J. R. HARBECK.

EXPLOSIVE ENGINE.

APPLICATION FILED JUNE 11, 1909.

1,166,902.

Patented Jan. 4, 1916.

2 SHEETS—SHEET 1.

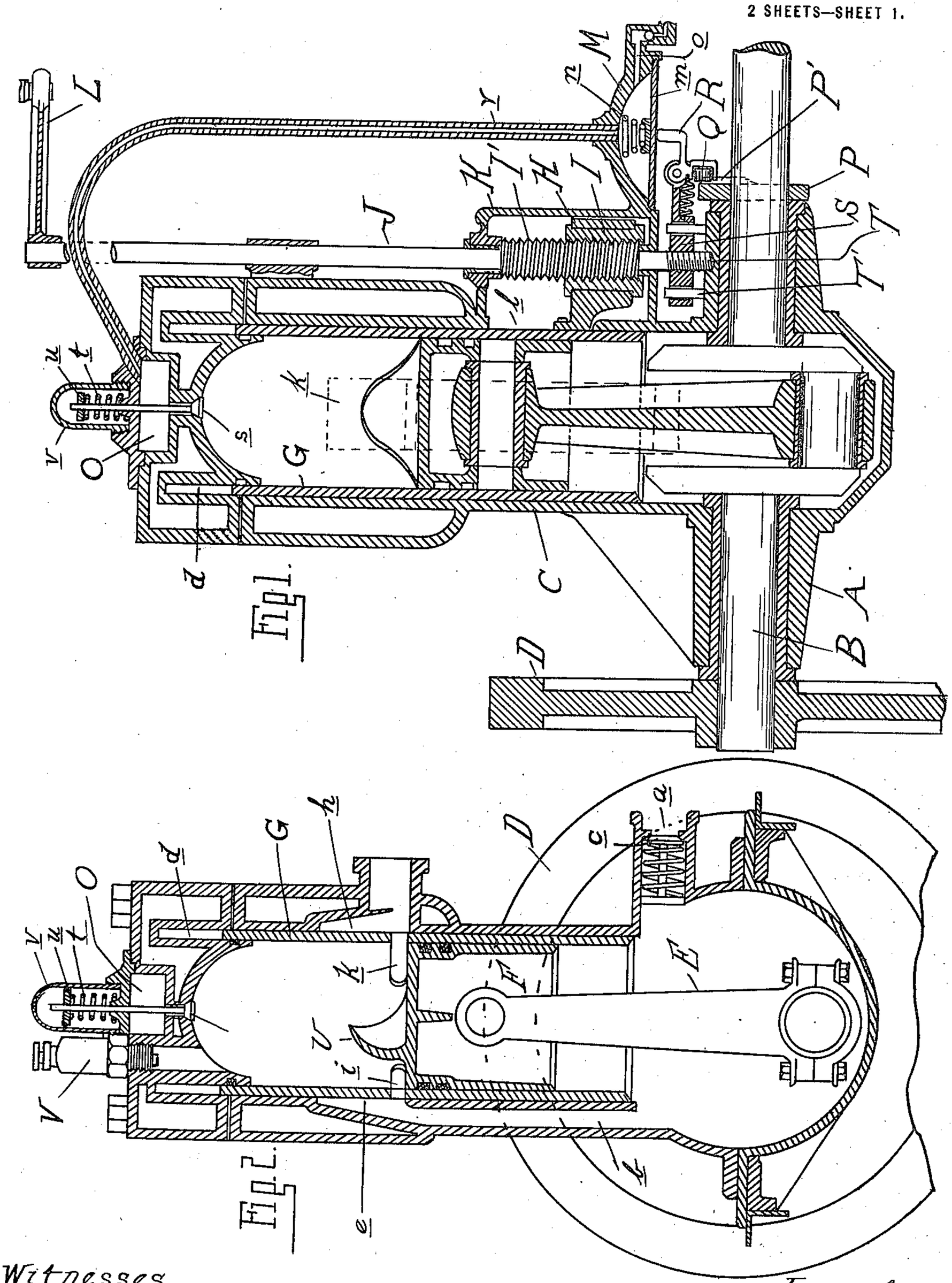

Fig 1.

Fig 2.

Witnesses

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2 SHEETS—SHEET 2.

Fig 4.

