E. ROUNDS.

EXPLOSIVE ENGINE.

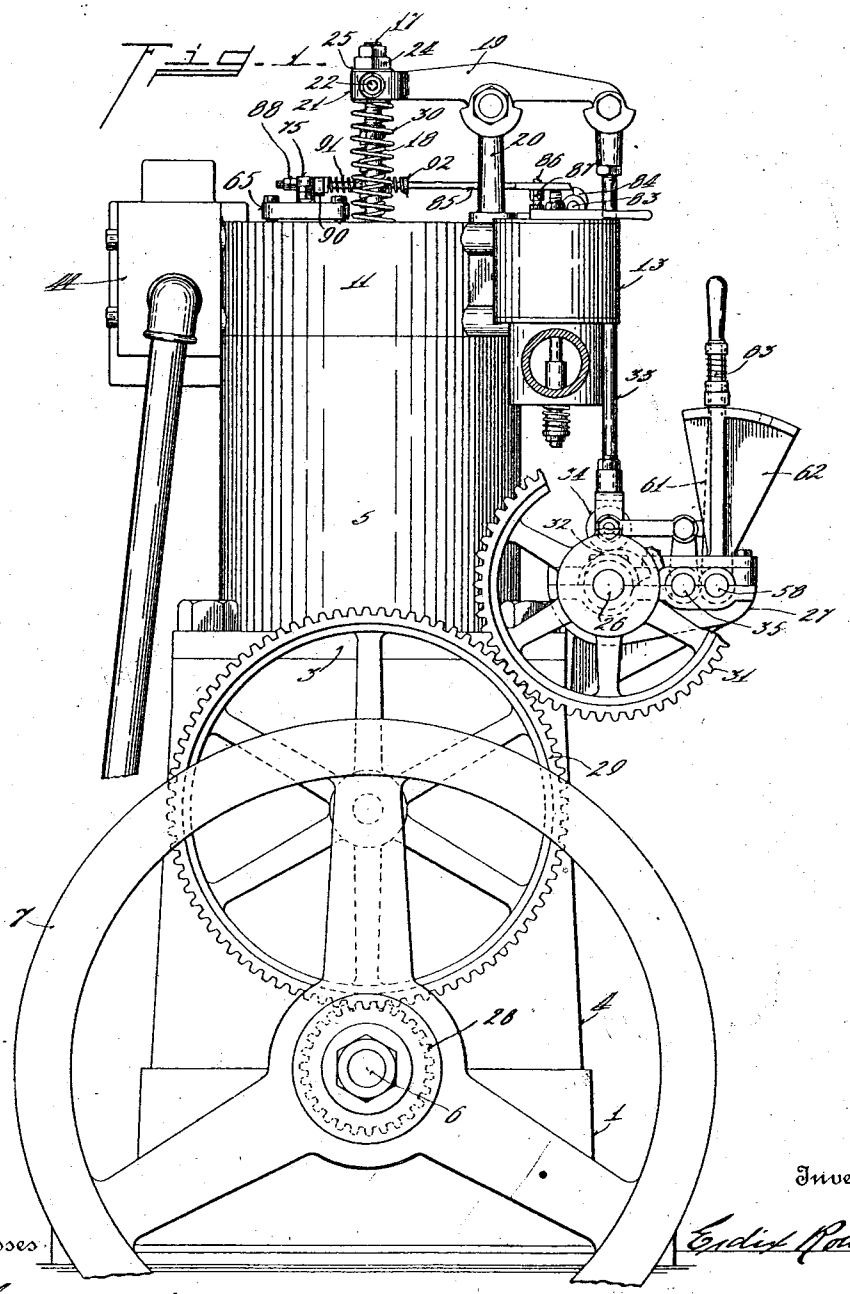
APPLICATION FILED MAR. 13, 1911.

1,175,820.

Patented Mar. 14, 1916.

6 SHEETS—SHEET 1.

Fig. 1.




Witnesses

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C. B. Foster

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Erskine Rounds

By Wood & Wood

Attorneys

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6 SHEETS—SHEET 2.

