(No Model.) 3 Sheets—Sheet 1.

W. K. AUSTIN.

STEAM ENGINE.

No. 383,430. Patented May 29, 1888.

Fig. 1.

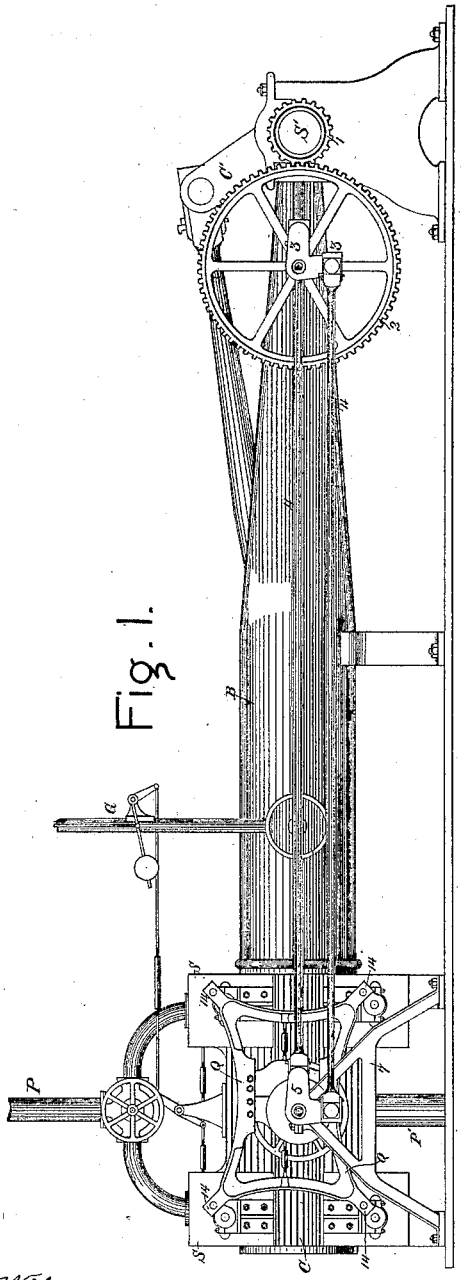
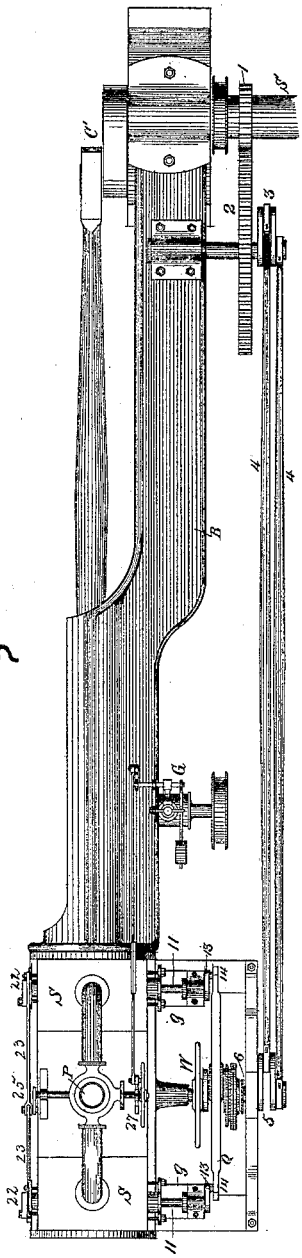


Fig. 2.



Witnesses:
A. B. Dodge.
J. A. Rennie

Inventor,
Wm. K. Austin.
By W. C. Dunn,
Attorney.

(No Model.)

3 Sheets—Sheet 2.

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STEAM ENGINE.

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Fig. 3.

