(No Model.) 3 Sheets—Sheet 1.

M. R. MOORE.

STEAM ENGINE.

No. 534,754. Patented Feb. 26, 1895.

Fig. 1.

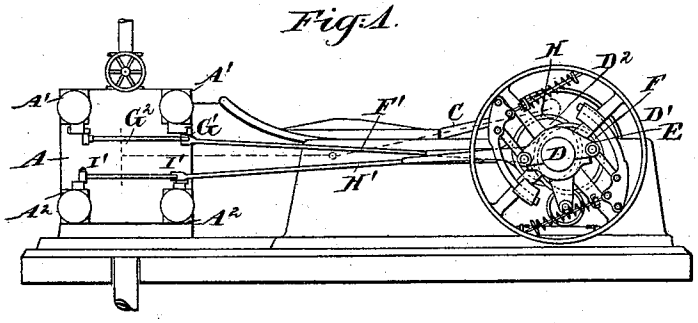


Fig. 9.

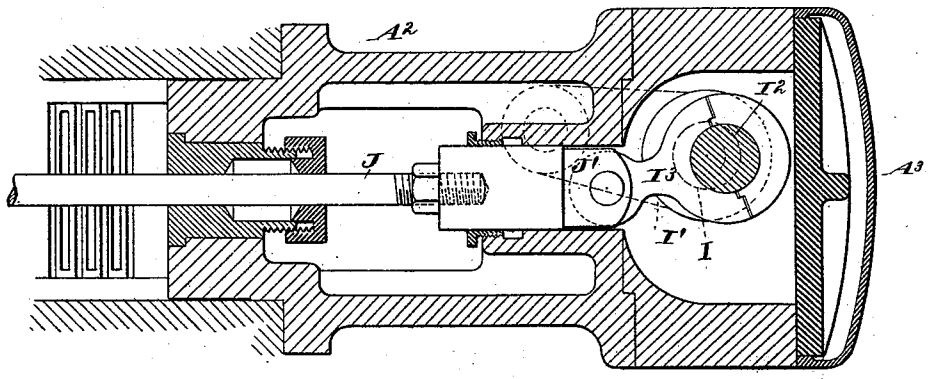


Fig. 10.

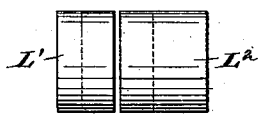


Fig. 12.

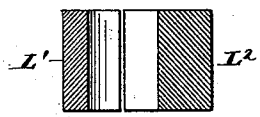


Fig. 11.

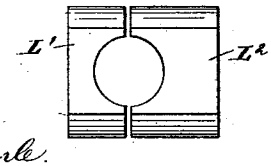
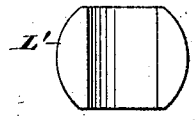


Fig. 13.



Witnesses:
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M. F. Boyle

Inventor:
Matthew R. Moore
by his attorney
Thomas Dyer Stetson

(No Model.) 3 Sheets—Sheet 2.

M. R. MOORE.

STEAM ENGINE.

No. 534,754. Patented Feb. 26, 1895.

Fig: 3.

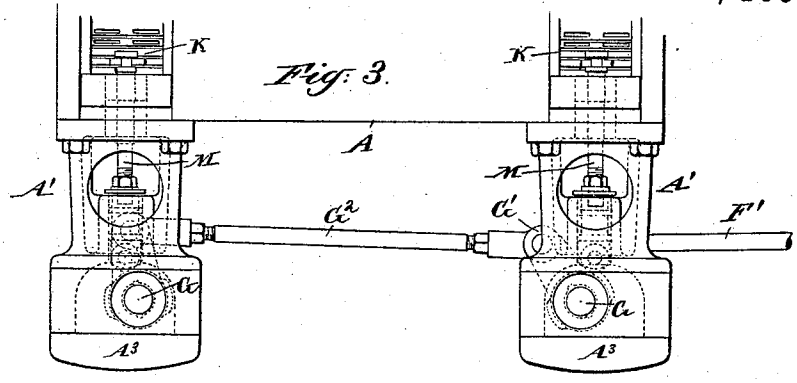


Fig: 4.

