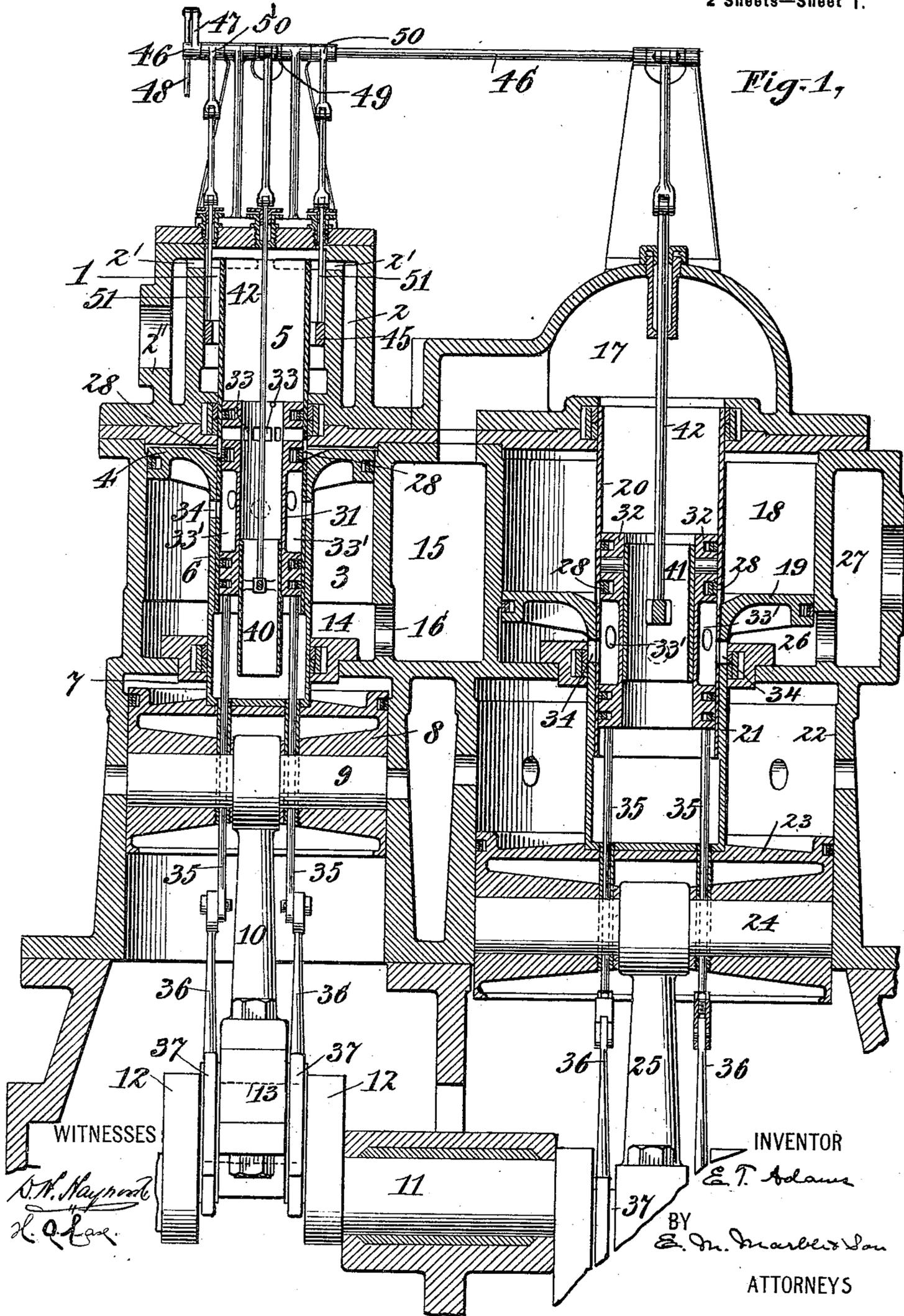


E. T. ADAMS.
STEAM ENGINE.

(Application filed July 28, 1899. Renewed May 1, 1900.)

(No Model.)

2 Sheets—Sheet 1.



No. 663,404.

Patented Dec. 11, 1900.

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2 Sheets—Sheet 2.

