No. 657,662. Patented Sept. 11, 1900.

F. A. LA ROCHE.

CONTROLLING MEANS FOR EXPLOSIVE ENGINES.

(Application filed Mar. 14, 1900.)

(No Model.) 2 Sheets—Sheet 1.

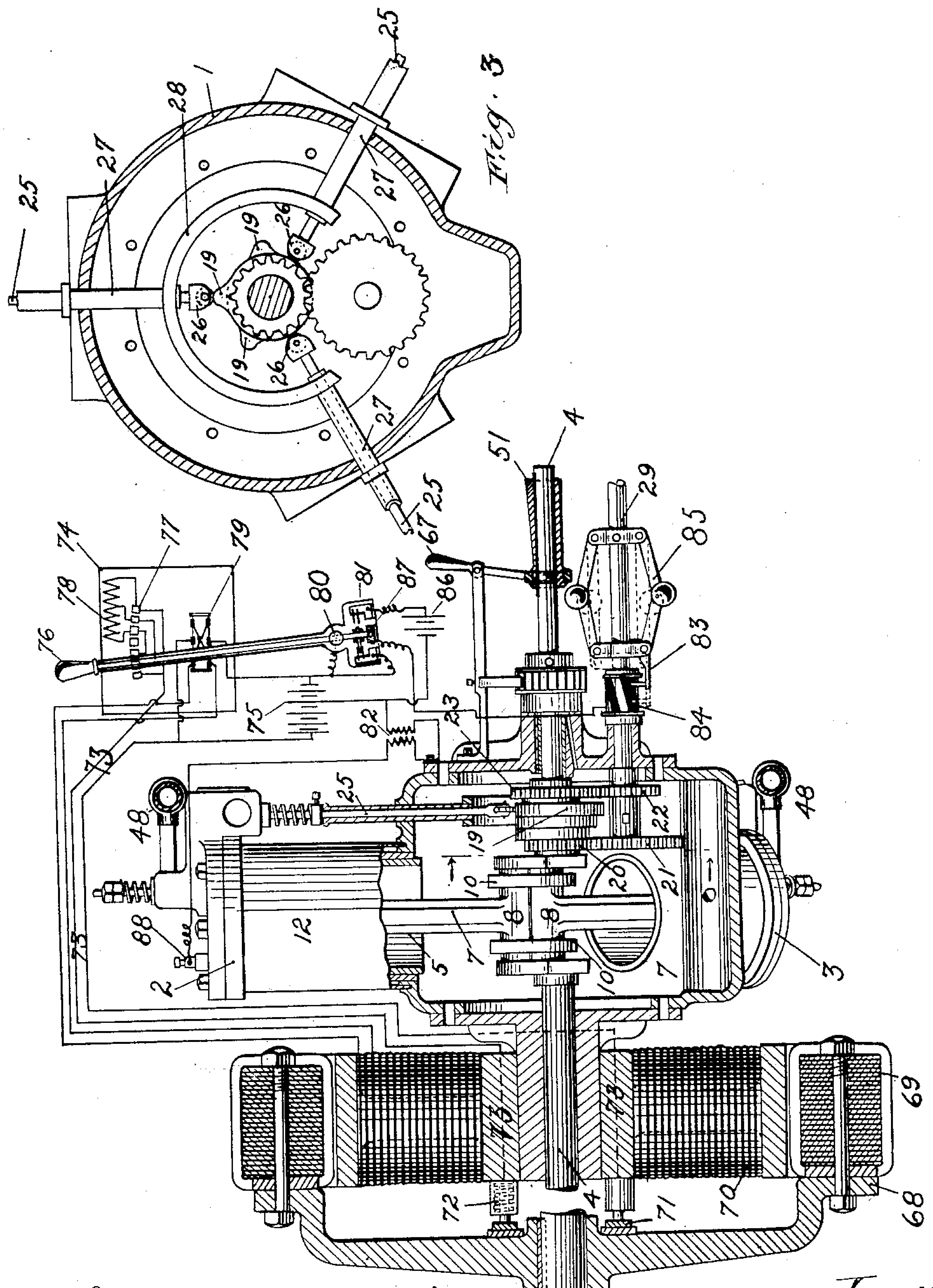

