(No Model.)

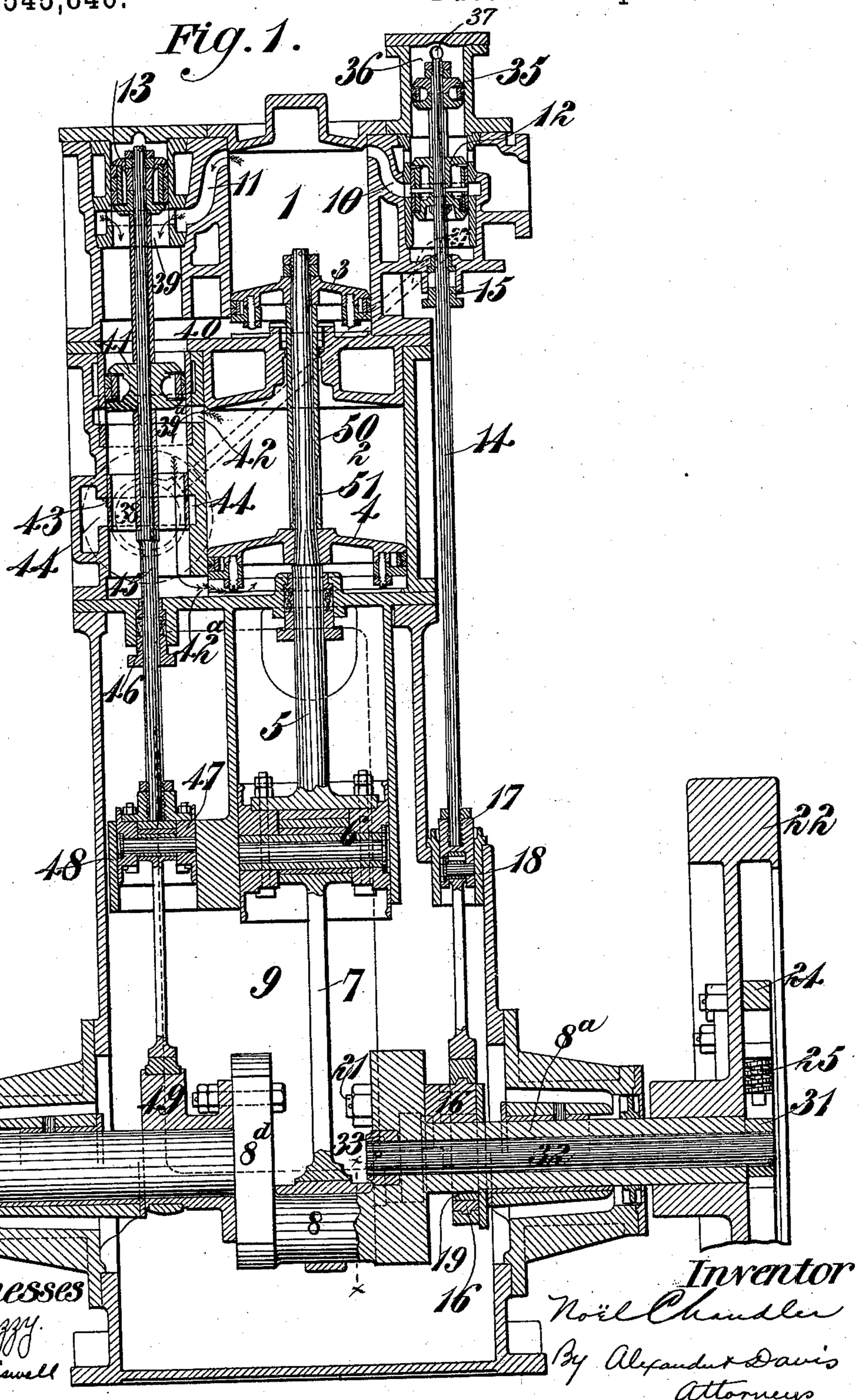
4 Sheets—Sheet 1.

