W. RABSILBER.

METHOD OF OPERATING INTERNAL COMBUSTION ENGINES.

APPLICATION FILED NOV. 21, 1910.

1,005,118. Patented Oct. 3, 1911.

3 SHEETS—SHEET 1.

Fig. 2.

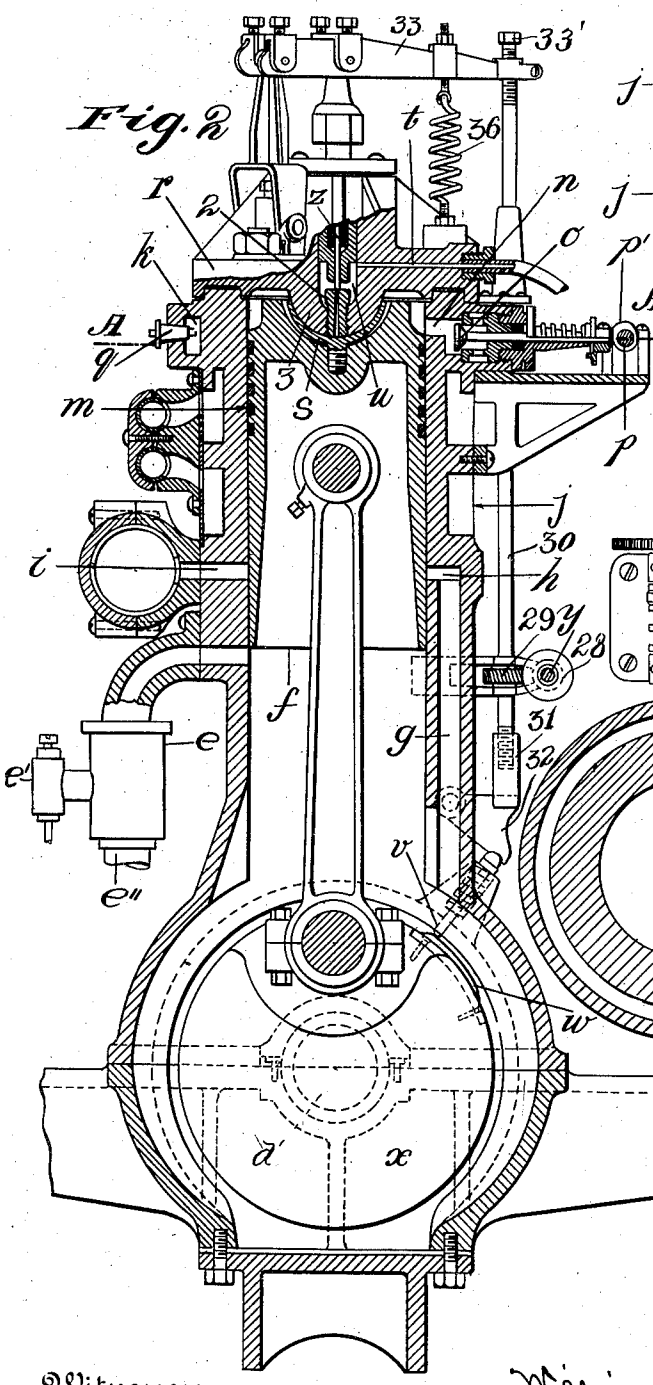
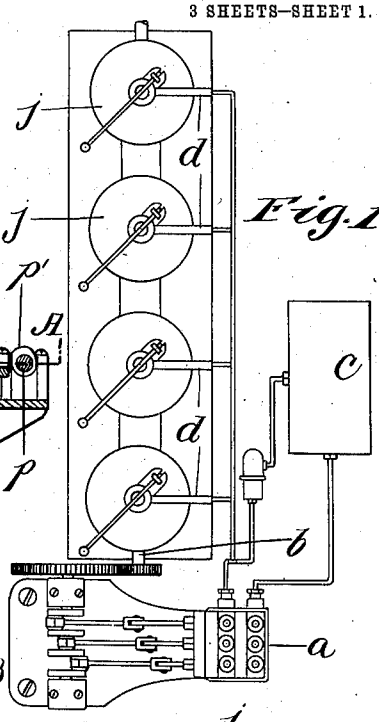


Fig. 1.



