G. J. WEBER.

EXPLOSIVE ENGINE.

APPLICATION FILED DEC. 9, 1907. RENEWED AUG. 2, 1909.

951,352.

Patented Mar. 8, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

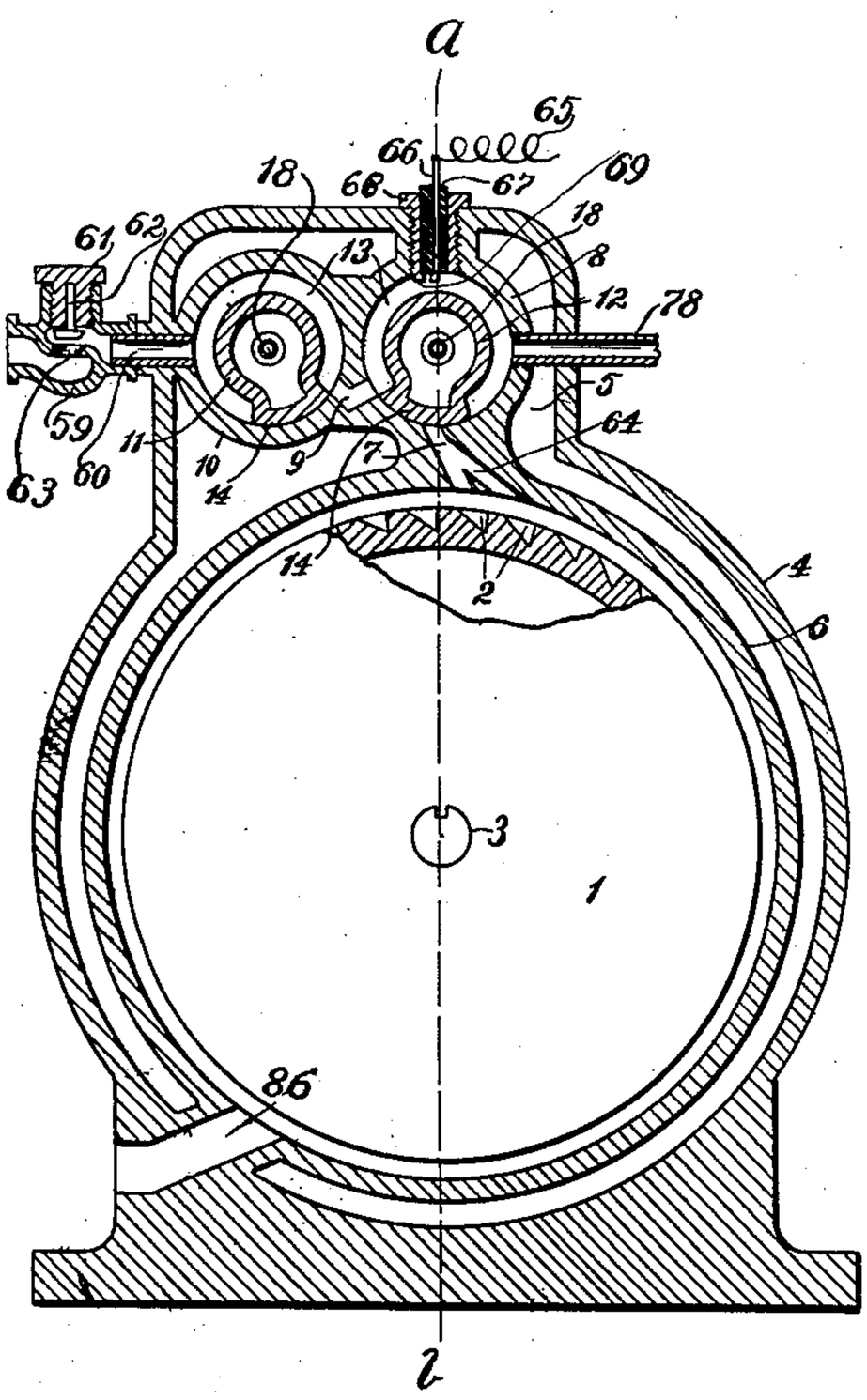


Fig. 2.