N. CHANDLER.

STEAM ENGINE.

No. 545,846. Patented Sept. 3, 1895.

Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

N. CHANDLER.

STEAM ENGINE.

No. 545,846. Patented Sept. 3, 1895.

Fig. 2.

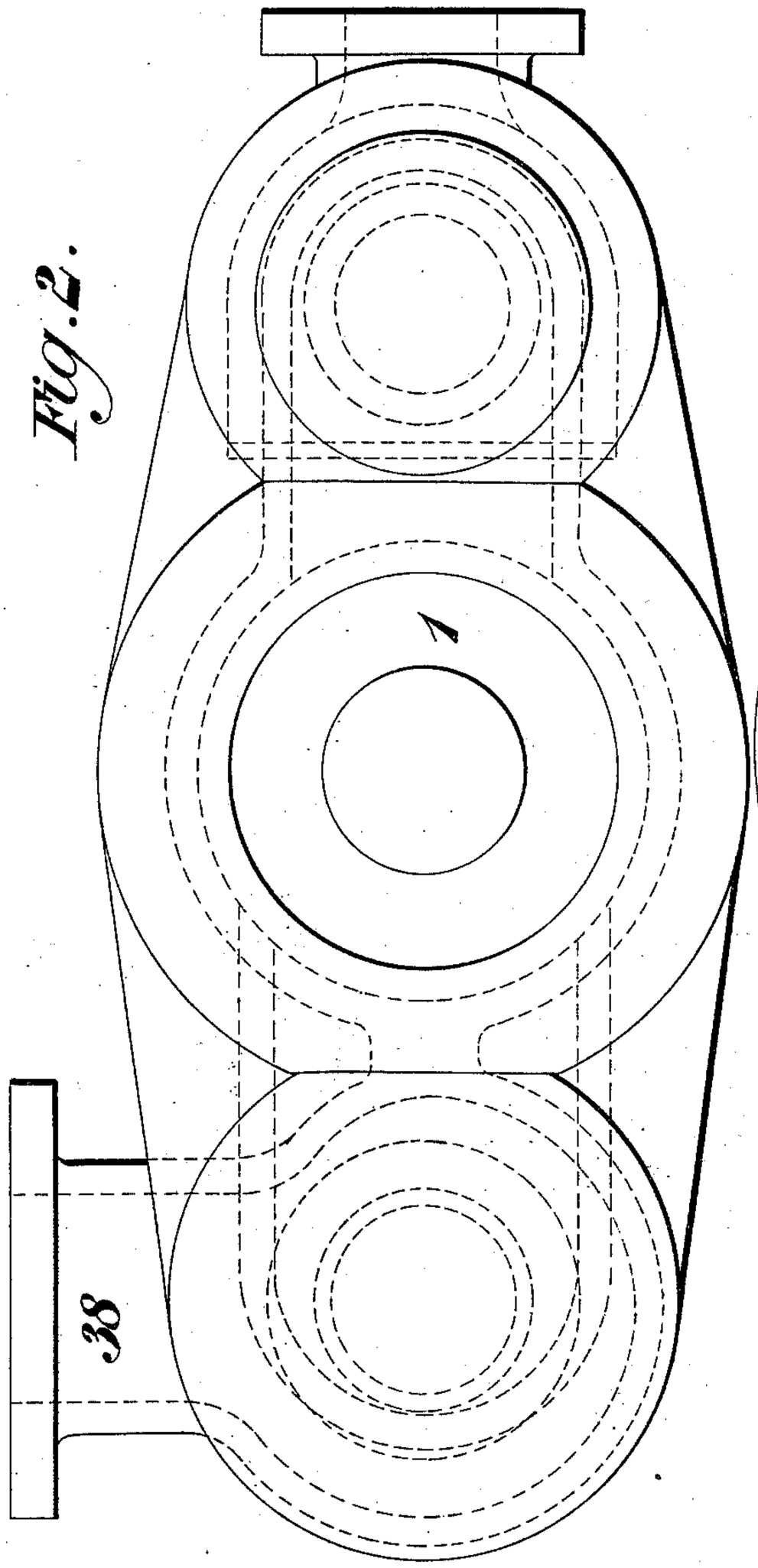
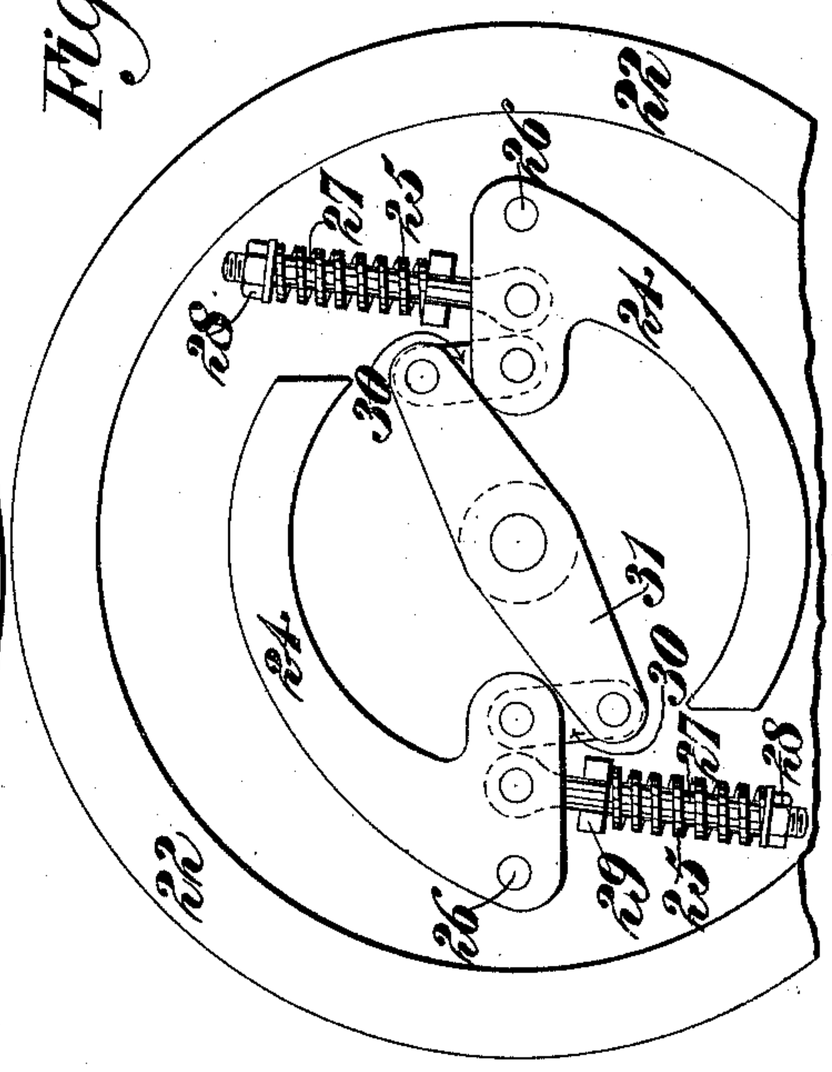


