

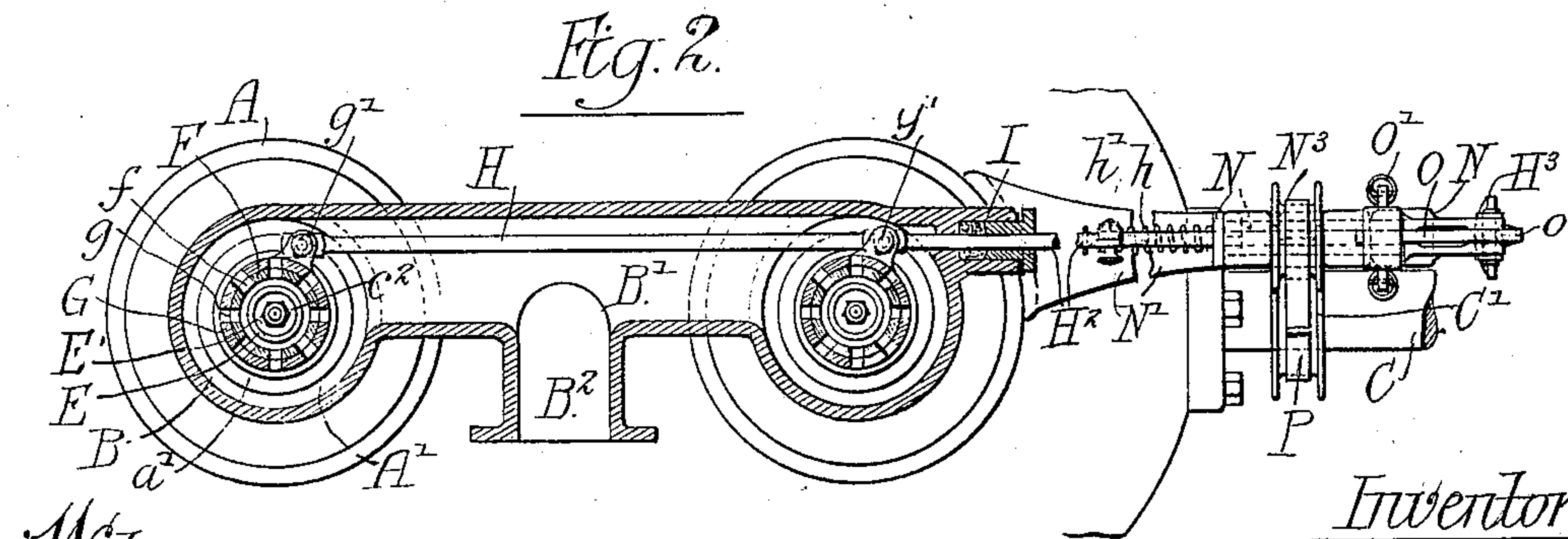
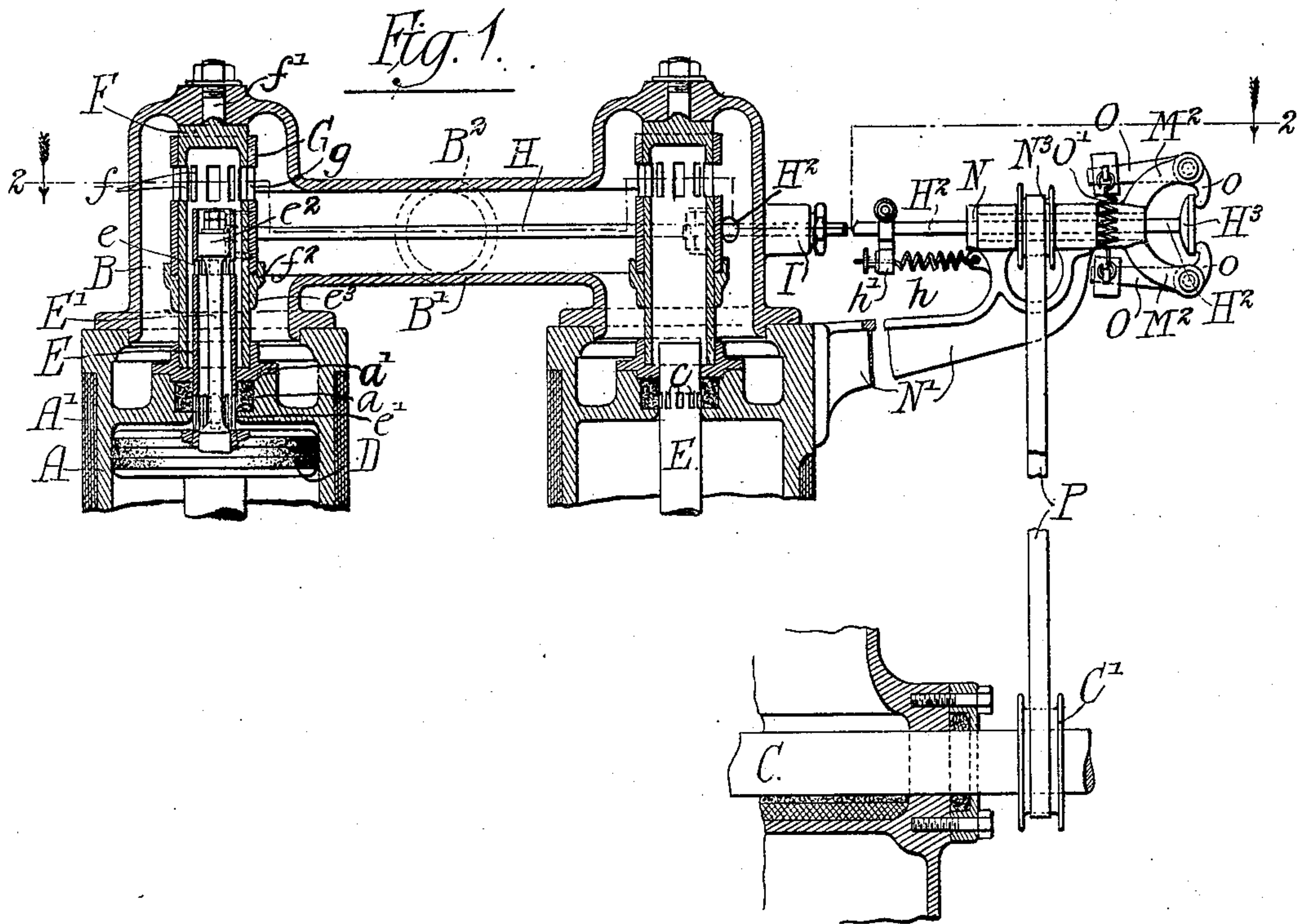
(No Model.)

