No. 739,219. PATENTED SEPT. 15, 1903.

J. H. REDFIELD.

EXPLOSIVE ENGINE.

APPLICATION FILED APR. 30, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 12.

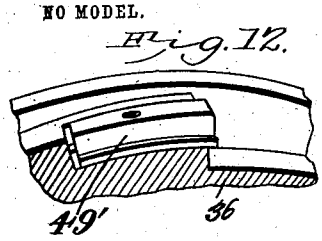


Fig. 13.

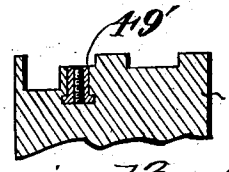


Fig. 1.

Witnesses

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.

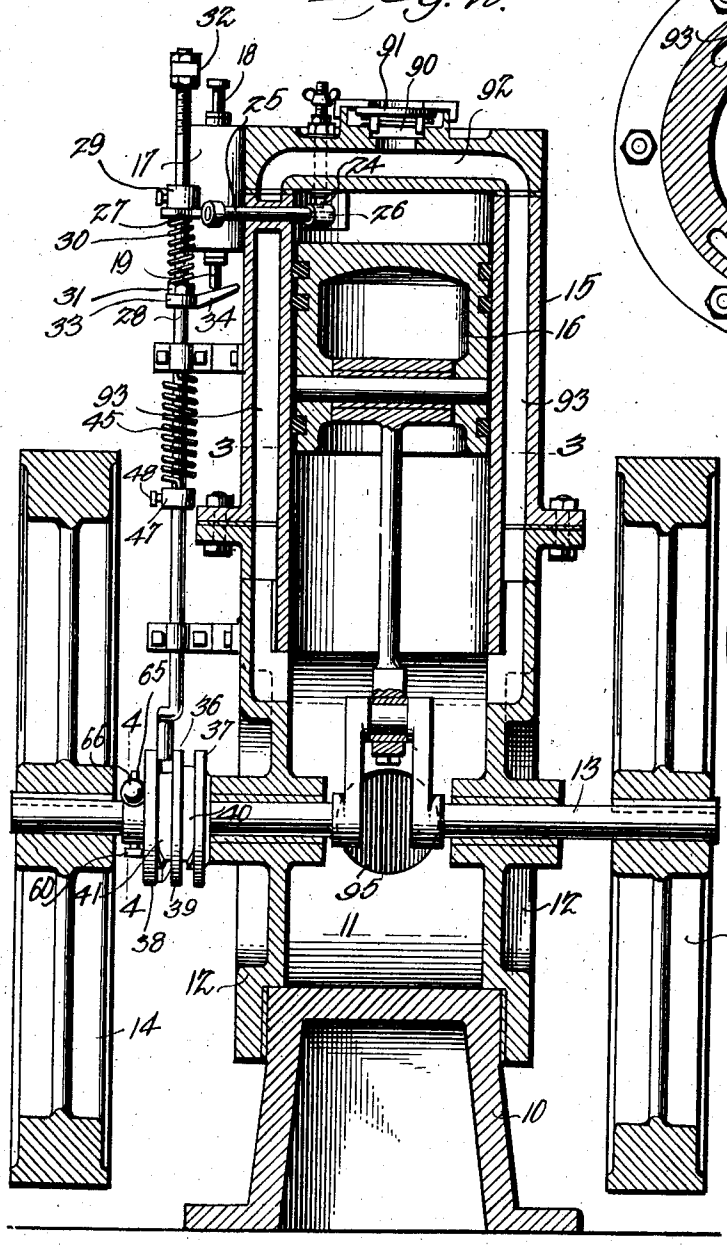


Fig. 3.

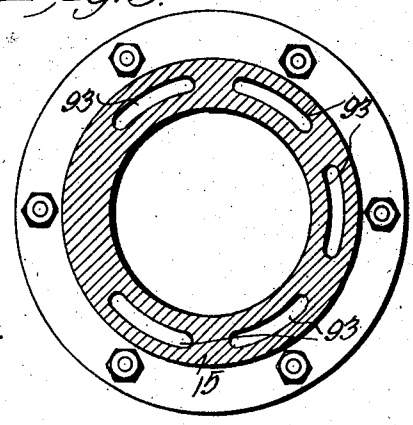


Fig. 4.

