(No Model.) 2 Sheets—Sheet 1.

J. H. EICKERSHOFF.

REVERSIBLE SINGLE ACTING COMPOUND ENGINE.

No. 339,281. Patented Apr. 6, 1886.

Fig. 1.

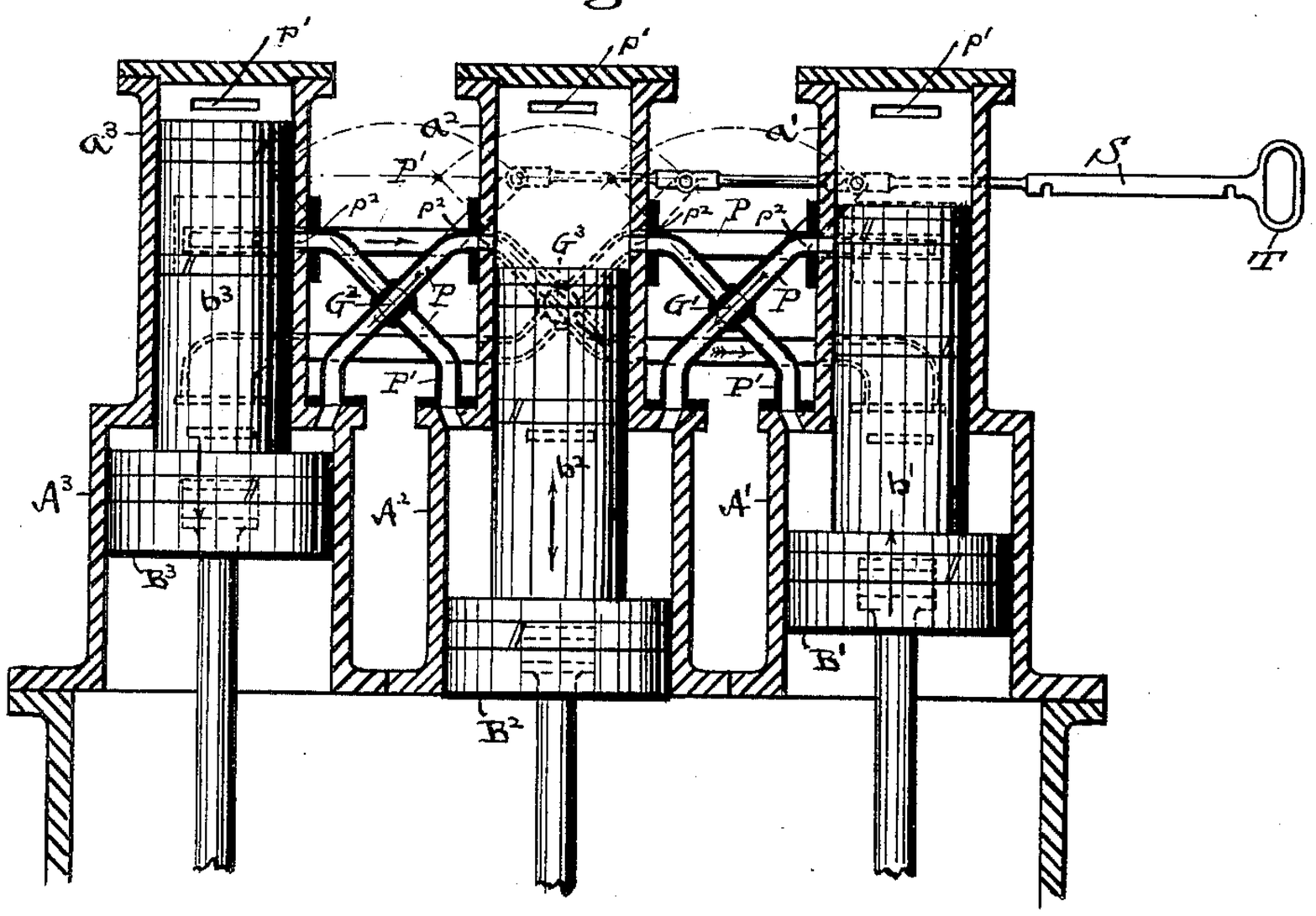
