

J. N. WILLIAMS.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED SEPT. 5, 1914.

1,139,617.

Patented May 18, 1915.

3 SHEETS—SHEET 1.

Fig. 1.

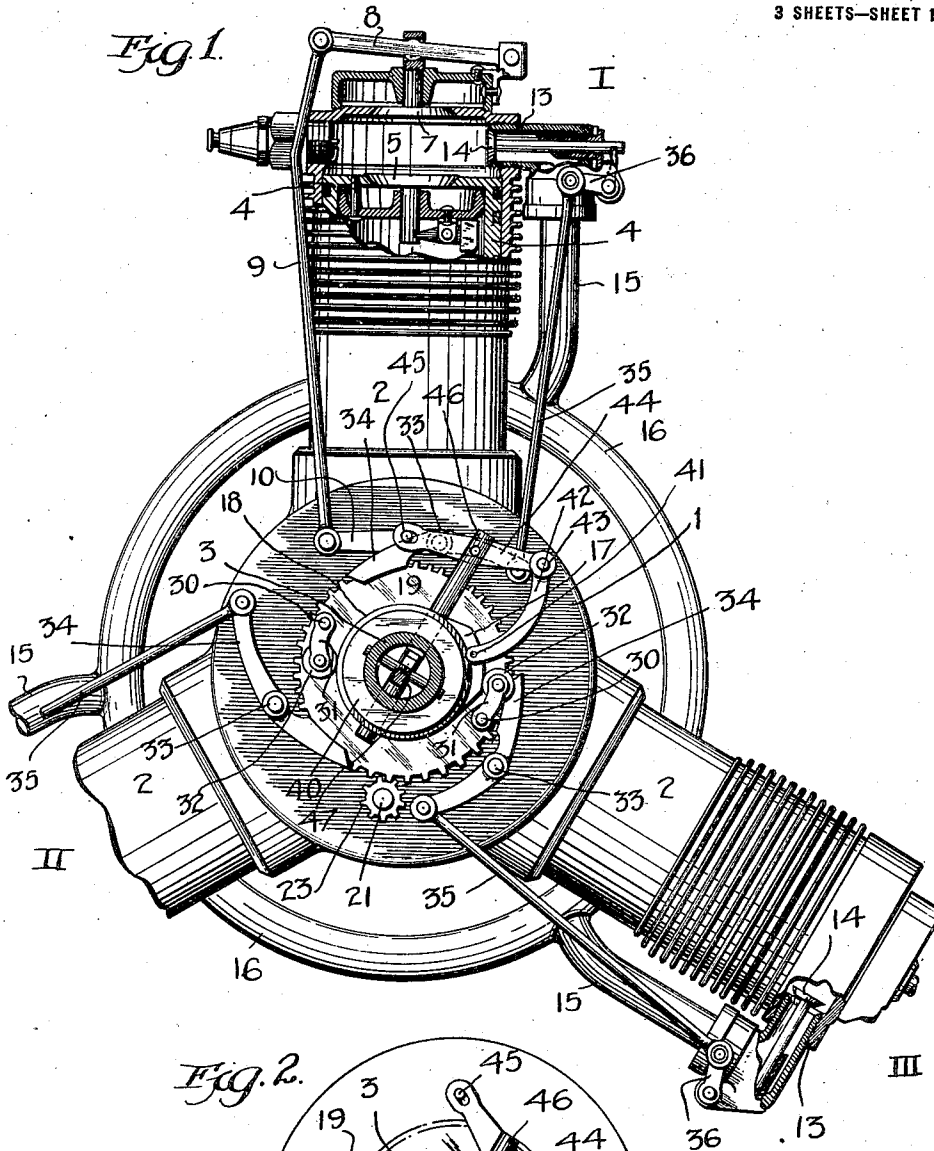
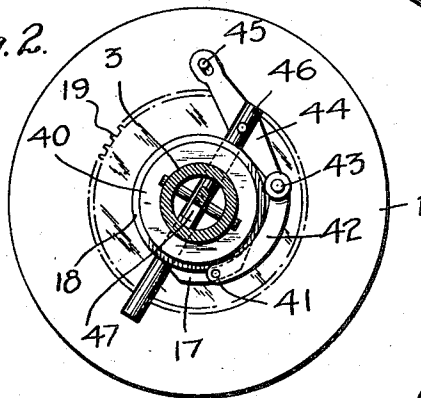


Fig. 2.