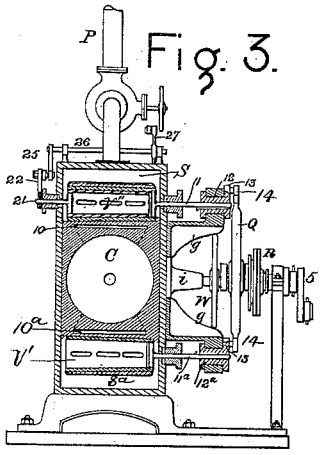


Fig. 4.

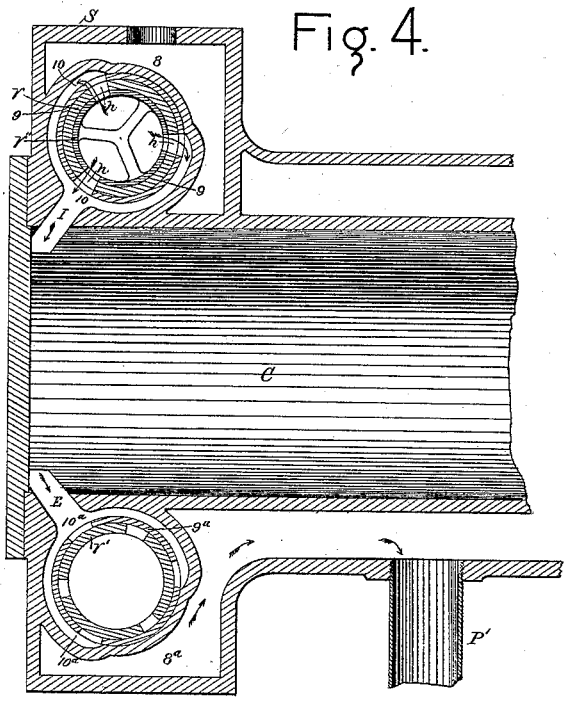


Fig. 6.

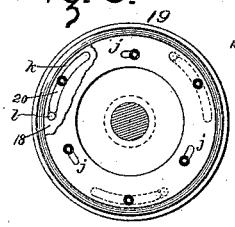


Fig. 7.

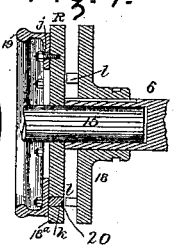


Fig. 5.

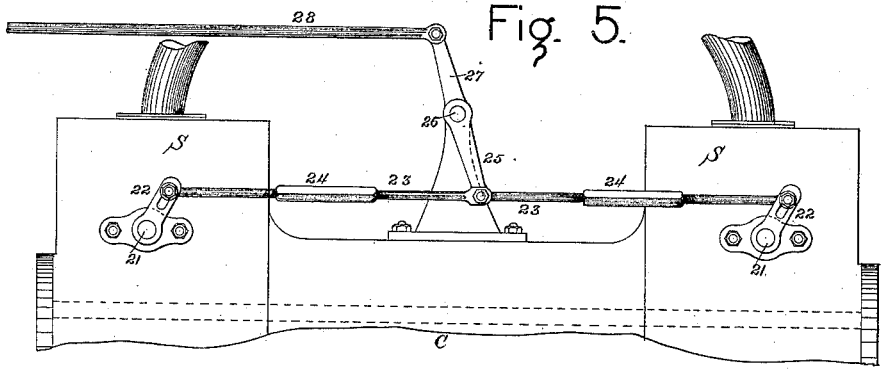
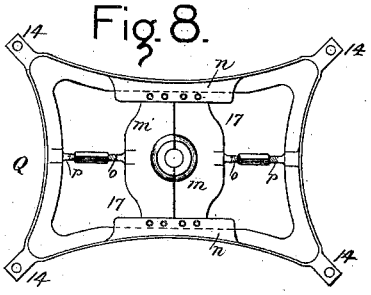


Fig. 8.



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W. K. AUSTIN.

STEAM ENGINE.

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Fig. 9.

