No. 814,793.

PATENTED MAR. 13, 1906.

F. M. METCALF.

STEAM PUMPING ENGINE.

APPLICATION FILED SEPT. 26, 1904.

5 SHEETS—SHEET 1.

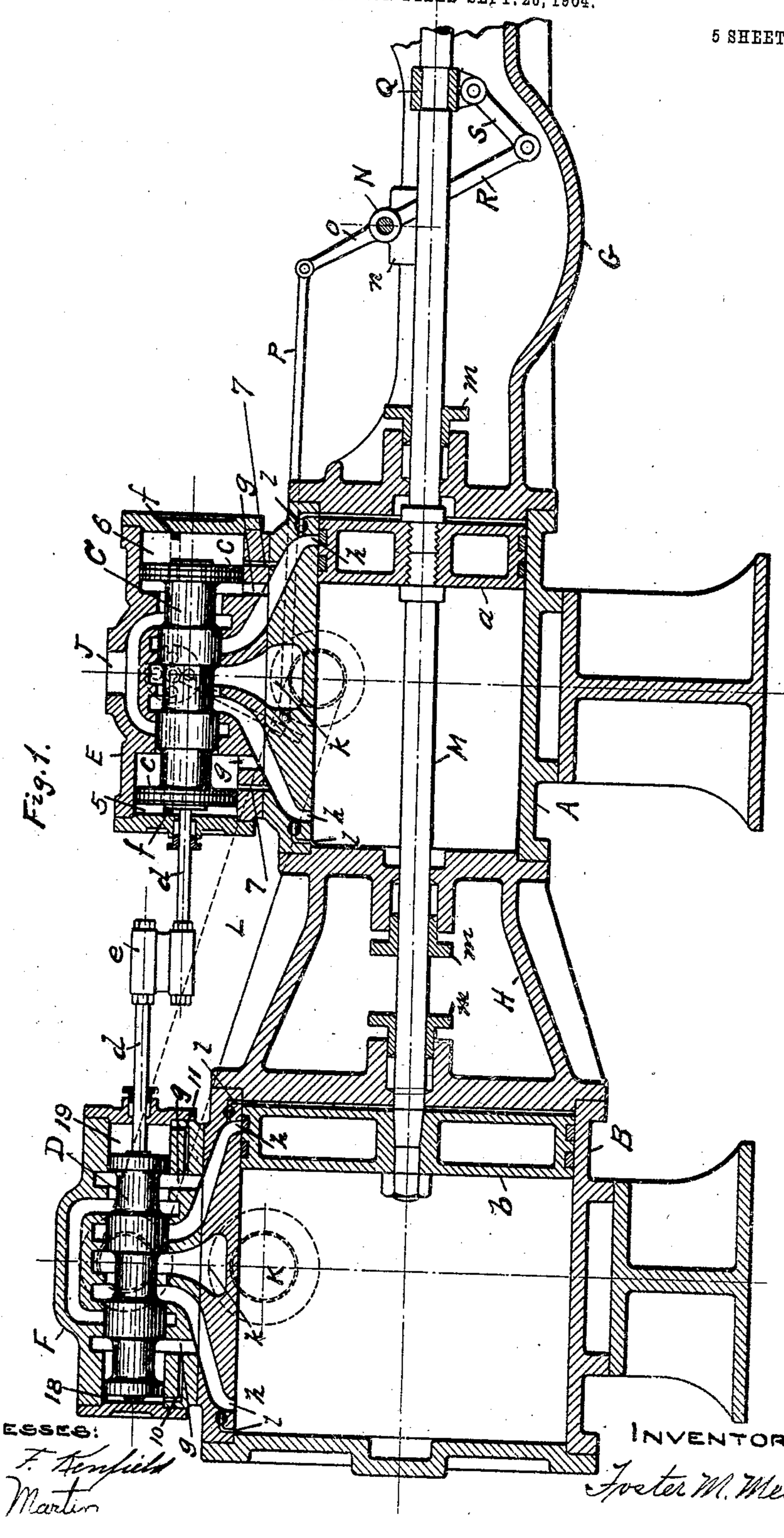

Fig. 1.

WITNESSES:

Wm F. Penfield

J. E. Martin

INVENTOR:

Foster M. Metcalf.

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5 SHEETS—SHEET 2.