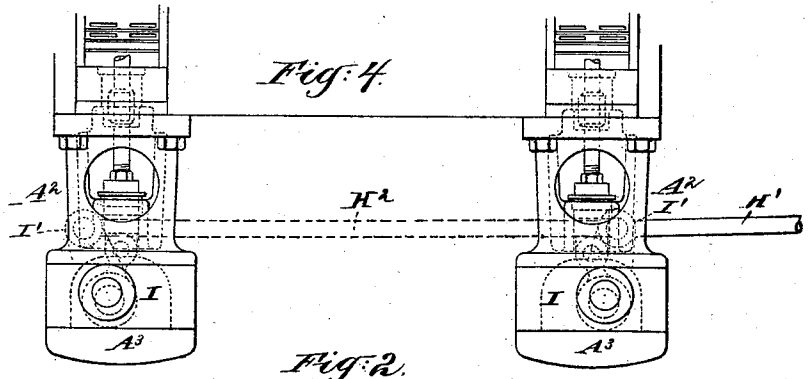
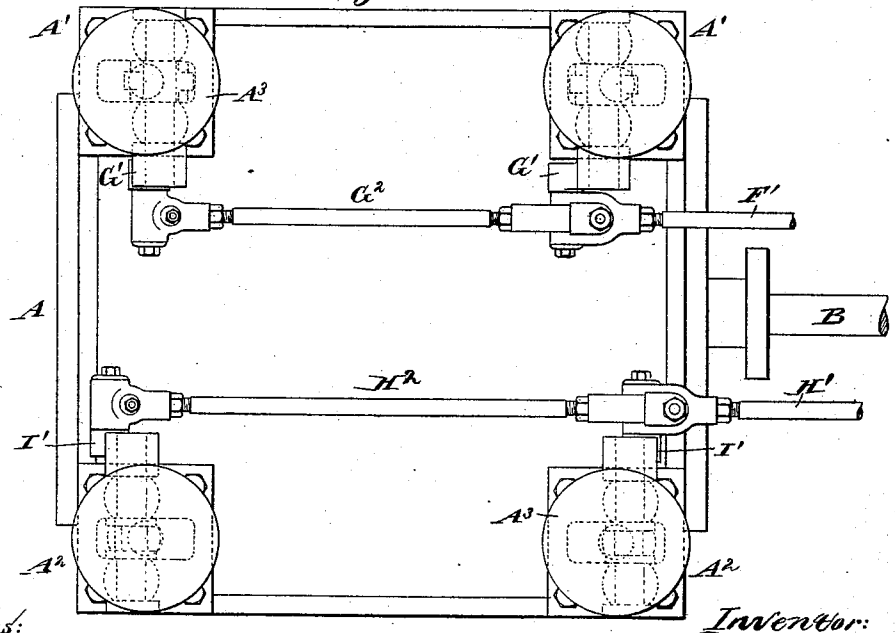


Fig: 2.



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(No Model.) 3 Sheets—Sheet 3.

M. R. MOORE.

STEAM ENGINE.

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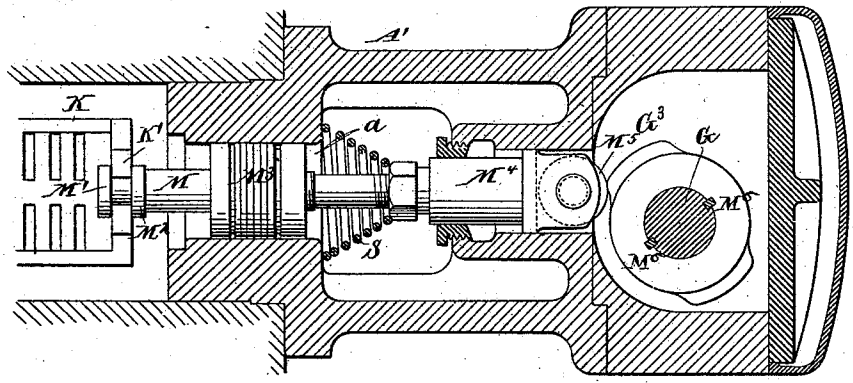


Fig: 5.

