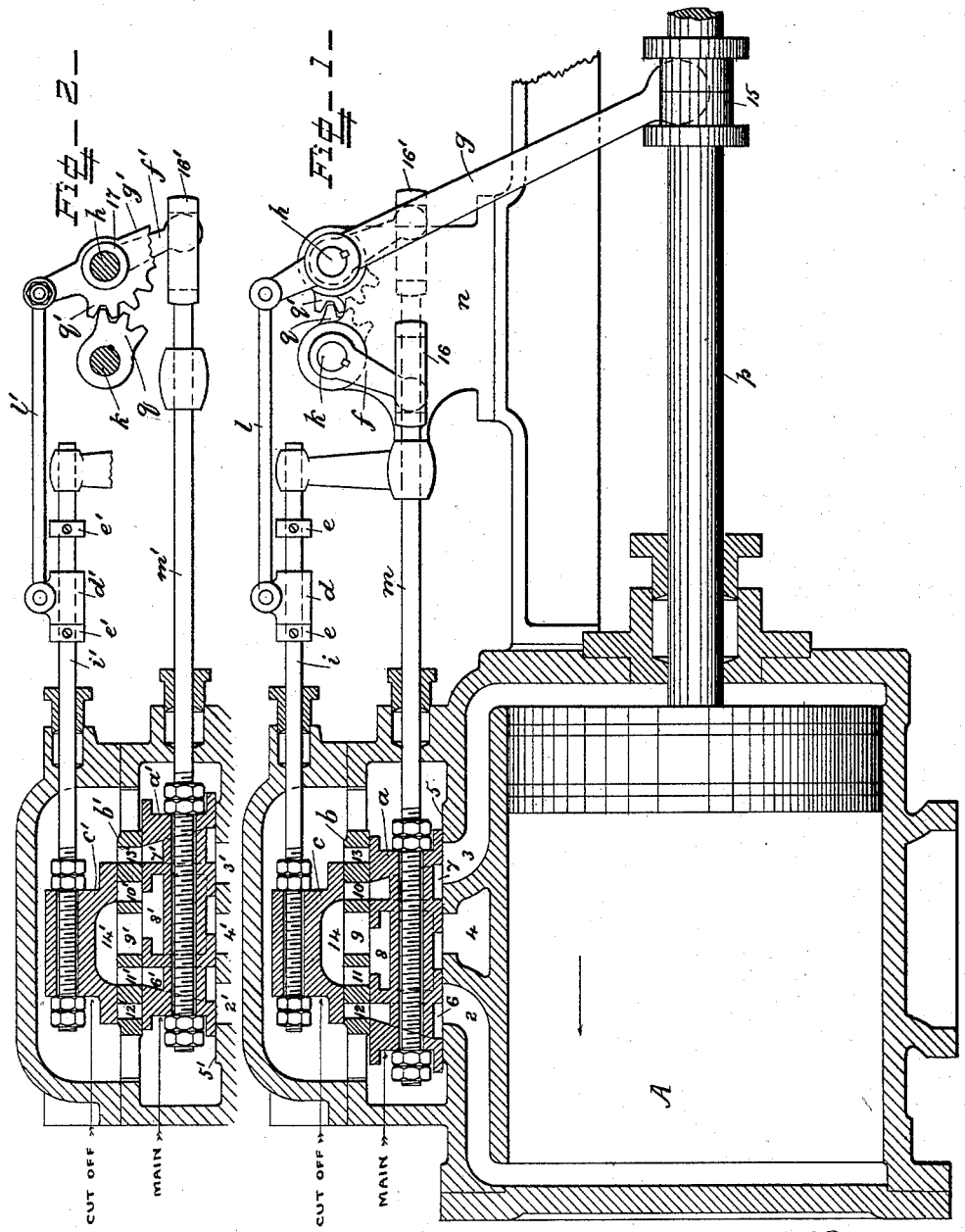
(No Model.) 4 Sheets—Sheet 1.

E. BARNES.

DUPLEX PUMPING ENGINE.

No. 456,753. Patented July 28, 1891.