Fig. 1

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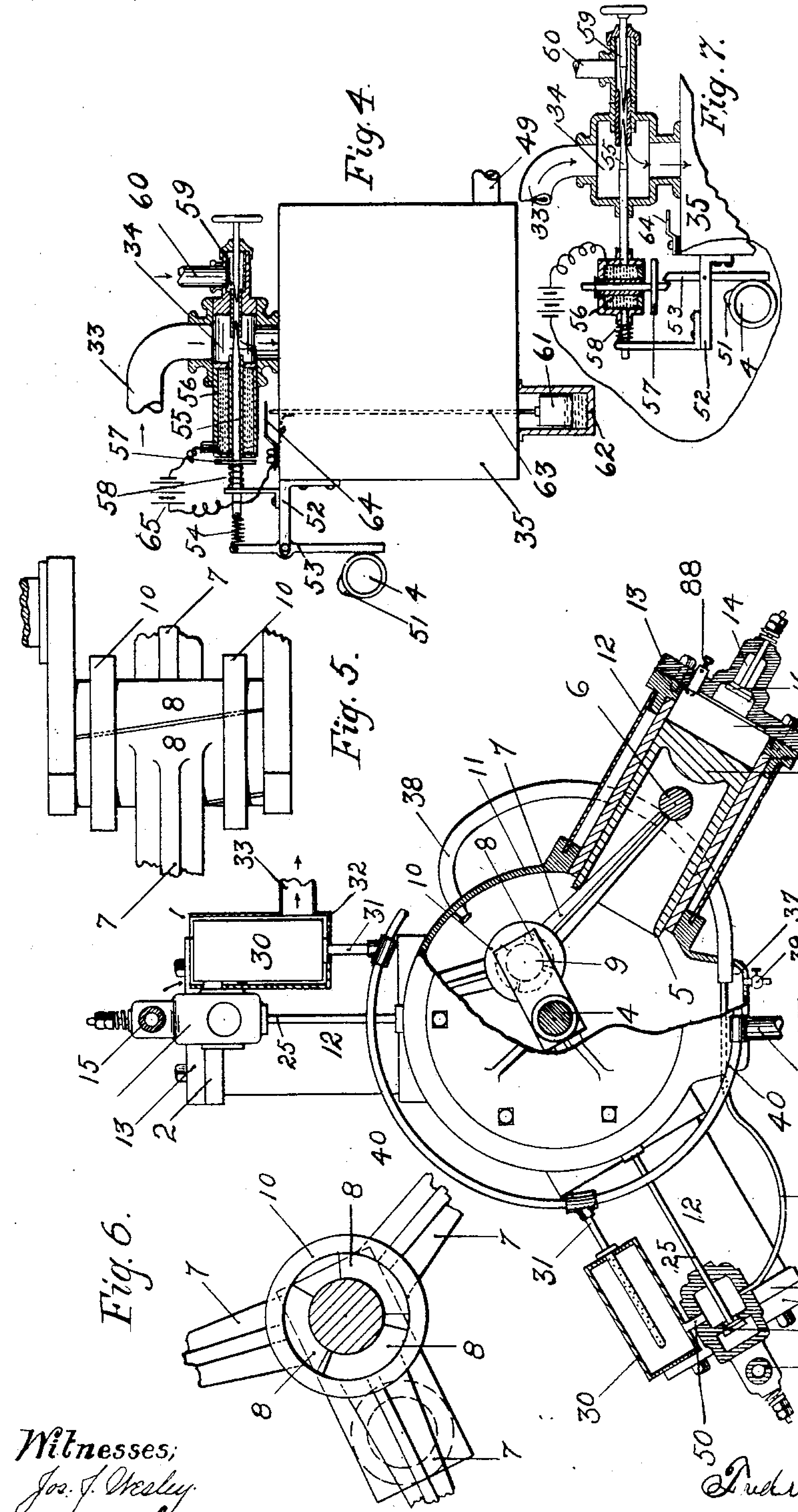

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CONTROLLING MEANS FOR EXPLOSIVE-ENGINES.

