O. W. YOUNG.

LOCOMOTIVE VALVE GEAR.

APPLICATION FILED AUG. 11, 1908.

1,029,038.

Patented June 11, 1912.

5 SHEETS—SHEET 1.

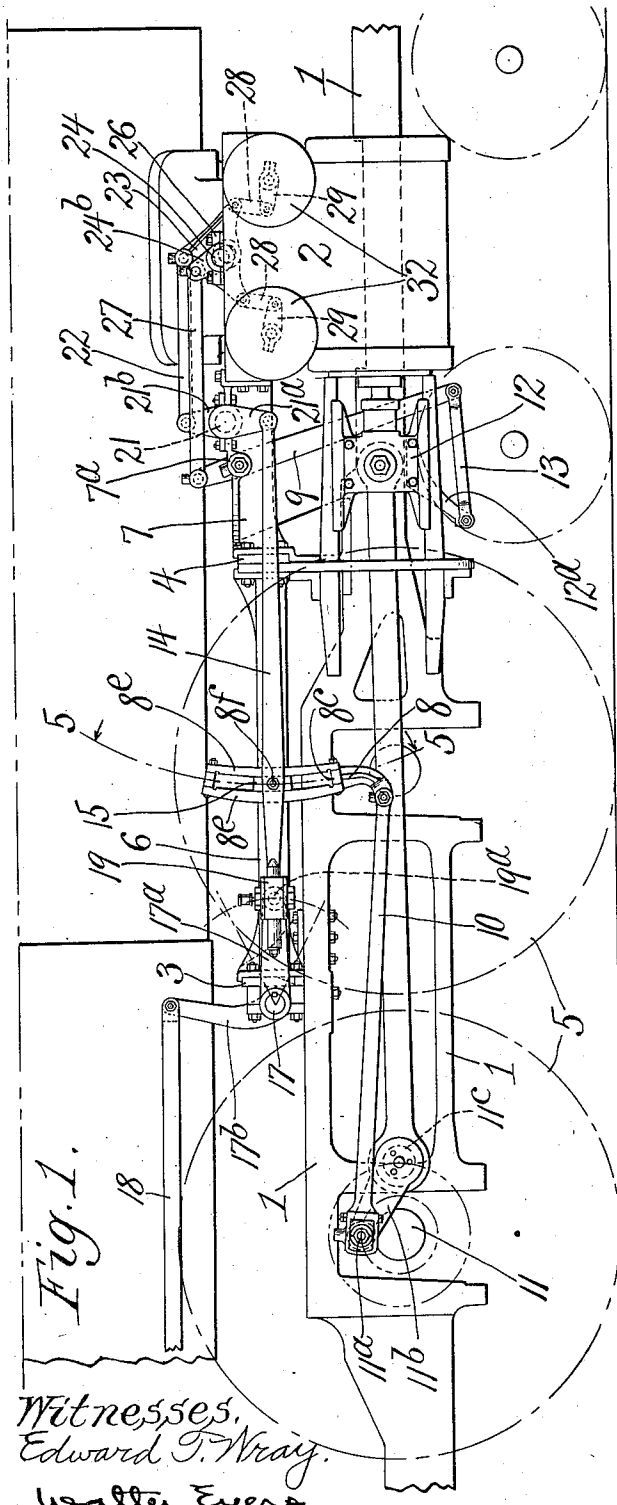

Fig. 1.

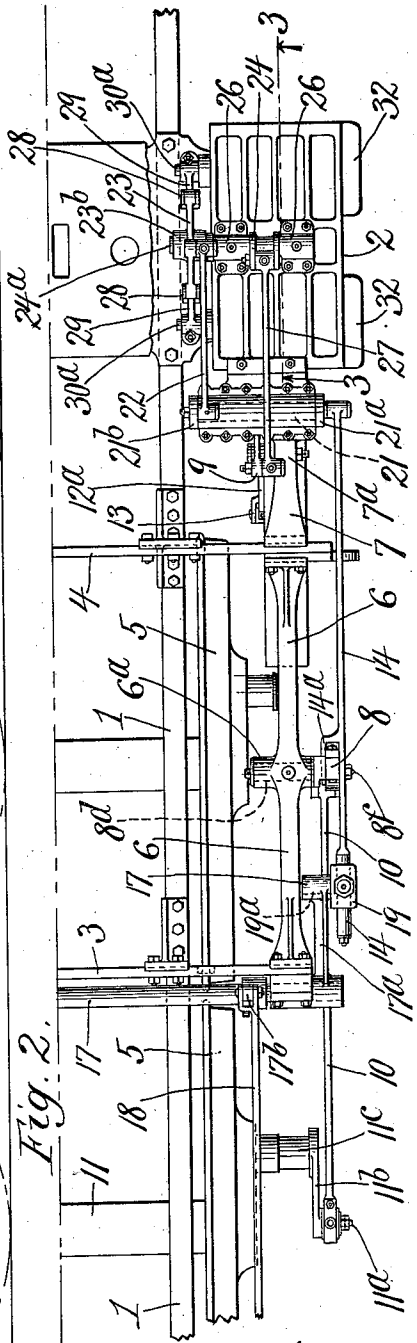

Fig. 2.