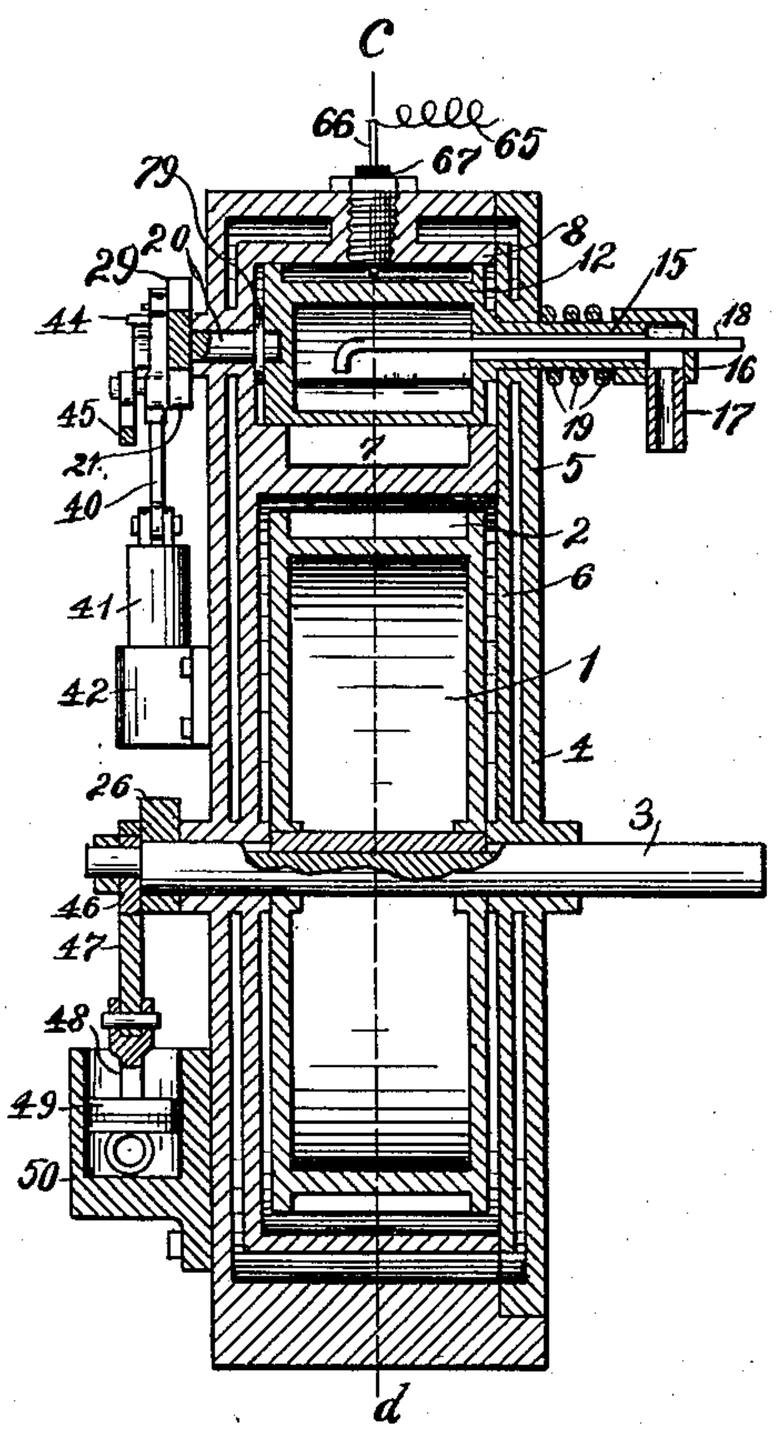
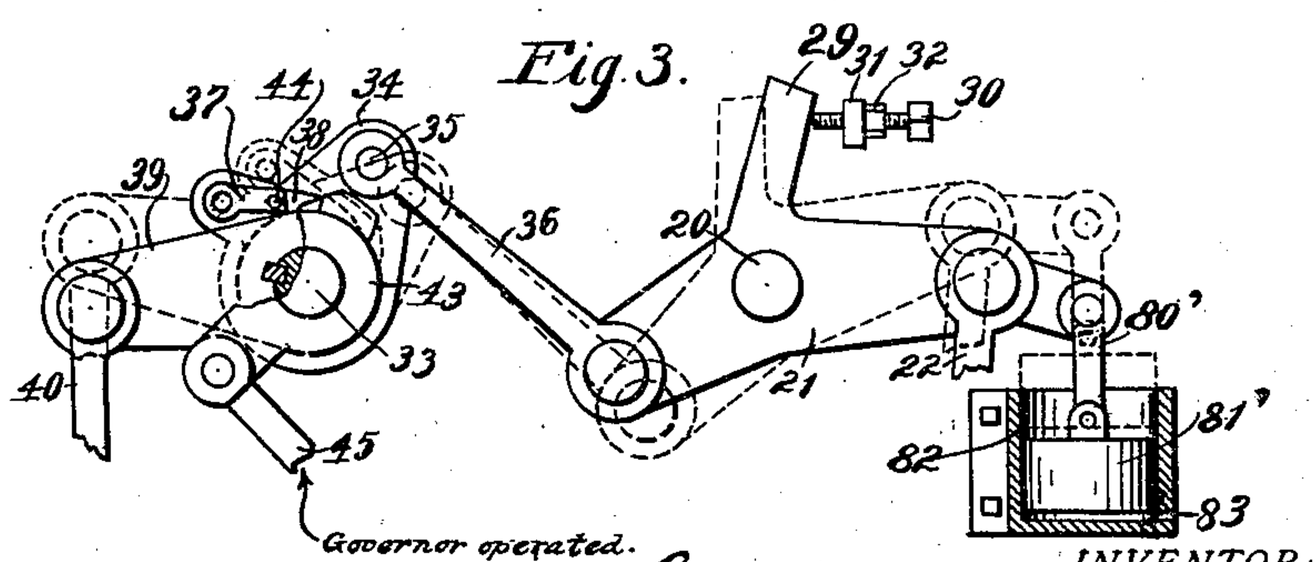


Fig. 3.



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2 SHEETS—SHEET 2.

Fig 4.