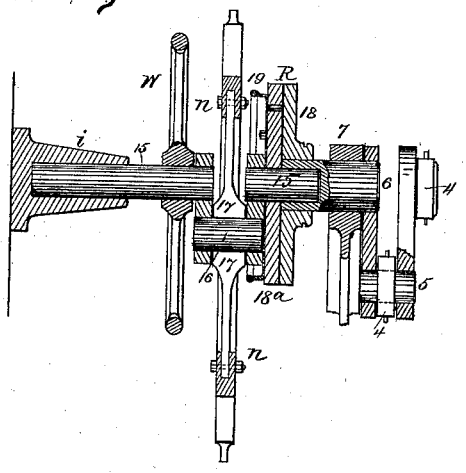


Fig. 10.

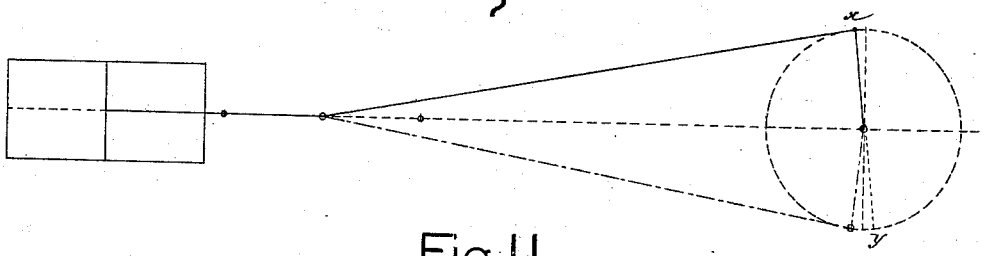
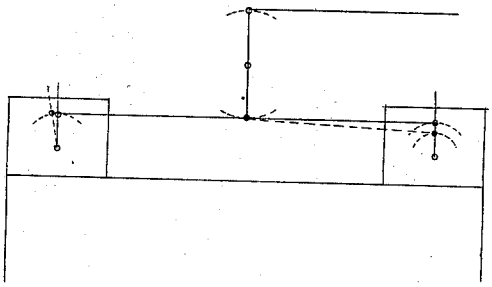


Fig. 11.



Witnesses:
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J. A. Rennie

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Wm. K. Austin.
By W. C. Dunn.
Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM K. AUSTIN, OF BROOKLYN, NEW YORK.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 383,430, dated May 29, 1888.

Application filed December 23, 1886. Serial No. 222,367. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM K. AUSTIN, of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Steam-Engine, of which the following is a specification.

This invention, which has relation to reciprocating steam-engines, comprehends improvements upon the stationary parts and the mechanism of engines, and also new and original constructions and modes of operation of various parts thereof.

Specifically my invention relates to improvements on the steam-chest and steam and exhaust chambers; to the induction and exhaust valves and the operation thereof; to the cut-off valves and devices for operating the same; to reversing mechanism for stationary engines; to the cut-off-valve gear and means of equalizing the cut-off for both sides of the piston; and, lastly, to details of construction and arrangement of the mechanism, which will be fully described farther on in this specification and summarized in the claims.

The objects of my invention are, first, to balance the valves of steam-engines; second, to admit and cut off the steam quickly with a slow motion of the valves; third, to insure even wearing of the valves and valve-seats and provide for taking up wear and preventing leakage; fourth, to make the valves of automatic cut-off engines independent of the cut-off mechanism and to operate them positively; fifth, to simplify the adjustment of the induction and eduction valves and the mechanism by which they are operated; sixth, to provide means for easily and quickly reversing automatic cut-off engines; seventh, to reverse engines by changing the valves directly and positively instead of through the valve-gear; eighth, to make the cut-off valves and valve-gear independent of the steam-valves and to operate them by independent positive acting mechanism; ninth, to equalize the cut-off for both strokes of the piston and obtain a steadier running of the engine.