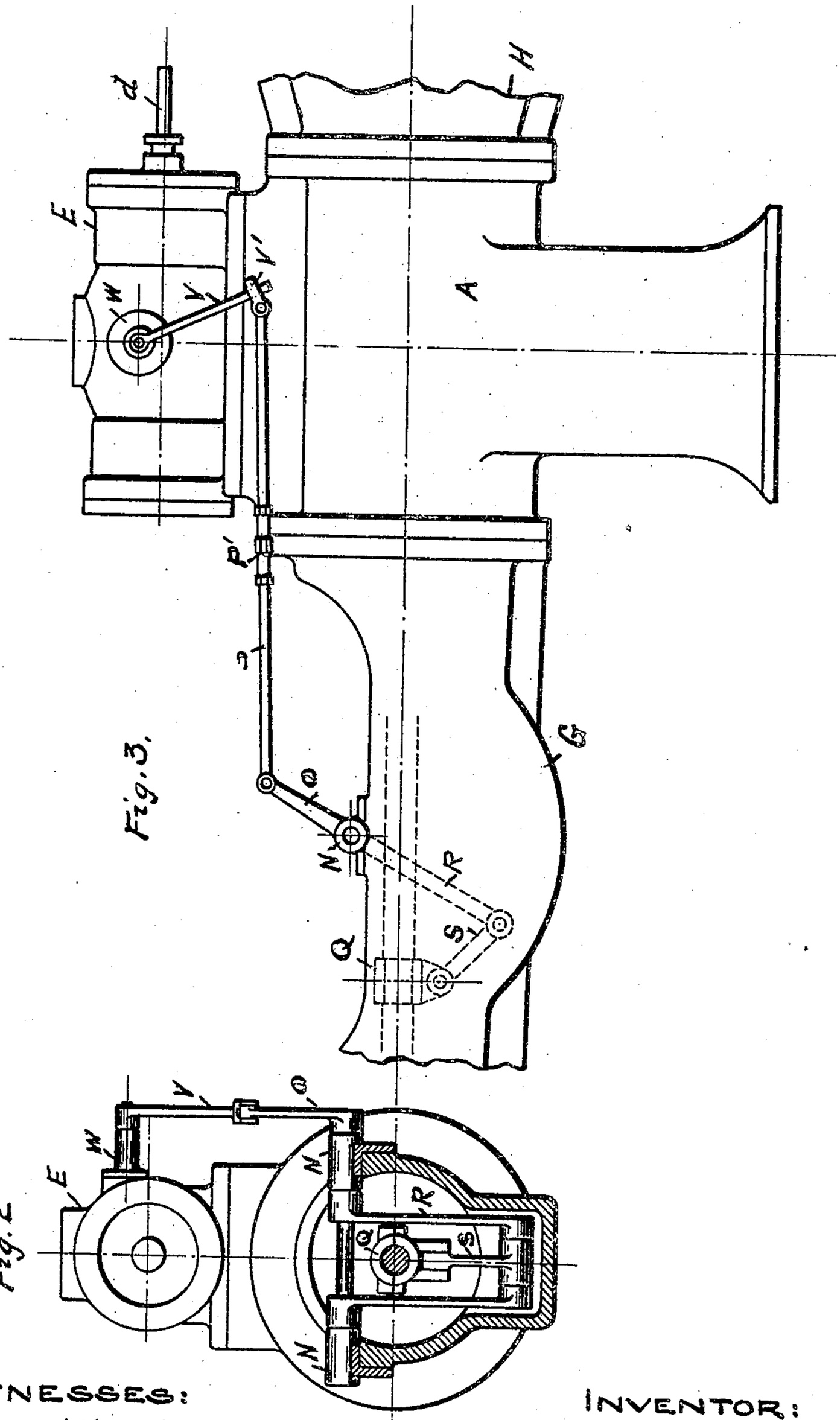

Fig. 3.

Fig. 2

WITNESSES:

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5 SHEETS—SHEET 3.

Fig. 5.

