

(No Model.)

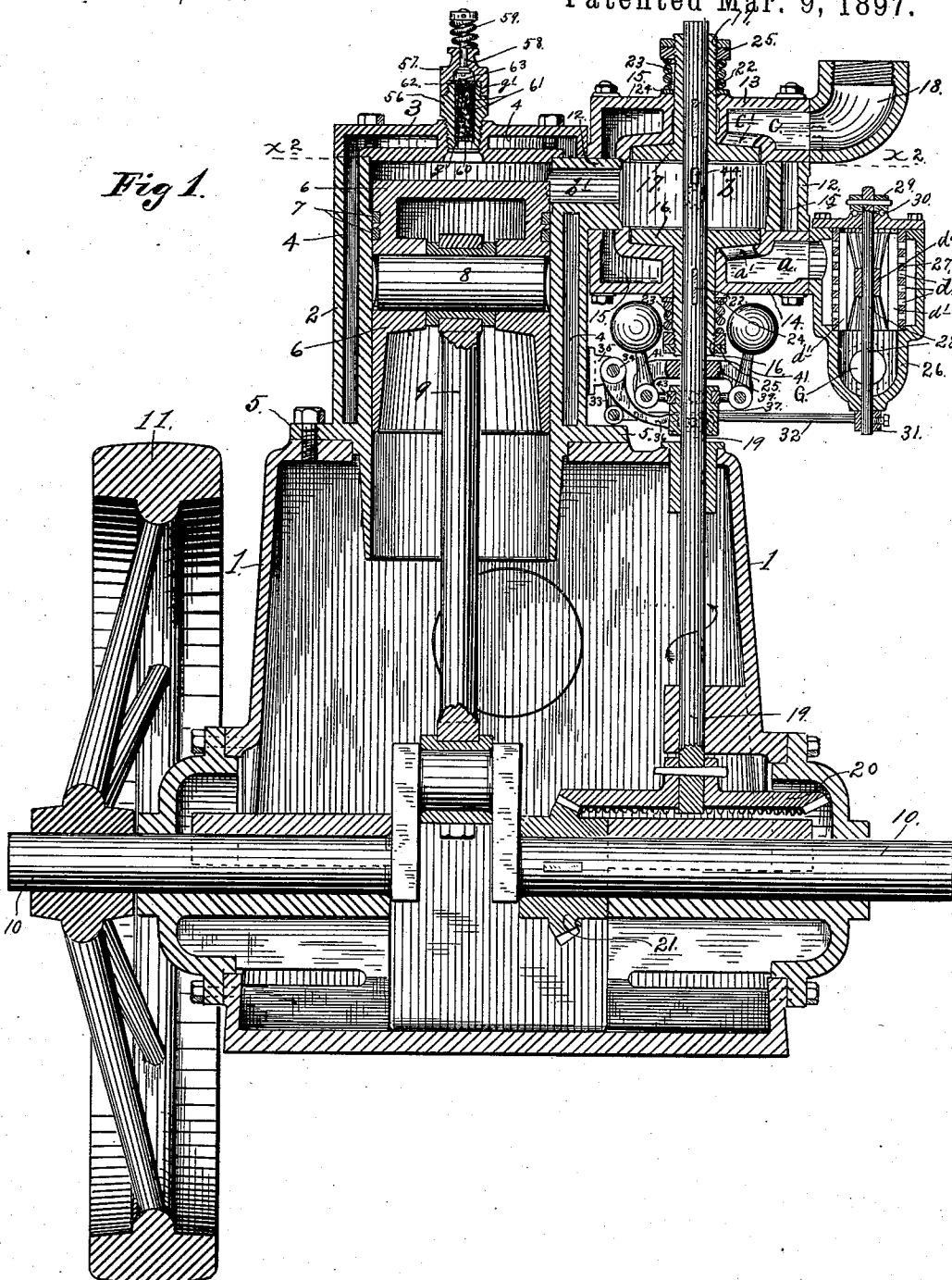
3 Sheets—Sheet 1.

J. WALRATH.
EXPLOSIVE ENGINE.

No. 578,377.

Patented Mar. 9, 1897.

Fig 1.



Witnesses.

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Inventor
Jesse Walrath

By his Attorney
Jas. F. Williamson

(No Model.)

3 Sheets—Sheet 2.

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Fig. 2.