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3 SHEETS—SHEET 2.

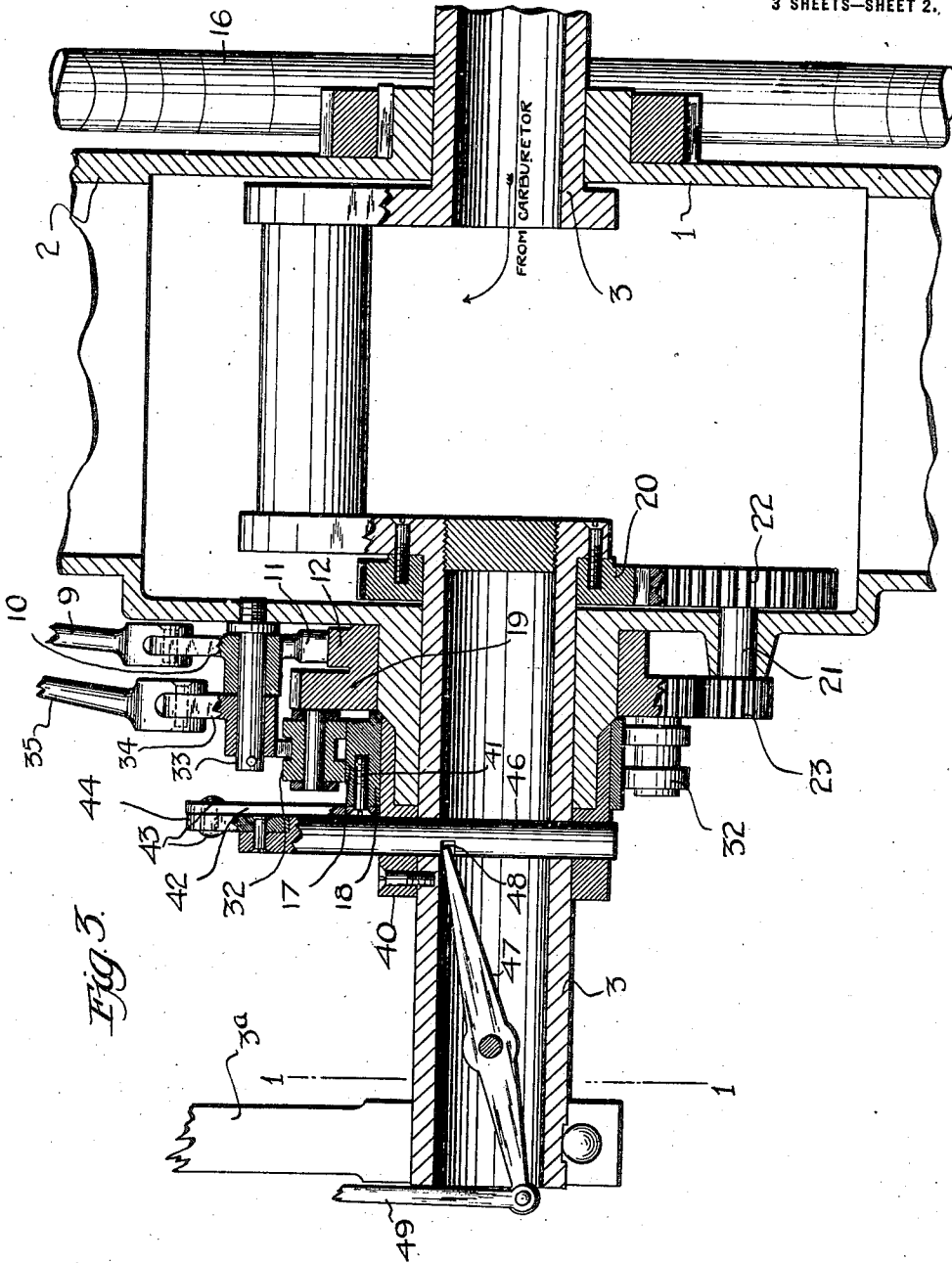


Fig. 3.

