(No Model.)

4 Sheets—Sheet 1.

M. N. FORNEY.

VALVE GEAR.

No. 557,794. Patented Apr. 7, 1896.

FIG. 1.

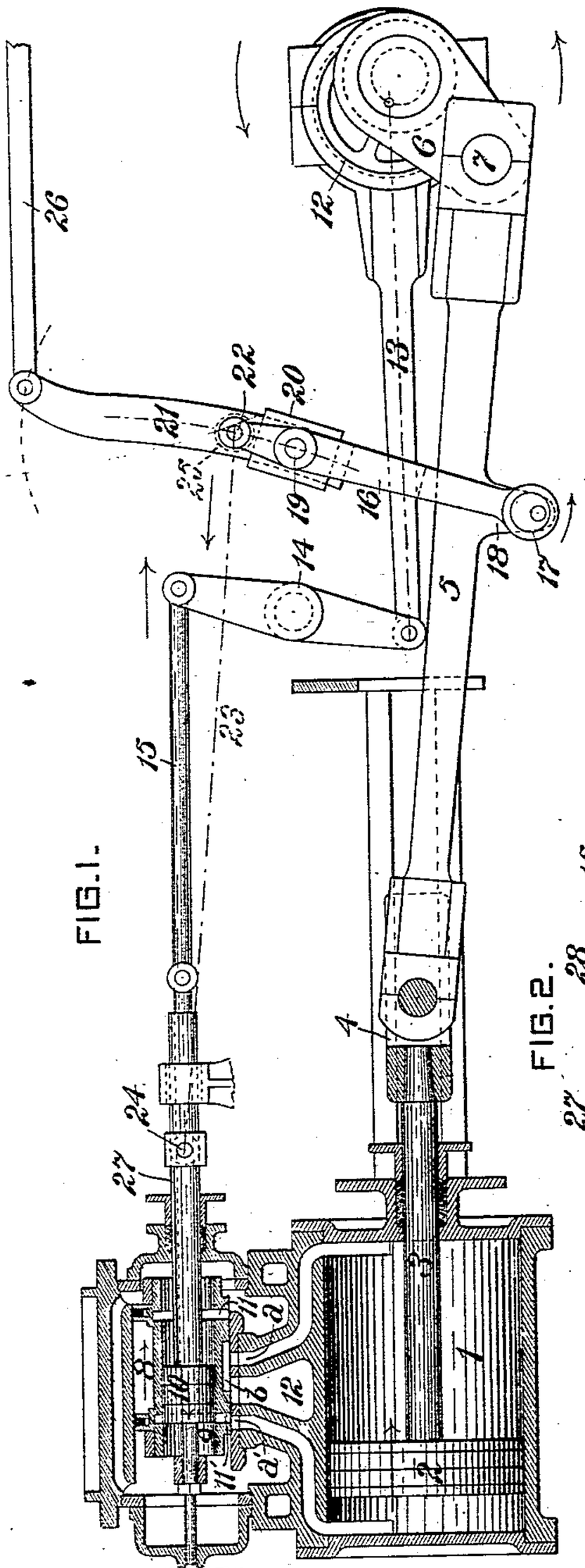


FIG. 2.

