(No Model.) 2 Sheets—Sheet 1.

J. DOW.

DUPLEX CRANK PISTON ENGINE.

No. 308,598. Patented Dec. 2, 1884.

Fig. 2.

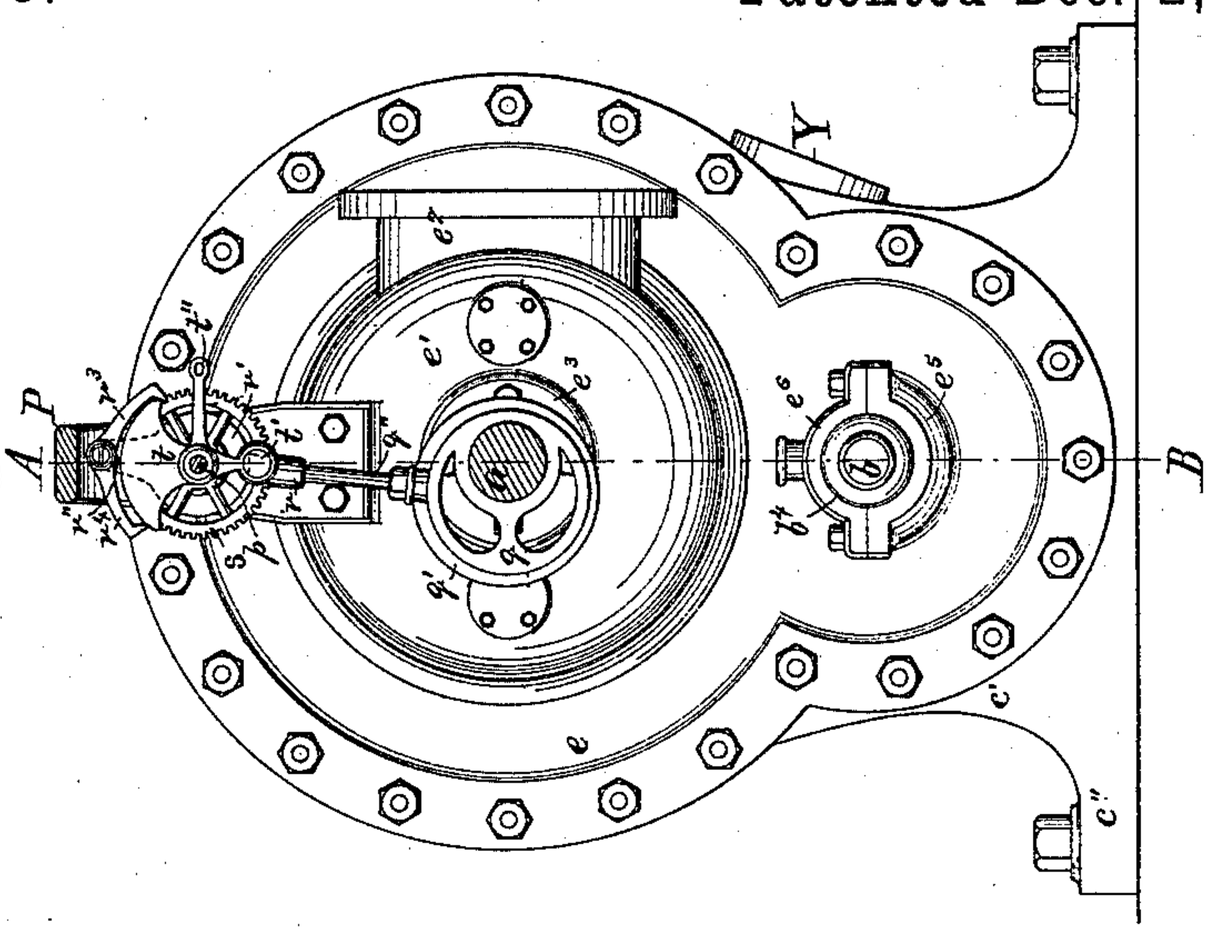
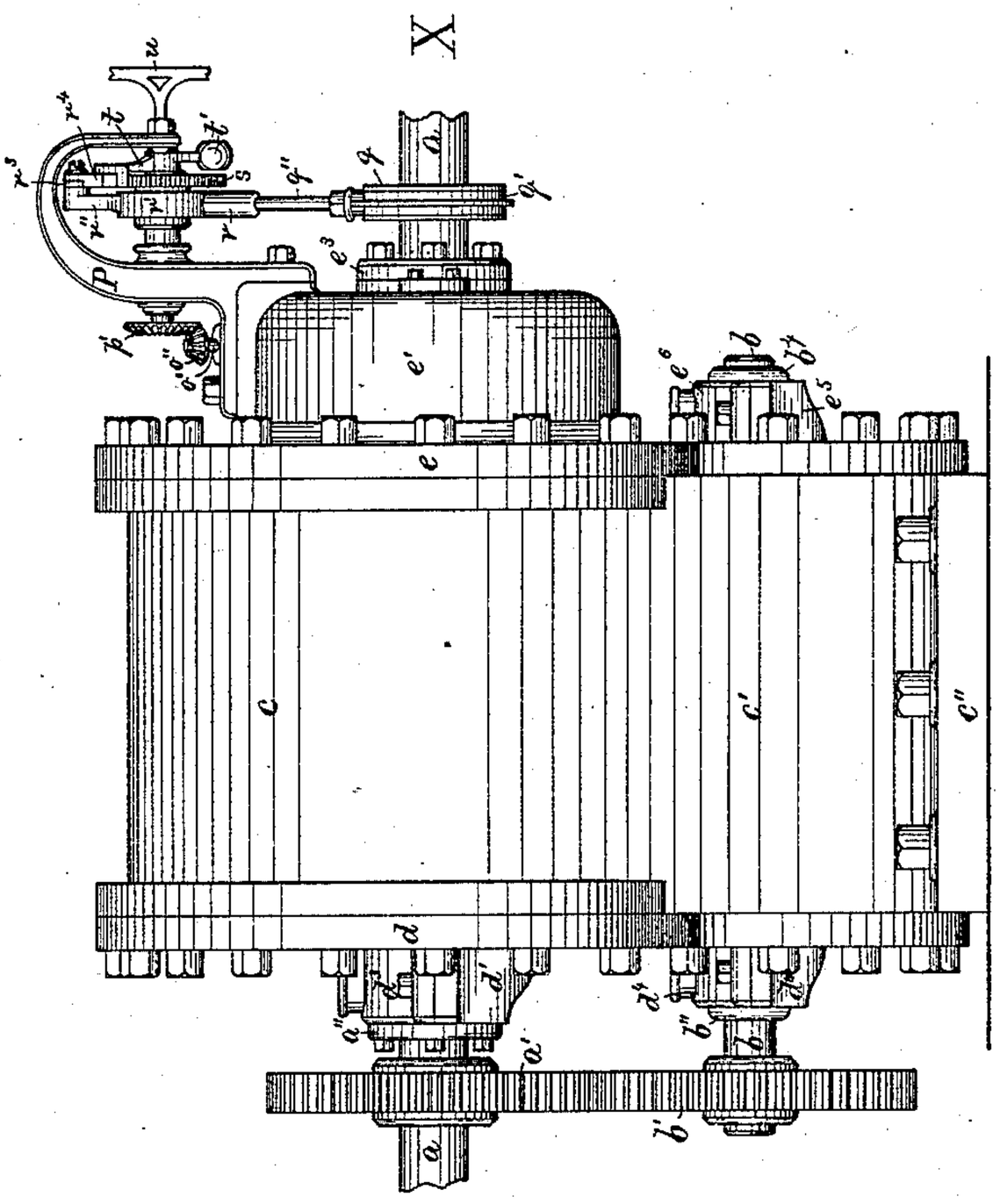