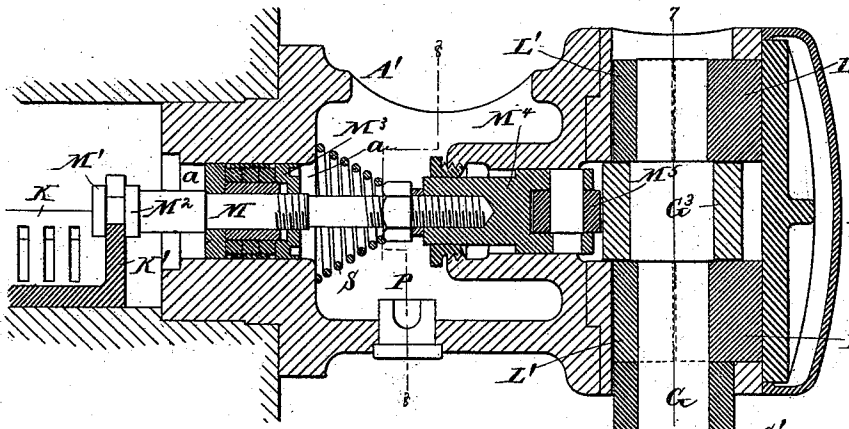
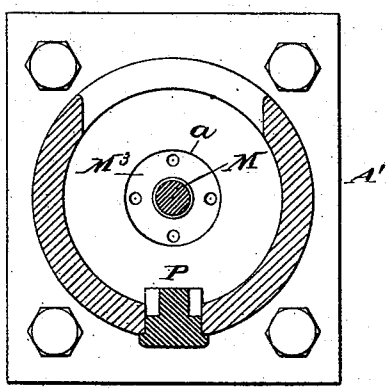


Fig: 6.

Fig: 8.



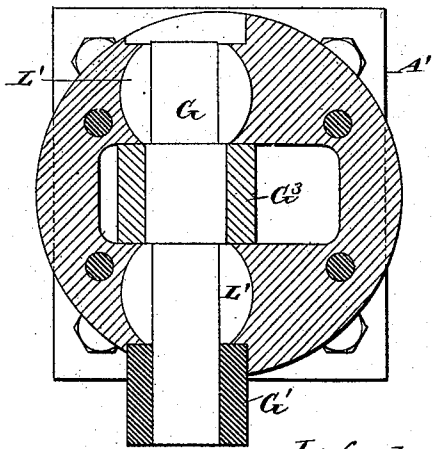


Fig: 7.

Witnesses:
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Fig: 14

Inventor:
Matthew R. Moore
by his attorney
Thomas Dyer Stetson

UNITED STATES PATENT OFFICE.

MATTHEW ROBERT MOORE, OF INDIANAPOLIS, INDIANA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 534,754, dated February 26, 1895.

Application filed July 9, 1894. Serial No. 516,913. (No model.)

To all whom it may concern:

Be it known that I, MATTHEW ROBERT MOORE, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented a certain new and useful Improvement in Steam-Engines, of which the following is a specification.