3 Sheets—Sheet 1.

M. C. BULLOCK.
STEAM ENGINE.

No. 564,000.

Patented July 14, 1896.



Witnesses:-

Louis M. F. Whitehead.

John W. Adams

Inventor:-

Milan C. Bullock.

By:-

Dayton Poole & Brown

His Attorneys.

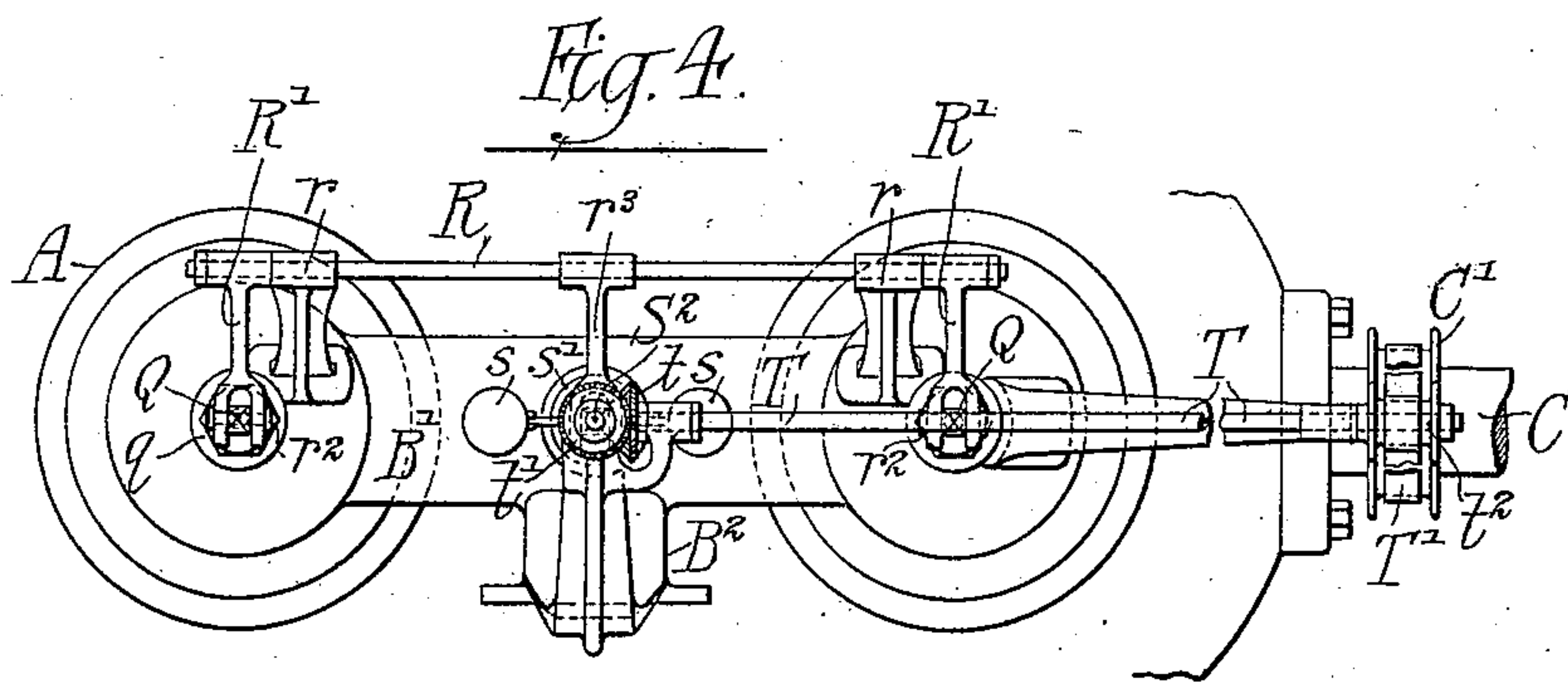
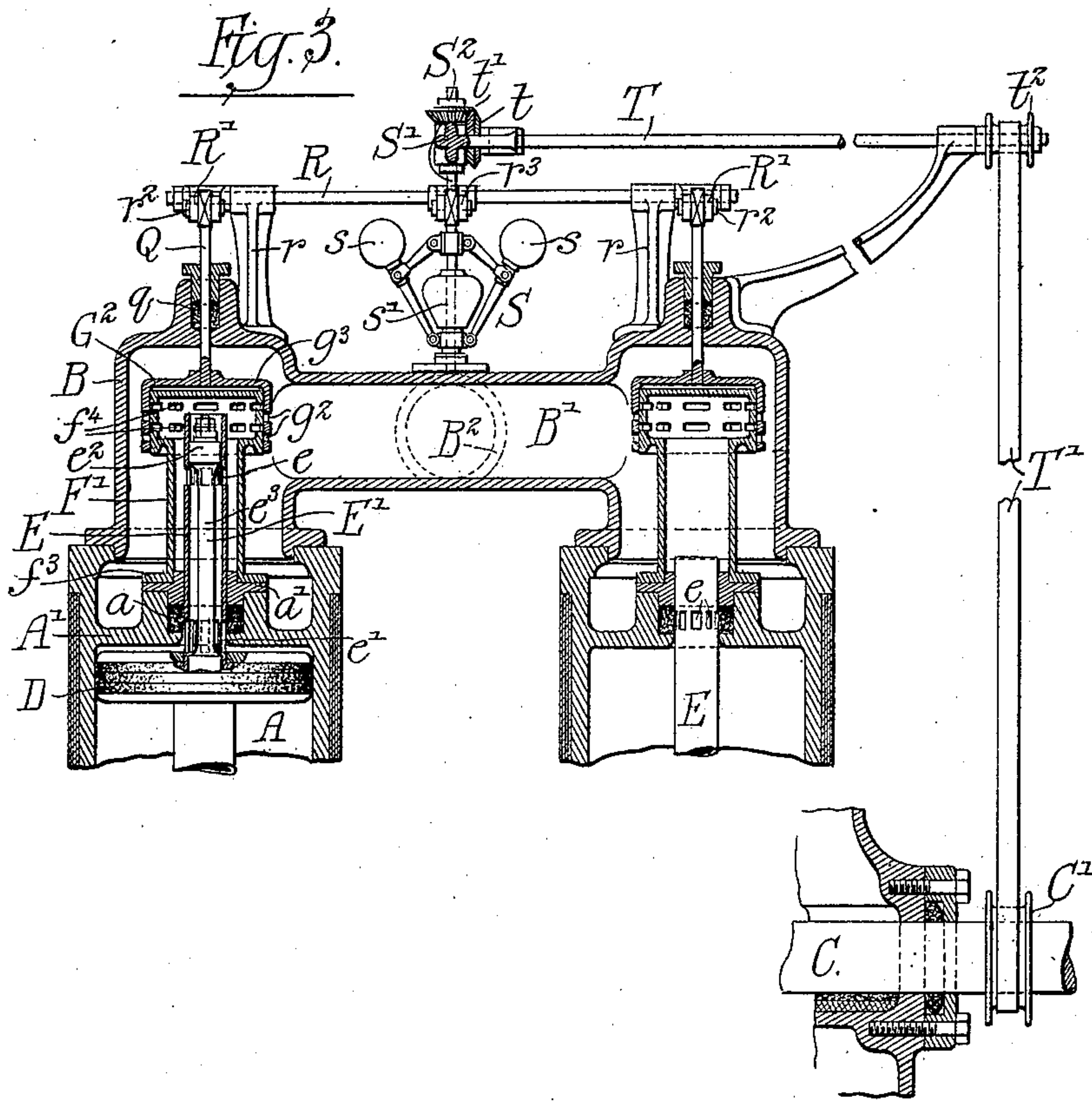
(No Model.)