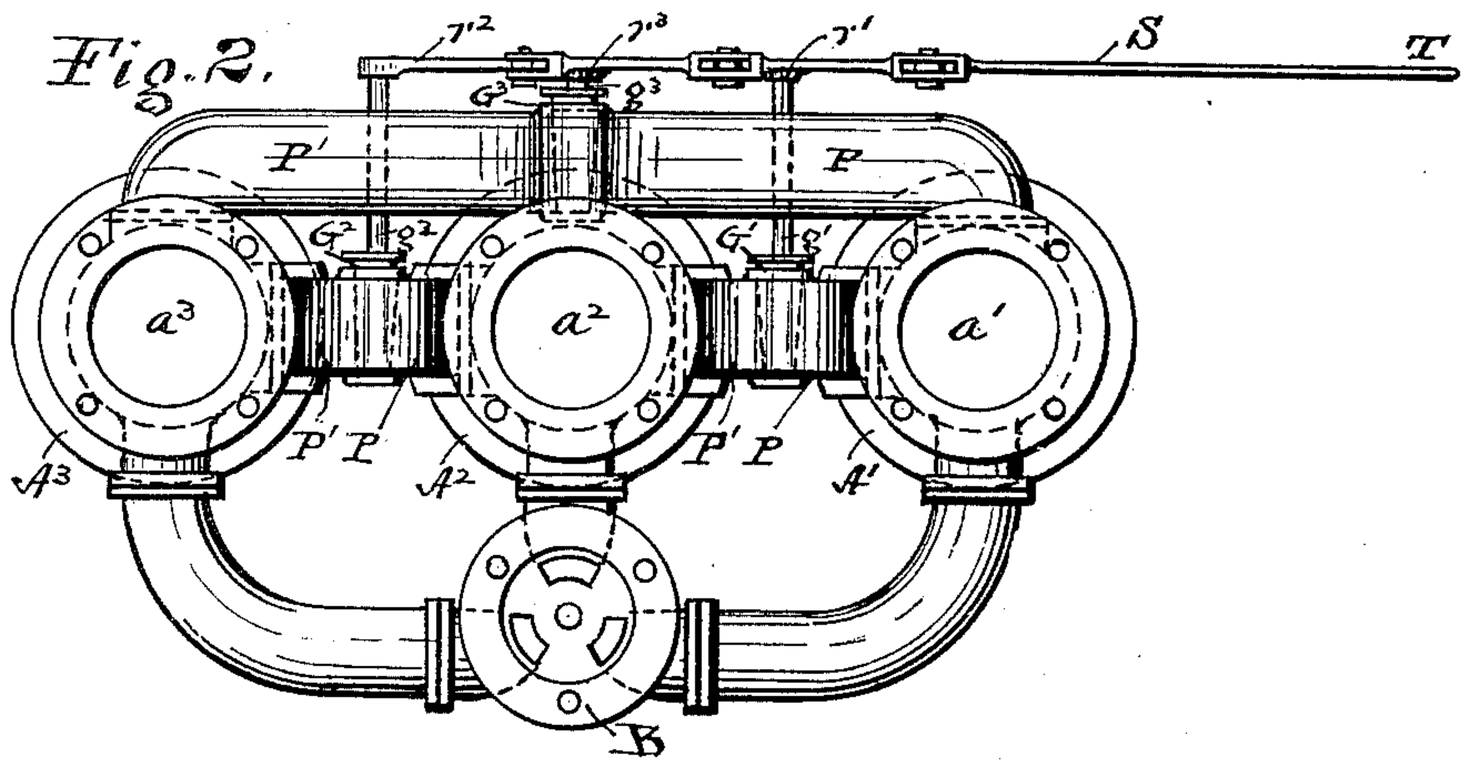


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

J. H. EICKERSHOFF.

REVERSIBLE SINGLE ACTING COMPOUND ENGINE.