In the accompanying drawings, Sheet I, Figure 1 represents a side elevation of my improved steam-engine; Fig. 2, a plan of the same. Sheet II: Fig. 3 represents a vertical transverse section of the cylinder of the engine taken in the plane of the axis of the induction-valve and showing the valve in sectional end elevation; Fig. 4, an enlarged longitudinal section of the cylinder, showing one of the induction-valves and one of the eduction-valves in cross-section. Fig. 5 represents the cut-off-valve gear; Fig. 6, a front view, and Fig. 7 a vertical section, of the reversing-clutch; Fig. 8, a detail of part of the valve-gear; Sheet III: Fig. 9, a sectional detail of the valve-gear; Figs. 10 and 11, diagrams illustrating the position of the crank and connecting-rod when the piston is at half-stroke.

Referring to the drawings, B is the bed or frame of the engine; C, the cylinder; S, the steam-chest; G, the governor, which may be of any type suitable for an automatic cut-off. S′ is the shaft; C′, the crank. P is the steam-pipe, having branches which connect with the two ends of the steam-chest; P′, the exhaust-pipe. The exterior form and arrangement of these parts, as shown in the drawings, may be departed from as in those respects, and also in respect of the relation which they bear to each other in the organized mechanism. They may be modified to adapt the engine to the requirements of the situation in which it may be placed and the work it is to perform without departing from the characteristic principles of the invention.

Motion is given to the induction and eduction valves' gearing by means of a pinion, 1, on the shaft, geared to a spur-wheel, 2, fixed to a shaft held in suitable bearings on the engine-frame. A duplex crank, 3, is fixed to the wheel or its shaft, and the rods 4 4 connect with the cranks. The opposite ends of the rods connect with another duplex crank, 5, fixed to the end of a shaft, 6, journaled in suitable bearings in a frame, 7, erected on the bed of the engine adjacent to the cylinder. The purpose of this mechanism is to communicate the rotary motion of the shaft to the valve-gear unchanged, and the object to be attained is to give a constant rotary motion to the valves. This is accomplished by means of a peculiar valve-gear, which will be described after the construction and location of the valves have been given.

The valve-chambers.—Inside the steam-chests is cast a valve-casing, 8, formed by a three-

part septum, two parts of which spring from the cylinder and steam-chest, respectively, and the third or middle part springs from the other two. The cylindrical valve-seat 9 is connected with the last, either by casting it with the septum or separately and fitting it to place. A chamber, 10, is thus formed between the valve-seat and the casing. This chamber terminates short of the ends of the valve seat, the casing being contracted at the ends, so as to join the ends of the valve seat, and thus close the chamber and prevent the passage of steam back to the steam-chest. The lower part of the chamber is shown in Fig. 3, and its length relatively to the valve-seat is there clearly indicated. These chambers are practically a prolongation of the induction-ports I, and hereinafter they will be referred to as port-chambers. A similar casing, 8^a, and valve-seat 9^a are cast under the eduction-ports E, and a similar chamber, 10^a, connects with or forms a prolongation of the ports. (See Figs. 3 and 4, Sheet II.)