3 Sheets—Sheet 2.

M. C. BULLOCK.
STEAM ENGINE.

No. 564,000.

Patented July 14, 1896.



Witnesses:-

Louis H. F. Whitehead.

John W. Adams

Inventor:-

Milan C. Bullock.

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His Attorneys.

(No Model.)

3 Sheets—Sheet 3.

M. C. BULLOCK.
STEAM ENGINE.

No. 564,000.

Patented July 14, 1896.

Fig. 5

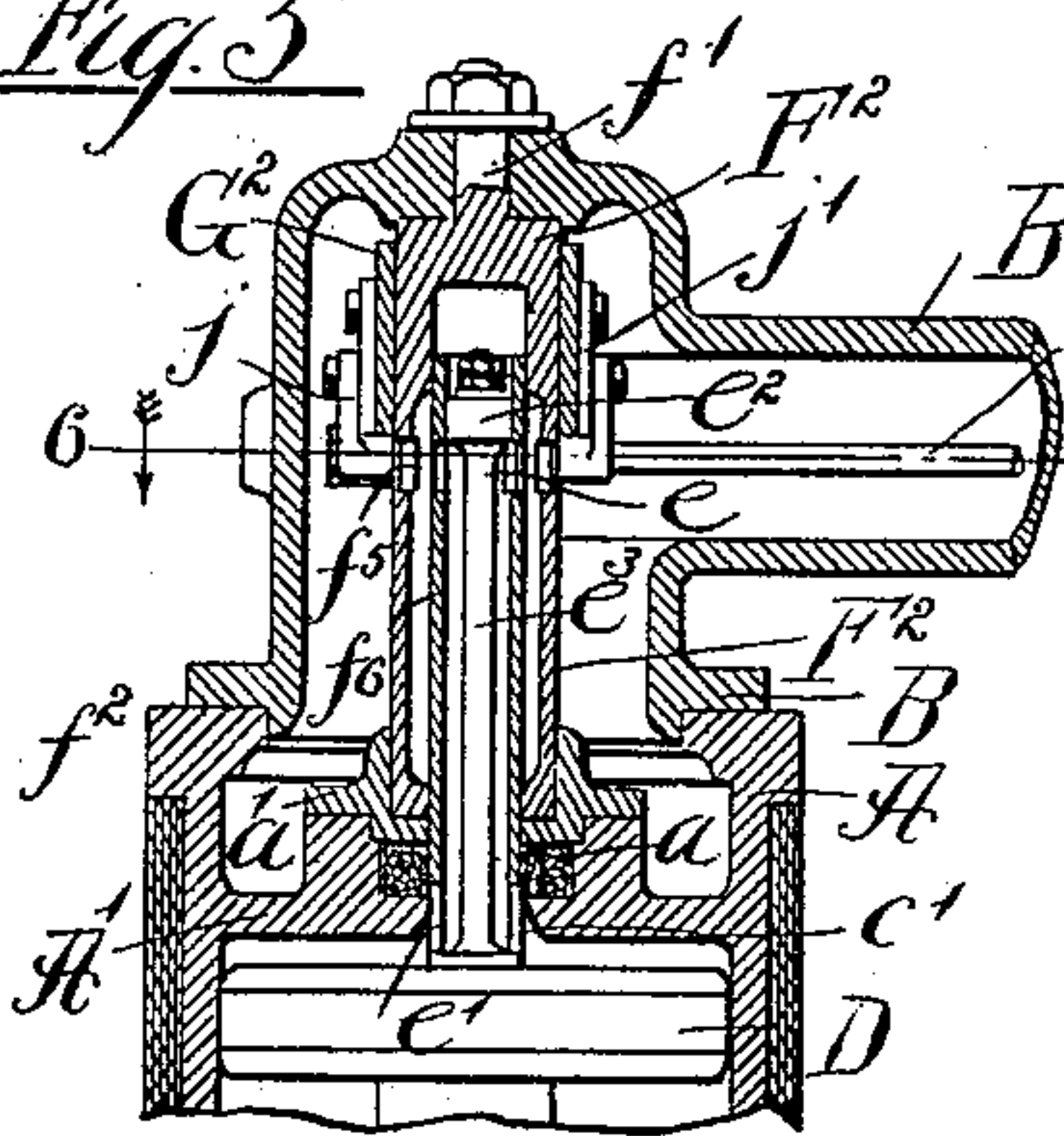


Fig. 6

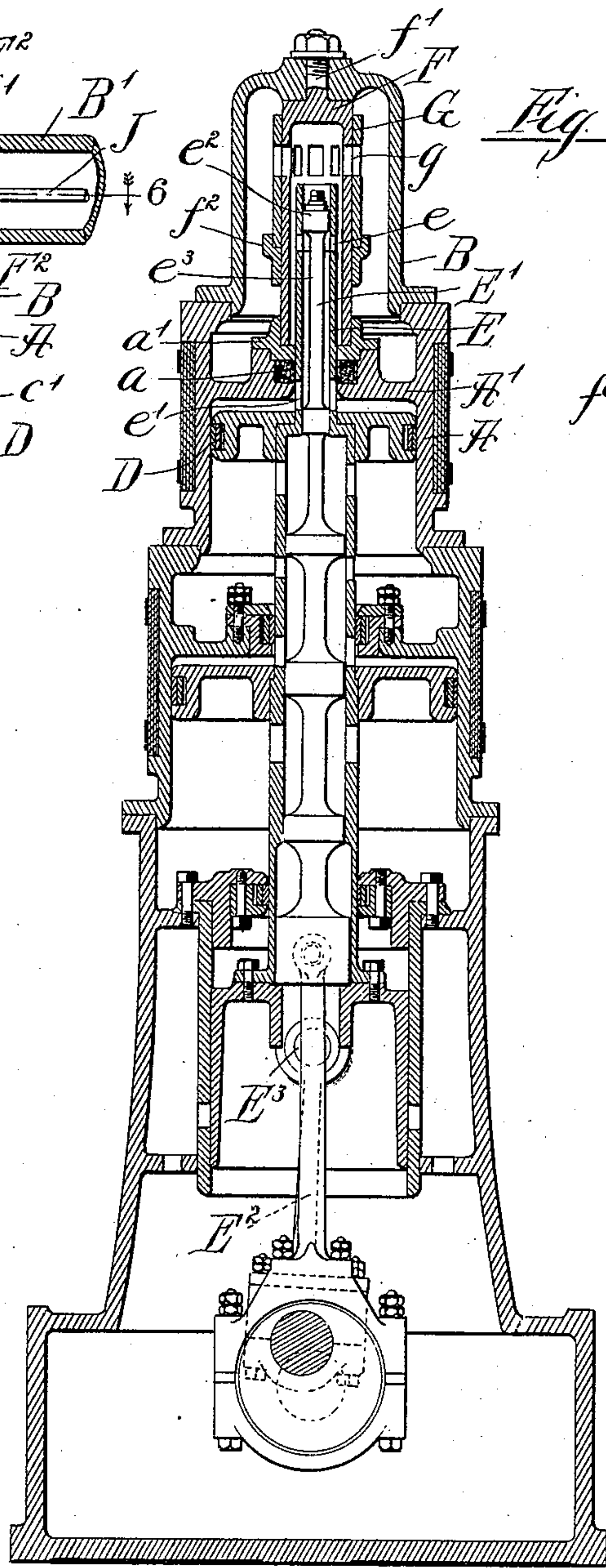
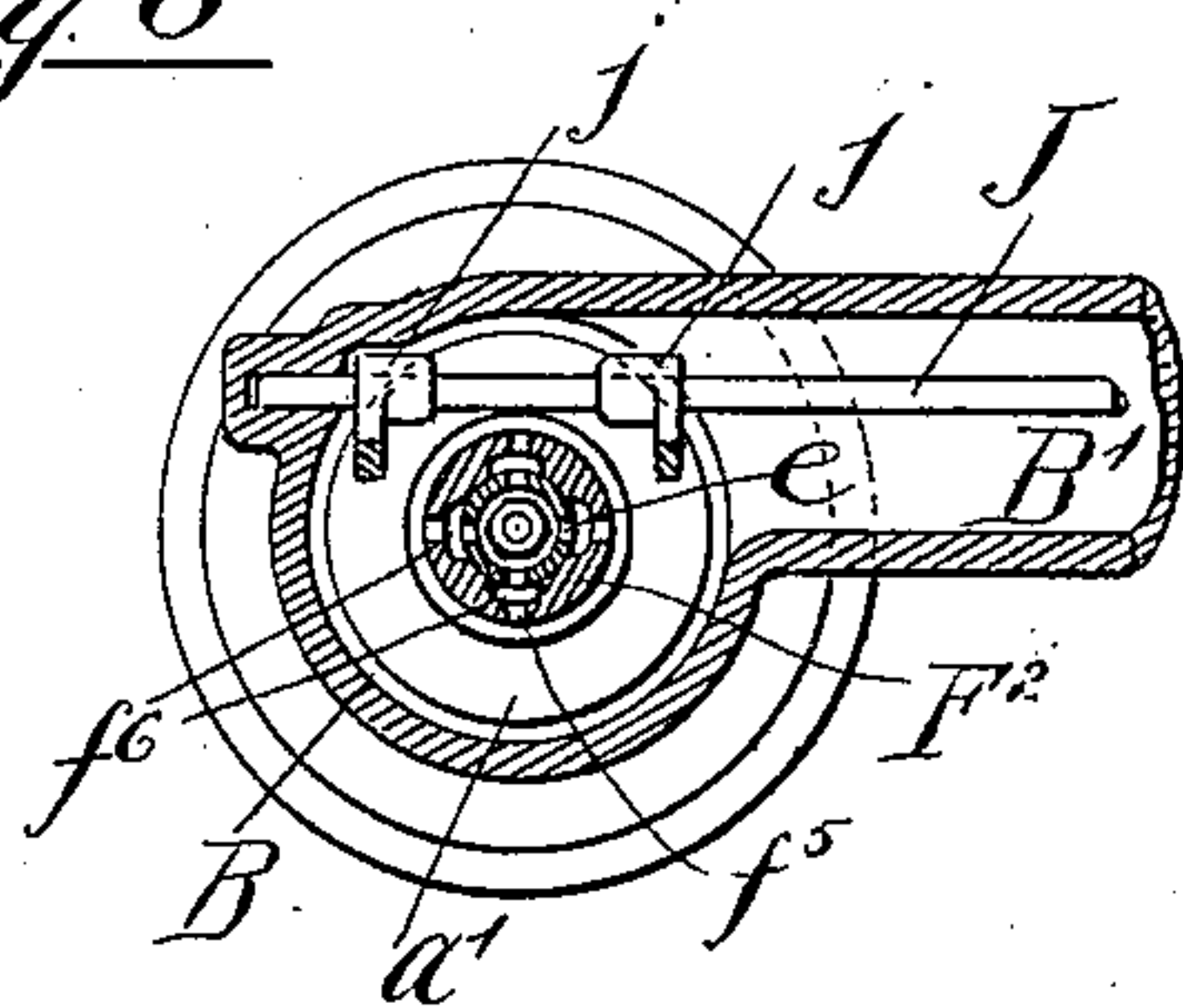


