust from that end of the cylinder until the valve is again moved in the reverse direction.

When, as in some classes of rock-drills, a rifle-bar is used engaging with the rear end of the piston, said piston must be somewhat longer than the length of the stroke, so as to prevent the rifle from leaving the piston when the latter is at the limit of its forward stroke. If, however, rotation of the piston is not required or is effected by spiral flutes on the piston-rod or by other means, the piston need be only long enough to accommodate packing-rings and provide sufficient support on each side of the same, the length of piston being independent of the length of stroke. The two ports of either passage 15^a or 16^a should be so spaced that before one of the same is uncovered by one end of the piston for the admission of pressure to move the valve the other will have been closed by the opposite end of the piston, so that only one port will be open to pressure or exhaust on opposite sides of the piston at the same time, and there will be no accumulation of pressure baek of the valve to cause its premature movement, as any leakage which might take place between the cylinder and packing-rings of the piston will escape through the exhaust from the opposite end of the cylinder until the piston covers the port on the exhaust side. While both ports of either passage 15^a and 16^a should not be uncovered on opposite sides of the piston at the same time, they may be open to either pressure or exhaust on the same side of the piston simultaneously, as in the case of the engine with the short piston. (Shown in Fig. 5.)

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The combination, in a reciprocating engine, of a cylinder, a piston, a valve-chest, a valve having end disks with passages therethrough, passages leading from the cylinder to the valve-chest inwardly beyond the end

disks of the valve, and live-steam chambers in the valve-chest inwardly beyond said cylinder-passages, whereby the valve is moved in each direction in the valve-chest by motive fluid admitted to the end of the valve-chest from the corresponding end of the cylinder and through the end disk of the valve and is retained in position in the valve-chest by motive fluid from the main supply, substantially as specified.

2. The combination, in a reciprocating engine, of a cylinder, a piston, a valve-chest, and valve having end disks with passages therethrough, passages leading from each end portion of the cylinder to valve-chest chambers inwardly beyond the end disks of the valve, and live-steam chambers in said valve-chest inwardly beyond said cylinder-chambers, whereby each end of the valve-chest is first caused to communicate with the corresponding end of the cylinder through the end disk of the valve, then with a main motive-fluid supply, and then with the exhaust through the opposite end of the cylinder, substantially as specified.

3. The combination, in a reciprocating engine, of a cylinder, a piston, a valve-chest, a valve having end disks, main motive-fluid-supply passages, and passages communicating with the cylinder some distance inwardly from the ends of the same, the end disks of the valve having passages therethrough, which, in one extreme position of the valve, communicate with said cylinder-passage, and in the other extreme position of the valve, communicate with the main motive-fluid-supply passage, substantially as specified.

4. The combination, in a reciprocating engine, of a cylinder, a piston, a valve-chest, a valve having a forward end disk, with passage therethrough, and a passage having branches terminating in front and rear ports in the cylinder, said passage having a valve-chest port, which, when the valve is in its forward extreme position, communicates, through the passage in the end disk of the valve, with the forward end of the valve-chest, substantially as specified.

5. The combination, in a reciprocating engine, of a cylinder, a piston, a valve-chest, a valve having a rear end disk with passage therein, and a passage having branches terminating in front and rear ports in the cylinder, said passage having a valve-chest port, which, when the valve is in its extreme rear position, communicates, through the passage in the end disk of the valve, with the rear end of the valve-chest, substantially as specified.

6. The combination, in a reciprocating engine, of a cylinder, a piston, a valve-chest, a valve having front and rear end disks each with passage therethrough, two passages each having branches terminating in front and rear ports in the cylinder, one of said passages having a valve-chest port, which, when the valve is in its extreme forward position, communicates, through the passage in the forward end disk of the valve, with the forward end of the valve-chest, the other passage having a valve-chest port, which, when the valve is in its extreme rear position, communicates, through the passage in the rear end disk of the valve, with the rear end of the valve-chest, substantially as specified.

7. The within-described valve for a reciprocating engine, the same having pairs of disks at each end, with passages extending to each end of the valve from the grooves between the pair of disks at that end of the valve, and a single central disk of larger diameter than the end disks, substantially as specified.

8. The within-described valve for a reciprocating engine, said valve having a pair of disks at each end, the disks at one end being of greater diameter than those at the other, and a single central disk of still greater diameter, substantially as specified.

9. The within-described valve for a reciprocating engine, the same having at each end pairs of disks, those at one end being of greater diameter than those at the other, and each end of the valve communicating with the groove between the disks at that end, the valve also having a single central disk of greater diameter than either of the end disks, substantially as specified.

10. The combination of the cylinder and its piston, a valve-chest, a valve having end disks and an intermediate disk of greater diameter than the end disk, said intermediate disk controlling the exhaust-chamber of the valve-chest, and being of less width than said chamber, with passages whereby movement of the valve in each direction is caused by pressure upon an end disk and upon the corresponding face of the central disk, substantially as specified.

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

THOMAS H. PHILLIPS.

Witnesses:
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JOS. H. KLEIN.