(No Model.)

4 Sheets—Sheet 1.

C. H. TREAT & T. HALL.

VALVE GEAR.

No. 584,023. Patented June 8, 1897.

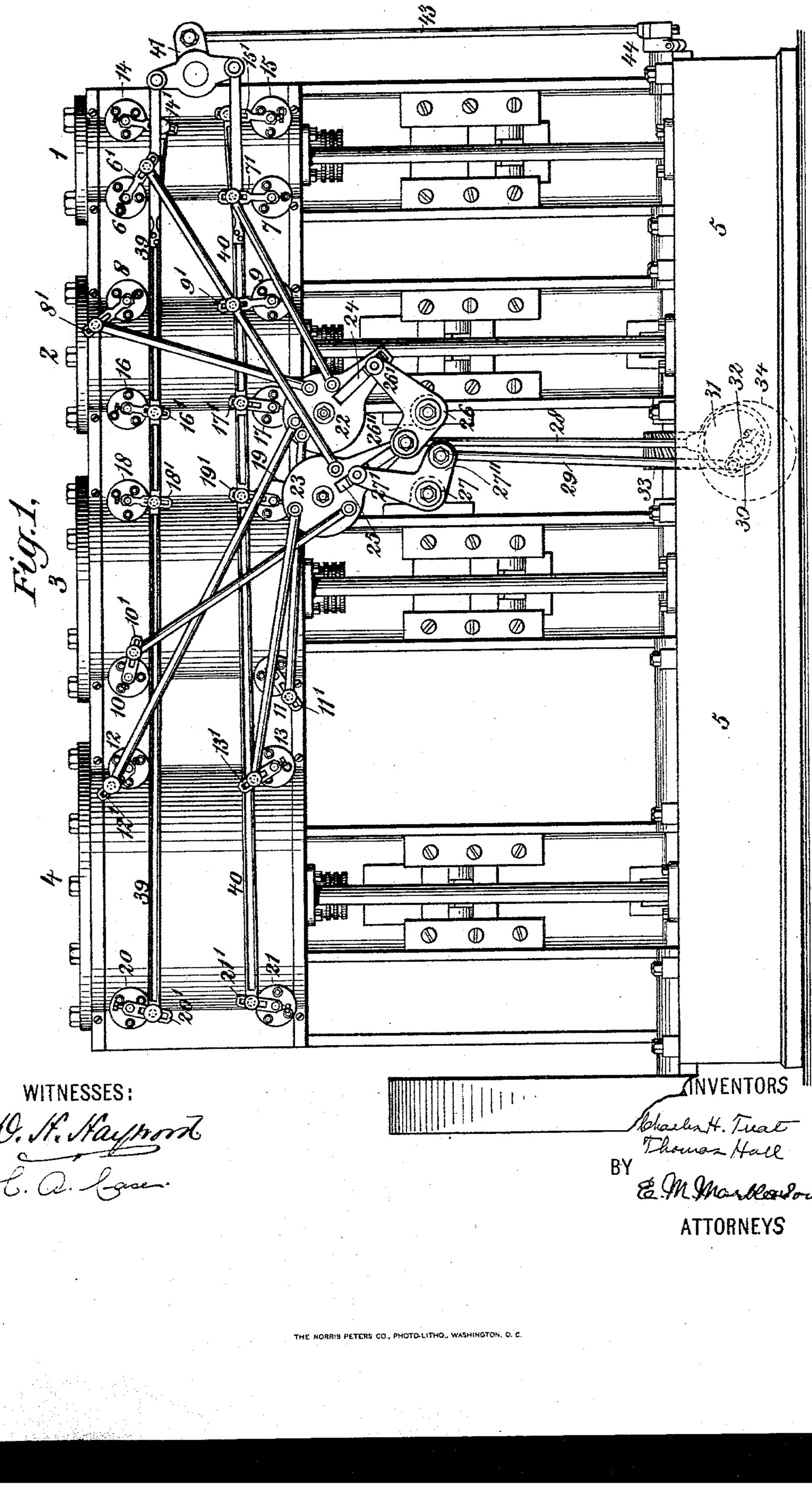

Fig. 1.

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VALVE GEAR.

No. 584,023. Patented June 8, 1897.

Fig. 2.