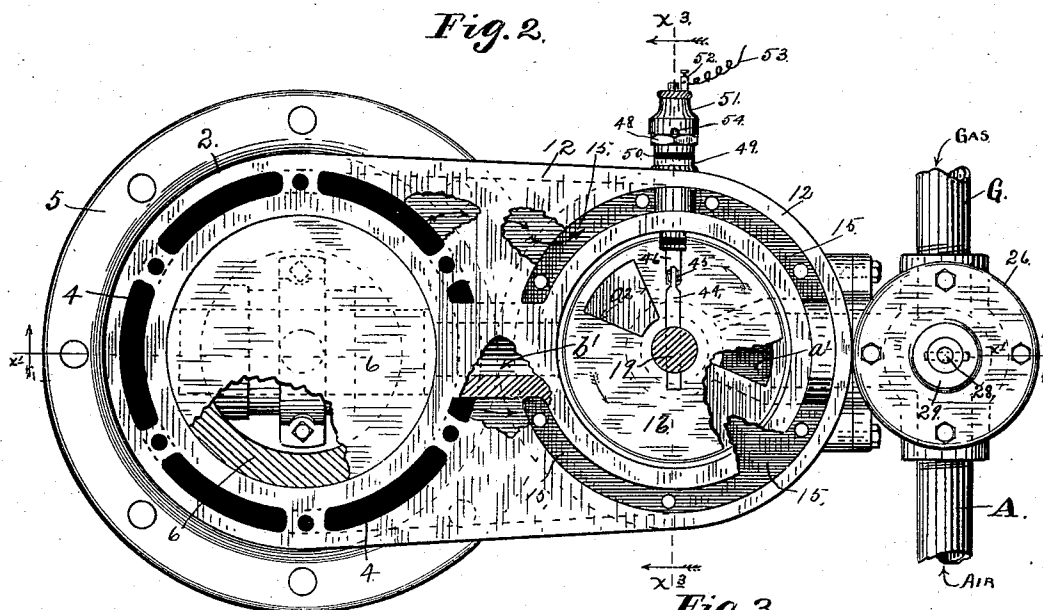


Fig. 3.

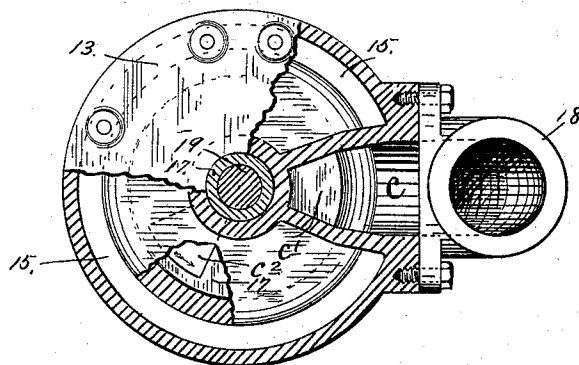


Fig. 4.

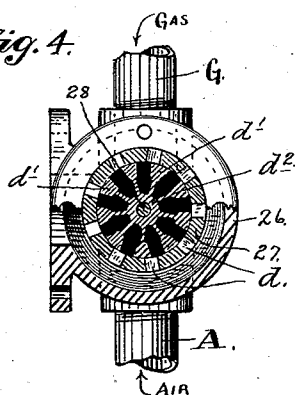


Fig. 5.

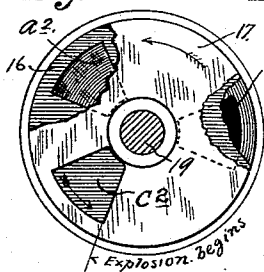


Fig. 6.

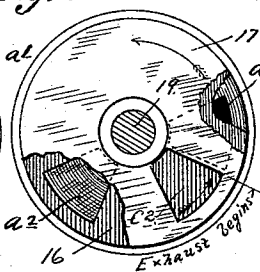


Fig. 7.

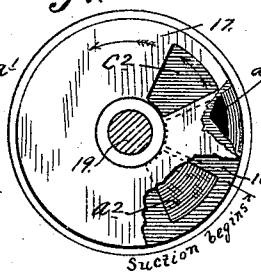
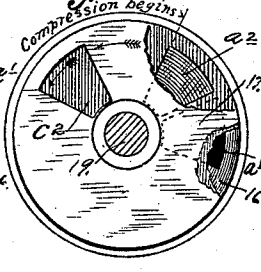


Fig. 8.