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Fig. 5.

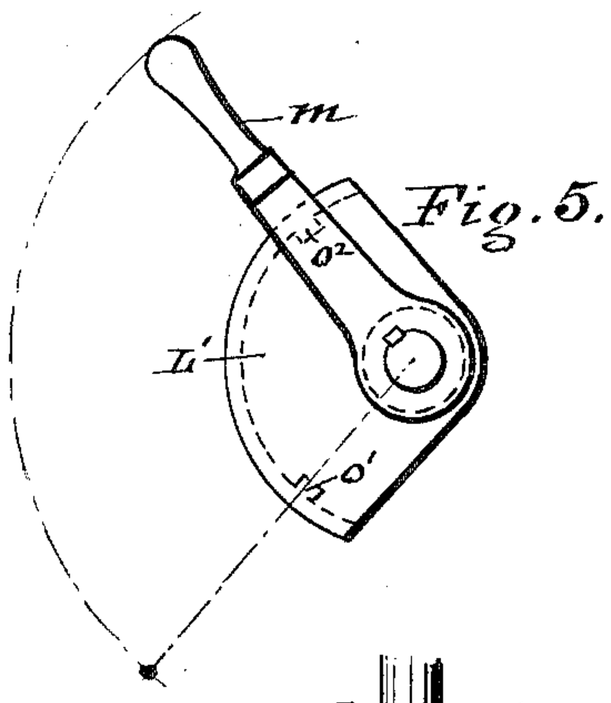


Fig. 4.

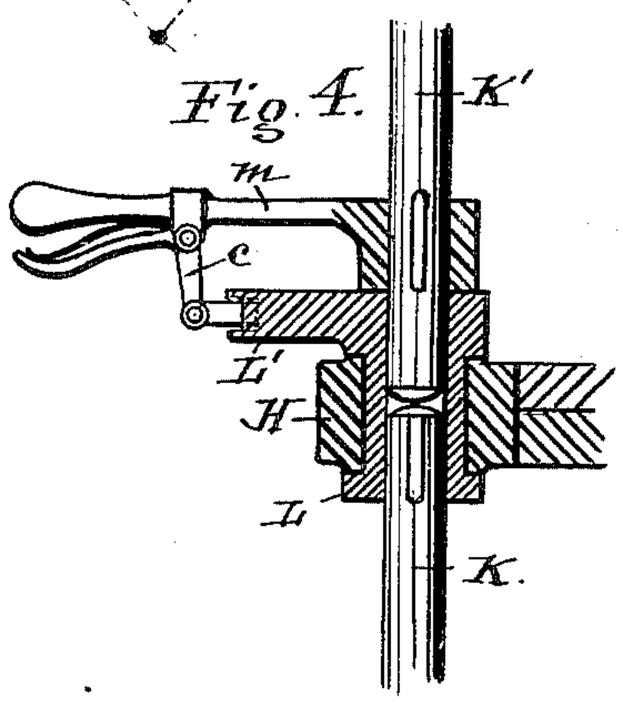


Fig. 3.