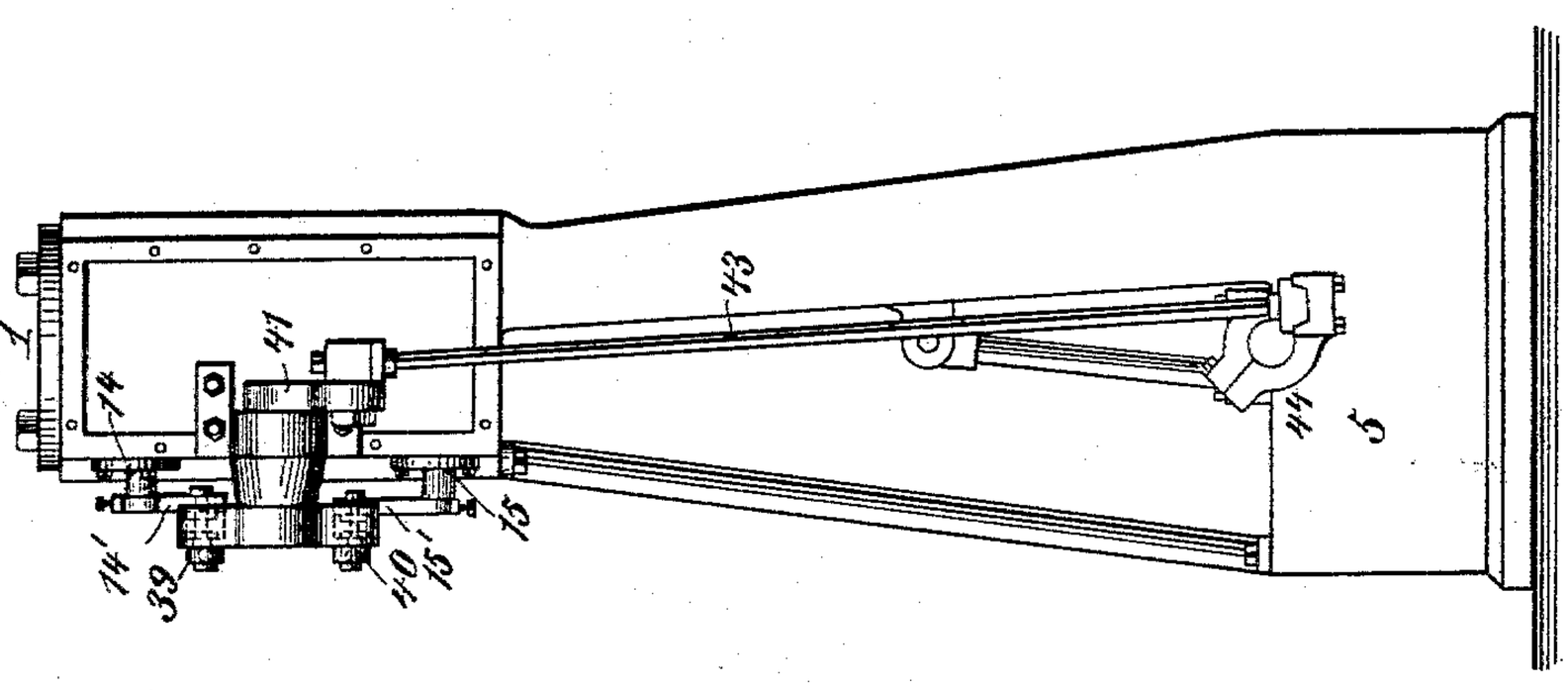
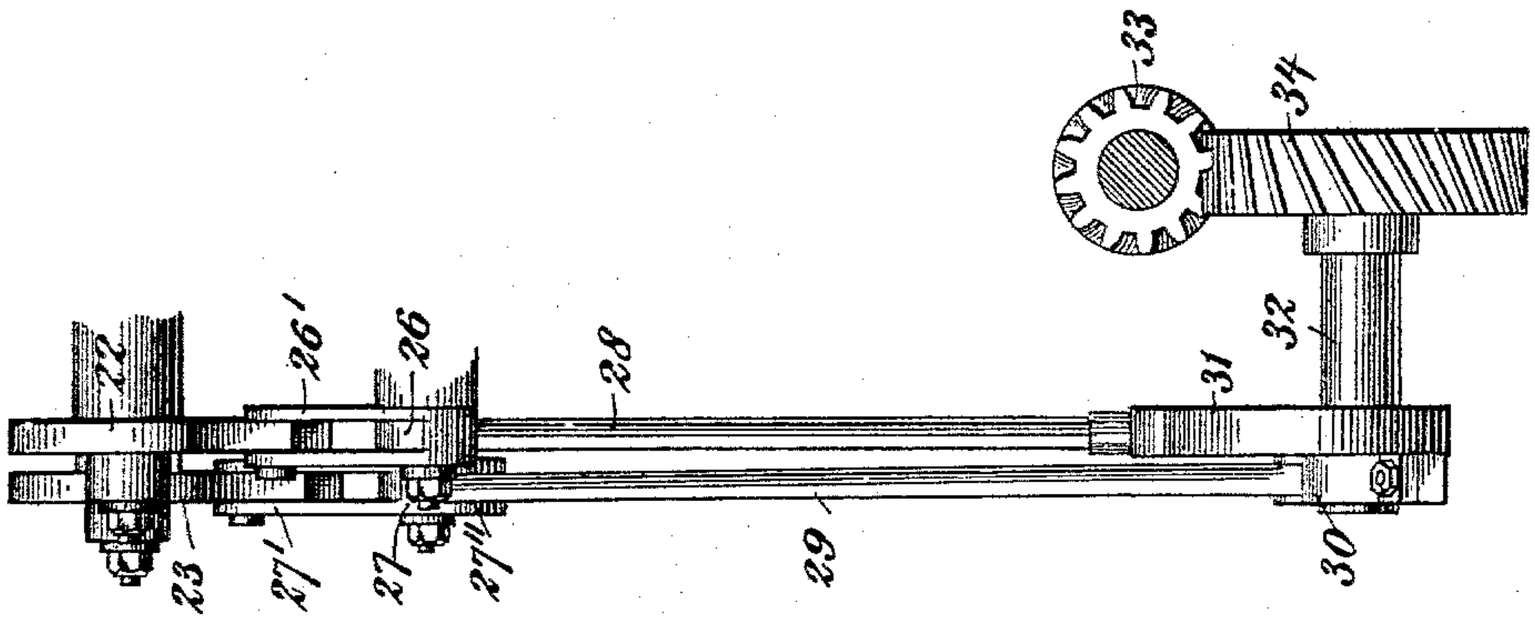