SPECIFICATION forming part of Letters Patent No. 657,662, dated September 11, 1900.

Application filed March 14, 1900. Serial No. 8,617. (No model.)

To all whom it may concern:

Be it known that I, FREDRICK A. LA ROCHE, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to gas-engines having multiple cylinders operated on the principle of what is generally known as the "Otto cycle" and using for their fuel a mixture of atmospheric air and an inflammable gas or some suitable hydrocarbon and ignited in the cylinders by an electrical igniting device; and the object of my invention is to effect a considerable reduction in the weight of such engines per horse-power of their capacity, to simplify the igniting device, and render it more efficacious and positive in its performance, while at the same time I have arranged said ignition device by my peculiar construction so as to cause ignition of the explosive mixture in the cylinders at a time best suited to the demands of load necessary to give the greatest torque on the crank-shaft and to effect the greatest possible acceleration of the crank-shaft under load by increasing the starting-torque as much per horse-power of the capacity of the engine as possible. It is also the object of my improvements in gas-engines to provide a ready and effective means for starting the engine automatically when at rest with a minimum of labor on the part of the operator and by a construction which is both simple and effective and to devise a simpler and more effective means of governing engines of this class than any of which at the present time I am aware, as well as to provide a better, simpler, and more economical means of regulating the supply of fuel to the engine than that which has, to the best of my knowledge, been in vogue previous to my invention, all of which I attain by carrying out my improvements in the manner described in this specification and fully illustrated in the drawings forming part thereof, in which the different features of my invention are illustrated in the several figures, respectively, wherein—

Figure 1 is a side sectional elevation of my improved gas-engine, showing particularly the governor-shaft and crank-shaft and the electrical generating fly-wheel or dynamo-armature and the system of electrical distribution for starting the engine when at rest. Fig. 2 is a front sectional view of the same looking toward the end of the crank-shaft and governor and showing the disposition of the oiling system and exhaust-cylinders. Fig. 3 is a detailed sectional view of the crank-case of my improved engine, showing the disposition of the valve-stem. Fig. 4 is a vertical section of my improved carbureter and fuel-supply regulator, showing the manner in which the cam on the engine-shaft controls the supply of fuel to the engine. Fig. 5 is a detail plan view of my improved multiple crank-box. Fig. 6 is a sectional detailed view of the same. Fig. 7 is a sectional vertical view of a modification of the fuel-feed mechanism shown in Fig. 4.

Similar numerals of reference refer to similar parts throughout the different views.

The type of engine which I have illustrated in the drawings and to which the different figures refer I shall designate the "transportation" type, being more particularly adapted to the propulsion of launches or the like or to the propulsion of road-vehicles, tram-cars, &c. I prefer in this type of engine to employ three cylinders 1, 2, and 3, situated at points radially to the crank-shaft 4 and at angles one hundred and twenty degrees apart, as shown in Figs. 1 and 2. Each of the three cylinders is provided with a cylindrical tubular piston 5, adapted to move freely within the cylinders, as commonly employed in gas-engine construction. Swinging within the cylinder-piston 5 on the wrist-pin 6 are the connecting-rods 7, having segmental bearing-terminals 8, which bear against the crank-pin 9. The three segmental bearing-terminals 8 of the connecting-rod 7 are held to their seats upon the crank-pin 9 by the collars 10. These collars are adapted to admit of freedom of oscillation of the segments 8 upon the crank-pin 9 while the engine is in operation and are provided with bearing-surfaces having facilities for lubrication, and inasmuch as that they are adapted to merely hold the connecting-rods 7 together upon the crank-pin 9, so as to move the pistons 5 against friction and air resistance, they may be made comparatively light, as shown in the drawings.

Surrounding the cylinders 1 and 2, which extend radially from the crank-case 11, are the water-jacket cylinders 12, as customary, supplied with water in the usual manner, for taking up the excessive heat of the cylinder-walls when the engine is in operation.

