No. 646,187. Patented Mar. 27, 1900.

J. H. MOORE.

VALVE FOR ENGINES.

(Application filed Nov. 15, 1899.)

(No Model.) 3 Sheets—Sheet 1.

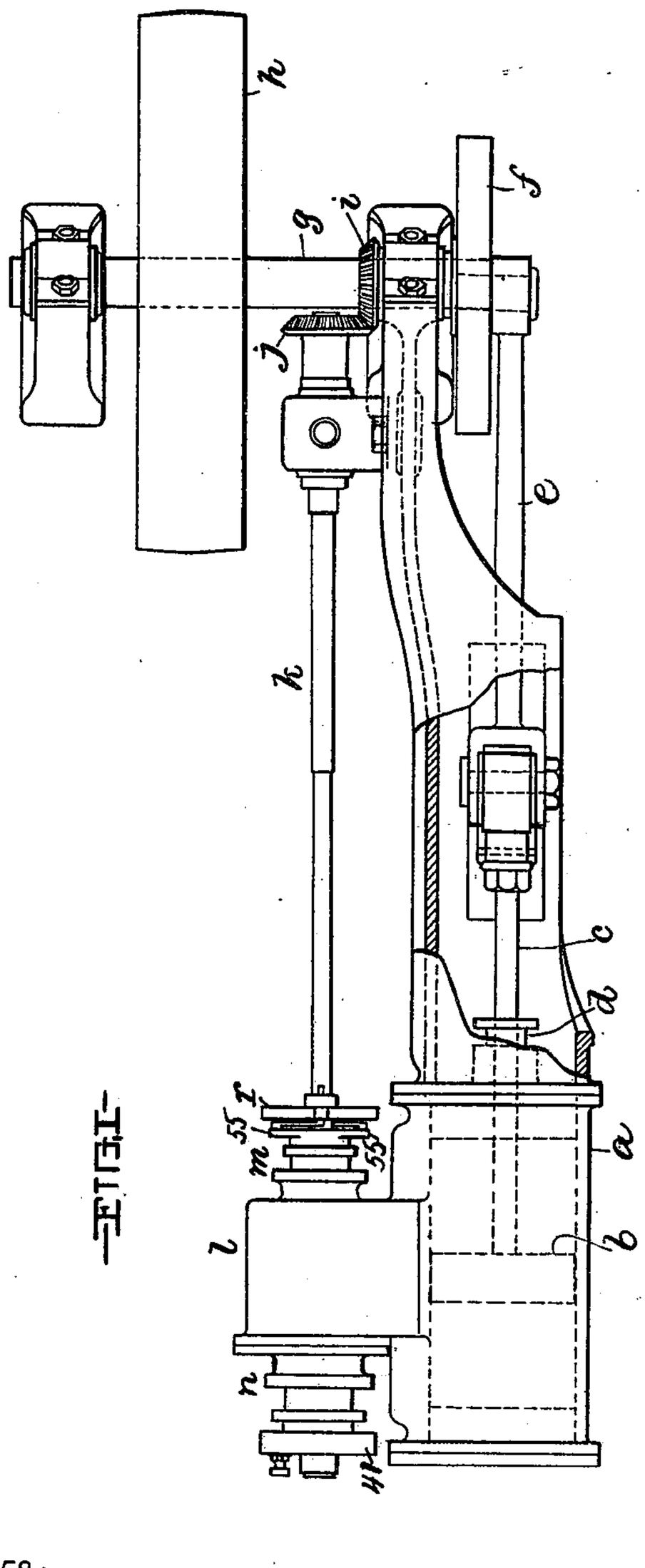

FIG. 1.

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(No Model.) 3 Sheets—Sheet 2.

FIG. II.