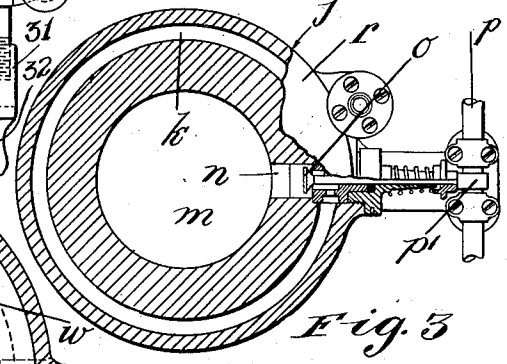


Fig. 3.

Witnesses:
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M. Hamilton

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3 SHEETS—SHEET 2.

Fig. 4

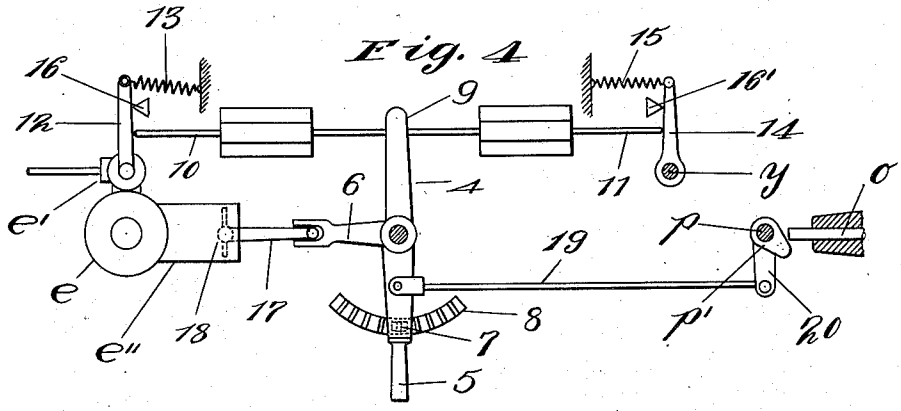


Fig. 5.

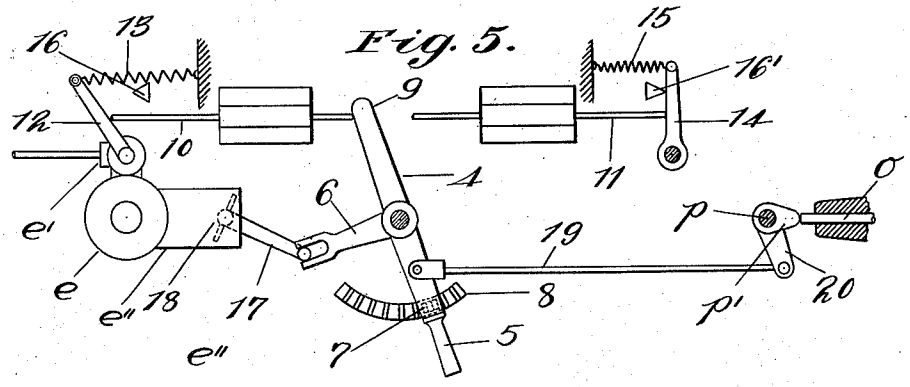
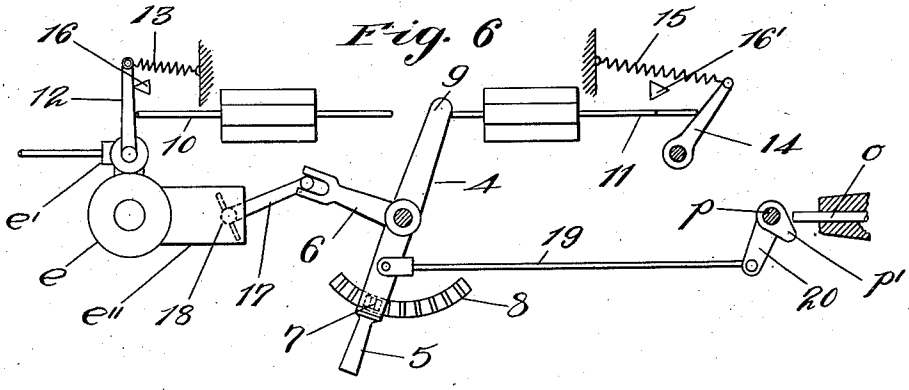