Cast with the cylinder-heads 13 are the intake-valve chambers 14, having inlets 15, adapted to be connected to the fuel-supply pipe 48, (shown in Fig. 1,) receiving its supply of fuel from the carbureter 35, through the fuel-supply outlet 49, and spring-retracted puppet-valve 16. It will be readily understood that upon an inward movement being given to one of the pistons 5, so as to increase the clearance-space 17 in the cylinder 3 sufficiently, the puppet-valve 16 will be forced in against the action of its retracting-spring by virtue of the reduction of pressure in the aforesaid clearance-space 17, thereby opening a passage from the inlet 15 to the interior of the cylinder, thus enabling the explosive mixture to enter the cylinder.

Contiguous with the cylinder-heads 13 and intake-valves 14 are the balanced spring-retracted puppet exhaust-valves 18, lifted by the cams 19, revolving on the shaft 4, driven by the counter-shaft 29 through the system of gearing, to wit: driving-gear 20, keyed to engine-shaft 4, reduction-gear 21, and drive reduction-gear 22, both keyed to counter-shaft 29, and reduction-gear 23, secured to cams 19. The gear relation is so arranged as to operate the valves in a manner suitable for the Otto cycle, and has therefore a ratio of two to one—that is, for every two revolutions for the engine-shaft 4 the counter-shaft 29 shall make one revolution, which will drive the cams 19 through the system of gear, as aforesaid, at the same speed, thereby lifting the exhaust-valves 18 by the valve-stems 25 and rolling contact-points 26 once in every two revolutions of the engine-shaft 4. The disposition of these cams and the manner in which they are adapted to operate the valve 18 by their stems 25 alternately may be more clearly understood by reference to Fig. 3, in which it will be observed that the valve-stems 25 are provided at their ends nearest the cams 19 with rollers 26, so as to reduce the friction at the point of contact with the surface of the cams 19 when the engine is in operation. The valve-stems 25 are guided by the tubular bearings 27, which are secured at their outer ends to the crank-case 1 and at the inner end by the ring 28. It will be readily understood that by rotating the crank-shaft 4 a movement will be communicated to the counter-shaft 29 through the gear, as already described, lifting the valve 18 once for every two revolutions of the engine-shaft 4. The exhaust-valve 18 has a port 50 leading to the closed muffling exhaust-head 30, with perforated exhaust-tube 31 tightly secured to that end of the exhaust-head nearest the crank-shaft 4, as clearly shown in Fig. 2. Tightly secured to the bottom of the exhaust-head 30 is the annular air-shaft or hot-air jacket 32, (with an outlet 33,) open at the top to receive the cooler air from the surrounding atmosphere, which after being warmed by the heat of the exhaust, which raises the temperature of the cylinder-walls, is carried by the outlet 33 to an electrically-controlled needle fuel-controlling valve 34 and carbureter 35. A portion of the exhaust-gases is led off by the small branch exhaust-pipe 36, which is loosely coupled with the crank-pin-lubricating feed-pipe 38, whereby upon each impulse of the exhaust a portion of the oil in the supply-tank 37 is blown through the pipe 38 and onto the crank-pin 9 and sectional crank-pin box 8 during every two revolutions of the crank-shaft 4. This keeps up a continual lubrication of the crank-pin bearings. The surplus of oil thus fed to the crank-bearings drops back into the oil-tank 37 and is being continually used over and over until at length it may be removed by the faucet 39.