Witnesses,
Edward T. Wray.
Walter Eyers

Inventor,
Otis W. Young.
by Burton & Burton
his Attys.

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5 SHEETS—SHEET 2.

Fig. 3.

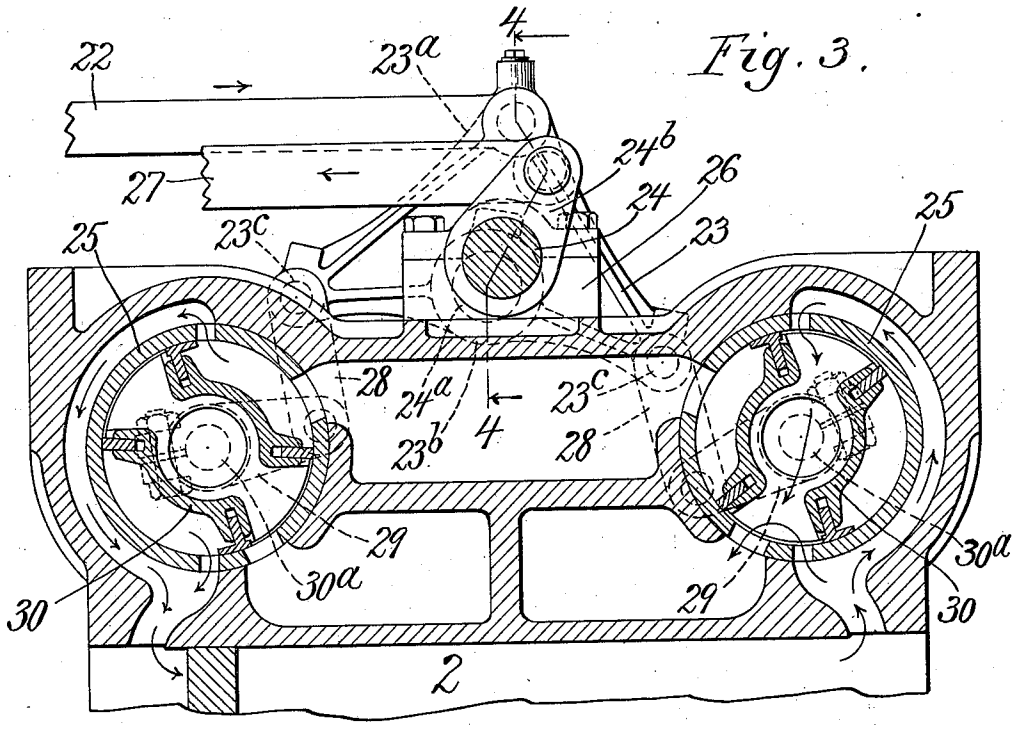
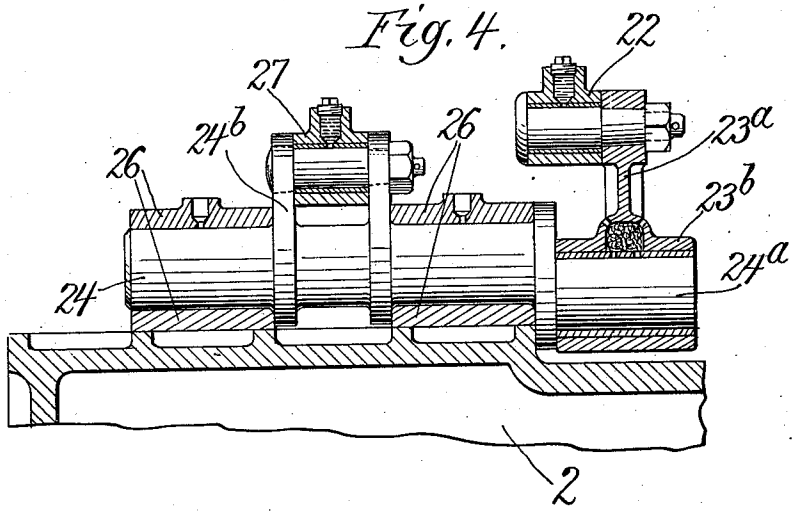


Fig. 4.