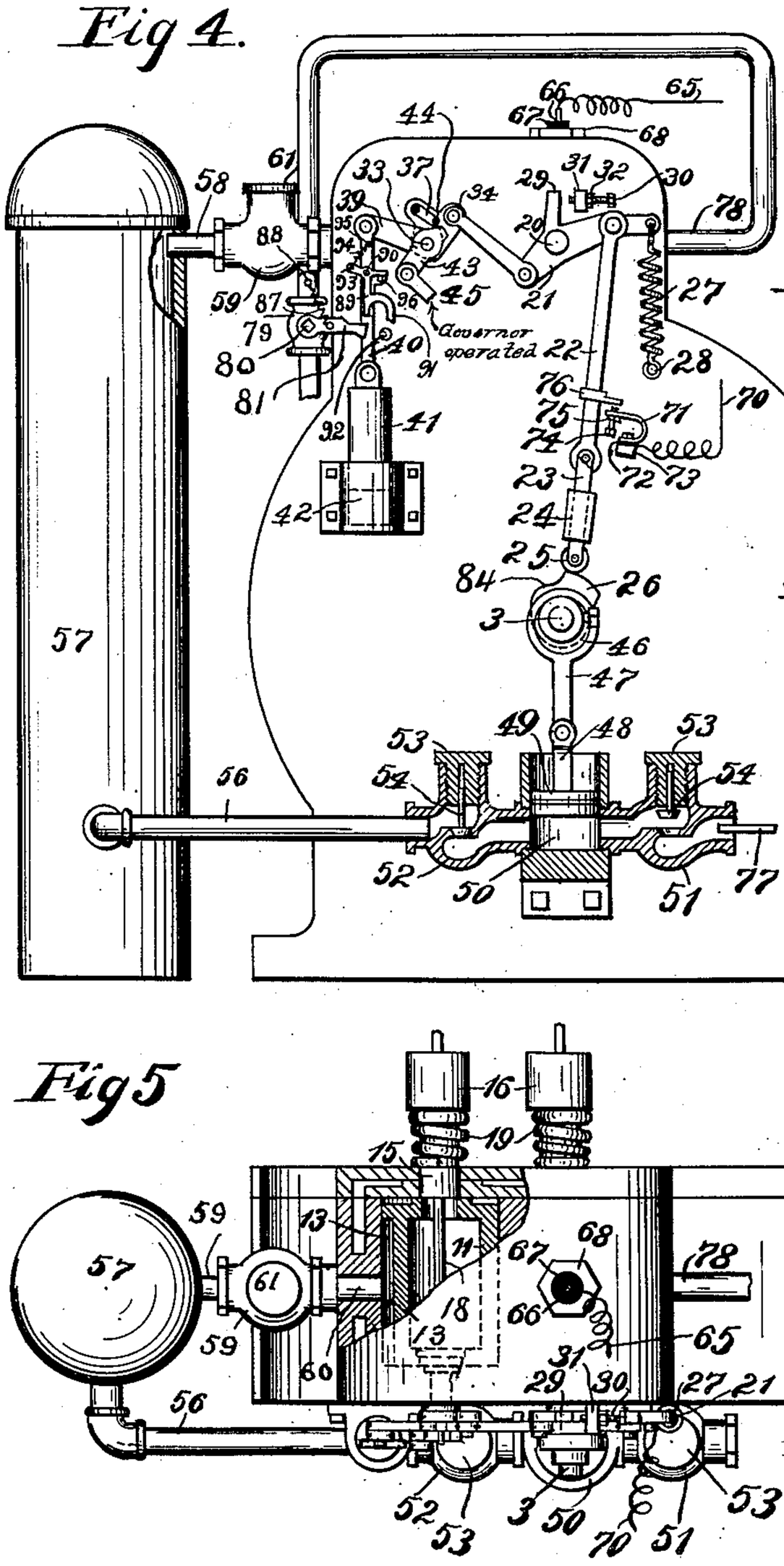

Fig 6.

Fig 7.

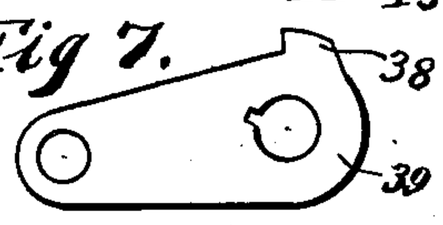

Fig 8.

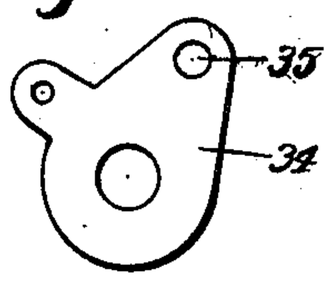

Fig. 9.

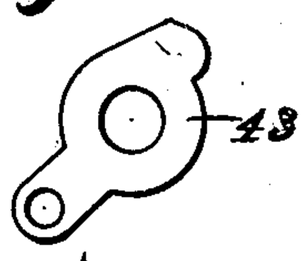

Fig. 11

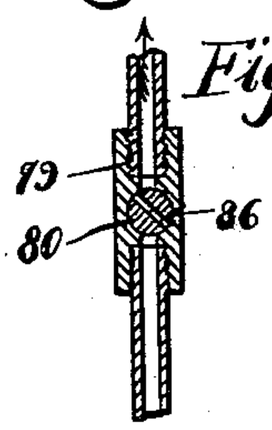

Fig 10.