WITNESSES

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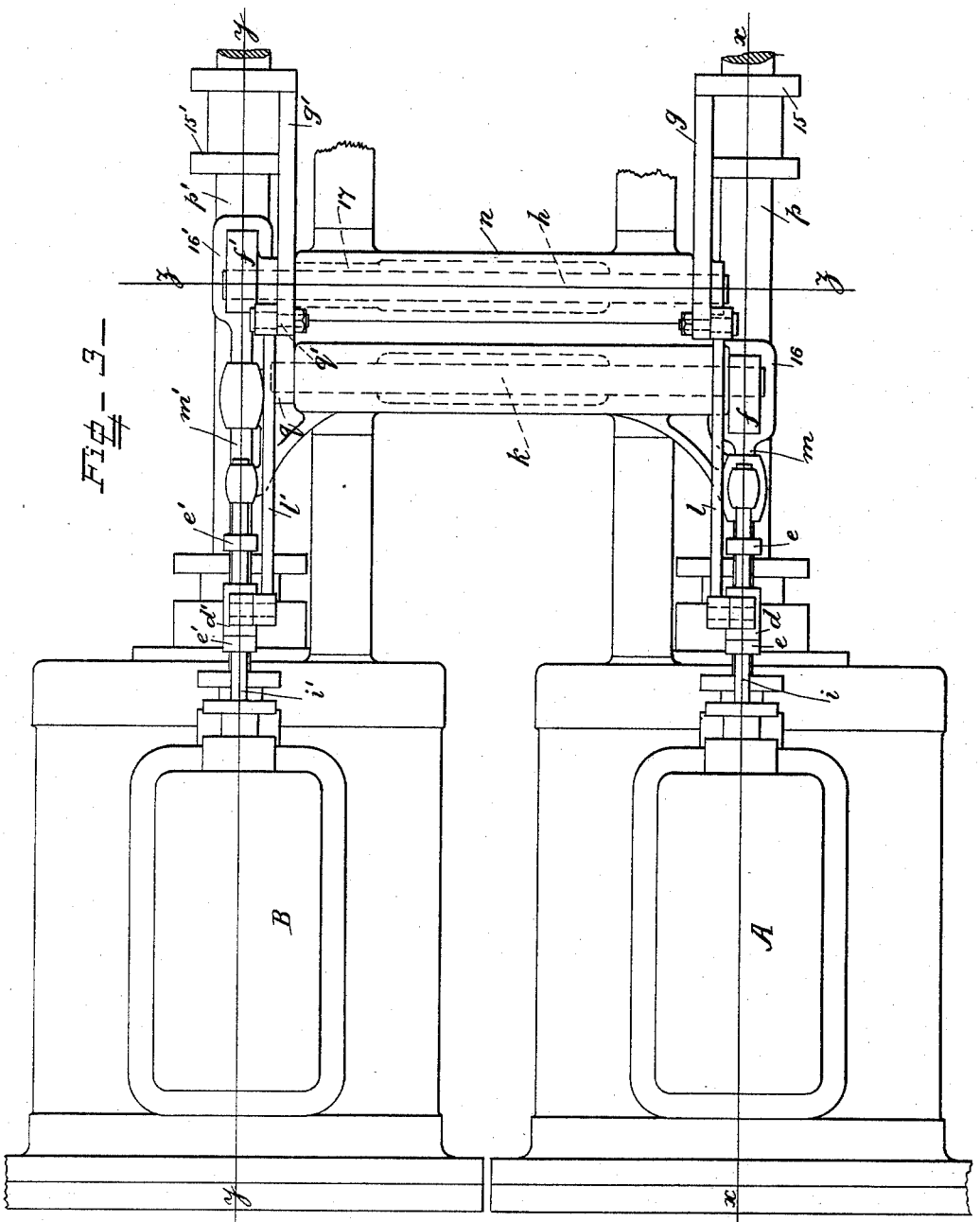
Fig. 3.



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DUPLEX PUMPING ENGINE.