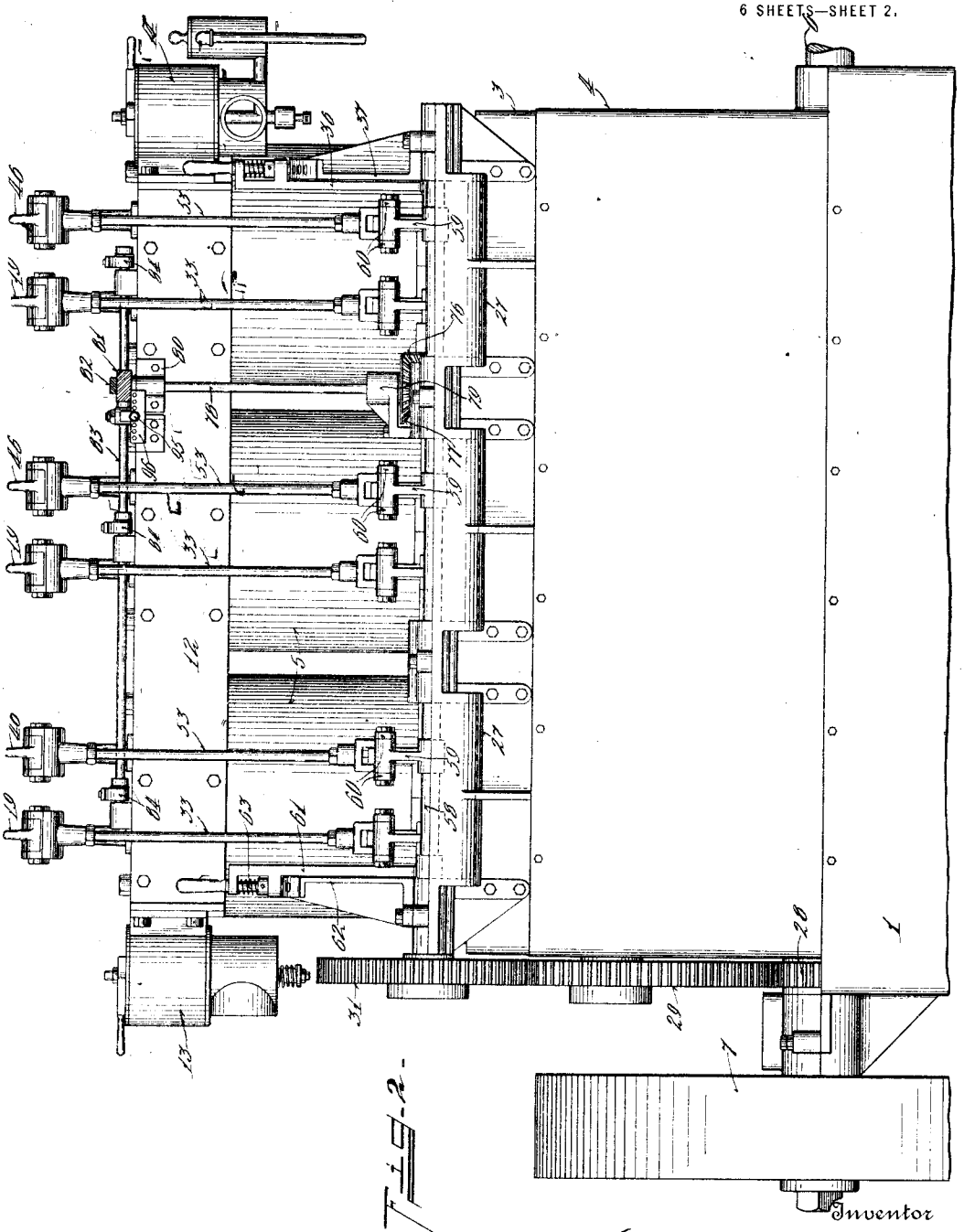


Fig. 2.

Witnesses

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EXPLOSIVE ENGINE.

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6 SHEETS—SHEET 3.

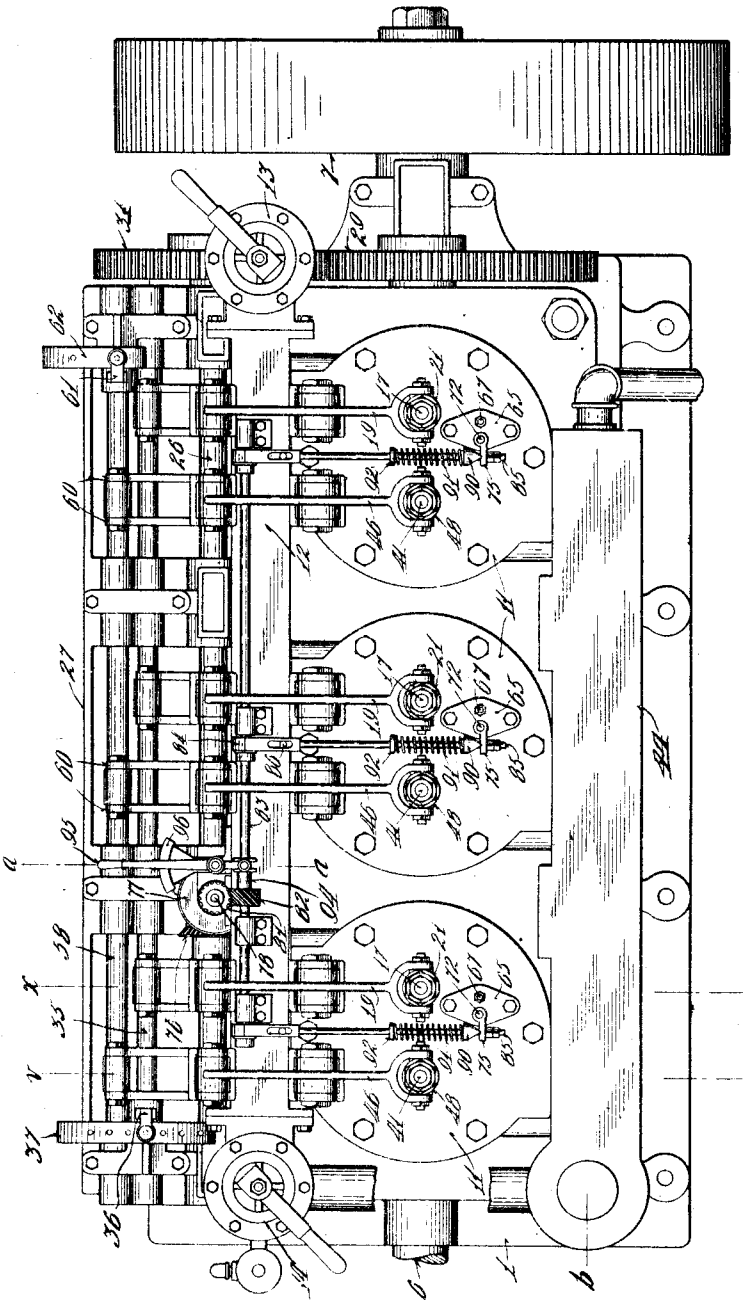


Fig. 3.

Witnesses

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E. ROUNDS.

EXPLOSIVE ENGINE.