Fig. 4.



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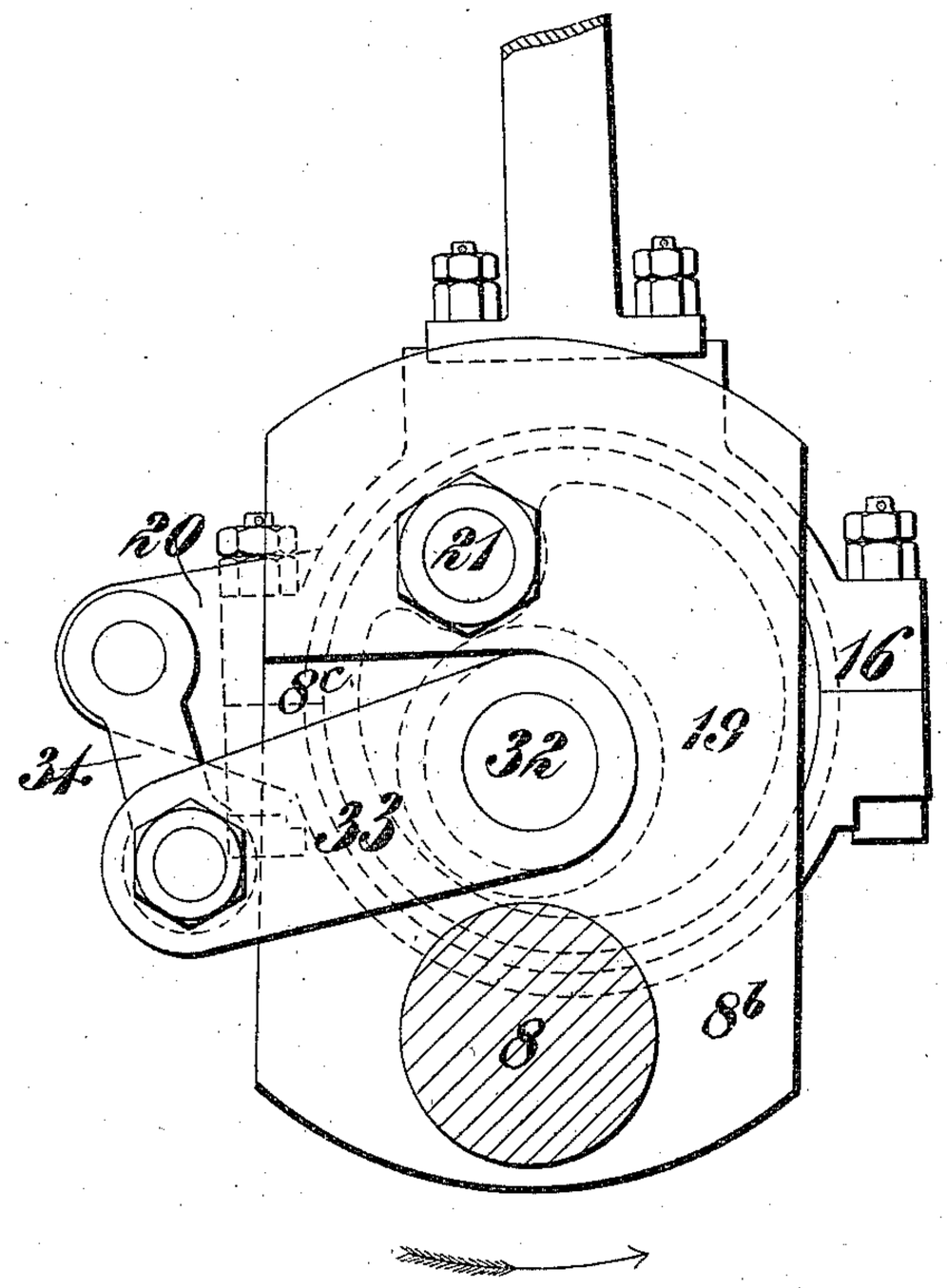
(No Model.) 4 Sheets—Sheet 3.

N. CHANDLER.

STEAM ENGINE.

No. 545,846. Patented Sept. 3, 1895.

Fig. 3.



