(No Model.) 2 Sheets—Sheet 1.

J. H. EICKERSHOFF.

SINGLE ACTING COMPOUND ENGINE.

No. 339,280. Patented Apr. 6, 1886.

Fig. 1

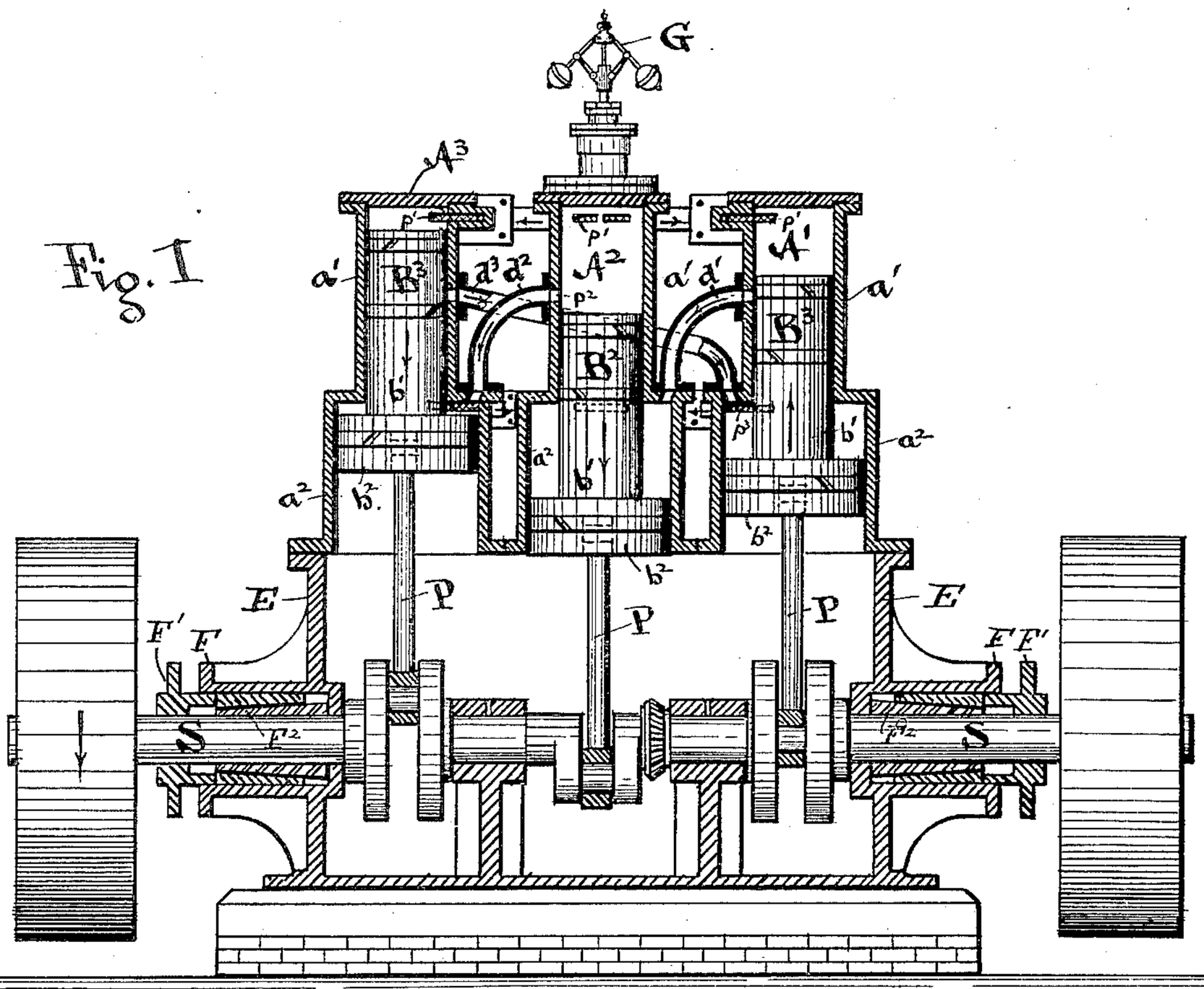
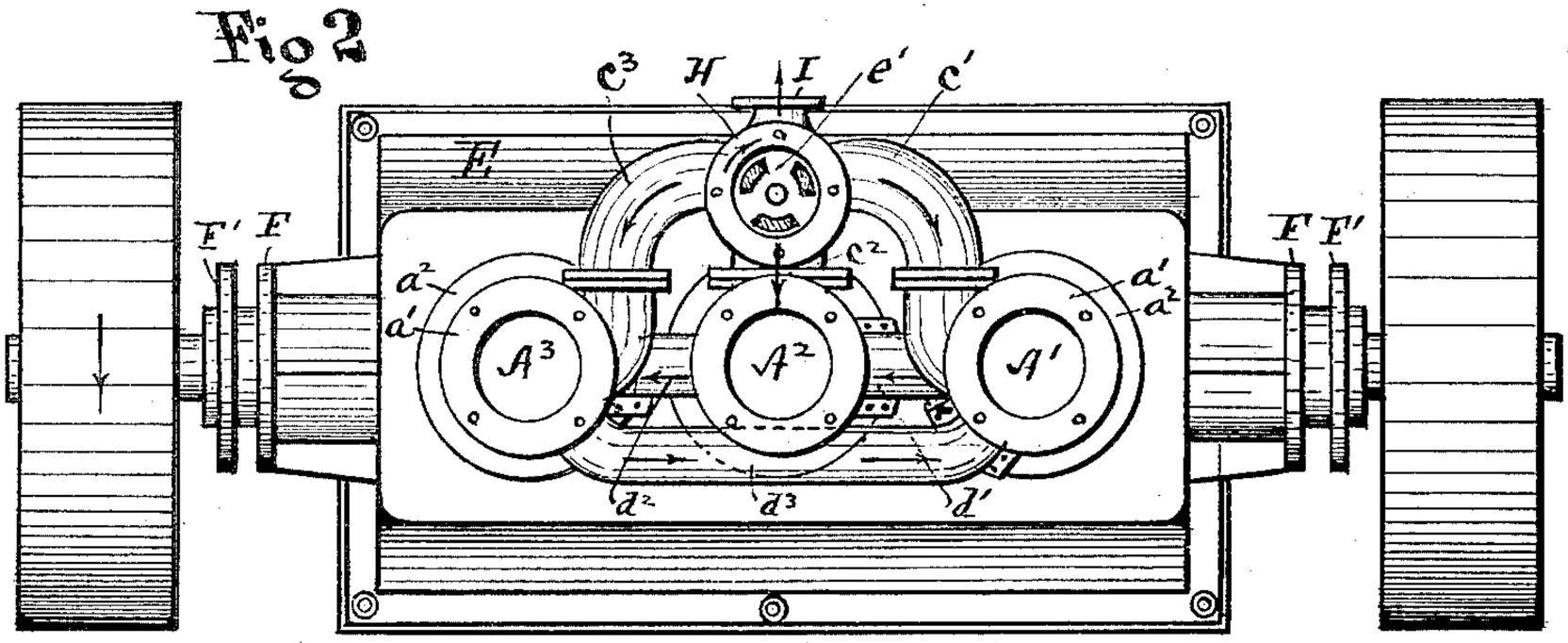