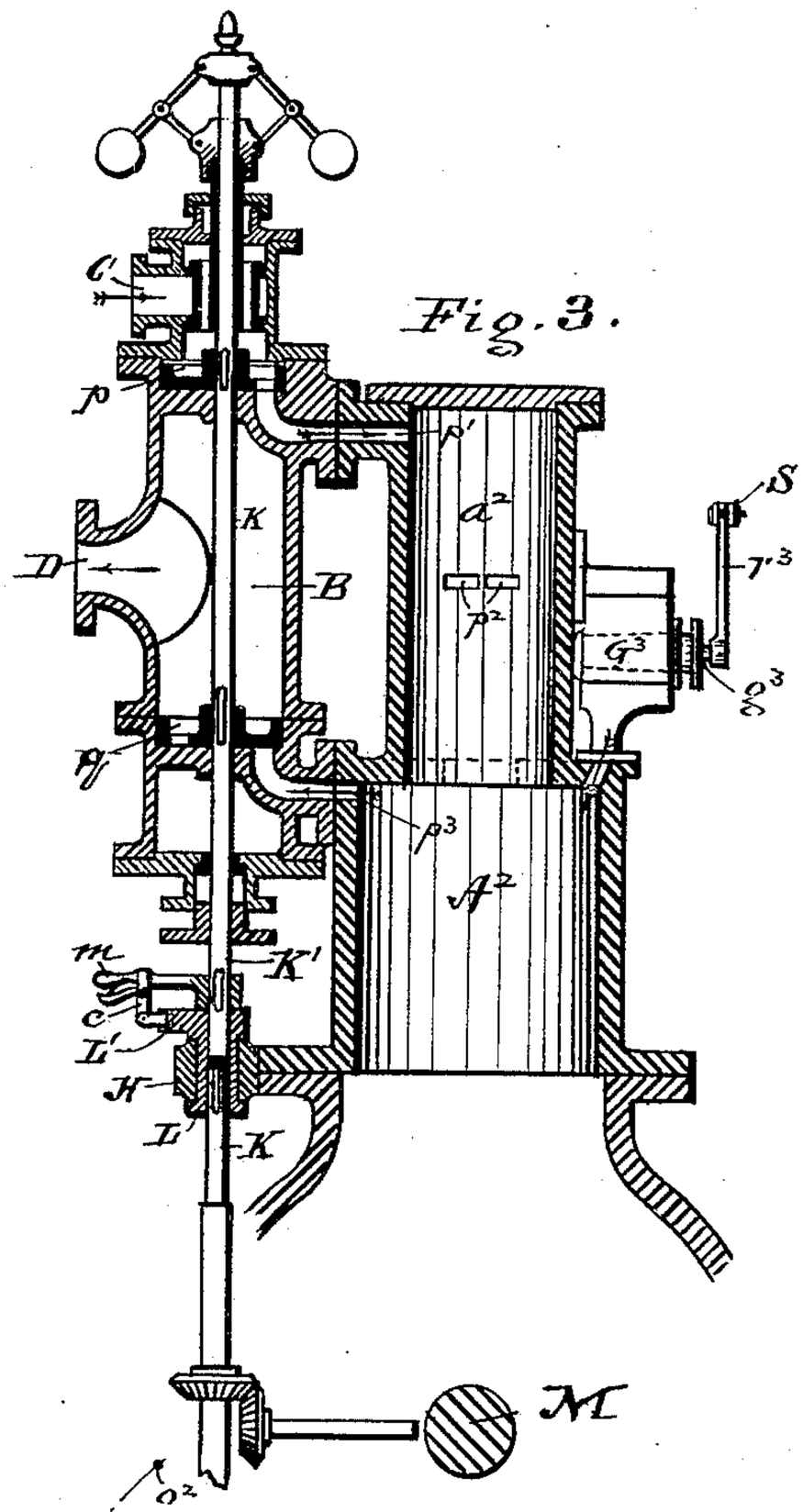


Fig. 6.