Fig. 3.



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VALVE GEAR.

No. 584,023. Patented June 8, 1897.

Fig. 4,

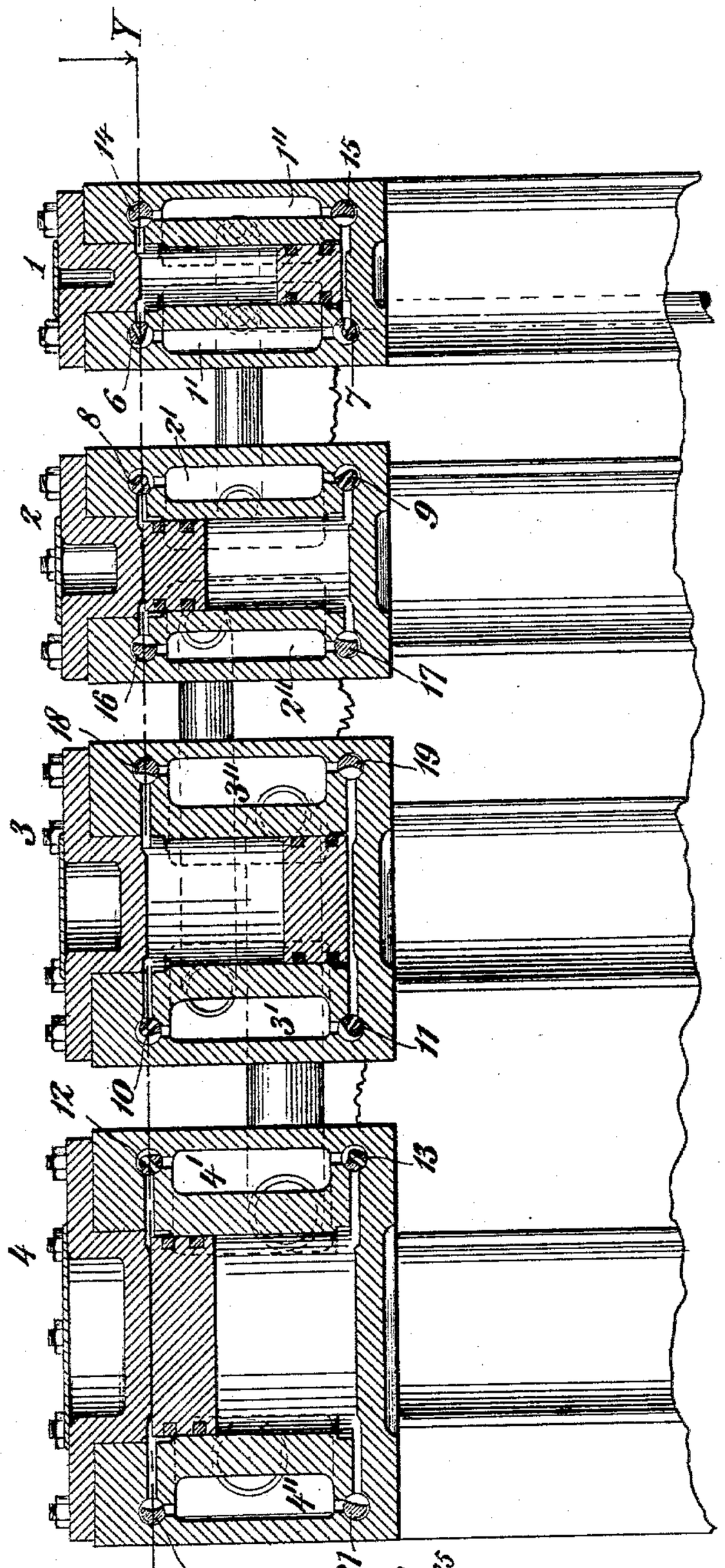
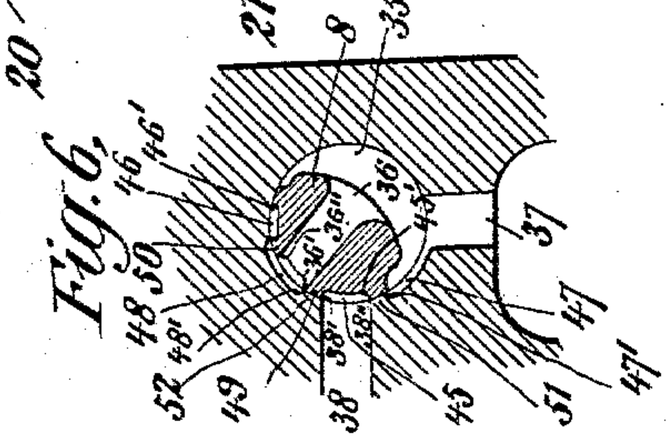