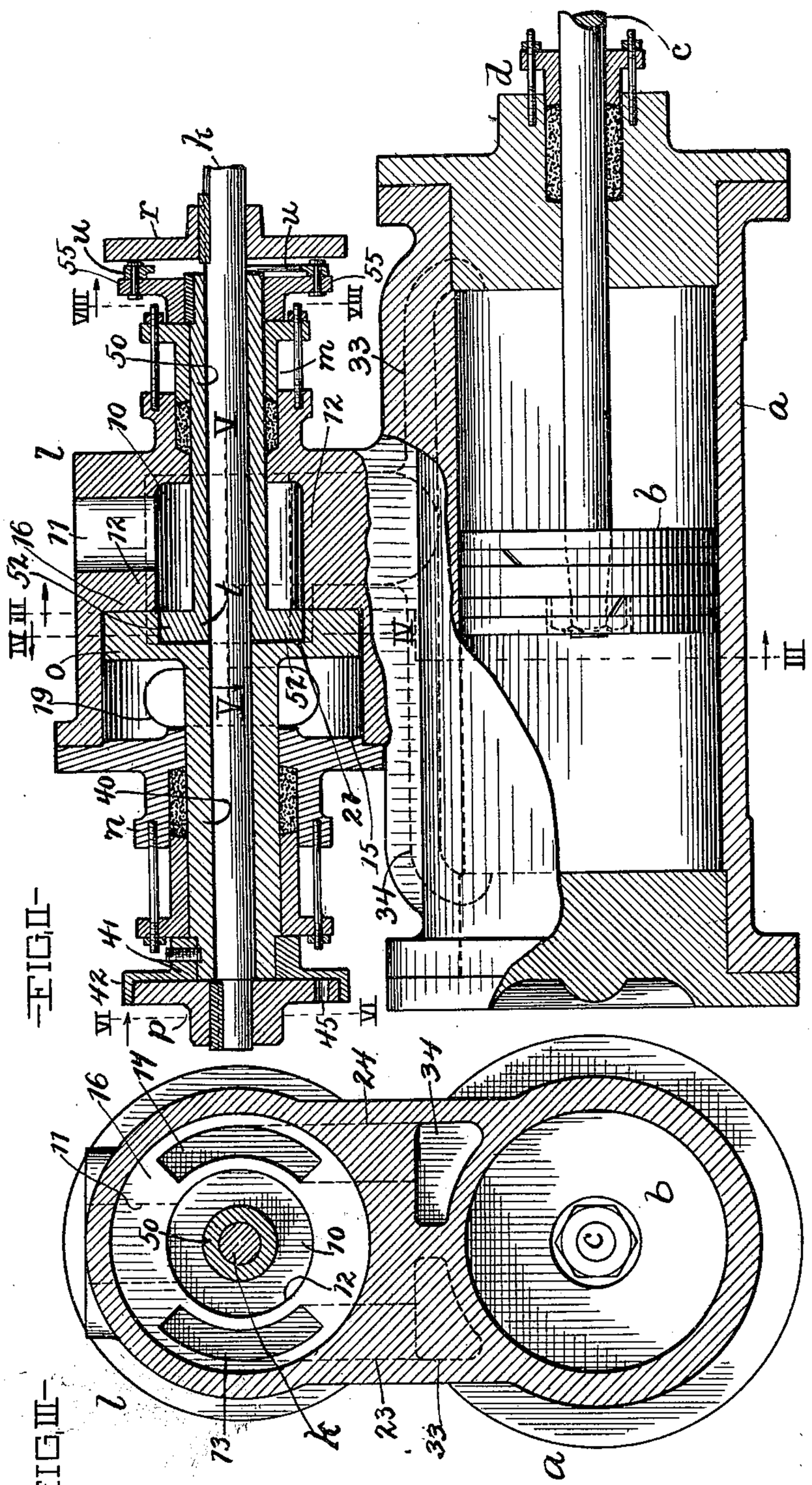

FIG. III.

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(No Model.) 3 Sheets—Sheet 3.

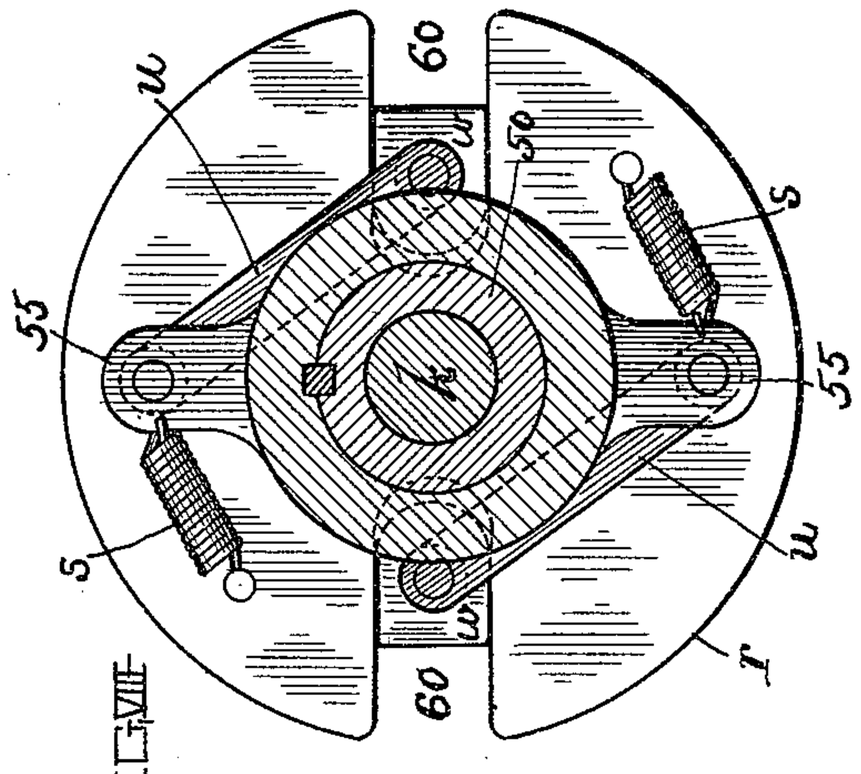

FIG. VIII.