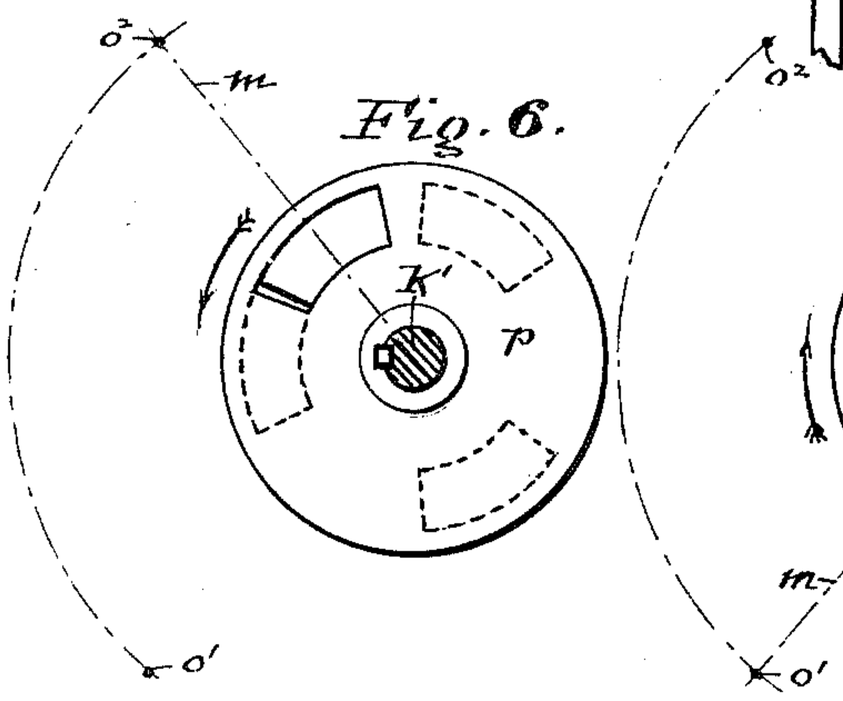
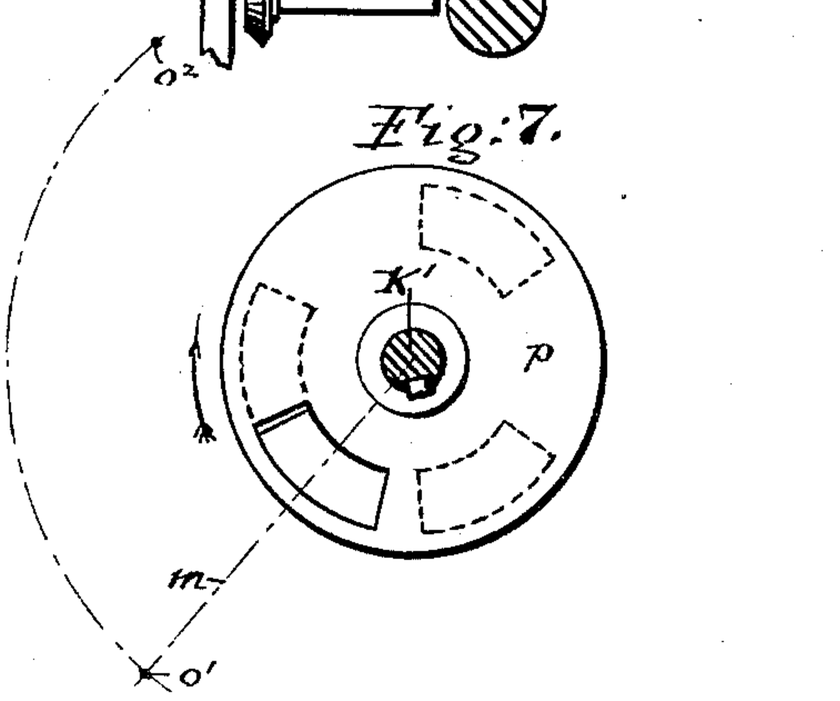


Fig. 7.



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UNITED STATES PATENT OFFICE.

JOHN H. EICKERSHOFF, OF CINCINNATI, OHIO.

REVERSIBLE SINGLE-ACTING COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 339,281, dated April 6, 1886.

Application filed November 14, 1885. Serial No. 182,861. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. EICKERSHOFF, a citizen of the United States, residing at Cincinnati, Ohio, have invented new and useful Improvements in Reversible Single-Acting Compound Engines, of which the following is a specification.

My invention relates to compound single-acting engines in which the steam in compounding is passed directly from one cylinder to another, as fully described and illustrated in another application, No. 176,337, filed by me September 7, 1885, and now pending, allowed for issue.

The object of my present invention is to produce an engine of the kind referred to which, while possessing all the advantages incident to its general construction and functions, may also be reversible at will and operate equally well in both directions.