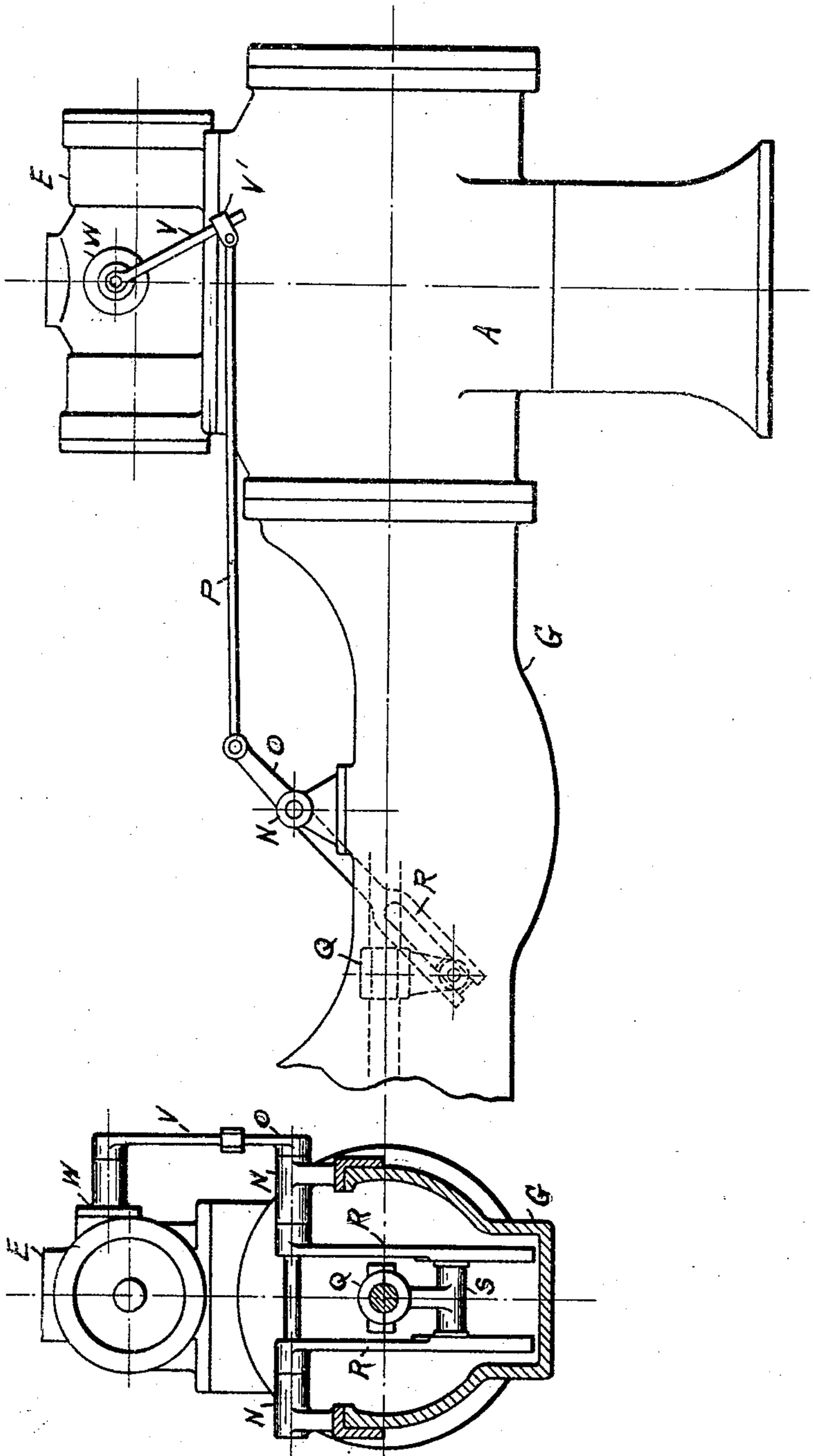

Fig. 4.

WITNESSES:

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5 SHEETS—SHEET 4.