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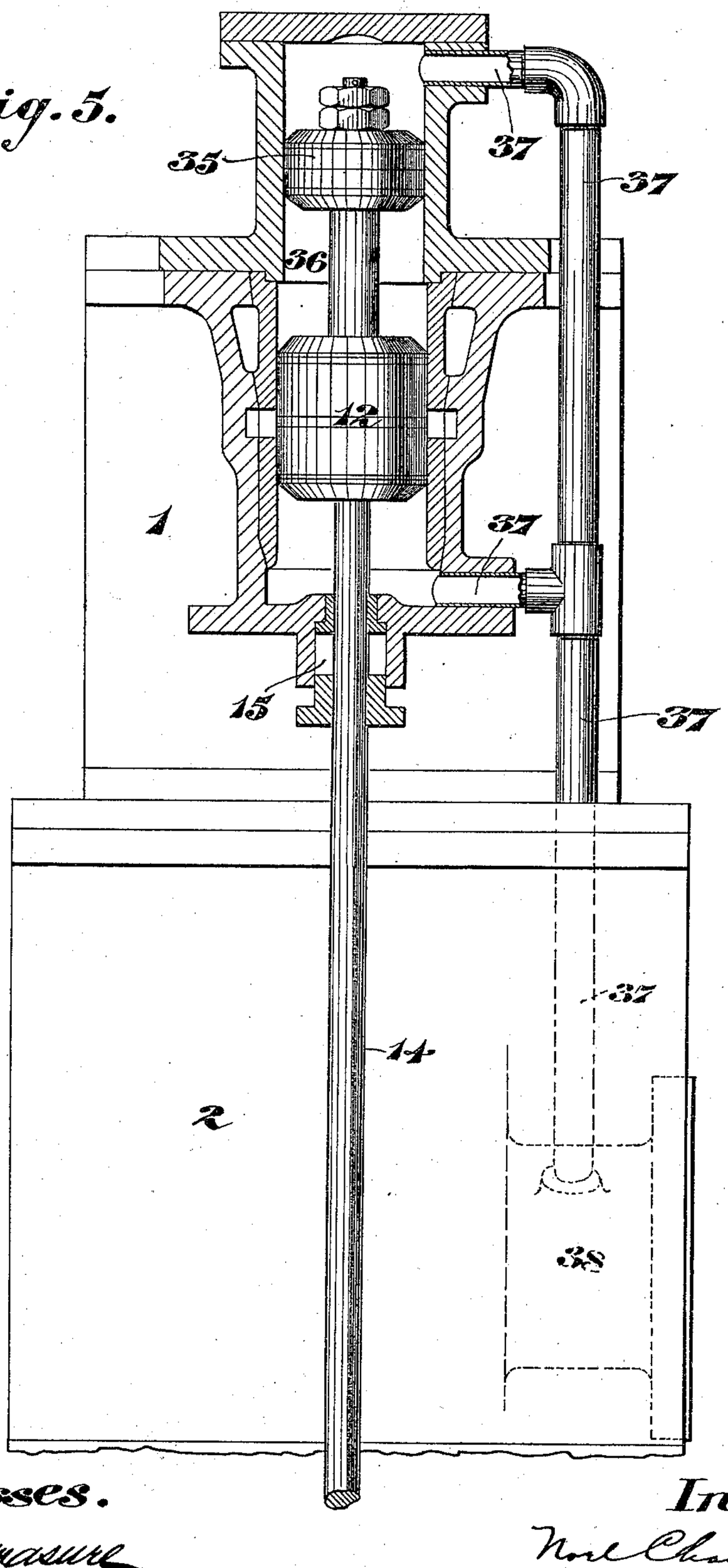
(No Model.) 4 Sheets—Sheet 4.

N. CHANDLER.

STEAM ENGINE.

No. 545,846. Patented Sept. 3, 1895.

Fig. 5.



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UNITED STATES PATENT OFFICE.

NOËL CHANDLER, OF HEDNESFORD, ENGLAND.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 545,846, dated September 3, 1895.

Application filed May 31, 1893. Serial No. 476,017. (No model.)

To all whom it may concern:

Be it known that I, NOËL CHANDLER, a subject of the Queen of Great Britain and Ireland, residing at Hednesford, in the county of Stafford, England, have invented Improvements in Steam-Engines, of which the following is a specification.