The valves.—These are designated by the letters V V′, the former induction and the latter eduction valves. They are hollow cylinders internally bored true, but externally coned or tapered slightly from the stem ends, and they are fitted into the valve-seats, which internally are correspondingly coned or tapered, so that the valves fit closely. The object in tapering or coning the valve-seats and valves is to obtain a steam-tight fitting of one within the other, and to maintain this condition without reboring. This is done by simply moving the valve longitudinally when it becomes loose by wear. Owing to the construction and mode of operation of the valves the wear is perfectly uniform, and it can be compensated for by merely moving the valves in the direction of their axes, and securing them in their new position by keying their stems in the sleeves to which they are fastened, which will be referred to hereinafter. The larger end of the valves is provided with cross-arms, and from these project a stem, 11, which is carried through a suitable stuffing-box in the walls of the steam-chest, and has its end inserted and fastened by a spline into a collared sleeve or box, 12, which is journaled in a suitable bearing in a bracket, *g*, and has on its exterior end or collar a crank, 13, which connects with the valve-gear. Both induction and eduction valves are constructed in this manner and connect by the same means with the valve-gear. In the walls of the valves are slots or openings *h* at equal intervals apart, (measuring on the periphery,) which serve as passages for the steam. These slots may be continuous lengthwise, or broken, as shown. Three equidistant openings or lines of openings are shown; but it is obvious that the number may be increased or diminished. The greater the number the slower the movement of the valve and the greater the area of the steam-passages. The objects sought are as large passages for the steam to the induction-ports as may be consistent with a movement of the valve sufficiently rapid to prevent wire-drawing. The valve-seats have corresponding openings in number, area, and relative position. When the valves are in motion, the several openings in the valve-seat are opened simultaneously by the coming into line of the corresponding openings in the valve. The steam passes from the steam-chest into the valve, and as both ends of the valve are open, the communication through the valve is perfectly free and the pressure of the steam on every exposed part of the valve is uniform, and the pressure upon the valve-seat through the several passages or openings is likewise equalized, as the openings are so placed that the pressure in one direction is met by a contrary opposing or counteracting pressure. The live steam surrounds the valve-stem, and the lateral pressure upon the bearings is practically uniform.

In the operation of the engine, the valve revolves and brings its pivots or openings in line with the openings in the valve-seat, the steam passes from the steam-chest through said openings into the port-chambers, and thence to the induction-ports. The eduction-valves V′ and valve-seats 9^a are the same in construction as the induction-valves and valve-seats, and the valve-stems 11^a connect with boxes 12^a in the same manner as the induction-valves, except, of course, that the steam passes from the piston through the exhaust-ports to the chamber, thence through the openings in the valve-seat into the valve, thence out of the valve to the exhaust-chamber and exhaust-pipe.

The valve-gear.—As before stated, the stems of the induction and eduction valves are fastened to collared sleeves 12 12^a, which are provided with cranks 13, and these cranks connect with the valve-gear. This valve-gear consists of a quadrilateral frame, Q, at the angles of which are projections 14, provided with suitable boxes which receive the pins of cranks 13. The frame connects with its motor in the following manner: A crank-shaft, 15, is journaled at one end in a sleeve, *i*, which projects from the cylinder-casing at a point equidistant from the valves, and at the opposite end has a bearing in a socket formed in the shaft 6. A crank, 16, is formed in said shaft, and the pin of said crank is passed through a box, 17, Fig. 8, in the center of the frame Q. Thus connected, when the crank 16 revolves, the frame is carried with it and rotates, its center being carried around the center of the crank, whereby the projections 14 are each made to move in a circular path the center of which is the valve-stems, and by this movement the cranks 13 are revolved and thence a constant rotary motion is communicated to the valves. The crank-shaft derives its motion from the shaft 6; but it has direct connection therewith only through a clutch, R, which is shown in detail in Figs. 6, 7, and 9. This clutch also serves as reversing mechanism. It is constructed as follows: One member, 18, is

