

No. 609,953.

Patented Aug. 30, 1898.

C. C. WORTHINGTON.
VALVE MOVEMENT FOR STEAM ENGINES.

(Application filed June 16, 1897.)

(No Model.)

4 Sheets—Sheet 1.

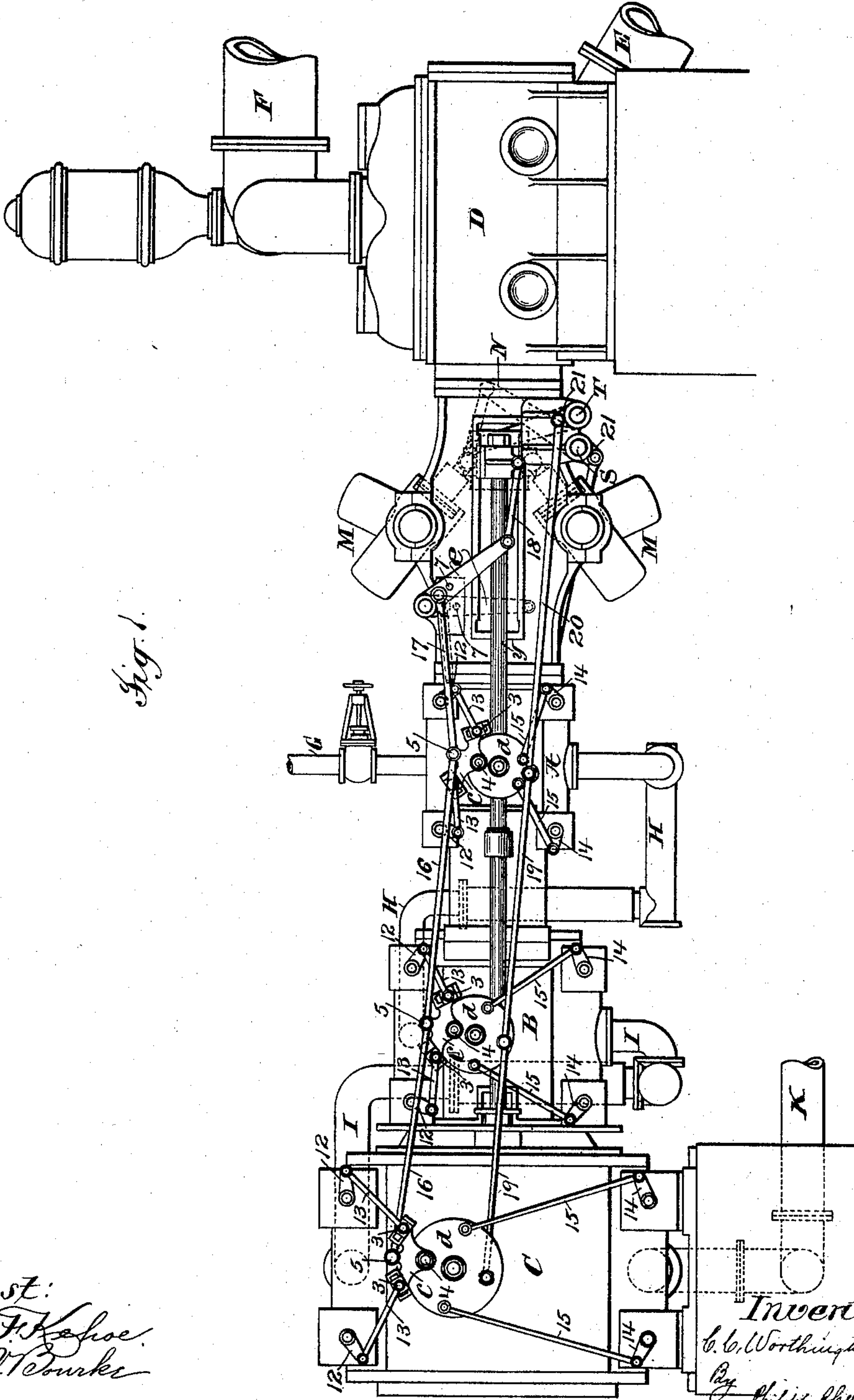


Fig. 1.