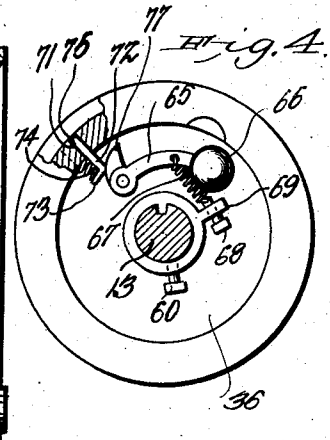
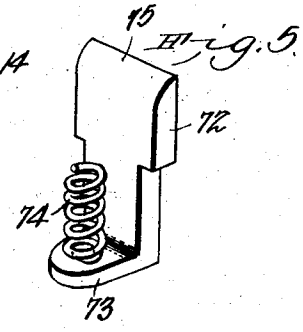


Fig. 5.



Witnesses
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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 6.

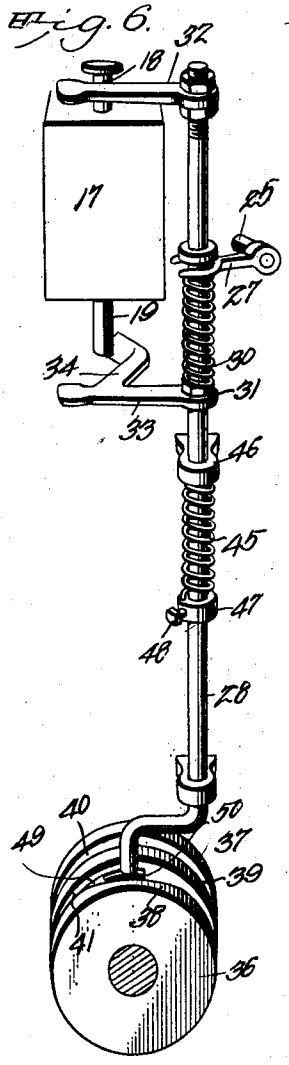


Fig. 7.

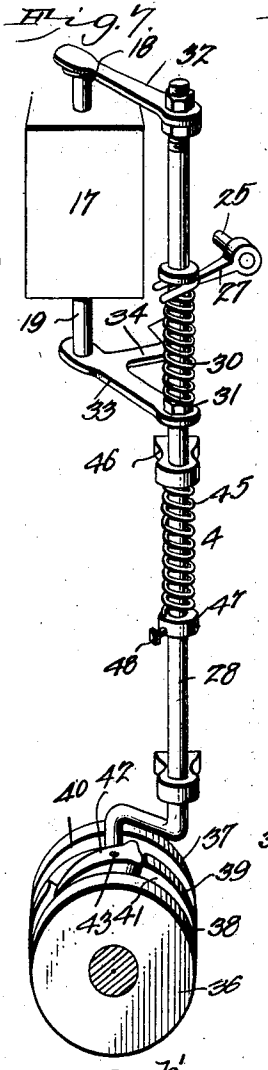


Fig. 8.

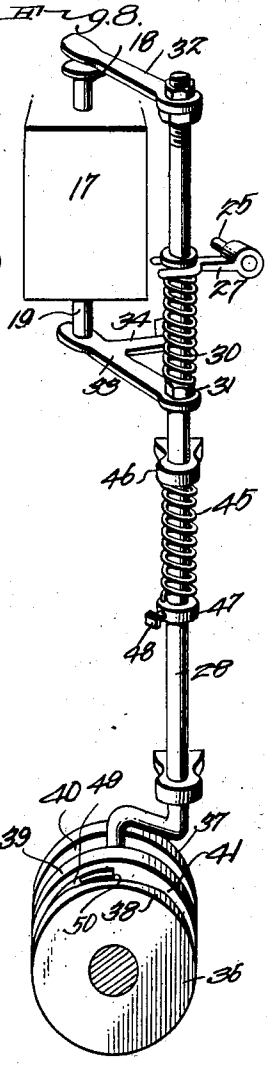
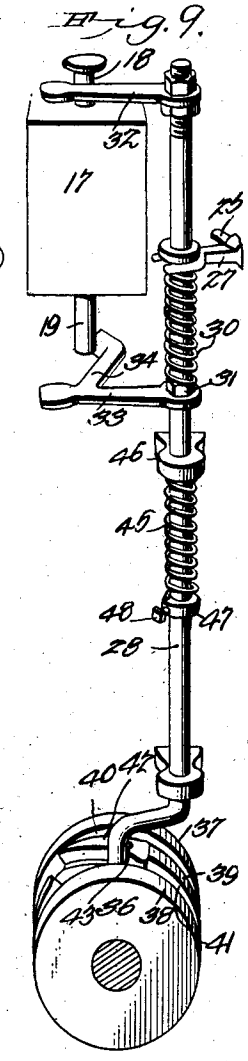


Fig. 9.