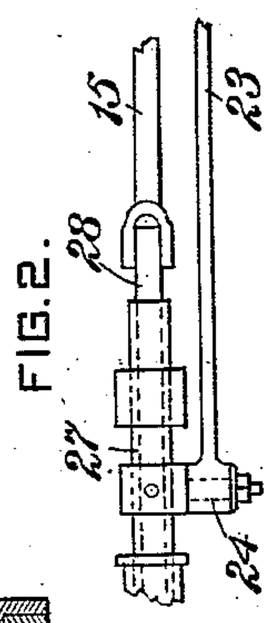
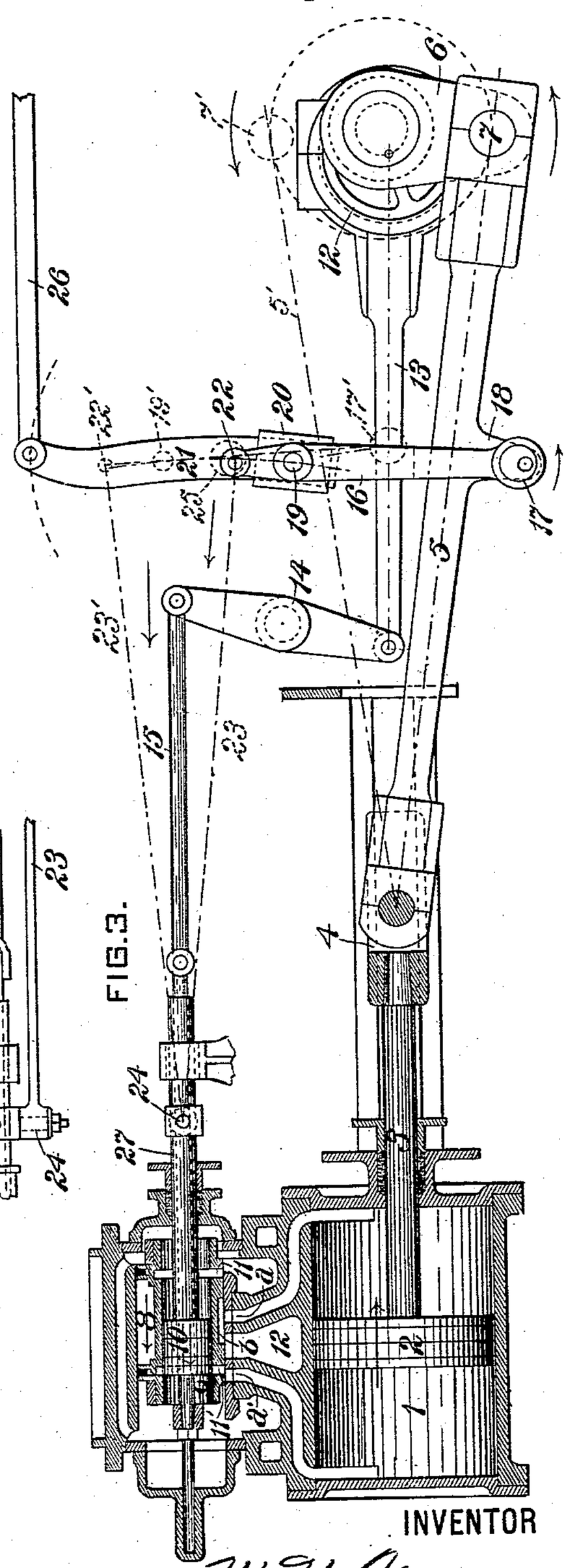


FIG. 3.



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4 Sheets—Sheet 2.

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VALVE GEAR.

No. 557,794. Patented Apr. 7, 1896.

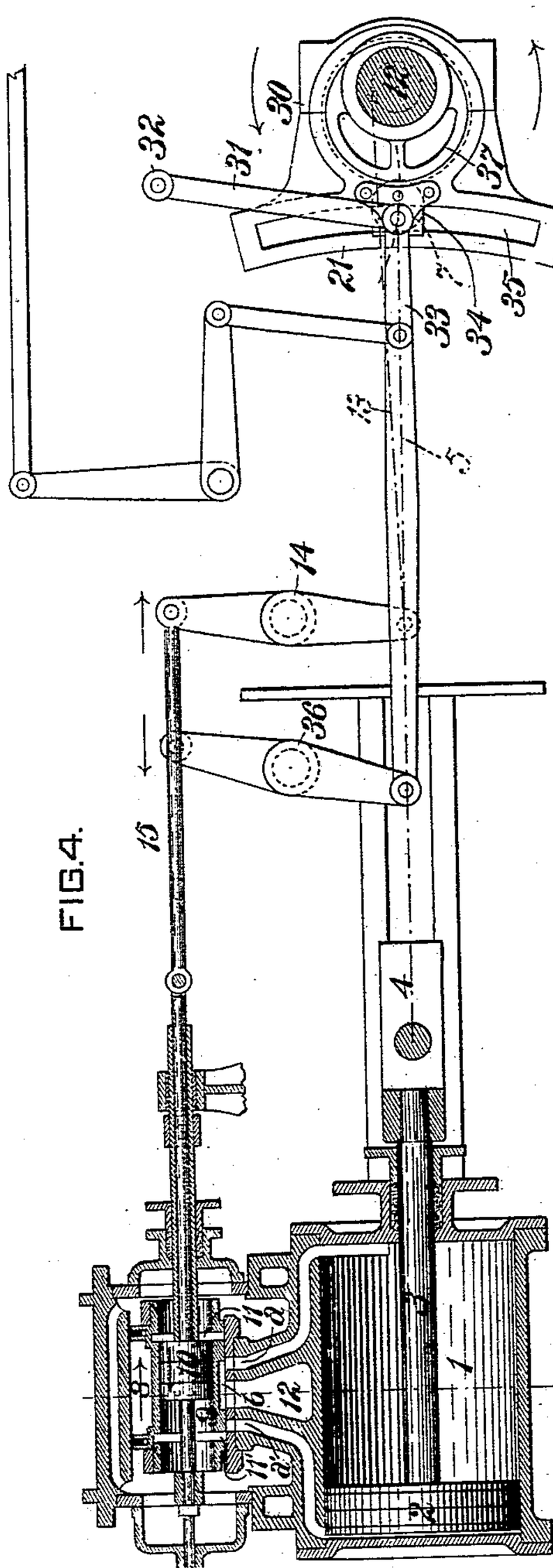

FIG. 4.