Attest:
J. F. Kahoe
A. V. Bourke

Inventor
C. C. Worthington
By Philip P. Sawyer
Attys

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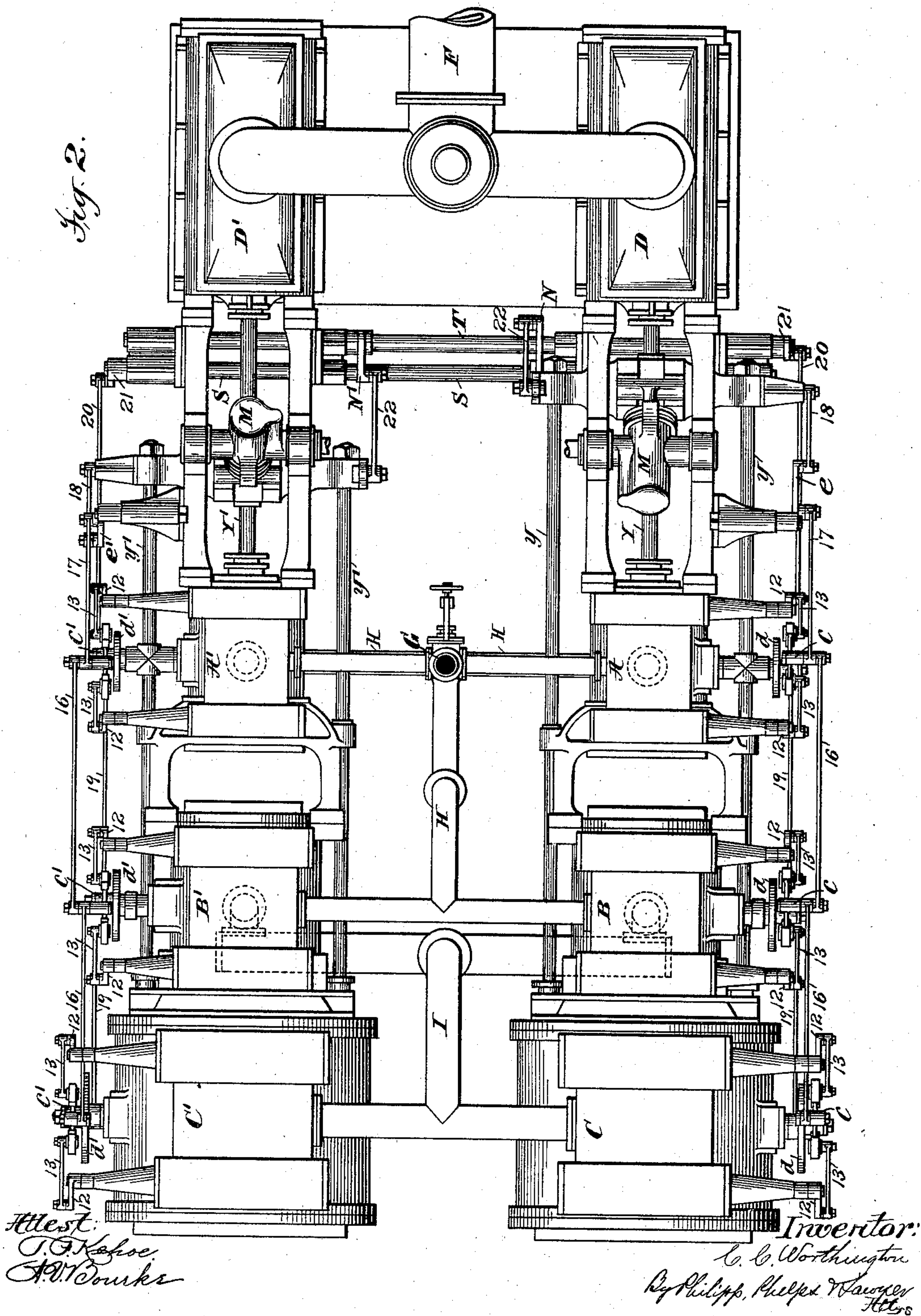