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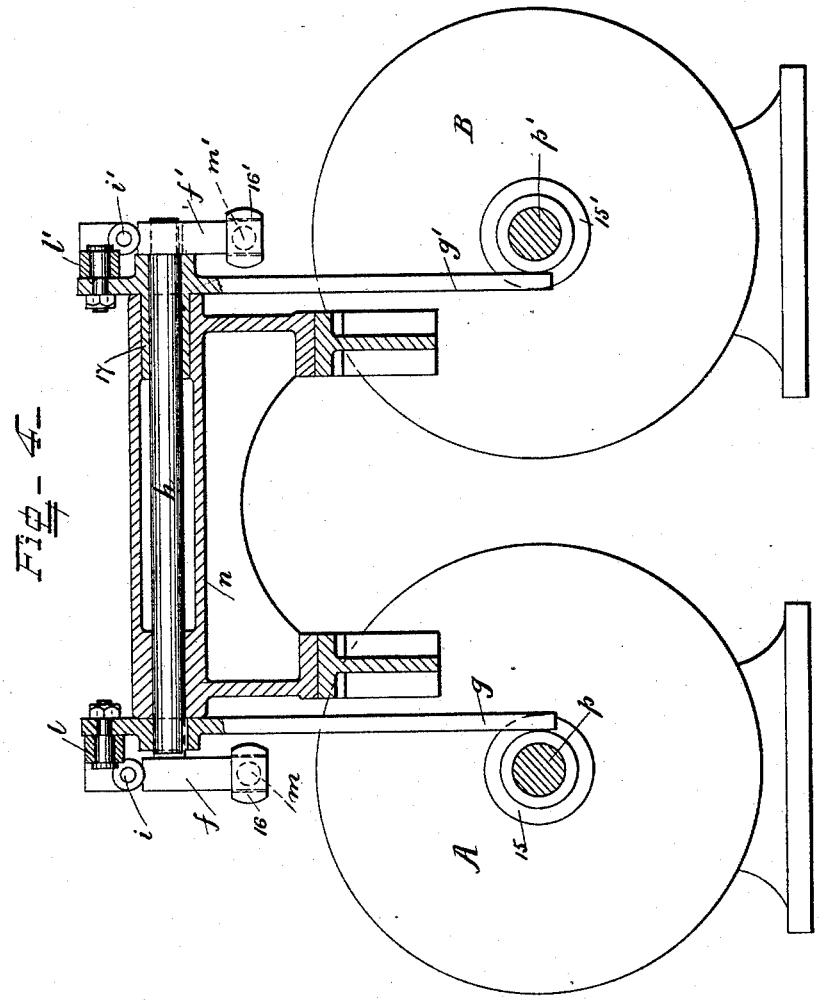

Fig. 4.

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DUPLEX PUMPING ENGINE.

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Fig. 5.

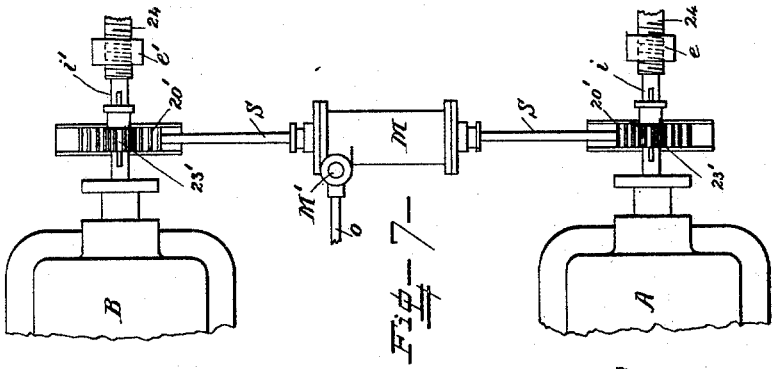

Fig. 7.