The invention relates to the means for working the valves. I will describe it as applied to engines having separately worked steam and exhaust valves of the grid-iron type, worked on grid-iron seats, and reciprocating transversely to the motion of the piston. The steam valves have a variable action, controlled by a governor. Each valve has a uniform extent of travel. On that side of the cylinder from which the valves are operated the valve-seat openings are covered by brackets corresponding in location, and somewhat resembling in appearance, the valve brackets of an ordinary Corliss engine. They contain guides for the valve-stems and bearings for the valve-operating devices, with provisions for adjusting, lubricating and protecting from dust and injury. Each bracket is made up of two principal parts, a body and a head, with several subordinate parts. An opening in the top of the substantially cylindrical hollow body of the bracket gives access to the interior. In the induction valve brackets provision is made for operating the valve by hand in starting. In the head of each bracket is arranged a reservoir of lubricant, so that the working parts therein are immersed in oil. I provide stuffing boxes to keep the lubricant out of contact with any steam which may leak from the valve chests, as otherwise the oil is liable to become foamy. Each valve is operated by a distinct and separate shaft mounted in bearings in its bracket, and oscillated by a connection from the engine. The shaft for each valve is arranged sufficiently out of line with the axis of its valve to compensate for the slight friction involved in operating it, so that the opening force will be exerted as nearly as possible in the line of motion of the valve. The shaft for each steam valve carries a properly shaped cam which acts on a roller on the valve-stem to force the valve in one direction, the return motion of the valve being induced by the action of the steam on the cross-sectional area of the valve-stem, or upon a small piston playing in a cylinder concentric to the valve-stem. The returning force thus varies automatically in a direct ratio with the pressure of the steam and consequently with the principal element in the frictional resistance of the valve. In addition to the provision for returning the valve by steam pressure a spiral spring is provided for each valve-stem, to act in concert with the steam pressure, and to insure the return of the valve when there is no pressure. It needs, therefore, to be only strong enough to overcome the friction of the valve when there is no pressure upon it. The use of these devices is simply to keep the roller in contact with the cam, the shape of which determines the character of the motion. The cam shafts are given a variable oscillatory motion by connection with an eccentric of variable throw controlled by a shaft governor. The exhaust valves are mounted and reciprocate in a somewhat similar manner, but with the important difference that they are moved positively in both directions. Each is worked by a crank on a corresponding oscillatory shaft. These shafts are rocked uniformly, a separate eccentric of fixed throw being provided therefor.

The rocking shaft for each valve, with its cam or crank, is wholly inclosed in the bracket which supports it, except one end on which is keyed the lever arm or crank through which it receives its motion. The lever arms of each pair of shafts, for the steam or exhaust valves, are connected together and to the appropriate eccentric by suitable rods or links. The brasses mounted in these brackets to form bearings for the rocking shafts are peculiarly formed and fitted to adapt them to serve reliably for long periods, with provisions for taking up wear. All the parts, especially the connections from the valve-moving mechanism to the valves, are equipped for allowing accurate adjustment to the conditions under which the engine is to operate. A strong plane cap and a tastily swelled hood applied tightly on each bracket gives a neat finish and incloses the whole oil-tight. I fill the head of each bracket with the lubricant through an aperture provided in the top, into

which may be screwed an oil-cup, or a plug, to exclude dust.

The accompanying drawings form a part of this specification and represent what I consider the best means of carrying out the invention.

Figure 1 is a general side elevation showing the engine complete. Fig. 2 is a corresponding side view of the cylinder and its immediate attachments on a larger scale. The remaining figures show details detached. Fig. 3 is a plan view of the steam valve mechanism. Fig. 4 is a plan view of the exhaust valve mechanism. The remaining figures are on a still larger scale. Fig. 5 is a central horizontal section of one of the brackets in the steam valve mechanism. Fig. 6 is a corresponding vertical section. Fig. 7 is a cross section on the line 7—7 in Fig. 6. Fig. 8 is a vertical section on the line 8—8 in Fig. 6. Fig. 9 is a horizontal section through a portion of the exhaust valve mechanism. Figs. 10, 11, 12, and 13 are detail views of the removable brasses which constitute the bearings for the upright shafts. Fig. 10 is a side elevation. Fig. 11 is a corresponding plan view; Fig. 12, a central vertical section, and Fig. 13 an interior view of one of the brasses. Fig. 14 is a diagram showing the means for determining the epicycloidal form of the cams.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

A is the main cylinder, certain portions being designated, when necessary, by super-numerals.

A′, A′, are the brackets for the two separate steam valves, and A^2, A^2, are the corresponding brackets for the exhaust valves. The brackets are arranged as in the ordinary Corliss engine.

B is the piston-rod. The piston, not shown, may be of any ordinary or suitable construction, adapted to serve in the ordinary manner. The motion is communicated as usual by a connecting rod C to the crank on the main shaft D. On the latter is a shaft governor D′, which may be of the style set forth in the patent to me dated May 26, 1885, No. 318,782, or of any suitable construction.