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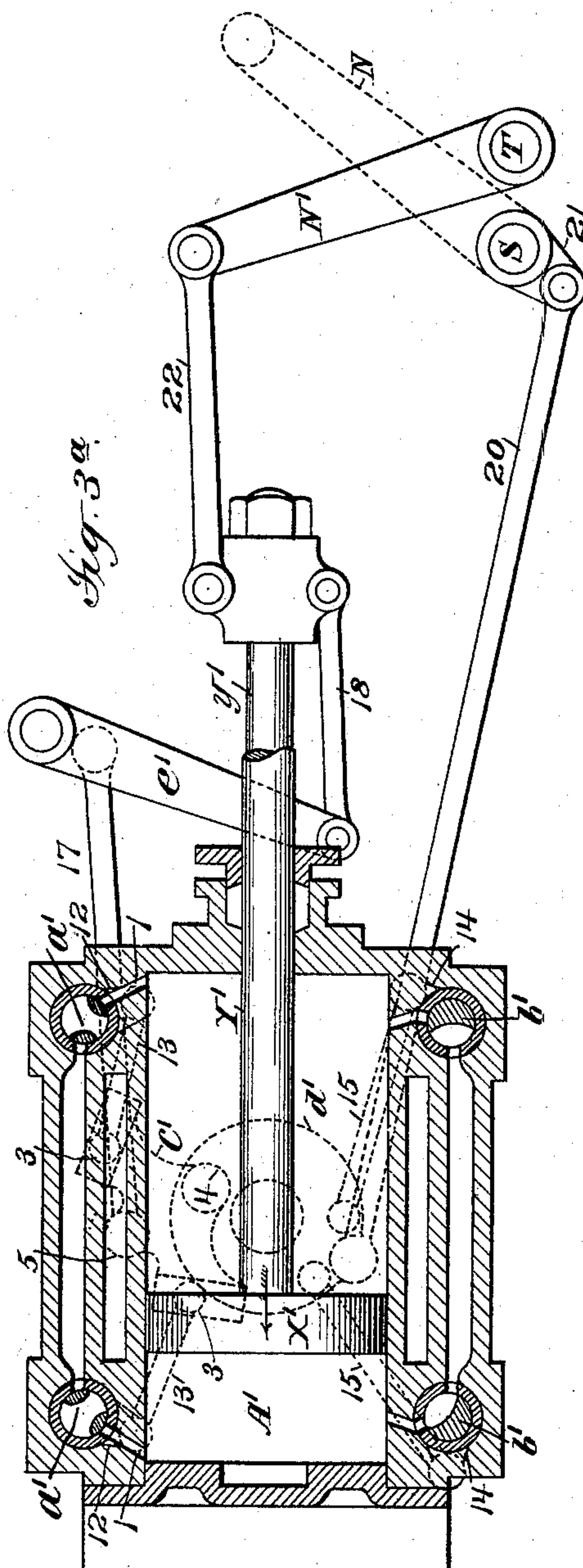
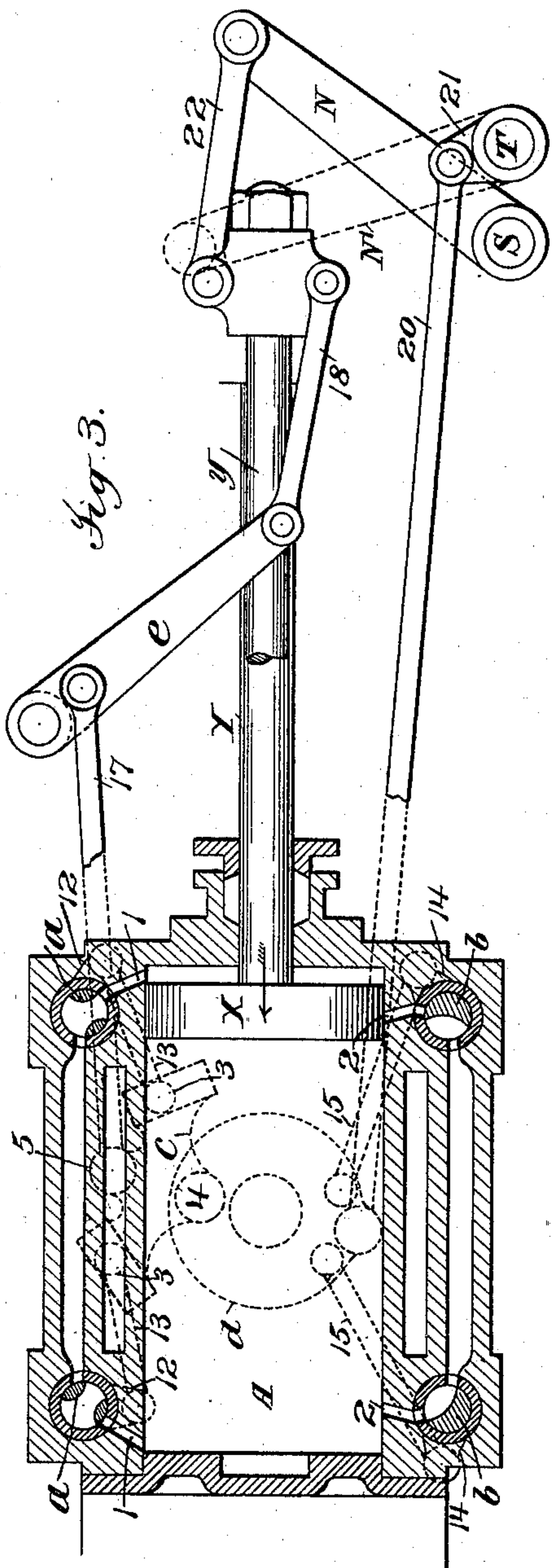
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4 Sheets—Sheet 3.