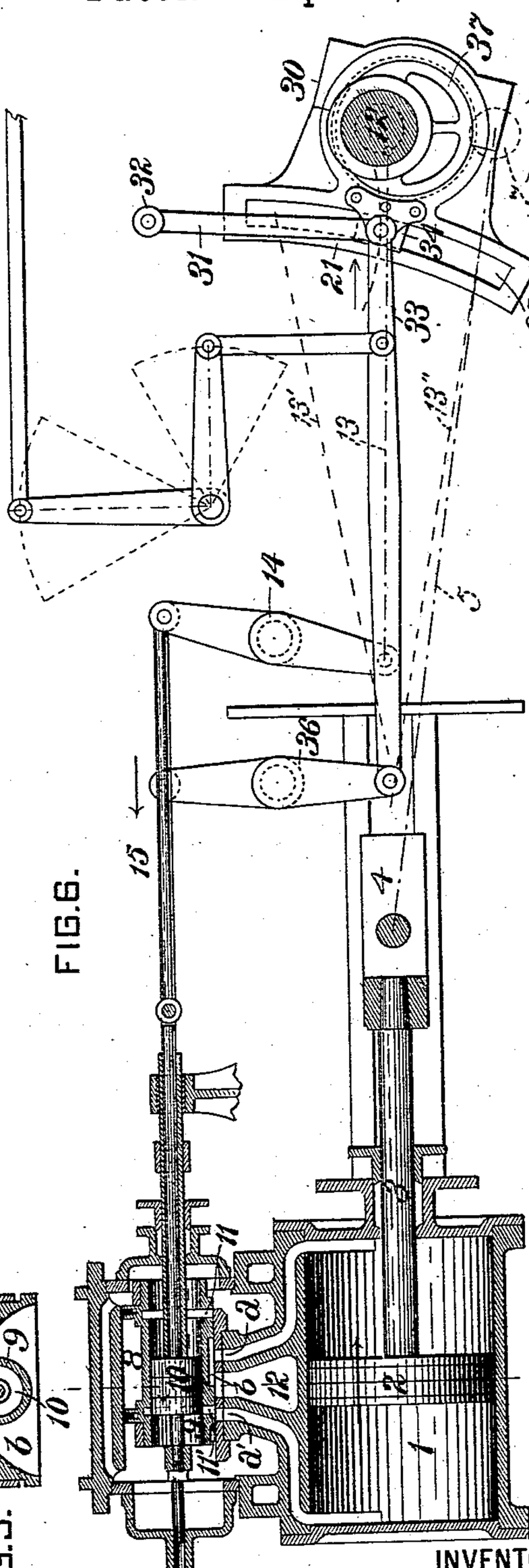

FIG. 6.

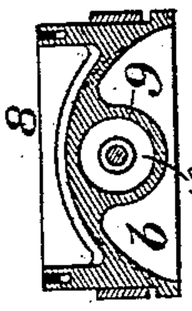

FIG. 5.

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VALVE GEAR.

No. 557,794. Patented Apr. 7, 1896.