Fig 2



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(No Model.) 2 Sheets—Sheet 2.

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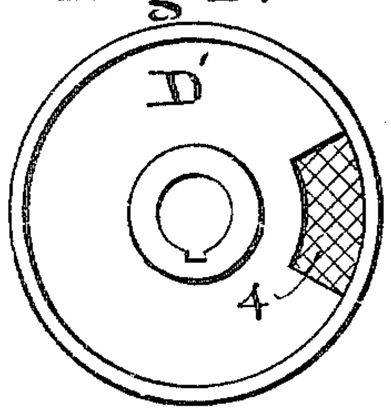
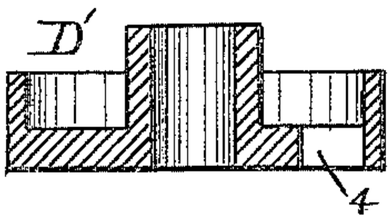
Fig. 4.





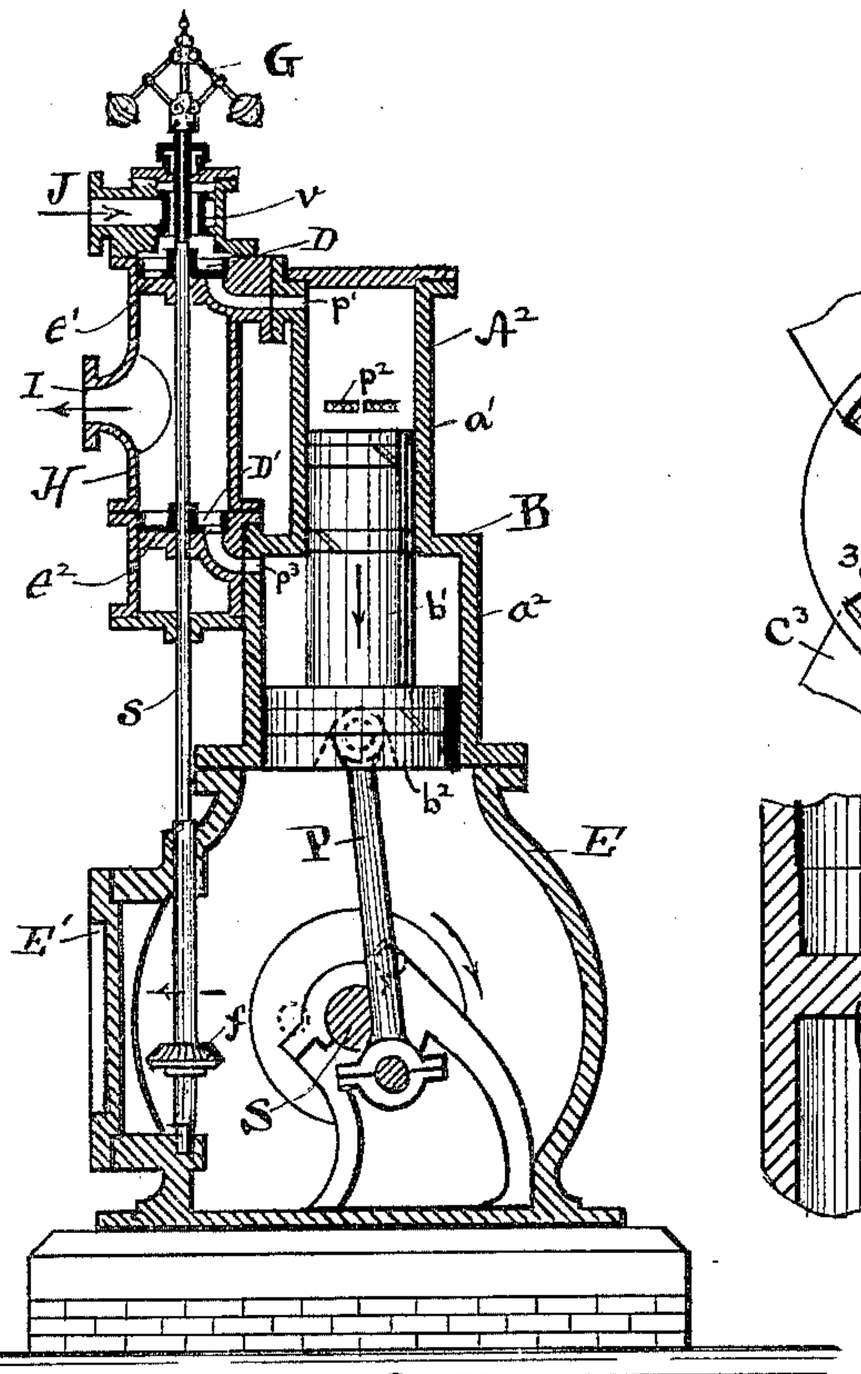
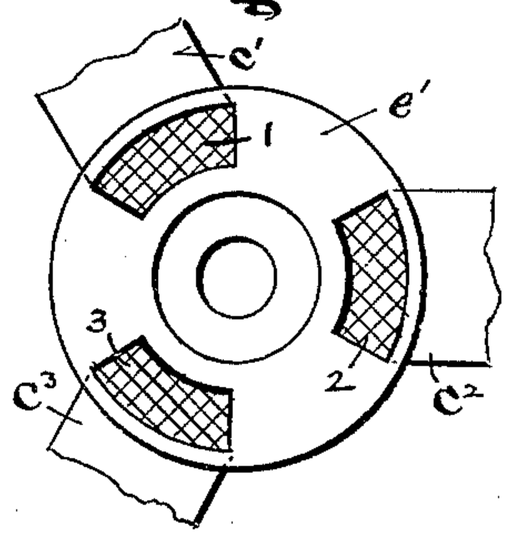


Fig. 5.