held by means of a spline to shaft 6, so as to revolve therewith, and at the same time be movable lengthwise of the said shaft to a limited extent, a suitable device being employed to move it. The other member, 18^a, is placed on shaft 15 and fixed thereto. The latter has also a flanged locking-plate, 19, connected with its rear face by bolts and nuts passed from the member through slots *j* in the flange. Through the member 18^a are made segmental slots *k*, into which are placed removable segmental chucks 20, which are shorter than the slots, and are held by bolts and nuts, the bolts passing through the locking-plate. The points or bayonets *l* of the movable member of the clutch enter said segmental slots between the ends of the chucks and the ends of the slots. The length of the slots is such that by shifting the points or bayonets from one end to the other the clutch is caused to operate the engine reversely—that is to say, if the valves are set to run the engine in one direction—say from left to right, when the left-hand valve is open and the right closed, by changing the position of the valves and the clutch-connections the operation is reversed. This shifting of the clutch-connection is effected automatically, after the changing of the chucks, in the following manner: The engine being brought to a stand, the movable member of the clutch is thrown back, out of connection with the other member. The locking plate being loosened, it is turned until the chucks are moved sufficiently to be stopped by the ends of the slot toward which they are moved, whereupon the locking-plate is again made fast. By the movement of the chucks to one end the opposite ends of the slots are left open for engagement. It will be observed that the adjustment of the chucks is effected entirely by the locking-plate, which is allowed by the presence of the slots *j* sufficient movement to carry the chucks the required distance to admit the clutch-pins between its ends and one or the other ends of the slots. When this change or adjustment has been made, the valves are set by means of the hand-wheel W on shaft 15, and when they are in the proper position to reverse the engine the clutch-pins enter the proper end of the slots. In order that the engagement of the two members of the clutch may be brought about automatically, the movable or shifting member should be governed or controlled by a spring operating to retain it in coupling with the fixed member. It is obvious that instead of setting the valves directly in the manner above indicated the same result may be produced by turning the shifting member of the clutch, using the driving-wheel of the engine for that purpose.

The automatic cut-off.—This is illustrated in detail by Figs. 3, 4, and 5, and in connection with the governor in Figs. 1 and 2. The cut-off valves V″ are cylindrical and placed within the steam-valves, and by referring to Figs. 3 and 4 it will be seen that they are in all respects the same in construction as the steam-valves, having the same number of steam-passages open at one end, and at the other, which is at the open end of the steam-valve, having cross-arms, from which a stem, 21, extends, which is carried through the side of the steam-chest in a suitable stuffing-box, and terminates with a slotted arm, 22. The steam-valve serves as a seat for the cut-off valve, which turns or rotates freely within, but independent of, the steam-valve. The valve-gear consists of rods 23 23, each in two parts, connected by screw-couplings 24, and each rod connected at one end by a pivot with the slotted arm 22 on the valve stem 21, and at the other end with the pendent arm 25, of a rocker fixed to one end of a shaft, 26, journaled in suitable bearings transversely of the steam-chest, and carrying at the opposite end the arm 27 of the rocker, which in turn connects with the governor-rod 28.

Normally the openings in the cut-off valve coincide with the openings in the valve-seat, as in Fig. 4, so that when the steam-valves arrive at the open position the full area of port-opening is reached; but when the engine is running the action of the governor turns or oscillates the cut-off valve oppositely to the direction the steam-valves turn, decreasing the port opening and cutting off the steam. Thus, by the oscillation of the cut-off valves under the influence of the governor, the steam can be cut off at any point of the stroke up to a complete closing of the valves. This is effected positively and in entire independence of the steam-valve, as there is no connection whatever between the two valves or the valve-gears; hence certainty of action, delicacy of adjustment, and sensitiveness to the motion of the governor are attained to a degree which has heretofore been found impossible.

The equalizing of the cut-off for both strokes of the piston is effected by means of the cut-off-valve gear. By reference to the diagram of the piston, connecting-rod, and crank, Fig. 10, it will be seen that when running in the direction of the arrow at the half-stroke the crank is at *x*, some degrees to the left of the vertical line or the ninety-degree point, where it should be after moving one-half the distance required to make one stroke of the piston. In other words, theoretically the crank should move through an arc of ninety degrees in making a half-stroke; practically it falls short of it some degrees. This results from the angle of the connecting-rod to the piston-rod at the end of the half stroke, whereby the connecting-rod is actually caused to move through a space greater than the length of the crank while the latter moves through an arc of ninety degrees. The cut-off mechanism can be adjusted to compensate for this difference of position on the forward stroke, but not for both, as if adjusted for one it will not be for the other, and in that case the cut-off will take place too early. In the diagram it is seen that on the return stroke, when the piston reaches the half-stroke, the crank has passed the ver-

tical or ninety-degree point, the same distance as on the forward stroke it fell short of it, while the cut-off took place at a point, *y*, short of ninety degrees, or too early, by the same amount that it was too late on the forward stroke. To compensate for this difference of position of the crank at the same piston position, and thus equalize the cut-off, I adjust the connection of the valve-gear with the valve, so that one cut-off valve shall move in advance of the other, or more rapidly, to the extent of the difference between the piston position and the crank position at the moment of cut-off.