Attest:
T. F. Lahoe.
A. V. Bourke

Inventor:
C. C. Worthington
By Philipp, Phelps & Sawyer
Attys

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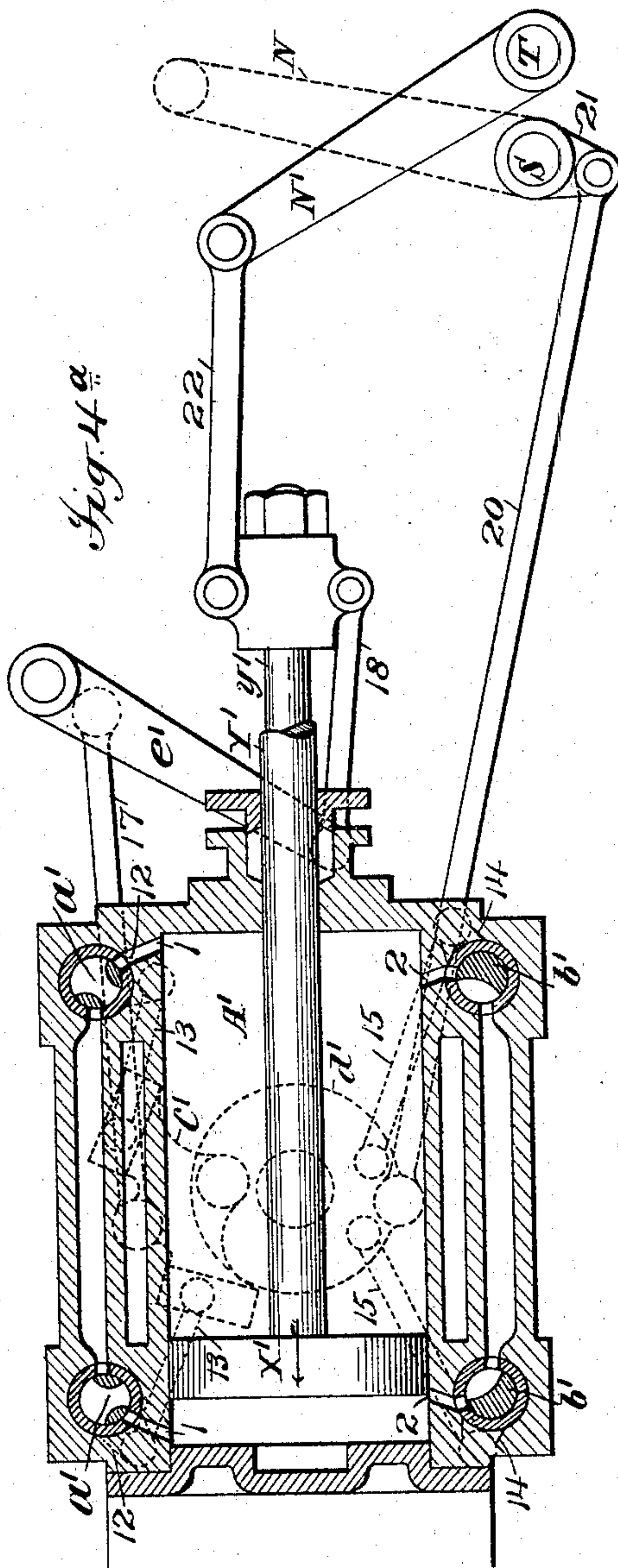
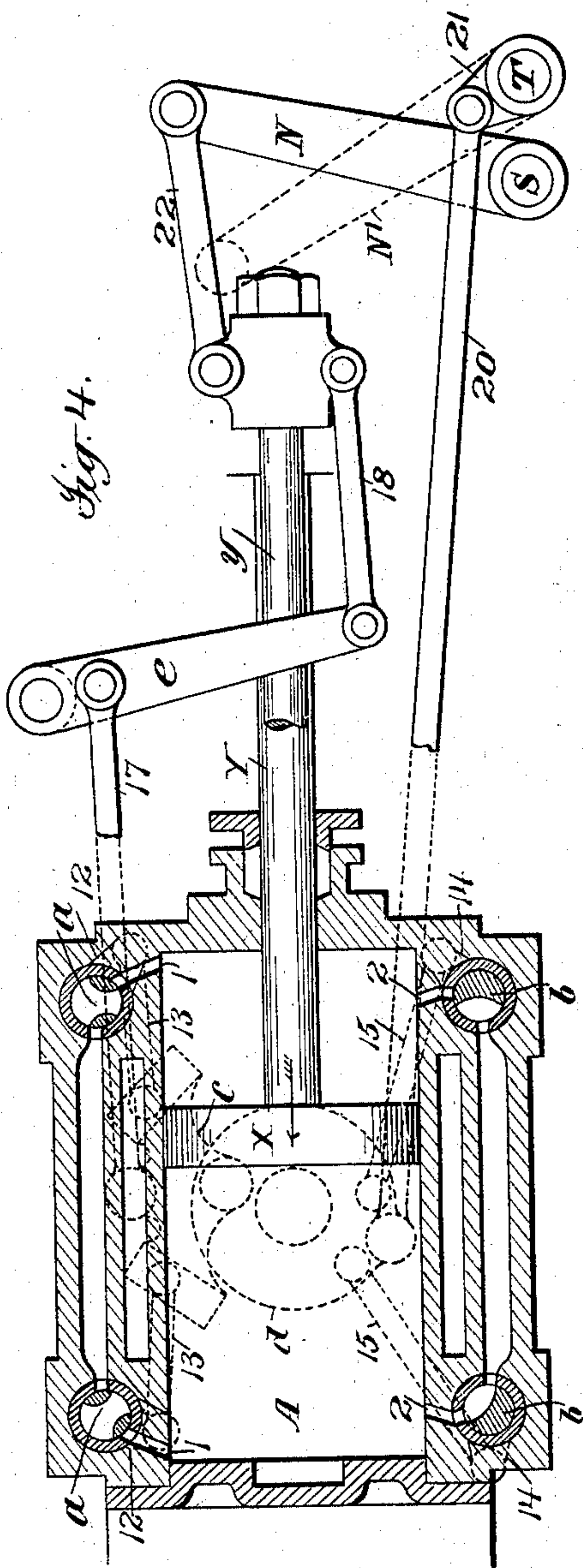
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(No Model.)