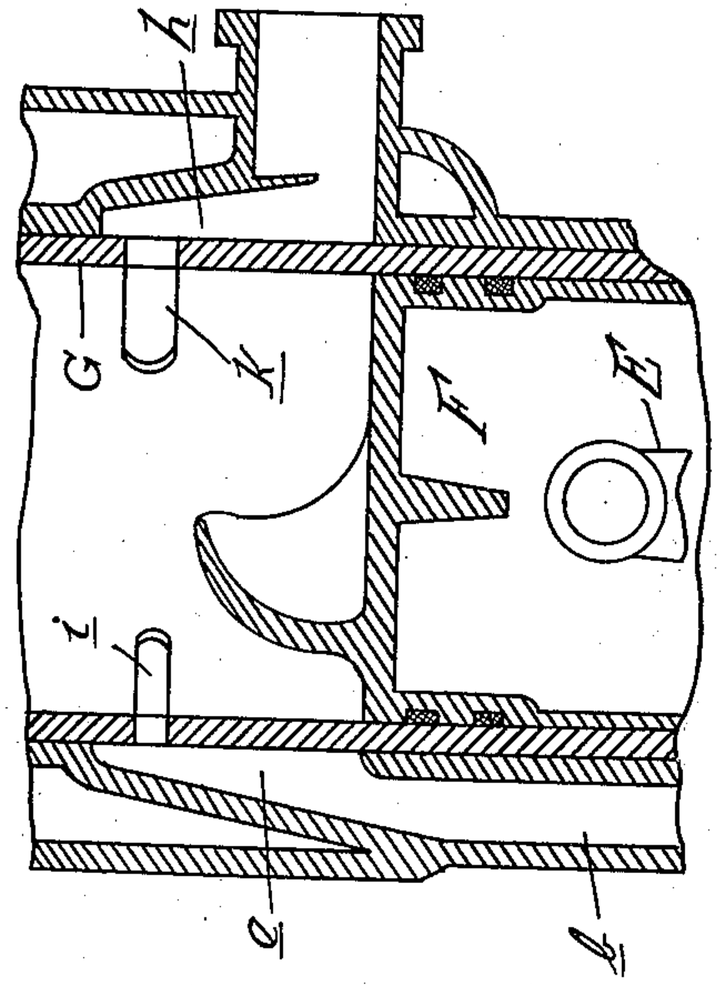


Fig 5.

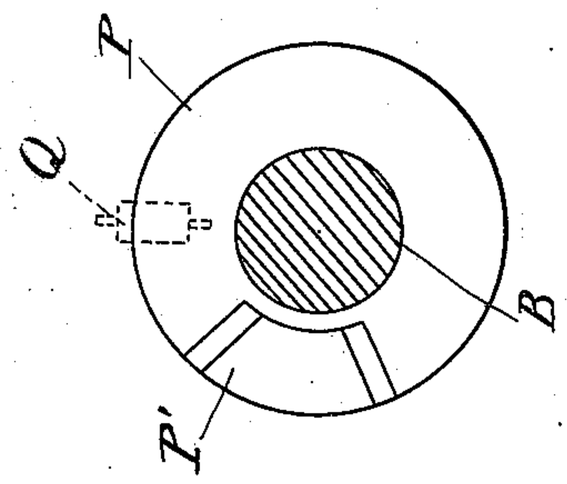
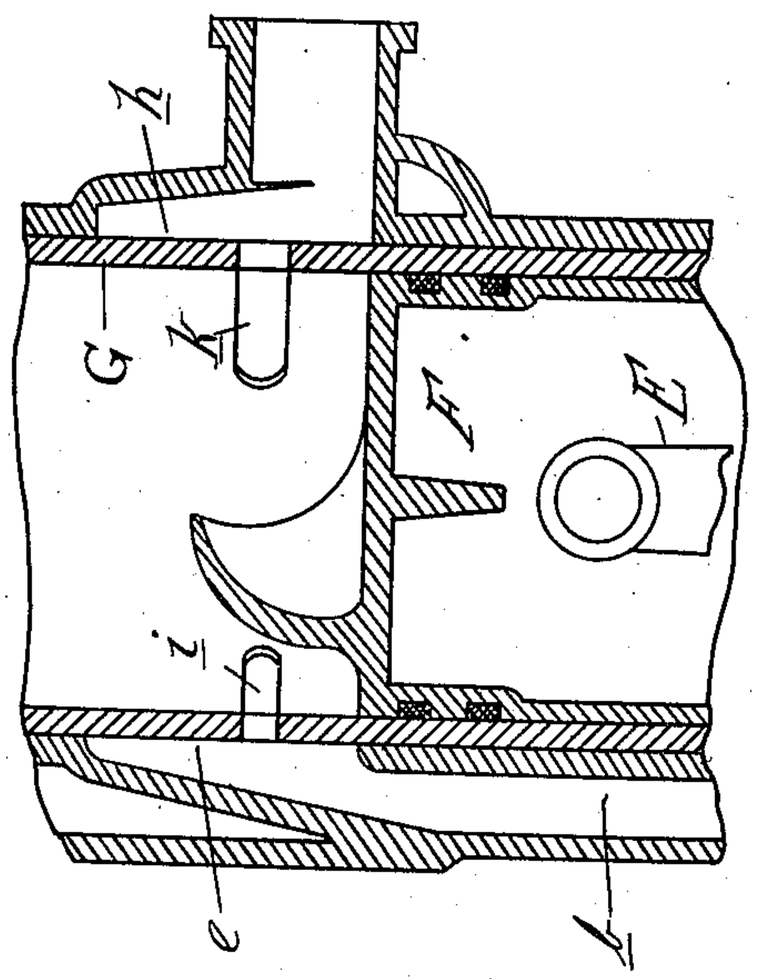