Fig. 7

Witnesses

Edw. H. Hamlin
R. G. L. Vivian

Inventor

M. C. Bullock

By *Wayton, Poole & Brown*
his Attorneys

UNITED STATES PATENT OFFICE.

MILAN C. BULLOCK, OF CHICAGO, ILLINOIS.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 564,000, dated July 14, 1896.

Application filed January 31, 1894. Serial No. 498,634. (No model.)

To all whom it may concern:

Be it known that I, MILAN C. BULLOCK, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to steam-engines of that kind having a hollow or tubular piston-rod through which steam is admitted to the cylinder of the engine.

The invention consists of the matters hereinafter described, and pointed out in the appended claims.

The features to which my invention relates are herein shown as applied to a single-acting engine having a plurality of steam-cylinders located side by side, a single crank-shaft, pistons in the cylinders, piston-rods acting on the crank-shaft, and steam-chests located adjacent to the cylinder-heads, said piston-rods being tubular and extending through the cylinder-heads into the steam-chests, the engine shown in these respects being like that described and illustrated in a prior patent, No. 339,242, granted to P. W. Willans April 6, 1886.

In the accompanying drawings, illustrating my invention, Figure 1 is a sectional view of the steam-chests and adjacent parts of the cylinders of a throttling-governor engine, together with a part of the crank-shaft, it illustrating one embodiment of my invention. Fig. 2 is a sectional plan view of the same parts, taken on line 2 2 of Fig. 1. Fig. 3 is a view similar to Fig. 1, showing another embodiment of my invention. Fig. 4 is a plan view of Fig. 3. Fig. 5 is a detail section of one steam-chest, showing a construction slightly different from that of Fig. 1. Fig. 6 is a plan section of the same, taken on line 6 6 of Fig. 5. Fig. 7 is a sectional view taken through one set of cylinders of a two-cylinder engine, illustrating a connection for operating the central valve from the connecting-rod of the engine.

As shown in Figs. 1 to 6 of the drawings, A A indicate two engine-cylinders; B B,

steam-chests connected with the ends thereof; C, a crank-shaft operated by the pistons within the cylinders, one of which pistons is indicated at D. The cylinders A A may be considered as representing the steam-cylinders of a single-acting two-cylinder simple or compound engine, or said cylinders may be the high-pressure cylinders of a single-acting double-tandem compound engine, such as is shown in said prior Willans patent, the improvements constituting my invention being applicable to both simple and compound engines. The steam-chests B B are shown as connected by a steam-pipe B', to which steam is supplied through a main supply-pipe B², leading from the boiler or steam-generator. To each piston D is attached a hollow piston-rod E, which passes through the upper wall or head A' of the cylinder into the steam-chest B, said upper wall or head of the cylinder forming a diaphragm or partition, which separates the cylinder from the steam-chest in the same manner as in the construction shown in said prior Willans patent. The cylinder-head or partition A' is provided with a packing or stuffing box *a*, closed by a gland or ring *a'*, by which the escape of steam past the piston-rod is prevented in the usual manner. The hollow piston-rod E is provided with inlet-ports *e* and with exit-ports *e'* for the passage of steam through said rod to the upper end of the cylinder A. Said ports are controlled by an internal valve within the hollow piston-rod. Such internal valve may be operated to control the admission of steam to the cylinder in any suitable manner—as, for instance, as shown in said prior Willans patent or by an oscillating valve such as is shown in my prior patent, No. 533,157, granted January 29, 1895.

In Fig. 7 I have shown an actuating device by which the internal valve is operated from the connecting-rod of the engine, E² in said figure indicating the connecting-rod and E³ a lateral arm or projection thereon by which the valve E is operated through the oscillatory movement of the connecting-rod.

Means for permitting the escape of exhaust-steam from the cylinder are not herein shown, and the same may be of any suitable construction—such, for instance, as that shown

in the said prior Willans patent or that shown in my prior patent above referred to.