4 Sheets—Sheet 4.



Attest:

T. F. Kehoe
A. V. Bourke

Inventor
C. C. Worthington
By Philipp Phelps & Sawyer
Attys

UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

VALVE-MOVEMENT FOR STEAM-ENGINES.

SPECIFICATION forming part of Letters Patent No. 609,953, dated August 30, 1898.

Application filed June 16, 1897. Serial No. 640,967. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing at Irvington, county of Westchester, and State of New York, have invented certain new and useful Improvements in Valve-Movements for Steam-Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved valve-movement for steam and similar expansion engines of that class in which a single valve controls both the admission and cut-off of the steam or other motor fluid. While my improved valve-movement is applicable also with other steam-engines, both single and multiple cylinder, it is especially adapted for use with duplex direct-acting steam-pumps and similar duplex engines; and the general object of the invention is to provide an improved movement for such engines by which the opening of such single valves for the admission of steam is controlled by the opposite side of the engine and the closing of the valves for cut-off by their own side of the engine, and the invention includes certain features in such a construction and will be illustrated and described as thus applied.

As a full understanding of the invention can best be given by a detailed description of a construction embodying the same, such a description will now be given in connection with the accompanying drawings, forming a part of this specification, and showing all the features of the invention applied in the preferred form to a duplex direct-acting pumping-engine of the class now well known as the "Worthington" duplex pumping-engine, and the features forming the invention will then be specifically pointed out in the claims.

In the drawings, Figure 1 is a side elevation of a triple-expansion engine of the class referred to embodying the invention in its preferred form. Fig. 2 is a plan view of the same. Figs. 3 and 3^a are diagrammatic sectional views of the high-pressure cylinders on opposite sides of the engine, looking in the same direction as Fig. 1 and showing the parts in the same position as in the general views. Figs. 4 and 4^a are similar views showing the parts in another position.

Referring to said drawings, the engine shown is in general construction a Worthington triple-expansion direct-acting duplex pumping-engine, having the high, intermediate, and low pressure cylinders A B C and A' B' C' on opposite sides arranged in line with the high-pressure cylinders inside and two water-cylinders D D' on opposite sides of the pump and having suction-main E and force-main F. The plungers are shown as connected to the high-pressure pistons X X' on opposite sides by the main piston or plunger rods Y Y', and the intermediate and low pressure pistons are connected to the cross-heads on the piston-rods by side rods y y' on opposite sides of the high-pressure cylinders. Steam is supplied to the high-pressure cylinders through the induction-pipe G, the exhaust passing from the high-pressure to the intermediate-pressure cylinders through the pipe H and from the intermediate to the low pressure cylinders through the pipe I and the low pressure exhausting through the pipe K to the condenser or otherwise, as desired. The pump is supplied with compensating cylinders M, of any approved form, which may be supplied with fluid under the desired pressure from any suitable source, as usual in some pumps of this class.

The steam-cylinders are constructed with the admission-ports 1 at the top of the cylinders and separate exhaust-ports 2 at the bottom of the cylinders, the admission and cut-off on opposite sides of the engine being controlled by oscillating valves *a a'*, a single valve at each end of each cylinder, and the exhaust-port 2 by similar oscillating valves *b b'*. The admission and cut-off valves *a a'* are each connected by crank-arms 12 on the valve-stems and links 13 to rockers *c c'*, the connection between the rockers and links being made through connection-blocks 3, adjustable so as to secure the cut-off at the desired point, and these rockers *c c'* are pivotally mounted by suitable pivots 4 on movable members, which in the preferred form shown have an oscillating movement, and consist of rockers *d d'* on the steam-cylinders, these rockers also actuating the separate exhaust-valves *b b'* through crank-arms 14 on the valve-stems and links 15, connecting the crank-arms with the rockers *d d'*.

The rockers c c' of the intermediate and low pressure cylinders are connected to the rockers c c' of the high-pressure cylinders by connecting-rods 16, pivotally connected to the rockers by pivots 5, so as to be actuated together, and the rockers c c' of the high-pressure cylinders are pivotally connected by pivots 5 to connecting-rods 17, the other ends of which are connected to swinging levers e e' on the opposite sides of the engine, which are connected to the piston-rod cross-heads on the same side of the engine by links 18. Each of the rockers c c' , therefore, has two pivots, pivot 4 on the rocker d or d' and pivot 5 to the direct-actuating connections of the rocker, and the rockers c c' are oscillated upon these pivots, respectively, for cut-off and admission.