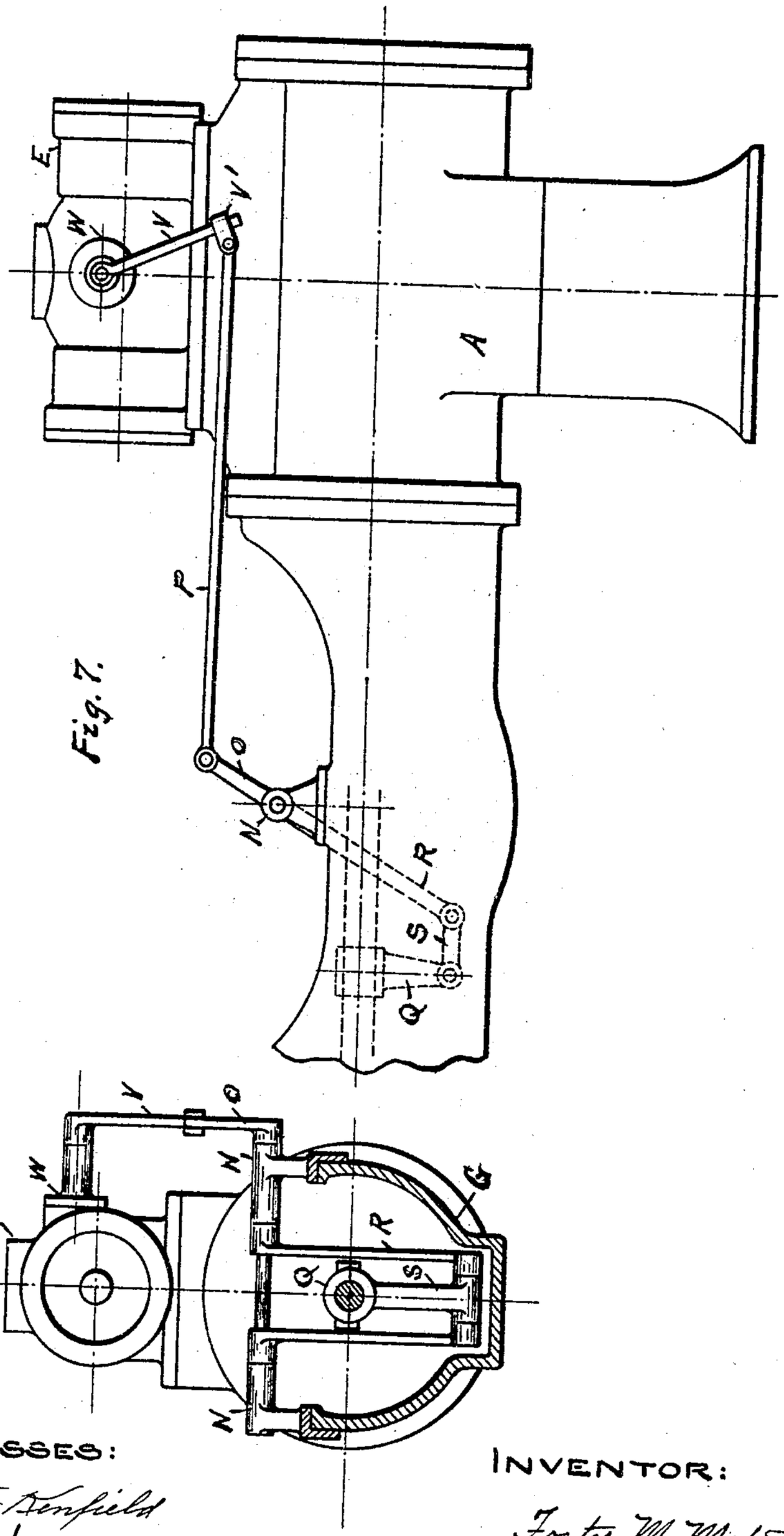

Fig. 7.

Fig. 6

WITNESSES:

Wm. F. Denfield

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STEAM PUMPING ENGINE.

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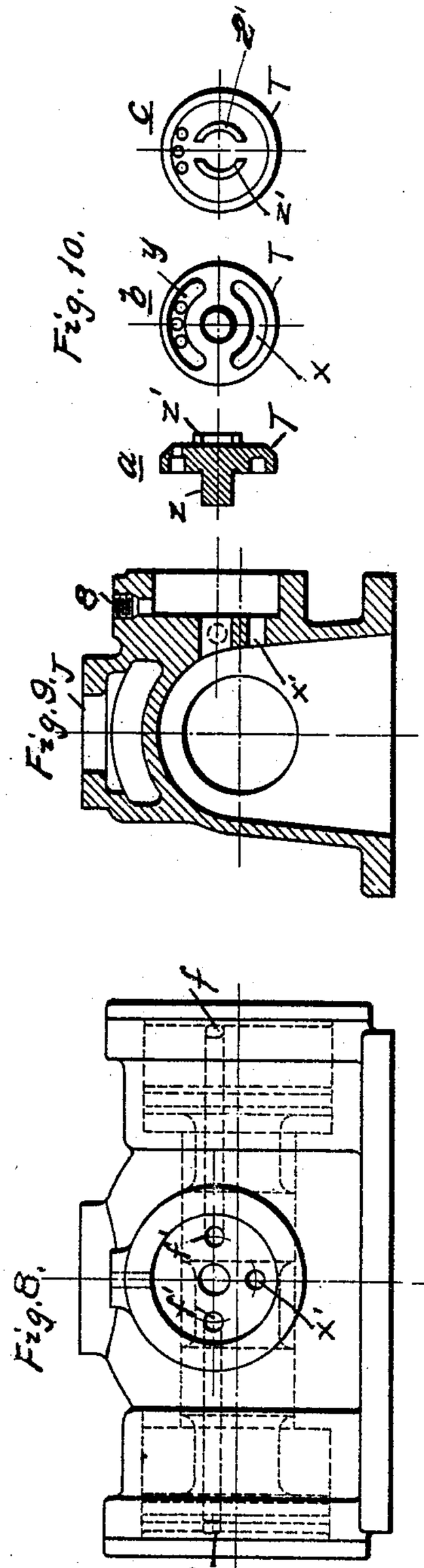
5 SHEETS—SHEET 5.