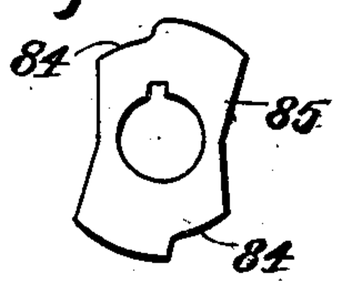

Fig 5

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EXPLOSIVE-ENGINE.

951,352. Specification of Letters Patent. Patented Mar. 8, 1910.

Application filed December 9, 1907, Serial No. 405,801. Renewed August 2, 1909. Serial No. 510,883.

To all whom it may concern:

Be it known that I, GEORGE J. WEBER, a citizen of the United States, residing at Kansas City, in the county of Jackson and State of Missouri, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification.

My invention relates to improvements in explosive engines.

It is particularly adapted to engines of the turbine type.

The object of my invention is to provide an explosive engine in which the full explosive force of the exploded charge is suddenly discharged against the rotary piston. This effect is produced by exploding the charge in a closed chamber and after ignition permitting the ignited charge to be suddenly discharged against the piston.

In a pending application filed by me and having Serial Number 235,215 there is described and claimed an explosive engine having certain features of construction which are common to the construction which is herein described, and to such features as are claimed in the aforesaid application I make no claim in this application.

The novel features of the present invention are hereinafter fully described and claimed.

In the accompanying drawings illustrative of my invention, Figure 1 is a vertical section on the dotted line *c*—*d* of Fig. 2. Fig. 2 is a vertical section on the dotted line *a*—*b* of Fig. 1. Fig. 3 is a view partly in front elevation and partly in vertical section of a portion of the mechanism for actuating the valves controlling the inlets and outlet to the explosion chamber. Two positions of the parts are shown in solid and dotted lines respectively, and a modified means for controlling the retraction of the outlet valve of the explosion chamber is shown. Fig. 4 is a view of the engine partly in vertical section and partly in elevation. Fig. 5 is a view of the engine, partly in horizontal section and partly in plan, a portion of the fuel oil feed mechanism being removed. Fig. 6 is a top view of some of the parts connected with the valve in the supplemental chamber. Fig. 7 is a side elevation of the crank for rocking the supplemental valve shaft. Fig. 8 is a side elevation of the bell crank lever mounted on the shaft of the valve located in the supplemental chamber. Fig. 9 is a side elevation of the wiper lever. Fig. 10 is a side elevation of a modified form of cam. Fig. 11 is a vertical section through valve casing 79.

Similar characters of reference denote similar parts.

1 denotes a cylindrical piston having peripheral pockets 2 which form blades to receive the impact of the propelling fluid.

3 denotes a horizontal central shaft supporting the piston and rotatively mounted in bearings provided at opposite ends of the casing 4 which encircles the cylinder 6 in which the piston 1 is mounted. Intermediate the casing 4 and the cylinder 6 is a water space 5. Above the cylinder 6 and connected therewith by an outlet 7 is an explosion chamber 8 having two inlet ports, one of which is denoted by 9, the other will be described hereinafter. In the explosion chamber 8 is mounted a rock valve 12, adapted to cover and uncover the ports 7 and 9. Adjoining the explosion chamber 8 and connected therewith by the inlet port 9, is a supplemental chamber 10 having mounted therein a rock valve 11, adapted to open and close the port 9 independently of the valve 12.

The valve 12 is wide enough to cover simultaneously ports 7 and 9. Each of the valves 11 and 12 is provided with a peripheral groove 13 for receiving the charge of air or fuel, as the case may be. Intermediate the ends of said groove is the valve face 14 fitted to the inner wall of the chamber in which the valve is located. Each valve is preferably hollow and has extending into its interior through a central, horizontal, tubular extension 15, a horizontal tube 18, through which a cooling fluid, such as water, is conveyed into the hollow space of the valve. The extension 15 extends through the casing 4 and has fitted on its outer end a cap 16 having a lateral discharge outlet 17. Encircling each extension stem 15 is a spring 19 which bears at one end against the casing 4 and its other end against the cap 16. The springs 19 hold the valves 11 and 12 tightly against the inner walls of the cylinder so as to prevent leakage of gas around the stems 15.

For rocking the valves 11 and 12 the following described parts are provided:—A horizontal rock shaft 20 which extends through the forward side of the casing 4 has its rear end secured to the center of the forward end of the valve 12. A bell crank lever 21 is secured to the outer end of the shaft 20 and has one arm pivoted to the upper end of a connecting rod 22, the lower end of which is pivoted to the upper end of a bar 23, which is reciprocative in a guide 24 provided on the forward side of the casing 4. On the lower end of the bar 23 is mounted a roller 25 which bears against a cam 26 secured upon and rotative with the shaft 3. The roller 25 is held against the cam 26 by a coil spring 27, one end of which is secured to the lever 21 and the other arm of which is secured to a pin 28 secured to the forward side of the casing 4. The cam 26 serves to rock the valve 12 to a position covering the port 7, while the spring 27 retracts the said valve to a position covering the port 9.

For regulating the degree to which the port 7 is opened by the valve 12, so as to obtain the greatest efficiency in the expansive force of the ignited charge, the lever 21 is provided with a vertical arm 29 adapted to strike a horizontal screw 30 mounted in a projection 31 on the forward side of the casing 4. By adjusting the screw 30 toward and from the arm 29 the stroke of the lever 21 and valve 12 may be adjusted. A lock nut 32 on the screw 30 is adapted to bear against the projection 31 to hold the screw in the adjusted position.