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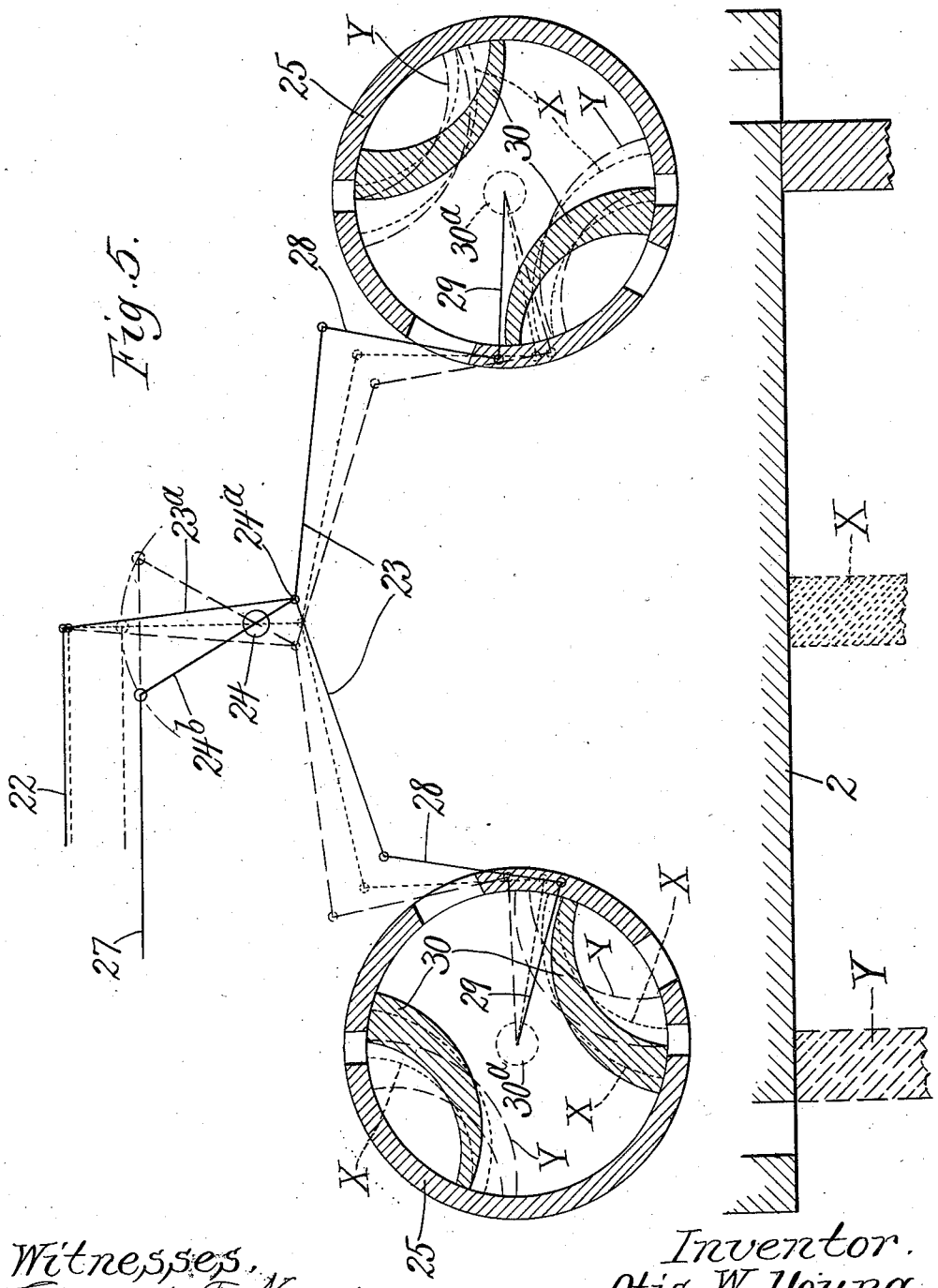
5 SHEETS—SHEET 3.

Fig. 5.



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COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

O. W. YOUNG.

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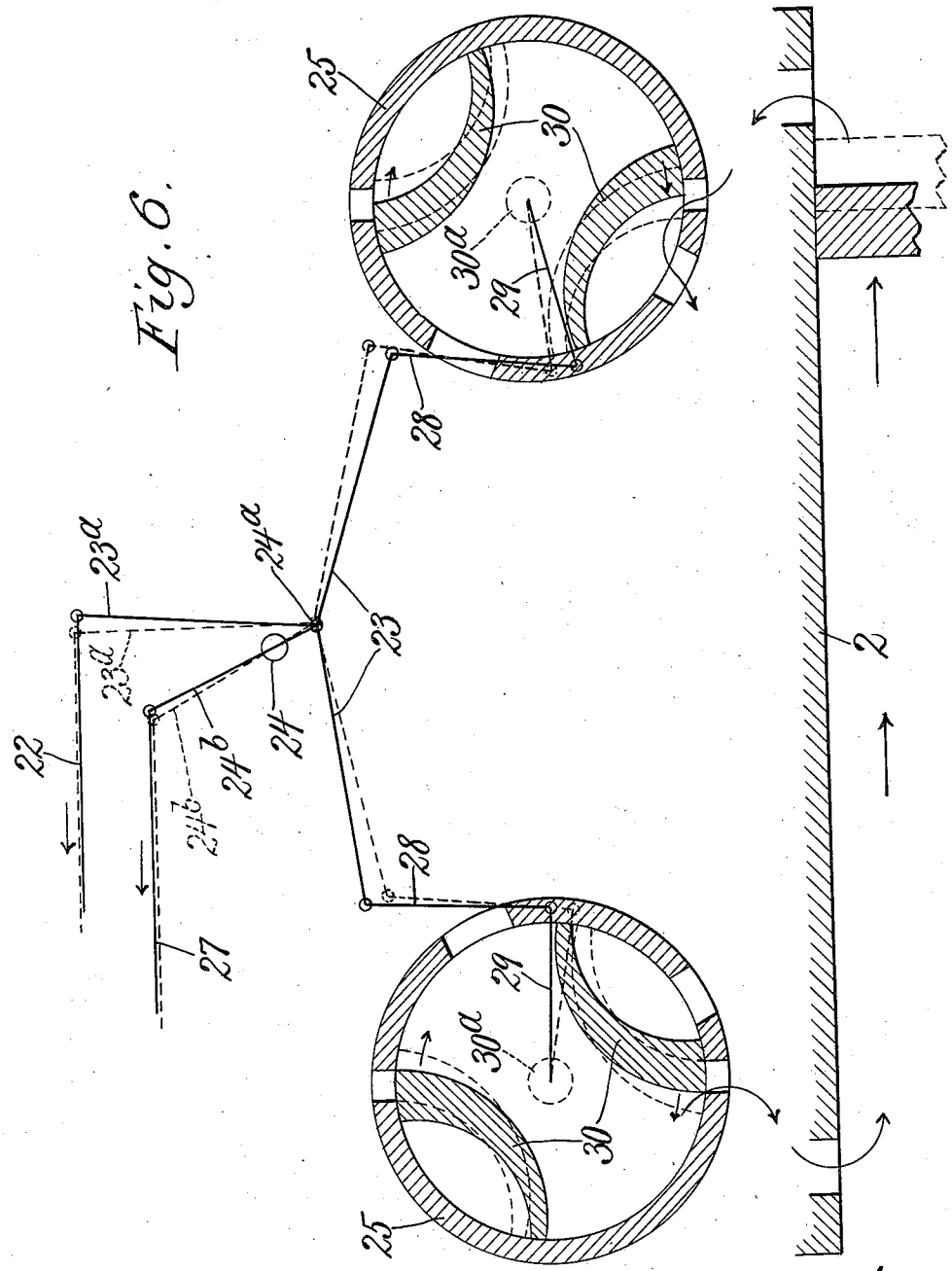
5 SHEETS—SHEET 4.

