No. 831,136. PATENTED SEPT. 18, 1906.

H. C. BEHR.

VALVE MOTION.

APPLICATION FILED MAR. 15, 1905.

3 SHEETS—SHEET 1.

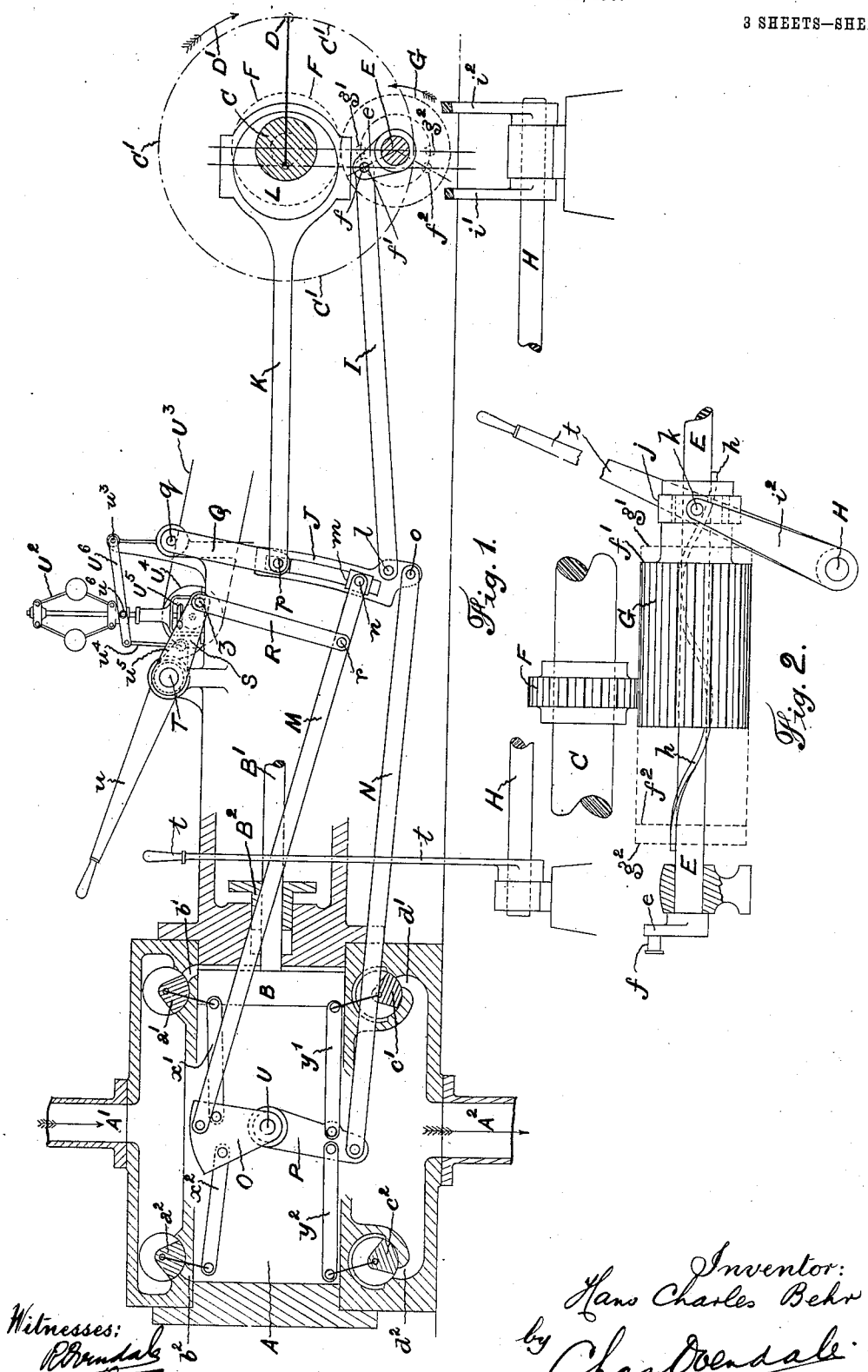

Fig. 1.

Fig. 2.