A horizontal rock shaft 33 having its rear end secured to the forward end of the valve 11, extends through the forward side of the casing 4. Pivotally mounted on said shaft 33 is a bell crank lever 34 having one arm pivoted to one end of a connecting rod 36 by a horizontal pin 35 secured to said arm. The other end of the rod 36 is pivoted to one of the arms of the bell crank lever 21. On the other arm of the lever 34 is pivoted a pawl 37 adapted to engage a tooth 38 on the lever 39 keyed on the shaft 33. To the lever 39 is pivoted the upper end of a rod 40 the lower end of which is pivoted to a piston 41 vertically reciprocative in a cylinder 42. The piston 41 is a weight which serves to move the valve 11 to a position closing the port 9. The cylinder 42 serves as a dash pot to slow the movement of the piston 41.

With each rotation of the piston 1, when the engine is not running faster than a certain predetermined speed, the cam 26 through the intermediacy of the roller 25, rods 22 and 23, lever 21 and rod 36, swings the bell crank lever 34 so that the pawl 37 engages the tooth 38 of the lever 39 and thereby rocks the valve 11 to a position uncovering the adjacent end of the port 9, thus permitting fluid to pass from the supplemental chamber 10 into the explosion chamber 8, the valve 12, at this time, being swung to the position shown in Fig. 1 and covering the port 7. After the raised portion of the cam 26 passes the roller 25, the spring 27 swings the levers 21 and 34 so as to rock the valve 12 to first close the port 9 and then open the port 7, and permitting the piston 41 to swing the valve 11 to cover the other end of port 9. While the valves 11 and 12 are in positions closing the ports 9 and 7 and before the port 7 has been opened, the compressed air which has been admitted from chamber 10 to chamber 8 mixes with fuel which has been introduced into chamber 8 as will be hereinafter described. The mixed fuel and air is then exploded while all the ports communicating with chamber 8 are closed. The valve 12 then uncovers port 7, thus permitting the ignited charge to pass therethrough into the cylinder 6 and against the peripheral blades on the piston 1, thus causing rotation of the piston. The continued rocking of the valves 11 and 12 uncovers the port 9 thus permitting a fresh charge of compressed air or compressed mixed air and hydrocarbon vapor to pass from chamber 10 into the explosion chamber 8, the valve 12 having previously covered the port 7.

To prevent the engine running at more than the proper rate of speed, the following described mechanism is provided. Pivoted on the shaft 33 outside the lever 39 is a lever 43, which is governor operated by any suitable mechanism connected with a rod 45, which is pivoted to the lever 43 and serves to swing the lever 43 to and fro. The lever 43 is provided with an inclined upper side adapted to strike the pin 44 on the pawl 37 to raise the pawl to a position in which it will miss the tooth 38 on the lever 39. When the pawl 37 misses the tooth 38 the lever 39 will not be swung so as to rock the valve 11 to a position in which the valve will uncover the port 9, and the charge contained in chamber 10 can not pass as usual into the explosion chamber 8. As the speed of the engine becomes reduced the lever 43 will be swung by the rod 45 to a position in which the inclined face of said lever will not raise the pawl 37 to clear the tooth 38, and the pawl again engaging said tooth will again swing the lever 39 so as to rock the valve 11 to the position uncovering port 9, thereby permitting a fresh charge to pass from chamber 10 to chamber 8.

Compression of the charge entering chamber 10 is obtained as follows:—On the shaft 3 is secured an eccentric collar 46 which is embraced by the upper end of a rod 47, the lower end of which is pivoted to the upper end of a bar 48, the lower end of which is secured to the upper side of a

piston 49 vertically reciprocative in a cylinder 50 secured to the forward side of casing 4. Connected to the lower part of the cylinder 50 on opposite sides thereof are two valve casings 51 and 52, each having an opening in its upper end in which is secured a plug 53 disposed above a valve opening in the casing controlled by a check valve 54, the vertical stem of which is slidable in a hole provided therefor in the lower end of the adjacent plug 53. As the piston 49 ascends air is drawn from the atmosphere into the valve casing 51, the valve in said casing is lifted and the air passes into the cylinder 50 below the piston 49. As the piston 49 descends the valve in casing 51 closes and the valve 54 in casing 52 is raised by the air pressure, thus permitting the air to pass from casing 52 by a conductor 56 into a storing or compression chamber 57 from which the compressed air passes by a conductor 58 into a valve casing 59. The valve casing 59 is provided with a valve opening 63, in which normally rests a valve 62, which is vertically guided in a hole provided in the lower end of a plug 61 which is secured in an opening in the upper end of the valve casing 59. The casing 59 is connected by a conductor 60 with the supplemental chamber 10. The valve 62 serves as a check valve to prevent the back passage of fluid through the opening 63 into the chamber 57.

From the above description it will be seen that rotation of the piston 1 will cause air to be compressed and stored in the chamber 57 from which charges will pass through chamber 10 and port 9, and that these charges will mingle in the explosion chamber 8 with charges of fuel. The charges of mixed fuel and air will be successively exploded in chamber 8 and will successively pass into the cylinder 6 by the port 7, the outer end of which is preferably bifurcated and the branch 64 disposed so that both branches of the port will simultaneously be opposite two blades of the piston 1.