Fig. 6.



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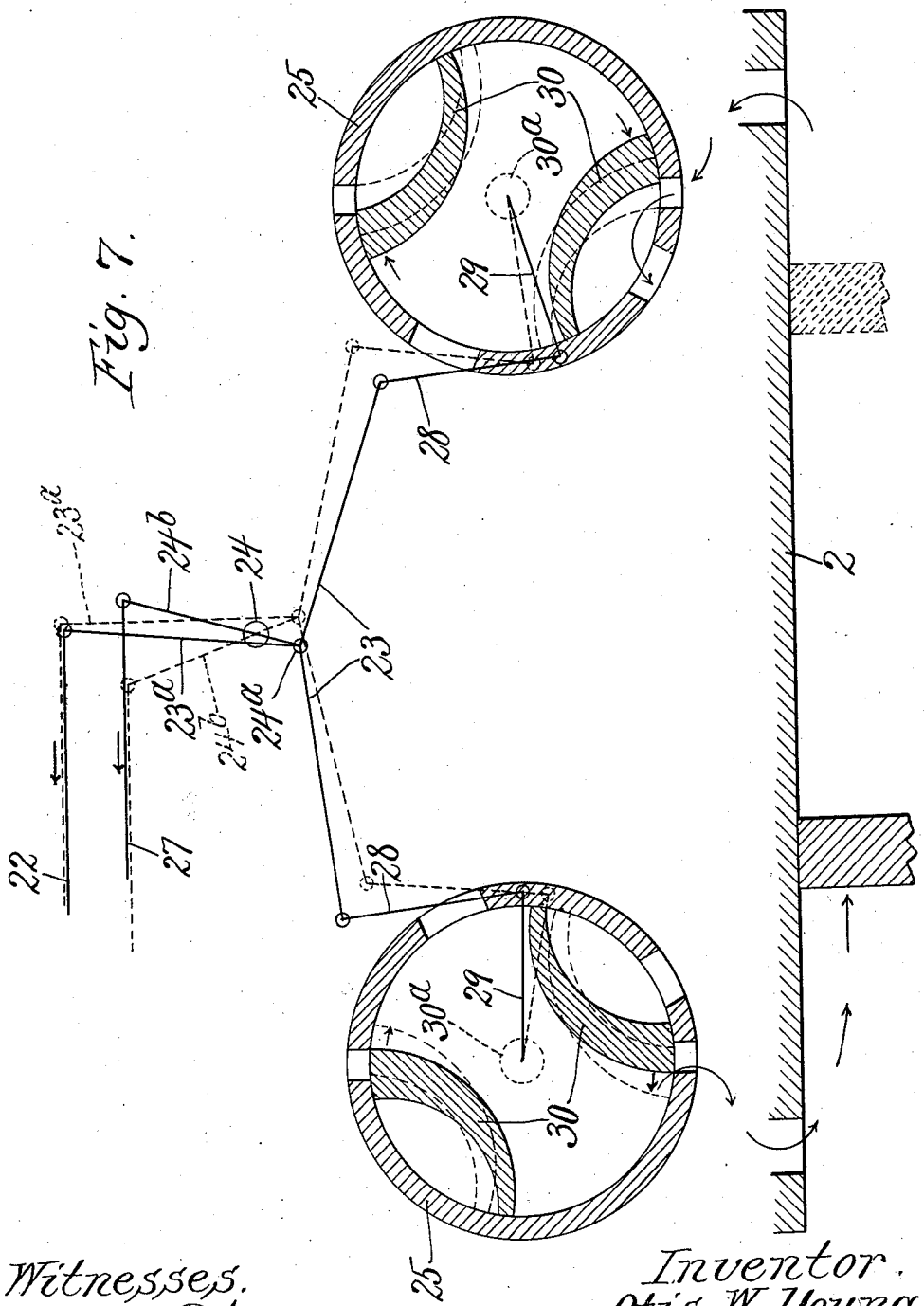
5 SHEETS—SHEET 5.