Referring now more particularly to the parts concerned in the present invention, F indicates a wall or tubular partition arranged within the steam-chest and located in axial alignment with the hollow piston-rod, said wall or tubular partition being closed at its upper end, so as to constitute in effect an inclosure or chamber within the steam-chest in which the upper end of the hollow piston-rod reciprocates. Said tubular partition F is provided with steam-ports ff , through which steam passes from the steam-chest to the interior of the same. A steam-tight joint is shown as formed between the said tubular partition and the cylinder-head. In Figs. 1 and 2 such joint is formed by fitting the tube F at its lower end in a cylindric recess formed in the cap a' of the stuffing-box a , the tube being held in place in the latter instance by a stem f' , which passes upwardly through a central opening in the top wall of the steam-chest, and is held by a nut applied to its upper end.

To now refer more particularly to the construction of the operative parts illustrated in said Figs. 1 and 2, the tubular partition or tube F is in this instance made somewhat greater in diameter than the piston-rod, so as to permit free access of steam to the steam-inlet ports ee of the piston-rod notwithstanding the reciprocatory motion of the piston-rod in the tube. Said ports ff are controlled by means of an oscillating valve-ring or sleeve G, which surrounds the tube F, and is provided with ports gg , located at the same distance apart as or corresponding in angular arrangement with the ports ff of the tube F. The valve-ring G is shown as resting at its lower edge on a collar or bearing-shoulder f^2 on the exterior of the tube F. The valve-ring or sleeve G is connected with and actuated by a suitable governing mechanism, as will be hereinafter described. It will, of course, be understood from the above that the said valve-ring G does not in said Figs. 1 and 2 directly control the admission of steam to the cylinders, a main steam-valve, such as the valve e^2 , which is located within the hollow piston-rod and attached to a valve-stem e^3 ,—that is to say, in the construction in the figures of the drawings last referred to the said sleeve G and the governor which actuates it act merely to control the steam supply to the main or engine valve in whatever form the latter may be constructed. The two valve-rings G G (shown in said Figs. 1 and 2) are connected with each other by a connecting-rod H, engaging lugs $g'g'$ on the valve-rings. A sliding stem H^2 , attached to the rod H and passing through a stuffing-box I, serves to communicate motion from the governor to the parts within the steam-chest.

The governing device illustrated in said

Figs. 1 and 2 is constructed as follows: N is a hollow shaft mounted in a bracket N' in axial alinement with the stem H^2 , which latter stem passes through said shaft N. At its outer end the hollow shaft is provided with two arms $M^2 M^2$, to the outer ends of which are pivoted weighted levers O, having inwardly-extending lever-arms oo , which bear against a disk H^3 attached to the outer end of the rod H^2 . Springs $O'O'$ act to draw inwardly the free ends of the weighted levers O O, and a spring h , applied between the bracket N' and an arm h' on the stem H^2 , acts to hold the disk H^3 in contact with the lever-arms oo . The shaft N is provided with a belt-pulley N^3 , and the crank-shaft C of the engine is provided with a belt-pulley C', from which motion is transmitted to the shaft by means of a driving-belt P, passing over said pulley C' and the pulley N^3 . The spring h holds the disk H^3 against the lever-arms oo , and when the weighted levers are thrown outwardly by centrifugal action the stem H^2 is moved endwise against the action of said spring h , thereby shifting both valve-rings G G at the same time and cutting off the supply of steam to both cylinders to an equal extent.

In Figs. 3 and 4 I have shown a throttling-governor applied to actuate a sliding valve-ring G^2 , instead of an oscillating valve-ring. In this instance a tube F' is provided within the steam-chest, which tube is made larger than the piston-rod, so as to leave a steam-space around the piston-rod, as described in connection with Figs. 1 and 2, but which is in some other respects different from that shown in the latter figures. In this instance the tube F' terminates at its top some distance below the upper wall of the steam-chest, and is secured rigidly in place by means of a flange f^3 at its lower end, which flange rests on the top of the stuffing-box, and is secured thereto by bolts. The said tube F' is provided near its upper end with annularly-arranged inlet-ports $f^4 f^4$, herein shown as placed in two annular rows, the ports in this instance being made narrow vertically in order to secure a large steam admission with a slight vertical movement of the valve-ring and in order to secure ample steam area in the ports while retaining the minimum width of the same. The said tube F' is shown as enlarged or made of greater diameter in its upper part, where said ports are located, than elsewhere. A valve-ring G^2 is employed in this case, having a number of rows of steam-inlet passages or ports $g^2 g^2$, corresponding with the ports $f^4 f^4$. There being in this instance two rows of ports $f^4 f^4$, the ring G^2 is provided also with two rows of ports $g^2 g^2$, which act in connection with both of said rows of ports $f^4 f^4$. The ring G^2 is, as shown in the said Figs. 3 and 4, actuated through the means of a valve-stem Q, which passes through a stuffing-box q in the top wall of the steam-chest, and is con-

5 nected with the said ring G^2 by means of a
 plate g^3 , which extends over the closed upper
 end of the tube F , in the manner shown.
 The valve-stems Q Q , belonging to the two ad-
 10 jacent cylinders of the engine, are actuated
 through the medium of a horizontally-ar-
 ranged rock-shaft R , which is mounted in
 brackets r over the steam-chests, and is pro-
 15 vided with arms R' , which extend horizontally
 therefrom and are connected with the upper
 ends of the valve-stems Q by pivot-pins r^2 ,
 which pass through slots in the ends of the
 arms R' to prevent binding of the parts in the
 oscillatory movements of said arms. S indi-
 20 cates, as a whole, a centrifugal weight-gov-
 ernor, of common form, of which s s are the cen-
 trifugally-acting weights and s' the weight
 surrounding the central spindle of the gov-
 ernor and acting to draw inwardly the weights
 25 s s , and also to move the valves in one direc-
 tion. The governor S is shown as mounted
 on a bracket S' located between the steam-
 chests, and is driven by a horizontal shaft T
 through the medium of bevel-gears t t' , said
 30 shaft having at its outer end a belt-pulley t^2 ,
 over which is trained a driving-belt T' , which
 passes over a driving-pulley C' on the engine
 crank-shaft C . The central spindle S^2 of the
 governor S is connected with and acts on a
 35 horizontal arm r^3 of the rock-shaft R , the ac-
 tion of the weight s' tending to depress said
 rod S^2 , and to thereby turn the rock-shaft in a
 direction to depress the valve-rings G^2 G^2 .
 The centrifugal action of the governor-weights
 40 tends to lift the rod S^2 , and thereby turn the
 rock-shaft in a direction to lift the valve-rings
 G^2 and to cut off the supply of steam to the
 engine. The hollow piston-rod E is in this
 case shown as provided with steam-inlet
 45 ports e and as containing an internal piston-
 valve e^2 , attached to a valve-stem e^3 , said pis-
 ton-valve acting in the same manner as the
 similar piston-valve shown in the prior Wil-
 lans patent to control the admission of steam
 to the cylinder.