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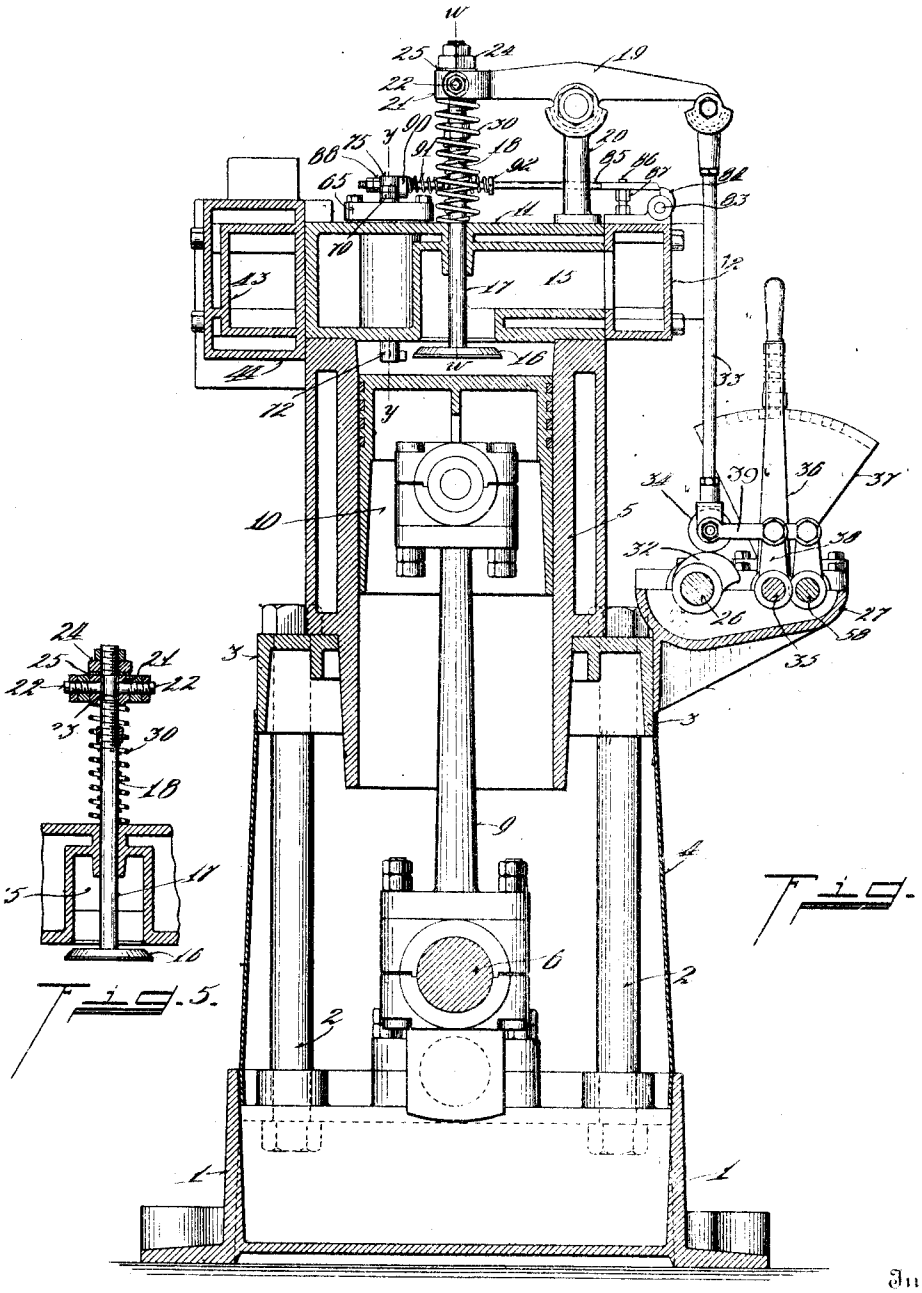


Fig. 4.



Fig. 5.

Inventor

Witnesses:

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EXPLOSIVE ENGINE.

APPLICATION FILED MAR. 13, 1911.

**1,175,820.**

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6 SHEETS—SHEET 5.

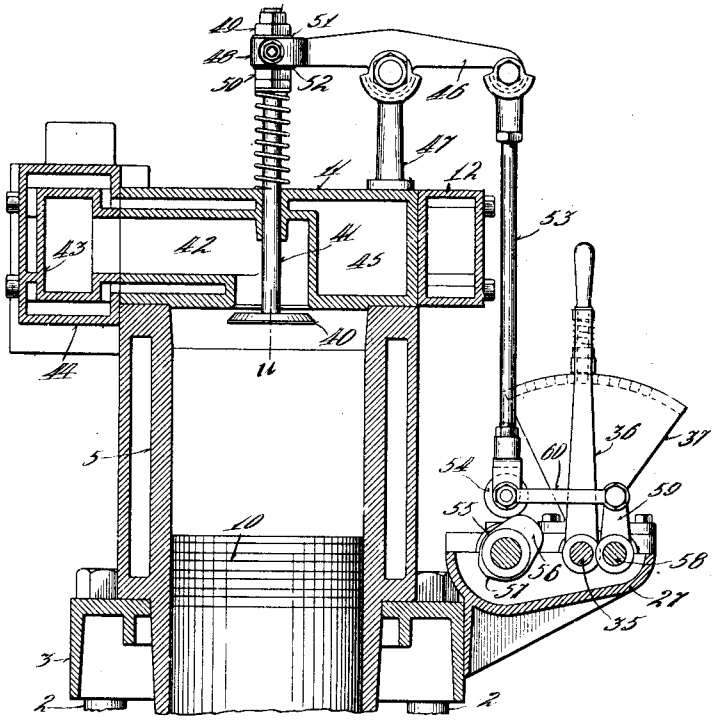


Fig. 6.