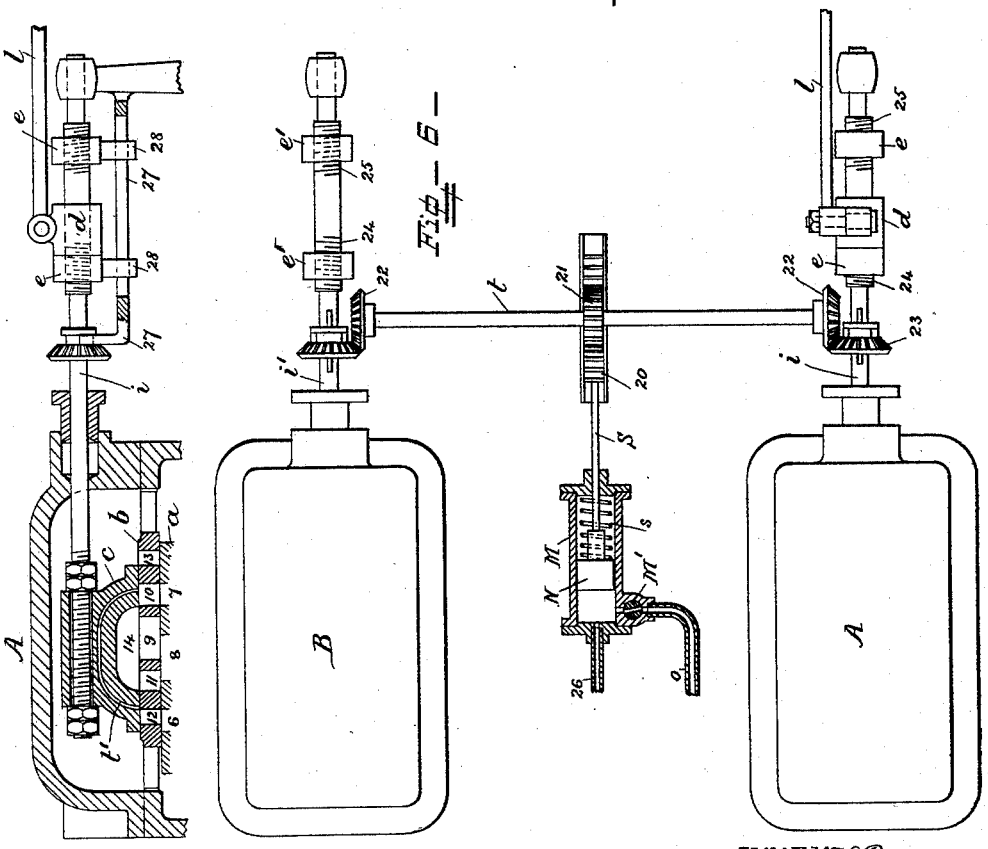

Fig. 6.

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UNITED STATES PATENT OFFICE.

EDWARD BARNES, OF HANDSWORTH, ENGLAND, ASSIGNOR OF ONE-HALF TO HERBERT W. T. JENNER, OF WASHINGTON, DISTRICT OF COLUMBIA.

DUPLEX PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 456,753, dated July 28, 1891.

Application filed November 28, 1890. Serial No. 372,869. (No model.) Patented in England June 5, 1889, No. 9,349.

To all whom it may concern:

Be it known that I, EDWARD BARNES, a citizen of Great Britain, residing at Handsworth, in the county of Stafford, England, have invented certain new and useful Improvements in Duplex Pumping-Engines, (for which I have obtained a patent in England, No. 9,349, dated June 5, 1889;) 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 appertains to make and use the same.

This invention relates to duplex pumping-engines; and it consists in the novel construction and combination of the parts hereinafter fully described and claimed.

In the drawings, Figure 1 is a longitudinal section through the cylinder and valves of the first engine, taken on the line x x in Fig. 3; and Fig. 2 is a corresponding section through the valves of the second engine, taken on the line y y in Fig. 3. Fig. 3 is a plan view from above of the two engines. Fig. 4 is a cross-section through the two engines, taken on the line z z in Fig. 3. Fig. 5 is a side view, and Fig. 6 is a plan view, partly in section, showing the devices for automatically adjusting the cut off. Fig. 7 is also a plan view showing a modification of the automatic devices for adjusting the cut off.

The cylinder of the first engine A is provided with the steam-ports 2 and 3 and the exhaust-port 4, and the cylinder of the second engine B is provided with similar steam-ports 2′ and 3′ and the exhaust-port 4′. Both engines are provided with steam-chests, pistons, piston-rods p and p', stuffing-boxes, and other essential parts, all of which may be of any approved form and construction.

The corresponding parts of the two engines are indicated by the same reference-characters, the parts of the engine A being marked a b c, &c., and the similar parts of the engine B being marked a' b' c', &c.

