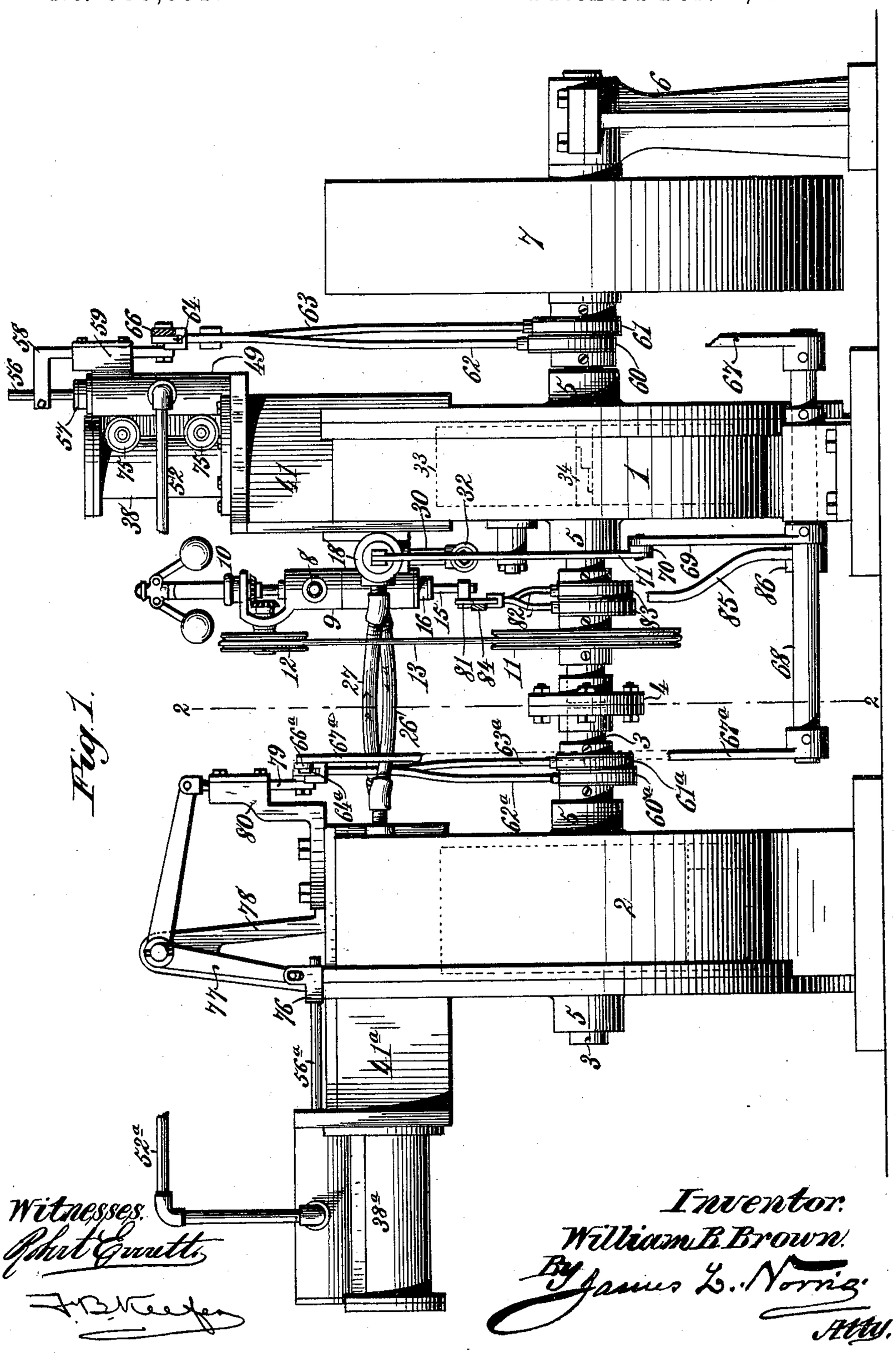
(No Model.) 4 Sheets—Sheet 1.

W. B. BROWN.

ENGINE.

No. 598,851. Patented Feb. 8, 1898.

Fig. 1.



Witnesses.
Robt Gruett.
F. B. Keeler

Inventor.
William B. Brown.
By James L. Norris.
Atty.

(No Model.)