When the heat of the compressed air admitted to chamber 8 is insufficient to cause ignition of the mixed fuel and air in said chamber the mixed air and fuel may be ignited by any other suitable means, as for instance, by a jump spark. To effect this latter mode of ignition a wire 65 is connected to the upper end of an electrode 66 which is mounted in a block of insulation 67 secured in a metallic screw threaded plug 68 fitted in a vertical threaded opening extending through the casing 4 into the explosion chamber 8. The inner end of the plug 68 is provided with an electrode 69, adjacent to but not touching the inner lower end of the electrode 66. A wire 70 has one end connected to a U-shaped metallic spring 71, shown in Fig. 4, which is mounted upon but insulated by insulation material 72 from a projection 73 on the front of the casing 4. On the free end of the spring 71 is mounted an adjustable screw 74 which extends through a hole in the spring and is secured thereto in the position to which it may be adjusted, by a lock nut 75.

On the rod 22 is secured a contact plate 76 which is adapted to strike the upper end of the screw 74 when the rod 22 descends. By properly adjusting the screw 74, as may be done when the engine is running, the plate 76 may be made to strike the screw 74 when the ports communicating with the explosion chamber 8 are all closed. Any suitable source of electric current may be employed to obtain a spark between the electrodes 66 and 69, the wires 65 and 70 forming part of the circuit in which the current is generated. The circuit is completed between the contact plate 76 and plug 68 by the rod 22, lever 21, shaft 20 and casing 4.

If desired a portion of the fuel may be taken with the air into valve casing 51 by means of a tube 77, shown in Fig. 4. I prefer, however, to introduce the fuel into the chamber 8 through a conductor 78, after the charge of air has been introduced into said chamber, and subsequently to the closing of the port 9 by the valve 11, and prior to the opening of the port 7. To accomplish this the conductor includes a valve casing 79 having mounted therein a rock valve 80 provided with a passage 86 extending upwardly through said valve. The valve 80 has secured to it a lever 81 by which the valve is rocked. The valve 80 is held normally in the closed position, shown in Figs. 4 and 11 by a coil spring 87 one end of which is secured to the lever 81, the other end being secured to a pin 88 secured to the conductor 78 above the valve casing 79.

A lever 89 is pivoted by a pin 90 to the forward side of the rod 40, and is adapted to have its lower end strike the lever 81 when the rod 40 is descending, thus rocking the valve 80 to the open position, and thereby permitting a charge of oil to enter the chamber 8 through the conductor 78. The disposition of the parts is such that the lever 89 will not swing the lever 81 to a position opening the valve 80 until the valve 11 has closed the port 9. When the valve 11 has been swung by the lever 39 to close the port 9, after a charge of compressed air has entered chamber 8 through the port 9, the lever 89 will strike the lever 81 and open the valve 80, thus permitting a charge of fuel or oil to enter chamber 8, where the charge mixes with the charge of compressed air and explodes before the valve 12 uncovers port 7. The heat of the highly compressed charge of air or the electrical igniting means may be employed to ignite the mixed fuel and air.

As soon as the proper charge of fuel has

passed into the explosion chamber 8 through the conductor 78, the lever 87 is disengaged from the lever 81, thereby permitting the spring 87 to close the valve 80. This disengagement of the levers 89 and 81 is obtained as follows:—On the lever 89 is a claw arm 91, which extends laterally and downward. In the path of movement of the claw arm 91 is a horizontal pin 92 disposed eccentrically to a rearwardly extending portion which is rotatively adjustable in the forward side of the casing 4. The lever 89 has an arm 93 to which is secured one end of a coil spring 94 the other end of which is secured to the rod 40. The spring 94 normally holds the lever 89 against a pin 96 secured to the rod 40, and in position to have the lower end of the lever 89 strike the lever 81.

After the charge of compressed air has been admitted through the port 9 into chamber 8, the weight 41 forces the lever 39 to a position closing port 9. The rod 40 in moving downward causes the lever 89 to strike the lever 81, after the valve 11 has closed port 9. The charge of fuel having been admitted to chamber 8 through conductor 78, the continued downward movement of the rod 40 brings the claw arm 91 against the eccentrically mounted pin 92 which swings the lever 89 to a position in which the lever 81 will be released, thereby permitting the spring 87 to close the valve 80 as before described. By rotating the eccentric pin 92, the position of the said pin may be changed so as to vary the time at which the lever 81 is released from engagement with the lever 89, thus varying the amount of fuel admitted.

From the above it will be seen that charges of air and fuel are consecutively admitted into chamber 8 through the inlets 9 and 78 while the valve 12 closes port 7, the charge of fuel being admitted subsequent to the closing of the port 9 and prior to the opening of port 7. The mixed charges are then exploded, the valves 11, 12 and 80 being all in the closed positions, after which, the valve 12 is swung to a position opening port 7 through which the charge escapes at high pressure into cylinders 6 and against the piston 1. By adjusting the screw 30 the degree the port 7 is uncovered may be varied, so as to permit the exploded motive fluid to pass quickly or less quickly into the cylinder. To prevent leakage around the shafts 20 and 33, each shaft is provided with a peripheral annular flange 79′ which bears against the inner wall of the chamber in which said shaft is located.