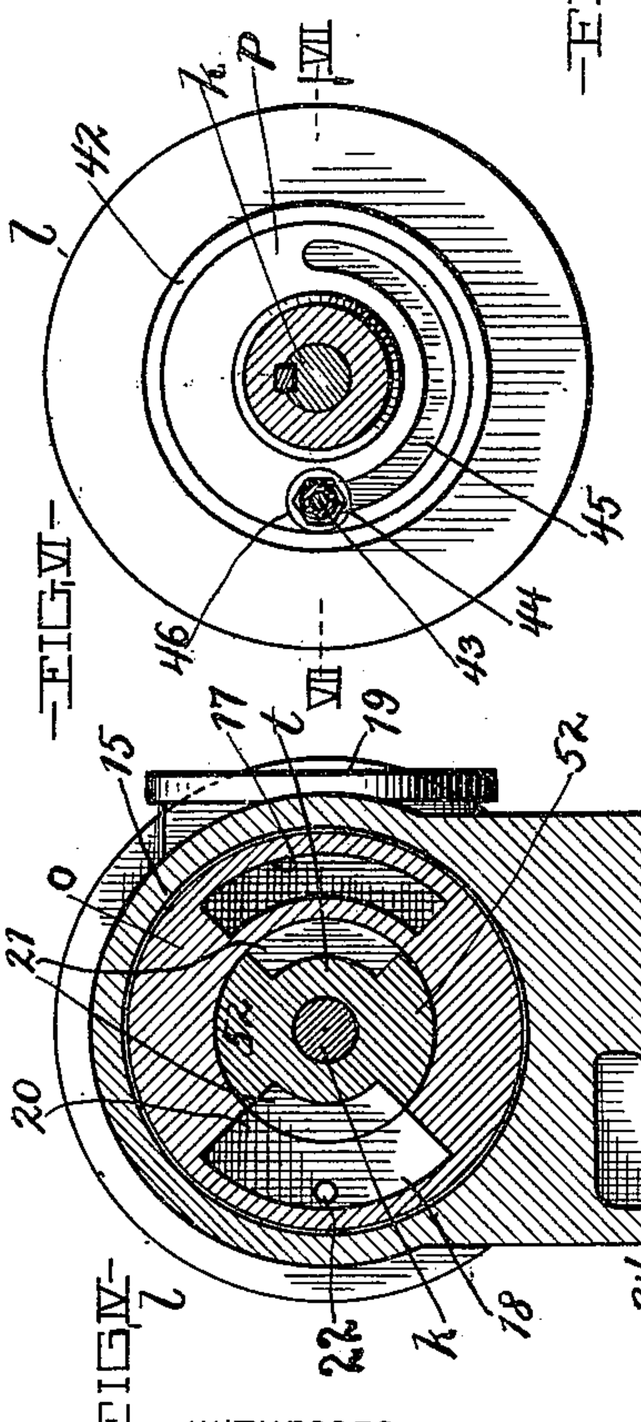

FIG. VI.

FIG. IV.

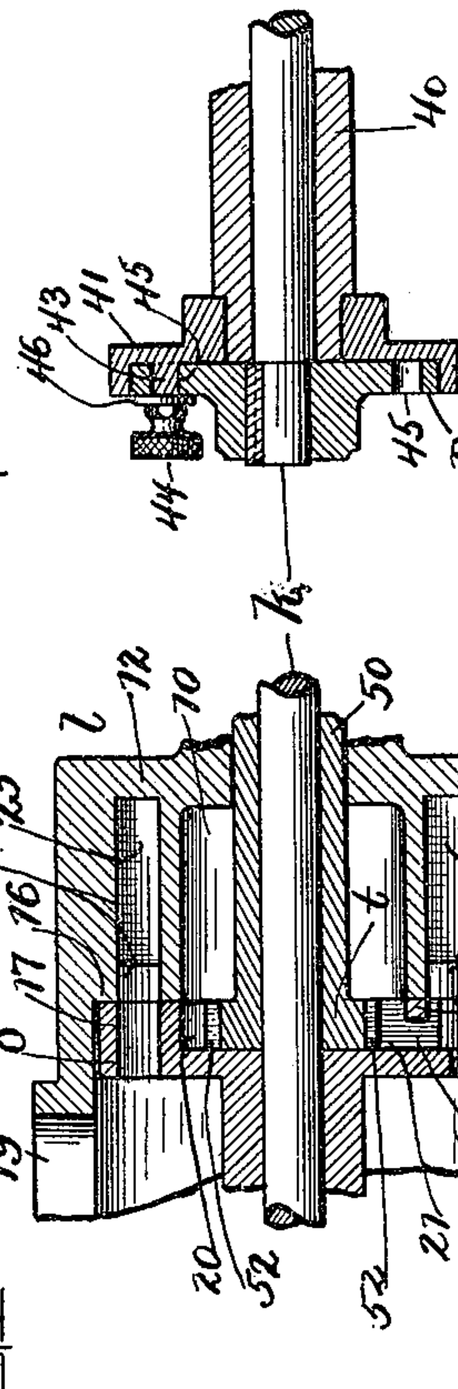

FIG. VII.