Fig. 6,



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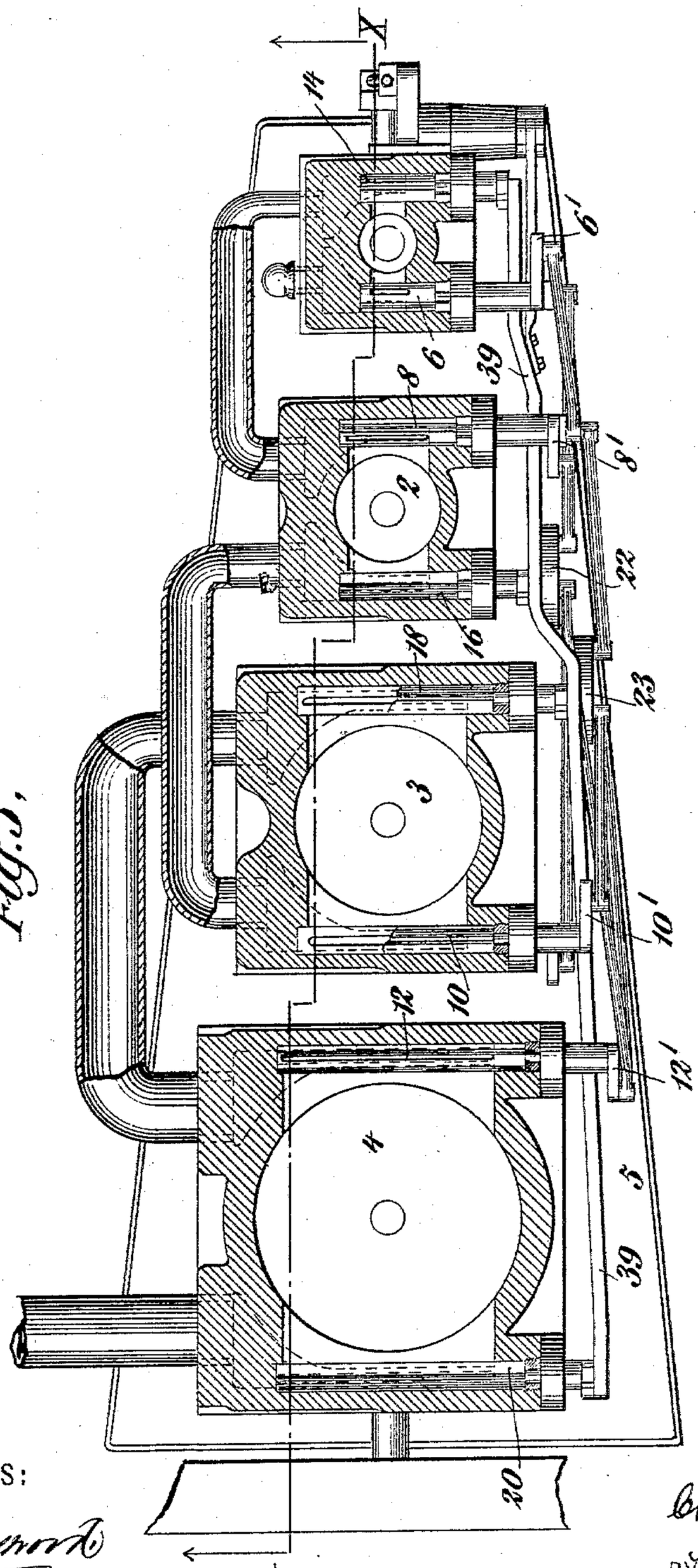
VALVE GEAR.

No. 584,023. Patented June 8, 1897.

Fig. 5,



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UNITED STATES PATENT OFFICE.

CHARLES HENRY TREAT, OF ITHACA, NEW YORK, AND THOMAS HALL, OF WASHINGTON, CANADA.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 584,023, dated June 8, 1897.

Application filed November 29, 1895. Serial No. 570,377. (No model.)

To all whom it may concern:

Be it known that we, CHARLES HENRY TREAT, a citizen of the United States, residing at Ithaca, in the county of Tompkins and State of New York, and THOMAS HALL, a subject of the Queen of Great Britain, residing at Washington, in the Province of Ontario, Dominion of Canada, have invented certain new and useful Improvements in Valve-Gears; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Our invention relates to valve-gears for steam-engines; and it consists in the novel means employed for operating the valve, and in the novel combination, construction, and arrangement of the parts constituting the valve-gear.