Fig. 6



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3 SHEETS—SHEET 3.

Fig. 7.

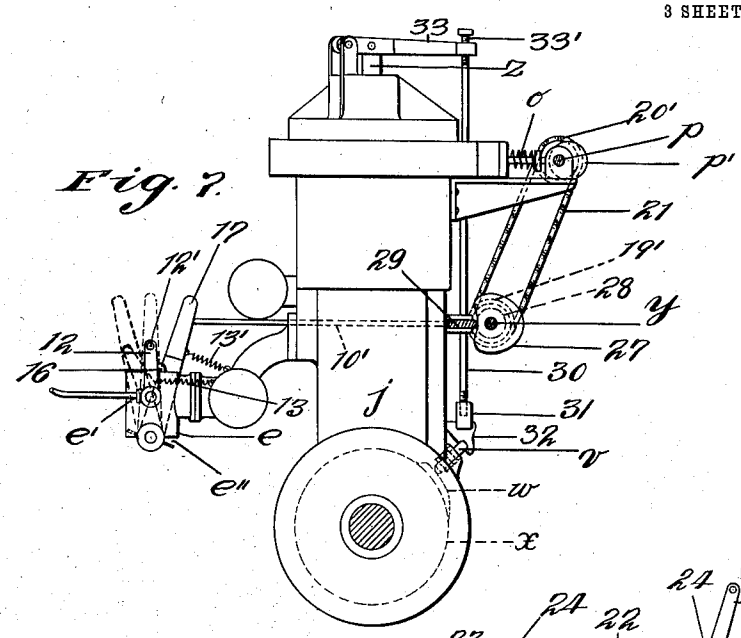
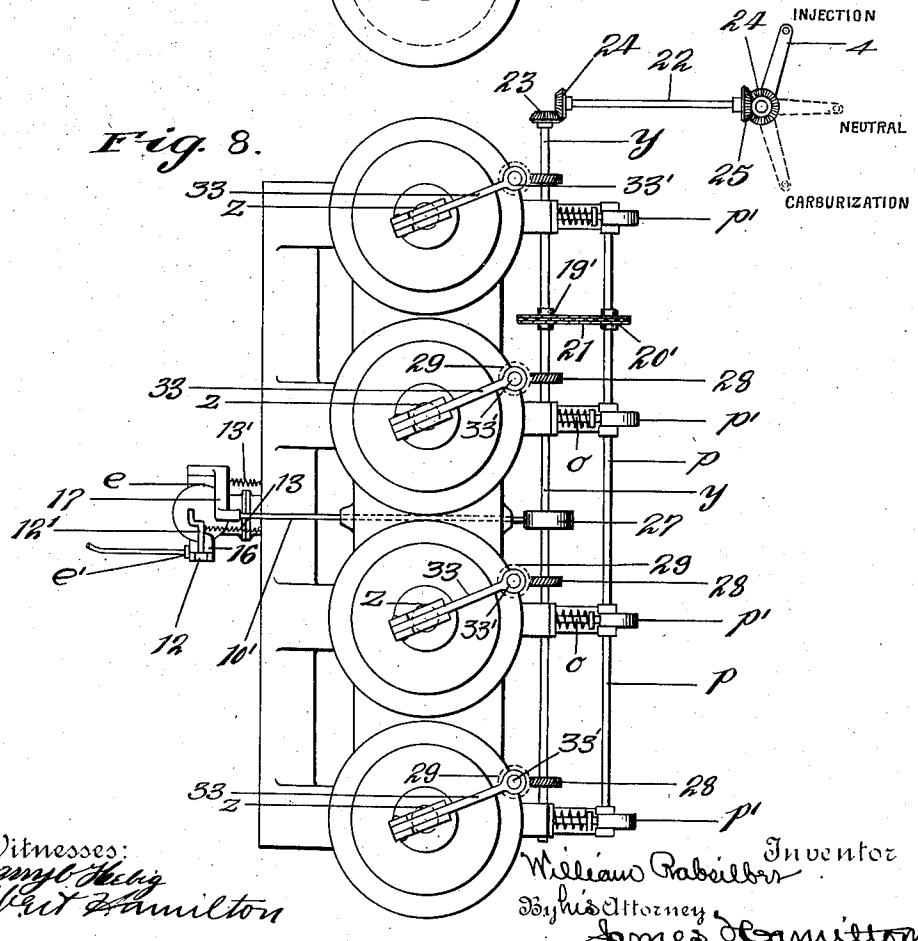