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3 Sheets—Sheet 3.

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Fig. 10.

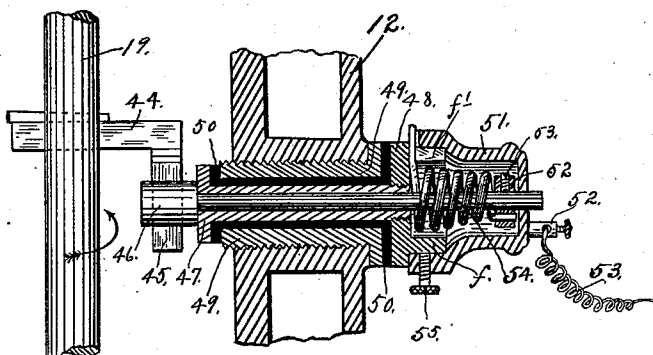


Fig. 12.

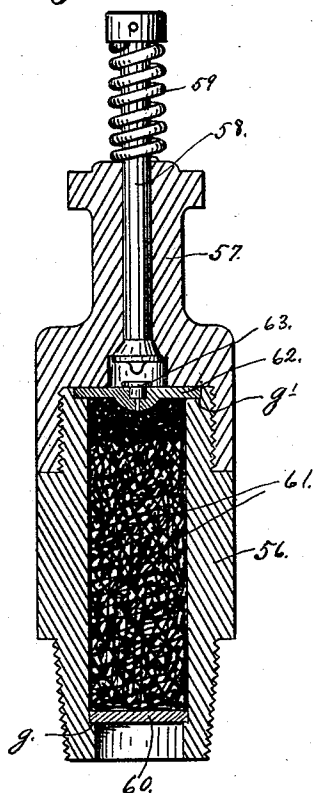


Fig. 11.

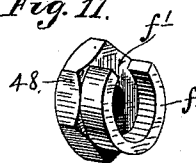
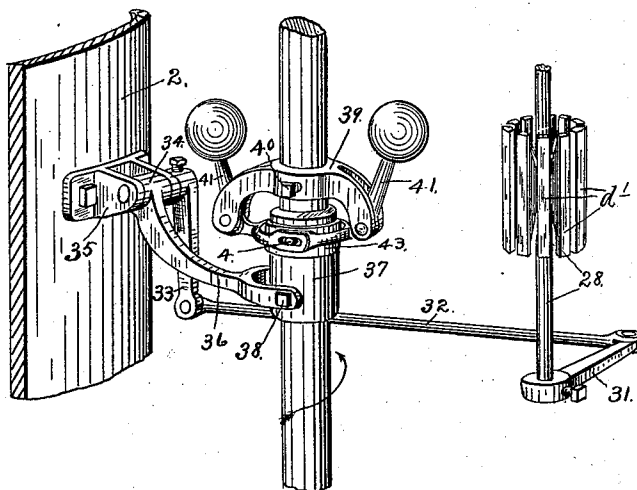


Fig. 9.



Witnesses.

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UNITED STATES PATENT OFFICE.

JESSE WALRATH, OF RACINE, WISCONSIN.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 578,377, dated March 9, 1897.

Application filed January 6, 1896. Serial No. 574,418. (No model.)

To all whom it may concern:

Be it known that I, JESSE WALRATH, a citizen of the United States, residing at Racine, in the county of Racine and State of Wisconsin, have invented certain new and useful Improvements in Explosive-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to explosive-engines, such as gas and oil engines, and has for its object to improve the construction with a view of increased efficiency.

15 To this end my invention is directed to the valve-gear, to the governor-controlled valve, to the igniter, and to the starter.

The several features of my invention will be hereinafter fully described, and defined in 20 the claims.