The objects of our invention are, first, to provide a valve-gear for steam-engines which shall be positive in its action, shall preserve full port-opening during as great a portion of the period of admission as possible, and shall move the valve quickly at the beginning of admission and at cut-off, with but little over-travel of the valve after cut-off; second, to provide a valve-gear which, while possessing the above advantages, may be capable of wide regulation of the events of the stroke; third, to provide a valve-gear which may be used on either single or multiple cylinder engines and with both slide and rotary valves; fourth, to provide a valve-gear which shall be capable of smooth and steady operation at high speeds; fifth, to provide a form of rotary valve which shall be compact and shall provide ample port-opening when near admission and cut-off to prevent wiredrawing, and, sixth, to make the valve-gear simple, compact, not liable to derangement, and durable. These objects are attained in the valve-gear herein described, and illustrated in the drawings which accompany and form a part of this application, in which the same reference-numerals indicate the same or corresponding parts, and in which—

Figure 1 is a side elevation of a four-cylinder engine of the vertical inverted-cylinder type, being a quadruple expansion-engine the valves of which are operated by our improved valve-gear. Fig. 2 is an end elevation of the high-pressure end of the engine, showing for the sake of simplicity only the high-pressure cylinder with the parts of the valve-gear thereunto pertaining. Fig. 3 is an end elevation of the valve-gear, likewise taken from the high-pressure end of the engine, the cylinders, frame, and bed-plate of the engine being omitted for the sake of clearness and in order that the counter-shaft and the worm-gearing by which the counter-shaft is driven from the crank-shaft of the engine may be shown. Fig. 4 is a vertical section of the steam-cylinders, taken on the irregular section-line X X of Fig. 5, the section being taken so as to show the steam and exhaust receiver spaces of each cylinder. Fig. 5 is a horizontal section of the engine through the upper steam and exhaust ports, the section being taken on the line Y Y of Fig. 4; and Fig. 6 is a detail section of one of the double-ported steam-valves and of the valve-chamber containing the same.

Referring to the drawings, and particularly to Figs. 1, 2, and 3, 1 is the high-pressure cylinder; 2, the first intermediate cylinder; 3, the second intermediate cylinder, and 4 the low-pressure cylinder. The cylinders are supported by suitable columns resting on a bed-plate 5. They have suitable steam passages and receivers, pistons, piston-rods, connecting-rods, and other moving parts, to which this invention does not relate and which therefore require neither description nor detail illustration. The steam and exhaust valves of the engine are of the rotary type, and for the steam-valves at least it is desirable to use double-ported valves, as hereinafter described. 6 and 7 are the steam-valves of cylinder 1; 8 and 9, the steam-valves of cylinder 2; 10 and 11, the steam-valves of cylinder 3, and 12 and 13 the steam-valves of cylinder 4. In the same order the exhaust-valves of the engine are 14 and 15 for cylinder 1, 16 and 17 for cylinder 2, 18 and 19 for cylinder 3, and 20 and 21 for cylinder 4. Each valve is rotated by a valve-lever secured to its stem, and these valve-levers are each in-

dicated in the drawings by the same numerals primed, which indicate the corresponding valves, as 6′, 7′, &c.

The arrangement of the steam and exhaust receiver spaces, the valve-chambers and valves, the steam and exhaust ports, and the passages between the cylinders are shown in Figs. 4 and 5. Each cylinder has cored out in one side a steam-receiver space, such as 1′, 2′, 3′, and 4′, and upon the other side an exhaust-receiver space, such as 1″, 2″, 3″, and 4″. The supply-pipe of the engine connects with the steam-receiver space of cylinder 1. The exhaust receiver space 1″ of cylinder 1 and the corresponding exhaust-receiver spaces of cylinders 2 and 3 are each connected with the steam-receiver space of the next adjacent cylinder by a steam-pipe, as shown particularly in Fig. 5. The exhaust-pipe of the engine connects with the exhaust-receiver space 4″ of cylinder 4. The valve-chambers are placed above and below these receiver-spaces, and are connected therewith and with their cylinders by proper ports.

Separate mechanisms are provided for operating the steam and exhaust valves of the engine, and the points of admission and cut-off of the steam-valves may therefore be adjusted without affecting exhaust and compression. The steam-valves are operated by rods connected to the above-mentioned valve-levers and to two vibrating wrist-plates 22 and 23, pivoted to the frame of the engine. In these wrist-plates are guide-slots 24 and 25, in which slide blocks pivoted to the extremities of arms 26′ and 27′ of bell-crank levers 26 and 27, themselves pivoted to the frame of the engine and having other arms 26″ and 27″, connected by rods 28 and 29 with a crank 30 and eccentric 31, respectively, on a counter-shaft 32. The counter-shaft is driven from the crank-shaft of the engine, as shown in Fig. 3, by reducing worm-gears 33 and 34, having a ratio of two to one, so that the counter-shaft makes but half a revolution while the crank-shaft is making a full revolution. A complete cycle of the steam-valve gear therefore occupies two complete revolutions of the crank-shaft. This fact makes it necessary to have the steam-valves operate somewhat differently in admitting and cutting off steam from the ordinary engine-valves, the cycle of which occupies but one revolution of the crank-shaft.