WITNESSES

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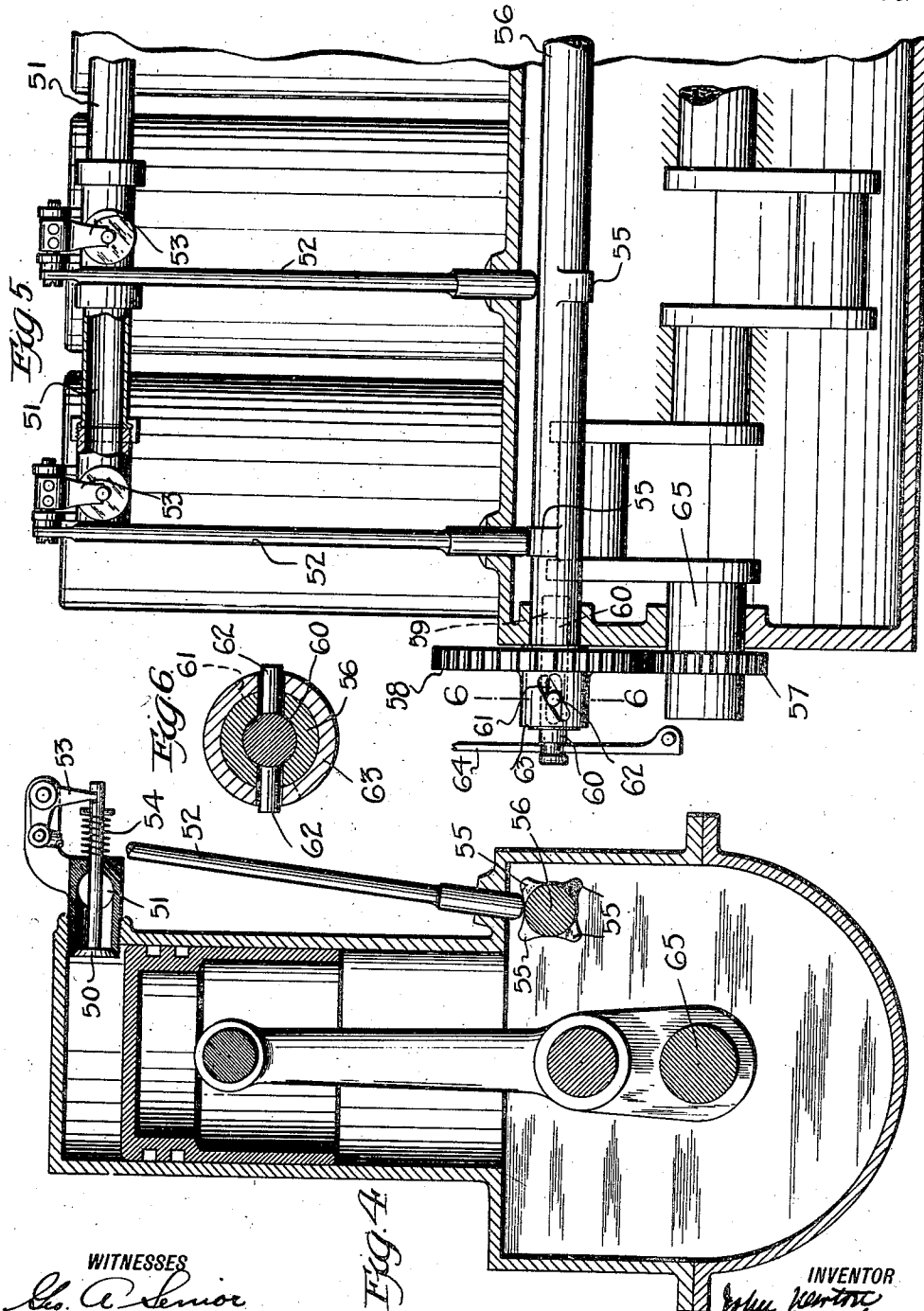
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3 SHEETS—SHEET 3.



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Fig. 5

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INTERNAL-COMBUSTION ENGINE.

1,139,617.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, JOHN NEWTON WILLIAMS, a citizen of the United States, and residing at Derby, in the county of New Haven and State of Connecticut, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a full description, illustrated in the accompanying drawings.

My invention relates to an internal combustion motor having a plurality of cylinders and having the several combustion chambers connected by a by-pass, through which a part of the fuel charge in the cylinder on the compression stroke may be conveyed and discharged into the cylinder then on the intake—or suction—stroke. The opening from the combustion chamber into the by-pass is controlled by a mechanically operated auxiliary valve, permitting the operator to reduce the amount of fuel in the compression chamber, thereby reducing the compression and the power and speed of the motor, to any desired degree from maximum to minimum.