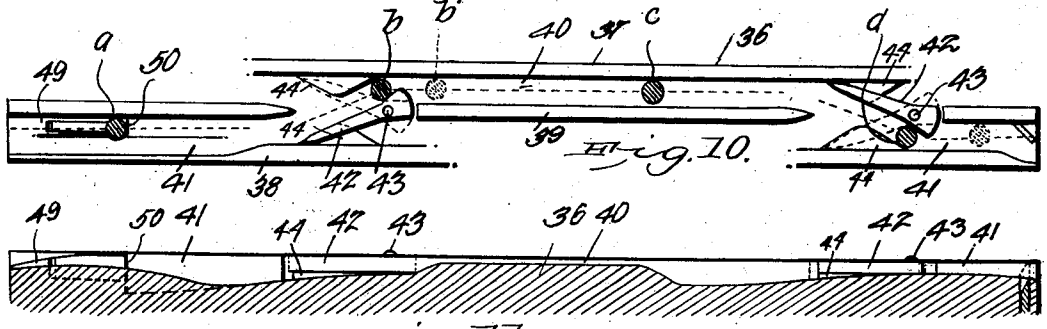


Fig. 10.

Fig. 11.

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No. 739,219. Patented September 15, 1903.

UNITED STATES PATENT OFFICE.

JOHN H. REDFIELD, OF SPOKANE, WASHINGTON, ASSIGNOR OF ONE-HALF TO CHARLES GRUTT, EMIL GRUTT, AND FRED GRUTT, OF SPOKANE, WASHINGTON.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 739,219, dated September 15, 1903.

Application filed April 30, 1902. Serial No. 105,385. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. REDFIELD, a citizen of the United States, residing at Spokane, in the county of Spokane and State of Washington, have invented a new and useful Explosive-Engine, of which the following is a specification.

The invention relates to certain improvements in explosive-engines, and while many of its features of construction are applicable to engines of various types the engine is intended principally for use in the operation of drills or other tools in mines, tunnels, and similar places where engines of this character cannot ordinarily be employed, owing to the nature of the exhaust and the consequent vitiation of the air.

One object of the invention is to provide an improved form of mechanism for actuating the valves and sparking device, in which a single rod and cam serves to open both the inlet and the exhaust valves and to make and break the circuit through the sparking electrodes.

A further object of the invention is to provide for the automatic governing of the speed of the engine by moving the spark-actuating mechanism to inoperative position when the speed of the engine is increased above the normal, and, further, to assist in the reduction of an abnormal speed by automatically opening the exhaust port of the engine.

A still further object of the invention is to provide for the adjustment of the time of sparking without adjusting the position of the actuating-cam as a whole and without interfering with or disturbing the movements of the inlet and exhaust valves.

A still further object is to provide for the movement of the movable electrode into contact with the stationary electrode or plug immediately preceding an explosion and to maintain the same separated throughout all of the stroke of the engine until the next compression-stroke following an explosion.

A still further object of the invention is to provide an improved form of cam for actuating both the valves and the sparking device, said cam having operative portions arranged in different planes so that when the sparking mechanism is being actuated it becomes impossible to open the valves, and vice versa.

A still further object of the invention is to provide for the cooling of the cylinder by entirely inclosing the crank-chamber and employing it as a suction-inlet chamber, of which the lower or inner face of the trunk-piston forms the operative element, the air to cool the cylinder being drawn in through an opening in the head of the cylinder and thence through ports or passages situated in the wall of the cylinder and into the crank-chamber, from whence it is discharged, together with the products of combustion, through a pipe leading to the outer air.

With these and other objects in view the invention consists in the novel construction and arrangement of parts hereinafter described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims.

In the drawings, Figure 1 is a perspective view of an explosive-engine constructed in accordance with my invention, one of the balance-wheels being removed in order to more clearly show the construction and location of the valve and sparker-actuating cam. Fig. 2 is a longitudinal sectional elevation of the engine. Fig. 3 is a sectional plan view through the cylinder on the line 3 3 of Fig. 2. Fig. 4 is a transverse sectional elevation of the cam-ring and governor on the line 4 4 of Fig. 2 and drawn to a slightly enlarged scale. Fig. 5 is a detail perspective view of the governor-actuated deflecting-plate. Figs. 6, 7, 8, and 9 are perspective views in the nature of diagrams illustrating four positions of the cam and the parts operated thereby, the position shown being that assumed at the completion, respectively, of the compression, explosion, exhausting, and suction strokes of a four-cycle gas-engine. Fig. 10 is a diagrammatic view of the operating-cam, the curved face of the cam being developed on a plane. Fig. 11 is a diagram illustrating the construction of the cam in profile, the section indicated being taken on the line running through Fig. 10 and indicating the course of the actuating-rod. Fig. 12 is a detail view of a portion of the cam. Fig. 13 is a sectional elevation of the same.