4 Sheets—Sheet 2.

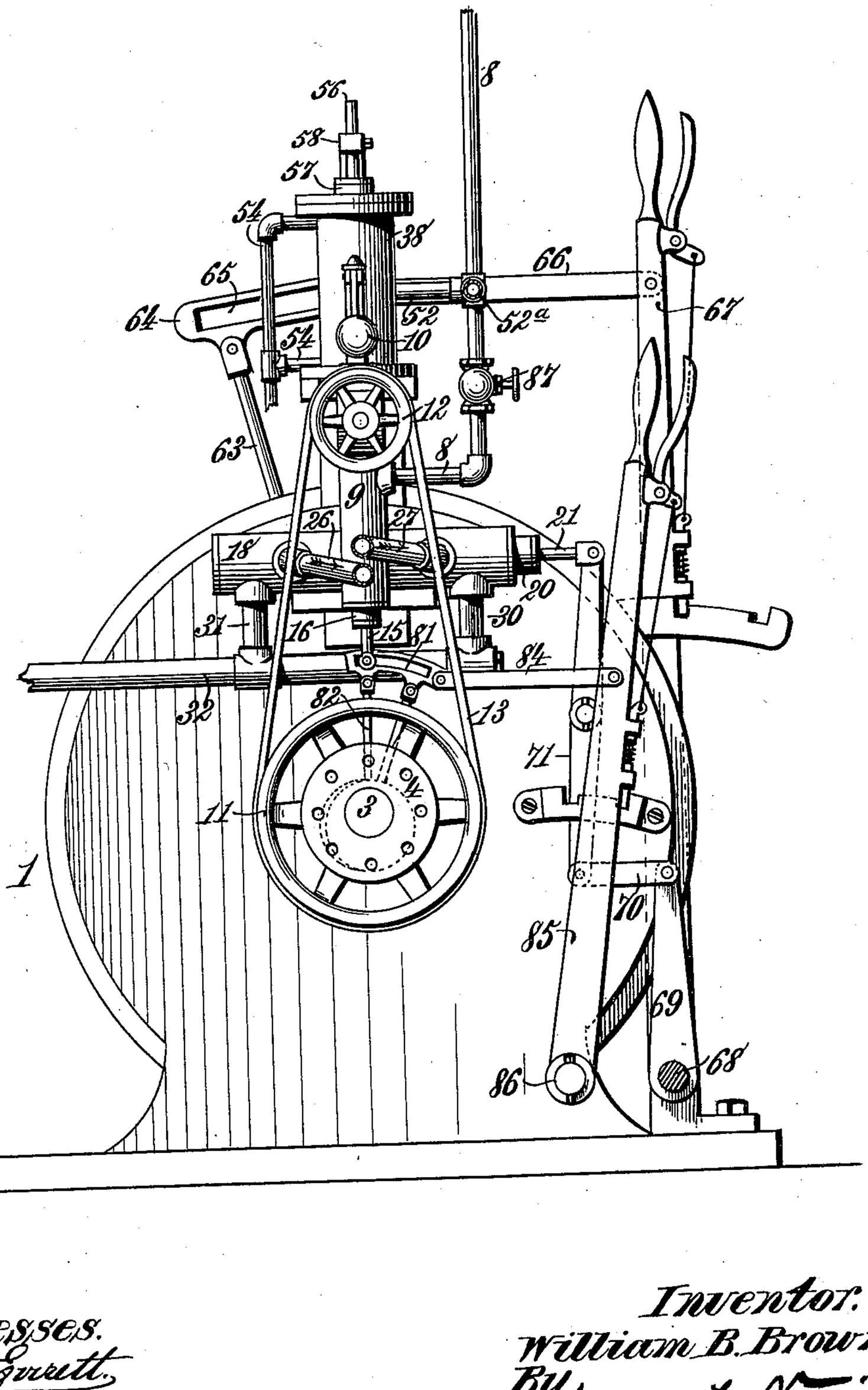
W. B. BROWN.

ENGINE.

No. 598,851

Patented Feb. 8, 1898.

Fig. 2.



Witnesses.
Robt Everett.
F. B. Kenyon

Inventor:
William B. Brown.
By James L. Norris.
Atty.

(No Model.) 4 Sheets—Sheet 3.

W. B. BROWN.

ENGINE.

No. 598,851. Patented Feb. 8, 1898.

Fig. 3

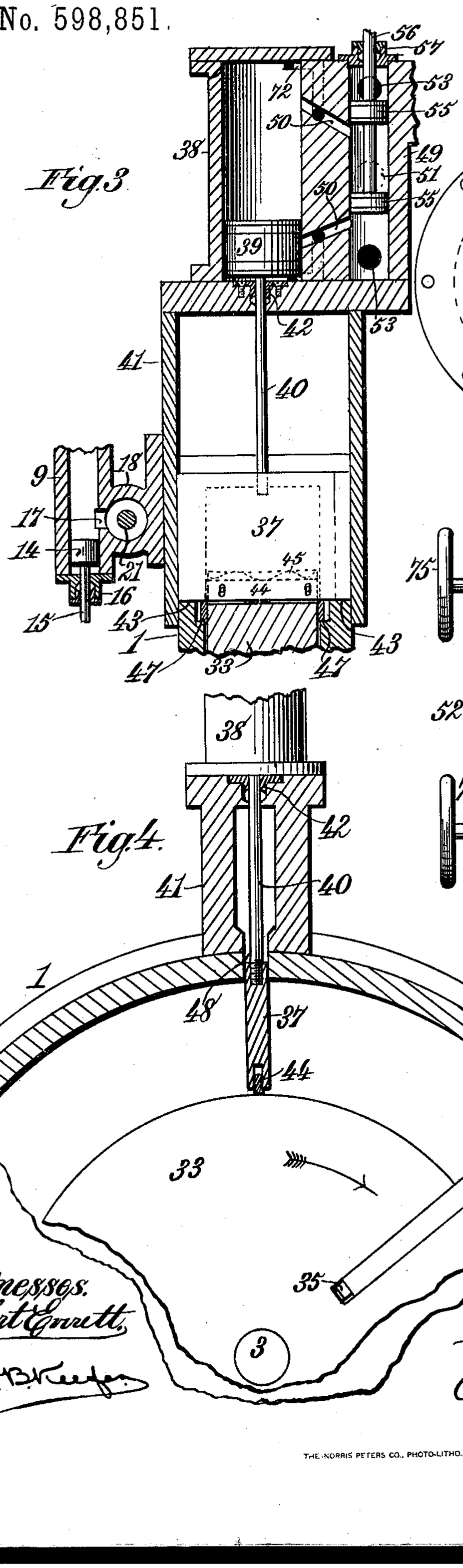


Fig. 5.