In Fig. 3 is shown a modified means for retracting the valve 12. In this form the lever 21 has pivoted to it the upper end of a rod 80′ the lower end of which is pivoted to the piston 81′ which is vertically reciprocative in a cylinder 82 secured to the forward side of the casing 4, and provided with an open upper end and a closed lower end. An air outlet 83 is provided in the cylinder 82 below the limit of the stroke of piston 81′. The weight of piston 81′ swings the lever 21.

When the valve 12 is in the position shown in Fig. 3, closing port 7, the raised portion of the cam 26 supports the roller 25. As the cam rotates said roller drops into a recessed portion 84 on the cam, at which time, the valve 12 will swing so as to close port 9, but not enough to open port 7. At this time the plate 76 will strike the screw 74 thus completing the electric circuit on which completion a spark will pass between the electrodes 68 and 69, and the motive fluid will be exploded in the chamber 8. Continued rotation of cam 26 will permit the roller to drop off recessed portion 84 of cam 26, and the lever 21 will be retracted by the spring 27 until the arm 29 strikes the screw 30. At this time the valve 12 will have closed port 9 and opened port 7.

In the modified form of cam shown in Fig. 10, the cam 85 is provided with two raised portions disposed diametrically opposite each other. Two similarly located recessed portions 84 are provided on the periphery of the cam. Upon every revolution of the shaft 3, the valve 12 will be rocked to and fro twice. The valve 11 may also be rocked twice during each rotation of the piston, thus permitting two charges of motive fluid to be discharged into and exploded in the chamber 8 during one revolution of the piston. The power of the engine may thus be materially increased by providing the cam 85 having two raised portions for raising the roller 25. The cylinder 6 and casing 4 is provided, as shown in Fig. 1 with a passage 86 for the escape of the used motive fluid.

Modifications of my invention, within the scope of the appended claims, may be made without departing from its spirit.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:—

1. In explosive engines, the combination with a cylinder, of an explosion chamber having two inlet ports and having an outlet port connecting with the cylinder, two valves, one controlling one inlet port, the other controlling the other inlet port and the outlet port, means for moving said valves to positions in which the inlet ports will first be closed and the outlet port then opened, and igniting means in the explosion chamber operative after the inlet ports are closed and prior to the opening of the outlet port.

2. In explosive engines, the combination with a cylinder, of an explosion chamber having two inlet ports and having an out-

let port connecting with the cylinder, a valve controlling one inlet port, a rocking valve controlling the other inlet port and the outlet port, means for moving said valves so as to first close the inlet ports and then open the outlet port, and igniting means in the explosion chamber operative after the closing of the inlet ports and prior to the opening of the outlet port.

3. In explosive engines, the combination with a cylinder, of an explosion chamber having two inlet ports and having an outlet port connecting with the cylinder, a valve controlling one inlet port and the outlet port, means for moving said valve so as to first close the inlet port controlled by it and then open the outlet port, and igniting means in the explosion chamber operative after the closing of the inlet port controlled by said valve and prior to the opening of the outlet port.

4. In explosive engines, the combination with a cylinder, of an explosion chamber having two inlet ports for admitting air and fuel respectively and having an outlet port connecting with the cylinder, a valve for consecutively opening and closing one of said inlet ports and the outlet port, and igniting means in the explosion chamber operative after the closing of the inlet port controlled by said valve and prior to the opening of the outlet port.

5. In explosive engines, the combination with a cylinder, of an explosion chamber having two inlet ports for admitting air and fuel respectively and having an outlet port connecting with the cylinder, means for consecutively opening and closing the two inlet ports and the outlet port, and igniting means in the explosion chamber operative after the closing of the inlet ports and prior to the opening of the outlet port.

6. In explosive engines, the combination with an explosion chamber having two inlet ports for the admission of air and liquid fuel respectively and having an outlet port, means for opening and closing in alternate order said inlet ports and the outlet port, and igniting means in the explosion chamber operative after the closing of the inlet ports and prior to the opening of the outlet port.

7. In explosive engines, the combination with an explosion chamber having two inlet ports and an outlet port, of means for discharging compressed air and liquid fuel into the explosion chamber through said inlet ports respectively, means for opening and closing said outlet port in alternate order relative to said inlet ports, and igniting means in the explosion chamber operative after the closing of the inlet ports and prior to the opening of the outlet port.

8. In explosive engines, the combination with an explosion chamber having two inlet and one outlet ports, of means for discharging compressed air and liquid fuel into the explosion chamber through said inlet ports respectively, two valves, one controlling one inlet port and the outlet port, the other valve controlling the other inlet port, means for moving said valves so as to open and close the outlet port in alternate order relative to said inlet ports, and igniting means in the explosion chamber operative after the closing of the inlet ports and prior to the opening of the outlet port.

9. In explosive engines, the combination with an explosion chamber having two inlet ports and an outlet port, of a rocking valve for simultaneously covering said outlet port and one of said inlet ports, a valve for closing the other inlet port, means for rocking said rocking valve so as to open and close said outlet port in alternate order relative to the inlet port controlled by said rocking valve, and igniting means in the explosion chamber operative when all of said ports are closed.

10. In explosive engines, the combination with an explosion chamber having two inlets for air and fuel respectively and having an outlet, of two valves, one controlling said outlet port and one of the inlet ports, the other valve controlling the other inlet port, means for igniting the charge of mixed fuel and air in the explosion chamber when said valves are in the closed position, and means for actuating said valves independently of the pressure in the explosion chamber.