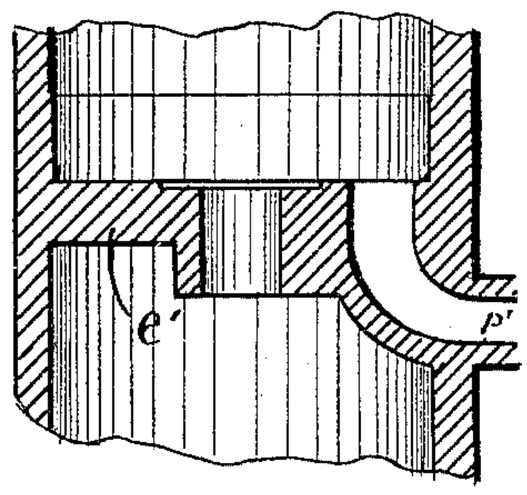


Fig. 3.

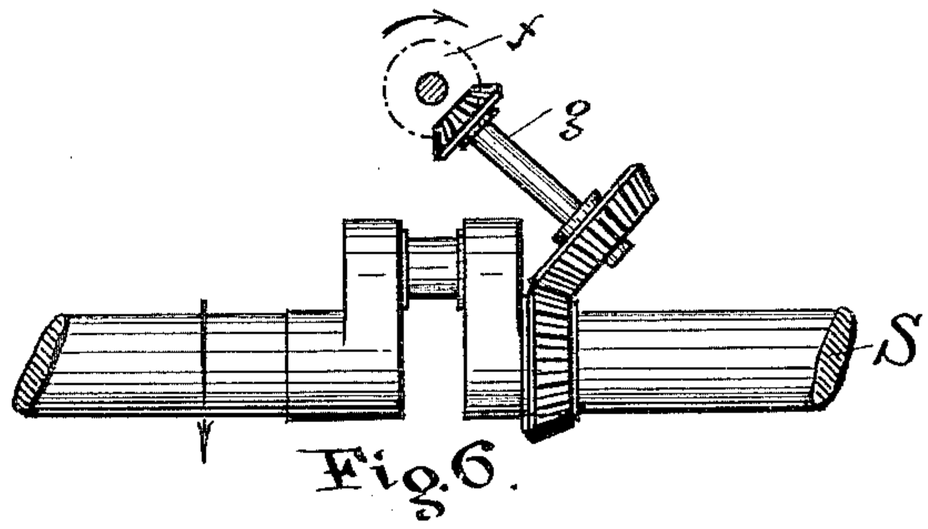


Fig. 6.

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UNITED STATES PATENT OFFICE.

JOHN H. EICKERSHOFF, OF CINCINNATI, OHIO.

SINGLE-ACTING COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 339,280, dated April 6, 1886.

Application filed September 7, 1885. Serial No. 176,337. (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, Hamilton county, Ohio, have invented new and useful Improvements in Single-Acting Compound Engines, of which the following is a specification.

My invention relates to single-acting steam-engines, its object being to introduce and combine therewith the principle and advantages of compounding the steam; to which end my invention may be said to consist in a single-acting compound engine constructed as hereinafter more fully set forth, and in certain details of construction involved therein, but susceptible of independent application and usefulness.

Mechanism embodying my invention is illustrated in the accompanying drawings, in which Figure 1 is a vertical section of the engine through the common axial plane of the cylinders and shaft-bearings; Fig. 2, a plan view of the engine with the valve-chest cover and valve removed, showing the induction-valve seat and ports; Fig. 3, a vertical cross-section of the engine complete through the common axial plane of the central cylinder and the valve-chest; Fig. 4, a plan view and corresponding vertical cross-section of the admission (or eduction) valve detached; Fig. 5, a plan view and corresponding vertical section of the admission (or eduction) valve seat, and Fig. 6 a detail plan of the driving-connection between the main shaft and valve-stem.