The invention is illustrated in the accompanying drawings, wherein, like notations referring to like parts throughout the several views—

Figure 1 is a vertical central section through a vertical engine on the line $x'x'$ of Fig. 2 or substantially in the plane of the horizontal crank-shaft, looking outward or toward what is ordinarily regarded as the front of the engine. With the parts arranged as shown the crank-shaft turns toward the observer facing Fig. 1. Fig. 2 is a view chiefly in plan, but partly in section, on the line x^2x^2 of Fig. 1, or, in other words, with the cylinder-head and the upper or cap section of the valve-chest and the upper or exhaust valve removed and with some parts broken away. Fig. 3 is a view, partly in plan and partly in section, of the cap-section of the valve-chest and the top or exhaust valve detached, with some parts broken away. Fig. 4 is a view, partly in plan and partly in section, of the commingling chamber or casing for the governing-valve and its seat detached, with some parts broken away. Figs. 5 to 8, inclusive, are plan views of the two disk valves which control the admission and exhaust of the explosive mixture as they would appear at the beginning of the four different actions involved in the cycle, some parts being broken away and some parts being shown in section. Fig. 9 is a perspective view showing the relation and connection

tions of the governing-valve to the governor and the valve-gear shaft. Fig. 10 is a detail of the igniter, showing the same in vertical section on the line $x^3 x^3$ of Fig. 2, with most of the parts of the engine broken away. Fig. 11 is a perspective of one of the details of the igniter, and Fig. 12 is a longitudinal central section of the starter detached.

On a suitable base 1 is mounted in an upright or vertical position the engine-cylinder composed of the body-casting 2 and the head-casting 3, which unite with a tight joint and are both constructed with double walls spaced apart to form a circulating chamber or jacket 4 for the cooling-water. The double walls of the cylinder-body 2 extend downward to the flange 5, which rests upon the top of the base 1, and is securely bolted or otherwise made fast thereto, while the inner wall or cylinder proper of the body-casting extends farther downward into the interior of the hollow base-casting 1 and is open at its lower end, as shown in Fig. 1. The cylinder is fitted with a trunk-piston 6 of the proper length to serve also as a cross-head for the connecting-rod and provided near its upper end with a pair of packing-rings 7. The piston 6 connects directly, by means of cross-head pin 8 and main rod 9, with the crank of the engine-shaft 10. The said crank or engine-shaft 10 is horizontally disposed in the base-casting 1 on suitable bearings forming a part of or secured to the said base. The engine-shaft projects outward beyond the side walls of the base and is provided with a pair of combined balance wheels and pulleys 11, one at each end of the shaft, but only one of which is shown in the drawings.

The cylinder-body casting 2 has formed integral therewith a double-walled hollow casting 12, which projects laterally from the said cylinder-casting at one side thereof in a horizontal position, and serves as the central or body section of a combined valve-chest and explosion-chamber, the other parts of which are formed by a double-walled cap-section casting 13 and a double-walled base-section casting 14, which are bolted or otherwise made fast to the body-section 12 with tight joints, as shown in Fig. 1. When the said parts 12, 13, and 14 are thus secured together, they form a chamber *b*, which is in communication with the cylinder-bore through a passage *b'*, tap-

ping the cylinder-bore at or near the upper end of the same, and the double walls of the said castings 12, 13, and 14 are spaced apart to form a circulating space or jacket 15 for the cooling water, which is in communication with the circulating-space 4, which surrounds the cylinder, as is best shown in Fig. 2.

The casting 14 is provided with a suitable inlet-passage *a* for the explosive material leading to a port *a'* through the inside member of the bottom walls of said casting, which is of proper form to serve as a seat for the inlet or admission valve 16. This valve 16 is of disk-like form, is located within the chamber *b*, is spring-seated outward against its seat, and provided with a port *a''* for co-operation with the port *a'* to admit the mixture to the chamber *b*. The top casting 13 is provided with an outlet or exhaust passage *c*, leading to the exhaust-pipe 18, and the inside plate of its double top wall is provided with an outlet or exhaust port *c'*, which coöperates with the port *c''* in the exhaust-valve 17. The said valve 17 is similar in form to the valve 16, is located within the said chamber *b* and spring-seated outward against its seat. The said admission and exhaust valves 16 and 17 are both provided with hollow or sleeve-like stems, numbered the same as the valves themselves, which extend outward through suitable passages in the respective castings 13 and 14, and are mounted on a common valve-gear shaft 19, which extends entirely through the combined valve-chest and explosion-chamber castings in a vertical position or parallel with the cylinder-axis. The said valve-gear shaft 19 extends into the base-castings through suitable bearings therein, and is provided at its lower end with a beveled gear 20, which engages with the beveled pinion 21 on the crank or engine shaft 10. These gears 20 and 21 are of the proper size to require two revolutions of the engine-shaft to turn the gear-shaft 19 one revolution.