The manner of adjusting the cut-off valves is immaterial, and it can be done in various ways and by various means modified or adapted to the different kinds of valves and engines to which it may be desired to apply the principle. In the present case I prefer to effect the desired object by the mechanism shown in Fig. 5. This consists in adjusting the valves by varying the length of the rods 23 and changing the pivotal connection of the same with the arms of the valve stems relatively to the axes of the valves. For this purpose the arms 22 are provided with longitudinal slots and the rods with screw-couplings 24, by which they may be lengthened and shortened. By dropping the pivoted end of the right-hand rod, (which connects with the valve that cuts off for the return stroke,) thus bringing it nearer the axis of the valve, and adjusting the rod to its new position, so that the valve will retain its normal position—which should be the same as the opposite valve when the engine is running—the movement of the governor in the same space of time or by the same movement of the rocker 25 will produce a greater movement of the left-hand valve than the right-hand, owing to the greater arc through which the pivoted end of the rod moves. The adjustment must be such that when the engine is at rest both cut-off valves will occupy the same relative positions to their respective valve seats and the steam-passages therein. Now, when the engine is in motion and running at the required speed, the action of the governor will have the effect of moving the right-hand valve to a position that will cut off the steam exactly at the proper point—say half-stroke—although the crank will not have reached the ninety-degree angle, and on the return stroke, on the other hand, the left-hand valve will not cut off until the crank passes the ninety-degree angle far enough to carry the piston to the half-stroke. The adjustments can be made perfect experimentally, but cannot of course be determined beforehand for every kind of engine. Furthermore, when the engine is reversed the valve adjustment must be reversed.

The induction-valves are susceptible of the same adjustments for lap and lead that the slide-valve is capable of, these objects being attained by changing the position of the valve-openings relatively to the openings in the valve-seat.

Details.—The box 17 of the quadrilateral frame Q is composed of two parts, *m m*, which have their top and bottom edges placed in grooves formed by flanges *n n*, bolted or formed in one with the frame and secured therein by lateral bolts. The parts are provided with screw projections *o o*, which connect by means of screw-couplings with studs *p p* on the opposite sides of the frame. The object of this construction is to brace the boxes against the lateral thrust and pull of the crank. The steam-chests may be connected together by the casing of the cylinder, so that steam can flow from one to the other, and thus if the admission into one be insufficient the deficiency is supplied from the other.

When the engine is reversed, the cut-off is changed by connecting the governor-rod with the opposite end of the rocker 27.

I claim—

1. In steam-engines, the combination of a steam-chest, a valve-casing placed in said chest and inclosing a steam chamber that forms a prolongation of the port leading into the cylinder, a hollow cylindrical valve-seat provided with lateral openings for the passage of the steam to the ports, a hollow cylindrical rotary valve having open ends for the admission of steam from the steam-chest, and lateral openings for the exit of the steam from the valve, and through which the steam passes into the steam-ports, substantially as specified.

2. The combination of a steam-chest, a valve-casing placed inside said chest and inclosing a steam-chamber that connects with the steam-port of the cylinder, a hollow cylindrical steam-valve seat provided with lateral openings, a hollow cylindrical rotary valve having open ends for the admission of steam to the interior of the valve, and lateral openings for the exit thereof, and a hollow cylindrical cut-off valve placed inside the steam-valve and having open ends and lateral openings, said cut-off valve being moved independently of the steam-valve, substantially as specified.