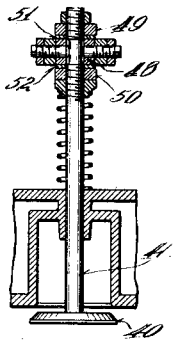


Fig. 7.

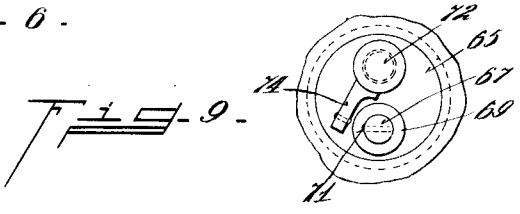


Fig. 9.

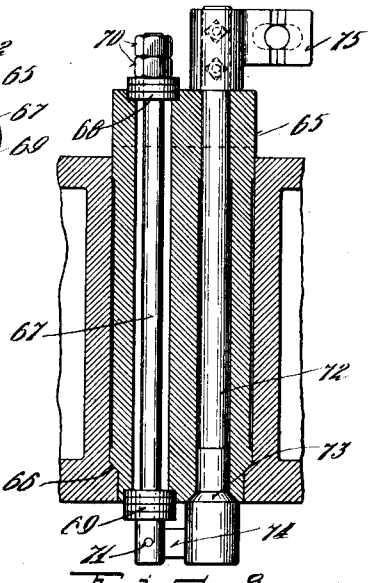


Fig. 8.

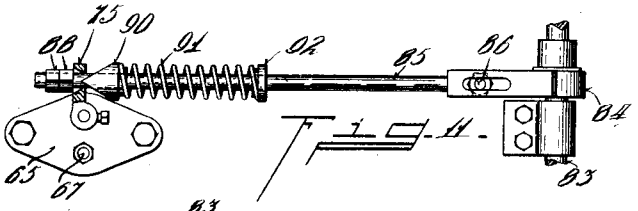


Fig. 11.

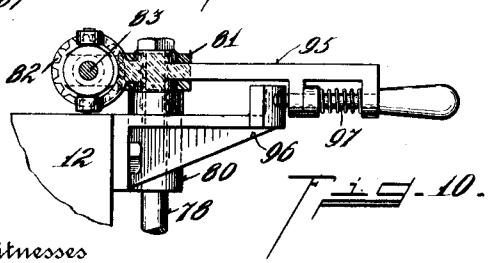


Fig. 10.

Witnesses

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E. ROUNDS.

EXPLOSIVE ENGINE.

APPLICATION FILED MAR. 13, 1911.

**1,175,820.**

Patented Mar. 14, 1916

6 SHEETS—SHEET 6.

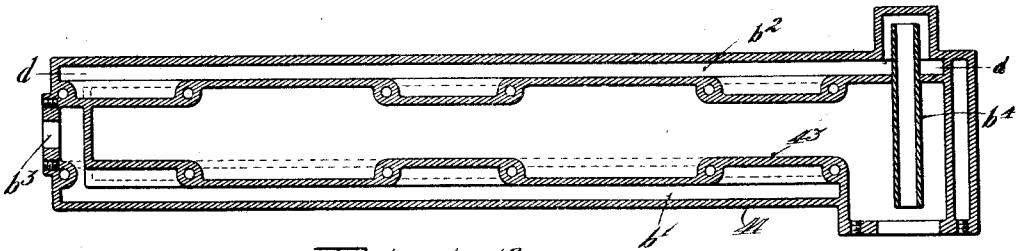



Fig. 12.

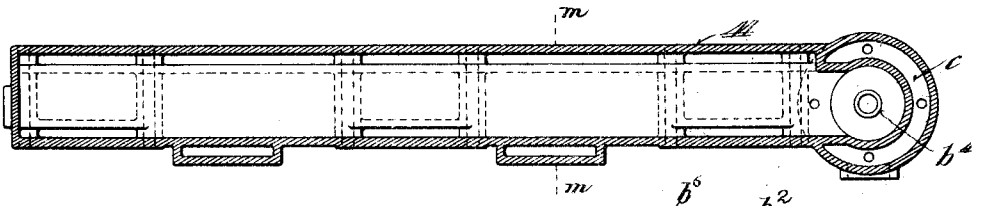



Fig. 13.

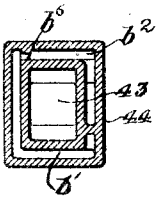



Fig. 16.

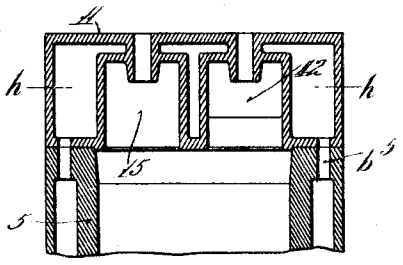



Fig. 14.

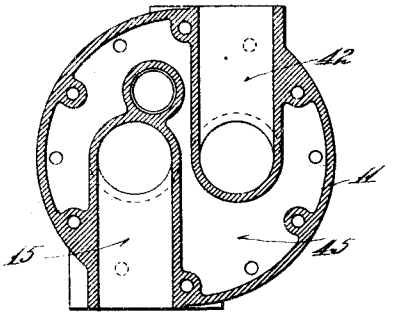



Fig. 15.

Witnesses

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Attorneys

# UNITED STATES PATENT OFFICE.

ERDIX ROUNDS, OF OWENSBORO, KENTUCKY, ASSIGNOR OF ONE-HALF TO GUNTHER-WRIGHT MACHINE COMPANY, OF OWENSBORO, KENTUCKY, A CORPORATION.