The valves 16 and 17 are connected to the gear-shaft 19 for rotation therewith, but with freedom for sliding motion thereon, which connection is, as shown, afforded by suitable feathers 22 on the shaft-engaging grooves (not shown) in the hollow valve-stems. The stems of the said valves, outward of the castings 13 and 14, are encircled by springs 23, which react against suitable washers 24, resting on the castings, and the inner members of pairs of double nuts 25, having screw-threaded engagement with the valve-stem. The said springs 23 thus applied tend to hold the valves 16 and 17 in their outermost or seated positions, and the said nuts 25 afford a means for adjusting the tension of the said springs 23 whenever so desired. The said valves 16 and 17 are so set in respect to each other on the shaft 19 that their respective ports *a''* and *c''* will stand on the quarters with respect to each other, as may be readily seen on reference to Figs. 5 to 8, inclusive.

The inlet-passage *a* in the casting 14 con-

nects with a casing 26, shown as bolted to the central casting 12 of the combined valve-chest and explosion-chamber in an upright or vertical position. This casing or casting 26 is provided with a cylindrical valve-seat 27, fixed therein in an upright position and with a rotary valve 28, mounted within the said cylindrical seat. The said valve-seat 27 is provided with a multiplicity of openings or passages *d*, which are arranged in a series of parallel rows lengthwise of the said cylinder, and the valve 28 is provided with a series of radial wings or headed arms *d'*, one for each of the said rows of openings *d* in the seat. The radial wings *d'* of the valve 28 are spaced apart from each other in the same way or to the same extent as the rows of openings *d* in the seat and are supported from a common hub *d''* on the valve-stem in such a way as to afford the utmost clearance between the said arms or wings and on the interior of the circle formed thereby. Otherwise stated, the said valve 28 is practically a hollow valve, affording the free passage of the fluid throughout all parts of the valve and permitting the same to escape therefrom uniformly through the openings *d* whenever so permitted by the proper movement of the valve wings or heads *d'*. The casing 26 is provided below the valve-seat and the body of the valve, as shown, with suitable inlets A and G for the air and the gas or vaporized oil, respectively. The said casting 26 therefore constitutes a commingling-chamber for the air and gas or the air and vaporized oil, and the supply of the said mixture when thus commingled is controlled by the coöperation of the valve-seat 27 and the governing-valve 28 above described. The special construction of the said valve 28 and its seat 27 permits the control, according to load, to be effected by an extremely small movement of the said valve. This is due of course to the multiplicity of openings in the seat, which are controlled by the radial wings of the valve, inasmuch as, in virtue of this construction, a very small movement of the valve will make a comparatively large difference in the total area of openings uncovered or covered, according to the direction of the valve's movement. The upper protruding end of the stem of the valve 28 is provided with a head 29, keyed or otherwise made fast thereto, which rests on ball-bearings 30, seated between the said head 29 and a suitable boss on the top or cap plate of the casing 26. The weight of the valve 28 is therefore taken on the ball-bearings 30, and as the valve is a balanced valve it is easy to move, or, otherwise stated, is extremely sensitive to control from the governor.

The lower projecting end of the valve-stem 28 is provided with a crank-arm 31, which is connected by rod 32 with the outer arm 33 of a rocker 34, journaled in a suitable bearing 35, secured to the cylinder-body casting 2. The other arm 36 of the said rocker is forked to embrace the governor-sleeve 37 and is con-

nected thereto by screw-bolts 38 or in any other suitable way. The governor-yoke 39 is made fast to the gear-shaft 19 by set-screw 40 or otherwise, and the inner arms of the ball-levers 41, carried by the said yoke, are forked and slotted, as best shown in Fig. 9, and the coincident or lapping slots thereof engage pins 42 on a collar 43, which is loosely mounted with freedom for rotary motion in a suitable groove or seat, formed in the sleeve 37. This construction affords a suitable mounting for the governor on the valve-gear shaft 19, which will permit the necessary vertical movement of the sleeve 37 under the centrifugal action on the balls, without requiring the sleeve 37 to turn on the shaft 19. The vertical movement of the said sleeve 37 will be converted into a rocking motion on the governing-valve 28 through the connections 31 to 38, inclusive, hitherto noted. The said governing-valve 28 will therefore be controlled by the centrifugal governor for varying the supply of the explosive mixture, according to the load on the engine. The centrifugal governor is shown as mounted on the valve-gear shaft 19, but it will of course be understood that it might be mounted on the engine-shaft 10 or the wheels 11.