Fig. 7.



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UNITED STATES PATENT OFFICE.

OTIS W. YOUNG, OF CHICAGO, ILLINOIS, ASSIGNOR TO YOUNG-MANN-AVERILL COMPANY, A CORPORATION OF ILLINOIS.

LOCOMOTIVE VALVE-GEAR.

1,029,038. Specification of Letters Patent. Patented June 11, 1912.

Application filed August 11, 1908. Serial No. 447,939.

To all whom it may concern:

Be it known that I, OTIS W. YOUNG, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Locomotive Valve-Gears, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

This invention relates to valve gear for engines, and particularly for locomotives, and its purpose is primarily to provide an improved valve gear in which the two components of the valve movement shall be derived respectively from the reciprocation of the piston and from a secondary crank or eccentric wrist on the main crank shaft situated relatively to the main crank wrist for communicating movement alternately with the piston strokes; secondarily, to adapt the same to the adjustable valve actuator or wrist plate for actuating the valves, which is shown in my Patent No. 751,131, dated February 2, 1904. Further specific purposes are to adapt the same to the rocking valve shown in that patent, and to provide an improved construction of supports for the rocker and reducing lever by which the two components of the valve movement are communicated.

It consists of the elements and features of construction and their combination which are herein shown and described as indicated in the claims.

In the drawings:—Figure 1 is a side elevation of a portion of a locomotive showing a valve gear embodying this invention. Fig. 2 is a top plan view of the same, the pitman being omitted. Fig. 3 is a section at the line 3—3 on Fig. 2 on a larger scale. Fig. 4 is a section at the line 4—4 on Fig. 3. Fig. 5 is a diagrammatic view, partly sectional, section being made transversely of the valve axes and longitudinally of the cylinder, representing several positions of the valves, the connecting valve operating parts being indicated by lines only, and the valves being also shown diagrammatically and without regard to detail construction. Fig. 6 is a view similar to Fig. 7 showing the parts adjusted for a maximum cut-off. Fig. 7 is a similar view showing the parts adjusted for a minimum or very short cut-off.

The drawings show a locomotive of familiar type in its general outlines and construction, having a rigid frame which comprises and is represented by the side-bar, 1, the cylinders and steam chest, 2, and the usual accessory elements which may be hereinafter referred to, all rigidly united for carrying the parts requiring rigid support. For the particular purposes of this invention, this rigid frame comprises transverse members, 3 and 4, which extend across the vertical plane of the drivers, 5, and project outside the same nearly as far as the steam chest, 2, projects. The purpose of these transverse members projecting thus outwardly past the vertical plane of the drivers is to carry outside the drivers longitudinal members for supporting certain fixed fulcrum bearings for elements of a certain structure hereinafter described which are necessarily located outside the drivers. These longitudinal members consist of the beam, 6, which extends from the transverse member, 3, to the transverse member, 4, being bolted rigidly to said members, and the beam, 7, which extends from the transverse member, 4, to the steam chest being bolted rigidly to both of said members. The beam, 6, has a fixed fulcrum bearing, 6^a, for the rocker, 8. The beam, 7, has a fixed fulcrum bearing, 7^a, for the reducing lever, 9, provided, as hereinafter explained, for communicating the component of the valve movement which is derived from the stroke of the piston. Both the rocker, 8, and the reducing lever, 9, necessarily extend outside the drivers, as will appear from their respective functions as hereinafter indicated. The rocker, 8, has an extension, 8^a, from the lower end of its arc for connection by means of the pitman link, 10, with the secondary crank wrist, 11^a, formed on the end of a return crank arm, 11^b, rigid with the main crank wrist, 11^c, of the main crank shaft, 11. The construction thus described for operating the rocker, 8, is substantially that which is commonly known as the Walschert valve gear, and is not specifically a part of the present invention. The reducing lever, 9, fulcrumed, as stated, on the longitudinal beam, 7, has its longer arm extending down past the piston cross-head, 12, and connected at its lower end by a link, 13, with said cross-head, which is provided with a downwardly extending arm, 12^a, for that purpose. The purpose of the link, 13, it will be understood, is merely to accommodate the curved path

of the end of the reducing lever, 9, as it vibrates about its fixed fulcrum on the bar, 7. The radius rod, 14, is pivoted at 8^f to the sliding block, 15, of the rocker, and extends past that block rearward for pivotal and longitudinally sliding connection with the forwardly extending arm, 17^a, of the radius rod shifter rock shaft, 17, to whose lever arm, 17^b, the reverse-lever-connecting rod, 18, is connected, said rod 18 extending rearward for operation by any customary means not shown. The particular construction for pivotal sliding connection of the radius link with the radius rod shifter, 17^a, comprises a sleeve or slide bearing, 19, through which the cylindrical end portion of the radius rod extends and slides, said sleeve having a pivot stud, 19^a, jutting off from its rear side and journaled in a bearing, 17^c, on the end of the shifter, 17^a.