Fig. 2,

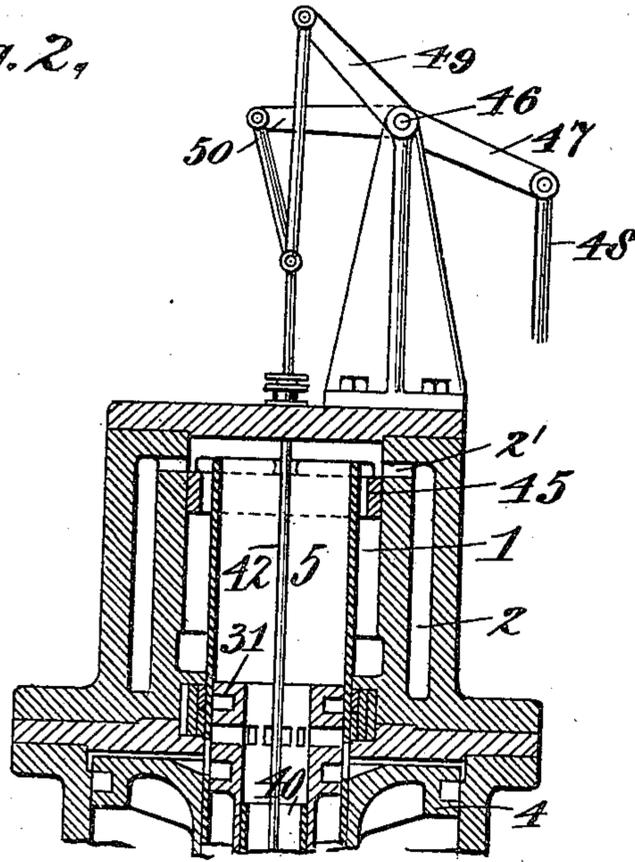
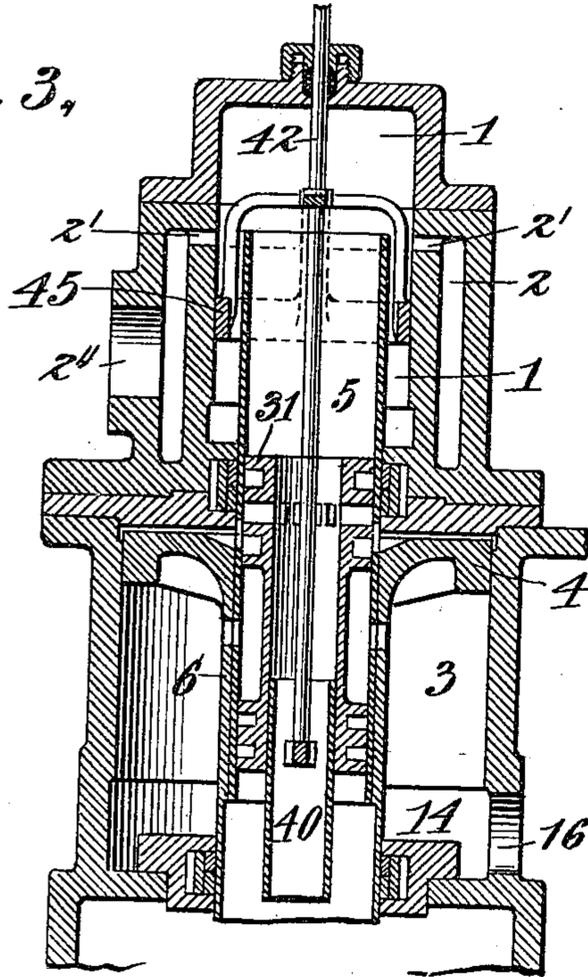


Fig. 3,



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UNITED STATES PATENT OFFICE.

EDWARD THOMAS ADAMS, OF MILWAUKEE, WISCONSIN.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 663,404, dated December 11, 1900.

Application filed July 28, 1899. Renewed May 1, 1900. Serial No. 15,133. (No model.)

To all whom it may concern:

Be it known that I, EDWARD THOMAS ADAMS, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Steam-Engines; 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.

My invention relates to steam-engines and other fluid-motors, and particularly to engines of what are known as the "central-valve" class, in which steam or other working fluid is introduced into the cylinders through a hollow piston-rod.

My invention consists in the novel construction and arrangement of the distribution-valves of such motors, in the combination of automatic variable cut-off and throttle valves employed, and generally in the novel combination, construction, and arrangement of the parts.