Similar numerals of reference are employed

to indicate corresponding parts throughout the several figures of the drawings.

The engine is provided with a supporting-base 10, on which is bolted a crank-chamber 11, having removable heads 12, the latter being provided with suitable bearings for the support of a crank-shaft 13, having one or more fly-wheels 14, either or both of which may be used as belt-wheels. On top of the crank-casing is bolted a cylinder 15, in which is a trunk-piston 16, connected in the usual manner to the crank-shaft.

At one side of the cylinder is bolted a valve-chamber 17, formed in the usual manner and provided with inlet and exhaust valves, of which the stems are indicated at 18 and 19, respectively. This portion of the structure may be similar to that ordinarily followed in the construction of four-cycle engines and forms no part of the present invention. The explosive mixture is fed to the valve-chamber 17 through a supply-pipe 20, and the exhaust is led through a pipe 21 to a muffler 22, which may be of any ordinary construction, and from thence to the outer air in a manner more particularly described hereinafter.

In the upper portion of the explosive-chamber is an insulated sparking plug 24 of the usual construction and which may be connected to a source of electrical energy in the ordinary manner. In the side of the explosion-chamber is a bearing for the reception of a rock-shaft 25, to the inner end of which is secured a movable contact 26, which forms the opposing terminal of the circuit, the separation of the two electrodes resulting in the formation of an arc and the spark igniting the explosive mixture in the usual manner. To the opposite end of the rock-shaft, at a point outside the explosive-chamber, is secured a bifurcated arm 27, adapted to partially embrace the vertically-disposed actuating-rod 28. The rod is provided with an adjustable collar 29 for contact with the upper face of the arm 27, and bearing against the lower face of said arm is a compression-spring 30, having its lower end resting on a nut 31, adapted to a threaded portion of the rod and adjustable to increase or decrease the stress of the spring, as may be required. During a portion of the compression-stroke of the engine an upward movement is transmitted to the arm 27 through the medium of the spring 30, and the movable contact is pressed against the stationary electrode, the force exerted being yielding and permitting the employment of an inelastic contact-block, which will last for a much longer period than the elastic electrodes in common use.

On the threaded upper end of the rod 28 is an adjustable tappet-arm 32, movable into alinement with the stem of the inlet-valve and adapted to depress the stem to positively open the valve and hold the same in open position throughout the suction-stroke or through such portion thereof as it may be desired to admit explosive mixture to the cylinder. The tappet-arm may be adjusted vertically on the rod to permit of any desired degree of lost motion before the valve is opened, and thus to some extent govern the quantity of gas supplied to the cylinder.

Secured to the actuating-rod 28 is a second tappet-arm 33, adapted to engage with the stem 19 of the exhaust-valve and serving when the rod is elevated to open the valve and hold the same in open position throughout the exhaust-stroke of the engine. The tappet-arm 33 is provided with an arcuate finger 34, struck from a center coincident with the axis of the rod 28 and inclined upwardly, so that at times when the tappet-arm is turned to the position indicated in Figs. 6 and 9 this inclined portion will be directly under and in contact with the lower end of the stem 19.

On the main shaft of the engine is secured a cam 36, having three annular flanges 37, 38, and 39, forming two parallel cam grooves 40 and 41. A portion of the flange 39 at the center of the cam is cut away, and in the space thus formed is mounted a tongue 42 on a stud 43, said tongue acting as a switch for shifting the lower end of the vertical rod from one groove to the other. The outer end of the tongue is pointed in order to facilitate the movement of the actuating-rod, and its rear end is of considerable width, as indicated in the diagram Fig. 10, so that when the rod 28 is in the position *b* of Fig. 10, with the cam moving in the direction of the arrow, the contact with said rod with the butt of the switching-tongue will move the same to the dotted-line position (indicated at *b*) or the full-line position, (indicated at *d*,) the tongue then remaining in adjusted position to engage with and move the rod from the groove 40 to the groove 41 at the next complete rotation of the cam. To facilitate a switching of the rod, I arrange lugs 44 at the bottom of each groove at points near the switching-tongue, the tongue being movable over such lugs to assume either of its operative positions.