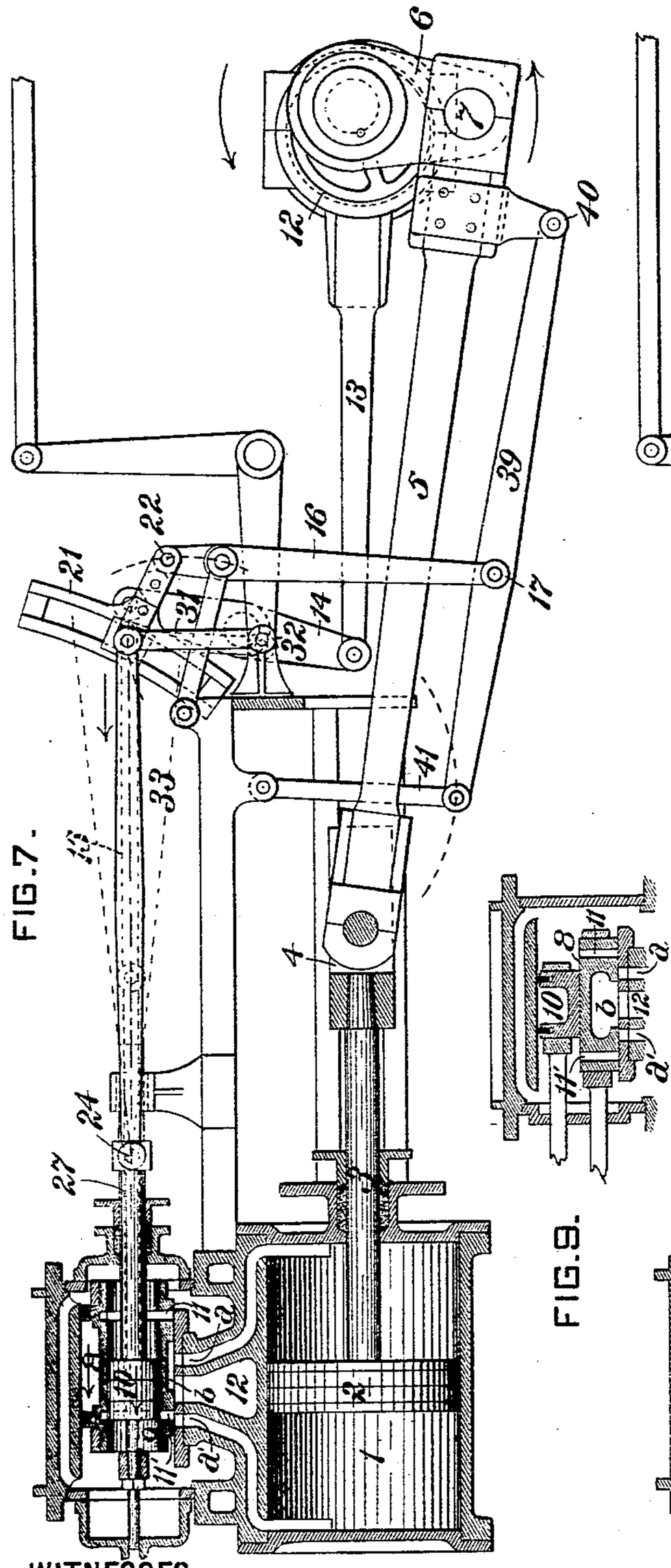

FIG. 7.

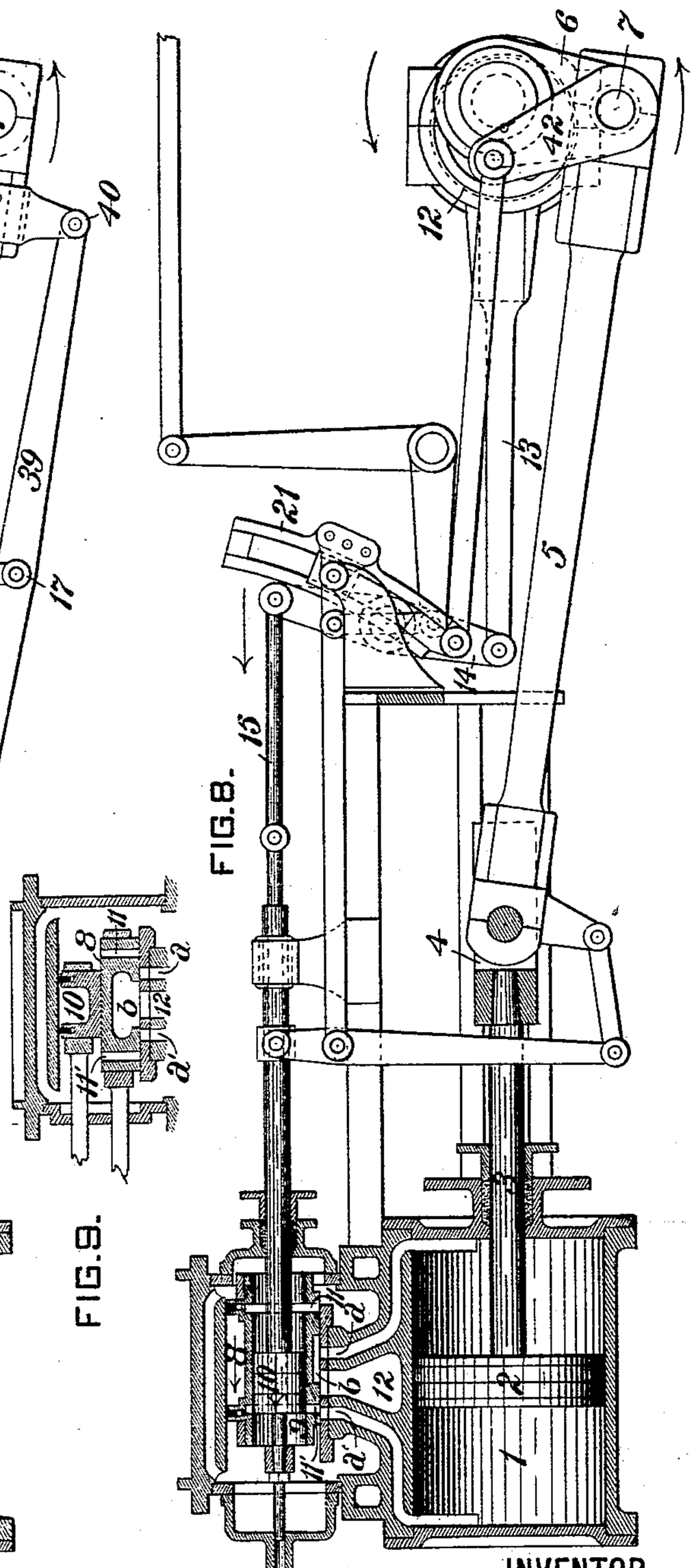

FIG. 8.