3. The combination, with the cylinder of a steam-engine, of the rotary cylindrical induction valve and cylindrical cut-off valve incased therein, the said valves being provided with open ends that communicate with the steam-chest, and a rotary cylindrical exhaust-valve having open ends and lateral openings for the passage of the exhaust-steam into the interior of the valve, and suitable mechanism for moving the said valves in harmony with each other, substantially as specified.

4. The combination of the rotary cylindrical induction-valves, the stems 11, collared sleeve fixed to said stems and carrying the crank 13, the quadrilateral frame Q, shaft 15, carrying a crank which connects with frame Q, and suitable mechanism to connect shaft 15 with the main shaft of the engine, substantially as specified.

5. The combination of the rotary cylindrical induction and exhaust valves, having stems

which connect with collared sleeve-bearings carrying cranks 13, the frame Q, shaft 15, carrying a crank which connects with the frame Q, and suitable mechanism to connect shaft 15 with the main shaft of the engine, substantially as specified.

6. The combination of the rotary cylindrical induction and exhaust valves having stems which connect with the collared sleeves carrying cranks 13, the frame Q, shaft 15, and crank 16, suitable connections between shaft 15 and duplex crank 5, the connecting-rods 4 4, spur-wheel 2, and pinion 1, fixed to the main shaft S′, substantially as specified.

7. The combination of the rotary cylindrical valves connected with the crank 16 by suitable mechanism, the crank-shaft 15, journaled in sleeve *i*, and shaft 6, a suitable clutch to connect shaft 15 with shaft 6, and suitable mechanism for connecting shaft 6 with the main shaft of the engine, substantially as specified.

8. The combination of the valves having stems provided with cranks which are connected together by a frame, Q, placed on crank 16, the crank-shaft 15, the shaft 6, connected with the main shaft of the engine, and a reversing-clutch interposed between crank-shafts 16 and 6, substantially as specified.

9. The combination, with the valves of a steam-engine and the valve-gear connecting the same with the main shaft S′, of the reversing-clutch R, composed of the member 18 on shaft 6, provided with suitable clutch-pins, and the member 18^a on shaft 16, having slots *k* for the clutch-pins, and movable chucks 20, for filling the space between the clutch-pins and the opposite ends of the slots, substantially as specified.

10. The combination, with the member 18^a, of the clutch R, having slots *k* and the movable chucks 20, the flanged face-plate 19, provided with slots *j*, connected with the member 18^a by bolts for adjusting the chucks to change the valves, substantially as specified.

11. The combination of the induction and exhaust valves having stems which connect with sleeves carrying cranks 13, the quadrilateral frame Q, the shaft 15 and crank 16, the reversing-clutch R, the shaft 6, duplex crank 5, rods 4 4, spur-wheel 2, and pinion 1, fixed to the main shaft S′, substantially as specified.

12. The combination of the induction-valves, the cut-off valves provided with suitable stems, slotted arms 22, connected with the stems, adjustable rods 23, rock-levers 25 and 26, and governor-rod 28, substantially as specified.

13. The combination, with the rotary cylindrical induction-valves, of cylindrical cut-off valves placed inside the induction-valves at each end of the cylinder, a governor and governor-rod, and connections between the cut-off valves and the governor-rod, said connections being susceptible of adjustment for the purpose of changing the positions of the cut-off valves independently of each other and setting said valves so that the cut-off at one end of the cylinder will be later than the cut-off at the opposite end, substantially as specified.

14. The method herein described of equalizing the cut-off in steam-engines, consisting in changing the position of the governor-connections with the cut-off valves for the purpose of causing one cut-off valve to move in advance of the other, substantially as specified.

In testimony that I claim the foregoing as my invention I have hereunto set my hand this 9th day of December, 1886.

WM. K. AUSTIN.

In presence of—
GEO. B. GOUGH,
A. B. DODGE.