WITNESSES:

Wm F. Kenfield

J E. Martin

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UNITED STATES PATENT OFFICE.

FOSTER M. METCALF, OF BATTLE CREEK, MICHIGAN.

STEAM PUMPING-ENGINE.

No. 814,793. Specification of Letters Patent. Patented March 13, 1906.

Application filed September 26, 1904. Serial No. 225,878.

To all whom it may concern:

Be it known that I, FOSTER M. METCALF, a citizen of the United States, residing at Battle Creek, in the county of Calhoun and State of Michigan, have invented certain new and useful Improvements in Steam Pumping-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to that class of steam or other fluid engines in which the main steam-valve is actuated by an auxiliary valve operated by link-and-lever connection to the piston-rod, and has for its object the prompt and certain action of the engine under all conditions, the construction and arrangement of same being such that the parts cannot assume such a position as would cut off steam from both main and auxiliary valve ports at the same time, it being obvious that if either is in position for action the engine will start immediately when steam is applied.

A further object of this invention is to provide means for producing a smooth and easy terminal for each stroke of the piston, thus avoiding the serious shocks produced by water-hammer in the pump end common to direct-acting engines in which the steam-valve action is too emphatic. As is well known to those versed in the art to which this invention applies, the sudden stopping and starting of the piston at the completion and beginning of each stroke produces violent water-hammer in the pump end and is not only destructive to valves and fittings, but produces disagreeable sounds, which are often telephoned about to distant parts by means of the delivery-pipings. In the usual types of direct-acting steam-pumps as heretofore made the steam-valve is forced to a quick reversal, producing the conditions and results as described above.

My improvement consists in a peculiar and novel arrangement of both the main and auxiliary valves and passages and the link-arms and levers connecting to and communicating motion from the piston-rod, as will hereinafter appear.

In the drawings, in which like figures and letters of reference denote similar parts in the various views, Figure 1 is a sectional elevation of my invention as applied to the steam end of a compound pumping-engine, showing the main steam-valves, pistons, and actuating-levers of the auxiliary motion. Figs. 2 and 3 show details of the link-motion for operating the auxiliary valve. Figs. 4, 5, 6, and 7 illustrate modifications of the link-motion with slightly-differing arrangement of parts. Figs. 8 and 9 show details of the main steam-chest and passages with the main steam-valve drawn in dotted lines. Fig. 10, *a b c* shows the auxiliary valve in section, front and rear views. Fig. 11 illustrates the auxiliary valve with stem, lever, and bonnet as connected in position; and Fig. 12 is an outside view of the same.

The parts indicated by letters of reference are as follows.

A is the high-pressure steam-cylinder.
B is the low-pressure steam-cylinder.
a is the high-pressure steam-piston.
b is the low-pressure steam-piston.
C is the high-pressure steam-valve.
D is the low-pressure steam-valve.
E is the high-pressure steam-chest.
F is the low-pressure steam-chest.
H is the steam-cylinder yoke.
G is the water-cylinder yoke.
c c are the steam-valve heads or actuating-pistons.
J is the steam-pipe connection.
K is the exhaust-pipe connection.
L is the receiver-pipe connecting exhaust from high-pressure cylinder to chest of low-pressure cylinder.
d d are the steam-valve stems.
e is the valve-stem coupling.
f f are the steam-valve trip-ports.
g g g g are the steam-ports from chests to cylinders.
h h h h are the main cylinder-ports.
k k are the exhaust-ports.
l l l l are the cushion-ports.
M is the piston-rod.
m m m are the piston-rod glands.
N is the rock-shaft.
n n are rock-shaft brackets.
o is the rock-shaft lever.
P is the auxiliary-valve rod.
Q is the piston-rod link-box.
R is the rock-shaft fork.
S is the rock-shaft link.
T is the auxiliary valve.
U is the auxiliary-valve stem.
V is the auxiliary-valve lever.
W is the auxiliary-valve bonnet.
x is the exhaust-port in auxiliary valve.
y is the steam-port in auxiliary valve.
Z is the auxiliary-valve spindle.

Z′ represents the clutch-lugs on auxiliary valve.