## EXPLOSIVE-ENGINE.

1,175,820. Specification of Letters Patent. Patented Mar. 14, 1916.

Application filed March 13, 1911 Serial No. 614,146.

*To all whom it may concern:*

Be it known that I, ERDIX ROUNDS, a citizen of the United States, residing at Owensboro, in the county of Daviess and State of Kentucky, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification.

My invention relates to an improvement in explosive engines, primarily of the four-cycle type.

One of the objects of my invention is to provide an explosive engine with means for controlling the intake valve relatively with the movement of the piston, and primarily during the suction stroke thereof, for variably controlling the length of time of valve opening, and in consequence controlling the compression requisite for an efficient operation. This is invaluable when moderate speed is desired, and when full power is not needed, in changing the kind of fuel or controlling the engine for various altitudes.

Another object of my invention is to provide means governing the control of the intake valve, whereby the valve can be operated by the suction stroke of the piston to insure opening at the proper time, together with power means for variably controlling the valve, whereby on the suction stroke of the engine, the valve is governed relative to the movement of the suction stroke of the piston; the valve can be maintained open for a full stroke of the piston, or lesser degree, or maintained closed.

Another object of my invention is to provide means governing the control of the exhaust valve, for varying the time of operation, whereby the exhaust valve can be held open in starting, after the engine has taken in a charge, relieving the compression relatively to the stroke of the engine.

Various other features of my invention relate to certain details of construction, illustrated in the drawings, and more fully set forth in the description thereof, forming a part of this specification, in which:—

Figure 1 is an end elevation of my improved engine, but with the various pumping mechanisms, common in engines of this class, omitted. Fig. 2 is a side elevation of the same. Fig. 3 is a top plan view of the same. Fig. 4 is a section on line *x*, *x*, Fig. 3. Fig. 5 is a section on line *w*, *w*, Fig. 4. Fig. 6 is a section on line *r*, *r*, Fig. 3, of the upper portion of the engine. Fig. 7 is a section on line *u*, Fig. 6. Fig. 8 is a section on line *y*, *y*, Fig. 4, through the sparker mechanism. Fig. 9 is a bottom plan view thereof. Fig. 10 is a section on line *a*, *a*, Fig. 3. Fig. 11 is a detailed top plan view of the sparker controlling mechanism. Fig. 12 is a section on line *b*, Fig. 3 through the exhaust conduit. Fig. 13 is a section on line *d*, *d*, Fig. 12. Fig. 14 is a central vertical section through one of the cylinder heads. Fig. 15 is a section on line *h*, *h*, Fig. 14. Fig. 16 is a section on line *m*, *m*, Fig. 13.

In the drawings, the engine is illustrated as a three-cylinder type of engine, but my improvements are equally applicable to a single cylinder engine, or any multiple type, and in the description, I will confine myself in general to the elements essential in the operation of the engine as a single-cylinder engine, without specifically describing duplicate parts, to form the multiple-cylinder engine, herewith illustrated.

1 represents the base plate, which is preferably of trough formation, to catch or receive the lubricating oil for the crank and crank shaft.

2 represents vertical supports secured to the base plate 1, and supporting the cylinder cross-plate 3.

4 represents a casing secured to said cross plate 3 and base plate, for inclosing the crank shaft and crank, whereby the lubricant is maintained within the reservoir base.

In practice provision is made to prevent the oil within the crank base from reaching the pistons, which would cause excessive oiling and a carbon deposit upon the combustion chamber. An oiling system for oiling the crank bearings and the various rotative and moving elements is provided, and the distribution of oil being effected by the use of pumps or otherwise, but as the system of lubrication does not form a part of this application specific details and descriptions thereof are omitted.

5 represents a cylinder suitably secured to the cylinder supporting cross plate 3, said cylinder being suitably water-jacketed, as is common in engines of this class.

6 represents a crank shaft, suitably journaled in bearings formed in the base plate 1, and 7 represents the fly-wheel.

9 represents the connecting rod and 10 the piston connected to the crank in the usual manner.

11 represents the cylinder head suitably bolted to the cylinder, said head being provided with ports and passages for the fuel inlet and exhaust, and which passages are suitably water-jacketed, as illustrated in Figs. 4 and 6.

12 represents a conduit, for conducting the fuel from either the mixer 13 or carbureter 14, to the inlet passages 15 of the series.

I have not illustrated the gas mixer or carbureter in detail. The fuel for the carbureter is pumped to a chamber within the carbureter and a constant level maintained. Atomizing and vaporizing is produced, preferably, by a hot-air blast drawn around a vaporizing nozzle, and the air is heated by passing through a chamber or conduit *c* formed around the exhaust conduit, see Fig. 13.

16 represents the inlet or in-take valve, and 17 the stem therefor, projected upwardly, passing through a bearing formed in the cylinder head 11.

18 represents a spring through which the stem projects, one end engaging the cylinder-head 11, and the opposite end, a nut threaded upon the stem 17, for adjusting the tension of the spring. This spring has a tension sufficient to hold the valve 16 on its seat, but not against vacuum pressure within the cylinder.

19 represents a lever for operating the valve pivotally mounted upon the support 20, secured or projected from the cylinder head 11. Upon one end of said lever, a collar 21 is pivotally mounted, see Fig. 5, through which the valve stem slidably passes, to permit certain limits of valve movement, independent from the main valve controlling mechanism. The rock lever 19 is preferably provided with the pintles 22, projected through the collar 21 and free therewith, providing a pivotal connection and projecting to the annular groove 23, formed on the valve stem 17.