The first engine A is provided with two sliding valves a and c and a stationary valve-plate b for regulating the inlet and exhaust of the steam between the steam-chest and the cylinder. The lower valves, according to the present invention, are preferably made the main valves of both engines, and the cut-off is effected by the upper valves; but one of lower valves may be made the cut-off valve and one of the upper valves the main valve, if desired, as more fully set forth in a separate application filed of even date herewith, Serial No. 372,870. The valve a is preferably flat and slides between the face 5 and the plate b, and the valve c slides upon the other side of the said plate b. The valves a and c may be cylindrical valves or balanced valves of other approved form, if desired. The lower valve a is provided with the steam-ports 6 and 7 and the central exhaust-port 8. The valve-plate b is provided with a central exhaust-port 9, the intermediate exhaust-ports 10 and 11, and the steam-ports 12 and 13. The upper valve c is provided with an exhaust-cavity 14. The central exhaust-port 9 of the valve-plate b is always open, and the valve c is proportioned so that it will close one of the steam-ports 12 or 13 and the opposite exhaust-port 10 or 11 alternately, according to the direction of its motion. The steam-ports of the valve a are wider at the bottom, next to the face 5, than at the top, next to the valve-plate b, and the said ports 6 and 7 are constantly in communication with the respective ports 2 and 3 of the cylinder. The exhaust-port 8 of the main valve is wider at the top than at the bottom and is always in communication with the ports 4 and 9 and the cavity 14. The cut-off valve c is provided with the valve-rod i, and the main valve a is worked by the valve-rod m. The valve-plate b is supported in the valve-chest intermediate between the valves a and c. A block d slides upon the rod i between the collars e and is connected to the short arm of the lever g by the rod l. The collars e are adjustable upon the rod and may be slid upon it by hand and secured to it by set-screws, or the said collars may be adjusted automatically, as will be more fully described hereinafter. The long arm of the lever g is actuated from the engine piston-rod by any suitable means—as, for instance, by the flanged thimble 15, which engages with the lower end of the said lever. The valve-rod m is provided with a slotted head 16 and is operated by the arm f.

The engine B is provided in a similar manner with ports and valves as above described

with reference to the engine A. The proportions, however, of the steam-ports 6 and 7 and the exhaust-ports 8 and 9 may be varied, and it is not essential for the valves and valve-plates to be exact duplicates in the two engines. The widths of the ports and bridges may be made different and the lengths of travel of the valves may be different, as, although it is necessary that certain of the valves be moved simultaneously, as hereinafter more fully described, such movements need not necessarily be synchronous.

A bracket *n* is secured between the two engines, and *h* is an oscillatory shaft journaled in the said bracket. The lever *f'* of the engine B is secured to one end of the shaft *h* and the lever *g* of the engine A is secured to the opposite end of the shaft *h*. A second oscillatory shaft *k* is journaled in the bracket *n* parallel to the shaft *h*. The lever *f* of the engine A is secured to one end of the shaft *k*, and a toothed segment *q* is secured upon the opposite end of the shaft *k*. The lever *g'* is provided with a sleeve 17, which is journaled in the bracket *n* and upon the shaft *h*, and *q'* is a toothed segment projecting from the lever *g'* and gearing into the said toothed segment *q*, secured on the shaft *k*.

The action of the mechanism is as follows: When the parts are in the positions shown in Figs. 1, 2, and 3, the pistons of both the engines A and B are at the ends of their outstroke. The steam and exhaust ports of the engine A are closed, as shown in Fig. 1, and the steam-ports 13' 7' 3' and exhaust ports and passages 4' 8' 9' 14' 11' 6' 2' of the engine B, are fully open. The piston of the engine B thus having steam admitted to its front side and being exhausted on its rear side, will make an instroke toward the cylinder-cover. The piston-rod *p'* turns the lever *g'*, and the block *d'*, which is connected to the lever *g'* by the rod *l'*, strikes against the front collar *e'* and moves the valve-spindle *i'*, thereby causing the valve *c'* to close first the steam-port 13' and then the exhaust-port 11' of the valve-plate *b'*. This motion of the lever *g'* also turns the shaft *k* by means of the intergearing toothed segments *q'* and *q*. The lever *f*, secured on shaft *k*, moves forward the valve-rod *m* and the main valve *a* of the engine A, and the main valve *a* is thereby placed in the same relative position with regard to the cylinder, valve-plate, and cut-off valve as the valve *a'* is when in the position shown in Fig. 2. The steam-ports 13 7 3 of the engine A thus being open, and the exhaust ports and passages 4 8 9 14 11 6 2 also being open, the piston of the engine A makes an instroke toward the cover and in the direction of the arrow. The piston-rod *p* turns the lever *g*, and the block *d*, which is connected to the lever *g* by the rod *l*, strikes against the front collar *e* and moves the valve-rod *i*, thereby causing the cut-off valve *c* to close first the steam-port 13 and then the exhaust-port 11 of the valve-plate *b*. This motion of the lever *g* also turns the shaft *h*, and the lever *f'*, secured to the other end of the shaft *h*, pushes back the valve-rod *m'*, thereby moving the main valve *a'* of the engine B to the opposite end of its travel. The valves *a'* and *c'* of the engine B thus being placed in the conversely-opposite positions from those in which they are shown in Fig. 2, the piston of the engine B makes an outstroke, closes its own cut-off valve *c'*, as before described, but in the opposite direction, and at the same time opens the main valve *a* of the engine A, also as before described, but in the opposite direction. The piston of the engine A then makes an outstroke and moves its own cut-off valve *c* and the main valve *a'* of the engine B to their original positions, as represented in Figs. 1 and 2, thus completing the cycle. By moving the collars *e e'* longitudinally upon the rods *i i'* the cut off of the steam may be made to take place earlier or later, as desired, and the engine may be arranged to use the steam in the most economical manner possible and be adapted to work against various heads of water or air. This movement of the collars also affords a means for adjusting the amount of compression, as the closure of the exhaust from one end of the cylinder follows close upon the cut off of the steam to the other end of the cylinder. The closure of both the steam and exhaust ports may thus be arranged to take place at that part of the stroke of the engine found most suitable to the conditions under which the engine has to work.