This invention of improvements in steam-engines has reference to an improved construction and arrangement of the valves and valve-gear for such an engine whereby the admission of steam to the engine-cylinder or to the high-pressure cylinder of a compound engine can be cut off at any desired point of the piston-stroke without altering the points of exhaust from or compression in the said cylinder or in either of them when more than one is employed, thus improving the efficiency and working of the engine. For this purpose I construct the cylinder, or the high-pressure cylinder in the case of a compound engine, with separate steam admission and exhaust ports and passages controlled by separate and independently-operated steam admission or cut-off and exhaust valves, the cut-off valve or valves being actuated by an eccentric the position of which can be adjusted by hand or automatically by a governor, while the exhaust-valve is operated by a non-adjustable eccentric.

In order that the nature of my invention may be fully understood, I will proceed to explain the same by aid of the accompanying drawings, in which—

Figure 1 is a vertical section of a single-acting compound vertical engine having a closed crank-chamber and provided with valves and valve-gear constructed and operating according to this invention. It also shows the improved means for lubricating the crank-shaft bearings. Fig. 2 is a plan of the engine drawn to a larger scale. Fig. 3 is a cross-section on the line *x x*, Fig. 1. Fig. 4 is an end elevation drawn to a smaller scale than Fig. 1, illustrating a centrifugal governor carried by one of the fly-wheels of the engine. Fig. 5 is a vertical section, to a larger scale, taken through the center of the valve-chest and adjacent parts of the high-pressure cylinder in a plane at right angles to Fig. 1.

1 is the high-pressure cylinder, and 2 the low-pressure cylinder, arranged one above the other, with their pistons 3 and 4 mounted upon a common rod 5, which through the cross-head 6 and coupling-rods 7 works the single driving-crank 8, which is arranged to work in the closed crank-chamber 9. The cylinder 1, according to this invention, is constructed with separate steam and exhaust ports and passages 10 and 11, respectively, that are controlled by separate cut-off and exhaust valves 12 and 13.

The cut-off valve 12 is fixed upon a rod 14, that works through a stuffing-box 15, and is operated from a shifting eccentric 16, the rod of which is jointed to the cross-head 17, to which the valve-rod is fixed, and which works in a bored guide 18. The cut-off eccentric 16, which is mounted within the closed crank-chamber 9, is, in the example shown, made with a central opening 19 for the passage of one end of the crank-shaft 8^a and with an arm or lug 20 and is journaled on a pin 21, that is shown as fixed to an extension of one of the crank-webs 8^b. The position of this cut-off eccentric may be adjusted so as to close the cut-off valve early or late, as may be required, either by hand or automatically by a centrifugal governor, according to the purpose for which the engine is designed. In the example shown, the regulation is effected automatically by a centrifugal governor carried by one of the fly-wheels 22, with which the crank-shaft is fitted outside the crank-shaft bearing 23. This governor, which is of known construction, comprises weights 24, that are subjected to the action of springs 25 and to the action of centrifugal force when the fly-wheel is rotating, the two forces acting in opposite directions. The weights are pivoted to the fly-wheel at diametrically-opposite points 26 on the fly-wheel 22 and have jointed to them rods 27, carrying the coiled springs 24, which abut against the regulating-nuts 28, carried by the said rods and against stops 29, fixed to the fly-wheel, and which have a tendency to oppose the outward movement of the respective weights, due to centrifugal force. The governor may be connected with the eccentric 16 by jointing the weights 24 by links 30 to the two ends of a lever 31, fixed on a spindle 32, that passes through an axial hole in the crank-shaft 8^a and has fixed to its inner end a lever-arm 33, that works in a recess 8^c in the inner

side of the crank-web 8^b, and the outer end of which is connected by a link 34 to the arm or lug 20 on the eccentric. As will be seen, the construction is such that when the speed exceeds the normal the governor will shift the eccentric 16 so as to close the cut-off valve 12 earlier.

To regulate the position of the cut-off eccentric 16 by hand, when the engine is stopped, a handle or lever may be fixed to the outer end of the spindle 32, so as to be capable of being moved by hand and afterward fixed in any desired position.

The cut-off valve 12 may advantageously be balanced. For this purpose a balancing-piston 35 is secured on the valve-rod 14 above the said cut-off valve, the said balancing-piston being of the same cross-sectional area as the valve and fitted to work within a cylinder 36.