My invention also relates to a valve controlling mechanism, whereby the auxiliary valve may be closed and left closed, or may be opened during any desired period of the compression stroke, and regulated at will by the operator while the motor is running.

The object of this invention is to provide a motor for vehicle propulsion and like purposes, having the greatest range of flexibility, with convenient and simple means of controlling its wide range of power and speed, whether under its maximum or minimum load, and at the same time developing the greatest economy in fuel consumption when working at usual speeds.

The ordinary method of reducing and controlling the power and speed of combustion motors, is to throttle the charge of fuel during the intake—or suction—stroke, and retard the ignition on the firing stroke. In throttling the fuel supply, a partial vacuum is created in the cylinder on the suction stroke, causing resistance equivalent to a back pressure on the piston, which is a direct loss in effective power, and a corresponding loss in fuel. Throttling the motor also necessitates much heavier springs on the exhaust valves to hold them closed against the increased suction, thereby creating greater pressure, friction and wear on cams, rocker-

arms, valve-stems and all valve mechanism. This absorbs and wastes additional motor power, besides shortening the life of these working parts. Retarding the ignition on the firing stroke shortens the period of combustion and pressure on the piston, thereby reducing the applied power of the motor without reducing the amount of fuel consumed.

I am fully aware that in internal combustion engines, the general idea of discharging part of the mixture on the compression stroke for the sake of economy, has been disclosed prior to my invention. However, in these prior disclosures the mixture is returned to the intake chamber, which expedient I find exerts an undue back pressure upon the carbureter and causes disadvantages known to every one skilled in the art. In my novel construction, the intake compartment, connected to the carbureter is entirely separate from the by-pass through which the mixture is discharged, as above referred to.

My invention is illustrated in the accompanying drawings, in which,—

Figure 1 shows an end elevation of a rotating cylinder motor; Fig. 2 shows an end elevation of the central portion thereof with the elements in shifted position; Fig. 3 shows a longitudinal vertical section of the middle portion of the motor; Figs. 4, 5 and 6 show a modification of my invention applied to a multiple cylinder reciprocating piston motor.

To illustrate my invention I have shown in Figs. 1-3 a three revolving cylinder motor of the four-cycle type, rotating anti-clockwise, and the cylinders numbered consecutively in the same direction. Cylinder No. I being at the top may be considered at the end of the exhaust stroke, and the commencement of the suction stroke; cylinder No. II would be on the firing stroke, and cylinder No. III on the compression stroke.

I wish to state that my invention is not limited to the above form of motor, as its essential features may be embodied and operated in the ordinary reciprocating type of combustion motor, as will be explained with reference to Figs. 4 to 6.

In Figs. 1, 2 and 3, of the drawings, 1 represents the crank case of the three-revolving cylinder motor, 2 are the cylinders, 3 is the crank shaft suitably fixed at 3^a, and

4 the piston (shown in cylinder No. I). The mixture is taken into the crank case through the hollow crank shaft (see right hand side of Fig. 3), and passes into the
 5 combustion chamber of each cylinder at the suction stroke of the piston by means of intake valve 5 provided in the piston head. In this particular case of a revolving cylinder motor, this valve is held on its seat
 10 by centrifugal force acting on counter-balance weight 6 disposed at one end of a lever arm, the other end of which engages the stem of valve 5. This mechanism is balanced so that the centrifugal force holds
 15 valve 5 closed, except as opened by the suction at the intake stroke. 7 is the exhaust valve provided in the cylinder head and controlled by a lever mechanism 8, 9, 10 and 11 from cams 12, one of which is shown in
 20 Fig. 3. This mechanism is in substance common to this type of internal combustion engine, and its further detailed description is therefore omitted.