Fig 3.



Witnesses

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UNITED STATES PATENT OFFICE.

JERVIS R. HARBECK, OF DETROIT, MICHIGAN.

EXPLOSIVE-ENGINE.

1,166,902. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed June 11, 1909. Serial No. 501,609.

To all whom it may concern:

Be it known that I, JERVIS R. HARBECK, a citizen of the United States of America, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

The invention relates to that type of gas engine known as a two-cycle engine, and more particularly to a two-cycle engine in which the cylinder is scavenged by air and the hydrocarbon supplied to the compressed-air charge.

The invention consists in means for varying the amount of the air-charge by adjusting the exhaust port in the cylinder longitudinally thereof, and in the means for varying the amount of the hydrocarbon supplied to the compressed-air charge, and also in the means for effecting the variation in the air-charge and in the amount of hydrocarbon supplied, simultaneously and in proportionate ratio; and further, in the construction and arrangement in combination of the various parts, all as more fully hereinafter described and particularly pointed out in the claims.

In the drawings: Figure 1 is a vertical central longitudinal section through a gas engine embodying my invention; Fig. 2 is a vertical central section through Fig. 1; and Figs. 3 and 4 are sections similar to Fig. 2, of the engine cylinder, showing the different points of adjustment of the exhaust-port. Fig. 5 is a detail side view of a disk cam and coöperating roller which in the invention actuate the oil feed.

A is the crank case, B the crank-shaft, C the cylinder, and D the fly-wheel—of a gas engine of the two-cycle type. The crank-case has an air-inlet port *a* and the port *b* leading from the crank-case to the cylinder. The air-inlet port *a* is shown as provided with a check-valve *c*.

E is the connecting-rod, F the piston.

The cylinder proper of the embodiment of my invention which I have herein shown is of slightly larger diameter than the piston, and is lined with a cylindrical sleeve G which, at its upper end, engages in a cylindrical slot *d* in the head of the cylinder. The cylinder proper is provided, upon opposite sides, with the elongated inlet-port *e* and the elongated exhaust-port *h*.

The lining G of the cylinder is provided on one side with the inlet-port *i* and on the opposite side with the exhaust port *k*. These ports *i* and *k* register with the ports *e* and *h*, being of lesser dimension longitudinally of the piston, so that if the sleeve is adjusted longitudinally the inlet and exhaust ports will be adjusted at different points in the stroke of the piston. This adjustment of the sleeve G with its ports may be effected by any suitable mechanism, that which I have shown consisting of a bracket H projecting through a slot *l* in the wall of the cylinder proper, this bracket having secured to it a nut I with which a screw I′ on the shaft J engages. This screw being held against endwise movement, if the shaft is turned, it is obvious that the nut I with the bracket and sleeve G will be moved vertically.

The parts just described are inclosed in a lateral extension K on the side of the cylinder, the shaft J passing through a suitable stuffing-box and being provided at its upper end with actuating means, such as the crank handle L.