The objects of my invention are to increase the economy and efficiency of steam-engines and other fluid-motors, and particularly of motors of the central-valve class, to avoid expansion below the back-pressure line when the engine is working with an early cut-off, to simplify the valve-gear of central-valve motors, and to make the engine simple, compact, durable, and comparatively inexpensive. These objects are attained in the invention herein described, and illustrated in the drawings which accompany and form a part of this specification, in which the same reference-numerals indicate the same or corresponding parts, and in which—

Figure 1 is a central vertical section of a cross compound central-valve engine constructed in accordance with my invention. Fig. 2 is a detail section of the steam-chest of the high-pressure cylinder, taken on a plane at right angles to Fig. 1 and showing the cut-off and throttle valves in the positions corresponding to cut-off at one-quarter stroke; and Fig. 3 is a detail section of the high-pressure cylinder and steam-chest, showing a different method of operating the cut-off and throttle valves from that shown in Figs. 1 and 2.

In the drawings, 1 is the steam-chest of the

high-pressure cylinder, and 2 an annular space surrounding the steam-chest and connected thereto by ports 2'. Steam from the supply-pipe is admitted through the opening 2" into this annular space 2.

3 is the high-pressure cylinder, 4 the high-pressure piston, and 5 and 6 are concentric tubes which together form the piston-rod of the high-pressure cylinder. The piston 4 and tube 6 are integral.

7 is a guide and cushion cylinder beneath the high-pressure cylinder, such as are commonly employed in single-acting central-valve engines.

8 is the combined cross-head and piston within the cylinder; 9, the cross-head pin; 10, the connecting-rod; 11, the crank-shaft, and 12 the cranks for the high-pressure piston. The crank-pin 13 is shown in dotted lines.

14 is the exhaust-space beneath the cylinder 3; 15, the receiver, connected with the exhaust-space 14 by a port 16, and 17 the steam-chest of the low-pressure cylinder.

18 is the low-pressure cylinder; 19, the low-pressure piston; 20 and 21, concentric tubes together forming the low-pressure piston-rod, (the piston 19 and tube 21 being integral); 22, the guide and cushion cylinder beneath the low-pressure cylinder, and 23 the combined piston and cross-head of cylinder 22.

24 is the low-pressure cross-head pin, and 25 the low-pressure connecting-rod.

26 is the exhaust-space beneath the low-pressure cylinder, and 27 the exhaust-chest of the engine.

The cranks of the high-pressure and low-pressure cylinders are one hundred and eighty degrees apart. This is not essential, but is preferable in an engine of this class. The tubes 5 and 20, which form parts of the high-pressure and low-pressure piston-rods, respectively, and through which steam is admitted to the high-pressure and low-pressure cylinders, are open at the top, communicating with the steam-chests 1 and 17, respectively. They pass through suitable stuffing-boxes in the upper cylinder-heads and at their lower ends are connected in any suitable manner to the lower tubes 6 and 21 of the piston-rods.

28 28 are steam-ports in the admission-tubes 5 and 20, respectively.

31 and 32 are the high-pressure and low-pressure distribution - valves, respectively. They are hollow sleeves within the admission-tubes 5 and 20 and are provided with ports 33, adapted to register at certain positions of the valves with the steam-ports 28 in the admission-tubes 5 and 20. The valves 31 and 32 are provided with suitable packing-rings. They are also provided with recesses 33' in their sides, forming exhaust-ports adapted to convey steam from the upper to the lower sides of the pistons in certain positions of the valves. The piston-rod tubes 6 and 21 are provided with exhaust-ports 34 in communication with these exhaust-ports 33' of the valves.

The tubes 6 and 21, which transmit the pressure upon the pistons to the cross-heads, pass through suitable stuffing-boxes in the lower cylinder-heads and are secured to the cross-heads in a suitable manner.

The valves 31 and 32 are reciprocated with respect to the pistons and the ports in the hollow piston-rods by valve-rods 35, connected by eccentric-rods 36 to eccentric-straps 37, the eccentrics of which are upon the crank-pins. Within the distribution-valves 31 and 32 are cut-off sleeves 40 and 41, forming in effect riding cut-off valves and supported by valve-rods 42, passing through stuffing-boxes in the tops of the steam-chests 1 and 17. By means of these valve-rods the cut-off sleeves may be moved up and down. Such movement is necessary, however, only when the point of cut-off is to be changed. The ports 33 of the distribution-valves 31 and 32 override these sleeves 40 and 41 as the pistons descend, and so are closed. These cut-off sleeves operate close to their engine-cylinders and do not leave large clearance-spaces in which the steam expands while the pistons descend, as is the case when a cut-off valve is placed in the steam-dome at the top of the hollow piston-rod, as is frequently done.