In ordinary engines the valve admits steam to the cylinder by moving so as to bring its port registry with the port in the valve-seat leading to the cylinder and cuts off the steam by moving back to its original position, steam being cut off by the same edge of the valve-port at which admission begins. With our valve-gear as applied to the engine shown in Figs. 1, 2, and 3, however, the valve at admission moves so as to bring its port into registry with the port in the valve-seat and at cut-off moves onward, not backward, steam being cut off by the opposite edge of the valve-port from that at which admission began. After cut-off there is a slight overtravel of the valve, and the direction of motion of the valve is then reversed, so that when the next revolution of the engine begins the valve is in position to admit steam as before, admission beginning at the edge of the valve-port at which cut-off took place during the preceding revolution. This will be understood by reference to Fig. 6, which shows in detail section one of the steam-valves, with the ports corresponding thereto.

8 is the valve, and 35 its valve-chamber.

36 is the valve-port within the valve, having edges 36′ and 36″.

37 is the admission-port to the valve-chamber, and 38 the port in the valve-seat leading to the interior of the cylinder and with which the port 36 in the valve coacts. During one revolution of the engine the valve moves so as to admit the passage of steam through valve-port 36 into port 38, admission beginning at the edge 36′ of valve-port 36. At cut-off the valve has moved onward, so that port 38 is closed by the edge 36″. After cut-off there is a slight overtravel and the motion of the valve is reversed in direction. The valve then moves backward, and at the instant when the next revolution begins the valve has moved so that admission begins at edge 36″—the edge which cut off the steam in the preceding revolution. Further movement of the valve causes the port 36′ to cut off the steam, the valve moves onward, reverses its direction of movement, and a new cycle of the valve-gear begins. With this method of operating the valve, since the speed of the valve-gear is thereby reduced to half the speed of the engine, there is less danger of pounding or vibration due to the valve-gear and less danger of breakage of the valve-gear—advantages of considerable moment, since it is impossible in practice to balance the moving parts of the valve-gear properly; but the greatest advantage gained by this method of operating the valves is that by this means the period of admission is caused to coincide with the period at which the valves are moving most rapidly, so that quick admission and cut-off and wide port-opening may be obtained without excessive valve travel. Each bell-crank lever and wrist-plate is arranged to vibrate equally on both sides of a line drawn through their pivots. The wrist-plate and bell-crank revolve in opposite directions, and therefore at the extremes of their vibrations the arm of the bell-crank is at an angle with the guide-slot in the wrist-plate, and the sliding block, which is attached to the extremity of the bell-crank arm and slides in the guide-slot, has moved to the outer extremity of the slot. These two facts, therefore—viz., the angular position of the guide-slot relative to the bell-crank arm and the fact that the sliding block is at the extremity of the slot—combine to make the motion of the wrist-plate very slow with respect to that of the bell-crank at and near the ends

of the vibrations of wrist-plate and bell-crank. Thus the arm 26′ of bell-crank 26 begins to move inward along slot 24 considerably before the time for admission to begin in valves 7, 8, 11, and 12; but since at the extreme position the arm 26′ is practically at right angles to the slot 24 the arm 26′ may move through a considerable portion of the angle between its extreme position and the vertical position before the movement of the wrist-plate 22 becomes marked. As the arm 26′ nears the vertical position, however, the movement of the wrist-plate 22 becomes much more rapid than that of the bell-crank 26, since the radial distance of the extremity of arm 26′ from the center of the wrist-plate becomes shorter and shorter. The angular advance of the eccentric 31 is such that admission takes place when the arm 26′ is within a few degrees of the vertical position, and cut-off takes place when the arm 26′ has passed the vertical position by a few degrees, after which the motion of the wrist-plate 22 decreases so rapidly that the overtravel of the valves is slight.

To further increase the rapidity of port-opening and to avoid wiredrawing, we prefer to use double-ported steam-valves, such as are shown in Fig. 6, formed with auxiliary ports on each side of the main steam-port 36. These ports are formed by recesses 45 and 46 in the face of the valve on each side of the main port 36 and corresponding recesses 47 and 48 in the walls of the valve-chamber on each side of the port 38, these recesses being separated from the main steam-ports by bridges of metal 49, 50, 51, and 52 of sufficient breadth to prevent reopening of the valve after cut-off. At the same instant when the edge 36′ of the port 36 moves over the edge 38′ of port 38 to place ports 36 and 38 in communication the edge 45′ of the recess 45 moves over the edge 47′ of the recess 47, thus permitting steam to pass from chamber 35 through recesses 47 and 45 into the port 38 and greatly increasing the port-opening at the beginning of admission. In the same manner when port-opening begins to be restricted just before cut-off steam passes through recesses 48 and 46 into the port 38, thus increasing the port-opening and preventing wiredrawing. At the instant when the edge 36″ of port 36 passes over the edge 38″ of port 38 to cut off steam the edge 46′ of recess 46 moves over the edge 48′ of recess 48, thus preventing the passage of steam through these recesses and causing complete cutting off of steam.