In Figs. 5 and 6 I have shown a construc-
 tion similar to but some what different from
 that shown in Figs. 1 and 3. In this instance
 50 the hollow piston-rod is provided with lat-
 eral steam-inlet ports e e near its upper end,
 through which steam is admitted to the hol-
 low piston-rod in the same manner as in the
 construction hereinbefore described, and a
 tubular partition F^2 is employed, having ports
 55 f^5 f^5 , located at a point below the upper limit
 of the movement of the top of the piston-rod.
 In this case the piston-rod fits closely within
 the tube F^2 , the walls of which are made con-
 siderably thicker than those shown in Figs. 1
 60 and 3, and a tube is provided in its inner sur-
 face at points opposite the ports e e with longi-
 tudinal grooves or passages f^6 f^6 , which are
 connected with the steam-inlet ports f^5 f^5 and
 extend vertically along the inner surface of
 65 the tube a distance equal, or nearly so, to the
 stroke of the piston-rod. The passages thus
 arranged afford communication between the

steam-inlet ports f^5 and the ports e throughout
 the greater part of the stroke of the piston-rod
 and during all of the time when it is necessary
 70 to admit steam into the cylinder. It is, of
 course, understood that the ports e of the hol-
 low piston-rod may pass downwardly below the
 lower end of the tube F in the downstroke of
 the piston-rod without detriment, as is com-
 75 mon in the Willans engine referred to, it be-
 ing practically unnecessary to continue the
 supply of steam to the cylinder up to the ex-
 treme end of the stroke of the piston. The con-
 struction described has the advantage of sav-
 80 ing much clearance or steam-space within the
 tube F^2 , there being in this construction no
 steam-space provided within said tube except-
 ing that actually necessary for the passage of
 the steam from the ports therein to the ports
 85 in the piston-rod. In said Figs. 5 and 6 a
 valve-ring G^2 is employed, which is arranged
 to slide vertically on the tube F^2 , and is ac-
 tuated by means of a rock-shaft J , having rigid
 arms j j , which are connected with the sleeve
 90 G^2 by means of links j' j' . When such a rock-
 shaft is employed, it will extend through the
 side walls of one of the steam-chests and will
 be actuated by a governing device—such, for
 instance, as that shown in Figs. 3 and 4. 95

It will be noted that in all the forms of con-
 struction hereinbefore described the tubular
 partition or the tube within the steam-chest
 constitutes in effect a stationary tubular ex-
 100 tension of the hollow piston-rod, having slid-
 ing or telescopic connections therewith, and
 forming a passage through which steam is ad-
 mitted to the said hollow piston-rod. It will
 also be observed that by applying to said sta-
 tionary tubular wall or partition a valve for
 105 controlling the admission of steam to the hol-
 low piston-rod such valve may be made of
 simple form and so located as to be readily
 connected with valve actuating or govern-
 ing devices. The employment of said station-
 110 ary tubular partition and placing the valve
 thereon has the important advantage in an
 engine having a throttling-governor such as
 has been hereinbefore described of enabling
 the governor-valve to be readily placed near
 115 the point where the steam enters the hollow
 piston-rod, thus avoiding excessive steam area
 between the throttling-valve and the steam-
 admission valves of the cylinders. The em-
 ployment of such stationary tubular wall or
 120 partition, however, also has important advan-
 tages when applied to an engine in which said
 valve constitutes the main steam-valve, or
 where there is no steam-admission valve car-
 ried by the hollow piston-rod itself, it being
 125 understood that an engine of the kind last
 mentioned may be provided with either an
 automatic cut-off governor by which the move-
 ment of the valve in the tubular partition is
 controlled, or with a throttling-governor in
 130 the steam-supply pipe, such as shown in said
 prior Willans patent, or the valve which is
 controlled by the governor and the main
 steam-valve.

In multiple-cylinder single-acting engines having tubular piston-rods through which the steam is applied to the cylinders as such engines have been heretofore constructed it has been common to place the throttling-valve in the steam-pipe which leads to the steam-chests belonging to both cylinders. This construction has the disadvantage of making the action of the governing devices to a certain extent uncertain or sluggish, it being obvious that, inasmuch as the steam-space within the steam-supply pipe and the steam-chests is relatively large, the desired increase or diminution of the supply to the engine-cylinders will not be instantly effected upon the movement of the throttling-valve. This will be rendered more clear by a consideration of the fact that in said prior construction when the throttling-valve moves in a direction to cut off or lessen the steam supply the body of steam under pressure between the throttling-valve and the steam-admission valves must become gradually exhausted, or must work out through the cylinders before the steam-pressure within the cylinders is reduced to the desired point, and similarly when the throttling-valve opens to supply steam to afford a greater pressure thereto said steam-space must become filled with steam before its full effect will be produced within the cylinders.

A construction in which a valve applied to a tubular wall or partition surrounding the end of a hollow piston-rod is connected by actuating devices with the crank-shaft of the engine, and forms the main or steam valve thereof, is claimed in a separate application, Serial No. 499,420, filed February 7, 1894, and forms no part of the present invention.