One common cause of poor economy at early cut-off in steam-engines as ordinarily constructed is the doing of negative work, expansion being carried below the back pressure against which the engine works, forming the familiar loop in the indicator-card below the back-pressure line. The result of the doing of such negative work is a great increase in steam consumption in proportion to the work actually done. To obviate such expansion of steam below back pressure at early cut-off, I provide a throttle-valve operated in conjunction with the high-pressure cut-off valve, but which does not begin to act until the cut-off valves have reached positions corresponding to an early cut-off. As herein-after described, the mechanism by which the automatic-cut-off valves and the throttle-valve are operated is such that once the throttle-valve begins to restrict the supply of steam the automatic-cut-off valves vary the point of cut-off but little. The throttle-valve by lowering the initial pressure in the high-pressure

cylinder decreases work done in the engine, and therefore obviates the necessity of cutting off at an earlier point in the stroke. 45 is this throttle-valve. It is located within the high-pressure steam-chest 1 and is a ring or sleeve adapted to slide up and down within such chest and when near the upper limit of its travel to restrict and finally to close the ports 2', through which the steam in the chamber 2 passes into the steam-chest 1. Both the cut-off sleeve and the valve-sleeve 45 are adjusted by means of a rock-shaft 46, which may be oscillated by an arm 47 and link 48, connected to any common speed-governor. Said rock-shaft carries a rocking lever 49, connected by a link to the valve-stem 42, and also carries rocking levers 50 50, connected by links to stems 51 51, connected to and supporting the throttle-valve 45; but the angular positions of the regulating arms 49 and 50 are different, so that when changing from a late cut-off to an early cut-off the cut-off sleeve 40 at first moves somewhat rapidly, while when a point of early cut-off is reached and the throttle-ring 45 begins to restrict the ports 2' the regulator-arm 49 has reached such an angular position that the cut-off valve 40 has little further movement, while the throttle-ring 45 moves somewhat rapidly. By this method of operating the throttle-ring 45 and the cut-off valve 40 I obtain a practically complete control of the speed of the engine at points of early cut-off by the throttle-valve and a practically complete control of the speed of the engine at medium and late points of cut-off by the automatic-cut-off valve, which is the arrangement affording the highest economy in operation.

The operation of this engine is as follows: In the drawings the high-pressure piston is shown at the top of its stroke, with the valve 31 just opening the steam-ports 28, and the low-pressure piston is shown at the bottom of its stroke, with the exhaust-ports 33' open. Live steam may pass, therefore, from the opening 2' through the annular space 2 and ports 2' (the throttle-valve 45 being in such position that said ports are open) into the steam-chest 1, and thus into the admission-tube 5 of the high-pressure piston-rod and through the ports 33 in valve 31 and ports 28 in admission-tube 5 into the upper part of the cylinder 3. Exhaust-steam may pass from the upper part of the low-pressure cylinder 18 through the port 33' of the valve 32 and through the ports 34 of the hollow piston-rod into the exhaust-space 26 of the low-pressure cylinder, and thence into the exhaust-chest 27, and so to the air or to a condenser. As the high-pressure piston descends the ports 28 override the cut-off sleeve 40, thus cutting off steam, so that during the remaining portion of the stroke the steam in the cylinder 3 will work expansively. The cut-off sleeves are shown in Fig. 1 in positions corresponding to a very late cut-off; but they may be as much higher in the tubes 5 and 20 as may be desired, thus giving

