

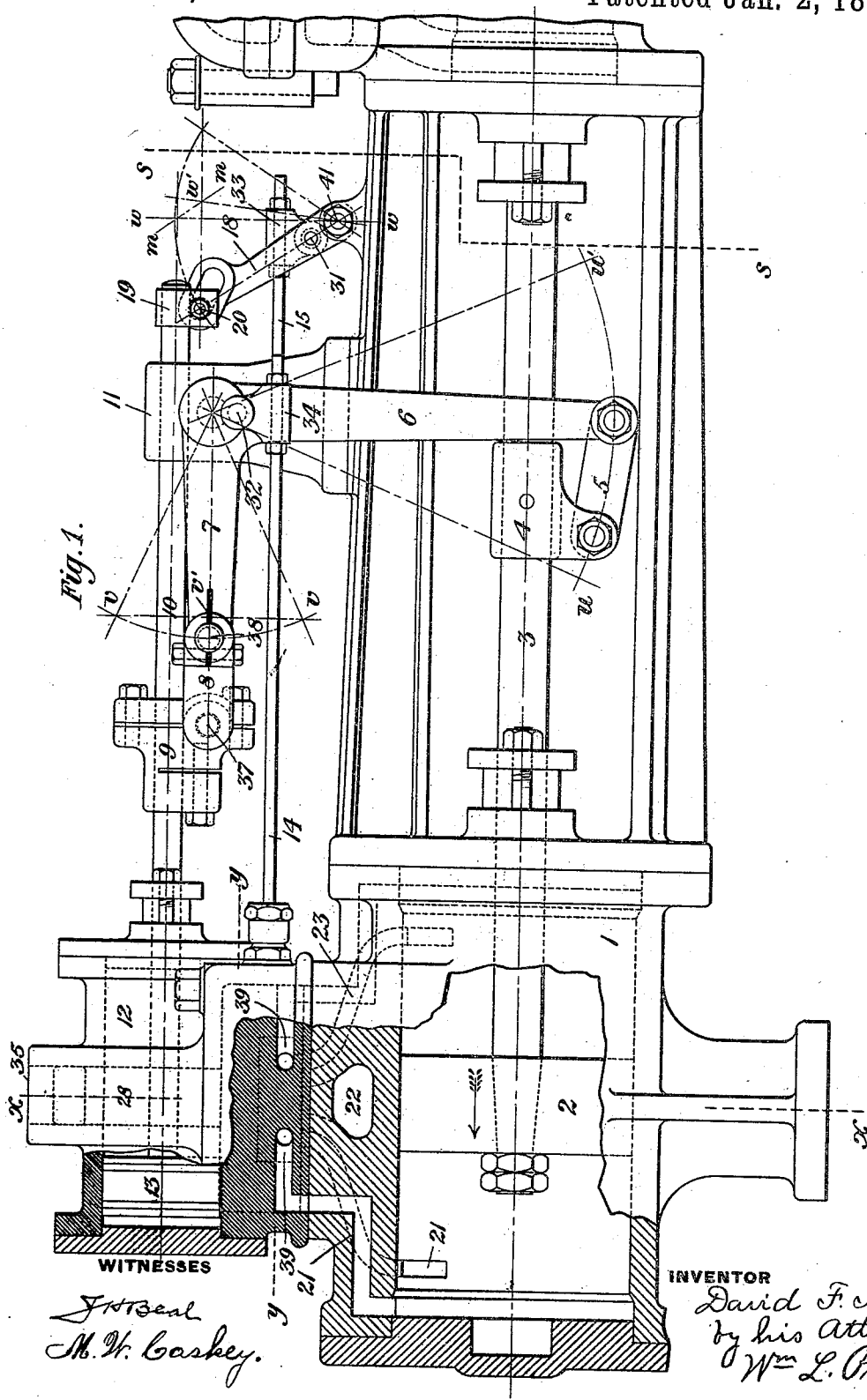
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3 Sheets—Sheet 1.

D. F. NISBET.
DIRECT ACTING STEAM ENGINE.

No. 511,905.

Patented Jan. 2, 1894.