37 is a pipe by which the space above the balancing-piston and the space below the cut-off valve can be placed in connection with the exhaust-passage 38, so as to convey any steam leaking past either piston 12 or 35 into the said exhaust-passage. By this arrangement also the stuffing-box 15 will be subjected only to the pressure of exhaust-steam and can be easily kept tight. The exhaust-valve 13 is mounted to work in a cylindrical chamber 39, that is arranged on the opposite side of the cylinder 1 to that at which the cylindrical chamber containing the cut-off valve 12 is arranged, and is in free communication by a port or passage 40 with the lower end of said cylinder.

41 is another valve arranged in the chamber 39^a, and adapted to control the flow of steam from the lower end of the high-pressure cylinder to the upper end of the low-pressure cylinder through the port 42, and to control the exhaust of such steam from the said upper end of the low-pressure cylinder to the lower end thereof through the chamber 39^a and the port or passage 42^a. 43 is a sleeve-valve, through which the said exhaust-steam can freely pass, and which is so adjusted that as the low-pressure piston nears the lower end of its stroke it will close the exhaust-port 44 to a sufficient extent to prevent a vacuum from destroying the compression of steam above the said low-pressure piston and the cushioning of this piston when it reaches the top center.

The three valves 13, 41, and 43 are fixed upon a common rod 45. This rod, which passes through a stuffing-box 46 and is connected by a cross-head 47, working in a bored guide 48, is operated from a non-adjustable eccentric 49, fixed to the webs 8^d of the crank 8.

The operation of the engine is as follows: Assuming the engine to be running and that the pistons 3 and 4 are at or near the end of their upstroke, the valves 12 and 41 are moved down so as to respectively admit high-pressure steam to the upper end of the high-pressure cylinder 1 from the high-pressure steam-chest and low-pressure steam to the upper end of the low-pressure cylinder 2 from the lower end of the high-pressure cylinder through the port 40, upper part of passage 39^a, and port 42, and thereby cause the pistons 3 and 4 to make their next downstroke, the exhaust-valve 13 at this time being closed and the sleeve-valve 43 being open, so as to place the lower end of the low-pressure cylinder in communication with the exhaust-passage 38. At a suitable part of the downstroke of the piston 3, determined by the governor, the valve 12 moves up and cuts off the supply of high-pressure steam to the cylinder 1. As the pistons approach the end of their downstroke, the valves 13 and 41 move upward into the positions shown in Fig. 1, opening the ports 11 and 42, respectively, thereby placing the two ends of each cylinder in communication with each other, so as to effect the cushioning of the pistons on their downstroke, and by nearly equalizing the pressure upon the two sides of each piston facilitating their next upstroke under the action of the fly-wheel of the engine. At this time the sleeve-valve 43 is closed. When the pistons approach the end of their upstroke, the valves 13 and 41 descend and close the ports 11 and 42, respectively, so as to effect the cushioning of the pistons at the end of their upstroke, all the valves at this time moving downward. Just before or at the completion of said upstroke the valve 12 again places the upper end of cylinder 1 in communication with the high-pressure steam-chest, the valve 41 again places the lower end of cylinder 1 and the upper end of cylinder 2 in communication with each other, and the valve 43 again places the lower end of the cylinder 2 in communication with the exhaust-passage 38, whereupon the above-described operations will be repeated. The exhaust-valve 13 is made of sufficient length to prevent it opening the exhaust-port on its downstroke, thereby avoiding the passage of steam to the upper side of said valve from said port.

As will be obvious, single-acting steam-engines of various designs can be constructed with independent cut-off and exhaust valves according to this invention, and a cut-off valve of the kind referred to may be arranged between and so as to control the flow of steam to each of the two high-pressure cylinders of a pair of compound engines.

The high and low pressure pistons may, as in the example shown, be separated by a distance-tube 50, that surrounds the common piston-rod 5, and is formed with steam-passages 51, the inlet and outlet to and from which are so arranged that steam can pass from the under side of the high-pressure cylinder to the upper side of the low-pressure cylinder just before the low-pressure piston completes its upward stroke for the purpose of cushioning such piston, as described in the

specification of another application for Letters Patent filed by me, dated April 5, 1893, Serial No. 469,217.