Axially sliding upon the engine-shaft 4 in a keyway is the fuel-supply-regulating cam 51, having a gradual rise from zero at its inner end nearest the crank-box 1 of about eight per cent. of its length at the other end. In Fig. 4 I have shown an end view of the cam 51 and the manner in which it is adapted to operate the fuel-supply valve. Secured to the carbureter 35 is an arm 52, to the free end of which is pivoted a lever 53 of the first order, one extremity of which is caused to bear against the surface of cam 51 by the retracting action of the tension-spring 54, secured to the opposite end of lever 53, the other end of the retracting-spring 54 being connected to the free end of the needle-valve stem 55, the other end of this being fitted to the fuel-supply valve 34. The valve-stem 55, carrying the armature 57, passes through the inner core of the annular electromagnet 56, a compression-spring 58 being adapted to keep the stem 55 in toward the valve 34, so as to shut off the flow of oil or gasolene entering the carbureter 35 when the engine is inoperative, is overpowered by the stiffer tension-spring 54, when the lever 53 is thrust in toward the carbureter 35 by the rotation of the cam 51 when the engine is running, thereby admitting that quantity of fuel into the carbureter through the inner end of the pipe 33 which is admitted by way of the hand feed-valve 59 through the inlet 60. When a greater quantity of gasolene shall have been admitted to the carbureter by the action of the valve 34 than that which can be retained in the gaseous state in the quantity of air contained in the carbureter, a quantity of the liquid would have been precipitated, with the result that the fuel would have been carried to the engine in a liquid state rather than in the form of a combustible gas properly mixed with the air for the rapid combustion which impulse-engines demand. To obviate this difficulty, I have devised the electromagnetic check for the valve 34, comprising the circuit-closing float 61, carrying the contact-making stem 63, adapted to move freely up and down in the pocket 62, and the insulated contact-spring 64 and battery 65, connecting electrically one end of the electromagnet 56 and contact-spring 64 by suitable electrical conductors and connections, the other end of the electromagnet-windings being connected to the framework. With this manner of checking the overflow of gasolene it will be readily seen that only a very small quantity of liquid in the pocket 62 would be necessary to lift the float 61, causing the stem 63 to make contact with the insulated contact-spring 64, thus closing the circuit through the metallic framework, electromagnet, conducting-wires, and battery 65, thereby energizing the electromagnet 56 sufficiently to hold the valve 34 closed by the stem 55 and armature 57, thus shutting off any further supply of gasolene to the carbureter. After a quantity of air shall have been passed through the carbureter 35, the heated air being admitted by the air-supply pipe 33, as previously stated, the gasolene-supply being shut off, the saturated inflammable air being drawn out at 49 by the engine-cylinders will become weaker in gasolene, whereupon its absorbing property will have been increased, and after having absorbed a sufficient quantity of that left in the drip-pocket 62 the float 61 will fall, which will cause the stem 63 to break contact with the electrical conductors and spring and the aforesaid electric current through the magnet will be interrupted, thereby releasing the needle-valve 34 and allowing the engine to again automatically supply oil to the carbureter, as before.

In the arrangement which I have just shown and described and as illustrated in Fig. 4 I have devised a means of transmitting power to the valve-stem 56 through the medium of a tension-spring, which may be made to operate more or less sensitively, depending to a greater or less extent upon the conditions under which it shall be used. When I employ the carbureter for aerating the fuel-supply of gas-engines adapted to propel vehicles or the like, where there is a more or less possibility of vibration and jar, I prefer to transmit power to the valve-stem through the rigid connection shown in the modification, Fig. 7, of my improved electrically-controlled fuel-supply valve. In the modification the armature 57 of the electromagnet carries a latch 66, which when the electromagnet is not energized engages the upper end of the lever 53, and upon the magnet being energized, as already explained, the latch 66 is lifted by the armature clear of the end of the lever 53, thereby rendering the valve-stem inoperative, as already described for the construction shown in Fig. 4, and in each case the electromagnet is arranged so as to cut off the supply of gasolene when the electrical circuit is closed by the circuit-closing devices.