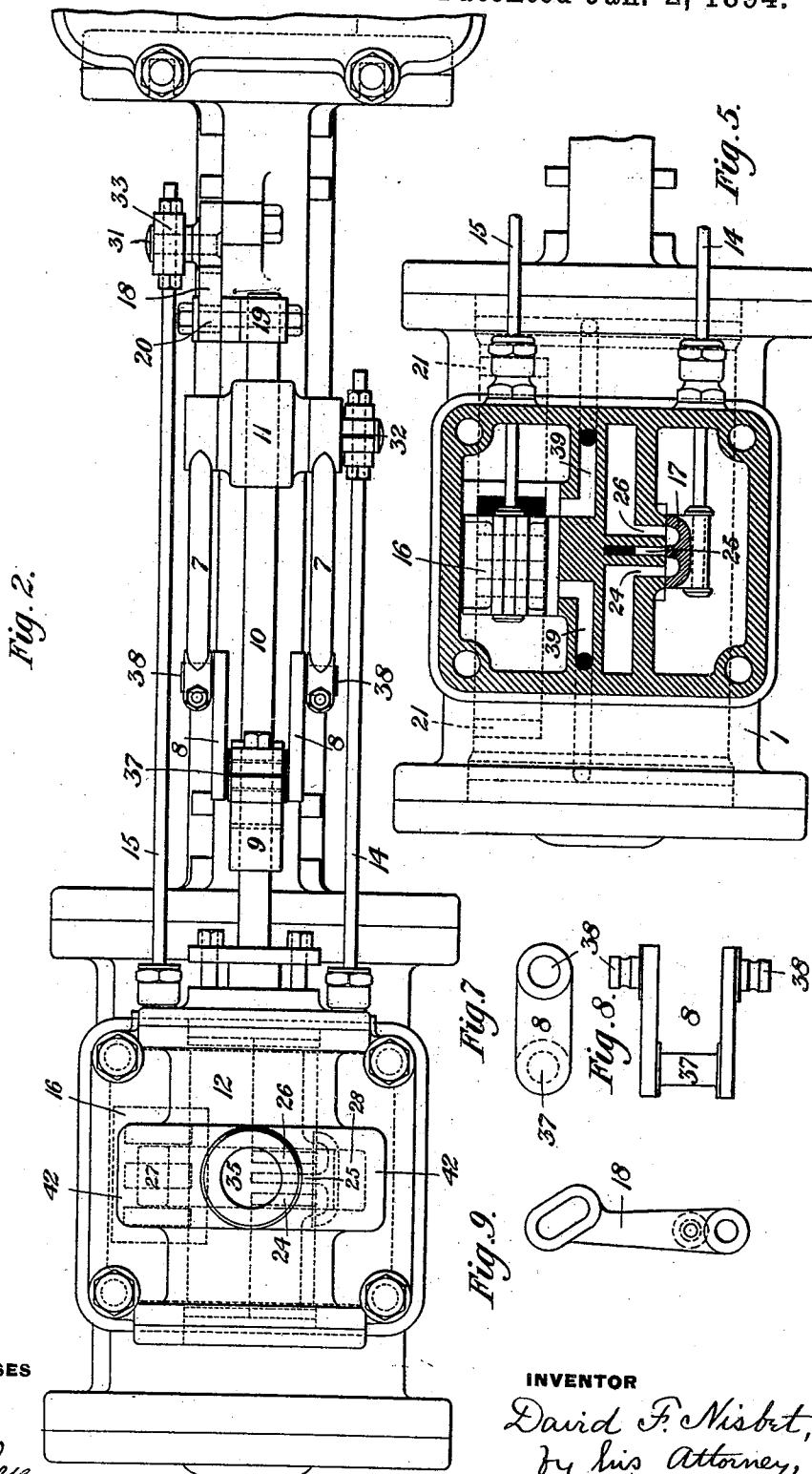
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M. W. Caskey.

INVENTOR

David F. Nisbet,
by his Attorney,
Wm L. Pierce.