The means I have shown for injecting the hydrocarbon into the compressed-air charge comprises a diaphragm pump M—which I have shown arranged beside the extension K—this pump having a flexible diaphragm *m* held in a normal position by the spring *n*; *o* being the inlet-connection for the gasolene or other hydrocarbon, and *r* the discharge connection leading to the cylinder-head.

In the cylinder-head I have shown a chamber O into which the pipe *r* discharges, this chamber having an outlet in its lower face controlled by a check-valve *s* which is held to its seat by a spring *t* bearing against a nut *u* on the stem of the valve. The spring, stem, and nut, I have shown as inclosed in the casing *v*.

On the shaft B is a disk P having on its side-face a cam P′ adapted to engage a roller Q on a vertical-arm of the bell-crank lever R pivoted on the nut S. The other end of this bell-crank lever is adapted to engage with the diaphragm M to push the same in and thus effect the pumping of the gasolene through the pipe *r* to the cylinder.

The nut S is carried on a reversely screw-threaded extension T of the shaft J, being held from rotation by means of the guide-pins T′ on the crank-casing. By turning the shaft J and its extension T the nut S

will be raised and lowered, and such raising and lowering will adjust the bell-crank lever R to or from the diaphragm *m* so as to adjust the throw or movement of that diaphragm and thus vary the amount of gasolene pumped.

I proportion the thread of the screw I′ and that upon the extension T so that as nearly as possible the amount of gasolene injected into the cylinder will be of uniform ratio to the amount of air compressed in the cylinder by the piston irrespective of the position in which the sleeve G is adjusted.

The parts being thus constructed, their operation is as follows: In the operation of the engine air is compressed in the crank-case on the downward stroke of the piston, and when the piston uncovers the port *i* the cylinder is scavenged by the air entering therein and passing up over the deflecting plate U and out through the exhaust port *k*. As the piston returns the ports *i* and *k* are closed and the air remaining in the cylinder is compressed. At the desired point fixed by the shape of the cam P′, and after the air is partially compressed, the diaphragm pump M will be operated, the pressure of the gasolene overcoming the tension of the spring *t*, lifting the valve *s* from its seat and spraying the charge of gasolene into the top of the cylinder. A spark-plug V ignites the charge, and the explosion returns the stroke for the repetition of the operation.

By adjusting the sleeve G longitudinally of the cylinder it is obvious that the amount of air compressed will be varied. I have shown in Figs. 3 and 4 different points of adjustment of the sleeve, with its ports, in relation to the cylinder and its piston.

By proportioning the charge of gasolene to the charge of air compressed the proper mixture for explosion may be maintained at all times, and yet the power of the engine can be varied because of the variation of the size of the charge and the compression thereof, due to variation in the position of the inlet and exhaust ports and the amount of gasolene injected therein.

The adjustment of the nut S carrying the bell-crank lever R not only adjusts the amount of gasolene which will be discharged into the cylinder but also changes the time relative to a given point of travel at which the injection takes place. Inasmuch as the lowering of the nut S withdraws the bell-crank lever farther from the diaphragm, and as that bell-crank lever has a uniform travel for each operation, there will be a greater lost motion when the bell-crank lever is in the lower postion before it strikes the diaphragm, and hence a retarding of the time of operation of the pump. This enables me to insure the closing of the exhaust-port, even if the same is at its highest point of adjustment, before the gasolene will discharge into the cylinder.

It is well-known that a two-cycle engine is a desirable engine to manufacture because of its cost, but it is extravagant in operation, and it has been heretofore impossible to effect a variation in the power with a corresponding reduction in the amount of fuel used, maintaining a proper mixture for the explosive charge. With my construction I am enabled to overcome the objection heretofore existing in a two-cycle engine, and to vary the charge—always of the proper mixture—by the construction described.

The construction herein shown is but a single form in which my invention may be embodied, and it is obvious that it can be produced in a number of other forms embodying the spirit of my invention.

What I claim as my invention is:

1. In a two cycle internal combustion engine, the combination with a cylinder, of means for scavenging the cylinder with air and for leaving a residual charge of air therein, a piston acting to periodically compress the residual charge of air, means for injecting a hydrocarbon into the compressed charge of air, and a normally stationary member manually adjustable to vary the amount of air to be compressed by the piston.