The lower end of the actuating-rod 28 is cranked and enters the cam-grooves, being pressed downwardly, so that its lower end comes into contact with the bottom of the groove by a spring 45, coiled around the rod and having one end connected to a perforated lug carried by the cylinder of the engine and also forming a bearing for the rod. The lower end of the spring is secured to a collar 47, which may be adjusted both circumferentially and longitudinally of the rod and locked in any adjusted position by a set-screw 48. The spring acts both as a compression and torsion spring, the downward tendency of the spring serving to keep the bottom of the rod in contact with the bottom of the cam-grooves, while the torque tends to maintain the tappet-arms 32 and 33 in the position indicated in Figs. 7 and 8.

In the outer groove 41 of the cam is placed an inclined flange 49, terminating in an ab-

rupt shoulder 50, this plane being the highest point of the cam and serving to elevate the rod when in the position indicated at *a* to an extent sufficient to force the movable contact into engagement with the stationary plug of the sparking device, and such contact occurs only immediately preceding the explosion, which occurs when the shoulder 50 has traveled beyond the rod and the latter is suddenly forced down by the spring 45 suddenly separating the two terminals and creating the spark. From this point to the position indicated at *b* in Fig. 10 and in Fig. 7 the engine is on the power or explosion stroke, the piston being driven outwardly by the expansive force of the gases and no further operative movement of the rod takes place, the rod being merely raised a trifle and shifted by the tongue 42 from the groove 41 to the groove 40. From the point indicated at *b* to the point indicated at dotted lines at *b'* the surface of the cam has an upwardly-tending incline, as shown in the profile. When the cam reaches this point, the piston is about starting on the exhaust-stroke and the rod is elevated to the position indicated in Fig. 8, opening the exhaust-valve and holding said valve open throughout the whole of the exhaust-stroke or until the position *c* is reached, at which point the rod descends and permits the closing of the exhaust-port, while the tappet-arm 32 engages with and depresses the stem 18 of the inlet-valve, moving said valve to open position and retaining the same in open position during so much of the suction-stroke as may be necessary to supply the required amount of explosive mixture. The rod at the completion of the suction-stroke reaches the position indicated at *d* and enters the groove 41 in the path of the inclined plane 49, which at the completion or near the completion of the compression-stroke elevates the rod and brings the movable contact against the stationary plug and completes the circuit prior to the production of the spark by the descent of the rod over the abrupt shoulder 50. This completes the cycle of operations.

The cam is secured to the shaft by a set-screw 60, so that it may be adjusted circumferentially to correspond to the position of the piston. It is desirable, however, to provide for the adjustment of the time of sparking independent of the valve movements, and in carrying out my invention I make the inclined plane 49 in two sections, as shown in Figs. 12 and 13, one of which, 49', is adjustable to increase or decrease the distance between the shoulder 50 and the tongue to any desired extent, and thus permit the separation of the electrodes and the production of the spark at any desired time in the compression-stroke. In this manner the speed and power of the engine may be regulated, and the expansive qualities of the gases utilized to the fullest extent.

In order to govern the speed of the engine, I employ a pivoted arm 65, carried by the cam and provided with a weight or ball 66, movable by centrifugal force in the direction of the periphery of the cam. The arm is connected by a tension-spring 67 to an adjustable screw 68, carried by a lug 69, projecting from the hub of the cam, the tension of the spring being adjusted to regulate the sensitiveness of the governor and in accordance with any desired speed which the operator may wish to maintain. In the cam is a radial opening 71 for the reception of a deflecting-blade 72, having a lower step 73, between which and the flanged portion of the cam is a compression-spring 74, normally tending to force the blade inwardly in the direction of the shaft and to keep its outer edge even with or below the bottom of the groove 41. The acting-face of the plate is curved, as indicated at 75, and the plate is set in the groove at an angle of forty-five degrees or thereabouts to the line of movement of the cam and in the path of the lower end of the actuating-rod 28. When the speed of the engine increases above the normal, the governor-ball is moved outwardly by centrifugal force and the cam 77, near its inner end, engages with the lower portion of the deflector-plate and projects the latter into the slot 41. As the cam travels the lower end of the rod will be struck by the plate and deflected from the inclined plane 49, which, as shown, occupies only the inner half of the groove, the latter being somewhat widened at this point to permit the passage of the rod around the shoulder, and thus prevent the formation of a spark. At the same time the finger 34 will come into contact with the exhaust-valve stem, opening said valve and permitting the escape of the compressed gas contained within the cylinder.

The engine is provided with a pair of supporting arms or hangers 80, the lower ends of which are bolted to the exterior of the crank-casing, and these arms are connected or are formed integral at a point above the top of the cylinder and are secured to a hanger formed in the manner shown in Fig. 1. The hanger is a two-part clip, comprising an upper member 81, secured to the arms, and a removable member 82, which is bolted in position after the engine is raised and hung by the member 81 on the supporting-rod 83. In this manner the engine may be elevated above the floor of the mine or tunnel to permit the passage of cars or workmen, and it may be braced in any suitable manner, either from the side walls of the tunnel or from the floor.