as early cut-off as desired. As the piston 4 descends the low-pressure piston rises, the steam continuing to exhaust through the ports 33' and 34 into the exhaust-space 26. When the stroke is nearly completed, the distribution-valve 31 of the high-pressure piston, which valve has been moving upward with respect to its piston, has risen so far that steam may pass from above the piston through the exhaust-port 33' in the side of said valve and through the exhaust-port 34 in the hollow high-pressure piston-rod into the exhaust-space 14 and receiver 15. Release is thus produced in the high-pressure cylinder. Meanwhile the distribution-valve 32 of the low-pressure cylinder has been moving downward with respect to its piston and in the latter portion of the stroke is closing the exhaust ports or passages 33' in said valve, and just as the end of the stroke is reached valve 32 opens the steam-ports 28 in the piston-rod. The cross-head piston 23 in rising compresses air against the lower head of the low-pressure cylinder, thus cushioning the reciprocating parts of the engine and serving to bring them to rest gently, and this cushioning action is assisted by the steam-pressure upon the end of the tube 6 and also to some extent by a slight cushioning in the low-pressure cylinder after the exhaust-ports 33' are closed. In the next succeeding half-revolution of the crankshaft the high-pressure cylinder exhausts and the low-pressure cylinder takes steam, the cut-off sleeve 41 cutting off this steam at the proper point in the stroke. Near the end of the stroke the exhaust-ports 33' in the low-pressure valve 32 are opened and the steam in the low-pressure cylinder is released and correspondingly exhaust closure and compression take place in the high-pressure cylinder, the high-pressure cross-head 8 compressing air in the cylinder 7 and cushioning the reciprocating parts. This cushioning action is assisted by the steam pressure upon the end of the tube 21.

If the speed of the engine increases beyond normal, the rock-shaft 46 is moved by a speed-governor, (not shown,) so as to raise the cut-off sleeves 40 and 41 and the throttle-ring 45. By the time the cut-off-valve sleeves have reached positions corresponding to cut-off at one-quarter stroke the rate of movement of the throttle-ring 45 has become rapid relative to the rate of movement of the cut-off sleeves 40 and 41, and the throttle-sleeve 45 is also in such position that it begins to throttle the steam, restricting the ports 2'. Further regulation of the admission of steam to reduce the speed of the engine is then effected mainly by the throttle-ring 45.

In an application for Letters Patent filed April 7, 1899, Serial No. 712,047, I have illustrated, described, and claimed a valve-gear for central-valve engines similar to that illustrated and described herein, except that in said application the main steam-distribution valves are upon the outside of the hol-

low piston-rod and except that no throttle-valve is employed operating in conjunction with cut-off valves. I do not claim, broadly, in this application, therefore, the combination, with a hollow piston-rod, of a valve-sleeve forming the main distribution-valve, nor the combination, with such piston-rod and distribution-valve, of a cut-off valve within the piston-rod. In my said former application I have also shown and described a tandem compound central-valve engine in which the distribution-valves for the high-pressure cylinders are sleeves surrounding the hollow piston-rods, while the distribution-valves for the low-pressure cylinders are valve-sleeves within the hollow piston-rods, the arrangement of said low-pressure valves and their cut-off valves being that herein illustrated and described, which arrangement has special advantages for tandem compound engines. In my said former application the low-pressure distribution-valves within the piston-rods are claimed only in combination with the high-pressure valves, broad claims for the distribution-valves within the piston-rods being necessarily reserved for this application.

An important advantage of employing for the distribution-valves of a central-valve engine sleeves located within the piston-rods, as illustrated and described herein, is that the valves are perfectly balanced.

In Fig. 3 I have shown both the throttle-valve 45 and the automatic-cut-off valve 40 operated by the same valve-rod 42. Such arrangement of the automatic-cut-off and throttle-valves is perfectly practicable, but requires a somewhat higher steam-chest and does not permit the reduction in the rate of movement of the cut-off valves relatively to that of the throttle-valve as the throttle-valve comes into operation.

Having thus completely described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination, with a cylinder, a piston, a steam-chest, and an admission-tube, moving with the piston, communicating with the steam-chest, and provided with ports communicating with the cylinder, of a valve-sleeve located within said admission-tube, movable longitudinally with respect to the ports thereof, and adapted to regulate admission to said cylinder, and having a steam-passage through it, and means for operating said valve.

2. The combination, with a cylinder, a piston, a steam-chest, and an admission-tube, moving with the piston, communicating with the steam-chest, and provided with ports communicating with the cylinder, of a valve-sleeve located within said admission-tube, movable longitudinally with respect to the ports thereof, and adapted to regulate admission to and exhaust from said cylinder, and having a steam-passage through it, and means for operating said valve.

3. The combination, with a cylinder, a steam-chest, a piston, and a hollow piston-rod communicating with said steam-chest and having ports communicating with said cylinder, of a valve-sleeve within the piston-rod and movable longitudinally with respect to the ports thereof, and having a steam-passage through it, and means for imparting to said sleeve longitudinal movement with respect to said ports with each stroke of the piston.