Z″ is the clutch on auxiliary-valve stem.

x' is the exhaust-port from auxiliary valve, and f' f' are ports in the seat of the auxiliary valve, said ports opening into the steam-passages, at the other ends of which are the steam-valve trip-ports f f.

As will be seen by reference to Figs. 8 to 10, ports x and y in the auxiliary valve are in the nature of arc-shaped grooves in the inner face of the valve. Exhaust port or passage x does not communicate with the outer side of the valve; but steam-port y is in such communication by means of apertures passing through the valve to admit live steam from port 8, which latter is connected with the main steam-pipe in any suitable manner. It will be noted that ports x and y are so arranged and are of such length that in one position of the auxiliary-valve port y admits steam therethrough into one of the ports f' and thence to the steam-valve trip-port f at one end of the steam-chest, while the other port f' is through port x placed in communication with the exhaust k, thus exhausting the other end of the steam-chest through its port f. In another position of the auxiliary valve this arrangement is just reversed, while in a third position ports f', f', and x' are closed and the ends of the steam-chest are by the action of the auxiliary valve placed in communication neither with the induction nor with the exhaust.

The operation is as follows: Reference being had to Fig. 1, with the parts in position shown, the pistons are at the limit of travel toward the right. The auxiliary valve has placed chest-chamber 6 under full steam-pressure by connecting the trip-passage leading from that chamber to live-steam-pipe influence from inlet 8 by means of the arced port y in the auxiliary valve. Chest-chamber 5 has been connected to exhaust in a similar manner by means of port x, and the high-pressure steam-valve has moved to the left, carrying with it the low-pressure valve, the stems being fixed to a common coupling e. It is obvious that the steam valves and ports are now in position to deliver steam to the right side of pistons, causing motion of the same toward the left. After completion of stroke the operation will be reversed in the same manner. It will be observed that before the completion of maximum valve travel port 7 on that end connects chamber 5 and 6 alternately in communication with the main-cylinder ports to which they lead. This serves not only to furnish preadmission steam to start the parts in motion, but introduces a governing element, as will presently appear. Calling particular attention to Fig. 1 and the relative position of parts therein shown, the several surfaces of the valve-heads are influenced by steam pressure and currents of varying intensity. In the high-pressure chest the entering steam passes to the right through the annular opening formed between the reduced neck of the valve and the bore of the chest-wall. It is thus projected against the inside surface of the valve-head before escaping through the port and passing to the cylinder. Both the pressure and impulse due to impinging velocity acting on the valve-head operate to close or restrict the admission-portage at the annulus by forcing the valve toward the right or in the direction of the current. After reaching the cylinder and starting the piston toward the left the reactive effect of the cylinder-steam upon the opposite side of the valve-head entering the outer end of the chest-chamber through port 7 is pressing the valve toward the left, a movement in which direction would give the admission more portage and deliver more steam to the high-pressure cylinder. The valve will then assume a position depending upon the relative strength of the forces which tend to move it in opposite directions, and it is obvious that the higher the cylinder-pressure may be due to increased piston load the wider will the admission-portage open, up to the limit of valve travel.

It is to be noted that reversal of the main valve is accomplished by means of the auxiliary valve admitting live steam through port f in front of one of the enlarged heads of the main valve and simultaneously exhausting through the other port f from in front of the other valve-head. Upon such reversal the auxiliary valve blocks ports f', f', and x', preventing passage of live or exhaust steam through ports f f. This is an important fact to be noted, for it enables the further movements of the main valve till the next reversal to be governed by the pressure of live steam flowing into the main cylinder and the back pressure from the steam-cylinder and live-steam passage, as just described. It is obvious that were chambers 5 and 6 constantly open through ports f either for admission of live steam or the exhausting of dead steam the automatic regulation of the movements of the main valve by the back pressure from the main cylinder would be rendered impossible. It is further to be noted that the cushion-ports l serve an important function in keeping the ends of the steam-chest in front of the heads of the main valve in communication with cylinder-pressure even after ports h have been covered by the main piston a. In other devices of this type having a steam-valve actuated by direct pressure delivered from the piston any attempt to make a self-governing feature positive in all conditions has failed, for the reason that communication between cylinder-steam and the outer chest-chamber is cut off during the period the piston-rings dwell upon the trip-holes or actuat-

the reduced passage, passages extending from the end chambers in rear of the enlarged valve-heads when in their inner positions to the main-cylinder ports, ports opening into the end chambers near the outer ends thereof and in front of the enlarged heads of the main valve, an auxiliary valve constructed to permit entrance of live steam through one of the last-mentioned ports and exhaust of spent steam through the other of said ports, the auxiliary valve at other times blocking passage of live or spent steam through said ports, link-and-lever mechanism connecting with a movable part for operating the auxiliary valve, and an automatic regulating-passage, one for each end chamber, communicating at one end with its chamber in front of the enlarged head of the main valve in the inner position of the latter and at the other end with the steam-cylinder, said end chambers being closed to passage of steam except as specified.