2. In a two-cycle internal combustion engine, the combination with a cylinder, of means for scavenging the same with air and for leaving a residual charge of air therein, a normally stationary member manually adjustable during the running of the engine to vary the amount of air to be compressed by the piston, means for injecting a hydrocarbon into the compressed air charge in the cylinder, and means for effecting a variation in the hydrocarbon charge complementary to the variation of the air compressed.

3. In a two-cycle internal combustion engine, the combination of means for scavenging the cylinder with air, means for injecting a hydrocarbon into the compressed air charge, and a normally stationary mechanism rotatively adjustable for effecting a complementary variation in the amount of air compressed and in the hydrocarbon injected.

4. In a two-cycle internal combustion engine, the combination of means for scavenging the cylinder with air and for leaving a residual charge of air therein, means for injecting a hydrocarbon into the compressed air charge in the cylinder, and a normally stationary member manually rotatively adjustable to effect a complementary variation in the amount of air compressed and in the hydrocarbon injected.

5. In a two-cycle internal combustion en-

gine in which the piston controls the exhaust port the combination with means for scavenging the cylinder with air and means for injecting hydrocarbon into the compressed air charge in the cylinder, of an element carrying the exhaust port, means for adjusting said element and with it the exhaust port longitudinally of the cylinder and means for varying the amount of hydrocarbon injected.

6. In a two-cycle internal combustion engine in which the piston controls the exhaust port, the combination with means for scavenging the cylinder with air and means for injecting hydrocarbon into the cylinder as the piston moves upward to compress the air, of an element carrying the exhaust port and means for simultaneously and proportionately adjusting said element, and with it the said exhaust port longitudinally of the cylinder and varying the amount of hydrocarbon injected.

7. In a two-cycle internal combustion engine in which the piston controls the exhaust port, the combination of an adjustable element carrying the exhaust port, means for adjusting said element longitudinally to arrange the port at different points longitudinally of the cylinder, means for injecting hydrocarbon into the compressed air charge in the cylinder and means for varying the time of such injection.

8. In a two-cycle internal combustion engine in which the piston controls the exhaust port, the combination of an adjustable element carrying the exhaust port, means for adjusting said element and its port longitudinally of the cylinder, adjustable means for injecting hydrocarbon into the compressed air charge and a common actuating device for effecting both adjustments.

9. In a two-cycle internal combustion engine, the combination of a movable sleeve in the cylinder having the exhaust port therein, which port is controlled by the piston, means for injecting a hydrocarbon into the cylinder, and a common means for adjusting the sleeve longitudinally of the cylinder and the time of operation of the hydrocarbon injecting device.

10. In a two-cycle internal combustion engine in which the piston controls the exhaust port, the combination of an element carrying an exhaust port from the cylinder, means for adjusting the said element longitudinally of the cylinder, means for injecting hydrocarbon into the cylinder and means for simultaneously adjusting the relative time of said injection and the volume injected, reducing the volume of hydrocarbon as the time of injection is retarded and increasing the volume as the time of injection is advanced.

11. In a two-cycle internal combustion engine in which the piston controls the exhaust port, the combination of an element carrying an exhaust port, means for adjusting said element longitudinally of the cylinder, hydrocarbon injecting means, and means for simultaneously adjusting the timing of the hydrocarbon injection means and the volume injected and the position of the exhaust port, whereby as the exhaust port is advanced the time of injection and volume injected is retarded and as the exhaust port is withdrawn the time of injection is advanced and the volume increased.

12. In a two-cycle internal combustion engine, the combination of a movable sleeve in the cylinder having the exhaust port therein controlled by the piston, a pump for injecting hydrocarbon into the cylinder, a shaft for adjusting said sleeve, and a connection from said shaft to adjust the time and volume of discharge of the pump complementarily to the adjustment of the sleeve.

13. In a two-cycle internal combustion engine, the combination with a cylinder and piston, of means for scavenging the cylinder with a uniform charge of air, a member adjustable within the cylinder for varying the amount of air to be compressed by the piston, means for injecting a hydrocarbon into the compressed charge, and a common means for adjusting said member within the cylinder and effecting a complementary variation in the hydrocarbon charge.

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

JERVIS R. HARBECK.

Witnesses:
JAMES P. BARRY,
ADELAIDE F. ADAMS.