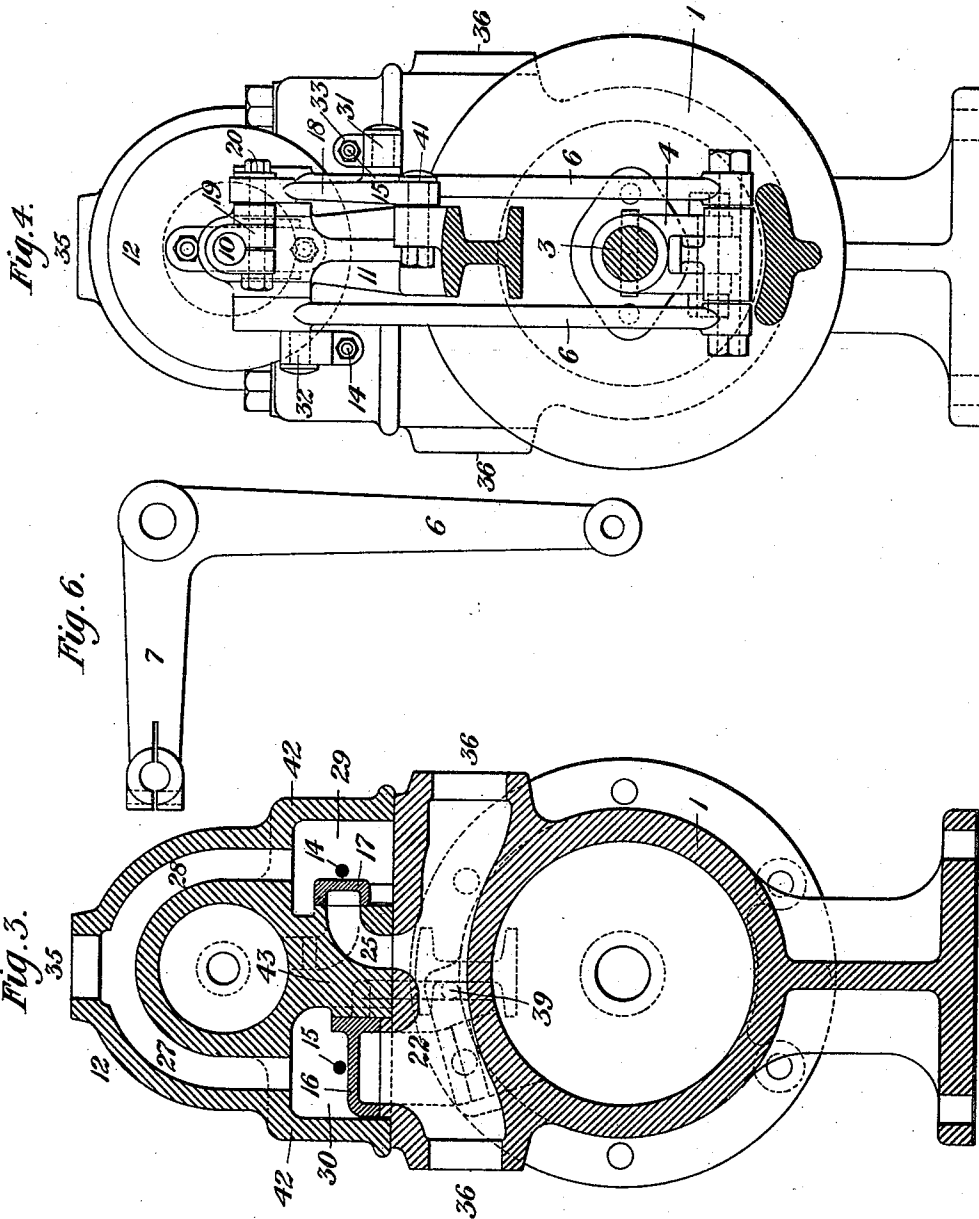
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UNITED STATES PATENT OFFICE.

DAVID F. NISBET, OF ALLEGHENY, PENNSYLVANIA.

DIRECT-ACTING STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 511,905, dated January 2, 1894.

Application filed November 10, 1892. Serial No. 451,578. (No model.)

To all whom it may concern:

Be it known that I, DAVID F. NISBET, a citizen of the United States, residing at Allegheny, in the county of Allegheny and State of Pennsylvania, have invented or discovered new and useful Improvements in Direct-Acting Steam-Engines, of which the following is a specification.

In the accompanying drawings which make part of this specification, Figure I, is a side elevation, showing the main and auxiliary cylinders, the devices by which the piston rods are connected, and the movements of their respective valves controlled. Fig. II, is a plan view of same. Fig. III, is a vertical transverse section on line $x-x$, through the main and auxiliary cylinders. Fig. IV, is a vertical section on line $s-s$, of Fig. I. Fig. V, is a horizontal section on line $y-y$, through the steam chests. Fig. VI, is an elevation of the right angled lever connecting main and auxiliary piston rods. Fig. VII is an end view and Fig. VIII, a plan of the double crank pivoted to right angled lever; Fig. IX, a side elevation of slotted lever through which motion is transmitted from piston rod of auxiliary piston to valve for main cylinder, and Fig. X is a slotted lever.

This invention relates to that class of direct acting, or non-rotative engines, which are usually used with pumps, air compressors, and kindred machinery, and consists principally of a novel arrangement of cylinders, steam chests, valves and ports and devices by which the movements of two piston rods are connected in a manner whereby the lengths, and times of strokes of the main and auxiliary pistons, relatively to one another, the length of travel of the steam valves, the events of admission and exhaust of steam to and from the cylinders, and the relation of these events to their respective piston movements, are made positively; and whereby the pistons make complete strokes at any speed of piston travel, from the minimum to the maximum, without the aid of a "fly-wheel," and furthermore the apparatus is not liable to disarrangement, and is easy of access for purpose of repairs or adjustment, all as is hereinafter more fully described and set forth specifically in the following description and claims.