Each cylinder has in its head a port 13 controlled by a valve 14. Each port leads
 25 by means of pipe 15 to a common by-pass 16, which in this particular case consists of a closed circular pipe, so that by this arrangement an intercommunication between the
 30 interior of the cylinders can be established under certain conditions. Valves 14 are operated by a valve operating mechanism which consists of an oscillatory cam 17 integral with a sleeve 18 mounted concentrically
 35 on the crank shaft 3, as shown in Figs. 1 and 3. Between this sleeve and the crank case is mounted a planetary gear 19 so that it can freely revolve on a suitable extension of the crank case. This planetary gear
 40 is driven as follows: Inside of the crank case a gear wheel 20 is fixed concentrically to the stationary crank shaft 3. A jack shaft 21 is journaled in the wall of the crank case which at one end carries a gear wheel
 45 22 in mesh with gear wheel 20 and at the other end a gear wheel 23 in mesh with planetary gear 19 above referred to. In the particular instance of a three-cylinder motor the gearing is chosen so that the
 50 planetary wheel 19 revolves at three-quarters the speed of the motor.

On diametrically opposite sides of gear wheel 19 are fixed two studs 30 which serve
 55 as pivotal supports for links 31 (Fig. 1), each of which carries on its outer end an anti-friction roller 32. In the adjacent wall of the crank case outside the periphery of gear wheel 19 are fixed three studs 33 each in suitable relation to one cylinder as shown.
 60 Upon each of these studs is fulcrumed a cam shoe lever 34 connected by a pull rod 35 and a bell crank 36 to a corresponding auxiliary valve 14. These auxiliary valves 14 are kept seated by centrifugal force of pull rods
 65 35 which through bell cranks 36 exert a

closing pressure upon these valves. Anti-friction rollers 32 are located in the same plane with cam 17 above mentioned, so that when the mechanism revolves, each roller will be raised as cam 17 passes underneath
 70 it. Likewise, cam shoe levers 34 are in the plane of travel of rollers 32. In operation, the cam shoe levers revolving with the motor faster than the anti-friction rollers and in a larger circle pass these rollers without
 75 contact at regular intervals. So that by such passing of levers and rollers separately over the cam (each roller passing idly over the cam just in time to get out of the path of a following lever) the cam shoe levers
 80 are not operated and valves 14 remain closed. In such neutral position of cam 17 wherein the auxiliary valve 14 remains closed, the motor operates at full compression without discharge of mixture at the
 85 compression stroke and thus at maximum power. The timing of the rollers and cam shoe levers is so that in this case they have passed the cam just after the commencement of the compression stroke. If it is now de-
 90 sired to reduce the compression by discharging some of the fresh mixture at the compression stroke into by-pass 16, the cam 17 may be advanced by suitable means, to be
 95 described later on, into a position in which the roller is lifted by the cam at the moment one of the cam shoe levers passes the cam, thereby lifting it and causing it to ride over the roller during the operation of the revolution. By such lifting the auxiliary valve
 100 14 is opened during a certain period of the compression stroke. If the cam is advanced to its maximum position, the auxiliary valve will be held open until near the completion of the compression stroke, and the greater
 105 portion of the fuel charge will be conveyed through the by-pass 16 into the cylinder then on the suction stroke by forcibly opening the auxiliary valve of that second cylinder. This reduces the compression charge
 110 of the first named cylinder to almost atmospheric pressure and reduces the motor power to its minimum. As the cam may be advanced or retarded by the means to be described later on, within suitable limits to
 115 any degree while the motor is running, a method is afforded for controlling the speed and power of the motor, entirely by varying the compression, with the widest range of flexibility, the greatest economy of fuel and
 120 the least stress and wear on the valve mechanism of the motor.

Inasmuch as the speed of rotation of the individual anti-friction rollers is determined by their contact with the cam and is greater
 125 than the velocity of the contact surfaces of the cam shoe levers, a portion of the cylindrical surface of the rollers is grooved peripherally to form a separate track for the cam shoe levers, of less diameter, the periph- 130

ery of which travels at a speed corresponding to that of the cam shoe levers. This secures a frictionless roller bearing, and inasmuch as pressure upon opposite sides of the roller is equal, all friction and wear of its pivotal bearing is practically eliminated.