Referring now to the drawings, in which I have selected for illustration a form of "three-cylinder" engine, A' A^2 A^3 designate three single-acting cylinders arranged in a common plane above a crank-shaft, S, with whose cranks, set at equal angles apart, the pistons B' B^2 B^3 of the cylinders engage by pitmen P, in the usual manner. I construct the cylinders double—that is, with two different diameters—or each with a rear or closed portion, a', of smaller diameter, for the action of "live" or high-pressure steam direct from the generator, and a front or open portion, a^2, of a larger diameter, for the action of the "expansion" or low-pressure steam, as hereinafter more fully explained; but, for convenience and brevity of explanation, I may refer to the smaller and larger ends of the cylinders as the "high-pressure" and "low-pressure" cylinders, respectively. The pistons B' B^2 B^3 are correspondingly constructed, each having a stem or plunger, b', of a diameter adapted to the smaller end of the cylinder, and an enlarged portion, b^2, adapted to the larger end of the cylinder. Both these parts of the pistons are suitably fitted with packing-rings—the larger portion with a single ring and the smaller with two—arranged relatively to the stroke as hereinafter more fully explained. Each cylinder is provided with three ports—p' at the upper end for the admission of live steam to the high-pressure end a'; p^2 midway in the length of the high-pressure end a', approximately at two-thirds of the piston-stroke downward from the top, for the exhaust of one high-pressure end into the low-pressure end of another cylinder, and p^3 at the upper end of the enlargement a^2, for the final exhaust of the steam. These ports are connected as follows: the ports p' of the cylinders A' A^2 A^3, respectively, with the induction-ports 1 2 3, respectively, of the induction-valve seat e^2 by pipes C' C^2 C^3, respectively, which may be cored in a common casting, if preferred. The ports p^2 of the cylinders A' A^2 A^3 are connected by independent pipes d' d^2 d^3 and openings with the upper ends of the enlarged or low-pressure portions a^2, respectively, of cylinders A^2 A^3 A'—that is, extending from one to another in the order named, to wit: port p^2 of A' by pipe d' into enlarged end of A^2, port p^2 of A^2 by pipe d^2 into enlarged end of A^3, and port p^2 of A^3 by pipe d^3 into enlarged end of A'. The ports p^3 extend by pipes to the orifices of the eduction-valve seat, respectively.

The operation of the engine, so far as relates to the parts described, is as follows: Steam, being admitted from the boiler by pipe J through port p' into the small or high-pressure end of cylinder A', drives the piston B' downward, the supply being cut off by the governing-valve before the piston uncovers its port p^2. As the piston uncovers the port p^2 the steam then in the small end a' flows thence over into the enlarged or low-pressure portion of a cylinder, A^2, and acts upon the enlarged portion of its piston B^2, which piston at that instant is ready to begin its downward stroke. The only exhaust of

this steam takes place from the low-pressure end of cylinder A^2 by its independent exhaust-port p^3, the residuum of steam in the high-pressure end a' of cylinder A′ being retained as a cushion at the conclusion of the backward stroke of the piston B′. So, in like manner, the live steam in the high-pressure end of cylinder A^2 is passed to the low-pressure end of cylinder A^3, and that of A^3 back to A′, the exhaust in each case taking place only from the low-pressure cylinders, and the residuum imprisoned in each high-pressure cylinder by the upward stroke of the plunger past the port p^2 being utilized as a cushion, in the manner described, and the residual steam of the low-pressure end being compressed in the expansion-pipe connection against the side of the plunger of the adjacent cylinder, thus avoiding all loss of heat in the high-pressure cylinder and in the expansion-pipes. As a constructive feature, the double piston is cast hollow. The plunger portion is turned to an easy fit with the bore of the high-pressure cylinder, and its steam-tight connection is made by two ordinary packing-rings—the upper one at the upper end of the plunger and the lower one in position to stand at the lower edge of the high-pressure cylinder at the lowest position of the piston-stroke. The valve-chest H is preferably of cylindrical form, attached vertically to the central cylinder, and is provided with two horizontal seats—the upper, e', adjacent to the upper ports, p', for the action of the induction-valve, and the lower, e^2, adjacent the exhaust-ports p^3, for the action of the eduction-valve. Each seat is a flat disk with three segmental openings, 1 2 3, connecting the proper ports, respectively, of the cylinders, and arranged at equal intervals from each other and equidistant from the center of the seat, through which passes a common stem, *s*, securing and operating both valves. The valves D D′ are also flat disks having a simple segmental opening, 4, arranged to govern the ports by rotation. The construction of valves and seats is similar each with each, the openings in the exhaust-valve and seat being somewhat larger than those of the induction-valve and seat. Into the chest-space between the upper face of the exhaust-valve and the lower face of the induction-valve seat the steam is exhausted through the valve-opening, and thence into the atmosphere by a piped orifice, I.

The space above the induction-valve is the steam-chest proper, and is provided with the ordinary governor mechanism, G.

The governor-balls or other mechanism for a similar purpose are attached, in the usual manner, to the projecting ends of the valve-stem, which passes entirely through the governor piston-valve *v*, operating in the throat of the steam-chest, and the said piston-valve is raised or lowered according to the speed of the valve-stem in rotation by the usual connections, and the quantity of steam admitted is thus regulated. The valve-stem projects entirely through the steam-chest cylinder through suitable stuffing-boxes, and extends below to the horizontal plane of the main shaft, where it is furnished with a beveled pinion, *f*, and receives its rotary motion from the main shaft by a short counter-shaft, *g*, and gearing.