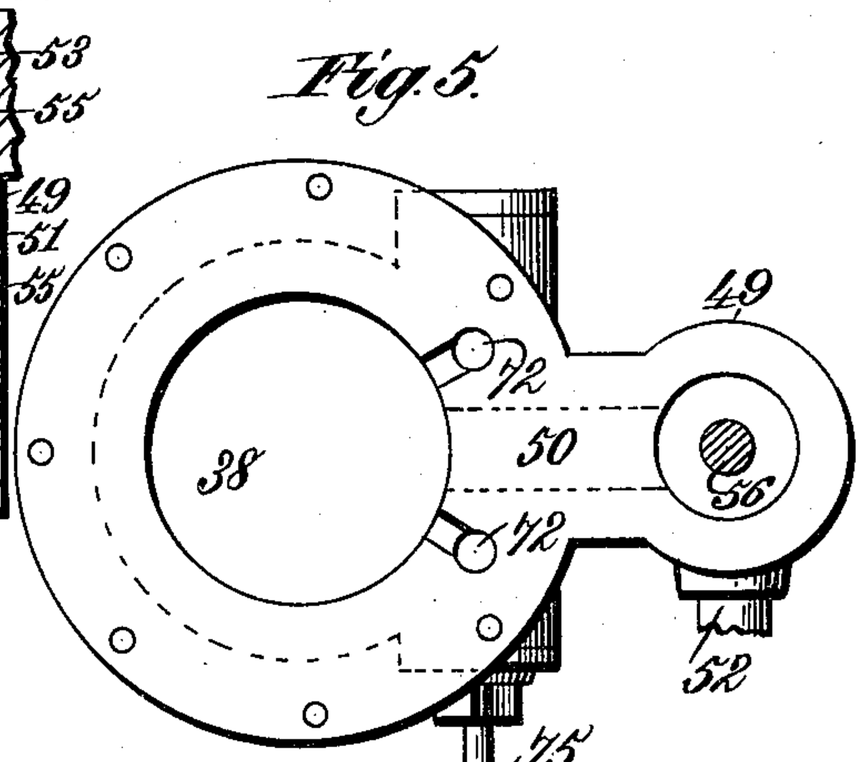


Fig. 6.

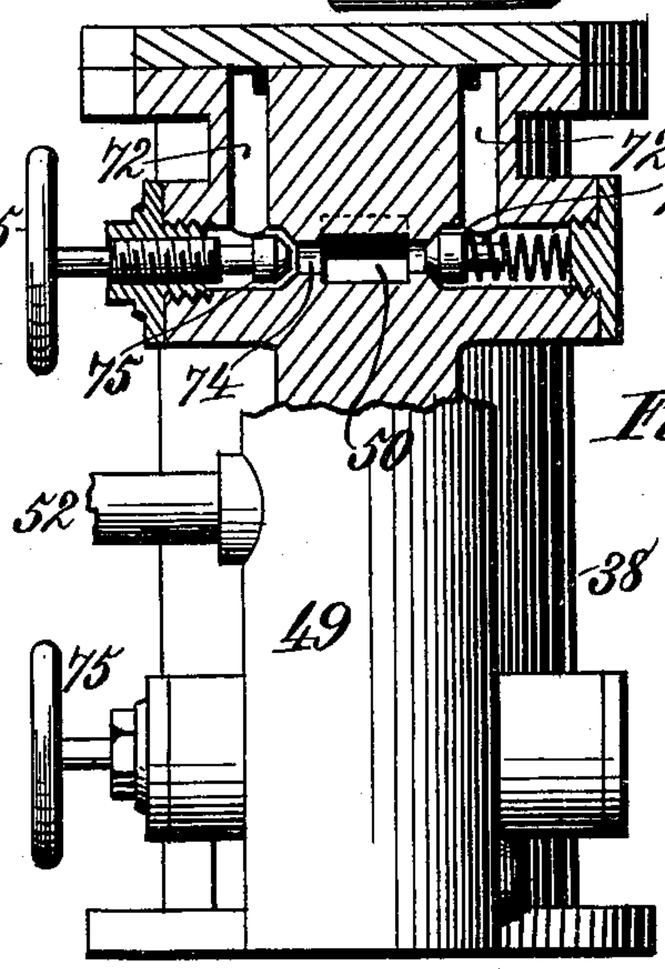


Fig. 4.

Witnesses.
Robt. Gnutt.
F. B. Keesler.

Inventor.
William B. Brown.
By James L. Norris.
Atty.

(No Model.)

4 Sheets—Sheet 4.

W. B. BROWN.

ENGINE.

No. 598,851. Patented Feb. 8, 1898.

Fig. 7.