FIG. 9.

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(No Model.) 4 Sheets—Sheet 4.

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VALVE GEAR.

No. 557,794. Patented Apr. 7, 1896.

FIG. 10.

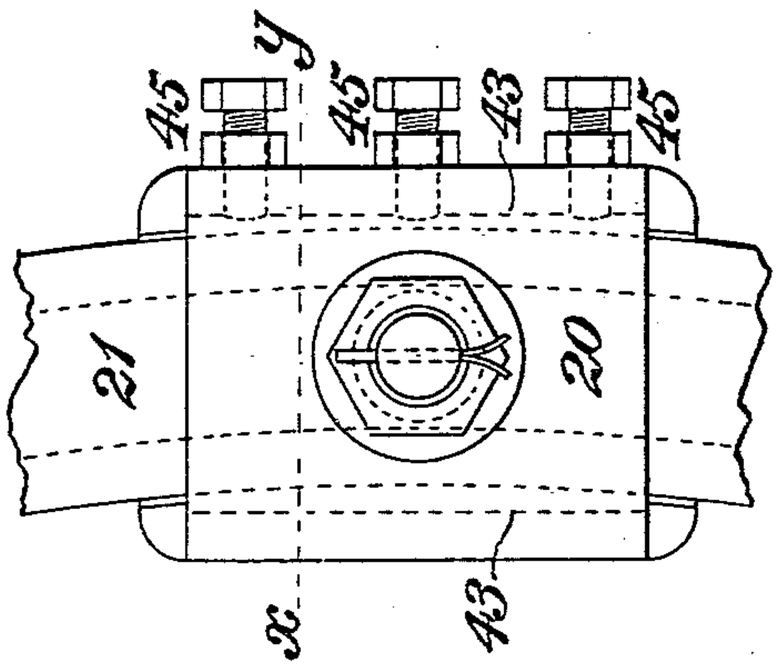


FIG. 12.

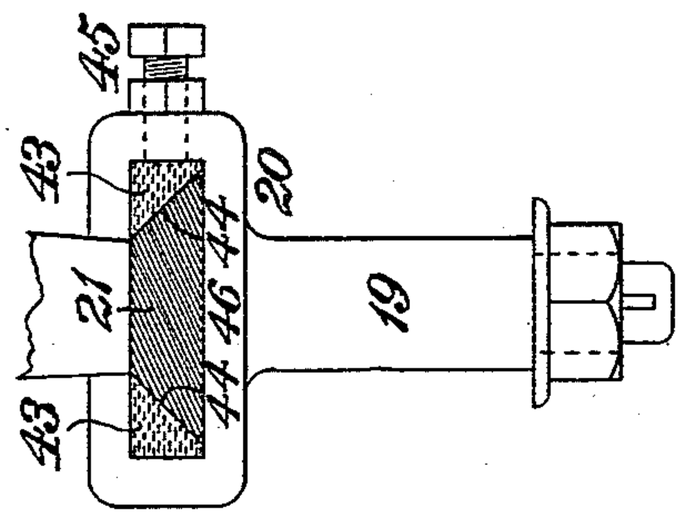
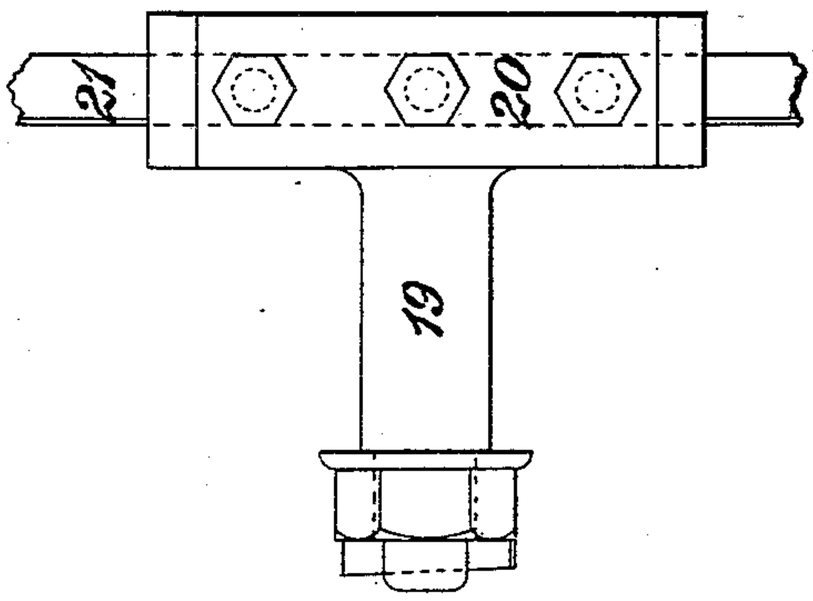


FIG. 11.