In order to cool the cylinder, I provide in the cylinder-head a port or passage 90, closed by an inwardly-opening check-valve 91. This opening communicates with a number of ports or passages 92, formed in the cylinder-head and communicating in turn with vertically-disposed ports 93, formed in the wall of the cylinder and terminating at the upper portion

of the closed crank-chamber 11. The construction is such that on the upstroke of the piston during the compression and exhaust of the gases a partial vacuum will be created in the crank-chamber and air will be drawn through the opening 90 and downwardly through the ports 92 and 93 to cool the cylinder. This air enters the crank-chamber and on the downstroke of the piston is forced out through a pipe 95, having an outwardly-opening check-valve 96. The pipe 95 is led directly to the outer air, so that a portion of the air in the tunnel or mine is constantly being pumped to the surface of the ground and must be replaced by fresh air from without, thus creating a natural circulation and at all times keeping up a constant supply of fresh air.

The exploded gases are led from the lower portion of the muffler through a pipe 97 to the air-exhaust pipe 95, the connecting pipe 97 being provided with an outwardly-opening check-valve 98, so that none of the exploded gases can enter the tunnel or mine and vitiate the air. As a further means of inducing the circulation the muffler may be provided with one or more pipes 99, having inwardly-opening check-valves 100 and a controlling-valve 101 to permit the flow of a quantity of fresh air into the muffler, there to mingle with the exploded gases and be carried off through the air-exhaust pipe 95.

While the construction herein described, and illustrated in the accompanying drawings is the preferred form of the device, it is obvious that various changes in the form, proportions, size, and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

Having thus described the invention, what I claim is—

1. The combination with a gas-engine having inlet and exhaust valves, of a movable rod having tappet-arms adapted to engage the stems of both valves to effect an opening movement thereof, the lower end of the rod being cranked and a cam engaging the cranked end of said rod to effect both a rocking and reciprocatory movement thereof.

2. The combination with a gas-engine having inlet and exhaust valves, of a movable rod, tappet-arms carried by the rod and adapted to be moved into engagement with the stems of both valves, there being a cranked portion at one end of said rod, a cam adapted to engage the cranked portion of the rod to effect both a rocking and reciprocatory movement thereof, and a combined compression and torsion spring encircling the rod and tending to resist the operative movement imparted by the cam.

3. The combination with a gas-engine having inlet and exhaust valves, of a rod having a cranked portion at one end, a pair of adjustable tappet-arms carried by the rod and movable into engagement with the stems of said valves, guides carried by the frame of the engine and supporting said rod, a grooved cam mounted on the main shaft of the engine and engaging the cranked portion of the rod to effect both a rocking and reciprocatory movement thereof, and a combined torsion and compression spring encircling the rod and tending to resist the operative movement imparted by the cam.

4. The combination with a gas-engine having a valve-operating rod and provided with a stationary sparking plug, of a movable contact arranged adjacent to said plug, a rock-shaft carrying said movable contact, an arm secured to the rock-shaft and having a bifurcated portion partly encircling the rod, a collar carried by said rod for engagement with said bifurcated arm, a compression-spring carried by the rod and adapted to engage the opposite side of said bifurcated arm, and an actuating-cam having an abrupt shoulder to permit a longitudinal movement of said rod to effect the separation of the movable terminal from the plug.

5. The combination with a gas-engine, having a valve-operating rod and provided with a stationary sparking plug, of a movable contact arranged adjacent to said plug, a rock-shaft carrying said movable contact, a bifurcated arm secured to the rock-shaft and partially encircling the rod, a collar carried by the rod for engagement with one face of said arm, a spring carried by the rod and engaging the opposite face of said arm, a cam engaging the rod and provided with an abrupt shoulder adapted to pass under the end of the rod, and a compression-spring tending to move said rod in the direction of the cam to separate the movable terminal from the plug.

6. The combination with a gas-engine having a valve-operating rod and provided with a stationary sparking plug, of a movable contact arranged adjacent to said plug, a rock-shaft carrying said movable contact, a bifurcated arm secured to the rock-shaft and partially encircling the rod, a collar carried by the rod for engagement with one face of said arm, a compression-spring encircling the rod and engaging the opposite face of said arm, a cam adapted to actuate the rod to effect an opening movement of the valve, a shoulder forming part of said cam and adapted to effect a closing movement of the movable contact, and a spring for moving said rod in the direction of the cam to break the contact between the movable contact and the plug.