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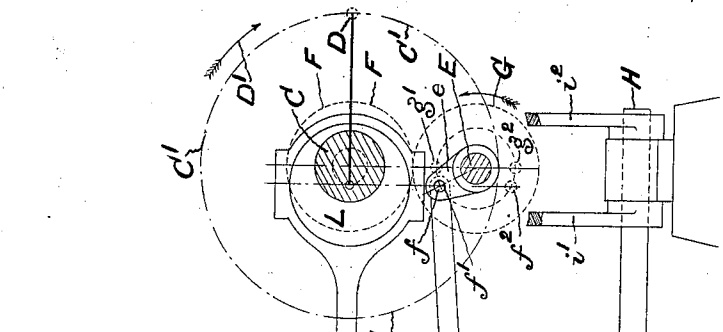

Fig. 4.

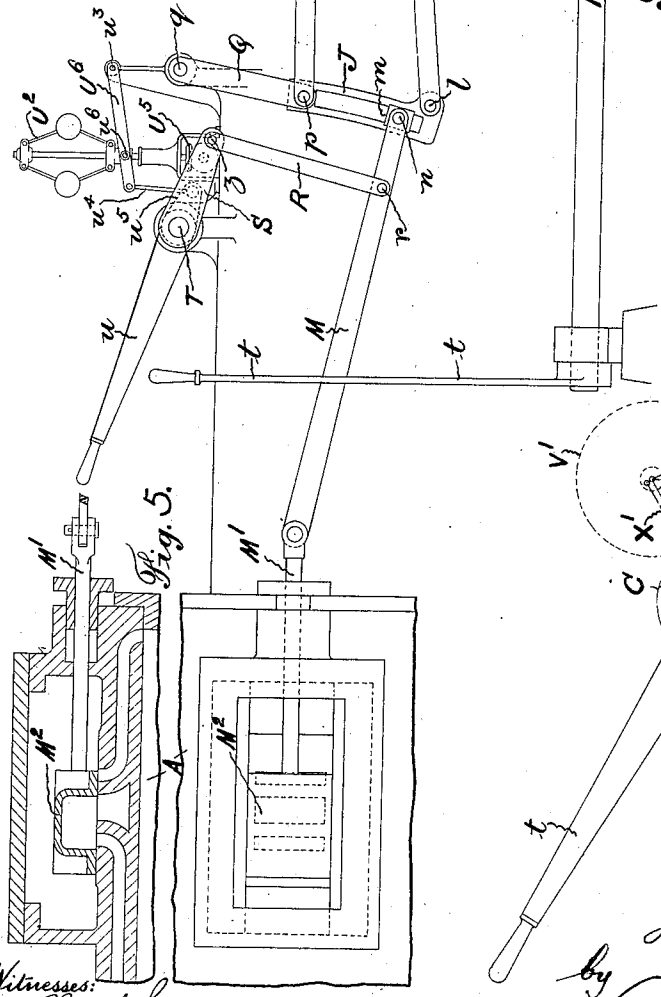

Fig. 3.

Fig. 5.

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3 SHEETS—SHEET 3.

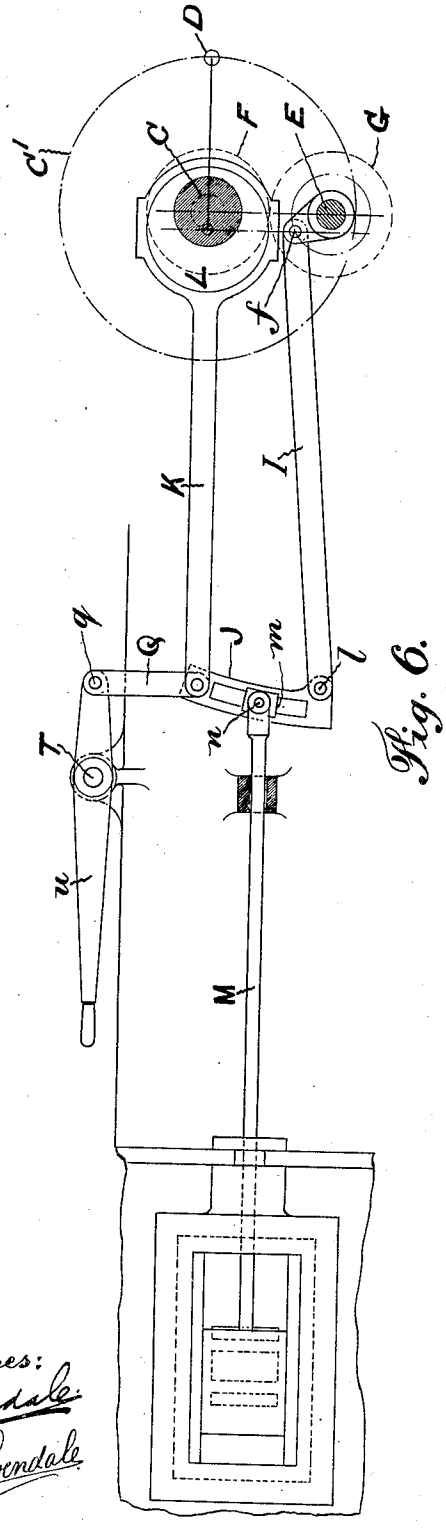

Fig. 6.