The arrangement of the cam 51 (shown in Fig. 1) admits of variations in the supply of gasolene by changes in stroke of the valve-stem 55 as the cam rotates, bearing against the lever 53 at different points along the line of its rise. When the greatest amount of stroke of the valve-stem is required, the cam 51 is drawn back into the position shown in Fig. 1 by the lever 67, which engages a groove and collar at the inner end of the cam 51, which brings that part of the cam having the greatest rise into bearing with the lever 53 as the engine-shaft rotates; but by moving the lever 67 in the opposite direction the cam may be moved through all decreasing degrees of rise while bearing against the lever 53 down to zero. To that end of the crank-shaft 4 opposite the cam 51 is keyed the fly-wheel 68 69, the rim of which, 69, is wound as a Gramme-ring armature, which together with the field-magnets and commutators 71 and brushes 72 constitute a dynamo-electrical generator, the dynamo leads 73 are carried back to the pole-changing controller 74 and storage battery 75. When the controlling-lever 76, comprising the parts 76′ and 76″, is standing in the position shown in Fig. 1, the pole-changer is thrown so as to connect the dynamo-circuits up with the storage battery as a generator; but when the lever 76 shall have been swung upon the pivot 80 in an opposite direction to that shown in the drawings the pole-changer will have been thrown into an opposite direction, changing the circuits of the generator, so as to cause it to run as a motor driven by the electrical current from the storage battery 75. The controlling-lever 76 has a sheath 76′, which swings upon the perforated pivot 80, the inner core of which, 76″, is adapted to be rotated in the perforated pivot 80.

The controller 74 is provided with a variable resistance 78, having contact-points 77 so arranged that when the lever 76 is thrown toward the center or vertical position more resistance shall have been thrown in as it passes over the contact-points consecutively; but when it shall have arrived at the center or vertical position, however, it shall have broken contact, and any further movement of the lever 76 in the same direction shall reverse the electrical connections of the generator by the action of the pole-changer and close the circuits through the highest resistance offered by the rheostat 78, but decreasing the resistance as lever 76 is moved farther and farther in the same direction over the contact-points 77. Thus it will be readily understood by following the path of the current through the circuits shown in the drawings how the dynamo-current may be cut down to zero by a movement being given to the lever 76 before converting the dynamo into a motor and how the potential of the storage-battery current is kept down at the motor-terminals and gradually increases as the motor gets under speed, making the reversal of conditions from dynamo to motor without the danger of burning out the insulation on the wire of the armature-windings attending the older devices for effecting such change when two or more levers and extra resistances are required to accomplish the same end, thereby complicating the operation of the controller and increasing the liability to err. At the pivot end of the lever 76 is the two-point rotating-switch 81, a contact-point of which, 82', is connected to one pole of the storage battery 75, the other pole thereof being electrically connected to the insulated diagonally-disposed commutator-segment 84, adapted to make and break contact with the rotating brush 83, which is carried around by the fly-governor 85. The switch-lever 87 of the switch 81 is connected to one terminal of the primary of the induction-coil 82 and the other terminal of the said primary is connected to the metallic framework of the engine, so as to establish through the same electrical connection with the contact-making brush 83, as shown in Fig. 1. Thus it will be readily understood how I am enabled by my improved controlling-lever to start the engine-shaft forward by a forward movement of the lever and increasing the speed of the rotating shaft as the lever is moved forward farther and farther in the same direction and gradually shutting down as the lever is brought back to its normal position, then how, by the lever being reversed, the direction of the rotation of the power-shaft is reversed, with gradual increases in speed as the lever is drawn back farther and farther, and that by rotating the handle of my improved lever how I am enabled to control the propulsion of the power-shaft by the action of the gas-engine at any period during the backward or forward movement of my controlling-lever, or when the same is in its normal position, thereby operating both the engine and its electrical starting mechanism, so as to back up, stop, or run forward faster or slower in either direction, or stop, with a single operating-lever.