7. The combination with a gas-engine having inlet and exhaust valves and provided with a movable contact forming one element of the sparking device, a rod adapted to operate both of the valves and the movable contact, and a cam for actuating said rod.

8. The combination with a gas-engine having inlet and exhaust valves and provided with a movable contact forming one element

of the sparking device, of a rod operably connected to said movable contact and provided with tappet-arms for engaging the stems of the valves, and a cam adapted to impart both a rocking and a reciprocatory movement to said rod.

9. The combination with a gas-engine having inlet and exhaust valves and provided with a movable contact forming one element of the sparking device, of a rod having a yielding connection with the movable contact, tappet-arms secured to said rod and adapted to engage with the stems of both valves, and a cam adapted to impart both a rocking and a reciprocatory movement to said rod.

10. The combination in a gas-engine having inlet and exhaust valves and provided with a movable contact forming one element of the sparking device, of a rod connected to the movable contact, tappet-arms secured to said rod and adapted to engage with the stems of both valves, and a cam having a pair of parallel annular grooves for the reception of the rod, and means for moving the rod from one groove to the other.

11. The combination with a gas-engine having inlet and exhaust valves, and provided with a movable contact forming one element of the sparking device, of a spring-pressed rod having tappet-arms for engagement with the stems of the valves, means for connecting the rod to the movable contact, means for reciprocating said rod, and means for rocking the rod to move said tappets to inoperative position when the sparking device is to be actuated.

12. The combination with a gas-engine having inlet and exhaust valves, and provided with a movable contact forming one element of the sparking device, of a rod having a yielding connection with the movable contact, tappet-arms carried by said rod for contact with the stems of the valves, means for reciprocating the rod to effect a movement of the valve and the movable contact, and means for moving the tappet-arms out of alinement with the valve-stems during the operative movement of the movable contact.

13. The combination with a gas-engine having inlet and exhaust valves, and provided with a movable contact forming one element of the sparking device, of a rod adapted to actuate the valves and movable contact, a cam having a pair of parallel annular grooves, in one of which is a cam-surface for effecting the operation of the valves, and in the other a cam-surface for effecting the operation of the sparking device, and means for shifting the rod from one groove to the other.

14. The combination with a gas-engine having inlet and exhaust valves, and provided with a movable contact forming one element of the sparking device, of a cam-actuated rod having an operative connection with the movable contact, tappets carried by the rod and adapted to engage the valve-stems, a cam having a pair of annular grooves for the reception of the lower end of the rod, the cam-surface in one of such grooves being arranged to effect the opening movement of the inlet and exhaust valves during the suction and exhaust stroke respectively, and the cam-surface in the second groove being adapted to effect first a closing of the circuit through the sparking device and then an abrupt movement of the movable contact to break the circuit.

15. The combination in a gas-engine having a stationary sparking plug, of a movable contact located adjacent to said plug, a cam having an operative portion for making and breaking the circuit between the plug and contact, a rod extending between the cam and contact, and means for deflecting the rod from the path of the operative portion when the speed of the engine is increased above the normal.

16. The combination with a gas-engine having a stationary sparking plug, of a movable contact, an actuating-rod connected thereto, an operating-cam engaging said rod and having an operative portion for effecting the opening and closing of the circuit through the sparking device, and means for automatically deflecting the rod from such operative portion of the cam when the speed of the engine is increased above the normal.

17. The combination with a gas-engine having a stationary sparking plug, of a movable contact, an actuating-rod connected thereto, an operating-cam engaging said rod and having an operative portion for effecting the opening and closing of the circuit through the sparking device, a deflecting-plate carried by the cam, and a governor for moving said plate into position to engage the rod when the speed of the engine is increased above the normal.

18. The combination in a gas-engine, of the sparking plug, a movable contact adjacent thereto, an actuating-rod connected to the movable contact, a rotatable cam engaging the lower end of said rod and having an operative portion for effecting a longitudinal movement of the rod, a deflecting-plate guided in said cam, and a governor carried by the cam and operatively connected to said deflecting-plate.

19. The combination in a gas-engine, of the sparking plug, a movable contact adjacent thereto, an actuating-rod connected to the movable contact, a rotatable cam engaging the lower end of said rod and having an operative portion for effecting the longitudinal movement of the rod, a deflecting-plate adapted to a slotted opening in said cam, a governor carried by the cam and adapted to force the deflected plate into the path of the rod when the speed of the engine is increased

above the normal, and a spring for returning the deflector-plate to inoperative position when the speed is decreased.