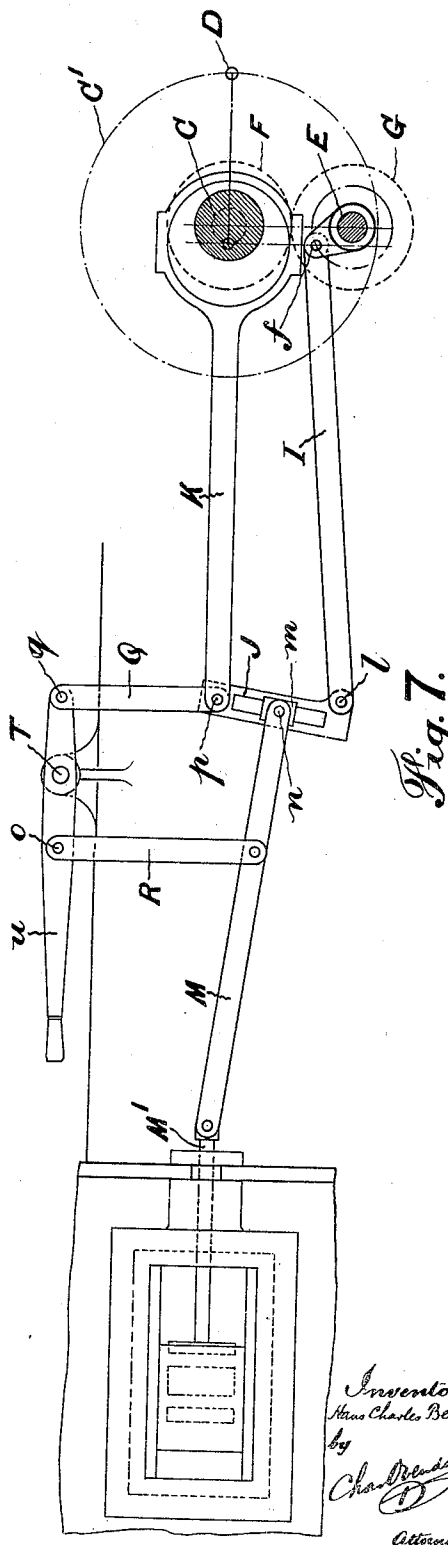

Fig. 7.

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UNITED STATES PATENT OFFICE.

HANS CHARLES BEHR, OF JOHANNESBURG, TRANSVAAL, ASSIGNOR OF ONE-THIRD TO GEORGE HENRY THURSTON, OF JOHANNESBURG, TRANSVAAL.

VALVE-MOTION.

No. 831,136. Specification of Letters Patent. Patented Sept. 18, 1906.

Application filed March 15, 1905. Serial No. 250,313.

To all whom it may concern:

Be it known that I, HANS CHARLES BEHR, a citizen of the United States, residing at Johannesburg, Transvaal, have invented certain new and useful Improvements in Valve-Motions Specially Applicable to Winding-Engines, of which the following is a specification.

This invention has reference to the class of positive valve-motions adapted more particularly to winding-engines.

The object of the invention is to secure the widest possible range of variation of expansion, thereby permitting easy starting with an engine smaller than would otherwise generally be required.

The invention consists, essentially, of a link operated by rods from the crank-shaft or other coincidently-rotating part of the engine, along the length of which link adjustment can be made to secure variation of cut-off while the engine is under way; in combination with means for rotatively adjusting the eccentric or crank reciprocating one end of the link to effect reversal of the engine and also partial or entire elimination of lead and compression, so as to retard the opening and closing of the valves.

The invention will be more fully described by aid of the accompanying drawings, in which—

Figure 1 represents a side elevation of the improved valve-gear as applied to an engine fitted with valves of the Corliss type, the cylinder being shown in section behind the gear. Fig. 2 represents a view at right angles to Fig. 1 of means for rotating, relatively to the engine crank-shaft, the crank operating one end of the link. Fig. 3 is an alternative construction for the detail illustrated in Fig. 2. Fig. 4 is a view similar to Fig. 1, illustrating the application of the valve-gear to an ordinary D slide-valve. Fig. 5 is a section of the slide-valve. Figs. 6 and 7 are modifications of the arrangement shown in Fig. 4, which modifications may also be applied to the more complete arrangement shown in Fig. 1.