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UNITED STATES PATENT OFFICE.

MATTHIAS N. FORNEY, OF NEW YORK, N. Y.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 557,794, dated April 7, 1896.

Application filed October 17, 1895. Serial No. 565,962. (No model.)

To all whom it may concern:

Be it known that I, MATTHIAS N. FORNEY, of the city, county, and State of New York, have invented a certain new and useful Improvement in Valve-Gear for Steam and other Fluid-Pressure Engines, of which improvement the following is a specification.

The object of my invention is to provide an improved mechanism for operating cut-off valves which are used in conjunction with slide or D valves, and to thereby effect a greater range of cut off or admission of motive fluid to the cylinder.

My invention also has the incidental advantage that it can readily be applied to locomotive or other engines with ordinary slide-valves operated either by single eccentrics or by what is known as a "link-motion."

The improvement claimed is hereinafter fully set forth.

In various forms of valve-gear, in which the cut off is effected by the relative movement of two slide-valves, the point of cut off is varied either by changing the travel of the cut-off valve or altering its "lap."

Under my invention the cut-off valve has an equable movement which is coincident in point of time with that of the piston, but this motion of said valve is in an opposite direction to that in which the piston moves. In addition thereto mechanism is provided by which this movement of the valve may either be delayed or advanced in relation to that of the piston and the main valve. The essential feature of this mechanism, as exemplified under different structural variations similar in operative principle, will now be described.

In the accompanying drawings, Figures 1 and 3 are side views, partly in elevation and partly in section, illustrating a preferred form of valve-gear embodying my invention as applied to an ordinary form of horizontal steam-engine. Fig. 2 is a plan view showing a part of the valve-stems and their connections; Figs. 4 and 6, views, partly in elevation and partly in section, illustrating a modified form of gear; Fig. 5, a transverse section of the main slide-valve; Figs. 7 and 8, views illustrating further modifications; Fig. 9, a longitudinal section of a form of valves different from those of the other views and to which my invention is applicable; Fig. 10, a side view, in elevation and on an enlarged scale, of the sliding block 20 and part of the link 21; Fig. 11, an end view of the same, and Fig. 12 a horizontal section on the line $x\,y$ of Fig. 10.

Referring to the drawings, the cylinder 1, piston 2, piston-rod 3, cross-head 4, connecting-rod 5, crank 6, and crank-pin 7 are all of the usual construction.

In Figs. 4 and 6, to avoid confusion, the connecting-rod is represented by dotted center lines only, and the crank-pin by dotted circles, and the crank is omitted.

For regulating the admission of steam to and exhausting it from the cylinder a main slide-valve 8 is used, which is of the usual D type, and is further provided with a central cylindrical valve-seat 9, in which a piston cut-off valve 10 works. I prefer this form of construction; but a flat cut-off valve placed on top of the main valve, as shown in Fig. 9, or in other relation to the main valve may be used. The main valve 8 has the usual exhaust-cavity b in its under side and has two steam-ports 11 11′, which conduct steam from the cylindrical valve-seat 9 to the steam-ports $a\ a'$ in the cylinder.

In the drawings the main valve is shown as operated by an ordinary eccentric 12. In Figs 4 and 6 this eccentric is not shown, its center only being indicated by the small circle 12, whose path is also shown by a dotted circle. The eccentrics in the different engravings are connected to rocking shafts 14 by rods 13, and the rocking shafts are connected to the main valves 8 by rods 15. The main valve, as already stated, may be worked by a link-motion, as in locomotives and in some other forms of engines, or by other kinds of gearing, and its travel may be either of uniform length or be made variable, as desired.

My invention, as before generally stated, consists in means for controlling the admission of steam to the cylinder by giving to the cut-off valve an equable movement coincident in time with that of the piston and a variable movement transversely to that of the piston. The mechanism for this purpose which I prefer is illustrated in Figs. 1, 2, and 3, in which the main valve 8 is shown as operated by an eccentric 12, and has a uniform length of

travel. The cut-off valve 10 is operated by a lever 16, which is connected to a downward projection 18 on the connecting-rod 5, and is connected near its upper end by a pivotal bearing 19 to a sliding block 20. The block 20 slides on a curved bar or link 21, the center of the curve of which is at 24 and which is attached to a shaft 25, (represented by a dotted circle,) which shaft can be turned by means of the rod 26. The upper end of the lever 16 is connected by a rod 23 to a tubular valve-stem 27, which is attached to the cut-off valve 10. Only the center line of the rod 23 which connects the lever 16 with the valve-stem 27 is shown.