In the engine shown in Figs. 1, 2, and 3 the cranks of the main crank-shaft are set at angles of one hundred and eighty degrees, so that the diagonally opposite steam-valves of adjacent cylinders operate simultaneously to admit and cut off steam. The crank 30 and eccentric 31 are set about ninety degrees apart on the counter-shaft 32, and each wrist-plate operates one steam-valve of each of the four cylinders and operates diagonally opposite valves of adjacent cylinders. That is, one wrist-plate operates all of the valves which admit steam in one portion of the revolution and the other wrist-plate operates all of the valves which admit steam during the other portion of the revolution. The rods which connect the valve-levers with the wrist-plates are adjustable along the valve-levers, so that the travel of the valves may be adjusted by adjusting the point of connection between the valve-levers and the rods which lead to the wrist-plates. By properly adjusting the travel of each valve and then adjusting its angular position with respect to the valve-lever the cut-off in each cylinder may be varied at will.

It will be evident that for single-cylinder engines each wrist-plate will operate but one valve. Therefore in such case the form of the wrist-plate will be changed and it will become a pivoted arm simply. It will also be evident that the pivoted lever which engages with the wrist-plate need not be a bell-crank lever necessarily, the configuration of the lever depending upon the direction in which force is applied to vibrate the levers. The essential feature of the valve-gear is two pivoted arms or levers, one having a radial slot or slide and the other having an arm engaging with this slot or slide at a point between the pivots of the two levers, so that the levers necessarily vibrate about their pivots in opposite directions, one lever being connected with the engine-valve and the other being provided with means whereby it is vibrated when the crank-shaft revolves.

The exhaust-valve gear, as above stated, is separate and distinct from the steam-valve gear, so that adjustments of the steam-valves may be made without affecting the exhaust-valves. Two rods 39 and 40 extend along the side of the engine and are connected to the valve-levers of the various exhaust-valves, one rod operating the upper valves and the other the lower valves. Both rods are connected to the arms of a double rocking lever 41, which is vibrated during each revolution of the crank-shaft by a connecting-rod 43, the other end of which is connected to a crank 44 on the crank-shaft of the engine. As the crank-shaft revolves the rods 39 and 40 are moved back and forth, operating the exhaust-valves.

It will be understood that the crank 30 and eccentric 31 are substantial equivalents, one being a crank and the other an eccentric merely as a matter of convenience, and that in the following claims the one term includes the other.

Having thus completely described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a valve-gear, the combination, with a pivoted arm connected with the engine-valve and arranged to operate said valve when vibrated, of a second pivoted arm having a moving connection with said first-named arm at a point between the pivots of said arms,

the point of connection between said arms moving along the first-named arm toward and from the pivot thereof when the arms vibrate, whereby, when said last-named arm is vibrated, said first-named arm is likewise caused to vibrate, but at a varying speed, and means for vibrating said last-named arm, substantially as described.

2. In a valve-gear, the combination, with a pivoted arm connected with the engine-valve and arranged to operate said valve when vibrated, and having a radial slot or slide, of a second pivoted arm having a connecting-piece engaging with said slot or slide at a point between the pivots of said arms, and means for vibrating said last-named pivoted arm, whereby said first-named arm is caused to vibrate, but at a varying speed, substantially as described.

3. In a valve-gear, the combination, with a pivoted arm connected with the engine-valve and arranged to operate said valve, when vibrated, at the mid-period of its vibration, and having a radial slot or slide, of a second pivoted arm having a connecting-piece engaging with said slot or slide at a point between the pivots of said arms, whereby when said last-named arm is vibrated said first-named arm is also caused to vibrate, but at a varying speed, and reducing-gearing driven from the crank-shaft of the engine and connected with said second pivoted arm, and arranged to vibrate said arm once during each two revolutions of the crank-shaft, substantially as described.

4. In a valve-gear, the combination, with valves for the opposite ends of the engine-cylinder, and two pivoted arms each arranged to operate the valve at one end of the cylinder, at the mid-period of its vibration, and each having a radial slot or slide, of two other pivoted arms corresponding each to one of said first-named pivoted arms and each having a connecting-piece engaging with the slot or slide in that arm at a point between the pivots of said arms, whereby, when said last-named pivoted arms are vibrated said first-named pivoted arms are also vibrated, but at varying speeds, and reducing-gearing driven from the crank-shaft of the engine and connected with said last-named pivoted arms, and arranged to vibrate said arms once during each two revolutions of the crank-shaft, and to vibrate said arms one stroke of the engine apart, substantially as described.

5. In a valve-gear, the combination, with a pivoted wrist-plate connected with the engine-valve and arranged to operate said valve, when vibrated, at the mid-period of its vibration, and having a radial slot or slide, of a pivoted lever engaging with the said slot or slide of the wrist-plate at a point between the pivots of the wrist-plate and lever, whereby, when said lever is vibrated, said wrist-plate is also vibrated, but at a varying speed, and reducing-gearing driven from the crank-shaft of the engine and connected with said pivoted lever, and arranged to vibrate said arm once during each two revolutions of the crank-shaft, substantially as described.