24 represents a nut, adjustable on the end of the stem, and 25 represents the leather washer interposed between the nut and collar 21, serving as a cushion on the cut-off stroke of the valve.

30 represents a spring interposed between the collar 21, and the cylinder-head, and of a strength sufficient to seat the valve and yielding under excessive degrees of vacuum on the piston power stroke and holding the collar firmly against the washer 25, and nut 24, when the lever is released by its operating cam.

26 represents a cam shaft journaled within bearings formed in the reservoir bracket 27, secured to the cylinder or cross-plate 3. Said shaft is rotated through the train of gearing, illustrated in Fig. 1, in which, 28 represents a gear fixed to the crank shaft, and 29 represents an intermediate gear journaled upon a stud shaft supported upon the base frame of the engine. The gear 29 is in mesh with the gear 28, and a gear 31 fixed to the cam shaft 26.

32 represents a cam fixed upon the cam shaft 26, and 33 represents a connecting rod, having bifurcated or yoke ends, one end pivotally connected to the rock lever 19, the opposite end provided with a roller 34, adapted to travel upon the cam 32, thereby imparting action to the connecting rod 33, rock lever 19, and inlet valve.

The time of inlet valve operation can be changed or varied relative to the stroke of the piston controlling the admission of fuel within the cylinder, consequently changing the compression, thereby serving as a throttle for governing the speed and power of the engine. With the mechanism provided, it is possible to change the time of valve opening while the engine is running. The mechanism employed comprises the following:— 35 represents a rock shaft journaled in bearings formed in the reservoir brackets 27. 36 represents a lever connected to said rock shaft and projected parallel with the quadrant 37. The quadrant is provided with a series of orifices to definitely engage and lock the lever 36 to adjust the roller 34 and the connecting rod 33, and relative to the cam. 38 represents a rock arm, fixed to the rock shaft 35, and 39 represents a connecting link pivotally connected to the rock or crank arm 38 and the connecting rod 33. Thus, when the lever occupies the position shown in Fig. 4, the valve when the roller 34 engages the cam, will remain open for a half stroke of the piston, as the engagement between roller and cam are such that they do not engage or travel over the entire surface or area of the cam, but only a limited portion thereof. Moving the lever to its extreme right, will swing the roller and connecting rod completely out of the path of the cam, and in which position the valve will not open at all, and adjusting the lever 36 to the left from its intermediate position, will control the valve to remain open for a full stroke of the piston or lesser degree. Whenever the cam engages the roller to actuate the rod 33, and rock lever 19, it will move the collar 21 idly for a predetermined limit, compressing spring 30 without actuating the valve. This free movement enables the valve to open from slight suction, insuring opening at the proper time. The tension spring 18 is not great enough to resist the vacuum pressure. Therefore, in starting the engine, the valve is free to open during the

power stroke by suction, and is only seated in the suction stroke by the spring 30.

40 represents an exhaust valve provided with a valve stem 41, projected through a bearing formed in the cylinder head 11, for controlling the exhaust through the passage 42.

43 represents a conduit connecting with the exhaust passage 42, and within a second conduit 44, providing an intermediate passage, leading to the chamber 45, in the cylinder-head, forming a water jacket space around the inlet and exhaust conduits.

As shown in Figs. 12 and 13, the exhaust conduit 43 is water-jacketed its entire length, and with the second conduit 44 constructed to provide lower and upper passages $b'$ and $b^2$ respectively. These passages are substantially separate from each other to direct the flow of water through a specific course to advantageously cool the engine. Communication may, however, be established between the passages $b'$, $b^2$, by providing perforations $b^6$ in the wall separating said passages, as illustrated in Fig. 16. The lower passage $b'$ is provided with an inlet $b^3$ at one end, with the over-flow pipe $b^4$ at the opposite end, leading from the passage $b^2$ into the exhaust passage of the exhaust conduit 43. $b^5$ represents passages formed in the cylinder and cylinder heads, providing connections between the cylinder jacket space and cylinder head. The cooling water is pumped to the engine, through inlet $b^3$, passage $b'$, entering the cylinder heads at the exhaust valves, filling the cylinder space with the over-flow at the highest point, freeing the engine of all air and preventing air pockets. This is also advantageous in starting the engine after it has been drained in delivering water at once where the heat is, protecting the exhaust conduit and cylinder heads from becoming heated, and preventing the various parts from cracking, as is the case where cold water enters initially at the base of the cylinder.

The exhaust valve is controlled similarly to the inlet valve by cam and lever mechanism. 46 represents a rock lever pivotally mounted upon the support or strut 47, secured to the cylinder head 11. 48 represents a collar pivotally connected to the yoke end of the lever 46, and through which the valve stem passes and is secured thereto, preferably, by the upper and lower nuts 49, 50, and interposed leather or fiber washers 51 and 52. Thus, in the valve opening movement of the rock lever, it will cause the collar to bear on the washer 52, thereby cushioning the connection between collar and valve stem, and with a like result in the seating of the valve. 53 represents a connecting rod, pivotally connected to the rock lever 46, at one end, with its opposite end provided with a roller 54, adapted to engage a double faced cam 55, in which the cam 56 thereof, may be termed the exhaust cam, and the cam 57, the relief cam, the latter being used in starting only, holding the exhaust valve open after a charge has been taken into the cylinder, relieving the compression a portion of the piston stroke. The relief cam will not, however, change the time of the exhaust valve. The roller and connecting rod are adapted to be adjusted, so that they will not engage the relief cam when the engine is running at full power.