FIG. V.

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UNITED STATES PATENT OFFICE.

JOHN H. MOORE, OF CLEVELAND, OHIO.

VALVE FOR ENGINES.

SPECIFICATION forming part of Letters Patent No. 646,187, dated March 27, 1900.

Application filed November 15, 1899. Serial No. 737,115. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. MOORE, a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented certain new and useful Improvements in Valves for Engines Operated by Fluid Under Pressure; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

This invention relates to improvements in engines operated by fluid under pressure, and more especially to the valve mechanism of the engine.

One object of this invention is to reduce to a minimum the wear upon the ported steam-receiving face of the rotary main valve that controls the supply of steam to opposite ends alternately of the steam-cylinder.

Another object of this invention is to balance the main valve and maintain a perfect bearing between the said valve and the valve-casing's seat for the said valve.

A further object of the invention is to avoid the use of eccentrics for reversing the engine.

Another object of the invention is to provide improved means for regulating the supply of steam to the steam-receiving port of the main valve and automatically to partially obstruct the size of the inlet to the said port as soon as a greater speed of the engine-shaft than is desirable obtains.

With these objects in view and to the end of realizing other advantages hereinafter appearing the invention consists in certain features of construction and combinations of parts hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure I is a top plan, partly in section, of a fluid-pressure engine embodying the invention that constitutes the subject-matter of this application. Fig. II is a top plan, mostly in central vertical section, of the engine's cylinder and the connected valve-casing. Fig. III is a transverse vertical section on line III III, Fig. II, looking inwardly. Fig. IV is a transverse vertical section on line IV IV, Fig. II, looking outwardly. Fig. V is a transverse vertical section on line V V, Fig. II, looking in the direction of the arrow. Fig. VI is a transverse vertical section on line VI VI, Fig. II, looking inwardly. Fig. VII is a transverse central section on line VII VII, Fig. VI, looking in the direction of the arrow. Fig. VIII is an enlarged transverse vertical section on line VIII VIII, Fig. II, looking in the direction of the arrow.

Referring to the drawings, *a* designates the fluid-pressure-receiving cylinder of the engine, *b* the piston arranged within and adapted to reciprocate endwise of the chamber of the cylinder, and *c* the piston-rod that extends through a stuffing-box *d*, formed upon the lower or inner end of the cylinder. The piston-rod *c* is operatively connected, by a pitman or link *e*, with the wrist of the crank *f*, with which the engine-shaft *g* is provided. The shaft *g* and the cylinder *a* are arranged horizontally and at right angles to each other. The shaft *g* and the cylinder *a* are supported in any approved manner, and the shaft at any convenient point is operatively provided with a bevel-gear *i*, that meshes with a bevel-gear *j*, operatively mounted upon the shaft *k*, that is arranged horizontally and parallel with the cylinder *a* and is supported in any approved manner. The shaft *k* extends longitudinally and centrally through the valve-casing *l*, that is formed upon or supported from one side of the cylinder *a* in any approved manner. The valve-casing *l* at its inner end adjacent to the inner or stuffing-box-bearing end of the cylinder *a* is provided with a stuffing-box *m* around the shaft *k*. The valve-casing within its inner end portion has an annular fluid-pressure-receiving chamber 10, that surrounds the shaft *k*, and the said chamber at the outer side of the valve-casing has a fluid-pressure inlet 11. The surrounding wall 12 of the chamber 10 is provided with two ports 13 and 14, arranged at diametrically-opposite sides, respectively, and concentrically of the shaft *k* and at opposite sides, respectively, of the inlet 11. Each of the ports 13 and 14 extends, preferably concentrically of the shaft, one-fourth of the distance around the shaft. The valve-casing within its outer end portion next to the chamber 10 is provided with a valve-containing chamber 15, that is larger diametrically than the chamber 10, so as to form a valve-seat forming annular shoulder 16 internally of the valve-casing at the outer end