Fig. 1.



Witnesses

Henry Chadbourn.

John H. Foster.

Inventor

Josiah Dow.

by Albert Andrew

his atty.

(No Model.) 2 Sheets—Sheet 2.

J. DOW.

DUPLEX CRANK PISTON ENGINE.

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Fig. 4.

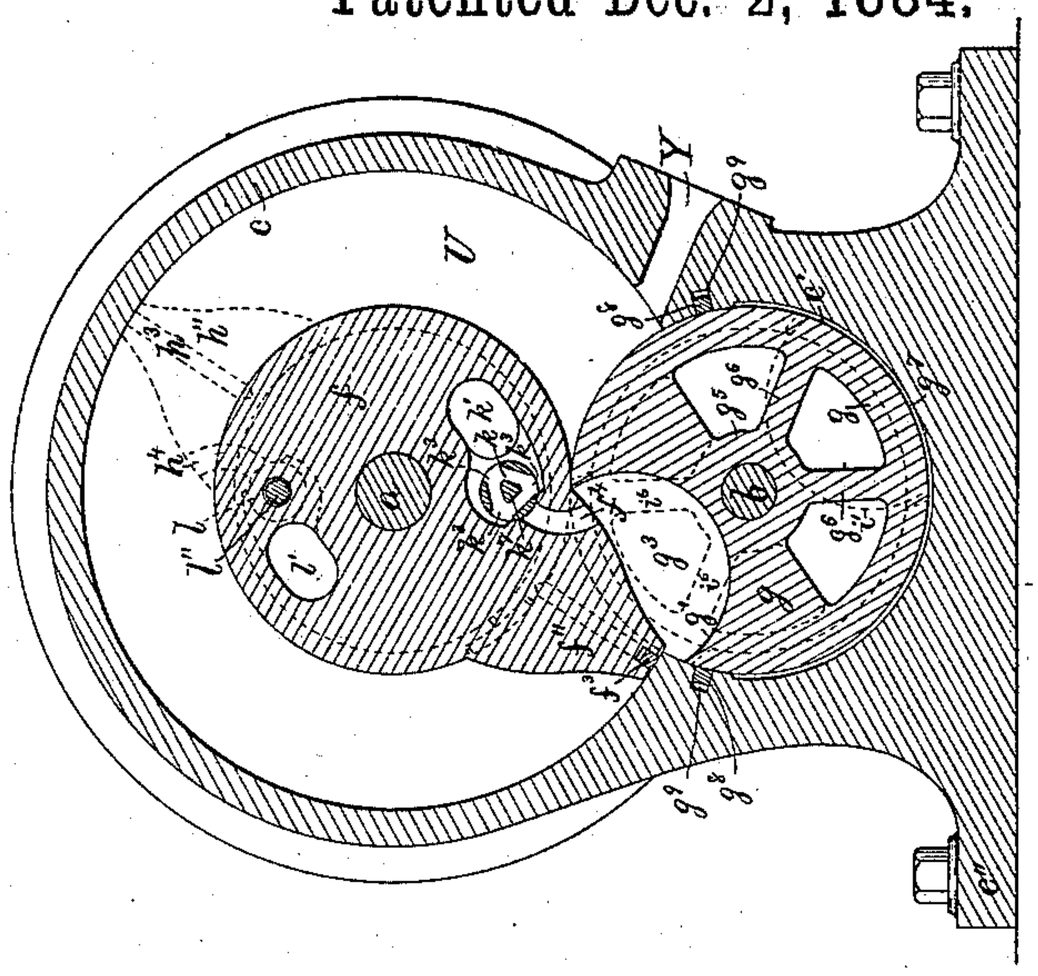


Fig. 5.

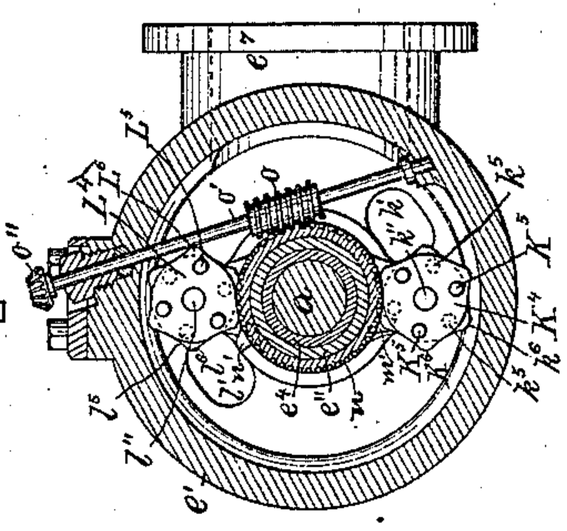


Fig. 3.

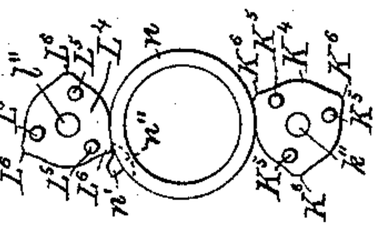


Fig. 8.

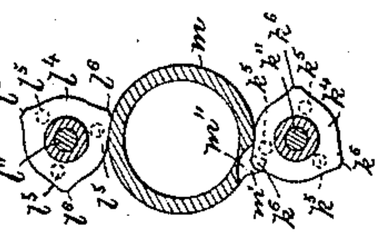


Fig. 1.