58 represents a rock shaft journaled in bearings formed in the reservoir brackets 27. 59 represents a crank arm fixed to the shaft 58, and 60 represents a link pivotally connected to the crank arm 59, and connecting rod 53. 61 represents a lever fixed to the rock shaft 58, and projected parallel with a quadrant 62, secured to the bracket 27, see Fig. 1. The lever 61 is provided with a handle spring-controlled detent 63 adapted to engage with orifices formed in the quadrant to lock the lever in its adjusted position. Thus, by shifting the lever 61, the roller and connecting rod can be moved within or out of the path of the relief cam 57. With the lever in the position, shown in Fig. 1, the parts are in position to be engaged by the relief cam 57, and when the lever is shifted to the right, the roller will miss said cam.

The exhaust valves are timed to give the best results at a given speed and by the variable control the lever 61 can be placed to give the proper timing to suit the speed while the engine is in motion, enabling the operator to observe the best position.

The variable cut-offs of the intake valve permit the piston to start down without any resistance, the valve closing after the piston has momentum, and creating a suction resistance at the end of the piston travel, relieving the crank of this resistance of checking the momentum of the reciprocating parts. In case the intake valve seats at the half-stroke of the piston, increased expansion is had from sixty down to ten pounds, where a fixed valve would exhaust at sixty pounds, losing this expansion. Indicator tests have shown the mean effective pressure of ninety pounds with this cut-off, using twenty-five per cent. less fuel than the fixed valve motion. With my variable valve adjustment, all the adjustments can be made while the engine is running, enabling an exact determination for producing the best results. For example, take an aeroplane at sea level; if the engine has proper compression when it reaches a higher point, the compression is only one-half. With my improvement, the engineer can keep the compression right, securing a rated power at all altitudes. The same can also be said in making

a change from one fuel to another for maintaining the proper compression.

As illustrated, when two or more engines are connected in units, the cam shaft 26 and rock shafts 35 and 58 are extended, to engage with and control the valve mechanism simultaneously, of each engine throughout the series. The valve mechanism, in each instance, being duplicates of those hereinbefore described, with one lever controlling all inlet valves, and a second, all the exhaust valves. The cylinder heads are likewise duplicates of each other and with the inlet and exhaust conduits leading thereto, forming main supply and exhaust passages, for the entire series. In providing the bracket 27 of reservoir form, providing an oil receptacle, all the cams and parts are thoroughly lubricated necessary to a free running of an engine.

To aid in explaining the operation and control of the inlet and exhaust valves, let it be assumed that the piston of one of the engines is moving downwardly on the suction stroke, during which relative interval the cam 32 is in a position to engage with the rod 33 and depress the spring 30 to relieve the valve of the spring pressure. The spring 18 is a weak spring, sufficient to hold the valve to its seat under atmospheric pressures on both sides of the valve. Thus the diminishing or suction pressure within the cylinder will readily unseat the valve when it is relieved from the pressure of spring 30. Now assume in starting the engine that the inlet valve is closed and the cam in a position opposite from its rod engaging position and the piston moves downwardly on the power stroke of the engine. Under such condition it is desirable to relieve the parts of the vacuum or diminishing atmospheric pressure within the cylinder. This is automatically accomplished when such internal pressure becomes slightly greater than the pressure of the spring 30, whereby the spring will be compressed opening the valve, causing instant relief, reducing the internal negative atmospheric pressure or vacuum. By adjusting the rod 33 and definitely locating the same relative to the cam, the inlet can be closed at any point of the suction stroke of the piston or adjusted so that the cam will not operate the rod 33, in which instance the vacuum within the cylinder on such stroke will automatically open the valve, when its pressure exceeds that of the spring 30.

The exhaust valve is positively actuated by the exhaust cam to open the same and closed by the spring, with the rod 53 adjustable to various positions relative to the cam. Its relative time of operation can be varied, as for instance at low speed the exhaust valve is opened late and at high speed is open early, with the condition at all times within the control of the operator while the engine is in motion. With the relieving cam on the same axis with the exhaust cam it will operate the connecting rod 53 when the rod is stationed to engage said cam in which instance the cam will operate to open the exhaust valve on the compression stroke of the piston. This is of advantage in starting to relieve the engine of such resistance.

The sparking mechanism and its control comprise the following instrumentalities: 65 represents a plug, for supporting the spark-electrodes leading into the cylinder and projecting through the cylinder head, having a ground joint 66, bearing upon the seat formed in the cylinder head, providing a tight connection between the two members. 67 represents a stationary electrode projected through a bore of larger diameter formed in the plug 65. 68, 69 represent mica washers for insulating the electrode 67, from the plug, with the electrode secured in position by the nuts 70. The inner end of the electrode is provided with a contact pin 71. The movable electrode comprises a rod 72, journaled in elongated bearings formed in the plug 65, and with the intermediate portion thereof of smaller diameter than the bore in the plug, providing clearance, which prevents sticking and affords easy removal. The rod at its lower end has a conical shoulder 73, fitting into a ground seat in the plug, thereby excluding the heat from the annular space surrounding the rod or the escape of products of combustion. 74 represents an arm projected from the rod, provided with a contact pin, adapted to engage the contact pin 71, of the stationary electrode, when the rod 72 is rocked. 75 represents an anvil arm sleeved upon the rod 72, and held securely thereon by the set-nut, which allows the arm to be adjusted to take up for wear between the electrode connections with the plug.