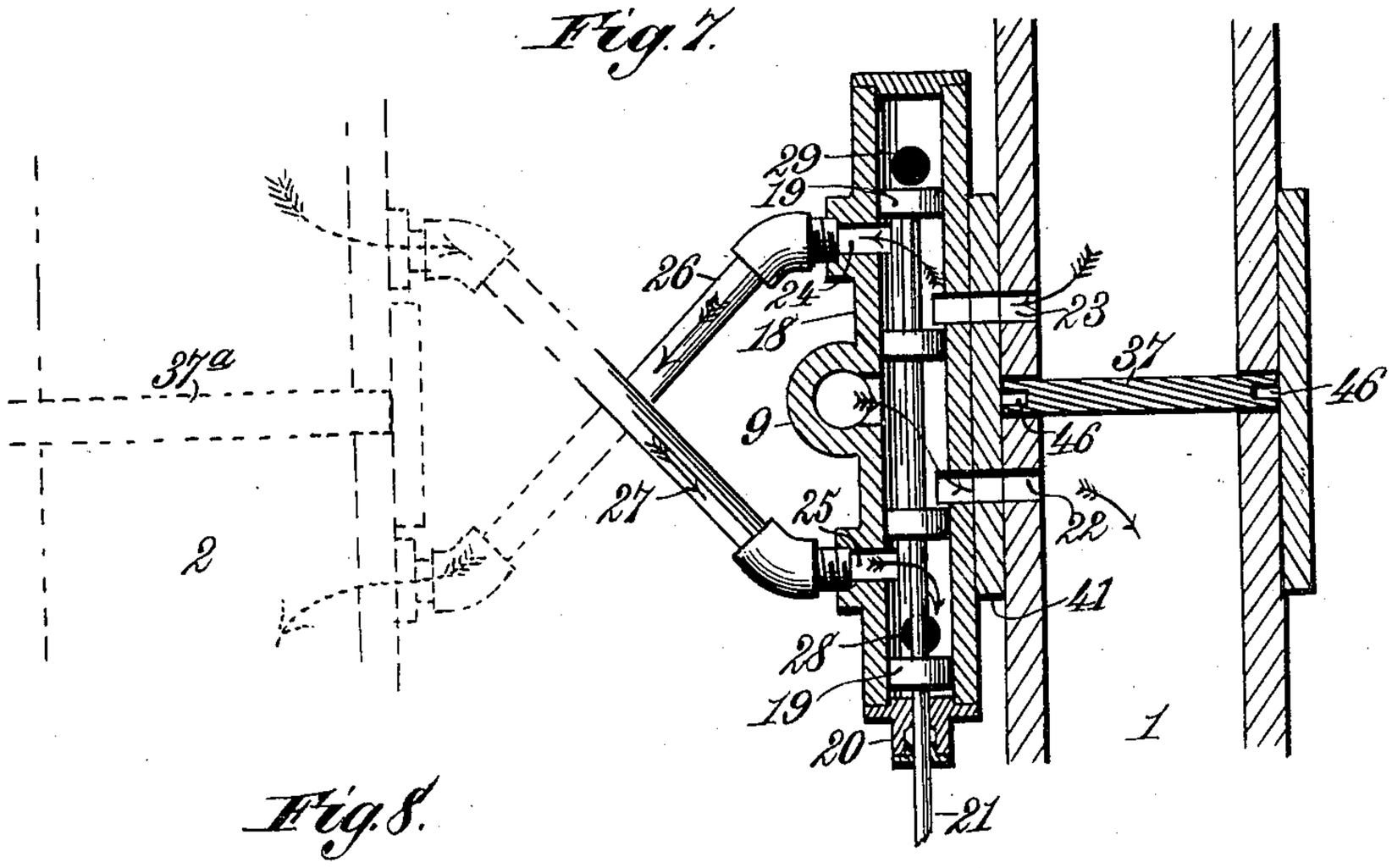


Fig. 8.

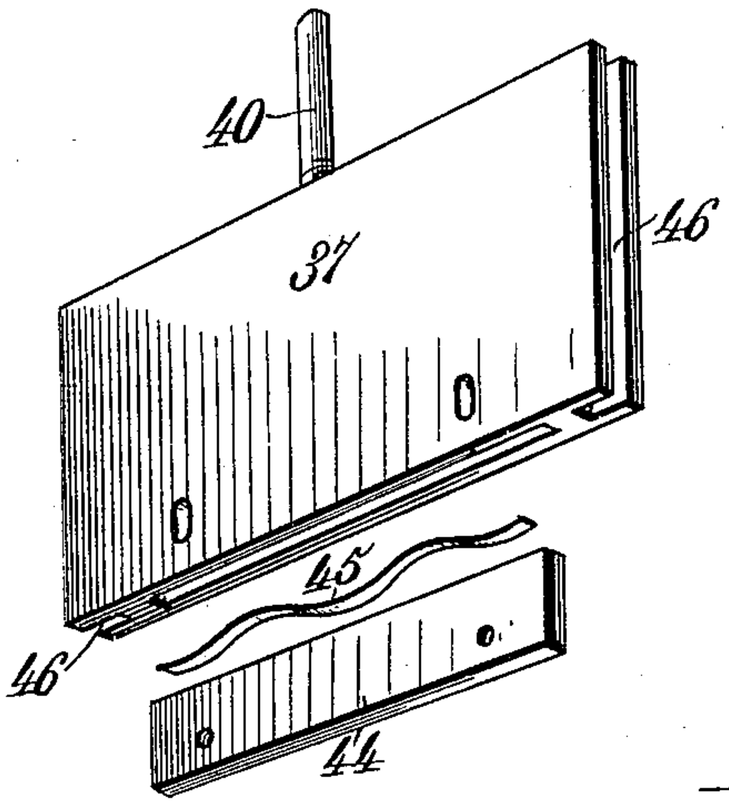


Fig. 9.