The radius rod is connected at its forward end with a lever arm, 21^a, on the outer end of a rocker, 21, which is journaled extending transversely on the upper side of the beam, 7, and at its inner end has a second lever arm, 21^b, connected by a link, 22, with the lever arm, 23^a, of the valve actuator or wrist plate, 23. Said valve actuator or wrist plate is pivotally mounted by its journal bearing, 23^b, on the crank wrist, 24^a, of a carrier, 24, which is itself pivotally mounted in bearings, 26, 26, fixed with respect to the valve seats, 25, 25. The carrier has a lever arm, 24^b, from which it is connected for actuation by a link, 27, with the shorter arm of the reducing lever, 9. The valve actuator or wrist plate, 23, which is essentially a double bell-crank lever, has the wrists, 23^c, of its corresponding arms connected by links, 28, 28, with the lever arms, 29, 29, of the rocking valves, 30, the shafts or stems, 30^a, of said valves protruding from the inner ends of the valve chambers, 32, to receive said lever arms by which the valves are operated. At the middle position of the carrier wrist plate and valves, the lever arms, 29, of the latter extend toward each other approximately at the plane containing the axes of both valves, and the links, 28, trend from the wrist plate in directions substantially parallel.

The fulcrum of the rocking carrier, 23, is located in a vertical plane midway between the axis of the two valves, and the parts are proportioned and connected to cause the path of oscillation of the actuator fulcrum, 24^a, to be symmetrical with respect to the same plane and to lie wholly below the horizontal plane of the carrier fulcrum; that is, between said plane and the valve paths. The two extremities of that path are therefore its highest points and the middle is its lowest point; that is, the point of nearest approach to the valve paths. Upon inspection, it will be evident that the movement of the actuator fulcrum toward the valve paths tends to increase the spread of the valves,—that is, to shift said paths of travel of the valves on their respective seats in the directions with respect to the corresponding ports to increase the inside clearance, and that its movement away from said paths diminishes the spread—that is, operates to shift said paths in the other direction and increases the outside clearance. It will be also observed that the symmetrical situation of the path of said actuator fulcrum with respect to the vertical plane midway between the axes of the valves, causes said actuator fulcrum to make both movements,—for approaching and for departing from the valve paths,—in each stroke of the piston in each direction, and that the nearest approach of said fulcrum to the valve paths, and consequently the position for maximum inside clearance of the valves, occurs midway in each stroke,—that is, midway in the travel of the piston.

The influence on the valve travel of the piston-communicated movement may be ascertained by noting the movement which is thus communicated when the radius rod is at the center of the link, 8,—so that the valve is not actuated at all by the link. Fig. 5 illustrates the valve movement under such conditions, showing in full line the valve positions at one limit of the piston's travel, in dotted line their positions at the middle of the stroke, and in broken line their positions at the opposite limit of the same stroke. Comparing these positions it will be seen that the valve controlling the ports at the end from which the piston is about to move at the commencement of the stroke is moved during the first half of the piston's stroke about twice as far as the other valve is moved during the same time, and that during the second half of the stroke the reverse is true, the second valve having double the movement of the first. But it will be noticed also that the direction of this movement is opposed to that which, during the first half of the stroke, will be communicated from the link, 8, if the radius rod is adjusted for deriving operating movement from the link, and is in the same direction as that which the link will communicate during the last half of the stroke,—after the link-operating crank wrist, 11^a, passes the center. During the first half of each stroke, therefore, the piston-communicated movement retards the valve action, such retardment being greater on the valve which is opening for inlet than on the valve opening for exhaust, the inlet valve being thus relatively retarded and the exhaust valve relatively hastened. The piston-communicated movement is invariable, and the link-communicated movement is variable with the adjustment for varying the cut-off.

This causes that the above described effect on the relative travel of the two valves due to the piston-communicated movement is relatively greatest when the actual valve travel derived from the link is least,—that is, during a short cut-off,—and diminishes relatively as the cut-off is lengthened. Also it will be observed that the period of retardment of the valve opening for inlet is the period of most rapid valve movement derived from the link, and of slowest movement derived from the piston, the main crank shaft being at that point passing the center, and the link-operating crank being ninety degrees removed from the main crank, and that the piston-communicated movement is accelerating and the link-communicated movement is diminishing from that point; and that at the point at which the two movements become equal the valve will "dwell" on its seat or suspend its movement thereover; and that this point of suspension of movement or dwelling of the valve will occur earlier in the stroke in proportion as the valve travel is shortened, because the link-communicated element of the movement is the more rapid or dominating element at the start and will lose its domination sooner according as it is itself less. The net result of these coöperating influences, it will be seen, is to cause the movement of the valve opening for inlet to be quicker at the first stage of opening, so that even on the shortest cut-off it will afford good opening and will stand or dwell at its position of maximum opening until the piston-communicated movement dominates the valve communicated movement, when its close will be accomplished quickly because the first movement is accelerating rapidly and the other movement is diminishing rapidly; and this is one of the especially desirable results sought by the construction shown.