of the aforesaid ported wall 12. A rotary valve *o*, that constitutes the main valve of the engine, is operatively mounted upon the shaft *k* at or contiguous to the aforesaid shoulder 16 and easily fits within the chamber 15 of the valve-casing. The valve is provided with two ports 17 and 18, arranged at diametrically-opposite sides, respectively, and concentrically of the valve-bearing shaft. The valve-ports extend concentrically of the shaft preferably one-fourth of the distance around the shaft. The said ports 17 and 18 of the valve are arranged, as required, relative to the ports 13 and 14 in the valve-casing, to render them (the valve-ports) capable of registering with the said valve-casing's ports during the operation of the valve. The valve-ports are formed, therefore, in the valve's face that is contiguous to and seated against the shoulder or seat 16, formed upon valve-casing's ported wall, and the ports 13 and 14 in the said wall of the valve-casing are open at the said shoulder or seat 16. One of the valve-ports (and port 17 of the valve illustrated) extends through the valve and is in open relation with the valve-containing and exhaust chamber 15 at the back of the valve and consequently is in open relation with the valve-casing's exhaust port or outlet 19, that is in open relation with the chamber 15 behind the valve. The said port 17 constitutes, therefore, the exhaust-port of the valve. The other valve-port 18 has its inner side wall provided with a lateral slot or aperture 20, that establishes open relation between the said valve-port 18 and the circular chamber 21, formed centrally of the valve next to and communicating with the fluid-pressure-receiving chamber 10 of the valve-casing. The slot or aperture 20 constitutes, therefore, the fluid-pressure inlet of the port 18. The valve *o* is provided also with a comparatively-small port-forming perforation or aperture 22, that establishes open relation between the valve-port 18 and the chamber 15 behind the valve. Hence the perforation or aperture 22 is formed in the back of the valve *o* and conducts enough of the fluid-pressure received by the valve-port 18 during the operation of the engine behind the valve to maintain the valve properly seated against the shoulder or seat 16, notwithstanding such wear upon any of the parts as would, in the absence of the perforation or aperture 22, result in unequal wear upon or separation of the opposing surfaces between the valve and the latter's aforesaid seat 16.

The ports 13 and 14 are connected by ports 23 and 24, respectively, as shown in dotted lines, with the different cylinder-ports 33 and 34, respectively, and the ports 33 and 34 connect with opposite ends, respectively, of the chamber of the cylinder *a*.

By the construction hereinbefore described it will be observed that during the operation of the engine fluid under pressure is admitted to the one or the other of the cylinder-ports from the chamber 10 of the valve-casing through the medium of the valve's chamber 21, port-inlet 20, valve-port 18, the valve-casing's port that is in open relation with the said valve-port 18, and the port that connects the said port of the valve-casing with the respective cylinder-port, and while fluid-pressure is admitted to one of the cylinder-ports the other cylinder-port exhausts, because the latter is then in open relation with the other valve-casing port that is then communicating with the valve-port 17, that is in open relation with the exhaust-port 19 of the valve-casing; that the port 18 of the valve shall during the operation of the engine communicate alternately with the different ports 13 and 14 in the valve-casing, and that fluid under pressure is consequently admitted to opposite ends of the chamber of the cylinder alternately. It is obvious also that as the ports 13 and 14 of the valve-casing and the ports 17 and 18 of the valve *o* extend one-quarter of the distance around the valve-bearing shaft steam is continually admitted to one or the other of the said valve-casing ports, since each valve-casing port receives steam as soon as the other valve-casing port has begun to exhaust.

The valve-casing, at the exhaust-chamber-forming end thereof, is provided with a stuffing-box *n* around the sleeve 40, that is mounted upon the valve-bearing shaft *k* and extends through the said end of the valve-casing. The sleeve 40 is rigid or integral with the valve and constitutes a portion of the means employed in establishing operative connection between the valve and the shaft *k*. The sleeve's outer end is provided at the outer end of the stuffing-box with a disk 41, that is operatively mounted, fixed, or formed upon the sleeve in any approved manner and is provided at its periphery with an annular flange or rim 42, that projects longitudinally of and outwardly beyond the sleeve's outer end and embraces a disk *p*, operatively mounted or formed upon the valve-bearing shaft in any approved manner. The last-mentioned disk is provided with a slot 45, that is arranged concentrically of the shaft and extends, preferably, half-way around the shaft and is engaged by a pin forming stud 43, that is formed upon the aforesaid disk of the sleeve of the valve. A nut 44 is mounted upon the outer end of the said stud, and a washer 46 is interposed between the nut and the outer side of the shaft's disk *p*. The arrangement of parts is such that preparatory to the commencement of the operation of the engine the pin 43 is at one end of the slot 45, and the said pin engages the one or the other end of the slot, according as the engine-shaft is to be driven in the one direction or the other. The engagement of the pin 43 with the one or the other end wall of the engaging slot 45 obviously causes the valve to rotate with the shaft. The means illustrated for transmitting power from the valve-bearing shaft to the valve is exceedingly simple in construction and effective for