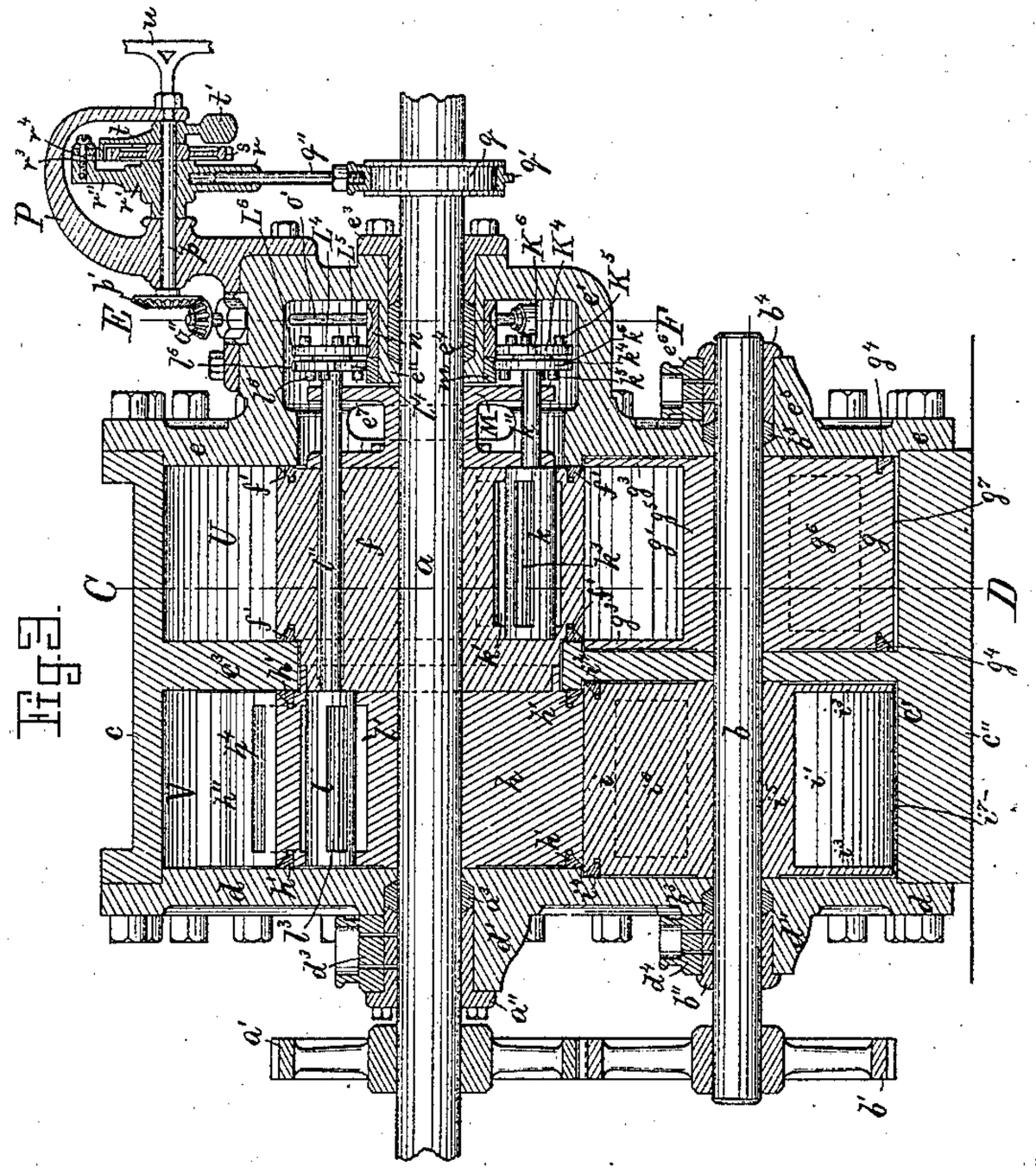


Fig. 6.

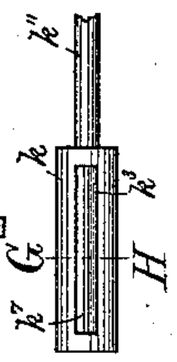
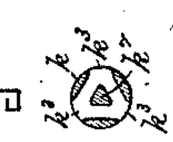


Fig. 7.



Witnesses

Henry Chadbourn.

John H. Foster.

Inventor

Josiah Dow.

by Alban Gudrén

his atty.

UNITED STATES PATENT OFFICE.

JOSIAH DOW, OF LOWELL, MASSACHUSETTS.

DUPLEX-CRANK-PISTON ENGINE.

SPECIFICATION forming part of Letters Patent No. 308,598, dated December 2, 1884.

Application filed March 10, 1884. (No model.)