To this end my invention consists, first, in the combination, with the cylinders, of duplicated steam-passages connecting their intermediate ports with the enlarged portions of adjacent cylinders, said passages being provided with controlling-valves and adjusting mechanism arranged to throw one set of such passages out of action for the time being; also, in a construction and arrangement of the valve-rod and connections whereby the play of the induction and eduction valves in relation to their seats, respectively, may be controlled and regulated to produce, in connection with the steam-passages before referred to, the desired reversal of motion of the engine.

Mechanism embodying my invention is illustrated in the accompanying drawings, in which Figure 1 is a vertical section of the engine-cylinders, taken axially through the cylinders to exhibit more especially the intermediate ports and connecting steam-passages, their valves, and the means for controlling said valves; Fig. 2, a plan view of the connected cylinders complete, omitting the valve-chest cover and governor; Fig. 3, a vertical cross-section of the intermediate cylinder and the valve-chest, showing the valve and governor connections; Fig. 4, a detail sectional elevation of the adjustable connection for the divided portions of the valve-rod; Fig. 5, a plan detail of the reversing-lever and its segment-rack; and Figs. 6 and 7, plan views of the induction (or eduction) valve with its seat-ports indicated by dotted lines, showing its direct and reverse positions, respectively.

The parts hereinafter designated are indicated on the drawings by the letters of reference, similar letters being employed to designate like parts.

In the drawings, A′ *a′* A² *a²* A³ *a³* designate the two-dimension cylinders; B′ *b′*, &c., the two-dimension pistons; B, the valve-chest; C D, induction and eduction steam-pipes, respectively; *p q*, the respective induction and eduction valves, and K the valve-rod driven by gearing from the main shaft M.

In the general operation of the engine steam is admitted by the valve *p* and admission-port *p′* into the small end of each cylinder and acts at high pressure upon the small end of the plunger *b*. The latter in its travel uncovers an intermediate port, p^2, by which the contained steam enters by expansion the larger end of the cylinder next in series and assists in completing the piston-stroke in said second cylinder, and is then exhausted by the port p^3 and exhaust-valve *q*.

The cylinders A′ *a′* A² *a²* A³ *a³* in respect to their general construction and arrangement, also the pistons B′ *b′* B² *b²* B³ *b³* and their connections and functions, likewise the construction and mode of operation of the induction and eduction valves, the valve-spindle, and driving-connections have been fully described in the application already referred to, to which this is supplementary, and need not be described more in detail here.

In said former application I described the arrangement in each cylinder of the admission-ports *p′*, governed by the induction-valve *p*, the intermediate or expansion ports p^2, governed by the plunger or piston *b* as a valve, and the exhaust-port p^3, governed by the exhaust-valve *q*. I also described a single set of steam-passages connecting the port p^2 of each cylinder with the upper part of each enlarged cylinder A next in series, whereby the steam, having partially completed its work in the high-pressure cylinder *a*, was admitted to the

low-pressure piston of the next cylinder in series, to assist in the final completion of its piston-stroke.

In my present invention, instead of employing single steam-passages P, connecting the side ports, p^2, respectively, with the enlarged cylinder next beyond in direct or forward series, I add an additional passage, P', to each cylinder, connecting said ports, respectively, with the enlarged cylinder next behind in reverse or backward series, so that in reversing the motion of the engine the same expansive action of steam takes place, but in reverse sequence in respect to the cylinders.

In the drawings I have shown the ports p^2 duplicated—that is, one at each side of each cylinder; but this is for constructive convenience merely, and to obtain the shortest possible passage-space and economize steam. By this arrangement the intermediate ports, p^2, of cylinder a' are connected with cylinders A^2 and A^3, those of cylinder a^2 with cylinders A' and A^3, and those of cylinder a^3 with cylinders A' and A^2 by means of the connecting-pipes P P'. These connecting-pipes cross and open into each other, and at each crossing are furnished with single-way rotary controlling-valves G' G^2 G^3, respectively, which permit but one passage to be open at a time.