The parts represented by the reference fig-

ures and letters are identical in the different views.

1, is the main cylinder; 2 the piston for said cylinder, 3 the main piston rod.

4 is a cross-head, on main piston rod.

5 is a link, by which motion is communicated to the right angled levers 6—7.

8 is a double crank the double ends 38, 38 of which are pins and pivoted in the arms 7, 7, and the single end 37 in the cross-head 9 of the piston rod 10, for the auxiliary cylinder.

11, is a post or bearing supporting one end of piston rod 10, and is also the pivotal bearing of the right angled levers 6—7.

12 is the auxiliary cylinder; 13 the piston of auxiliary cylinder.

14, the valve stem moving the valve for auxiliary cylinder.

15 is the valve stem operating the valve for main cylinder.

16 is a **D** valve and is the valve for main cylinder.

17 is a **B** valve and is the valve for auxiliary cylinder.

18 is a slotted lever pivoted at 41, through which motion is transmitted from the piston rod 10, through the clips 19, and pins 20 and 31, to clip 33, valve stem 15 and valve 16; 21 and 23 steam ports to main cylinder; 22 exhaust port for same; 24 and 26 steam ports for auxiliary cylinder.

25 is the exhaust port for the auxiliary cylinder.

27 and 28, are passages leading to steam chests 29 and 30.

31 is a valve driving pin for valve 16.

32, is a valve driving pin for valve 17.

33 and 34 are clips provided with pins 31, 32, the latter on arm 6, and connected to valve stems 15 and 14.

35 is an opening for the steam pipe; 36—36, openings for exhaust pipe on either side. 39—39, are lead ports.

The side extensions 42, 42, of the auxiliary cylinder inclose the steam chests 29 and 30, divided by the vertical longitudinal partition 43, containing ports and having its sides adapted to be used as valve seats.

The operation of my invention is as follows: Assuming that the various parts are in the position shown in Fig. I when steam is admitted, (it is immaterial, however, in what

position the parts may be at the time of starting, as there are no "dead points,") the main piston 2, it will be observed is at half stroke and the auxiliary piston 13 is at the end of its stroke. The valve 16, being operated by the auxiliary piston rod 10 through the clip 19, pin 20, slotted lever 18, pin 31, connection 33 and valve stem 15, is also at the end of its travel. This valve being a **D** valve, it follows that the port 23 is wide open and that the steam or other motive fluid is forcing the piston in the direction shown by the arrow, the motion of the piston rod 3 being communicated through the cross-head 4 and link 5 to the arm 6; the connection 34 will move synchronously with the arm 6, thereby moving the valve stem 14 and valve 17. This valve 17 being a **B** valve, the movement in this direction will ultimately cause the port 24 to be opened, admitting the motive fluid behind the piston 13. Concurrently with the movement of the arms 6 of the right angled levers 6, 7, the arms 7 will move toward the position *V* carrying the pins 38, 38, with them, thus moving the pins 37 and 38, 38, out of the line of centers, and permitting the forward movement of the piston 13 and rod 10. When the main piston 2 shall have reached the termination of its stroke and the center line of the arm 6 coincides with the line or position *u-u*, the pin 38 in arm 7 will have reached the position *V*. At this point the valve 17 being operated by arm 6, will be wide open and the resistance to the movement of the piston 13 will be very slight (owing to the crank 8 being perpendicular to the line of force, and also to causes which will be explained farther on). The piston 13 and rod 10 operating the lever 18 which controls the main valve 16, will move toward the completion of its stroke, and as the pin 37 passes the position shown by the vertical line *V, V'* the port 21 in main cylinder will be opened. It will be observed from the location of the ports 21 and 23 where they enter the cylinder, that just before the main piston 2 reaches the termination of its stroke it will cover one of these openings, and entrap the steam or other motive fluid remaining in the cylinder, thus forming a cushion which will absorb any momentum the parts may have acquired and also relieving the piston rod 10 of any undue stress. To admit steam behind the piston when the main ports are covered I use the lead ports 39, 39 in the smaller sizes of engines. In larger sizes I should use separate ports for admission and exhaust. As the piston 2 reaches the end of its stroke, it opens the port 21, by means of the rod 10, lever 18, valve stem 15, and valve 16; and at the same time admits steam to one of the ports 39, thus admitting steam behind the piston 2, sufficient to reverse the motion and move it past the port 21, when the full volume is admitted, and the piston will then continue its return stroke; the exhaust from port 23 to 23 taking place simultaneously with the openings of