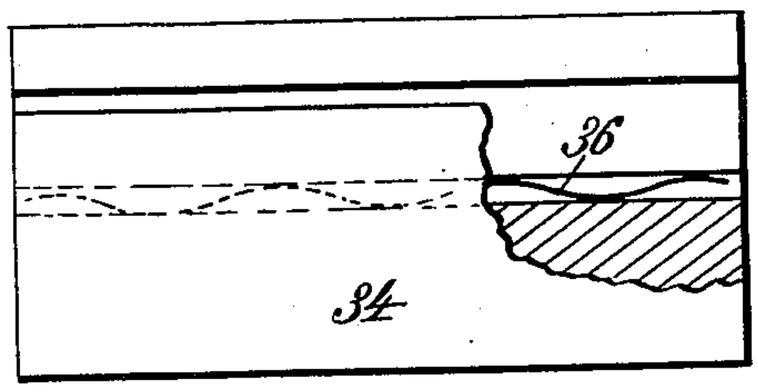
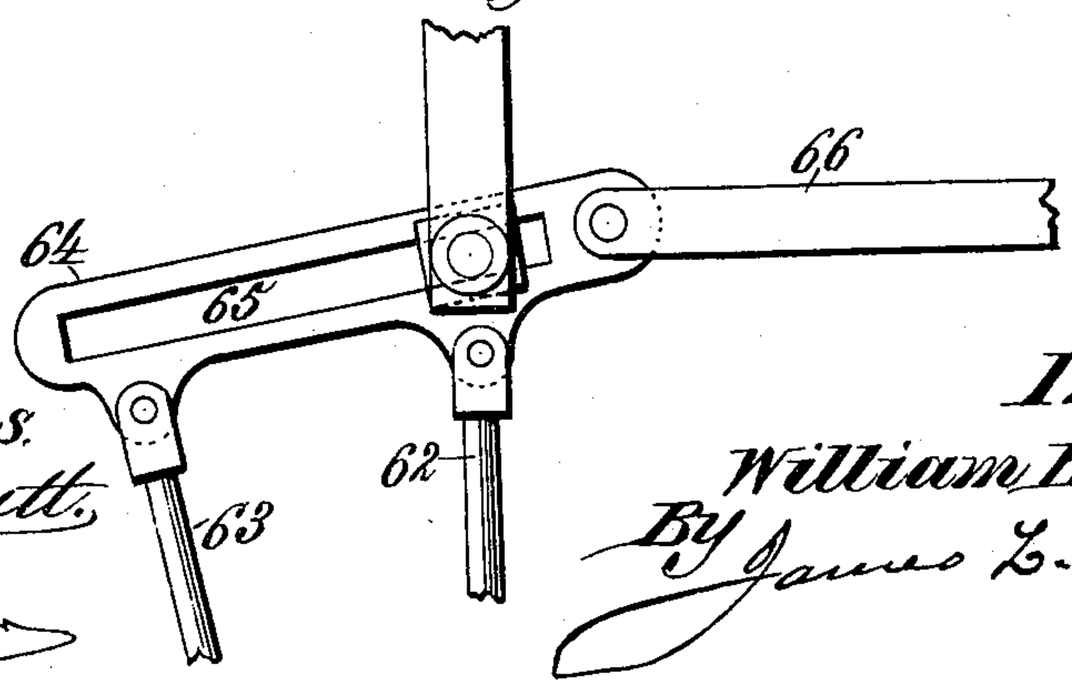


Fig. 10.



Witnesses.
Robt Garrett.
J. B. Keeler

Inventor.
William B. Brown.
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

WILLIAM B. BROWN, OF BALTIMORE, MARYLAND.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 598,851, dated February 8, 1898.

Application filed December 23, 1896. Serial No. 616,763. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM B. BROWN, a citizen of the United States, residing at Baltimore city, State of Maryland, have invented new and useful Improvements in Engines, of which the following is a specification.

This invention relates to engines or motors, and has for its main object an improved construction, arrangement, and combination of the parts comprised in a compound rotary steam-engine, as and for the purposes hereinafter set forth.

In the annexed drawings, Figure 1 is an elevation of my improved compound rotary engine with a few parts broken away or sectioned for convenience of illustration. Fig. 2 is a view in section on the line 2 2 of Fig. 1, showing the high-pressure cylinder and its immediate adjuncts in side elevation. Fig. 3 is an enlarged sectional view of an auxiliary engine of the reciprocating type for operating a sliding gate or abutment that coacts with a piston of the rotary engine. Fig. 4 is an enlarged sectional view of a portion of the high-pressure cylinder with rotary piston-body and piston-blade and showing the sliding gate or abutment in transverse section. Fig. 5 is an end view of a gate-operating engine and valve-chest, the heads being removed. Fig. 6 is a partly-sectional view illustrating check-valve and hand-valve mechanism for controlling supplemental passages between the cylinder and valve-chest of an auxiliary gate-operating engine. Fig. 7 is an enlarged sectional view illustrating the steam connections of the high-pressure and low-pressure cylinders through a reversing-valve that controls the direction in which the rotary pistons are to move. Fig. 8 is a perspective of a sliding gate and its spring packing-strip. Fig. 9 is a partly-sectional plan of a rotary piston-blade. Fig. 10 is an enlarged view of the link connections of a gate-gear.

Referring now to the construction and arrangement of the engine parts, it will be observed that Fig. 1 represents a two-cylinder compound engine of the rotary type, in which the numeral 1 designates the high-pressure cylinder and 2 the low-pressure cylinder. The main engine-shaft 3 is preferably constructed in two parts connected by couplings 4, of any suitable character, so that by disconnecting and resetting the two parts of the shaft the rotary pistons mounted thereon can be brought into any desired position with relation to each other. This shaft 3 occupies a central position with relation to the interior of the two cylinders 1 and 2 and is provided with suitable bearings 5 on the side walls thereof, as shown in Fig. 1, which also represents one end of the shaft as extended beyond the high-pressure cylinder and further supported on a pedestal 6, between which and the said cylinder there may be carried on the said shaft a fly-wheel 7 to give regularity to the revolutions of the engine-shaft, assist in overcoming dead-centers when the high-pressure cylinder is used alone, and to carry the rotary piston past the location of an opening and closing gate or abutment. Obviously by a proper relative arrangement of the pistons in two connected cylinders having a common shaft the fly-wheel may be dispensed with.