The rockers d d' of the intermediate and low pressure cylinders are connected to the rockers d d' of the high-pressure cylinders by connecting-rods 19, so as to be actuated therewith, and these rockers are connected by connecting-rods 20 to crank-arms 21 on cross-over rock-shafts S T , which are actuated by the piston-rods through the valve-movement levers N N' and links 22 from the cross-heads on opposite sides of the engine, the rock-shaft S thus being actuated from the A -cylinder side of the engine and the shaft T from the A' -cylinder side of the engine, each of the rockers d d' thus being actuated from the opposite side of the engine for admission and exhaust. It will be understood, however, that the exhaust-valves may be actuated by any other suitable connections to the opposite side of the engine instead of through the rockers d d' , although the construction shown is preferred.

The operation of the construction will be understood from the drawings, with a brief description referring especially to Figs. 3, 3^a, 4, and 4^a.

As shown in Figs. 3 and 3^a, piston X is just about to start on its stroke to the left, the valve a at the right end of the cylinder A having been opened by the movement of the piston X' on the opposite side of the engine, which is now moving to the left and is somewhat past the middle of its stroke. As the piston X moves to the left its piston-rod, by the link 18, connected to the cross-head, moves the lever e in the same direction as the piston—that is, to the left in Fig. 3—and thus through the link 17 swings the rocker c to the left upon its pivot 4, and thus through the link 13 and crank-arm 12 actuates the valve a at the right end of the cylinder A , so as to close this valve and cut off the steam at the proper point, which is about one-third stroke in the construction shown. This movement of the rocker c moves the valve a at the left end of the cylinder A slightly; but on account of the relation of the arc of movement of the left arm of the rocker c and link 13 to the crank-arm 12 on this valve the movement is not sufficient to open the valve, as it is ob-

vious from the drawings that the end of the link 13, connecting this valve to the rocker, moves nearly in the arc of a circle about its pivot to the crank-arm 12. Meanwhile the piston X' has continued its stroke to the left and is just about to finish its stroke, after which it will be reversed by the opening of the admission-valve a' at the left end of cylinder A' and the shifting of the exhaust-valves b' , so as to close the exhaust-valve at the left end of the cylinder A' and open that at the right end of this cylinder, which is secured by the movement of the piston X of cylinder A , as hereinafter described. The valves and valve-movement parts of the high-pressure cylinders on the opposite sides of the engine are now in the position shown in Figs. 4 and 4^a.

As the parts continue their movement from the position shown in Figs. 4 and 4^a the piston X , through the link 22, connected to its cross-head, and lever N , rocks the shaft S to the left in Fig. 4, and thus, through crank-arm 21 on the A' -cylinder end of its shaft and link 20, moves the lower side of the rocker d' on cylinder A' to the right in the figures, thus moving the upper side of the rocker d' to the left, which oscillates the rocker c' on its pivot 5, which is now stationary, except as the link 17 may swing on the lever e' as the piston X' is at the end of its stroke and the lever e' held stationary. This movement of the rocker c' through link 13 and crank 12 on valve a' at the left end of the cylinder A' oscillates this valve, so as to open it for the admission of steam to the left end of the cylinder A' , while it actuates the valve a' at the right end of the cylinder slightly, but not enough to open the port 1, the link 13 at this end of the cylinder swinging during this movement nearly in the arc of a circle from its pivot to the link 12. This movement of the rocker d' through links 15 and crank-arms 14 on exhaust-valves b' also shifts these exhaust-valves, so as to close the exhaust-port at the left end of cylinder A' and open that at the right end of the cylinder for the reversal of the piston X' . The piston X' now moves to the right, while the piston X completes its stroke to the left, and at the proper points in its stroke the piston X' , through its cross-head, link 18, lever e' , and link 17, rocks the rocker c' on cylinder A' to the right on its pivot 4, so as to oscillate valve a' at the left end of the cylinder to cut off the steam behind the piston X' in the same manner as previously described in connection with piston X , and after the piston X has completed its stroke to the left to move the rocker d on cylinder A through link 22, lever N' , rock-shaft T , crank 21, and link 20, so as to rock the rocker c on its pivot 5 and open valve a at the left end of the cylinder and at the same time to shift the exhaust-valves b in the same manner as previously described in connection with the action of piston X upon the valves of cylinder A' . Thus the cycle of operations is continued in the operation of the engine.

When it is desired to run the engine low duty—that is, without the cut-off and admitting steam throughout the stroke—the rockers *c c'* may be detached from the pistons and secured in any suitable manner, so as to hold the pivots 5 properly for the required action of the rockers *c c'* by the rockers *d d'*. Thus the levers *e e'* may be detached from the cross-heads and secured in central position by pins passed through openings 7 in levers *e e'* and entering the brackets on which levers *e e'* are pivoted to hold said levers in fixed position, as indicated in dotted lines in Fig. 1. These levers *e e'* may be held in this position by any other suitable means, however, or the links 17 may be detached from the levers *e e'* and pivoted at fixed points on suitable supports, the levers *e* then swinging idly or being removed.

While the rockers and connections for operating the valves have been shown and described as applied to a duplex engine and the invention consists in part of features in such constructions, it will be understood that the invention, broadly considered, is applicable in other classes of engine and that the rocker connected to the valves may be actuated for securing the required movement of the valves by any suitable means, either from the pistons of the different cylinders in multiple-cylinder engines or by cams, eccentrics, or other suitable devices in single engines. In the preferred construction separate exhaust-valves are employed; but the invention, considered broadly, is applicable also in engines of that well-known class in which a single valve controls the admission, exhaust, and cut-off.