the ports 21 and 39. When the piston reaches the termination of the return stroke, the same cycle of events takes place similarly as described. It will be observed that the nominal center of stroke of the piston rod 10 of the auxiliary cylinder is when the piston 13 has traversed a distance equal to one half its travel, at this point the center of the pin 37 will coincide with the position of the center of the pin 38, when in the position represented in the drawings in Fig. I, but the actual center as regards time of stroke, and the relation of the movements of the pistons 2 and 13, is when the center line of the crank 8 coincides with the vertical line *V, V'*, thus producing an obliquity which must be neutralized in the movement of the valve 16; or in other words, for unequal spaces traversed, in equal times, by the piston rod 10, there must be equal spaces traversed in equal times by the valve 16. To overcome the angularity, and produce an equable travel of the valve 16, I use the slotted lever 18, the center line of the slot, of which, is at an angle to the center line of the lever, the amount of "off set" of the slot being equal to the versed sine of the arc, of the angle subtended by the center line of the arm 7 at its extreme positions. This corrects the error due to the angularity of the crank 8, in relation to the travel of the valve 16. *w-w*, is the center line of lever 18 when vertical; *m-m*, the center line of the slot *w'*; the point *m-m* intersects the chord, and *z-z* the center line of lever passing through *w'*.

It will be observed that by the foregoing described means for operating the valves, I dispense with the use of a fly wheel for avoiding dead points, (as there is no point, but that either valve 16 or 17 is open to one end or the other of their respective cylinders,) and that the construction is simple, the movements positive, the lengths of stroke of each piston alike at all speeds, and the valve movements made with as much precision as with the connecting rods and eccentrics of the fly wheel type, and are so arranged as to be easy of access for adjustment or repair.

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

1. The combination in a steam engine of a main cylinder; a second cylinder superposed thereon; side extensions to said second cylinder inclosing steam chest space and a vertical longitudinal partition dividing said steam chest space, the said partition containing ports and its sides being utilized as valve seats, substantially as described.

2. The combination in a steam engine of a main cylinder an auxiliary cylinder; a piston and rod for each cylinder, and a bell crank lever pivotally connected to said piston rods by a link, and crank respectively, thus compelling a fixed relation of movement between said pistons, substantially as described.

3. The combination in a steam engine of a main cylinder; an auxiliary cylinder, a piston

and rod for each cylinder, a bell crank lever whose arms are pivotally connected to said piston rods; a valve for said auxiliary cylinder and a valve stem actuated from said bell crank lever, substantially as described.

4. The combination in a steam engine of a main cylinder; an auxiliary cylinder; a piston and rod for each cylinder; a bell crank lever whose arms are pivotally connected to said piston rods; a valve for said main cylinder, and the stem for said valve actuated from the auxiliary piston rod by intermediate mechanism, substantially as described.

5. In a steam engine the combination of a main cylinder; an auxiliary cylinder; a piston and rod for each cylinder; right angled levers connected by suitable links to the main piston, and by a double ended crank to the auxiliary piston, substantially as described.

6. In a steam engine, the combination of a main cylinder an auxiliary cylinder superposed thereon; a piston and rod for each cylinder; right angled levers having one pair of arms connected by suitable links with said main piston and a double crank having at one end pins connected with the other pair of arms and at the other end a pin connected with the auxiliary piston rod, substantially as described.

7. In a steam engine, the combination of a main cylinder; an auxiliary cylinder; a piston rod for each cylinder; the valve and stem of said main cylinder, a lever pivotally attached to said valve stem and having an oblique slot in one end by which it is pivotally connected with the auxiliary piston rod, substantially as described.

8. In a steam engine, the combination of a piston rod; a valve stem and a slotted lever connecting the rod and stem, the slot in said lever being inclined with reference to the center line of said lever, substantially as described.

9. In a steam engine, the combination of a main steam cylinder; an auxiliary steam cylinder; a piston and rod for each; a main piston valve and stem; an auxiliary piston valve and stem and intermediate mechanism whereby the main piston valve stem is actuated from the auxiliary piston rod and the auxiliary valve stem from the main piston rod, substantially as described.

In testimony whereof I have hereunto set my hand this 25th day of October, A. D. 1892.

DAVID F. NISBET.

Witnesses:

A. D. WILKIN,
WM. L. PIERCE.