Fig. 8.



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UNITED STATES PATENT OFFICE.

WILLIAM RABSILBER, OF NEW YORK, N. Y.

METHOD OF OPERATING INTERNAL-COMBUSTION ENGINES.

1,005,118. Specification of Letters Patent. Patented Oct. 3, 1911.

Application filed November 21, 1910. Serial No. 593,337.

To all whom it may concern:

Be it known that I, WILLIAM RABSILBER, a subject of the Emperor of Germany, residing at the borough of Brooklyn, city of New York, in the county of Kings and State of New York, have invented certain new and useful Improvements in Methods of Operating Internal-Combustion Engines, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to improvements in methods of operating internal combustion engines and particularly to improvements in methods of operating internal combustion engines in which are used compressions of the air corresponding to temperatures equal to or higher than the igniting point of the combustible used.

An object of this invention is to provide a method of operating engines of the type just referred to which will enable the same to be used for automobile and traction purposes, which will permit the use of heavy oils as the combustible and which will insure with such oils a complete, smokeless and instantaneous combustion and will dispense with the use of complicated mechanism for the attaining of these objects or results.

Another object of this invention is to provide a method of operating engines of this type which will render their starting easy, whether by hand or by igniting an explosive mixture, in a well-known manner.

In carrying out my new method an ignitible mixture of air with a combustible, which I shall call the primary combustible, is produced and is compressed to a degree the temperature corresponding to which is lower than the igniting point of the mixture. The latter is then ignited in any suitable manner and another combustible, which I shall call the secondary combustible, is subjected while under pressure to the heat generated by the combustion. Further, this combustion results in heating the walls of the combustion chamber and all parts inside the latter. The supply of the primary combustible is now cut off and air is supplied to the combustion chamber, the degree of compression is increased to a point the temperature corresponding to which is at least as high as the igniting point of the secondary combustible and the latter is introduced under pressure in a highly heated condition into this highly compressed air. Self-ignition of the preheated secondary combustible results and the heat of the combustion which ensues serves to preheat in turn the portion of the secondary combustible next to be injected and to keep hot the walls of the combustion chamber and the parts inside the same. To insure that the combustion of the preheated secondary combustible shall be instantaneous, complete and smokeless, the latter is injected between heated members both of which are subjected to the heat of the combustion which occurs in the combustion chamber and one of which is movable, the injection being timed to take place as these heated members come into close contact with each other, whereby the secondary combustible is instantaneously vaporized and is projected with great force and at a high velocity and in a finely divided state into the highly compressed air at or near the end of the compression stroke of the piston. Of course, the same light oil may be used as both the primary and secondary combustible; but for reasons of economy, a heavy oil will generally be used as the secondary combustible.