reversing the valve. If it is desired to reverse the valve, and consequently the engine-shaft, all that is required is to hold the pin 43 stationary until the shaft has rotated in the same direction in which it was rotating far enough to cause the opposite end wall of the slot 45 to come into engagement with the pin, whereupon the engine will be immediately reversed. I would have it understood, however, that my invention, so far as the reversing mechanism is concerned, embraces, broadly, any means for establishing operative connection between the valve-bearing shaft and the sleeve of the main valve by accommodating one-half of a rotation of the valve in the one or the other direction independently of the shaft and establishing operative connection between the valve and the shaft upon actuating the valve into one or the other of its extreme positions circumferentially and independently of the shaft; but certainly the slot 45 of the disk *p* of the means illustrated has its end walls most conveniently forming two stops that are arranged at diametrically-opposite sides, respectively, of and operatively connected with the valve-bearing shaft and are consequently arranged to limit the turning of the valve upon and independently of the shaft in opposite directions, respectively, because, as already indicated, the pin or member 43, that is formed upon the valve-sleeve and has a sweep between the aforesaid stop-forming walls, is in position to be actuated in the one or the other direction, according as it is engaged by the one or the other of the aforesaid walls.

The governor or mechanism for controlling the speed of the engine-shaft is shown to be as follows: A disk *r* is keyed or otherwise operatively mounted upon the valve-bearing shaft a suitable distance from the inner end of the valve-casing in suitable proximity to the outer end of a sleeve 50, that is mounted upon the valve-bearing shaft and extends from near the said disk *r* to the cut-off valve *t*, that is arranged within the chamber 21 of the valve *o*. The cut-off valve *t* comprises two heads 52 and 52, formed upon the inner end of the said sleeve 50 diametrically opposite each other and having their peripheral surfaces arranged close to the surrounding wall of the chamber 21 of the main valve *o*, and the one or the other head of the cut-off valve is caused to more or less close the slot 20, formed in the inner side wall of the valve-port 18, according as the said sleeve is turned in the one direction or the other independently of the main valve. The disk *r* is provided with two slots 60 and 60, arranged radially and at opposite sides, respectively, of the disk. The sleeve 50 adjacent to the disk *r* is provided with two laterally and outwardly projecting arms 55 and 55, arranged radially and at opposite sides, respectively, of the sleeve. The arrangement of parts is such that in their normal position the sleeve-arms 55 are arranged at right angles to the slots 60 in the disk *r*. Two weights *w* and *w* engage the different slots 60 and 60, respectively, and each weight is movable endwise of the engaging slot. The side walls of each slot 60 form, therefore, a radially-arranged slideway engaged by a weight-forming slide. One of the weight-forming slides is connected by a link *u* with the outer end of one of the sleeve-arms 55, and the other weight-forming slide is connected with the outer end of the other sleeve-arm 55 by a corresponding link *u*. In the normal position of the parts wherein neither head of the cut-off valve is in an operative position, so as to reduce the size of the passage-way to the steam-receiving port of the main valve, the slide-forming weights *w* and *w* engage the inner ends of the engaging slideways, and suitably-applied springs *s* act to retain the said weights in their normal position, and the two springs shown are attached at one end to the different sleeve-arms, respectively, and have their other end attached to the disk *r*. I would have it understood, however, that my invention is not limited to any particular cut-off valve within the main valve, but embraces any suitably-operated cut-off valve arranged within and capable of controlling or regulating the supply of steam to the steam-receiving port of the main valve.

The operation of the mechanism for operating the cut-off valve will be readily understood and is as follows: When the speed of the engine-shaft becomes greater than desired during the operation of the engine, the speed of the valve-bearing shaft will have become correspondingly greater and result in the actuation of the weights *w* and *w* by centrifugal force against the action of the springs toward the outer ends of the slideways engaged by the said weights, and the said outward movement of the weights results in the actuation of the cut-off valve as required to cause the valve to more or less obstruct the inlet of the steam-receiving port of the main valve, and thereby reduce the quantity of fluid under pressure admitted to the engine-cylinder, so as to result in a reduction of the speed of the engine-shaft, and when the engine-shaft's normal speed again obtains the weights *w* will have been returned to their normal positions at the inner ends of the engaging slideways by the action of the springs *s*.

What I claim is—

1. The combination, with the engine's cylinder; the piston within the cylinder, and the engine-shaft operatively connected with the piston, of a valve-casing having an exhaust-outlet and provided with a fluid-pressure inlet; a rotary valve within the valve-casing and having two ports formed therein diametrically opposite each other and arranged concentrically and extending one-fourth of the distance around the axis of the valve, which valve has one of the said ports in open relation with the exhaust-outlet of the valve-casing, and has the other port in open relation with the

fluid-pressure inlet of the valve-casing; means adapted to rotate the said valve and operatively connected with the engine-shaft, and two ports formed in the valve-casing diametrically opposite each other and arranged concentrically and extending one-fourth of the distance around the axis of the valve and the said valve-casing ports being arranged as required to conduct fluid-pressure from the pressure-receiving port of the valve to the chamber of the cylinder during the operation of the engine, substantially as and for the purpose set forth.