The steam or other working fluid for supplying motive power to the engine may be conducted from a boiler or other source through a pipe 8, Figs. 1 and 2, to a chest or chamber 9, in which is located a governor-valve (not shown) controlled by a governor 10, that is actuated from the engine-shaft through pulleys 11 12 and belting 13, as usual. The chest or chamber 9 is preferably in the form of a vertically-arranged cylinder constructed in two parts (upper and lower) that may have a screw-threaded connection, the governor-valve being located in the upper part, with which the steam-inlet pipe 8 connects. As shown in Fig. 3, there is located in the lower part of the cylindrical and vertically-arranged chest 9 a cut-off piston-valve 14, having its depending stem 15 working in a stuffing-box 16 on the lower end of said chest. This cut-off valve 14 controls the main or initial inlet 17 to a valve-casing 18, in which is arranged a reversing-valve 19, Figs. 3 and 7, of the three-chambered or four-pistoned variety. On one end of the valve-casing 18 is a stuffing-box 20, that affords passage for an extension of the valve-stem 21, through which the reversing-valve 19 may be set to control the operation of the engine in the direction desired, whether toward the right or the left.

In Figs. 1, 2, 3, and 7 the reversing-valve 19 is shown with its casing 18 supported on one

side of the high-pressure cylinder 1, with the interior of which it communicates through ports 22 and 23, Fig. 7, for admission and exhaust of steam or other working fluid. The casing 18 of the reversing-valve 19 is provided with other ports 24 and 25 for passage of exhaust-steam to and from the low-pressure cylinder through suitable crossed pipes 26 and 27, and the said valve-casing is also furnished with ports 28 and 29, Fig. 7, for final exhaust into branches 30 or 31 of a main exhaust-pipe 32, Fig. 2.

Each engine-cylinder 1 and 2 incloses a cylindrical and concentrically-arranged piston-body 33, Fig. 4, secured to the central engine-shaft 3 in any suitable manner. The cylindrical piston body or support 33 is radially slotted to receive a blade, vane, or piston 34, which is extended to the inner periphery of the cylinder. In order to maintain fluid-tight contact between the outer end of the piston-blade 34 and inner periphery of the cylinder, a spring 35, Fig. 4, is placed in the bottom of the slot or recess in which the said blade or piston is mounted. It is preferable to make each piston-blade 34 in two lateral halves that are reciprocally rabbeted along their inner edges, as shown in Fig. 9, and thus by means of a spring or springs 36 between the said rabbeted edges the two parts of the piston may be caused to maintain close fluid-tight contact with both sides of the cylinder throughout the revolutions of the piston.

To furnish an abutment against which the steam or other working fluid is to expand in driving the rotary piston there is provided a sliding gate 37, Figs. 3, 4, 7, and 8, that is arranged to be operated in both directions of its movement by a fluid at a pressure independent of that admitted to the high-pressure cylinder of the rotary engine. In other words, the slide or gate 37 is reciprocated in both directions by a fluid-pressure independent of that employed to rotate the piston in the high-pressure cylinder. This is accomplished in my rotary steam-engine by operating the sliding gate or abutment 37 from the piston of an auxiliary steam-engine cylinder 38, that takes its steam-supply on both sides of the piston from the same boiler that gives steam to the cylinder of the high-pressure rotary engine, but having its steam-passages and valves independent of those that control the supply of steam to the cylinder or cylinders of the main engine. Thus the pressure of steam for reciprocating the gate is independent of that employed for driving the rotary piston. Admission of live steam to the auxiliary cylinder cannot be cut off as long as the shaft of the main cylinder 1 revolves. Consequently should the governor 10 fail to act or the pressure in cylinder 1 be suddenly reduced from any cause the piston of the auxiliary cylinder will not be affected and the gate 37 will continue to reciprocate promptly and without liability of being struck by the rotary piston while impelled by momentum.

In the auxiliary cylinder 38 is a double-acting or reciprocating piston 39, having its piston-rod 40 connected with the sliding gate 37, as shown in Figs. 3 and 4. A housing 41 is provided to receive the gate 37 in its retracted position, and this housing may also serve as a support for the auxiliary gate-operating engine. Suitable packing 42 is provided for the piston-rod.

The pressure of the gate 37 in the main cylinder 1 does not come upon the rotary-piston body 33, but is supported by ledges 43, Fig. 3, of the cylinder-walls. Contact of the gate 37 with the periphery of the cylindrical piston-body 33 is insured by a packing-strip 44, Figs. 3, 4, and 8, inserted in the grooved bottom edge of the gate and arranged to be forced outwardly by a spring or springs 45, that will afford a yielding pressure sufficient to insure a close joint between the gate and the piston-body without undue friction. The side edges of the gate 37 are preferably provided with grooves 46, Figs. 7 and 8, for release of any steam or fluid pressure that might get access to the rear edge of the gate and obstruct its retractile movement. Packing-rings 47, Fig. 3, may be placed in the walls of the cylinder 1 at the edges of the rotary-piston body 33 to be pressed or expanded against the same by the action of springs at the rear of said rings. The construction of the piston-blade 34 in two laterally-expansible parts, Fig. 9, as already described, and its endwise adjustment by the spring 35, Fig. 4, will cause it to act not only as a piston but also as a packing in two directions, laterally and radially, and the construction of this piston-blade as shown is further important for the reason that being wider that the gate-guideway 48 it cannot spring into it in passing the retracted gate.

A steam-chest or valve-chamber 49, Figs. 1, 3, 5, and 6, communicates with the auxiliary cylinder 38 through diagonally-arranged ports 50 for admission and exhaust of working fluid to and from the opposite sides of the piston 39 in said cylinder. The chest or chamber 49 has an inlet-port 51, Fig. 3, connecting with a branch pipe 52, Figs. 1, 2, and 6, from the pipe 8, that takes steam from a boiler or other source of working pressure. The said valve-chest 49 is also provided with two exhaust-ports 53, connecting with exhaust-pipes 54, Fig. 2, that may discharge into the main exhaust from the rotary engine. To control the ports 50, 51, and 53, there is placed in the chest or chamber 49 a two-piston valve 55, Fig. 3, having its stem or rod 56 extended through a stuffing-box 57 and connected with a cross-head 58, Fig. 1, adapted to move in a guide-way 59, supported in a suitable position with relation to the required reciprocating movements of the valve.