To all whom it may concern:

Be it known that I, JOSIAH DOW, a citizen of the United States, residing at Lowell, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Duplex-Crank-Piston Engines; and I do hereby declare that the same are fully described in the following specification and illustrated in the accompanying drawings.

This invention relates to improvements in duplex-crank-piston steam-engines; and it is carried out as follows, reference being had to the accompanying drawings, in which—

Figure 1 represents a side elevation of the improved engine. Fig. 2 represents an end view, seen from *x* in Fig. 1. Fig. 3 represents a central longitudinal section on the line A B, shown in Fig. 2. Fig. 4 represents a cross-section on the line C D, shown in Fig. 3. Fig. 5 represents a cross-section on the line E F, shown in Fig. 3. Fig. 6 represents a side elevation of one of the intermittently-rotary valves for admitting steam to the cylinders. Fig. 7 is a section of the same on line G H in Fig. 6. Fig. 8 represents a detail view of the valve-opening mechanism, and Fig. 9 represents a similar detail view of the valve-closing mechanism.

Similar letters refer to similar parts wherever they occur on the different parts of the drawings.

In the drawings, *a* is the piston-shaft, to which the duplex-crank pistons are secured. Said shaft is located in suitable bearings in the ends of the shell or cylinder, hereinafter to be described, and has attached to it a spur-gear, *a'*, that gears into a gear, *b'*, of equal diameter and of equal number of teeth, the latter being secured to the shaft *b*, to which the rotary abutments are secured.

c is the shell or steam-cylinder cast in one piece with the abutment-chamber *c'* and base *c''*, as shown, and c^3 is a division-wall cast in one piece with cylinders *c c'*. Said wall c^3 is arranged midway between the ends of shell *c c'*, and by its use the said shell is divided in two equal compartments, U and V, as shown in Fig. 3, each of such compartments containing a rotary piston and corresponding abutment-cylinder.

d represents the head, secured by means of screw-bolts or equivalent or well-known devices to the left-hand end of shell *c c'*, as shown in Fig. 3; and it has perforations through which the respective shafts *a* and *b* project outside of said head.

In one piece with head *d*, I prefer to cast the outwardly-projecting brackets *d'* and *d''*, the former serving as a support for the stuffing sleeve or bearing *a''* on shaft *a*, such bearing having a cap, d^3, or equivalent device for holding sleeve *a''* in place. The sleeve *a''* may be made in two semicircular parts or in one single piece, as may be desired.

a^3 is a packing surrounding the shaft *a* at the inner end of bearing or stuffing box *a''*, in the usual manner, to effect a steam-tight joint between the shaft *a* and its head *d*, as shown in Fig. 3. In a similar manner the bracket *d''* supports the bearing *b''* for the shaft *b*, and is provided with cup d^4 and stuffing b^3, for the same purpose, as above described.

To the opposite end of shell *c c'* is secured the head *e*, in one piece with which is cast or otherwise secured the outwardly-projecting valve-chamber *e'*, having a central bearing-sleeve, *e''*, provided with stuffing-box e^3 and stuffing e^4 for the piston-shaft *a*, as shown in Fig. 3. In its lower end the head *e* has an outwardly-projecting bracket, e^5, supporting the bearing b^4 and its cap e^6 for the abutment-shaft *b*, in the same manner as the corresponding bearing in head *d*, heretofore described.

b^5 is the stuffing for shaft *b* in the head *e*, as usual.

On the shaft *a*, within the compartment U, is secured the rotary cylinder *f*, provided with annular tapering grooves at the junction of its ends and curved surface, which grooves contain the tapering packing-rings *f' f'*, made of metal or other suitable material, for the purpose of effecting a steam-tight connection between said cylinder and the ends of its compartment U, in which it rotates. In one piece with said cylinder *f* is cast the radially-projecting piston *f''*, made tapering from its base outward, to insure proper strength, and made to fit closely against the sides and curved portion of compartment U, and provided at such place with a packing, f^3, made of metal or suitable material, resting in a corresponding groove in the sides and outer end of said piston, as shown, so as to effect a steam-tight

joint between it and the interior of compartment U.

To the shaft *b*, directly below the cylinder *f*, is secured the abutment-cylinder *g*, which is of exactly the same diameter as the cylinder *f*, and said cylinders are held in contact with each other, so as to allow the one to roll on the other with equal surface velocity, and at the same time preventing the steam from escaping between them. Directly opposite the piston *f''* is made on the abutment-cylinder *g* a curved cut-away portion, *g'*, to permit the piston *f''* to pass by the cylinder *g* as they rotate together in opposite directions. The curvature of the cut-away portion *g'* is such as to keep the piston *f''* in immediate contact with it, so as to prevent escape of steam during such passage of the said piston.