Upon the rotation of the counter-shaft 29 by the operation of the engine crank-shaft 4 and gears when the engine is in operation, as already described, the contact-brush 83 shall be carried around by the governor, so as to make contact with the commutator-segment 84, thereby closing the electrical circuit through the battery and induction-coil primary, causing the secondary current to jump across the spark-gap 88 in the cylinder-head. (Shown in section in Fig. 2.) Upon a sufficiently-rapid rotation being given to the counter-shaft 29 the governor 85 and brush 83 will have moved from the position shown by the dotted lines into that shown by the solid lines in the drawings, and by virtue of the diagonal position of the segment 84 the brush 83 shall have made contact at an earlier period, when by the counter-shaft 29 revolving more rapidly the governor fly-balls are thrown out into position of the solid lines, thereby causing the spark to pass at the spark-gap at a time earlier in the stroke of the piston in the particular cylinder for which the commutator-segment 84 is connected. By this feature of my invention it will be understood by those versed in the art to which my invention pertains that I am enabled to increase the thermodynamic efficiency of my improved gas-engine, first, by increasing materially the isothermal range of the gases after ignition, or, graphically speaking, obtaining a higher isothermal curve, and, second, approximating more exactly an adiabatic expansion of the gases in the cylinder upon a forward movement of the piston during its working stroke, thus more closely approximating the conditions of Carnot's cycle as the speed increases. Therefore with the same amount of gas ignited in the cylinder upon an increase of speed the initial piston-pressure will be increased with the effect that the torque on the crank-shaft will be kept up in spite of the fact that the crank-shaft would be revolving faster. This I deem of considerable importance in the art of engine construction and will undoubtedly prove of value when used as a means of regulating the torque of engines adapted to propel vehicles, launches, or the like where an increase or constant torque of the power-shaft is required with an increase of speed of the said shaft. Though I have shown a simple and efficacious means of carrying out this feature of my invention in Fig. 1, I do not care to limit the scope of my invention in the manner in which I have herein illustrated and described the same, as I am aware that many minor changes may be made in the details of construction without departing in the least from the spirit of my invention.

For the three cylinders shown in the drawings I employ three commutator-segments having such relation with the contact-brush 83 as to close their respective circuits at the proper time for ignition of the gases in each cylinder. In order to carry out this feature of my invention, I employ three separate induction-coils having a terminal of their primaries each electrically connected with a segment in a similar manner to that which I have just described for one cylinder.

In the event of the storage battery being inoperative by becoming discharged I employ an auxiliary igniting-battery 86, having one of its poles connected to the other contact-point of the switch 81 and the other pole connected to the same circuits and connections as those to which the storage battery is connected. It will be readily understood that by rotating lever 76 in one direction and its bearing in the pivot 80 the switch 81 is adapted to turn on the current of the storage battery 75, and by giving it an opposite rotation the storage-battery current shall be shut off, and by continuing the rotation of the lever 76 the primary-battery current shall be thrown onto the igniting-circuit in lieu of the secondary battery in the first instance, whereby I am enabled to change from primary to secondary battery for my igniting-circuit by a change in the direction of rotation of the handle of the operating-lever 76. It will therefore be understood that with but one lever 76 I am enabled to control two sources of electrical supply for the igniting-circuit of my improved engine as well as to control the current which drives the motor or the current of the electrical generator which charges the storage-batteries; and having fully described my invention, so that any one who is versed in the art to which it pertains can operate and use the same,

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

1. In a gas-engine, in which the torque of the rotating power-shaft varies according to an inverse ratio of the speed, the combination therewith, of ignition mechanism, and means controlled by the speed of the engine, whereby the ignition is automatically timed in such a manner as to automatically compensate for the loss of torque, due to increase of speed of said power-shaft, substantially as described.

2. In a gas-engine, in which the torque of the rotating power-shaft varies according to an inverse ratio of the speed, the combination therewith of ignition mechanism, and means controlled by the speed of the engine, whereby the ignition is automatically timed in such a manner as to automatically compensate for the loss of torque due to increase of speed of said power-shaft, and a fuel-feed mechanism driven by the engine for operating the same, and a hand controlling means for said driving mechanism for controlling the torque, substantially as described.

3. In a gas-engine, in which the torque of the rotating power-shaft varies according to an inverse ratio of the speed, the combination therewith of ignition mechanism, and means controlled by the speed of the engine, whereby the ignition is automatically timed in such a manner as to automatically compensate for the loss of torque due to increase of speed of said power-shaft, and a fuel-feed mechanism driven by the engine for operating the same and a hand controlling means for said driving mechanism for controlling the torque, and means controlled by the excess supply of said fuel for regulating the fuel-feed, substantially as described.