E is an eccentric carried on the shaft D, but capable of being changed in position thereon by the action of the governor, so that as the speed rises, the eccentric is shifted inward to give less throw, and forward to make the movement earlier, the effect being, when the parts are properly proportioned and adjusted, to induce an opening of the steam valve at a uniform point under all conditions, and to allow the closing of the valve at periods varying from very early in the stroke to nearly the termination of the stroke, according as more or less steam is required to maintain a regular speed of the engine under varying loads and pressures of steam. The eccentric thus operated gives motion to the rocking shafts G, G, which operate the steam valves.

F is the eccentric strap, and F′ the eccentric rod leading to the crank arm G′ at the bottom of the shaft G for the nearest steam valve. A connection G^2 leads from the crank of this shaft to a corresponding crank arm on the shaft for the other steam valve. The parts are so arranged and proportioned that the proper working of the single eccentric E communicates the proper oscillating motion to the shaft G of the nearest steam valve, and also through the connection G^2 to the corresponding shaft for the farther steam valve.

G^3, G^3, are peculiarly shaped cams, keyed, one on each shaft G, and having a form adapted to give the required motion to the valve. These cams are symmetrical in shape, having the contour, approximately, of a circle of such radius as to tangent the valve-stem roller when the valve is in the closed position, to the opposite sides of which are joined two equal epicycloidal curves, the generating circle of which has a diameter equal to the space through which the valve must move to give the full opening to the ports. The effect of this shape is, that so long as the circular part of the cam moves in contact with the roller, the valve will remain closed, but as the cam turns, bringing one of the epicycloids into contact, the roller will mount thereon and the valve be opened, at first quickly, then more slowly, remaining wide open when the highest point of the curve is reached. The angle where the curve joins the circular part is filleted out so that it will meet the roller without shock. From the peculiar form of these cams, as well as from their circle-like shape and action, they may appropriately be called "epicycloidal," or "cycloidal cams," or I may refer to them simply as "cycloids." But one corner of each "cycloid" is in use at a time, but provision is made in fastening them on their shafts by the removable keys M^6 for shifting round or inverting them so that fresh corners are brought successively into action as those in use become worn.

Both the steam valves and the exhaust valves are of the forms set forth in an application for patent filed by me on or about May 2, 1894. It is sufficient for the present invention to say that each valve and each seat is provided with a number of uniform, and uniformly spaced, ports, extending parallel to the axis of the main cylinder, and transverse to the motion of the valves, and that when by the reciprocation of the valve the ports therein are brought to coincide with the ports in the seat the valve is open, and that when the valve is shifted to such a position that the ports no longer coincide the valve is closed.

K, K, are the steam valves. Each is controlled in position by being engaged by a separate valve-stem M, which is provided with collars M′, M^2, which embrace firmly the lug K′ of the valve, so that the stem and the

valve move together as one. A description of one will suffice for both. Each stem carries a piston M^3 which works steam-tight in a truly bored cylinder *a*, concentric to the valve-stem. The pressure of the steam on the inner face of the piston tends to move it outward, giving a corresponding motion to the valve. As an alternative construction I may employ instead of the piston M^3, shown and described, an enlarged portion of the valve-stem working through an ordinary stuffing-box. The outer end of the valve-stem M carries a detachable head M^4 in which is mounted a roller M^5. This roller performs the important function of receiving the action of the cam G^3, and giving the required opening motion to the valve, and of rolling upon the cam and holding the valve open the required length of time, as determined by the governor, the returning motion of the cam then allowing the valve to be moved by the action of the steam on the piston M^3 to effect the closing.