4. In a steam-valve mechanism for pumping-engines, the combination with the steam-cylinder, of a steam-chest having a central steam-chamber and two end chambers communicating therewith by reduced passages, main-cylinder ports and an exhaust-port, a main valve longitudinally reciprocable within the steam-chest and of a diameter equal to the diameter of said reduced passages, said valve having enlarged heads within said end chambers and reduced regions in rear of said heads, said reduced portions being arranged to occupy said reduced passages alternately to permit passage of live steam from the central chamber to an end chamber and to cause said steam in its flow to impinge against the rear of the enlarged valve-head to tend to move the valve to close the reduced passage, passages extending from the end chambers in rear of the enlarged valve-heads when in their inner positions to the main cylinder-ports, ports opening into the end chambers near the outer ends thereof and in front of the enlarged heads of the main valve, an auxiliary valve constructed to permit entrance of live steam through one of the last-mentioned ports and exhaust of spent steam through the other of said ports for the purpose of reversing the main valve, the auxiliary valve at other times blocking passage of live or spent steam through said ports, link-and-lever mechanism connecting with a movable part for operating the auxiliary valve, and an automatic regulating-passage, one for each end chamber, communicating at one end with its chamber at a point in front of the enlarged head of the main valve in the inner position of the latter and at the other end with the main-cylinder port.

5. In a steam-valve mechanism for pumping-engines, the combination with the steam-cylinder, of a steam-chest having a central steam-chamber and two end chambers communicating therewith by reduced passages, main-cylinder ports and an exhaust-port, a main valve longitudinally reciprocable in the steam-chest and of a diameter equal to the diameter of said reduced passages, said valve having enlarged heads within the end chambers and reduced portions in rear of said heads, said reduced portions being arranged to occupy said reduced passages alternately to permit passage of live steam from the central chamber to an end chamber and to cause said steam in its flow to impinge against the rear of the enlarged valve-head to tend to move the valve to close the reduced passage, passages extending from the end chambers in rear of the enlarged valve-heads when in their inner positions to the main-cylinder ports, ports opening into the end chambers near the outer ends thereof and in front of the enlarged heads of the main valve, an auxiliary-valve seat provided with a port leading to the exhaust and with other ports communicating with the last-named ports, an auxiliary oscillating disk valve on said seat provided on its inner surface with an arc-shaped exhaust-passage and with an arc-shaped steam-passage, the latter only communicating with the outer surface of the valve, live-steam connection to the outer surface of the auxiliary valve, link-and-lever mechanism connecting with a moving part for positioning the auxiliary valve with the exhaust-passage therein covering the exhaust-port and one of the other ports in the valve-seat and the steam-passage over the remaining port, the auxiliary valve at other times blocking passage of live or spent steam through the ports in its seat, and an automatic regulating-passage, one for each chamber, communicating at one end with its chamber at a point in front of the enlarged head of the main valve in the inner position of the latter and at the other end with the main-cylinder port.

6. In a steam-valve mechanism for pumping-engines, the combination with the steam-cylinder, of a steam-chest having a central steam-chamber and two end chambers communicating therewith by reduced passages opening into the cylinder at a distance from its ends, main-cylinder ports and an exhaust-port, a main valve longitudinally reciprocable within the steam-chest and of a diameter equal to the diameter of said reduced passages, said valve being provided with enlarged heads within the end chambers and reduced portions in rear of said heads, said reduced portions being arranged to occupy the reduced passages alternately to permit passage of live steam from the central chamber to an end chamber and to cause said steam in its flow to impinge against the rear of the enlarged valve-head to tend to move the valve to close the reduced passage, passages extending from the end chambers in rear of the enlarged valve-heads when in their inner positions to the main-cylinder ports, ports open-

ing-ports, and at this stage of motion the valve is liable to rebound and either stop or short-stroke the pump.