The cylinder *g* is provided with webs g^3 g^3 on the ends of the cut-away portion *g'*, between which webs the piston *f''* enters during its passage into said space *g'*, to still further prevent the escape of steam at this point.

At the junction of the ends and curved part of abutment-cylinder *g*, I make tapering grooves, into which are fitted the tapering packings g^4 g^4, made of metal or suitable materials, to effect a tight connection between said cylinder and the interior of the chamber in which it revolves.

I prefer to make the abutment-cylinder *g* skeleton fashion—that is, with a central hub, g^5, secured to shaft *b* and radial arms g^6, as shown—so as to make it as light as possible.

g^7 is a semicircular (more or less) space between the exterior of abutment-cylinder *g* and interior of abutment-chamber *c'*, adapted to receive steam, and thus to equalize the pressure in compartment U, and causing the cylinders *f g* to be held in close contact against each other during their rotation, and also to aid in lubricating the said abutment-cylinder in its motion.

g^8 g^8 are packing-rods of metal or other material located in corresponding grooves, g^9 g^9, in the upper sides of abutment-chamber, as shown in Fig. 4, such grooves being made deep enough to contain springs, if desired, to hold said packings against the abutment-cylinder to effect a close joint at such place.

Behind the cylinder *f* is secured to the shaft *a* the secondary cylinder *h* constructed in the same manner as cylinder *f*, and secured to it in a suitable manner. The cylinder *h* is located in compartment V, and is provided with tapering packing-rings *h' h'*, projecting piston *h''*, having packing h^3 like the corresponding parts on cylinder *f*, with this difference, that the piston *f''* is located in a diametrically-opposite direction to the piston *h''*, as shown in the drawings, to effect a perfect balance of said cylinders.

Below the cylinder *h*, in the corresponding abutment-chamber, is located on the shaft *b* the abutment-cylinder *i*, of equal diameter with said cylinder *h*, and provided with curved cut-away portion *i'*, webs i^3 i^3, tapering packings i^4 i^4, central hub, i^5, radial arms i^6, semicircular space i^7, packings and grooves in a similar and corresponding manner to those on abutment-cylinder *g*, with this difference, that the cut-away portion *i'* is located in a diametrically-opposite direction to the cut-away portion *g'* on cylinder *g*, to effect a perfect balance of said abutment-cylinders.

e^7 is the steam-inlet to the valve-chamber *e'*, as shown in Fig. 3, from which the steam is conducted back of the respective pistons *f''* *h''*, as follows:

Through the cylinder *f* is made two longitudinal conduits, *k'* and *l'*, the former leading to the cylindrical valve *k* in cylinder *f*, and the latter leading to the corresponding cylindrical valve, *l*, in cylinder *h*.

k'' and *l''* are the valve-stems, respectively, for the valves *k* and *l*, as shown in Figs. 3 and 4.

M is a flanged collar or bearing-piece secured to the outer end of cylinder *f*, and adapted to serve as a bearing for the outer ends of valve-stems *k'' l''*, as shown in Fig. 3.

f^4 and h^4 are steam-channels in the respective cylinders *f* and *h*, leading from the respective valves *k* and *l* directly behind the respective pistons *f'' h''*, as shown in Fig. 4, by means of which the steam-pressure is conducted back of the pistons *f'' h''* in the respective compartments U and V.

The cylindrical steam-valve *k* has three communicating side openings, (more or less,) k^3 k^3 k^3, with preferably a central core, k^7, for strengthening it, as shown in Figs. 6 and 7, and the valve-stem *k''* has attached to its outer end a cam-disk, k^4, which I term the "steam-supply or valve-opening cam," and said cam is provided with three side projections, k^5 k^5 k^5, one of which is actuated by the projection *m'* on the stationary ring *m*, that is secured to the exterior of the valve-chamber-bearing sleeve *e''*, as shown in Figs. 5 and 8, for each time that the cylinder *f* completes its revolution, and thus causes the valve *k* to be turned one-sixth of a revolution around its axis to admit steam through channel f^4. The cam-disk k^4 is also provided with three radial projections, k^6 k^6 k^6, and concavo-convex curves connecting said projections, as shown in Figs. 5 and 8, adapted to lie in contact with the ring *m*, and to retain the valve *k* in an open position, in connection with corresponding opening-curves on closing cam-disk, until acted on by a corresponding cut-off mechanism.