I prefer to construct the frame of the engine as a substantially-cylindrical horizontal casing, E, in the ends of which are arranged the bearings of the main shaft S. This casing is preferably closed at all sides, (thus excluding all access of dirt, &c., from the working parts,) and in front is provided with a removable door or cover, E′, of sufficient length to admit access to all the cranks and pitman-connections, and also to remove the central portion of the crank-shaft for inspection, repairs, &c.

The end bearings of the shaft are preferably constructed as follows: The casing is extended at each end into a cylindrical boxing, F, similar in form to the ordinary stuffing-box of piston-packing, and provided with a close-fitting gland, F′, bored flaring or conical interiorly. The shaft rests in a true-fitting sleeve, F^2, of brass or other suitable metal, dressed exteriorly to conical form to engage within the conical interior of the gland. The sleeve is cut longitudinally into three or more equal parts, sufficient metal being removed to permit these parts to close inward and take up wear. The gland being adjusted inward from time to time, as required, the parts of the sleeve are closed together by the wedging action of the gland, thus maintaining always an exact central adjustment of the shaft, regardless of the wear of parts.

I am aware that the attempted utilization of a piston-valve operating in unison with a main piston as a separate high-pressure piston in a single-acting three-cylinder engine is described in English Patent No. 1,572 of 1880. The construction and mode of operation, however, of such engine are essentially different. In such case the piston-valve casings or cylinders are wholly distinct from the main cylinders and separated from the latter by a common chamber, into which the valve-casings open, and into which steam is exhausted. Moreover, the piston-valve or high-pressure piston is not a "plunger," and, besides acting to admit steam to the main cylinder, also governs the exhaust from the main cylinder, said exhaust taking place back through the high-pressure cylinder. Obviously in such a construction and mode of operation all expansive benefit of steam is practically lost by the excessive waste-spaces cooled by the exhaust into which the expansion is directed. There is also a loss of energy by the cooling effect of the exhaust upon the high-pressure cylinder and its piston. These effectually counterbalance any economy due to the "expansion" into the large cylinder.

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

1. In a single-acting steam-engine, two or more cylinders, each having two diameters, with corresponding double pistons, and provided with ports p', p^2, and p^3, the intermediate port, p^2, of each cylinder being interconnected directly and without the intervention of a receiver or valves with the adjacent cylinder, substantially as and for the purpose set forth.

2. In a single-acting compound engine, two or more continuous cylinders, each of two diameters, with suitable port-connections for admitting live steam into the smaller or high-pressure end, and for exhausting the spent steam ultimately from the larger or expansion end, in combination with a piston in the larger end extended as a close-fitting plunger acting as a piston into the smaller end, and an intermediate port governed by said piston as a valve for permitting the expansion of the live steam after a partial stroke of the piston into an adjoining cylinder, substantially as and for the purpose set forth.

3. In a single-acting steam-engine, the combination of two or more cylinders, A, as constructed, having ports p' p^2 p^3, arranged as shown, and connections d, with pistons B, as constructed, and suitable induction and eduction valves, substantially as and for the purpose set forth.

4. In a single-acting steam-engine, the combination of three cylinders, A' A^2 A^3, as constructed, provided with ports p' p^2 p^3, and connections d' d^2 d^3, and with double pistons B' B^2 B^3, arranged for operation substantially as set forth.

5. In a multiple-cylinder single-acting compound engine, the combination and arrangement of the continuous two-diameter cylinders, the double pistons or piston-plungers, the intermediate expansion-ports, and connecting-pipes, with the sole independent exhaust-ports at the larger ends of the cylinders, and the common induction-valve and eduction-valve, operating substantially as set forth.

6. In a multiple-cylinder single-acting steam-engine, a valve-chest having two parallel seats with ports, respectively, for induction and eduction, connected with the cylinders, and two disk-valves carried upon a single stem projecting through the seats and arranged to govern the ports by rotation, substantially as set forth.

7. In a three-cylinder single-acting engine, in combination with the cylinders and their working connections, a cylindrical valve-chest, H, having port-seats e' e^2, disk-valves D' D^2, and a stem, s, projecting through and operating both valves, the valves and seats arranged in relation to the steam-connections, 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.