In the several figures of the drawings like letters denote like parts in so far as they apply.

Referring more particularly to Figs. 1 and 2, A designates the cylinder of an engine, and A′ A^2 the inlet and outlet or exhaust pipes for the motive fluid. a' a^2 represent the valves over the inlet or steam ports b' b^2, and c' c^2 the valves over the exhaust-ports d' d^2. B is the piston adapted to be reciprocated in the cylinder A, and B′ represents the piston-rod working through the stuffing-box and gland B^2. The piston B is shown at the forward end of the cylinder A and the valves in running adjustment for this position—that is to say, the inlet-port b' is open to admit the motive fluid to the front of the piston, while the exhaust-port d^2 is open to the back of the piston B. C is the engine crank-shaft, and C′ represents the crank-pin path. D marks the position of the crank-pin corresponding to that of the piston B. E is another shaft arranged parallel with the crank-shaft C. This shaft E is rotated from the crank-shaft C by means of a toothed wheel F, Fig. 2, fixed on the crank-shaft C and a wide-toothed wheel G, mounted on shaft E. The wheel G is of the same diameter and has the same number of teeth as the wheel F. On the shaft E is formed or fixed a spiral feather h, and in the bore of the wheel G is formed a spiral groove of corresponding pitch. The wheel G is not fixed to the shaft E and is capable of sliding longitudinally thereof while remaining in mesh with the wheel F. When moved longitudinally of the shaft E, it rotates the latter by means of the spiral feather h, thereby adjusting shaft E rotatively in relation to the crank-shaft C either for the purpose of reversing the engine or varying the phases of opening and closing the valve a' a^2 c' c^2 in order to facilitate starting. On the shaft E is fixed a small crank e, which serves for operating the valve-gear from shaft E. The arrow D′ in Fig. 1 indicates the direction of rotation as determined by the position f' of the crank e. If the pin f were moved into the position indicated at f^2, the direction of rotation of the crank-shaft C would be reversed.

The mechanism shown and described in connection with Figs. 1 and 2 for rotating the crank or arm e was chosen for the purpose of illustration on account of its simplicity and the clearness with which its functions can be described and illustrated and because it does not obscure the other parts in connection with which it operates. This construction

may not be suitable for all cases, and any other suitable gear for accomplishing this same purpose may be used. It would probably be found preferable in most cases of actual practice to employ another well-known device like that illustrated in Fig. 3. In the arrangement illustrated in this figure the wheels F G do not mesh with each other, but the wheel G is fixed on the shaft E and is driven from wheel F through the intermediate wheels V and W, the centers of which are connected and maintained equidistant from the wheels F and G and from each other by the links X Y Z. For the purpose of reversing the engine the chain of links X Y Z, with the wheels V and W, are moved into the position X′ Y′ Z′ V′ W′, thereby rotating the wheel G with the shaft E and the crank *e*, with which shaft E the wheel G is rigidly connected. The approximate extreme rotation accomplished in this way by either of the devices described or by any equivalent mechanism takes place approximately between such limits as indicated by g' and g^2 in Figs. 1 and 2, if the path of adjustment is over arc $g'\ f'\ f^2\ g^2$ and between limits $f\ f^2$ if the adjustment is over the arc $g'\ g^2$. For these limits the valves open a little later than the beginning and close slightly before the completion of the piston-stroke. This affords conditions for easy starting of a double engine with cranks at right angles like an ordinary winding-engine. In such engines equipped with ordinary valve-gear it must be borne in mind not only that one engine may be on the dead-center when starting and that therefore only one full crank is then available for this purpose, but also that there are other positions of either crank before it reaches the dead-center for which the admission-valves are beyond the point of latest cut-off and cannot, therefore, admit steam to the cylinder, and thereby aid the other crank, which latter being at a considerably less angle than ninety degrees from the center line acts at a much reduced leverage. It is to enable steam to be admitted to that cylinder whose valves are normally past the point of latest cut-off that the extra rotative adjustment from f' to g' or from f^2 to g^2 is provided, because thereby the valves are forced to close later during the stroke of the engine. As soon as the engine is under way—*i. e.*, after, say, one revolution—the wheel G is slid back, so as to cause the shaft E to rotate ahead from the position g' or g^2 to f' or f^2, which latter is the normal position for running, giving approximately constant lead for all ranges of cut-off. The actual displacements in Fig. 2 corresponding to the angular ones in Fig. 1 are denoted by the same letters—namely, $f'\ f^2\ g'\ g^2$. It is evident that the rotative adjustment of *e* can also be made over the other part of the circle, in which case the pin *f* passes over the positions $g'\ g^2$, giving no lead or compression during reversal from one position $f'\ f^2$ of adjustment for normal running to the other, f^2 or f'.