It will be understood that my improved valve-movement may be used with valves of different form and movement from those shown and that many other modifications may be made in the constructions illustrated without departing from the invention, and I am not to be limited to the exact form or arrangement of any of the devices shown.

What I claim is—

1. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker having two pivots, connections from the rocker to the respective valves, and means for oscillating the rocker on one of its pivots for operating the valves for admission and on the other pivot for operating the valves for cut-off, substantially as described.

2. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker having two pivots, connections from the rocker to the respective valves, means for oscillating the rocker on one of its pivots for operating the valves for admission and on the other pivot for operating the valves for cut-off, and sep-

arate exhaust-valves and means for operating the same, substantially as described.

3. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker connected to the respective valves, a movable member on which the rocker is pivoted, means for operating the movable member to oscillate the rocker for operating the valves for admission, and means for oscillating the rocker on its pivot to the movable member for operating the valves for cut-off, substantially as described.

4. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker connected to the respective valves, a movable member on which the rocker is pivoted, means for operating the movable member to oscillate the rocker for operating the valves for admission, means for oscillating the rocker on its pivot to the movable member for operating the valves for cut-off, separate exhaust-valves, and operating connections between said valves and the movable member, substantially as described.

5. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker connected to the respective valves, a second rocker on which said rocker is pivoted, means for actuating said second rocker to oscillate the first-mentioned rocker for operating the valve for admission, and means for oscillating the first-mentioned rocker on its pivot to the second rocker for operating the valves for cut-off, substantially as described.

6. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker connected to the respective valves, a second rocker on which said rocker is pivoted, means for actuating said second rocker to oscillate the first-mentioned rocker for operating the valves for admission, means for oscillating the first-mentioned rocker on its pivot to the second rocker for operating the valves for cut-off, separate exhaust-valves, and operating connections between said exhaust-valves and said second rocker, substantially as described.

7. The combination with an engine-cylinder, and a single valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a rocker connected to the valves, a movable member on which the rocker is pivoted, actuating means having a pivotal connection to the rocker for oscillating said rocker on the movable member for operating the valves for cut-off, said actuating means being detachable and adapted to be secured in a fixed position for the operation of the valves without cut-off, and means for actuating said movable member to oscillate the

rocker on its pivotal connection to the actuating means for operating the valves for admission, substantially as described.

8. The combination with two cylinders, and a single valve at each end of each cylinder controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder having two pivots, separate connections from each rocker to the respective valves of its cylinder, and connections between each of said rockers and the pistons of both of the cylinders for oscillating the rockers on their respective pivots for operating the valves for admission and cut-off, substantially as described.

9. The combination with two cylinders, and a single valve at each end of each cylinder controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder having two pivots, separate connections from each rocker to the respective valves of its cylinder, connections between each of said rockers and the pistons of both of the cylinders for oscillating the rockers on their respective pivots for operating the valves for admission and cut-off, and separate exhaust-valves and means for operating the same.

10. The combination with two cylinders and a single valve at each end of each cylinder controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder, separate connections between the rocker of each cylinder and the respective valves of its cylinder through which each of said valves is operated by said rocker for admission and cut-off, and connections between the rocker of each cylinder and the pistons of both the cylinders, all combined and operating to actuate the valves of each cylinder through said rocker by the piston of the other cylinder to admit the motor fluid and through the same rocker by its own piston to cut off the motor fluid, substantially as described.

11. The combination with two cylinders and a single valve at each end of each cylinder controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder, separate connections between the rocker of each cylinder and the respective valves of its cylinder through which each of said valves is operated by said rocker for admission and cut-off, connections between the rocker of each cylinder and the pistons of both the cylinders, all combined and operating to actuate the valves of each cylinder through said rocker by the piston of the other cylinder to admit the motor fluid and through the same rocker by its own piston to cut off the motor fluid, separate exhaust-valves, and means for actuating the exhaust-valves of each cylinder by the piston of the other cylinder, substantially as described.

12. The combination with two cylinders and single valves controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder connected to the respective valves of its cylinder, a movable member for each cylinder on which the rocker is pivoted, con-

nections between each of said movable members and the piston of the other cylinder, and connections between each of said rockers and the piston of its own cylinder, all combined and operating to actuate the valves of each cylinder by the piston of the other cylinder to admit the motor fluid, and by its own piston to cut off the motor fluid, substantially as described.

13. The combination with two cylinders and single valves controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder connected to the respective valves of its cylinder, a movable member for each cylinder on which the rocker is pivoted, connections between each of said movable members and the piston of the other cylinder, connections between each of said rockers and the piston of its own cylinder, all combined and operating to actuate the valves of each cylinder by the piston of the other cylinder to admit the motor fluid, and by its own piston to cut off the motor fluid, separate exhaust-valves, and operating connections between said valves and the movable members, substantially as described.