Cam 17 may be advanced and retarded in the following manner: It is stated above that this cam is integral with a sleeve 18 rotatably mounted on a suitable portion 40 of the stationary crank shaft. Attached to this sleeve at the pivotal point 41 is a link 42 pivotally attached at 43 to lever 44. This lever is pivoted at its other end with a lost motion connection at 45 to a pin which is suitably fixed in the motor frame (not shown here). Intermediate its ends lever 44 is pivotally attached to a sliding bar 46 which has a sliding support in the portion 40 of the crank shaft (see particularly Fig. 3). Inside of the hollow crank shaft is pivoted a lever 47, the inner end of which engages bar 46 in a notch 48, whereas the outer end is pivotally attached to a control rod 49 which may for instance lead to a hand control (not shown). It is obvious that when control bar 49 is operated and thereby bar 46 shifted in one or the other direction, the link system 44—42 is operated in such manner that sleeve 18 with its cam 17 is angularly moved on its support and the cam 17 thereby advanced or retarded in the direction of rotation of the motor. The retarded position of the cam is shown in Fig. 2, whereas the advanced position is shown in Fig. 1.

In Figs. 4, 5 and 6, I have shown how my novel idea may be embodied in a reciprocating internal combustion engine. In Fig. 5, a portion of a four-cylinder motor is shown. The intake and exhaust valves are omitted in these figures as they are not concerned in my present invention. 50 represents the auxiliary valve which controls the discharge of fresh gases into the by-pass 51 connected with all four cylinders in the manner shown in Fig. 4. 52 are the push rods which by means of bell cranks 53 open their respective auxiliary valve 50 which in this case is held on its seat by a spring 54. Each push rod 52 is operated by a cam 55 mounted on a cam shaft 56. In order to advance and retard the cams 55 relatively to the rotation of the crank shaft I provide the following mechanism: Cam shaft 56 is driven from a gear wheel 57 mounted on the crank shaft by means of a gear wheel 58 loosely mounted on cam shaft 56. The free end of the cam shaft has a boring 59 in which a plunger 60 is slidably disposed. A slot 61 in parallel to the axis of the cam shaft is provided in the wall of the hollow portion of the cam shaft through which a pin 62 protrudes which is fastened to plunger 60. This pin is long enough to also protrude through a

slot provided in the hub 63 of gear wheel 58 which slot is inclined to the central axis of the cam shaft 56 as shown. Plunger 60 may be longitudinally shifted in boring 59 by means of a hand lever 64 in the manner illustrated. It is obvious that by such shifting the angular position of gear wheel 58 is shifted relatively to that of cam shaft 56, which latter is further advanced or retarded relatively to gear wheel 58 and thus relatively to the crank shaft 65 of the engine. Thereby the same effect as described with regard to Figs. 1 to 3 may be obtained, i. e., the auxiliary valve 50 may be opened at the earlier or later part of the compression stroke of the piston. In order to obtain in this case a full compression similar to the case in the first described modification, where auxiliary valve 14 is not opened at all, I advance the cams 55 so far that each auxiliary valve 50 is opened by its cam at the suction stroke of that particular cylinder. Inasmuch as this occurs with every cylinder no gases can be taken from by-pass 51 at the suction stroke, because none have been discharged into it and thus in such cam position the auxiliary device has no effect and the cylinder receives its full charge through the intake valve (not shown here) and compresses this full charge without interference by the auxiliary valve.

The operation of the motor (see Figs. 1-3) is as follows: Cylinder No. III being on the compression stroke and having moved about 50° from dead center, and its piston having traveled about $\frac{1}{2}$ of its stroke, the charge is now but slightly compressed; at this point, the mechanism described before may open the auxiliary valve of cylinder No. III, permitting fuel mixture to escape through the by-pass 16 into cylinder No. I now commencing the suction stroke, the auxiliary valve of cylinder No. I being held open automatically by the combined compression on the side of by-pass 16 and suction on the cylinder side. Each cylinder therefore successively taking in a full charge of fuel through intake valve and auxiliary valve and again discharging a part of it into a succeeding cylinder, reduces by just that much the fuel supplied through the carbureter and consumed by the motor. Holding the auxiliary valve open till near the completion of the compression stroke reduces the charge while leaving it at nearly atmospheric pressure, and instead of retarding the ignition, it is fired at, or just before, the dead center, giving a mild impulse for the full half revolution, or power stroke of the motor.

As the controlling mechanism may be operated to close the auxiliary valve at any earlier point of the piston travel, up to its first opening, or may be left closed during the entire compression stroke—when the mo-

tor develops its full power—it follows that the operator may, by increasing or diminishing the compression and fuel supply, regulate the power and speed of the motor from maximum to minimum, with the compression and the fuel charge diminished to a degree not practicable by the carbureter throttling and vacuum system. This novel system secures the widest range of motor flexibility with the greatest economy of fuel consumption; while reduction of friction and resistance gives increased net power and motor efficiency. As more than 75% of the operation of vehicle motors occurs while developing less than one-half their maximum power, the economy of operation at moderate power and speeds is of very great importance.