2. The combination, with the engine's cylinder; the piston within the cylinder, and the engine-shaft operatively connected with the piston, of a valve-casing having a valve-accommodating and exhaust chamber and a fluid-pressure inlet; a suitably-operated rotary valve contained within the said chamber of the valve-casing and provided with two ports formed therein diametrically opposite each other and extending one-fourth of the distance around the axis of the valve, which valve has one of the said ports in open relation with the exhaust-chamber of the valve-casing, and has the other port in open relation with the fluid-pressure inlet of the valve-casing, and has an aperture or perforation connecting the fluid-pressure-receiving port of the valve with the exhaust-chamber of the valve-casing; an annular seat for the valve formed internally of the valve-casing, and passage-ways establishing open relation between the different ports, respectively, of the valve and opposite ends, respectively, of the chamber of the cylinder, during the operation of the engine, substantially as and for the purpose set forth.

3. The combination, with the engine's cylinder; the piston within the cylinder, and the engine-shaft operatively connected with the piston, of a valve-casing arranged at the side of and parallel with the cylinder and having an exhaust-outlet and a fluid-pressure inlet; a rotary valve within the valve-casing, which valve has two ports formed therein, at opposite sides, respectively, of its axis, has one of the said ports in open relation with the exhaust-outlet of the valve-casing, and has the other port in open relation with the valve-casing's fluid-pressure inlet; a shaft bearing the said valve and arranged longitudinally of the path of the piston and operatively connected with the engine-shaft; an annular shoulder formed internally of the valve-casing and affording bearing for the valve, and two ports formed in the valve-casing at opposite sides, respectively, which valve-casing ports are in open relation, at one end, with opposite ends, respectively, of the chamber of the cylinder and have their opposite ends arranged as required to establish open relation between them and the different valve-ports, respectively, during the operation of the engine, substantially as and for the purpose set forth.

4. In an engine of the character indicated, the combination, with the fluid-pressure-receiving cylinder having two ports communicating with opposite ends, respectively, of the cylinder's chamber; the piston within the cylinder, and the engine-shaft operatively connected with the piston, of a suitably-supported valve-casing arranged at the side of and parallel with the cylinder and having an exhaust-chamber and provided with a fluid-pressure-receiving chamber having an inlet; an annular valve-seat-forming wall formed between the last-mentioned chamber and the exhaust-chamber; two ports formed within opposite sides, respectively, of the said wall, which ports are in open relation with the different cylinder-ports, respectively, and extend to the surface of the aforesaid seat; a rotary valve operatively connected with the engine-shaft and having a face contiguous to the aforesaid seat; two ports formed within opposite sides, respectively, of the valve and arranged to register with the different ports, respectively, of the valve-casing during the rotation of the valve, one of the valve-ports being in open relation with the pressure-receiving chamber of the valve-casing, and the other valve-port being in open relation with the exhaust-chamber of the valve-casing, and the relative arrangement and length of the valve-ports and the valve-casing ports around the axis of the valve being such that, as soon as communication between the fluid-pressure-receiving port of the valve and one of the valve-casing ports shall be interrupted during the operation of the engine, communication shall have been established between the said fluid-pressure-receiving port and the other valve-casing port.

5. The combination, with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder, and the engine-shaft operatively connected with the piston, of another shaft arranged parallel with the path of the piston; a rotary valve mounted upon the last-mentioned shaft and arranged in a plane at right angles to the path of the piston, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means adapted to rotate the said valve and operatively connected with the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine.

6. The combination, with the engine's cylinder having two ports communicating with

opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; a rotary valve having an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine, of means for establishing operative connection between the valve and the valve-bearing shaft and arranged and constructed to permit a half-rotation of the valve independently of the valve-bearing shaft in the one or the other direction before causing the valve to rotate with the shaft, substantially as and for the purpose set forth.

7. The combination, with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; a rotary valve having a sleeve loosely embracing the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine, of a pin or projecting member formed upon the valve-sleeve and revoluble with the rotation of the sleeve, and two stops formed upon and arranged at diametrically-opposite sides, respectively, of the valve-bearing shaft and arranged furthermore to limit the movement of the said pin or projecting member in opposite directions, respectively, independently of the valve-bearing shaft, substantially as and for the purpose set forth.

8. The combination, with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; a rotary valve having a sleeve loosely embracing the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine, of a disk operatively connected with the valve-bearing shaft and having a slot or opening arranged concentrically of and extending half-way around the shaft, and a member engaging the said slot or opening and operatively connected with the aforesaid valve-sleeve, substantially as and for the purpose set forth.

9. The combination with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; a rotary valve having a sleeve embracing the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine: of a disk operatively connected with the valve-bearing shaft and having a slot arranged concentrically of and extending half-way around the shaft, and another disk operatively connected with the aforesaid valve-sleeve and provided with a pin engaging the aforesaid slot, substantially as and for the purpose specified.