The axial displacement of the wheel G is performed in any convenient manner, as through the medium of the arms $i'\ i^2$ engaging the collar *j* by means of the pins *k*. The arms $i'\ i^2$ are fixed on the shaft H, which may be operated by any convenient means, such as the hand-lever *t*. (See Figs. 1, 2, and 3.)

In order to impart the motion of the points f', f^2, g', or g^2 to the valves, there is interposed intermediate mechanism consisting of rods and links. The rod I is connected at one end to the pin *f* in crank *e* and at the other to the pin *l* in the lower end of a curved link J, suspended by the upper end at *p* from a link Q, pivoted to the engine-frame at *q*. On the engine crank-shaft C there is mounted an eccentric L, the rod K of which is pivoted to the upper end of the link J at *p*. The eccentric L is so placed that it will impart to the upper end of the link J a motion approximately proportional to that of the piston B, or, more correctly, to the projected path of the crank-pin D on the center line of the engine. The extent of the motion at each side of the center of the upper end of the link J is approximately equal to the distance from its central position of a pin *f* in crank *e* when in position f' or f^2, at which distance the pin *f* is adjusted for running conditions when the engine crank-pin D is on the dead-center. By this arrangement constant or approximately constant lead for all grades of expansion can be secured.

The valves are operated in the case illustrated from the link J through a system of rods and wrist-plates, like in a Corliss gear, with separate independently-operated wrist-plates for inlet and exhaust valves. In this case the rod M operates the inlet-valves through wrist-plate O and rods $x'\ x^2$, while the rod N operates the exhaust-valves through wrist-plate P and rods $y'\ y^2$. The rod N is pivoted to the link J at *o*. The wrist-plates O P are pivoted at U. The rod M, actuating the inlet-valves, is pivoted at *n* to a block *m*, fitted to slide in the slot of link J. For the purpose of varying the expansion the block *m*, with end of rod M, is adjusted along the slot of the link, the cut-off being the earlier the nearer the block is to the point *p*, where the eccentric-rod K is pivoted to the link. The adjustment of block *m* along J may be performed by a hand-lever *u*, as shown, through the medium of shaft T, lever S, and link R, attached at *z* to arm S and at *r* to rod M.

The hand adjustment may evidently be replaced by automatic adjustment, as by an ordinary centrifugal governor, as shown at U^2 in connection with Figs. 1 and 4. U^3 is a belt for driving the governor through pulley U^4 and bevel-wheels U^5 from the engine crank-shaft C. U^6 is a lever pivoted at u^3 to

the engine-frame and at the other end attached, by means of link u^4, to lever u^5, fixed on shaft T. The lever U^6, between the point of attachment to the engine-frame and the link u^4, is attached to the governor, as indicated at u^6. The motion of the governor transmitted through the lever u^6 and link u^4 to lever u^5 by rotating the shaft T actuates the rod M through the lever S and link R in a similar manner to the hand-lever u, as previously described.

The case illustrated represents a type of the most perfect valve operation—that is to say, one in which the variation of expansion by adjustment of the admission valve-rod M along the link J does not affect the periods of opening and closing of the exhaust-valves, as would be the case were the exhaust-valves operated from the same point of the link J as the inlet-valves. This latter condition would be similar to the case of an ordinary single plain slide-valve controlling both inlet and exhaust and operated by a Stephenson link-motion. In Figs. 4 and 5 I illustrate the application of the invention to a plain slide-valve. In this case the rod N would be omitted and rod M connected directly to the rod M′ of the slide-valve M^2. It is also possible to modify the gear described in various ways. For example, the link R may be pivoted at z to a fixed point and not to an arm S, and the link J, with rods K, I, and N, might be adjusted vertically to effect variation of expansion, the rod M then remaining practically in alinement, as shown in Fig. 6, or the rod M and the link J, with attached rods, might be moved in opposite directions, like in the Allan link-motion, as shown applied to this invention in Fig. 7. All such variations I also consider mere modifications of arrangement of my invention.