6. In a valve-gear, the combination, with a valve, a pivoted wrist-plate arranged to operate said valve, when vibrated, at the mid-period of its vibration, and having a radial slot or slide, and means for varying the travel of the valve, of a pivoted lever engaging with said slot or slide at a point between the pivots of the wrist-plate and lever, whereby, when said lever is vibrated said wrist-plate is also vibrated, but at a varying speed, and reducing-gear driven from the crank-shaft of the engine and connected with said pivoted lever, and arranged to vibrate said arm once during each two revolutions of the crank-shaft, substantially as described.

7. In a valve-gear, the combination, with valves for each end of the engine-cylinder, and a pivoted wrist-plate for each end of the cylinder connected to the valve of that end of the cylinder and arranged to operate said valves, when vibrated, at the mid-period of its vibration, and having a radial slot or slide, of a pivoted bell-crank lever for each wrist-plate, one arm of which engages with the slot or slide of said wrist-plate at a point between the pivots of said wrist-plate and bell-crank lever, a counter-shaft, geared to the crank-shaft of the engine, and arranged to rotate at half the speed of said crank-shaft, and two cranks on said counter-shaft, set one in advance of the other by an angle corresponding to one stroke of the engine, and each connected to one of said bell-crank levers and arranged to vibrate said lever, substantially as described.

8. In a valve-gear, the combination, with steam and exhaust valves for each end of the engine-cylinder, a pivoted wrist-plate for each end of the cylinder connected to the steam-valve at that end of the cylinder and arranged to operate said valve, when vibrated, at the mid-period of its vibration, and having a radial slot or slide, a pivoted bell-crank lever for each wrist-plate one arm of which engages with the slot or slide of said wrist-plate at a point between the pivots of said wrist-plate and bell-crank lever, a counter-shaft, geared to the crank-shaft of the engine, and arranged to rotate at half the speed of said crank-shaft, and two cranks on said counter-shaft set one in advance of the other by an angle corresponding to one stroke of the engine, and each connected to one of said bell-crank levers and arranged to vibrate the same, of a pivoted rocking lever connected to the exhaust-valves of the engines, and means for vibrating said lever at each revolution of the engine, substantially as described.

9. In a valve-gear, the combination, with a rotary valve, a valve-lever for operating the same, a pivoted wrist-plate, and a rod, connecting said wrist-plate and valve-lever, and adjustable along said valve-lever, whereby the travel of the valve may be regulated, said wrist-plate being arranged to operate the

valve at the mid-period of its vibration, and a radial slot or slide for said wrist-plate, of a pivoted lever engaging with the slot or slide of the wrist-plate at a point between the pivots of the wrist-plate and lever, whereby, when said lever is vibrated said wrist-plate is also vibrated, but at a varying speed, and reducing-gear driven from the crank-shaft of the engine and connected with said pivoted lever, and arranged to vibrate said lever once during each two revolutions of the crank-shaft, substantially as described.

10. In a valve-gear for multiple-cylinder engines, the combination, with engine-cylinders having oppositely-set cranks, and valves for each end of each cylinder, of two pivoted wrist-plates, each connected with one valve of each cylinder and connected with diagonally opposite valves of adjacent cylinders, and arranged to operate said valves, when vibrated, at the mid-period of its vibration, and a radial slot or slide for each wrist-plate, of a pivoted bell-crank lever for each wrist-plate one arm of which engages with the slot or slide of said wrist-plate at a point between the pivots of said wrist-plate and bell-crank lever, a counter-shaft, geared to the crank-shaft of the engine, and arranged to rotate at half the speed of said crank-shaft, and two cranks on said counter-shaft set one in advance of the other by an angle corresponding to one stroke of the engine, and each connected to one of said bell-crank levers and arranged to vibrate the same, substantially as described.

11. The combination, with a valve-chamber having a rotating valve therein and corresponding ports in said chamber and valve adapted to register when the valve is rotated, of a recessed steam-passage in the side of said valve-chamber and at one side of the port thereof, a corresponding and oppositely-placed steam-passage in the side of the valve and at such distance from the port of said valve that when the ports of the valve and valve-chamber are in partial registry the said recessed passage of the valve connects the recessed passage and the port of the valve-chamber, and means for rotating said valve within said chamber, substantially as described.

12. The combination, with a valve-chamber having a rotating valve therein and corresponding ports in said chamber adapted to register when the valve is rotated, of two recessed steam-passages in the side of said valve-chamber placed one on each side of the port of said chamber, two corresponding and oppositely-placed steam-passages in the side of the valve, one on each side of the port of the valve and at such distance therefrom that when the ports of the valve and valve-chamber are in partial registry one of the said recessed passages of the valve connects one of the said recessed passages of the valve-chamber and the valve-port thereof, and means for rotating said valve within said chamber, substantially as described.

In testimony whereof we affix our signatures in the presence of two witnesses.

CHARLES HENRY TREAT.
THOMAS HALL.

Witnesses for Charles H. Treat:
JOHN E. SWEET,
K. F. CASSIDY.
Witnesses for Thomas Hall:
GEORGE A. HALL,
WM. HAZLITT SMITH.