Considering the action at the other end of the cylinder, it will be observed from the same comparison of the movements influencing the valve travel: First, that the influence of the piston-communicated movement during the first half of the stroke is to relatively hasten the opening for exhaust, and the more so as the cut-off is shortened; and this again is the result desired, because it counteracts the usual tendency of shortening the cut-off, which, as well understood, is to shorten the exhaust period; second, that from the middle of the stroke,—the point at which the link-communicated action begins to be reversed, but at which, by reason of the link-operating crank being then passing the center, the influence of that movement is minimum and on the increase, the piston-communicated movement, being at its maximum and in the same direction as the link-communicated movement, causes the valve now moving for closing the exhaust to gain rapidly in speed, and to make its port-closing travel very rapid. This makes it practicable to position the valve path with respect to its port so that the valve makes a large portion of its travel entirely beyond the port after uncovering it for exhaust, thus allowing a very long exhaust interval; that is to say, the valve by this means has a very quick movement in opening for exhaust and closing for compression, and allows thus a maximum exhaust interval.

The particular relation of the several fulcrums and link connections of the valve actuator carrier and valve lever arms affects the valve action in minor respects more or less important, and the proportioning of the parts and properly relating the distances and directions of the several pistons and fulcrums from each other involves the exercise of good mechanical judgment in view of the particular work for which the locomotive is designed. But in order to cause the piston-communicated movement to produce the maximum spread of the valves, as above explained,—that is, to cause the maximum difference between the rate of movement communicated by the piston connections to the two valves which are respectively opening for inlet and exhaust,—the link, 28, which connects either valve with the actuator should, at the stage at which the valve is about to open for inlet, be tangential to the paths of its pivotal connections to the valve and to the actuator when the radius rod is at the center of the link, 8. This position of the parts is approximately that represented in full line in Fig. 5, from which it will be seen that the length of the link necessary to give it the tangential relation to the paths of the two pivots at the stage shown, enables the actuator to transmit maximum angular movement to the valve from the rocking movement of the actuator. It will also appear from consideration of the same figure that the effect of a given downward movement of the actuator fulcrum, 24^a, due to the rocking of the carrier through a given angle, produces a maximum spread of the valves when the relative proportions of the parts are such that the links, 28, 28, are parallel at the middle position of both actuator and carrier, being the position shown in dotted line. Both these features, therefore,—the tangential relation of the links to their pivot paths and their parallel relation to each other,—I consider of substantial importance, though the main purposes of the invention may be accomplished even though there be some departure from these details of structure.

Among other results which this construction yields, one of the most important is that notwithstanding the above described result in respect to the quick and comparatively

large opening for inlet and the long exhaust and short compression period with short cut-off, the structure is adapted to permit a very long cut-off, it being possible, as shown in Fig. 6, to admit steam throughout 14/15 of the stroke and obtain admission at or before commencement of the return stroke and also a sufficiently prompt exhaust to prevent premature compression upon the return stroke.

Since the valve-actuator carrier is operated by connections from the piston so that its movements are synchronous with the reciprocations of the piston, its extreme positions in either direction corresponding with those of the piston; and since the secondary crank wrist which operates the link, 8, is 90 degrees separated from the main crank wrist, so that the extreme positions of the piston and said valve actuator carrier correspond with the middle position of the link, it will be seen that the position of the valves at the limit of each piston stroke is rendered invariable by making the connections from the piston for operating the carrier invariable, so that the carrier has always the same range of movement whatever be the length of cut-off. This causes the steam lead to be constant for all lengths of cut-off.

I claim:—

1. In an expansive fluid motor, in combination with two valves which operate alternately as inlet and exhaust valves, an oscillating element and connections therefrom to the valves for operating them; an oscillating fulcrum for said element having its axis parallel with and substantially equi-distant from the valve seats; the motor shaft, and connections therefrom angularly separated approximately ninety degrees thereabout to said oscillating element and said oscillating fulcrum respectively for oscillating them.

2. In an expansive fluid motor, in combination with the motor shaft, two valves which operate alternately as inlet and exhaust valves; an oscillating element and connections therefrom to the valves respectively for giving their seating faces movement of travel with respect to the ports which they control; an oscillating fulcrum for said oscillating element having its axis parallel with the axis of said oscillating element, and connections from the motor shaft at points approximately ninety degrees apart thereabout to said oscillating element and said fulcrum respectively for oscillating them.

3. In an expansive fluid motor, in combination with the motor crank shaft, two rocking valves which operate alternately as inlet and exhaust valves; an oscillating element and connections therefrom to the valves for operating them; an oscillating fulcrum for said element having its axis parallel with and substantially equi-distant from the axis about which the valves respectively rock, and connections from points approximately ninety degrees apart about the motor crank shaft to the oscillating element and to said oscillating fulcrum respectively for oscillating them.

4. In an expansive fluid motor, in combination with the motor crank shaft and piston, two valves which act alternately as inlet and exhaust valves; a pivoted valve actuator and links therefrom trending divergently to the valves respectively for actuating them; a movable fulcrum for said actuator; a part which moves synchronously with the piston, and connections therefrom for moving said fulcrum to modify the trend of the links in each stroke of the piston.