10. The combination with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; a rotary valve having a sleeve embracing the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-

bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine: of a disk *p* operatively connected with the valve-bearing shaft and provided with the concentrically-arranged slot 45; another disk 41 operatively connected with the aforesaid valve-sleeve and provided with an annular flange or rim surrounding the slotted disk; a pin-forming stud engaging the aforesaid slot, and a nut upon the stud at the outer side of the slotted disk, substantially as shown, for the purpose specified.

11. The combination, with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder, the piston within the cylinder, the engine-shaft operatively connected with the piston; another shaft; the rotary main valve operatively connected with the last-mentioned shaft; the valve-casing containing the said valve and provided with a seat for the valve, an exhaust-outlet and a fluid-pressure inlet; ports within the valve, valve-casing and cylinder having such arrangement that fluid under pressure shall be conducted through the valve and valve-casing into opposite ends of the cylinder alternately, and one end of the cylinder shall exhaust while the cylinder's other end is taking fluid under pressure, and a cut-off valve for regulating the supply of fluid under pressure through the main valve, and governor mechanism establishing operative connection between the cut-off valve and the valve-bearing shaft.

12. The combination, with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; the rotary main valve operatively connected with the last-mentioned shaft; the valve-casing containing the said valve and provided with a seat for the valve, an exhaust-outlet and a fluid-pressure inlet; ports within the valve, valve-casing and cylinder having such arrangement that fluid under pressure shall be conducted through the valve and valve-casing into opposite ends of the cylinder alternately, and one end of the cylinder shall exhaust while the cylinder's other end is taking fluid under pressure; of a cut-off valve mounted upon the valve-bearing shaft and arranged as required to render it capable of regulating the supply of fluid under pressure through the main valve, and governor mechanism establishing operative connection between the cut-off valve and the valve-bearing shaft, substantially as and for the purpose set forth.

13. The combination, with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; the rotary main valve upon and operatively connected with the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine, of a cut-off valve mounted upon the valve-bearing shaft within the fluid-pressure-receiving chamber of the main valve and arranged and constructed as required to render it capable of regulating the supply of fluid under pressure through the main valve, and governor mechanism establishing operative connection between the cut-off valve and the valve-bearing shaft.

14. The combination with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; the rotary main valve upon and operatively connected with the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine: of a cut-off valve mounted upon the valve-bearing shaft within the fluid-pressure-receiving chamber of the main valve and having the two oppositely-arranged heads 52 and 52, and governor mechanism establishing operative

connection between the cut-off valve and the valve-bearing shaft, substantially as and for the purpose specified.

15. The combination with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; the rotary main valve upon and operatively connected with the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine: of the cut-off valve arranged within the main valve and provided with a sleeve that embraces the valve-bearing shaft; two weights supported from the valve-bearing shaft in such a manner as to render them capable of being moved apart when an abnormally-high speed of the shaft obtains; two arms formed upon opposite sides, respectively, of the sleeve of the cut-off valve and operatively connected with the different aforesaid weights, respectively, and means acting to retain the weights in their normal position, substantially as and for the purpose set forth.

16. The combination with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; the rotary main valve operatively connected with the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine: of a cut-off valve arranged within the main valve and provided with a sleeve that embraces the valve-bearing shaft; two weights supported from the valve-bearing shaft in such a manner as to render them capable of being moved apart when an abnormally-high speed of the shaft obtains; two arms formed upon opposite sides, respectively, of the sleeve of the cut-off valve and operatively connected with the different aforesaid weights, respectively, and means acting to retain the weights in their normal position, substantially as and for the purpose set forth.

17. The combination with the engine's cylinder having two ports communicating with opposite ends, respectively, of the chamber of the cylinder; the piston within the cylinder; the engine-shaft operatively connected with the piston; another shaft; the rotary main valve operatively connected with the last-mentioned shaft, which valve has an exhaust-port and a fluid-pressure-receiving port formed therein, at opposite sides, respectively, of the valve-bearing shaft; means establishing operative connection between the valve-bearing shaft and the engine-shaft, and the valve-casing, for the aforesaid valve, having the following: a seat, internally of the casing, for the valve; an exhaust-outlet in open relation with the valve's exhaust-port; a fluid-pressure inlet in open relation with the valve's fluid-pressure-receiving port, and two ports connected with the different cylinder-ports, respectively, and arranged as required to simultaneously communicate with the different valve-ports, respectively, during the operation of the engine: of the cut-off valve *t* having the sleeve 50 and the two arms 55 and 55; the disk *r* having the radially-arranged slideways 60 and 60; the weights *w* and *w;* the links *u* and *u*, and the springs *s* and *s*, all arranged and operating substantially as shown, for the purpose specified.

Signed by me at Cleveland, Ohio, this 4th day of November, 1899.

JOHN H. MOORE.

Witnesses:
C. H. DORER,
A. H. PARRATT.