The position of the collars *e e'* may be adjusted automatically, as shown in Figs. 5, 6, and 7.

M is a cylinder provided with an adjustable outlet-valve M' and an outlet-pipe *o*.

N is a piston sliding in the cylinder M and normally pressed toward one end of it by the spring *s*. The piston-rod S is secured to a toothed rack 20, which gears into the toothed pinion 21, secured upon the cross-shaft *t*. Beveled toothed wheels 22 are secured upon the ends of the shaft *t* and gear into the beveled toothed wheels 23, splined on the valve-rods *i* and *i'*. The said valve-rods are provided with right and left hand screw-threads 24 and 25, which engage with the corresponding screw-threads in the collars *e* and *e'*, as shown in the drawings. Water is forced by the engine into the cylinder through the pipe 26 and out of the valve M'. This water may be obtained from the main delivery-pipe of the pump or pumps or from a separate pump or pumps positively connected with the engine to be regulated. By regulating the size of the outlet-passage through the valve M' the pressure against the piston and its spring, which is a constant load, will be made to vary according to the speed of the engine. When the speed of the engine increases, the pressure against the piston also increases, and the rack and intermediate driving mechanism will move the collars nearer together upon the valve-rods, and thereby cause the

steam to be cut off earlier. A dead-weight or other equivalent device adapted to form a constant resistance to the piston may be used instead of the spring *s*.

In the modification shown in Fig. 7 the piston-rod S is carried through both ends of the regulator-cylinder, which is arranged transversely of the engines. Two toothed racks 20′ are provided and gear into the toothed pinions 23′, splined upon the valve-rods, so that the distances between the collars on both valve-rods may be varied simultaneously. A guide 27 is provided, which engages with the projections 28 on the collars and prevents the collars from being revolved with the valve-rods. The piston-rod M′ may also be connected to the throttle-valve of the engine, if desired, so as to regulate the pressure of the steam in addition to varying the cut off.

When the engines are arranged to exhaust into a condenser, a small passage *t′* is provided in the cut-off valves *c c′*. This passage admits steam from the steam side of the piston to the exhaust side just before the end of each stroke. This steam places the two sides of the piston in equilibrium and forms a cushion which prevents the piston from striking against the end of the cylinder.

What I claim is—

1. The combination, with a cylinder, of two sliding valves and a stationary valve-plate intermediate between the two sliding valves, the said cylinder, valves, and plate being provided with steam and exhaust passages, substantially as set forth.

2. The combination, with a cylinder, of a sliding main valve next to the cylinder, a sliding cut-off valve, and a stationary valve-plate intermediate between the main and the cut-off valve, the said cylinder, valves, and plate being provided with steam and exhaust passages, substantially as set forth.

3. The combination, with a cylinder provided with steam and exhaust ports, of a sliding valve next to the cylinder, provided with tapered steam-ports and a reversely-tapered exhaust-port, a sliding valve provided with an exhaust-cavity, and a stationary valve-plate intermediate between the two sliding valves and provided with steam-ports, a central exhaust-port, and intermediate exhaust-ports between the steam-ports and the said central port, substantially as and for the purpose set forth.