The provisions for operating the exhaust valves differ from those described for actuating the steam valves in the following particulars:—A separate eccentric D^2 keyed rigidly on the shaft gives a uniform motion through the eccentric strap H, eccentric rod H′ and connection H^2 to the crank-arms I′ on the rocking shafts I. On these shafts, instead of cams are small cranks or equivalent eccentrics I^2, connected by short links I^3 to knuckles J′ on the ends of the corresponding valve-stems J. As the exhaust valves are moved positively in both directions there is no provision on the valve-stems J, J, for working by steam pressure. They work through ordinary stuffing-boxes. These small cranks or eccentrics I^2 are so placed relatively to the valves that their centers are at farthest throw outward when the valves are in their closed positions. Hence they may swing through a considerable arc about this position without giving the valves practically any motion; but having moved some distance off the center they cause the valve to open very quickly. The driving eccentric D^2 passing its center when the valve is open causes a dwell of the valve in the opened position, succeeded by a quick closing, and another dwell in the closed position by the small crank I^2 passing its center as described. The shafts I are oppositely offset from the lines of motion of the two valves, and the crank-arms I′ are so connected that one valve or the other remains nearly stationary in the closed position while the other is opening and closing, during substantially a half revolution of the main shaft. This arrangement, with the adjustments provided, furnish all the required provisions for pre-exhaust, cushioning, &c.

The bearings for the rocking shafts G and I are each formed in two parts or brasses L′, L^2. Each has a cylindrical exterior, with a flattened upper and lower face, and is fitted in a corresponding cylindrical seat in the head of the bracket. These seats may be formed by boring in the proper lines parallel to the valve stem, and are firmly faced at each end, as will be understood from the drawings. The brasses are each a soldid cylinder with a portion cut off at the top and bottom, and with a half of a hollow cylinder cut out across one end. The two ends thus bored are placed together and snugly embrace the corresponding portion of the shaft. The brasses fit tightly in their respective cylindrical inclosures, and as neither is subject to any wear on its exterior they will continue to fit indefinitely. When, by wear from the shafts rocking therein, lost motion occurs, the brasses may be removed and their adjacent faces filed off to restore the fit. When reinserted, the adjustment is made good by shiming the end of the proper brass with thin sheet metal or paper.

A^3 is a cap and hood adapted to fit tightly on the end of each bracket A′, A^2. They perform the several functions of allowing access to the interior of the bracket to insert and remove the brasses L′, L^2, inclosing the working parts to protect them from dust, forming a receptacle for lubricant, and giving a pleasing finish to the bracket. When all is properly adjusted for working, I fill the hollow interior of the head of the bracket with oil, thus insuring unusually efficient lubrication. Provision in the form of packing not shown is made to prevent leakage of oil around the projecting ends of the shafts G and I and the valve-stems M and J. Packing is also provided to inclose the head on each valve stem and allow each bracket head to be filled with oil while the body of the bracket is empty. Ordinary provisions are made for adjusting each packing.

In the bottom of the interior of each steam valve bracket A′ is a fulcrum support P. The top of each of these brackets is open except that it receives a light cover, not shown, to exclude the dust. Whenever it is required to shift the valve by hand, as to back the engine off the center, or in starting, the cover is taken off and a convenient lever is thrust down into the fulcrum P in the bracket. The lever is then caused to act against a shoulder on the valve-stem, and the valve shifted in opposition to the pressure of the steam on the piston M^3 as it would be shifted at the proper time by the proper cam G^3, some provision being necessary to insure the proper closing of the valves when there is not sufficient pressure in the cylinder to act on the piston M^3.

M^6 M^6 are keys set in spline grooves in the shafts G and cams G^3. By removing these keys and giving a cam G^3 a half revolution and reinserting the keys one of the changes will be made in the cam so as to present a new corner to be worn. By removing the cam and reversing it and reinserting the keys in two positions, two further changes will be made so as to use all the cam corners but it

will be observed that by reason of the oscillating motion only one cam corner is used in any given adjustment of the cam and keys.

I insert in each steam valve bracket a spiral spring S, as shown in Figs. 5 and 6, compressed between a shoulder in the bore of the bracket and an adjustable nut on the valve-stem. The spring acts in concert with the steam pressure in urging the valve outward and holding each roller M^5 in contact with its proper cam G^3.

The vertical arrangement of the shafts G and I is important because it presents them in a position transverse to the reciprocating motion of the valves and also in a position to receive the required oscillating motion from eccentric rods operated in the ordinary manner by the engine-shaft.