Referring to the drawings, Figure 1 is a schematic or diagrammatic view in plan of a four-cylinder engine to the operation of which my new method is applicable. Fig. 2 is a central vertical section through one of the working cylinders of the engine shown in Fig. 1; Fig. 3 is a section on the line A—A of Fig. 2; Figs. 4, 5 and 6 are diagrammatic views showing different positions of mechanism controlling the degree of compression and the change from the use of the primary combustible to the use of the secondary combustible; and Figs. 7 and 8 are views illustrating the engine of Figs. 1, 2 and 3 equipped with mechanism of the character shown diagrammatically in Figs. 4, 5 and 6, Fig. 7 being an end elevation and Fig. 8 being a plan.

A multiple-plunger pump *a* is driven from the engine-shaft *b* and draws from the tank *c* the fuel which is forced by the pump through the valve-controlled conduits *d*. The engine illustrated in the drawings is of the two-cycle, three-port type in which the carbureter is shown at *e*, the piston at *f*, the passage for the charge of carbureted air at *g*, the inlet port for the charge at *h* and

the exhaust port at *i*. Near its upper end each working cylinder *j* is formed with an annular auxiliary combustion chamber *k* which communicates with the main combustion chamber *m* through a passage *n* controlled by the valve *o*. The position of the latter may be varied by turning the camshaft *p* and thereby the cam *p'*. When the engine is started, the piston *f* acts in the usual manner in the operation of a two-cycle three-port engine to draw carbureted air from the carbureter *e* and compress it in the chambers *k*, *m*. The charge is ignited by means of an igniter *q*. The cylinder-head *r* is formed with a fuel-passage *t* the inner end of which communicates with a heating chamber *u* which is also formed in the cylinder-head *r* and from which the fuel flows through the nozzle 2. The flow of the fuel through the latter is controlled by a needle-valve *z* the inner end of which is normally seated in closed position upon the top of the nozzle 2 and the upper end of which is attached to a lever 33. For each cylinder there is mounted on the engine-shaft *d* a disk *x* formed with a cam-lug *w* into the path of which may be projected the inner end of a spring-controlled plunger *v* upon the outer end or head of which rests a lever 32 that supports the lower bifurcated end of a shoe 31 screwed on the lower end of the valve-controlling rod 30 the upper end of which bears against a pin 33' carried by the free end of the lever 33 (Fig. 2). Upon the rod 30 is keyed a spiral gear 29 which is in mesh with a spiral gear 28 mounted fast upon a shaft *y*. The lever 33 is held down by the strong coil-spring 36 which keeps the needle-valve *z* normally firmly on its seat on the top of the nozzle 2. By turning the shaft *y* the rod 30 may through the gears 28, 29 be screwed out of and into its shoe 31 and its active length thereby may be increased and diminished and the inner end of the spring-controlled plunger *v* thrown into and out of the path of the cam-lug *w*, all as is fully explained in my pending application Serial Number 567,187. After the engine has been run in this manner for a time, the side-wall of the combustion chamber, the top *r* of the latter and the cup-shaped receptacle *s* carried by the piston *f* will become well heated. Since the top or cylinder head *r* becomes highly-heated, the fuel in the passage *t* and heating chamber *u* formed in the cylinder-head *r* will be preheated. Thereupon the fuel-inlet *e'* of the carbureter *e* is closed, communication between the chambers *k*, *m* is cut off by closing the valve *o* and the inner end of the plunger-pin *v* is forced inwardly into the path of the cam-lug *w* on the disk *x* by turning the shaft *y*, whereby the needle-valve *z* which controls the flow of the fuel from the heating-chamber *u* through the discharge-nozzle 2 into the main combustion chamber *m* is opened and closed once during each revolution of the engine crank-shaft. The engine now works with fuel-injection and high compression. It is to be observed that the inner face of the cylinder-head *r* is formed with an inwardly-projecting boss 3 which is located directly in line with and above the cup *s* so that at the end of the compression stroke of the piston *f* the boss 3 fits snugly in the top *s* (see Fig. 2). The action of the needle-valve *z* is so timed that the fuel is injected just as the inner wall of the cup *s* is about to close over the boss 3; and since the latter and the cup *s* are highly heated, the fuel will be instantly vaporized and will be pressed out in a finely-divided state from between the hot walls of the cup *s* and the boss 3 into the highly-compressed air in the combustion chamber *m*. A perfect, smokeless and instantaneous combustion follows without the use of any igniting agencies.