4. The combination, with the two cylinders, of two main valves for admitting the steam to the cylinders, each valve being operated by the cylinder to which it does not pertain, two cut-off valves, each operated by the cylinder to which it does pertain, and two stationary valve-plates, each provided with steam and exhaust passages and arranged intermediate between the said cut-off and main valves.

5. The combination, with the two cylinders, of the two main valves arranged next to the cylinders for admitting steam to them, each said main valve being operated by the cylinder to which it does not pertain, two cut-off valves, each operated by the cylinder to which it does pertain, and two stationary valve-plates, each provided with steam and exhaust passages and arranged intermediate between the said cut-off and main valves.

6. The combination, with a cylinder, of a sliding main valve next to the cylinder for admitting steam to it, a sliding cut-off valve provided with an exhaust-cavity and a passage connecting the end faces of the said cut-off valve and adapted to supply steam to place the piston in equilibrium at the ends of its stroke when the engine exhausts into a condenser, and a stationary valve-plate provided with steam and exhaust passages and arranged intermediate between the said main and cut-off valves.

7. The combination, with a cylinder, of a slide-valve provided with two steam-ports and a central exhaust-port, a slide-valve provided with an exhaust-cavity, and a stationary valve-plate interposed between the two said slide-valves and provided with two steam-ports, a central exhaust-port, and two intermediate exhaust-ports, one of the said slide-valves having a constant travel and the other a variable travel, whereby the steam may be cut off at different points of the stroke, substantially as set forth.

8. The combination, with a cut-off-valve rod provided with right and left hand screw-threads, of two adjustable sliding collars engaging with the said screw-threads, a regulator-cylinder provided with an outlet-valve and a means, such as a spring, for effecting a constant resistance to the motion of the regulator piston-rod, intermediate driving mechanism operatively connecting the regulator piston-rod with the valve-rod and adapted to revolve the said rod, and a sliding block operated by the engine and arranged between the said collars, substantially as and for the purpose set forth.

9. The combination, with the two cut-off-valve rods, each provided with right and left hand screw-threads, of two adjustable sliding collars engaging with the screw-threads on each rod, a regulator-cylinder provided with an outlet-valve and a resistance-spring, intermediate driving mechanism operatively connecting the regulator piston-rod with the two valve-rods and adapted to revolve the two rods simultaneously, and sliding blocks operated by the engine and arranged between the collars on each valve-rod, substantially as and for the purpose set forth.

10. The combination, with the two cut-off-valve rods, of the beveled toothed wheels splined to the valve-rods, the cross-shaft provided with beveled toothed wheels, a toothed pinion secured on the cross-shaft, a regulator-cylinder provided with an outlet-valve and a resistance-spring, and a rack secured to the regulator piston-rod and engaging with the said pinion, substantially as and for the purpose set forth.

11. The combination, with the cut-off valve of the first engine, of a lever operated by the said engine and operatively connected to the said valve, an oscillatory shaft having the said lever secured upon it, a lever also secured on the said shaft, and the main valve of the second engine operatively connected to the last said lever, substantially as and for the purpose set forth.

12. The combination, with the cut-off valve of the second engine, of a pivoted lever operated by the said engine and operatively connected to the said valve, an oscillatory shaft positively connected to the said lever and turning in the reverse direction, a lever secured on the said shaft, and the main valve of the second engine operatively connected to the last said lever, substantially as and for the purpose set forth.

13. The combination, with the pivoted lever operated by the second engine for operating the cut-off valve of the second engine, of an oscillatory shaft, toothed gearing positively connecting the said lever and shaft, a lever secured to the said shaft and adapted to operate the main valve of the first engine, a second oscillatory shaft, a lever operated by the first engine and secured on the said second shaft, and a lever also secured on the said second shaft for operating the main valve of the aforesaid first engine, substantially as set forth.

14. The combination, with the two cylinders, of two main valves for admitting steam to the cylinders, two cut-off valves, two stationary valve-plates, each provided with steam and exhaust ports and arranged between the said cut-off and main valves, intermediate driving mechanism operatively connecting each cut-off valve with the cylinder to which it pertains, and an automatic regulating device, such as a regulator-cylinder, operatively connected to the said driving mechanism and adapted to vary the cut-off of each engine simultaneously, according to the speed of the engine.

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

EDWARD BARNES.

Witnesses:

JNO. FREDK. PARKES,

ERNEST HARKER.