The valve-gear has been shown in the drawings applied to engines fitted with Corliss valves and an ordinary D slide-valve; but it will be evident that it may be adapted with equal facility for flat slide-valves or piston-valves.

What I claim as my invention, and desire to protect by Letters Patent, is—

1. In an engine valve-motion, means for actuating the valves and comprising a rocking link and a rod moved by said link and pivotally connected at one of its ends therewith, means for longitudinally adjusting said rod end and link relatively, reversing-gear for the engine, connections controlled by said reversing-gear for independently adjusting the position of one end of said link and means actuated by the engine for rocking the link.

2. In an engine valve-motion, means for actuating the valves and comprising a rocking link and a rod moved by said link and pivotally connected at one of its ends therewith, and means for longitudinally adjusting said rod end and link relatively, reversing-gear for the engine, connections controlled by said reversing-gear for independently adjusting the position of one end of the said link and means controlled by the engine for imparting to one end of the link a motion proportional to that of the projection of the engine-crank-pin path on the center line of the engine.

3. In an engine valve-motion, means for actuating the valves, and comprising a rocking link and a rod moved by said link and pivotally connected at one of its ends therewith, means for longitudinally adjusting said rod end and link relatively, reversing-gear for the engine, a movable rod controlled by said reversing-gear and leading to one end of said link for independently adjusting said end, and connections including a rod operated by the engine for imparting rocking movements to the link aforesaid.

4. In an engine valve-motion, means for actuating the valves and comprising a rocking link and a rod moved by said link and pivotally connected at one of its ends therewith, means for longitudinally adjusting the said rod end and link relatively, reversing-gear for the engine, a movable rod controlled by said reversing-gear, and leading to one end of said link for independently adjusting said end, and a movable rod controlled by the engine and connected with the other end of said link.

5. In an engine valve-motion, means for actuating the valves and comprising a rocking link and a rod moved by said link and pivotally connected at one of its ends therewith, means for longitudinally adjusting said rod end and link relatively, reversing-gear for the engine, and a part connected therewith and rotated by the engine crank-shaft, a movable rod connected with said rotatable part and leading to one end of said link for independently adjusting said end, and a movable rod also controlled by said crank-shaft and connected with the other end of said link.

6. In an engine valve-motion, means for actuating the admission and exhaust valves of an engine, comprising a rocking link and a rod leading from the admission-valves and pivotally connected at one of its ends with the link, means for longitudinally adjusting said rod end and link relatively, a rod leading to the exhaust-valves, and at one of its ends pivotally connected to a fixed point of the link, reversing-gear for the engine, connections controlled by said reversing-gear for independently adjusting the position of one end of said link, and means controlled by the engine for rocking the link.

7. In an engine valve-motion, means for actuating the admission-valves of an engine, means independent of those first named for actuating the exhaust-valves of an engine, a

rod leading to the first-named means and pivotally connected at one of its ends with a link, means for longitudinally adjusting said rod end and link relatively, a rod leading to the aforesaid exhaust-valve-operating means connected at one end to a fixed point of the link, reversing-gear for the engine, connections controlled by said reversing-gear for independently adjusting the position of one end of said link, and means controlled by the engine for rocking the link.

8. In an engine valve-motion, means for actuating the admission-valves of an engine, means independent of those first named for actuating the exhaust-valves of an engine, a rod leading to the first-named means and pivotally connected at one of its ends with the link, means for longitudinally adjusting the said rod end and link relatively, a rod leading to the aforesaid exhaust-valve-operating means pivotally connected at one of its ends with a fixed point of the link, reversing-gear for the engine, and a part connected therewith and rotated by the engine crank-shaft, a movable rod connected with said rotatable part, and leading to said link and means controlled by the engine for independently rocking the link.

9. In an engine valve-motion, means for actuating the admission-valves of an engine, means independent of those first-named for actuating the exhaust-valves of said engine, a rod leading to the first-named means and pivotally connected at one of its ends with a link, means for longitudinally adjusting said rod end and link relatively, a rod leading to the aforesaid exhaust-valve-operating means and pivotally connected with a fixed point of the link, reversing-gear for the engine, and a part connected therewith and rotated by the engine crank-shaft, a movable rod connected with said rotatable part, and leading to one end of said link, and a movable rod also controlled by said crank-shaft and connected with the other end of said link.

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

HANS CHARLES BEHR.

Witnesses:

CHAS. OVENDALE,

R. OVENDALE.