20. The combination in a gas-engine, of the exhaust-valve having a stem, a rod, a tappet-arm secured thereto and movable into contact with the stem of the valve, an arcuate upwardly-extending finger carried by the tappet and also movable into engagement with the valve-stem, a cam for imparting both a rocking and a reciprocatory movement to the said rod, and a governor-actuated deflector carried by the cam and movable into contact with said rod to thereby increase the degree of angular movement of the rod and move the valve to open position by the engagement of the said inclined finger with the valve-stem.

21. The combination in a gas-engine, of the exhaust-valve having a stem, a rod, a tappet-arm secured thereto and movable into contact with the stem of the valve, an upwardly-extending finger carried by the tappet and also movable into engagement with the stem of the exhaust-valve, a governing device adapted to move said finger to a point below the exhaust-valve stem, and an actuating-cam having an operating portion for engagement with the lower end of the rod to effect an upward movement of the finger when moved into proper position by the governor.

22. The combination in a gas-engine, of the exhaust-valve having a stem, a rod, a finger carried by the rod, a governor adapted to move the rod and finger to adjust the latter to a position below the exhaust-valve stem when the speed of the engine increases above the normal, and a cam having an operating portion adapted to engage said rod and elevate the rod and finger to open the exhaust-valve.

23. The combination in a gas-engine, of the exhaust-valve having a stem, an operating-cam adapted to be connected to said stem to effect an opening movement of the valve, and a governor-controlled means for adjusting the relative positions of the cam and its connections to effect an opening movement of the exhaust-valve when the speed of the engine is increased above the normal.

24. The combination in a gas-engine, of the exhaust-valve having a stem, a rod, a tappet carried thereby, a finger carried by said tappet and movable into operable relation with the valve-stem, a cam with which the lower end of the rod engages, a governor carried by the cam, and a deflector-plate carried by the cam and movable by the governor into the path of the rod.

25. The combination in a gas-engine, of the exhaust-valve having a stem, a rod, a finger operatively connected to the rod and movable to a position below the said stem, an operating-cam, a centrifugal governor carried by the cam, a deflector guided by an opening in the cam and movable into the path of the rod to vary the position of the rod in accordance with the speed of the engine.

26. The combination in a gas-engine, of a cam having operating portions projecting to different distances from the center of rotation of the cam, a valve, a sparking device, an operating-rod connected to both the valve and the sparking device and bearing against the cam, and a governor carried by said cam for determining which of the cam-operating surfaces shall come into contact with the rod.

27. The combination in a gas-engine, of a cam having operating portions projecting to different distances from the center of rotation of the cam, a valve, a sparking device, an operating-rod connected to both the valve and the sparking device and bearing on the cam, a deflector-plate carried by the cam, and a governing device adapted to move said deflector-plate into the path of the rod, substantially as specified.

28. The combination in a gas-engine, of the exhaust-valve, a sparking device, a rod operatively connected to a movable member of the sparking device, a tappet-arm carried by the rod and movable into and out of operable relation with the stem of the exhaust-valve, a finger carried by said tappet-arm and adapted for similar movement, a cam adapted for contact with the rod and having actuating-surfaces of varying form, and a governor-operated deflector carried by the cam for determining the position of the tappet and the finger.

29. A governing mechanism for gas-engines comprising in combination, a revoluble cam, a centrifugal governor carried by the cam for determining the degree of operative movement thereof, a rod extending from the cam to the sparking device and movable by the governor to inoperative position with respect to the spark-actuating surface of the cam when the speed of rotation of said cam is above the normal, and an exhaust-valve-operating finger movable into operable relation to the exhaust-valve for effecting the opening movement of said exhaust-valve, substantially as specified.

30. The combination with a sparking device having a movable contact, of a rod connected to said contact, a cam in engagement with the rod and having a shoulder adapted through the rod to first effect a closing movement of the movable contact and then an abrupt opening movement of the same, and a governor-actuated deflector carried by the cam and movable into the path of the rod to deflect the same from contact with said shoulder when the speed of rotation of the cam is above the normal.

31. The combination with a sparking device having a movable contact, of a rod connected to said contact, a cam in engagement with the rod and having a shoulder for effecting a reciprocating movement of said rod to close and open the sparking circuit by effecting a movement of the movable contact, a deflecting-plate having a rounded contact-face

movable into and out of the path of the operating-rod, a governor carried by the cam and adapted to move said deflector-plate in one direction, and a spring for effecting the movement of the plate in the opposite direction.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

JOHN H. REDFIELD.

Witnesses:
FRANK S. APPLEMAN,
JNO. E. PARKER.