The pipe-crossings being arranged at the same angle and in the same horizontal plane, the spindles g' g^2 g^3 of the controlling-valves are brought to a common vertical plane, and provided with cranks r' r^2 r^3, by which they are operated in unison by a hand-lever, T, to which they are pivotally connected. The position of the valves G, as shown in the drawings, Fig. 1, allows the expansion to take place from high-pressure cylinder a' to low-pressure cylinder A^2, from a^2 to A^3, and from a^3 to A'. By reversing the controlling-valves the sequence would be from a^3 to A^2, a^2 to A', and a' to A^3.

It will be thus obvious, without further description, that by controlling the connecting-passages the relative sequence in which the high-pressure steam is allowed to pass for expansion purposes from the high-pressure cylinders into the low-pressure cylinders can be changed at will; but in order to render this effective in reversing the engine it is also necessary to change the relative action of the valve, which is accomplished by the following mechanism: The valve-spindle is divided horizontally into two distinct portions, K K', abutting in the same axial line. The lower portion, K, receives motion by gearing from the main shaft, and transmits it to the upper portion through an adjustable clutch, constructed as follows: The upper end of the part K is keyed to a bushing, L, journaled in a bearing, H, attached to the engine-frame, and permitting only rotary motion. The upper part of the bushing is extended laterally into a segment-plate, L', having two notches, o' o^2, at its outer periphery, spaced apart sufficiently for the purposes hereinafter described. The lower end of the spindle part K' is seated in the vertical aperture of the bushing L, abutting upon the part K. Just above the bushing L a handle, m, is keyed to the spindle part K', having upon the under side of the handle a spring-actuated bell-crank catch, C, adapted to engage the handle with the notches o' o^2 of the segment-plate. The points of engagement are apart about one-quarter of a circle, and the two portions of the valve-spindle are thus adjustable to these limits of interengagement.

The induction-valve p and the eduction-valve q are in disk form, keyed to the valve-spindle K', and have each one segmental port. They operate upon seats with three segmental ports, each arranged equidistantly around the center.

The dotted lines of Figs. 6 and 7 indicate the positions of the lever m upon its segmental rack and the position of the valves in the two ultimate positions, while the arrows indicate the direction of the motion. To reverse the engine, it is necessary only to move the lever m from one ultimate position to another, and to reverse the valves G by a single action of the lever S by means of its handle T.

The construction and action of the governor and of the other parts of the engine not herein specifically described remain the same as described in the pending application referred to.

I claim as my invention and desire to secure by Letters Patent of the United States—

1. In a compound engine of the character described, duplicated steam-passages connecting the intermediate ports of each high-pressure cylinder with two low-pressure cylinders in series, provided with controlling-valves for regulating the order of admission from one to the other, substantially as set forth.

2. In a compound engine of the character described, the crossed steam-passages connecting the intermediate ports of adjacent high-pressure cylinders with the low-pressure cylinders in series, provided at each crossing with a single-way valve adapted to control the passages and open only one such passage at a time.

3. In a compound steam-engine of the character described, the crossed steam-passages connecting the cylinders, as and for the purpose described, said crossings being provided with controlling-valves with actuating-cranks connected with a single actuating-lever operating the same in unison, substantially as set forth.

4. In a compound steam-engine of the character described, in combination with the rotary induction and eduction valves mounted upon a common valve-rod, the divided valve-rod K K', provided with a collar covering the point of division of said rod, in which said rods may be adjustably secured in relatively different radial positions, substantially as set forth.

5. The combination of the two-part valve-rod K K′, the collar L, segment-rack L′, and engaging catch C and arm *m*, substantially as set forth.

6. The combination of the cylinders A′ *a*′ A² *a*² A³ *a*³, connecting-pipe P, valves G′ G² G³, cranks *r*′ *r*² *r*³, and actuating-rod S, substantially as set forth.

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

JOHN H. EICKERSHOFF.

Witnesses:
L. M. HOSEA,
C. D. KERR.