I claim:

1. A multiple cylinder internal combustion motor having means for taking in combustible mixture, a by-pass independent from said intake means and adapted to communicate with any of the motor cylinders, and means for controlling such communication to cause discharge of a predetermined amount of mixture into said by-pass from one cylinder at the compression stroke of its piston and to permit the discharge of mixture from said by-pass into another cylinder at the suction stroke of its piston.
2. A multiple cylinder internal combustion motor having means for taking in combustible mixture, a by-pass independent from said intake means and adapted to communicate with any of the motor cylinders, and auxiliary valves for controlling such communication to cause discharge of a predetermined amount of mixture into said by-pass from one cylinder at the compression stroke of its piston and to permit the discharge of mixture from said by-pass into another cylinder at the suction stroke of its piston.
3. A multiple cylinder internal combustion motor having means for taking in combustible mixture, a by-pass independent from said intake means and adapted to communicate with any of the motor cylinders, and means for controlling such communication to cause discharge of a predetermined amount of mixture into said by-pass from one cylinder at the compression stroke of its piston and to permit the discharge of mixture from said by-pass into another cylinder at the suction stroke of its piston, and means for adjusting said controlling means to vary said predetermined amount of mixture.
4. A multiple cylinder internal combustion motor having means for taking in combustible mixture, a by-pass independent from said intake means and adapted to communicate with any of the motor cylinders, and auxiliary valves for controlling such communication to cause discharge of a pre-

determined amount of mixture into said by-pass from one cylinder at the compression stroke of its piston, and to permit the discharge of mixture from said by-pass into another cylinder at the suction stroke of its piston, and means for varying the opening and closing of said auxiliary valves in timed relation to the operation of the motor to vary said predetermined amount of mixture.

5. A multiple rotating cylinder internal combustion motor having a mixture intake valve for each cylinder, a by-pass independent of the control of said intake valves and adapted to communicate directly with each cylinder, an auxiliary valve for each cylinder controlling such direct communication to cause discharge of a predetermined amount of the mixture into said by-pass from one cylinder at the compression stroke of its piston and to permit the discharge of mixture from said by-pass into another cylinder at the suction stroke of its piston, a push rod and a cam shoe lever for each auxiliary valve, cam rollers movably disposed and operated at a suitably rotative speed relatively to the rotating speed of the motor and adapted to cooperate with said cam shoe levers when passing same, and a cam, stationary relatively to said rollers and cam shoe levers, adapted to cooperate with said rollers to move them into the path of said levers to cause the operation of said valves.

6. A multiple rotating cylinder internal combustion motor having a mixture intake valve for each cylinder, a by-pass independent of the control of said intake valves and adapted to communicate directly with each cylinder, an auxiliary valve for each cylinder controlling such direct communication to cause discharge of a predetermined amount of the mixture into said by-pass from one cylinder at the compression stroke of its piston and to permit the discharge of mixture from said by-pass into another cylinder at the suction stroke of its piston, a push rod and a cam shoe lever for each auxiliary valve, cam rollers movably disposed and operated at a suitably rotative speed relatively to the rotating speed of the motor and adapted to cooperate with said cam shoe levers when passing same, and a cam, stationary relatively to said rollers and cam shoe levers, adapted to cooperate with said rollers to move them into the path of said levers to cause the operation of said valves, said cam being oscillatingly disposed to cause its operation of the rollers before or at the time they pass said levers to control the opening and closing of said valves in timed relation to the operation of the motor to vary said predetermined amount of mixture.

7. In a rotating cylinder internal combustion engine having valves, cam shoe levers for operating said valves, cam rollers rotating at a speed different from that of

the levers and adapted to contact with said
levers on passing same to operate said
valves, and a cam stationary relatively to
said rollers and levers adapted to lift said
5 rollers into contact with said levers and
means for moving said cam to vary the
point of co-incidental contact between the

cam, the rollers and the levers to control
said valves in timed relation to the rotation
of the cylinder at will.

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Witnesses:

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