The link 21 consists of a single curved bar, the form of which is shown in the sectional plan, Fig. 12. The sliding block 20 embraces the bar and has a journal 19 on one side, which carries the lever 16. As the lever is attached to one side of the block, the tendency of its action is to cause the block to work loose and rock in relation to the link. To obviate this, the back edges 44 of the link are made of beveled form, as shown in Fig. 12, and beveled bearings 43 are fitted into the block and bear against the beveled surfaces 44 of the link. Set-screws 45 are screwed into the block and bear against the bearings 43. As these are in contact with the beveled edges 44, the effect of screwing up the set-screws is to take up any wear or longitudinal lost motion between the edges of the link and the block 20. At the same time the pressure of the bearings 43 against the inclined surfaces 44 has the effect of drawing the face 46 of the block against the face of the link, and thus preventing the block from working loose or rocking on the link 20. By this means the wear of the block or the link may easily be taken up, and by properly adjusting the set-screws the block will be made to work in the link without any lost motion. In order to lessen the tendency which the lever has to cause the block to work loose, the bearing 19 is made of ample length and diameter.

In Fig. 3 the piston 2 is shown in the middle of the cylinder and the bar or link 21 in a vertical position. The connecting-rod 5 and crank-pin 7 are then very nearly in their mid-position between the two extremities of their horizontal movement. The lever 16 and its connections are so proportioned that when the piston and connecting-rod are in the position described and shown the lever 16 will be in a vertical position. The cut-off valve 10 is made of such a length that when it is in its middle position it will just cover the steam-port 11′ in the main valve when the piston is at half-stroke, and the connections of the cut-off valve with the lever 16 are so proportioned that when the lever is vertical this valve will be in the middle of its travel. By following the darts which indicate the direction of the revolution of the crank and of the movements of the piston, the lever 16, and the cut-off valve 10 it will be seen that at this point in the revolution of the crank the main valve is nearly or quite stationary, while the cut-off valve is moving rapidly toward the left, as indicated by the dart marked on it. Consequently when the parts reach the position shown the cut-off valve has closed the port 11′ in the main valve, and as the cut-off valve is then moving at its greatest speed the closing of this port is effected very quickly. An exactly similar action occurs when the piston reaches the middle of its return stroke. The lever 16 then again stands vertical, but the connecting-rod is in the position indicated by the dotted line 5′. The lower end of the lever 16 is then at 17′, the fulcrum 19 at 19′, and its upper end 22 at 22′, and the valve-rod 23 is in the position shown by the dotted line 23′. As the form of the bar or link 21 on which the block 20 and fulcrum 19 slide is curved, the vertical movement of the block 20 has no effect on the cut-off valve when the link is in a vertical position, as shown in Fig. 3. Consequently when the crank-pin is at 7′ and the lever 16 is in the vertical position indicated by the dotted center line 22′ 17′ the cut-off valve is again in the middle of its stroke; but while the crank-pin is moving from the position 7 to 7′ the eccentric has moved the main valve toward the left, so as to bring the port 11 over the steam-port *a*, and they then occupy a relation to each other which is the converse of that in which the ports 11′ and *a*′ are shown in Fig. 3. Therefore the cut-off valve will cover the port 11 when the crank reaches the position 7′ and the piston is again at half-stroke.

In Fig. 1 the bar or link 21 is shown in an inclined position. It will be seen that then as the block 20 moves downward on the link it must assume a position farther toward the left, or in the direction toward which that end of the link inclines. Consequently the cut-off valve is also moved farther toward the left after the piston begins its stroke than it is when the link is in the position shown in Fig. 3, and therefore the port 11′ is closed earlier when the link is inclined, as shown in Fig. 1, than it is when it stands vertical, as in Fig. 3. The degree of inclination of the link will thus determine the period when cut off will occur.

By following the darts in Fig. 1 it will be seen that when the piston and crank are in the positions in which they are there shown the two valves are moving in opposite directions, and consequently the port *a*′ is closed very quickly. When the crank is in the reverse position from that in which it is shown, then the block 20 is at the upper end of the link 21. As the upper end inclines toward the right, the reverse action takes place, and the port 11 is then closed by the action of the cut-off valve. By this means the ports 11′ and 11 may be opened wide and closed, while the piston has moved only one-eighth or even a less proportion of the stroke.