For exploding the mixture at the proper times within the explosion-chamber *b* I employ an electric igniter with its electrodes within the said chamber and one member thereof carried by the valve-gear shaft 19. This electric igniter differs in certain features of improvement over the prior art, so far as known to me, which details of difference or improvement will be readily understood on reference to Figs. 10 and 11 of the drawings. The wiper or rotary member 44 of the electrodes is adjustably keyed to the shaft 19 in the ordinary way, and receives current from the engine, some part of which is connected to one pole of an electric battery or other source. The other electrode 45 is carried on the inner end of a spindle 46, which extends outward through the sleeve 47 and is made fast, by screw-threaded engagement, with a flanged nut 48. The sleeve 47 and the spindle or electrode stem 46, together with a cap 48 and the parts carried thereby, are separated from the screw-threaded holder 49 by a suitable bushing 50 of insulating material. The holder 49 is tapped into a thimble portion of the double-walled casting 12. On the flanged nut 48 is seated a cap 51, having binder-post 52, with wire 53 to one pole of the battery or source. On the spindle or electrode stem 46, within the cap 51, is a collar 52, adjustably secured thereto by set-screw 53 or other suitable means. A coiled spring 54, properly constructed for torsional action, encircles the stem 46 within the cap 51, and has its outer end made fast to the collar 52 and its inner end extended radially outward through a suitable passage *f'*, formed by the space between the ends of the incomplete or

cut-away annular flange *f* on the nut 48, and engaging with a suitable hole or seat in the cap 51. The cap 51 is free for rotary movement on the flanged nut 48, and may be held, wherever set, by a set-screw 55. With this construction of the igniter it is obvious that whenever the wiper-electrode 44, carried by the shaft 19, is made to engage with the spindle-electrode 45 the said spindle-electrode will be rotated for a limited movement against the torsional action of the spring 54, and that whenever the said contacts 44 and 45 separate, thereby producing the spark and firing the mixture, the spring 54 will instantly return the spindle-electrode into its normal position. It is also obvious that the conical spring 54 also serves to hold the electrode-spindle 46 in its outermost position, thereby insuring a tight joint between the headed inner end of the same and the headed inner end of the sleeve 47. Otherwise stated, the said conical spring 54 serves the double function of seating the electrode-spindle 46 and returning the same to its normal position after partial rotation thereof by the wiper-electrode 44. The relative construction of the flanged nut 48, cap 51, and the mounting of the spring 54 permits the tension of the said spring to be adjusted at will by rotating the cap 51 on the nut 48 and securing the same in any position desired by the thumb-screw 55. This form of igniter is further convenient in that all the parts thereof requiring attention are exposed to the eye and are readily accessible for the changes required.

I also provide an improved construction or form of starter, which will be readily understood by reference to Figs. 1 and 12.

The magazine 56 and the breech-block 57 are of a suitable construction to permit the same to be rigidly connected together or separated from each other at will. The breech-block is provided with the customary spring-seated striker or hammer 58, which is normally held in its outermost position by the spring 59. The magazine 56 is made of slightly-less bore at its cylinder or open end than throughout its body or loading-chamber proper, in order to provide a suitable shoulder or seat *g* for a paper disk or wad 60, which is placed in the said magazine before the same is charged with the powder 61 or other explosive material constituting the charge. The outer end of the magazine 56 is provided with a suitable seat *g'* for a permanent washer 62, composed of metal or other suitable material adapted for repeated permanent use. The said washer 62 is provided with a central perforation and seat for a fulminating-cap 63. After the magazine has been charged and a cap has been placed in the seat for the same in the washer 62 the said washer is applied to its seat *g'*. By then applying the breech-block 57 to the magazine 56 the said washer 62 will be securely clamped in proper working position, as best shown in Fig. 12. The magazine 56

is secured to the cylinder-head, as shown, by tapping the same into a thimble portion of the double-walled cylinder-head 3.