In order to actuate the reciprocating valve 55 of the auxiliary gate-operating engine at a proper stroke or cut-off suited to the requirements of the engine, there is provided what I term a "gate-gear," consisting of two eccen-

trics 60 and 61, Fig. 1, carried on the main-engine shaft 3, and provided with connecting-rods 62 and 63 to a link 64, having therein a slot 65, Figs. 2 and 10, with which an arm of the cross-head 58 is engaged in a manner that is usual in the linking of a cut-off-valve gear. A bar 66 connects one end of the link 64 with a hand-lever 67 on a rock-shaft 68, Figs. 1 and 2, which is connected through a system of levers 69, 70, and 71 with the rod or stem 21 of the reversing-valve 19, hereinbefore described. Thus the reversing-valve is so connected with the gate-gear that the proper opening and closing of the gate is insured when the direction of steam-inlet or piston movement is reversed. The opening and closing of the gate with relation to the position of the rotary piston can be varied at pleasure by simply altering the position of the eccentrics and the valve of the auxiliary engine.

To effect a rapid opening and closing of the steam-actuated gate 37 without hammering or shock, it is important to provide for a steam-cushioning of the piston 39 in the gate-operating engine. For this purpose the diagonal ports 50 are placed near the ends of the cylinder 38, and supplemental passages or by-passes 72 are provided between the ends of the cylinder and each diagonal port. When either port 50 is covered by the piston 39, a spring-pressed check-valve 73, Fig. 6, will admit steam to the rear side of the piston, as at the beginning of its return stroke, to carry it past the closed port; but the check-valve at the other by-pass will not allow any escape of steam after the piston passes the adjacent diagonal port. The steam thus confined at either end of the cylinder will serve as a cushion for the piston and connected gate, but is gradually released at a port 74, Fig. 6, controlled by a partially-opened hand-valve 75, which can be so set as to afford the degree of cushioning desired. This cushioning of the piston in the auxiliary cylinder 38 and the means for controlling the degree of steam compression will insure a proper opening and closing of the steam-actuated gate 37 without shock or vibration and with great promptness and certainty in that the gate will be caused to move as rapidly as the steam at boiler-pressure can be made to act on the reciprocating piston in the auxiliary cylinder, thus affording the longest possible time for steam to exert its power on the rotary piston of the main cylinder.

A governor, as 10, is required with this type of engine, because if the engine is to run slow and the gate is set to open just before the rotary piston comes into striking distance it is obvious that should the piston speed be suddenly increased a collision of the piston and gate would ensue. If it is desired to run the engine at a high speed, it is necessary that the gate be set to open or retract earlier than when the engine runs slow. It is plain that the gate can always be set so that no matter how high the speed of the rotary piston the gate can always be made to open at the proper time in that it is actuated in both directions from the same boiler-pressure that drives the rotary piston. In both the main cylinder and the auxiliary cylinder 38 the steam is used expansively or with full pressure desired and does not depend upon impact or velocity for efficiency of engine operation.

The importance of having the sliding gate 37 arranged for operation in both directions from an auxiliary cylinder independent of the main cylinder will be apparent, for while the pressure in the main cylinder may be reduced to ten pounds or less from a boiler-pressure of, say, one hundred pounds, the pressure in the auxiliary cylinder will be unaffected, being always taken direct from the boiler and controlled by passages and valves entirely independent of those provided for the main cylinder. Consequently no failure in the operation of the gate need be feared, as in case the pressure in the auxiliary cylinder should be less than that in the main cylinder or the pressure in the main cylinder suddenly rise through failure of the governor or from other cause. If the rotary piston revolves from momentum alone, the pressure of steam in the main cylinder being cut off or suddenly reduced, the gate-operating engine will continue to work, its valve being actuated from the main-engine shaft.

In Figs. 1, 2, 3, and 4 the sliding gate of the high-pressure cylinder 1 is arranged to operate radially toward and from the axis of the rotary piston, and the gate-operating engine is shown as vertically reciprocating.

In connection with the low-pressure cylinder 2, Figs. 1 and 7, the gate 37^a is arranged to reciprocate transversely of the rotary piston-body and parallel with the engine-shaft 3, and the auxiliary gate-operating engine 38^a is therefore placed horizontally. This arrangement affords several advantages in that it permits an earlier closing-off of the space in which the rotary piston operates. The cushioning of the gate-operating piston does not begin until the gate has closed, and the gate does not require a packing in its lower edge to insure contact with the piston-body, but may have a spring at the top. The gate-housing 41^a is located on the side of the low-pressure cylinder and supports the horizontally-placed gate-operating engine. The construction of this engine is similar to the engine 38, except that it does not require auxiliary exhaust-valves. It is operated independent of the pressure in the cylinder 2 and receives live steam from the boiler through a pipe 52^a, that may connect with the main steam-supply pipe 8, Fig. 2. The valve-rod 56^a connects with a slide-block 76, actuated from one arm of a bell-crank lever 77, fulcrumed to a standard or bracket 78 on the engine-frame. The other arm of this bell-crank lever 77 connects with a slide 79, working in a guideway 80, and which is connected

with the link 64ª of a gate-gear that comprises also eccentric-rods 62ª 63ª and eccentrics 60ª and 61ª on the main engine-shaft, the construction and operation being the same as already described with reference to the gate-actuating mechanism of the high-pressure cylinder. The link 64ª connects by a bar 66ª with a lever 67ª on the same rock-shaft 68 with which the gate-gear of the high-pressure cylinder also connects. With this rock-shaft 68 are also connected the operating-levers of the reversing-valve 19, as already explained, so that when the main engine is reversed the set of the valves for the auxiliary gate-actuating engines is correspondingly varied.