5. In an expansive fluid motor, in combination with the piston; two valves which operate alternately as inlet and exhaust valves; a pivoted actuator for the valves; connections from said actuator to the valves respectively; a movable fulcrum for the actuator; means for moving said fulcrum with respect to the valve seats in direction to retract each valve when it is opening for inlet and advance it when it is opening for exhaust; an element which moves synchronously with the piston, and connections therefrom for operating said actuator adjusting means.

6. In an expansive fluid motor, in combination with the piston; two valves which act alternately as inlet and exhaust valves; a pivoted valve actuator; connections therefrom to the valves respectively; a movable fulcrum for said actuator; a part connected with the piston for movement synchronously therewith, and connections therefrom for moving the fulcrum during the valve-actuating movement of the actuator in the direction for hastening the exhaust-opening movement of each valve.

7. In an expansive fluid motor, in combination with the main crank shaft and the piston; two valves which act alternately as inlet and exhaust valves; a valve actuator; connections from the main crank shaft substantially ninety degrees in advance of the piston-operating crank wrist to said valve actuator; a carrier for said actuator which is movable for varying the spread or distance between the paths of travel of the seating faces of the valves; a part which moves synchronously with the piston, and operating connections from said part to said actuator-support for moving it at each stroke of the piston.

8. In an expansive fluid motor, in combination with the main crank shaft and the piston, two valves which act alternately for inlet and exhaust; a pivoted valve actuator; spindles or rock shafts for the valves; lever arms for such spindles or rock shafts; links connecting the lever arms with the actuator; a pivoted fulcrum carrier for the actuator

which is movable about its pivot to shift such fulcrum each way from a position midway between the valve seats; a part which moves synchronously with the piston and connections therefrom to the fulcrum carrier adapted to move the same to carry the fulcrum at each piston stroke toward the seat of the valve which is to operate as the inlet valve in the succeeding opposite stroke, and operating connections from the crank shaft to the valve actuator for rocking it to operate the valves.

9. In an expansive fluid motor, in combination with two valves which act alternately as inlet and exhaust valves; variable means for actuating said valves from the engine crank shaft for inlet and exhaust, and invariable means for changing the relative positions to vary the spread or distance between the paths of travel of their seating faces, said invariable means comprising connections operating synchronously with the piston strokes.

10. In an expansive fluid motor, in combination with the main crank shaft and the piston; two valves which act alternately as inlet and exhaust valves; means for actuating the same from the main crank shaft; means for changing the relative positions to cause the lead of the valve operating for inlet to be reduced at the same time that the valve operating for exhaust is caused to open earlier and close later; a part moving synchronously with the piston in the back-and-forth movement of the latter, and operating connections from said member to said valve position-changing means for actuating the latter in each stroke of the piston.

11. In an expansive fluid motor, in combination with the main crank shaft and the piston; two valves which act alternately as inlet and exhaust valves; a pivoted valve actuator; rocking carriers for the valves having lever arms for connection with the actuator and links which connect them with the latter, the parts being relatively proportioned and positioned to cause the links to be approximately parallel at the middle position of the actuator in the path of its oscillating movement.

12. In an expansive fluid motor, in combination with two rocking valves which act alternately for inlet and exhaust; stems or spindles on which the valves are carried and rocked; lever arms connected with such stems or spindles; a pivoted actuator for the valves, and links which connect such actuator to said lever arms respectively; means for rocking the actuator to operate the valves, the parts being proportioned and positioned to cause the link pivots to approximate alinement with the valve spindle axis and the actuator axis at one limit of the rocking movement of the actuator and the links to be parallel at the middle position of the actuator.

13. In an expansive fluid motor, in combination with the main crank shaft and the piston cross-head; two valves which operate alternately as inlet and exhaust valves; a valve-operating wrist plate, and connections therefrom for actuating the valves; a movable fulcrum for the wrist plate and a pivoted carrier for such fulcrum having its axis parallel with and substantially equidistant from the valve seats; a reducing lever extending transversely to the cross-head; a link connecting its longer arm to the cross-head; a link from a point nearer the fulcrum of said lever connecting it with the fulcrum carrier, and connections from the motor crank shaft at a point angularly advanced with respect to the piston-operating crank wrist for rocking the wrist plate about said fulcrum.

14. In an expansive fluid motor, in combination with the main crank shaft and piston cross-head; two rocking valves which operate alternately as inlet and exhaust valves; a rocking valve actuator and links which connect it with said valves respectively for rocking them; a rocking fulcrum carrier for said actuator having its axis parallel with and substantially equidistant from the axes respectively of the rocking movements of the valves; a reducing lever having a fixed pivot; a link connecting the longer arm of the lever with the cross-head; connections from the shorter arm of the lever to the fulcrum carrier; a rocker having a fixed fulcrum; a link for actuating the rocker connected with the crank shaft at a point angularly advanced thereabout with respect to the piston-actuating crank wrist; a radius rod having between its ends pivotal engagement with said rocker; a reverse lever with which said link has pivotal and sliding connection at its rear end, said radius rod having operating connections at its forward end with the rocking valve actuator.

In testimony whereof, I have hereunto set my hand, in the presence of two witnesses, at Chicago, Illinois, this 6th day of August, 1908.

OTIS W. YOUNG.

In the presence of—
WALTER EYERS,
M. GERTRUDE ADY.