To permit the projections k^6 to pass by the circular ring *m* at the time its projection *m'* acts on either of the side projections, k^5, I make a depression, *m''*, on the ring *m* in close proximity to the ring projection *m'*, as shown in Fig. 8.

The steam cut-off or valve-closing mechanism is carried out as follows:

On the valve-stem *k''*, outside of the cam-disk k^4, is secured a similar cam-disk, K^4, which I term the "cut-off cam," and said cam is provided with three side projections, K^5 K^5

K^5, and three radial projections, K^6 K^6 K^6, and intermediate concavo-convex surfaces precisely like those described on disk k^4, and adapted to engage with the projection n' on the movable ring n, that is loosely supported and made to turn around the bearing-sleeve e'', as shown in Figs. 3 and 9.

n'' is a depression on the outside of ring n, in close proximity to its projection n', for the same-purpose as described relative to projection m' on ring m—that is, to permit the radial projections K^6 to pass by ring n while the valve is in the act of being turned. The ring n is toothed on its outer surface, and into it is geared the worm o, secured to worm-shaft o', located in suitable bearings in valve-chamber e', as shown in Figs. 3 and 5.

To the outer end of worm-shaft o' is secured the small bevel-pinion o'', that gears into the bevel gear p', secured to shaft p, located in bearings in the bracket P, secured to valve-chamber e', as shown in Figs. 1, 2, and 3.

The shaft p is rotated more or less in either direction to cut off the steam at any desired part of the stroke, or to maintain any desired and uniform speed of the engine, by the following mechanism:

To the main shaft a is keyed the eccentric-block q, surrounded by the loose ring q', having an upwardly-projecting rod, q'', attached to it, the upper end of which plays loosely in the sleeve r, forming a part of the hub r', loosely supported on shaft p, as shown in Fig. 3.

To the hub r' is made an upward extension, r'', having hinged to it loosely the two pawls r^3 and r^4, as shown in Figs. 2 and 3.

Directly below pawls r^3 and r^4 is secured on shaft p the spur or pawl gear s.

To the shaft p is hinged loosely the shield-plate t, that overlaps the upper portion of gear s, and may be swung on the said shaft p to the right or left by its connection to any ordinary governor, so as to permit one of the pawls r^3 or r^4 only to engage at one time into the teeth of gear s, as shown in Fig. 2.

t' is a downwardly-projecting balance-weight cast onto the lower side of the hub on shield-plate t, as shown in Figs. 1, 2, and 3, such balance-weight being arranged for the purpose of balancing or steadying the plate or shield t in its rocking motion on shaft p.

t'' is a short lever attached or made in one piece with shield t or its hub or balance-weight t', which is to be connected in any suitable manner to a governor or regulator of any desirable construction, such governor being, however, not shown in the drawings. This speed-regulating mechanism acts as follows: By the eccentric q q', rod q'', and sleeve r the pawls r^3 r^4 are oscillated on top of gear s continually, the shield t being, however, during this motion of pawls r^3 r^4 so worked and held in position by its connection to the governor-lever u that only one pawl at the time, or neither of them, acts on the gear s, the other one, or both, sliding loosely on top of shield t, as shown in Fig. 2, so as to cause the gear s to turn in one direction, according to whether the governor and engine runs above or below its normal speed. As the gear s is turned it imparts motion to the loose ring n by the connecting mechanism, as described, and said ring is thereby automatically turned around the bearing-sleeve e'' to cause its projection n' to act on the cut-off cam K^4, and its side projections, K^5, to turn the cylindrical valve k one-sixth of a revolution, so as to cut off the supply of steam to piston f'' at any desired position of its stroke or revolution, as may be desired. In a similar manner to the valve k, the valve l has attached to its valve-stem l'', on the outer end thereof, the steam-supply cam-disk l^4, having side projections, l^5, and radial projections l^6, as shown in Figs. 3 and 8.

To the valve-stem l'' is also secured the corresponding cut-off cam, L^4, provided with side projections, L^5, and radial projections L^6, as shown in said Figs. 3 and 9. The valve l has, like the valve k, three communicating side openings, l^3 l^3 l^3, to permit the steam to pass from conduit l' through the valve l and conduit or channel h^4 into the compartment V, back of the piston h''. The valve l has, like the valve k, a central core to strengthen it.

The valves k and l are made to rotate intermittently in one and the same direction by the opening and closing mechanism, as above described.