The movable electrode is actuated by the following mechanism:—76 represents a bevel gear, see Fig. 2, fixed to the cam shaft 26, in mesh with a bevel gear 77, fixed to the shaft 78. The shaft 78 is journaled in bearing brackets 79 and 80, mounted on the bracket 27 and fuel conduit 12, respectively. 81 represents a spiral gear, fixed on the shaft 78, in mesh with a spiral gear 82, splined on the cam shaft 83; see Figs. 3 and 10. The cam shaft 83 is extended to convey motion and operate the electro-tripper mechanism of each engine in a series having a cam mounted thereon for each of the tripper mechanisms with each cam arranged relatively for a proper timing of ignition to each of the engine cylinders. These are the duplicates of each other, and, therefore, I will only describe one of them in detail. 84 represents a cam on the cam shaft 83, adapted to engage and actuate the trip rod 85, in

certain timed periods in its rotation. The trip rod 85, at its cam engaging end, is slotted, through which a guide and supporting stud 86 projects, and 87 represents a nut adjustable thereon, and upon which trip rod rests and slides, and whereby it can be alined and adjusted relative to the cam. The opposite end of the trip rod 85 projects through a tapering orifice in the anvil arm 75, to provide a universal connection therewith; and 88 represents a nut threaded upon the trip rod 85, abutting the anvil arm to maintain the connection between the parts in one direction of movement. Upon the opposite face of the arm 75, a knife edged sleeve 90 engages, slidably supported upon the trip rod 85, providing a hinged connection with the anvil arm. 91 represents a spring upon the trip rod interposed between the sleeve 90, and nut or collar 92, fixed to the rod, to yieldingly maintain the sleeve in engagement with the anvil arm 75, and to impart motion thereto, when the tension of the spring is sufficient to overcome the resistance of the movable electrode through the compressing movement of the trip rod 85.

The ignition mechanism is what is known as the "make and break" type, and in producing [illegible] the shoulder of the cam 84, engages the trip rod 85, moving the same through the anvil arm 75, compressing the spring 91, and through the spring energy moves the arm 75, rod 72, and electrode arm 71, bringing the pins of the stationary and movable electrode into contact with each other to complete an electric circuit. Upon further rotation of the cam 84, the trip rod 85 is released and the spring 91 will force it to normal position, separating the electrodes by a hammer blow on the anvil arm 75, thereby making a quick break. By this construction, but one spring is employed, and a very little action is had on any of the moving parts, and no stop plug is required to hold the parts in proper position. The movement of the trip rod is the same for either early or late ignition, and such ignition is controlled as follows:—The spiral gear 82, as before stated, is splined on the cam shaft 83, to permit lateral movement thereof, and provided with a sleeve extension 94. 95 represents a hand lever pivotally mounted upon the quadrant 96, secured to the fuel conduit, with one end of said lever [illegible] to engage into the annular groove, formed on the sleeve extension 94, of the spiral gear 82. 97 represents a spring controlled detent, adapted to engage into orifices in the quadrant, to lock the lever 95 in any adjustable position. Thus, as the gear 82 is shifted laterally, to the right or left, it will advance or retire the cam relative to the time controlled movements of the inlet valve and piston, thereby producing early or late ignition, as desired, and when the lever 95 is locked in any adjustable position, such early or late ignition will be constant and continued.

The general design and arrangement of my engine affords compactness, accessibility, and thorough lubrication, and all parts under absolute control with any and all fuel insuring the correct compression, and thereby providing a greater power.

Having described my invention, I claim:—

1. An internal combustion engine of the nature disclosed combining an induction valve and seat therefor, pressure means for closing said valve yielding to excessive degrees of vacuum within the engine cylinder upon said valve for valve opening, a rotative cam member, a swinging actuator adapted to be actuated by said cam member imparting motion to said spring to relieve the valve of its pressure and means for determinately swinging said actuator to alter its cam engaging station for varying the periodicity of cam actuation.

2. An internal combustion engine of the nature disclosed combining an induction valve and seat therefor, pressure means for closing said valve yielding to excessive degrees of vacuum within the engine cylinder upon said valve for valve opening, a rotative cam member, a swinging actuator adapted to be actuated by said cam member imparting motion to said spring to relieve the valve of its pressure and means for determinately swinging said actuator to alter its cam engaging station for varying the periodicity of cam actuation or position in neutrality.

3. An internal combustion engine of the nature disclosed combining an induction valve and seat therefor, a spring for closing said valve yielding to excessive degrees of vacuum upon said valve within the engine cylinder for valve opening, a second spring for closing said valve under balanced pressures upon both sides of said valve and yielding to any prevailing vacuum within the engine cylinder, when said valve is relieved of the pressure of said first named spring, a rotative cam member, a swinging actuator adapted to be actuated by said cam member imparting motion to said first-named spring to relieve the valve of its pressure, and means for determinately swinging said actuator to change its cam engaging or non-engaging station.

4. An internal combustion engine of the nature disclosed combining a valve and seat therefor, a rotative cam member, a rocking member coöperating with said valve, an actuator rod fulcrumed upon said rocking member and adapted to be actuated by said cam member, and adjusting device connecting with said actuator rod to swing its cam engaging end transversely to the cam axis for determining its cam engaging station to

vary its periodicity of cam coöperation or position said actuator to neutrality.

5. An internal combustion engine of four cycle type of the nature disclosed combining an inlet valve and seat therefor, a spring for seating said valve under atmospheric pressure on both sides thereof, a second spring expanding to close said valve, contracted to relieve the valve from its pressure on the first or suction stroke of the engine piston and releasable and capable of resisting normal diminishing pressure within the cylinder at any point during said first piston stroke, a rotary cam member, a reciprocating member for contracting said second spring actuated by said cam member during the suction stroke of the piston and an adjusting device operatively connected with said reciprocating member for determining the actuating period of said reciprocating member.

In testimony whereof, I have hereunto set my hand.

ERDIX ROUNDS.

Witnesses:
JNO. S. WRIGHT,
E. W. PEGNAM.