What I claim is—

1. In a single acting steam engine, the combination of a cylinder, piston and piston rod, a cut-off valve for controlling the admission and cut-off of steam into the cylinder, a crank shaft connected to the piston rod, an eccentric journaled upon a pin, said pin being carried by the crank shaft and set eccentrically to its axis, and means for rotatively adjusting said eccentric on its journal pin, substantially as described.

2. In a steam engine, the combination of a cylinder, a piston and piston rod, a crank shaft, a cut-off valve controlling the admission and cut-off of steam to the cylinder, an eccentric connected to said cut-off valve, said eccentric being journaled eccentrically upon a pin mounted eccentrically to the axis of the crank shaft, a shaft extending axially through the crank shaft and carrying a lateral arm, and means connecting said lateral arm to the eccentric whereby said eccentric may be rotatively adjusted upon its pin, substantially as described.

3. In a single acting engine, the combination of a cylinder having separate admission and exhaust ports, a steam passage connecting the opposite ends of said cylinder, and an exhaust passage adapted to be placed in communication with said steam passage, a cut off valve and shifting eccentric for controlling said admission port, and exhaust valve and eccentric for controlling said exhaust port, and a valve arranged to control said exhaust passage substantially as herein described.

4. In a single acting engine, the combination of a cylinder having separate admission and exhaust ports, a steam passage connecting the opposite ends of said cylinder, an exhaust passage communicating with said steam passage, a cut off valve and shifting eccentric for controlling said admission port, an exhaust valve and eccentric for controlling said exhaust port, and a sleeve valve arranged to work in said steam passage and constructed to admit the passage of steam through itself while its periphery commands the exhaust passage substantially as herein described.

5. In a single acting engine the combination of a high pressure cylinder having separate admission and exhaust ports, a steam passage connecting the opposite ends of said cylinder, a low pressure cylinder, a steam passage connecting the lower end of the high pressure cylinder with the upper end of the low pressure cylinder and also the upper end of the low pressure cylinder with the lower end thereof, an exhaust passage leading from said last mentioned steam passage, a cut off valve and shifting eccentric for controlling the admission of steam to said high pressure cylinder, an exhaust valve and eccentric for controlling the exhaust port of said high pressure cylinder, a valve arranged to control the passage of steam to and from the upper end of the low pressure cylinder, and a valve arranged to control said exhaust passage substantially as herein described.

6. In a single acting engine, the combination of a high pressure cylinder having separate admission and exhaust ports, a low pressure cylinder arranged below said high pressure cylinder, a steam passage in communication with the upper and lower ends of each of said cylinders, an exhaust passage leading from said steam passage, a balanced cut off valve and shifting eccentric for controlling the admission of steam to said high pressure cylinder, an exhaust valve 13 for controlling the passage of exhaust steam from the upper to the lower end of said high pressure cylinder, a valve 41 arranged to control the passage of steam from the lower end of the high pressure cylinder to the upper end of the low pressure cylinder and thence to the lower end thereof, and a sleeve valve 43 the periphery of which controls said exhaust passage, a rod whereon said valves 13, 41 and 43 are mounted, and an eccentric for actuating said valve rod substantially as herein described.

7. In a single acting engine, the combination with the engine cylinder, of an imperforate cut off piston valve fixed to a rod passing through a stuffing box and fitted to work in a steam chamber, an imperforate balancing piston connected to said cut off valve and arranged to work in said steam chamber, a steam admission port to said chamber between said valve and piston, and a steam pipe or passage connecting the parts of said steam chamber at the outer sides of said cut off valve and balancing piston directly with the exhaust pipe or passage substantially as herein described for the purpose specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

NOËL CHANDLER.

Witnesses:

JOHN HENRY FROST,

JOHN HERBERT CHANDLER.