Each spring S should have only sufficient force to move the connected valve K when there is no steam present thereon. The resistance to the motion of the valve is then very slight. In proportion as the steam pressure is increased the resistance to the motion of the valve increases and the aid from the action of the steam on the small piston M^3 is correspondingly increased. It may be noted that the pressure is nearly balanced at this point when the valve is moving in either direction.

I attach importance to the provisions by stuffing boxes around each valve stem head for keeping the lubricant which fills the bracket head from flowing into and filling the bracket body, because I am able by this means to keep the oil in its proper liquid condition. If it were allowed to fill the bracket body any slight leakage of steam past the piston M^3 would mingle with the oil and induce foaming.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. Instead of placing the governor and eccentrics which operate the valve gear on the main shaft D, as shown, I can place them upon an auxiliary shaft receiving its motion from the main shaft through suitable gearing. I can apply the invention to vertical engines, only making such changes in the positions of the parts as will adapt them to the new conditions. I can apply it to a tandem compound engine by connecting the steam valves of all the cylinders in line by means of rods similar to G^2, with a single variable eccentric, as E, and in like manner all the exhaust valves with a single rigid eccentric, as D^2. Each cylinder will thus be brought under the control of the governor and the proper distribution of steam secured for each.

I claim as my invention—

1. In a steam engine the separate steam valves K, K, each provided with a valve-stem, and means, as the roller M^5, for receiving the thrusting action of a cam, a separate suitably arranged shaft G and cam G^3 with means, as the spiral spring S, for keeping the roller in contact with the cam, and suitable connections for operating such cam shaft, with a rocking or oscillating motion, combined and arranged for joint operation substantially as herein specified.

2. In a steam engine having separate steam valves and a separate oscillating cam and cam roller for each valve, the piston M^3 subject to the action of the steam for keeping the oscillating roller and cam in mutual contact by steam pressure, in combination with the spring S having sufficient tension in the same direction to close the valve when the steam is partially or entirely shut off arranged for joint operation, substantially as herein specified.

3. In a steam engine, two separate steam admission valves K, K, reciprocating transversely and corresponding upright shafts G G each provided with an oscillating cam and roller, with means for securing their mutual contact, all connected together by suitable links, as G^2, for operation by a single variable eccentric E under the control of a speed governor, substantially as herein specified.

4. In a steam engine having separate steam valves each with an operating stem having an enlarged portion and an anti-friction roller M^5 carried by such enlargement, a hollow valve bracket for each valve stem, a bracket head for each containing the valve operating mechanism, and a stuffing box N through which the enlarged portion of the stem works all combined and arranged for joint operation substantially as herein specified.

5. In a steam engine having separate steam valves, a cam for operating each valve independently mounted upon an upright oscillating shaft each cam having two or more working corners, with the removable keys M^6 for throwing such working corners out of action as they become worn, and bringing the unworn corners successively into operation, by turning round or reversing the cam upon its shaft, substantially as herein specified.

6. In a steam engine having two exhaust valves, an upright oscillating shaft I for each valve, having on it a crank I^2 connected by a link I^3, a knuckle J′ and stem J to the valve, and by a link or links H′, H^2, to the eccentric D^2 for regularly oscillating such shaft, the parts arranged in such relative positions that the valve will be positively opened and closed during a part of each oscillation and remain practically stationary in the closed position during the remainder of such oscillation, all substantially as herein specified.

7. In a steam engine the separate steam valves K, K, a piston M^3 for each, subject to pressure of the steam, means as the roller M^5 for receiving a thrusting action from a cam, a separate vertically arranged shaft G and cam G^3 for each, and means as the variable eccentric E and suitable connections for oscillating each shaft, in combination with a

hollow bracket A', and with the fulcrum rest P adapted to allow the insertion of a hand-lever through the open top of such bracket, and thereby engage the valve-stem to allow its being moved by hand in starting, all arranged for joint operation substantially as herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

MATTHEW ROBERT MOORE.

Witnesses:

ROLLIN DEFREES,

E. K. MARQUIS.