11. In explosive engines, the combination with an explosion chamber having two inlets and one outlet, of a rocking valve controlling the outlet and one of said inlets, a valve controlling the other inlet, means for igniting a charge in the explosion chamber where said inlets and outlet are closed, and means for actuating said valves independently of the pressure in the explosion chamber.

12. In explosive engines, the combination with an explosion chamber provided with an outlet and having an inlet for fuel, of means for exploding a charge admitted to the explosion chamber, an air compressing chamber discharging into said explosion chamber, a valve controlling discharge of air from said compression chamber to the explosion chamber, a valve controlling said outlet, a valve controlling the fuel inlet, and means by which all the valves may be held closed when the charge is ignited in the explosion chamber.

13. In explosive engines, the combination with an explosion chamber having two inlets and an outlet, of means for exploding a charge in the explosion chamber, three valves

controlling respectively said inlets and outlet, means for actuating said valves so as to retain them all in the closed position at one time, and means by which the valve controlling said outlet may operate independently of the other valves.

14. In explosive engines, the combination with a cylinder, of a piston rotative in the cylinder and having a plurality of blades, an explosion chamber having two inlets for admitting air and fuel respectively and having an outlet connecting with the cylinder for conveying the ignited charge against said blades, two valves, one controlling said outlet and one of said inlets, the other valve controlling the other inlet, and igniting means in the explosion chamber operative when said outlet is closed.

15. In explosive engines, the combination with a piston, of an explosion chamber having an outlet discharging against said piston and having two inlets for air and fuel respectively, means independent of the pressure in the explosion chamber for opening and closing said inlets and outlet, and means for igniting the mixed charge of air and fuel in the explosion chamber when said inlets and outlets are closed.

16. In explosive engines, the combination with an explosion chamber having two inlets and an outlet, of valves controlling said inlets and outlet respectively, means for actuating the inlet valves independently of the outlet valve, all of the valves being actuated independently of the pressure in the explosion chamber, means controlled by the speed of the engine for regulating the inlet valves, and means for igniting a charge in the explosion chamber when said valves are closed.

17. In explosive engines, the combination with a piston, of an explosion chamber having two inlets for air and fuel respectively and having an outlet discharging against the piston, valves controlling said inlets and outlet, means for opening and closing the valve controlling the outlet, means for opening and closing the valves controlling said inlets independently of the valve controlling said outlet, means controlled by the speed of the engine for actuating the valves controlling said inlets, and means for igniting a charge in the explosion chamber when all the valves are in a closed position.

18. In explosive engines, the combination with a cylinder, of a rotary piston in said cylinder having blades, an explosion chamber having two inlets for air and fuel respectively and having an outlet discharging in said cylinder against said blades, valves controlling said inlets and outlet respectively, means for igniting a charge in the explosion chamber when said valves are in the closed position, means for actuating the valve controlling said outlet, and means controlled by the speed of the engine for actuating said valves controlling said inlets.

19. In explosive engines, the combination with an explosion chamber having inlets for compressed air and fuel respectively, and having an outlet, of valves controlling said inlets and said outlet, and means for actuating said valves by which charges of air and fuel are admitted consecutively into said explosion chamber while the valve controlling said outlet is closed, one of said charges being admitted after the valve controlling the other inlet is closed.

20. In explosive engines, the combination with an explosion chamber having inlets for admitting air and fuel respectively, and having an outlet, of valves controlling said inlets and outlets, means for actuating said valves by which the charges of air and fuel are admitted into the chamber in consecutive order, and means for igniting the mixed charges when all said valves are closed.

21. In explosive engines, the combination with an explosion chamber having two inlets and an outlet, of valves controlling said inlets and outlet respectively, means for actuating said valves in consecutive order, and adjustable timing means controlling the operation of one of said inlet valves.

22. In explosive engines, the combination with an explosion chamber having two inlets and an outlet, of valves controlling said inlets and outlet respectively, means for actuating said valves in consecutive order, and governor operated means controlling the operation of said inlet valves.

23. In explosive engines, the combination with an explosion chamber having two inlets and an outlet, of valves controlling said inlets and outlet respectively, means for actuating said valves in consecutive order, adjustable timing means controlling the operation of one of said inlet valves, and governor operated means controlling the operation of both of said inlet valves.

24. In explosive engines, the combination with an explosion chamber having an outlet, of a cylinder communicating with said outlet, a piston mounted in said cylinder, a valve controlling said outlet, means for moving said valve to the open and closed positions, means for discharging in consecutive order into said explosion chamber charges of air and fuel, and means for igniting the mixed charges while the outlet valve is in the closed position.

25. In explosive engines, the combination with an explosion chamber having an outlet, of a cylinder communicating with said outlet, a piston mounted in said cylinder, a valve controlling said outlet, means for moving said valve to the open and closed posi-

tions, means for discharging in consecutive order into said explosion chamber charges of air and fuel respectively, means for igniting the mixed charges while said valve is in the closed position, and means for timing the admission of one of said charges.

In testimony whereof I have signed my name to this specification in presence of two subscribing witnesses.

GEORGE J. WEBER.

Witnesses:
E. B. HOUSE,
J. S. MCILREE.