Only one main cut-off valve 14, Fig. 3, will be necessary for both cylinders 1 and 2 when properly connected through the reversing-valve 19, as described. The rod or stem 15 of this cut-off valve connects with a slotted link 81, Figs. 1 and 2, to which are attached eccentric-rods 82, connecting with eccentrics 83 on the main engine-shaft. A bar 84 connects the link 81 with a lever 85, fulcrumed on a stud 86 on the engine-frame. The lever 85 is used to reverse the cut-off valve when the engine is reversed and also to modify the point of cut-off in a measure. The cut-off point is regulated principally by setting the cut-off valve 14 and its eccentric connections. The cut-off valve can be disconnected from the cut-off gear, if desired, leaving port 17 open. Compounding may be accomplished by setting the valve 14 to cut off at, say, one-half stroke in the high-pressure cylinder and allow the steam to expand to, say, three-quarters, at which point the gate can be set to open and allow the further expansion to act on the rotary piston of the low-pressure cylinder. With two cylinders having their rotary pistons on the same shaft and the gates and piston-blades set to operate in proper relation there is no period during the operation of the engine that the steam is not fully acting in one cylinder or the other. A hand-valve 87, Fig. 2, may be connected with the main steam-pipe 8 to control the supply of steam to the rotary piston or pistons or cut it off entirely, and it will be noted that this valve is so located that neither its opening nor closing will in any way affect the supply of steam to either auxiliary gate-operating engine.

Although I have shown only one rotary piston-blade and one reciprocating gate for each cylinder, it will be obvious that in large engines two or more blades and gates may be provided, together with suitable means for operating the gates in proper time movements.

What I claim as my invention is—

1. In an engine, the combination of a high-pressure cylinder, a low-pressure cylinder, rotary pistons in said cylinders, a main engine-shaft on which said pistons are mounted, sliding gates for said cylinders, auxiliary reciprocating engines having their pistons in operative connection with said gates, slide-valves for said auxiliary engines actuated from the main engine-shaft, reversing-valve mechanism through which the high-pressure and low-pressure cylinders communicate, and a cut-off valve for controlling admission of fluid-pressure to the reversing-valve mechanism, substantially as described.

2. In an engine, the combination of a high-pressure cylinder, a low-pressure cylinder, rotary pistons in said cylinders, a sliding gate in one cylinder adapted to be actuated radially toward and from the axis of the rotary piston, a sliding gate in the other cylinder adapted to be actuated parallel with the axis of the rotary piston in that cylinder, auxiliary cylinders having their pistons in operative connection with said sliding gates and actuated in both directions of their movement by a pressure independent of that in the high-pressure cylinder, and slide-valves for said auxiliary cylinders each actuated from the main engine-shaft, substantially as described.

3. In an engine, the combination of a high-pressure cylinder, a low-pressure cylinder, rotary pistons in said cylinders, a main engine-shaft on which the rotary pistons are mounted, said pistons being adapted to be set in any required relation to each other, a sliding gate for one of said cylinders adapted to be operated radially toward and from the engine-shaft, a sliding gate in the other cylinder adapted to be actuated in a direction parallel with the engine-shaft, auxiliary engines having reciprocating pistons connected with said sliding gates and actuated in both directions by a fluid-pressure independent of the pressure acting on the rotary piston in the high-pressure cylinder, and reciprocating pistoned slide-valves for said auxiliary engines and each operated from the main engine-shaft, substantially as described.

4. In an engine, the combination of a high-pressure cylinder, a low-pressure cylinder, a rotary piston in each of said cylinders, an engine-shaft on which said pistons are mounted, the said shaft being formed in two parts having a coupling to permit change in the relative position of the rotary pistons, a sliding gate for one of said cylinders arranged to be operated radially toward and from the engine-shaft, a sliding gate for the other cylinder arranged to be operated parallel with the engine-shaft, auxiliary reciprocating engines having their pistons connected with said sliding gates and actuated in both directions by a fluid-pressure independent of that acting on the rotary piston in the high-pressure cylinder, slide-valves for said auxiliary engines, connections for actuating said slide-valves from the engine-shaft, a reversing-valve in communication with the high-pressure cylinder and the low-pressure cylinder, a cut-off valve for controlling admission of fluid-pressure to said reversing-valve, and lever mechanism connecting the reversing-valve with the slide-valves of the auxiliary cylinders, substantially as described.

5. In an engine, the combination of a high-pressure cylinder, a low-pressure cylinder, rotary pistons in said cylinders, an engine-shaft on which said rotary pistons are mounted, a sliding gate for each of said cylinders, auxiliary reciprocating engines having their pistons in operative connection with said gates and actuated in both directions by a fluid-pressure independent of that acting on the rotary piston in the high-pressure cylinder, slide-valves for said auxiliary engines, actuating connections from the engine-shaft to said slide-valves, a reversing-valve with which the high-pressure cylinder and the low-pressure cylinder both communicate, a chest or chamber for admission of working fluid to the said reversing-valve, a governor and a cut-off valve mounted in said chest or chamber, and lever mechanism connecting the reversing-valve with the operating slide-valve connections of the auxiliary cylinders, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

WILLIAM B. BROWN.

Witnesses:
ALBERT H. NORRIS,
A. R. BROWN.