14. The combination with two cylinders and single valves controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder connected to the respective valves of its cylinder, a second rocker for each cylinder on which the first-mentioned rocker is pivoted, connections between each of said first-mentioned rockers and the pistons of both the cylinders, connections between each of said second rockers and the pistons of the other cylinder, and connections between each of said first-mentioned rockers and the piston of its own cylinder, all combined and operating to actuate the valves of each cylinder by the piston of the other cylinder to admit the motor fluid, and by its own piston to cut off the motor fluid, substantially as described.

15. The combination with two cylinders and single valves controlling the admission and cut-off of the motor fluid, of a rocker for each cylinder connected to the respective valves of its cylinder, a second rocker for each cylinder on which the first-mentioned rocker is pivoted, connections between each of said first-mentioned rockers and the pistons of both the cylinders, connections between each of said second rockers and the pistons of the other cylinder, connections between each of said first-mentioned rockers and the piston of its own cylinder, all combined and operating to actuate the valves of each cylinder by the piston of the other cylinder to admit the motor fluid, and by its own piston to cut off the motor fluid, and separate exhaust-valves and connections between said exhaust-valves and the second rockers, substantially as described.

16. The combination with a cylinder and a valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of a movable member, rocker *c* pivoted on said movable member between the valves,

separate link connections between said rocker and each of said valves, and means for actuating rocker *c* and movable member for operating the valves through said rocker for admission and cut-off, substantially as described.

17. The combination with a cylinder and a valve at each end of the cylinder controlling the admission and cut-off of the motor fluid, of rocker *d* mounted on the cylinder, rocker *c* pivoted on said rocker *d* between said valves, a link connection between said rocker *c* and each of said valves, and means for actuating rockers *c* and *d* for operating the valves through rocker *c* for admission and cut-off, substantially as described.

18. The combination with a cylinder having a valve at each end of the cylinder controlling the admission and cut-off of the motor fluid and separate exhaust-valves, of rocker *d* mounted on the cylinder, connections between said rocker *d* and the exhaust-valves, rocker *c* pivoted on said rocker *d* between the valves, a link connection between said rocker *c* and each of the valves controlling the admission and cut-off, and means for actuating rockers *c* and *d* for operating the valves through rocker *c* for admission and cut-off and for operating the exhaust-valves through rocker *d*, substantially as described.

19. The combination with a cylinder having a valve controlling the admission and cut-off of the motor fluid and a separate exhaust-valve, of a rocker provided with a block connected to the valve controlling the admission and cut-off and adjustable to vary the point of connection between the valve connections and rocker, means for actuating said first-mentioned valve for admission and cut-off through said rocker, and means independent of the adjustment of said block for actuating said exhaust-valve substantially as described.

20. The combination with a cylinder having single valves controlling the admission and cut-off of the motor fluid at opposite ends of the cylinder, and separate exhaust-valves, of a rocker provided with separate blocks connected to the respective valves controlling the admission and cut-off and adjustable to vary the points of connection between the valve connections and rocker, means for actuating the valves for admission and cut-off through said rocker and means independent of the adjustment of said blocks for actuating the exhaust-valves substantially as described.

21. The combination with cylinder A hav-

ing single valves controlling the admission and cut-off of the motor fluid, of rocker *c* having adjustable connection-blocks 3, links connecting said blocks to the respective valves, and means for actuating said rocker *c* for operating the valves for admission and cut-off through said rocker *c*, substantially as described.

22. The combination with a cylinder having single valves controlling the admission and cut-off of the motor fluid at opposite ends of the cylinder, of rocker *c* mounted between said valves, link connections between said rocker and the respective valves, and rocker *d* on which rocker *c* is pivoted at such point that each of the valves is substantially stationary while the other valve is being operated by the rocker *c* for cut-off, substantially as described.

23. The combination with a cylinder having single valves controlling the admission and cut-off of the motor fluid at opposite ends of the cylinder, of rocker *c*, link connections between said rocker and the respective valves, rocker *d* on which said rocker *c* is pivoted and by which the valves are operated for admission, said rockers and link connections being constructed and arranged to hold each of said valves substantially stationary while the rocker *d* is actuating the other valve for admission, substantially as described.

24. The combination with a cylinder and an oscillating valve at each end of the cylinder controlling the admission and cut-off and cranks 12 on the valve-stems, of a movable member, rocker *c* pivoted on said movable member, and means for actuating said rocker *c* and said movable member to operate the valves for admission and cut-off through said rocker *c*, substantially as described.

25. The combination with a cylinder and an oscillating valve at each end of the cylinder controlling the admission and cut-off and cranks 12 on the valve-stems, of rocker *d* mounted on the cylinder, rocker *c* mounted on said rocker *d* between the valves, single links 13 connecting said rocker *c* to the cranks 12, and means for actuating said rockers *c*, *d* to operate the valves for admission and cut-off through said rocker *c*, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHAS. C. WORTHINGTON.

Witnesses:

ANDREW J. CALDWELL,
BOWEN W. PIERSON.