I desire to call particular attention to the method of auxiliary-valve travel by means of my peculiar linkwork, in that the speed of same decreases at and near the ends of piston travel. This is very important because securing a smooth and easy opening and closing of the tripping-ports and consequent slower starting of the piston free from attendant jerks which a quick reversal would produce. I also desire to call attention to the ready means for valve adjustment provided. P′ is a right-and-left coupling on the auxiliary-valve rod by means of which the piston travel may be equalized with reference to the cylinder-bore. If the piston strikes the cylinder-head or travels too near the outboard end, the rod should be shortened; if too near the inboard end, lengthened. The auxiliary-valve rod is attached to the auxiliary-valve lever by a clamp-lug, which may be secured in any position on the lever. Raising this lug will advance the lead of the auxiliary valve and shorten the stroke or piston travel. Dropping the lug will retard the lead and increase the piston travel. As either of these adjustments may be made while the pump is in motion, any desirable change in the piston travel is possible to meet operating conditions.

While I have more particularly made my description as applied to compound pumping-engines, I do not confine myself to that type, as it is obvious that the device is equally applicable to the single-cylinder simple type.

Having thus fully illustrated and described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a steam-valve mechanism for pumping-engines, the combination with the steam-cylinder, of a steam-chest having a central steam-chamber and two end chambers connecting therewith by reduced passages, main-cylinder ports and an exhaust-port, a main valve longitudinally reciprocable within the steam-chest and of a diameter equal to the diameter of said reduced passages, said valve having enlarged heads within said end chambers and reduced portions in rear thereof, said reduced portions being arranged to occupy alternately the reduced passages to permit passage of steam from the central chamber to an end chamber and to cause said steam in its flow to impinge against the rear of the enlarged valve-head to tend to move the valve to close the reduced passage, passages extending from the end chambers near the reduced passages to the main-cylinder ports, ports opening into the end chambers near the other ends thereof, an auxiliary valve constructed to permit entrance of live steam through one of the last-mentioned ports and exit of spent steam through the other of said ports for the purpose of reversing the main valve, the auxiliary valve at other times blocking passage of live or spent steam through said ports, and an automatic regulating-passage, one for each end chamber, communicating at one end with its chamber at a point in front of the passage leading to the main-cylinder port and at the other end with the steam-cylinder.

2. In a steam-valve mechanism for pumping-engines, the combination with the steam-cylinder, of a steam-chest having a central steam-chamber and two end chambers connecting therewith by reduced passages, main-cylinder ports and an exhaust-port, a main valve longitudinally reciprocable within the steam-chest and of a diameter equal to the diameter of said reduced passages, said valve having enlarged heads within said end chambers and reduced portions in rear of such enlarged portions, said reduced portions being arranged to occupy alternately said reduced passages to permit passage of live steam from the central chamber to an end chamber and to cause said steam in its flow to impinge against the rear of the enlarged valve-head to tend to move the valve to close the reduced passage, passages extending from the end chambers near the reduced passages to the main-cylinder ports, ports opening into the end chambers near the other ends thereof, an auxiliary valve constructed to permit entrance of live steam through one of the last-mentioned ports and exhaust of spent steam through the other of said ports for the purpose of reversing the main valve, the auxiliary valve at other times blocking passage of live or spent steam through said ports, link-and-lever mechanism connecting with a movable part for operating the auxiliary valve, and an automatic regulating-passage, one for each end chamber, communicating at one end with its chamber at a point in front of the passage leading to the main-cylinder port and at the other end with the steam-cylinder.

3. In a steam-valve mechanism for pumping-engines, the combination with the steam-cylinder, of a steam-chest having a central chamber and two end chambers communicating therewith by reduced passages, the main steam-pipe opening into said central chamber, main-cylinder ports and an exhaust-port, a main valve longitudinally reciprocable within the steam-chest and of a diameter equal to the diameter of said reduced passages, said valve having enlarged heads within the end chambers and reduced portions in rear of said enlarged heads, said reduced portions being arranged to occupy said reduced passages alternately to permit passage of live steam from the central chamber to an end chamber and to cause said steam in its flow to impinge against the rear of the enlarged valve-head to tend to move the valve to close

ing into the end chambers near the outer ends thereof and in front of the enlarged heads of the main valve, an auxiliary valve constructed to permit entrance of live steam through one of the last-mentioned ports and exhaust of spent steam through the other of said ports for the purpose of reversing the main valve, the auxiliary valve at other times blocking passage of live or spent steam through said ports, link-and-lever mechanism connecting with a moving part for operating the auxiliary valve, an automatic regulating-passage, one for each chamber, communicating at one end with its chamber at a point in front of the enlarged valve-head in the inner position of the latter and at the other end with the main-cylinder port, and a passage extending from each end of the steam-cylinder to the adjacent cylinder-port.

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

FOSTER M. METCALF.

Witnesses:
FRED W. UHL,
RICHARD R. HICKS.