4. In a gas-engine, the combination with the rotary power-shaft thereof, of a fuel-feed mechanism, driven by the engine for operating the same; hand controlling means for said driving mechanism, and means controlled by the excess supply of said fuel for regulating the feed thereof, whereby the torque is controlled and regulated according to the variations in speed of said shaft, substantially as described.

5. In a gas-engine, having a carbureter adapted to convert liquid fuel for said engine into a gas, the combination of the valve or valves, adapted to admit said fuel to the carbureter, and means operated by said engine for carbureting the supply of fuel, which is adapted to pass through said valves, and of the supplemental controller for shutting off the supply of said liquid, actuated by an excess supply of liquid, when said gas shall have been oversaturated with said liquid fuel, substantially as described.

6. In a gas-engine, having an electrical igniting device, the combination of a stationary contact-making commutator, having the segments thereof diagonally disposed, a rotating brush revolving about said commutator, and a centrifugal governor, operated by said engine and connected to said brush, so as to move over the said stationary commutator, so as to vary time of ignition of the explosive mixture in the cylinder of said engine, substantially as described.

7. In an electric controlling and starting device for gas-engines the combination with suitable igniting-circuits, a storage battery charged by the engine and means for applying the power thereof to the engine-shaft, of a three-directional controlling-lever and connections whereby upon a movement thereof in one direction power is accumulated for starting the engine, by movement in another direction the ignition-circuits are thrown in, and upon movement in an opposite direction to the first movement the power accumulated in the storage battery will be applied to the engine-shaft for starting.

8. In an electric controlling and starting device for gas-engines the combination with suitable igniting-circuits, a storage battery charged by the engine and means for applying the power thereof to the engine-shaft of a controlling-handle capable of rocking about a pivot at right angles to its longitudinal axis and also movable about said longitudinal axis, and connections whereby when the handle is rocked in one direction power is accumulated for starting, when the handle is rocked in the opposite direction the accumulated power is applied to the engine-shaft for starting, and when the handle is moved about its longitudinal axis the ignition-circuits are thrown in or out.

9. In an electric controlling and starting device for gas-engines the combination of a storage battery charged by the engine and means for applying the power thereof to the engine-shaft, of a sparking igniter in circuit with the storage battery, an auxiliary ignition-battery also in circuit with the igniter and storage battery, and a controlling-lever and connections whereby movement thereof in one direction accumulates power for starting the engine-shaft, movement in the opposite direction applies the power accumulated to the engine-shaft, a third movement throws the storage battery onto the igniting-circuit,

and a fourth movement throws the auxiliary battery onto the igniting-circuit.

10. In an electric controlling and starting device for gas-engines the combination of a storage battery charged by the engine and means for applying the power thereof to the engine-shaft, of a sparking igniter in circuit with the storage battery, an auxiliary igniting-battery also in circuit with the igniter and storage battery, a controlling-handle capable of rocking about a pivot at right angles to its longitudinal axis and also movable about said longitudinal axis, and connections whereby rocking the handle in one direction accumulates power for starting, rocking it in the opposite direction applies the accumulated power to the engine-shaft, movement in one direction about its axis throws the storage battery onto the igniting-circuit and movement in the opposite direction throws the auxiliary battery onto the igniting-circuit.

11. In a gas-engine the combination with a sparking igniter of a storage battery charged by the engine and an auxiliary igniting-battery, both in circuit with the igniter and a single lever for throwing either the storage-battery current or the auxiliary-battery current onto the igniter at will.

12. In a controller for gas-engines the combination of a storage battery charged by the engine, means for applying the stored charge to the engine-shaft for starting, a variable rheostat, igniting-circuits including a sparking igniter, the storage battery and an auxiliary igniting-battery, a controlling-handle movable over the rheostat and capable of rocking movement in two directions and axial movement in two directions, and connections whereby the rocking movement introduces all the gradations of resistance both in energizing and discharging the storage battery, and the axial movement, according to its direction, throws the storage battery or the auxiliary battery into circuit with the sparker.

Signed at New York, in the county of New York and State of New York, this 13th day of March, A. D. 1900.

FREDRICK A. LA ROCHE.

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