4. The combination, with a cylinder, a steam-chest, a piston, and a hollow piston-rod communicating with said steam-chest and having ports communicating with said cylinder, of a valve-sleeve within the piston-rod and movable longitudinally with respect to the ports thereof, and controlling admission to and exhaust from said cylinder, and having a steam-passage through it, and means for operating said valve.

5. The combination, with a cylinder, a steam-chest, a piston, and a hollow piston-rod communicating with said steam-chest and having ports communicating with said cylinder, of a valve-sleeve within the piston-rod and movable longitudinally with respect to the ports thereof, provided with an exhaust-port through which working fluid may pass from the working side of the piston, and arranged to control admission to and exhaust from said cylinder, and having a steam-passage through it, and means for operating said valve.

6. The combination, with a cylinder, a steam-chest, a piston, and a hollow piston-rod communicating with said steam-chest and having supply-ports communicating with said cylinder on one side of the piston and exhaust-ports communicating with an exhaust-space, of a valve-sleeve within the piston-rod and movable with respect to the ports thereof, having in its sides an exhaust-recess adapted to connect the admission and exhaust ports of the piston-rod, and having a steam-passage through it, and means for operating said valve.

7. The combination, with a cylinder, a piston, and a hollow piston-rod having ports communicating with said cylinder, of a valve-sleeve within the piston-rod, forming the main valve, and adapted to open and close said ports, means for vibrating said sleeve, and a separate cut-off valve within the main-valve sleeve, and adapted to close said ports prior to the closure thereof by the main valve.

8. The combination, with a cylinder, a piston, and a hollow piston-rod having ports communicating with said cylinder, of a valve-sleeve within the piston-rod, forming the main valve, and adapted to open and close said ports, means for operating said valve, and a separate cut-off valve within the main-valve sleeve and adapted to close said ports prior to the closure thereof by the main valve.

9. The combination, with a cylinder, a piston, a steam-chest, and an admission-tube

communicating with the steam-chest and provided with ports communicating with the cylinder, of a main-valve sleeve located within said admission-tube and adapted to open and close said ports, means for operating said valve, and a cut-off valve within said main-valve sleeve and adapted to close said ports prior to the closure thereof by the main valve.

10. In an engine, the combination, with a cylinder, a steam-chest, a piston, and an admission-tube communicating with the steam-chest and having ports communicating with the cylinder, of a variable-cut-off-valve gear controlling the passage of steam through such ports into the cylinder, a throttle-valve, likewise controlling admission to the engine, and means for operating the throttle-valve and variable-cut-off gear in conjunction.

11. In an engine, the combination, with a cylinder, a steam-chest, a piston, and an admission-tube communicating with the steam-chest and having ports communicating with the engine-cylinder, of a main distribution-valve controlling the passage of steam through such ports, means for operating the same, a cut-off-valve sleeve adapted to vary the point of cut-off, a throttle-valve regulating the admission to the cylinder, and mechanism for operating the throttle-valve and cut-off valve, arranged to bring the throttle-valve into action when the cut-off valve is adjusted for early cut-off.

12. In an engine, the combination, with a cylinder, a steam-chest, a piston, and an admission-tube communicating with the steam-chest and having ports communicating with the engine-cylinder, of a sleeve within said admission-tube forming the main distribution-valve, means for operating the same, a sleeve within the main-distribution-valve sleeve forming a riding cut-off valve, a throttle-valve regulating the admission to the cylinder, and mechanism for operating the cut-off valve and throttle-valve, arranged to bring the throttle-valve into action when the cut-off valve is adjusted for early cut-off.

13. The combination, with a cylinder, a piston, a steam-chest, and an admission-tube communicating with the steam-chest and provided with ports communicating with the cylinder, of a main valve regulating the admission to the cylinder, a cut-off valve, a throttle-valve regulating the admission to the cylinder, valve-rods for adjusting said cut-off and throttle valves, a rock-shaft, and arms thereon connected to said valve-rods and occupying different angular positions, whereby as the throttle-valve comes into action the motion of the cut-off valve becomes less rapid.

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

EDWARD THOMAS ADAMS.

Witnesses:

B. T. LEUZARDER,

B. A. BRENNAN.