In Figs. 4, 5 and 6 there is shown in diagrammatic view, mechanism by which the change in the degree of compression is accomplished and the supply of the primary combustible is cut off and the injection of the preheated secondary combustible is started. A lever 4 is provided at one end with a handle 5 and near its middle with an arm 6 the outer end of which is forked. By the engagement of a spring-catch or latch 7 in the notches in a rack 8 the lever 4 may be held in its adjusted position. The end 9 of the lever 4 is arranged to swing between the opposed inner ends of the slide-rods 10, 11 and to bear against either of these ends, as may be desired. The outer end of the slide-rod 10 bears against the arm 12 which controls the position of the valve past which flows the primary combustible through the fuel-inlet *e'* of the carbureter *e*. A coil-spring 13 holds the arm 12 in its neutral position against the stop 16 in which position the fuel-inlet *e'* is closed. The outer end of the slide-rod 11 bears against an arm 14 fast on the shaft *y* and a coil-spring 15 holds this arm 14 in its neutral position against the stop 16', in which position the plunger-pin *v* is out of the path of the cam-lug *w*, (Fig. 2.) In the forked end of the arm 6 is engaged one end of the valve-lever 17 by which is regulated the position of the air-valve 18 which controls the air-inlet *e''* of the carbureter *e*. To the handle-end of the lever 4 is attached one end of a link-rod 19 the other end of which is connected to an arm 20 fast upon the cam-shaft *p* on which is mounted the cam *p'* which controls the valve *o*. In Fig. 4 the parts are shown in neutral position, both the valves *o* and *z* and both the air-inlet and the fuel-inlet of the carbureter being closed. In Fig. 5 the parts are shown in a position in which the main

and auxiliary combustion chambers are in communication and a combustible mixture of air and the primary combustible is supplied through the carbureter. In Fig. 6 the parts are shown in a position in which the auxiliary combustion chamber is cut off from the main combustion chamber (and, therefore, the degree of compression is increased), the fuel-inlet of the carbureter (and, therefore, the supply of the primary combustible) is cut off and the preheated secondary combustible is injected into the highly compressed air.

The engine will be run mainly with the parts in the position shown in Fig. 6; that is, with fuel-injection and high compression and with the igniting mechanism cut out. With the parts in this position and the igniting mechanism being still cut out, the operator may stop the engine by throwing the lever 4 into the position shown in Fig. 5. Upon stopping, the combustion chamber of the engine will be found filled with a fresh combustible mixture which may be ignited to start the engine again.

In Figs. 7 and 8 the controlling mechanism shown merely in diagrammatic form in Figs. 4, 5 and 6 is illustrated as applied to and embodied in a four-cylinder engine of the type depicted in Fig. 1. On one end of the shaft y is mounted fast a bevel gear 23 which meshes with a bevel gear 24 fast upon an end of the shaft 22 upon the other end of which is mounted a bevel gear 25. The latter meshes with a bevel gear 26 fast upon the same shaft with which is the arm or lever 4. On the shaft y is mounted fast a sprocket wheel 19′ and upon the camshaft p is mounted fast a sprocket-wheel 20′. The latter is connected with and driven by the sprocket-wheel 19′ through a sprocket-chain 21. The arm 12 carries at its upper end a laterally-extending pin or stud 12′ which projects into the path of swing of the upper end of the arm 17 (Fig. 8). Upon the shaft y is mounted fast a cam 27 against which presses the free end of a slide-rod 10′ the other end of which bears against the upper end of the arm 17. The latter arm is controlled by a spring 13′ and the arm 12 is held against the stop-lug 16 by the spring 13 when the fuel-inlet e' of the carbureter e is closed. As shown in full lines in Figs. 7 and 8, the parts are in such a position that the engine operates with fuel-injection and high compression. If the arm 4 be now thrown to a horizontal position in Fig. 8, the cam 27 will force the arm 17 to swing to a vertical position, in which position it just touches the pin 12′ but does not move the arm 12. Hence, the air-inlet e'' as well as the fuel-inlet e' of the carbureter e is now closed. The same turning movement of the shaft y which rotated the cam 27 caused also a turning of the rods 30, whereby the inner ends of the plungers v were withdrawn from out of the paths of the cam-lugs w on the disks x, as hereinbefore explained. Hence, the needle-valves z now remained closed. Further, the rotation of the shaft y through the sprockets 19′, 20′ and the sprocket-chain 21 drives the cam-shaft p and thereby turns the cams p', whereby the valves o are opened and communication between the auxiliary combustion chamber k and the main combustion chamber m of each cylinder is established through the passage n. This position of the parts is called by me "neutral". Upon turning the arm 4 still further in the same direction in Fig. 8, the arm 17 is thrown to the left still further in Fig. 7 and carries with it the arm 12, whereby the fuel-inlet e' and the air-inlet e'' of the carbureter e are both opened. The needle valves z remain closed and the chambers k and m remain still in communication with each other as before. The igniting mechanism is thrown into operative position or is cut in and the engine now operates under low compression and with carbureted air. Of course, the arm 4 may be thrown from one end of its travel to the other without being stopped at the neutral position.