Y is the exhaust-opening leading from compartments U and V. Such exhaust may be common to both of said compartments, or it may be divided in two exits—one for each compartment—if so desired.

The operation of this my improved engine is as follows: Steam, being admitted through steam inlet e^7 into valve-chamber e', passes through steam-conduits k' and l' to valves k and l, and out through openings f^4 h^4 into the respective compartments U and V and back of pistons f'' h''. Fig. 4 shows the position of piston f'' and its corresponding abutment-cylinder, g, at the time of admitting steam through opening f^4. The piston h'' is then diametrically opposite, and may be pressed onward by live or expanded steam, as may be desired. The steam in advance of the respective pistons f'' h'' is free to pass out through exhaust-opening Y. During the rotation of pistons f'' h'' and their respective abutment-cylinders g i the valves k and l are intermittently rotated in a constant direction by the opening and closing rings m and n, their respective projections m' and n', and the opening and closing cam-disks on the valve-stems, as hereinabove set forth and described, the whole of the mechanism being balanced properly, so that the engine may be run at a very quick speed without causing any noise or pounding and with a minimum of frictional resistance. The driving-shaft a may be supported outside of the shell or case c c' in suitable bearings or pillow-blocks, and be provided with a suit-

able fly or balance wheel in the usual manner, such devices being, however, not shown in the drawings.

Having thus fully described the nature, construction, and operation of my invention, I wish to secure by Letters Patent and claim—

1. In a steam-engine, the shell *c c'*, heads *d e*, the shafts *a b*, equally geared together, in combination with diametrically-opposed cylinders and pistons *f f'' h h''*, and their respective diametrically-opposed abutments *g i*, the steam-chest *e'* at the outer end of head *e*, into which the steam is admitted through the steam-supply pipe situated upon and through the said steam-chest *e'*, as described.

2. In a steam-engine, the rotary cylinder *f* and its piston *f''*, combined with abutment-cylinder *g*, of equal diameter with cylinder *f*, the cut-away portion *g'*, to permit passage of piston *f''*, and curved steam-space g^7 on the interior of abutment-chamber, into which the steam passes from the main cylinder for the purpose of pressing the abutment-cylinder *g* against and securing perfect contact with the rotary cylinder *f*, as described.

3. In a steam-engine, the rotary cylinder *f* and its piston *f''*, in combination with an abutment-cylinder of equal diameter, made skeleton fashion, with hub g^5, arms g^6, side webs, g^3 g^3, and having cut-away portion *g'*, substantially as described.

4. In a steam-engine, a rotary cylinder having arranged within it a cylindrical valve, *k*, with side openings, k^3 k^3 k^3, adapted to rotate in a continuous intermittent direction around its axis, to deliver and cut off the supply of steam, as set forth.

5. In a steam-engine, the rotary cylinder *f*, having arranged within it the cylindrical valve *k*, in combination with valve-opening cam k^4, secured to valve-stem *k''*, and provided with side projections, k^5, and radial projections k^6, to operate with stationary ring *m*, its projection *m'*, and recess *m''*, for the purpose of automatically opening the said valve *k*, as set forth.

6. In a steam-engine, the rotary cylinder *f*, having arranged within it the cylindrical valve *k*, upon the stem *k''* of which is arranged the steam-cut-off cam-disk K^4, having side projections, K^5, and radial projections K^6, in combination with the adjustable ring *n*, its projection *n'*, and recess *n''*, for the purpose of automatically closing said valve *k*, as set forth and described.

7. In a steam-engine, the steam-cut-off mechanism, as described, consisting of eccentrics *q*, its ring *q'*, and rod *q''*, rocking piece *r' r''*, with its sleeve *r*, the hinged pawls r^3 r^4, shield-plate *t*, connected to the governor, and provided with a counter-balance, *t'*, the gear *s*, secured to shaft *p*, the bearing-bracket P, and intermediate connecting mechanism, substantially as described, from shaft *p* to the loose ring *n*, as and for the purpose set forth.

8. In a steam-engine, the rotary cylinder *f*, having a steam passage or passages, *k'*, located between the axis and outer periphery of said cylinder and communicating with the steam-passage f^4, located behind the piston *f''*, as set forth and described.

9. In a steam-engine, the movable ring or collar *n*, geared to the worm-shaft *o'*, for the purpose of adjusting the point of cut-off by the action of the governor, as set forth and described.

In testimony whereof I have affixed my signature in presence of two witnesses.

JOSIAH DOW.

Witnesses:

ALBAN ANDRÉN,

HENRY CHADBOURN.