When the starter is charged, as above described, it is of course obvious that a stroke on the striker or hammer 58 will explode the cap 63 and fire the charge. The charge in the magazine is preferably composed of blasting-powder for its chief portion with a small portion of rifle-powder at its upper end or adjacent to the fulminating-cap. The form of starter above described is a material improvement over the prior art, so far as known to me. Hitherto it has been the custom to employ starters constructed to hold a gun-cartridge for the charge, and with this old form of starter it was necessary to provide a cock intermediate the cartridge and the engine-cylinder or explosion-chamber to prevent the products of combustion from entering the magazine of the starter and exploding the charge. With my improved starter, above described, such a cut-off cock is not required, as the paper disk or wad 60 affords sufficient protection to the charge.

All the parts of the engine which for the purposes of this case it is necessary to consider have now been specified. The operation is probably also apparent from the detailed description of the parts heretofore given, but may be briefly summarized as follows: Let it be assumed that the starter has been properly charged and that the piston has been brought into its uppermost position, or approximately into the position as shown, for example, in Fig. 1. The valve 16 and 17 will then be substantially in the position shown in Fig. 5, or, otherwise stated, be in position to close both the inlet and outlet ports to and from the explosion-chamber *b*. By then striking the hammer of the starter the charge from the starter will be fired and the explosion therefrom will be sufficiently powerful to impart one or more revolutions to the engine-shaft 10. During the first outward stroke of the piston under the force of the explosion from the starter the valves 16 and 17 will move from the position shown in Fig. 5 to the position shown in Fig. 6. During the first return stroke of the piston the said valves 16 and 17 will move from the position shown in Fig. 6 to the position shown in Fig. 7, or, in other words, the ports *c*² of the exhaust-valve 17 will cooperate with the port *c*¹ in its seat to afford an opening for the exhaust under the upward movement of the piston. Under the continued movement of the engine-shaft, due to momentum from the starter-explosion, the valve will move during the second outward stroke of the piston from the position shown in Fig. 7 to the position shown in Fig. 8, or, otherwise stated, the port *a*² of the inlet-valve 16 will cooperate with the port *a*¹ in its seat to permit the admission of the explosive material from the commingling-chamber 26 or the constant source under the suction-stroke of the piston. During

the second return stroke of the piston the valves 16 and 17 will move from the position shown in Fig. 8 to the position shown in Fig. 5, or, otherwise stated, the said valves will be so related to their seats as to confine the explosive material within the chamber *b* and the bore of the cylinder above the piston, so as to permit the said mixture to be compressed by the upward movement of the piston. As the piston reaches the upward limit of its said compression stroke the electrodes 44 and 45 of the igniter will separate to break the circuit and form the spark for exploding the compressed mixture. Thereafter the engine will continue to run under the supply of explosive material from the constant source, the cycle of movements for the piston and the valves 16 and 17 being the same as those before traced from the starter as a beginning. The action of the governor and governing-valve for controlling the supply of explosive mixture according to load has already been fully set forth.

From the foregoing description it must be obvious that the inlet and outlet of the explosive material is controlled in the most positive manner with an accurately-timed action and a delicate apportionment of quantity to load. It is also obvious that this work is accomplished by a simple construction and arrangement of parts which render all thereof which require attention readily accessible for adjustment and repair. The use of a combustion-chamber outside of the cylinder-bore is a radical improvement, not only for the purposes already noted, but for the further purpose of relieving the piston to some extent from the sudden and violent jar incidental to the initial effect of the explosion. Otherwise stated, it is thought that the violent initial jar from the explosion is taken chiefly on the walls of the combined explosion-chamber and valve-chest casting, and that when the pressure from the burning gases reaches the piston and cylinder it is more uniformly distributed than when the explosion-chamber is formed by a continuation of the cylinder-bore. Another point of advantage is that the debris from the explosion will collect chiefly in the explosion-chamber *b*, which is readily accessible for the removal of the same.

The details of the supporting-base 1 have not been specified; but it should perhaps be noted that the said base is preferably of such construction as to afford a receptacle for oil, which, under the action of the crank thereon and the inflow and outflow of air to the said base through a vent-pipe (not shown) under impulses imparted thereto by the piston, the necessary lubrication will be afforded to the piston, cylinder, and all the parts within the base.

The circulating connections for the cooling-water have not been shown, as they may be of any suitable kind.