I claim as my invention—

1. The combination with an engine-cylinder and steam-chest, a piston within the cylinder, a hollow piston-rod extending through the cylinder-head into the steam-chest, and a main valve within the piston-rod for controlling the admission of steam to the cylinder, of a wall or partition within the steam-chest forming an inclosure, separate from the steam-chest, within which the piston-rod reciprocates and which forms a passage for steam exterior to this piston-rod, a steam-inlet port in said wall or partition, a valve controlling the admission of steam through said port, and a governing device applied to actuate said valve, substantially as described.

2. The combination with an engine-cylinder and steam-chest, a piston within the cylinder and a hollow piston-rod attached to the piston and extending into the steam-chest, of a wall or partition within the steam-chest connected with the cylinder-head by a steam-tight joint and closed at its end remote from the cylinder-head so as to form an inclosure within which the latter reciprocates and which affords a passage for steam exterior to the piston-rod, annularly-arranged steam-inlet ports in said inclosure, a valve-ring con-

trolling the admission of steam through said ports, and a governing device applied to actuate said valve, substantially as described.

3. The combination with a plurality of steam-cylinders arranged side by side, two steam-chests connected by a pipe or passage, pistons within the said cylinders, and hollow piston-rods extending through the cylinder-heads into the steam-chests, of walls or partitions within the steam-chests forming inclosures in which the piston-rods reciprocate, said walls or partitions being provided with steam-inlet ports, valves controlling said ports, and means for actuating said valves embracing an actuating-rod which extends through said pipe or passage and is connected with all of the said valves, substantially as described.

4. The combination with a steam-cylinder, a steam-chest, a piston within the cylinder, and a hollow piston-rod extending through the cylinder-head into the steam-chest, of a tube closed at its upper end and connected with the cylinder-head so as to form an inclosure affording a passage for steam exterior to the piston-rod and within which the latter reciprocates, said tube being provided with a steam-inlet port and with a screw-threaded stem by which it is secured to the wall of the steam-chest, and a valve controlling the admission of the steam through the said port substantially as described.

5. A single-acting engine comprising a plurality of steam-cylinders, steam-chests attached to the cylinders, pistons within the cylinders, hollow piston-rods extending into the steam-chests through which steam is supplied to said cylinders, said piston-rods being provided with ports for admitting steam to the cylinders, valves carried by the piston-rods for controlling the admission of steam to the cylinders, walls or partitions forming tubular inclosures for the piston-rods affording steam-passages exterior to said rods, said walls or partitions being provided with steam-inlet ports, valves for controlling the admission of steam through said inlet-ports, and a speed-governor connected with and actuating all of said valves, substantially as described.

6. A single-acting engine comprising a plurality of steam-cylinders, pistons within the cylinders, hollow piston-rods extending into the steam-chests, said piston-rods being provided with steam inlet and exit ports, piston-valves within the piston-rods for controlling the passage of steam therethrough, walls or partitions within the steam-chests forming tubular inclosures affording steam-passages for steam exterior to said piston-rods and within which the latter reciprocate, said walls being provided with steam-inlet ports, valves for controlling the admission of steam through said inlet-ports, and a speed-governor connected with and actuating said valves, substantially as described.

7. A single-acting engine comprising a plurality of steam-cylinders, pistons within the

cylinders, hollow piston-rods extending into the steam-chests, said piston-rods being provided with steam inlet and exit ports, piston-valves within the piston-rods for controlling the passage of steam therethrough, walls or partitions within the steam-chests forming tubular inclosures affording passages for steam exterior to said piston-rods and within which the latter reciprocate, said walls being provided with steam-inlet ports, and also with steam-spaces at the side of the piston-rods to admit steam to the inlet-ports of the rods, valves for controlling the passage of steam through said inlet-ports, and a speed-governor connected with and actuating said valves, substantially as described.

8. The combination with an engine-cylinder, a steam-chest, a piston within the cylinder, and a hollow piston-rod extending into the steam-chest, of a tubular inclosure within the steam-chest surrounding the end of the piston-rod and affording a passage for steam external to said rod, said tubular inclosure being secured at its lower end to the cylinder-head, steam-inlet ports in said tubular inclosure, a valve for controlling said ports, and a speed-governor connected with and actuating said valve, substantially as described.

9. The combination with an engine-cylinder, a steam-chest, a piston within the cylinder, and a hollow piston-rod extending into the steam-chest, of a tubular inclosure within the steam-chest, surrounding the end of the piston-rod and provided with steam-inlet ports; said tubular inclosure affording a space, exterior to the piston-rod, for the longitudinal passage of steam from the inlet-ports to the interior of the rod, an oscillatory valve-ring or sleeve applied to the tubular inclosure for controlling the said ports, a

valve-rod connected with the valve-ring and extending outwardly through the wall of the steam-chest, and a speed-governor connected with said valve-rod for actuating the said valve-ring, substantially as described.

10. A single-acting multiple-cylinder engine comprising vertically-arranged steam-cylinders located side by side, steam-chests, pistons, hollow piston-rods extending into the steam-chests, tubular inclosures within the steam-chests provided with steam-inlet ports, oscillatory valve-rings or sleeves applied to the tubular inclosures to control said steam-inlet ports, and a speed-governor connected with and operating said valve-rings, the speed-governor being arranged with its main shaft parallel with the crank-shaft of the engine, and belt-pulleys on the governor and crank-shafts by which the governor is driven from the said crank-shaft, substantially as described.

11. The combination with an engine-cylinder, a steam-chest, a piston, a hollow piston-rod extending into the steam-chest and provided with steam inlet and exit ports, of a tubular wall or partition forming an inclosure in which the piston-rod moves, said wall or partition being provided with longitudinal grooves arranged in radial alinement with the said ports and forming passages extending along the sides of the hollow piston-rod for conducting steam from the inlet-ports of the wall or partition to those of the hollow piston-rod, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

MILAN C. BULLOCK.

Witnesses:

HENRY W. CARTER,
ALBERT H. GRAVES.