Fig. 2 is a plan view showing a portion of the main and cut-off-valve stems. The latter

is tubular in form and the main valve-stem passes through it. The cut-off-valve rod 23 is attached to an offset pivot 24, and the main valve-rod 15 is connected to the stem 28, which passes through the tubular stem 27.

As shown in Figs. 4 and 6, the cut-off valve is operated by a link 21, attached to the eccentric-strap 30. This link is suspended by pendulous links 31 from a fixed pivot 32, and a sliding block 34 works in a slot 35 in the link. The block 34 is connected by a rod 33 to a rocker 36 of the ordinary type, the upper arm of which is connected to the cut-off valve by another rod in the usual way. It is obvious that when the block is in the position in which it is represented in Figs. 4 and 6 only the horizontal movement of the eccentric 37 will be imparted to it and that by properly proportioning the parts the cut-off valve would close the ports 11 or 11′ when the piston reaches the middle of the stroke. From Fig. 6 it will be seen, further, that when the piston 2 reaches half-stroke and the eccentric has made nearly a quarter-revolution the link has assumed an inclined position and that the upper end has moved farther in the direction in which the block 34 is moving than the center and lower end of the link and the block itself have. Therefore if the block were moved upward in the slot 35 or toward the upper end of the link the cut-off valve 10 would be moved farther toward the left, and consequently would close the port 11′ or cut off steam earlier. The point of cut off can thus be regulated by the position of the block 34 in the link. If the block were moved downward in the link, cut off would be delayed and would occur later in the stroke.

Fig. 7 illustrates a further modification, in which the cut-off link is operated by a system of levers connected to the connecting-rod. The link 21 is supported by vibrating links 31, attached to fixed pivots 32. The lever 16 is connected to a bar 39, which is attached to the connecting-rod at 40, the other end being supported by the pendulous link 41. The movement imparted to the link is exactly similar to that shown in Figs. 4 and 6. In Fig. 8 the link is driven by an overhung or return crank 42, instead of which an eccentric might of course be equivalently employed.

The several structural modifications illustrated have the common operative feature of an equable movement of the cut-off valve coincident with that of the piston and the variation in cut off is effected by changing the movement of the cut-off valve transversely to that of the piston and the main valve. Similarly-operating mechanism has heretofore been employed for actuating ordinary single slide-valves, but so far as my knowledge and information extend has never been combined with independent cut-off valves as or substantially as herein described.

I claim as my invention and desire to secure by Letters Patent—

1. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a main valve having supply-ports adapted to communicate with ports in the cylinder, mechanism for reciprocating said main valve, and an independent cut-off valve controlling the supply-ports of the main valve and operated by an element having an equable movement coincident with that of the piston, and a variable movement transversely to that of the piston, whereby the movement of the cut-off valve may be delayed or advanced in relation to that of the main valve.

2. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a main valve having supply-ports adapted to communicate with ports in the cylinder and operated by an ordinary link-motion valve-gear, and an independent cut-off valve controlling the supply-ports of the main valve and operated by an element having an equable movement coincident with that of the piston, and a variable movement transversely to that of the piston, whereby the movement of the cut-off valve may be delayed or advanced in relation to that of the main valve.

3. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a main valve having supply-ports adapted to communicate with ports in the cylinder, mechanism for reciprocating said main valve, an independent cut-off valve controlling the supply-ports of the main valve, a link adjustably held by a fixed bearing or bearings, a sliding block fitted to said link, mechanism connected to the sliding block, to the cut-off valve and to the connecting-rod, and deriving its motion therefrom; and appliances for varying the adjustment of the link, the movement of the block, and that of the cut-off valve.

4. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston and rod working therein, a connecting-rod coupling the piston-rod to a crank, a main valve having supply-ports adapted to communicate with ports in the cylinder, mechanism for reciprocating said main valve, an independent cut-off valve controlling the supply-ports of the main valve, and operated by a lever connected to the connecting-rod, from which the lever and cut-off valve derive their motion; a link held by a fixed bearing or bearings and capable of angular adjustment thereon and carrying a sliding block to which the said lever is connected, and mechanism for varying the adjustment of the link, the movement of the block and that of the cut-off valve transversely to that of the piston.

5. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston and rod working therein, a connecting-rod coupling the piston-rod to a crank, a main valve having supply-ports adapted to communicate with ports in the cylinder, mechanism for reciprocating said main valve, an in-

dependent cut-off valve controlling the supply-ports of the main valve, a link capable of angular adjustment in pivotal bearings, by ordinary means, a block sliding on said link, and a lever connected to said block and to the cut-off valve, and deriving its motion from the connecting-rod, and thus imparting a movement coincident to that of the piston to the cut-off valve, and one transversely to that of the piston to the block, whereby the movement of the cut-off valve is advanced or delayed in relation to that of the piston and main valve by the angular position of the link.

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