It will be understood, of course, that the minor details of the construction disclosed

herein might be changed without departing from the spirit of my invention.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. In an explosive-engine, the combination with the cylinder and piston, of a combined explosion-chamber and valve-chest, outside the cylinder but communicating therewith, a valve-gear shaft extending through said chamber, a pair of disk valves on said shaft, within said chamber, connected thereto for rotation therewith but free to slide thereon, which valves are spring-seated against opposite walls of said chamber and control, respectively, one the admission and the other the exhaust of the explosive mixture, and an electric igniter operated by said shaft, substantially as described.

2. In an explosive-engine, the combination with the cylinder and piston, of the combined explosion-chamber and valve-chest, outside the cylinder but communicating therewith, the gear-shaft 19, driven from the engine-shaft and extending through said chamber, the disk valves 16 and 17, in said chamber, connected to turn with but free to slide on said shaft and having hollow stems projecting outward through the walls of said chamber, the springs 23 on said valve-stems, operating to seat said valves, coöperating ports in said valves and their seats, an electric igniter having its electrodes in said chamber with one thereof carried by said gear-shaft, and a governor with governing-valve controlling the supply of explosive mixture to said engine, according to load, substantially as described.

3. In an explosive-engine, the combination with a governor, of a governing-valve seat, having a series of parallel rows of openings or passages, a governing-valve thereon, having a corresponding parallel series of surfaces, for controlling said rows of openings, and a casing inclosing said valve and valve-seat, having inlets for the supply of the air and gas, or the air and oil and provided with an outlet leading to the distribution-valve chest, whereby said casing, valve and valve-seat, constitute a commingling-chamber, for the explosive materials, and the supply thereof to the distribution-valve, is controllable, according to load, by an extremely small movement of said governing-valve, substantially as described.

4. In an explosive-engine, the combination with a governor, of a governing-valve, valve-seat and casing, which seat is of cylindrical form and provided with a multiplicity of passages, arranged in parallel rows, lengthwise thereof, and which valve is mounted therein for rotary movement, and is provided with a series of radial wings, spaced apart from each other, corresponding to and for the control of said rows of openings in the seat, and which casing is provided with suitable inlets for the air and gas or oil, and with a suitable

outlet to the distribution-valve chest, all substantially as and for the purposes set forth.

5. In a starter for explosive-engines, the combination with a breech-block and firing device, of a charge-magazine constructed to retain a paper wad or disk, at or near its delivery end, insertible from the breech end thereof, for retaining and protecting the charge, and a permanent washer or cap-holder securable at the breech end of said magazine and provided with a perforated cap-seat, whereby the charge can be held and fired without the use of a cartridge and be protected from the combustion-chamber of the engine without the use of a cut-off cock, substantially as described.

6. The starter for explosive-engines, comprising the magazine 56 having the wad-seat *g* and the cap-holder seat *g'*, the breech-block 57 equipped with the spring-seated firing-hammer 58 and separably connectible to said magazine, and the permanent cap-holder 62 provided with a perforated seat for a fulminating-cap 63, all for coöperation, substantially as described.

7. In an electric igniter for explosive-engines, the combination with the rotary or spindle electrode, of a combined torsion and compression spring applied to said spindle and operative both to seat the spindle and return the same to normal position after its release from the wiper-electrode, and devices for independently adjusting the tension of said spring at will, either in respect to torsion or compression, substantially as described.

8. In an electric igniter for explosive-engines, the combination with the rotary or wiper electrode, of the rocking or spindle electrode and the parts for controlling the same, comprising the insulated sleeve 47, the flanged nut 48, the rotatively-adjustable cap 51, seated on said nut, the longitudinally-adjustable collar 52, on said spindle, the spring 54 having one end held by said collar and the other passed out through a passage in the flange of said nut and engaged by said cap, all coöperating substantially as and for the purposes set forth.

9. In an electric igniter for explosive-engines, the combination with the rotary or wiper electrode, of a rocking or spindle electrode, and parts for controlling the same, comprising the insulated sleeve 47, the flanged nut 48, the rotatively-adjustable cap 51, seated on said nut, and the spring 54 having one end secured to said spindle and its other end secured to said adjustable cap, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JESSE WALRATH.

Witnesses:

W. J. KLING,
T. P. HARDY.