I claim:

1. A method of operating an internal combustion engine which consists in running the engine by compressing and burning in the combustion chamber thereof carbureted air and thereby energizing the piston and warming the walls of the combustion chamber; subjecting fuel to the heat of combustion generated in the combustion chamber; reducing the carburization of the air to a degree so low that preignition cannot take place at high compression; increasing the compression to a high degree; and injecting the preheated fuel into air in a highly compressed state in the combustion chamber, after the walls of the latter have been warmed.

2. A method of operating an internal combustion engine which consists in running the engine by compressing and burning in the combustion chamber thereof carbureted air and thereby energizing the piston and warming the walls of the combustion chamber; subjecting fuel to the heat of combustion generated in the combustion chamber; reducing the carburization of the air to a degree so low that preignition cannot take place at high compression; decreasing the volume of the combustion chamber and thereby raising the compression to a high degree; and injecting the preheated fuel into air in a highly compressed state in the combustion chamber, after the walls of the latter have been warmed.

3. A method of operating an internal com-

bustion engine which consists in running the engine by compressing and burning in the combustion chamber thereof carbureted air and thereby energizing the piston and warming the walls of the combustion chamber; subjecting fuel to the heat of combustion generated in the combustion chamber; reducing the carburization of the air to a degree so low that preignition cannot take place at high compression; decreasing the volume of the combustion chamber and thereby raising the compression therein to a high degree; and injecting the preheated fuel into air in a highly compressed state in the combustion chamber, by pressing it out from between hot walls.

4. A method of operating an internal combustion engine which consists in producing an ignitible mixture of air and a primary combustible; compressing said mixture to a temperature below the igniting point of said mixture; igniting the latter; subjecting a secondary combustible under pressure to heat generated by the combustion of said mixture; reducing the proportion of the primary combustible in the mixture so low that preignition cannot take place at high compression; increasing the compression of the air to a temperature at least equal to the igniting point of the secondary combustible; and injecting into the highly compressed air the preheated secondary combustible.

5. A method of operating an internal combustion engine which consists in producing an ignitible mixture of air and a primary combustible; compressing said mixture to a temperature below the igniting point of the same; igniting said mixture; subjecting a secondary combustible under pressure to heat generated by the combustion of said mixture; reducing the proportion of the primary combustible in the mixture so low that preignition cannot take place at high compression; increasing the compression of the air to a temperature equal at least to the igniting point of the secondary combustible; injecting the latter in a preheated state between heated members; and pressing the secondary combustible out from between said heated members in a finely divided state and with great velocity into the highly compressed air.

In witness whereof I hereunto set my hand this nineteenth day of November, 1910, at New York city, New York, in the presence of the two undersigned witnesses.

WILLIAM RABSILBER.

Witnesses:
GEO. M. BURDITT,
JAMES HAMILTON.