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METHOD OF AND APPARATUS FOR SUPPLYING FUEL TO CYLINDERS OF INTERNAL COMBUSTION ENGINES.

APPLICATION FILED NOV. 29, 1918.

1,436,904.

Patented Nov. 28, 1922.

2 SHEETS—SHEET 1.

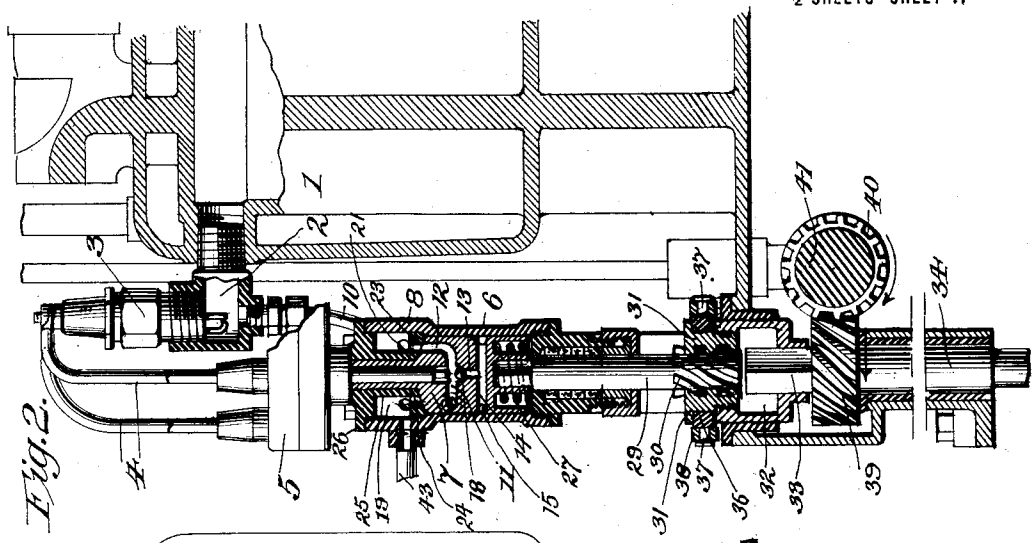


Fig. 2.

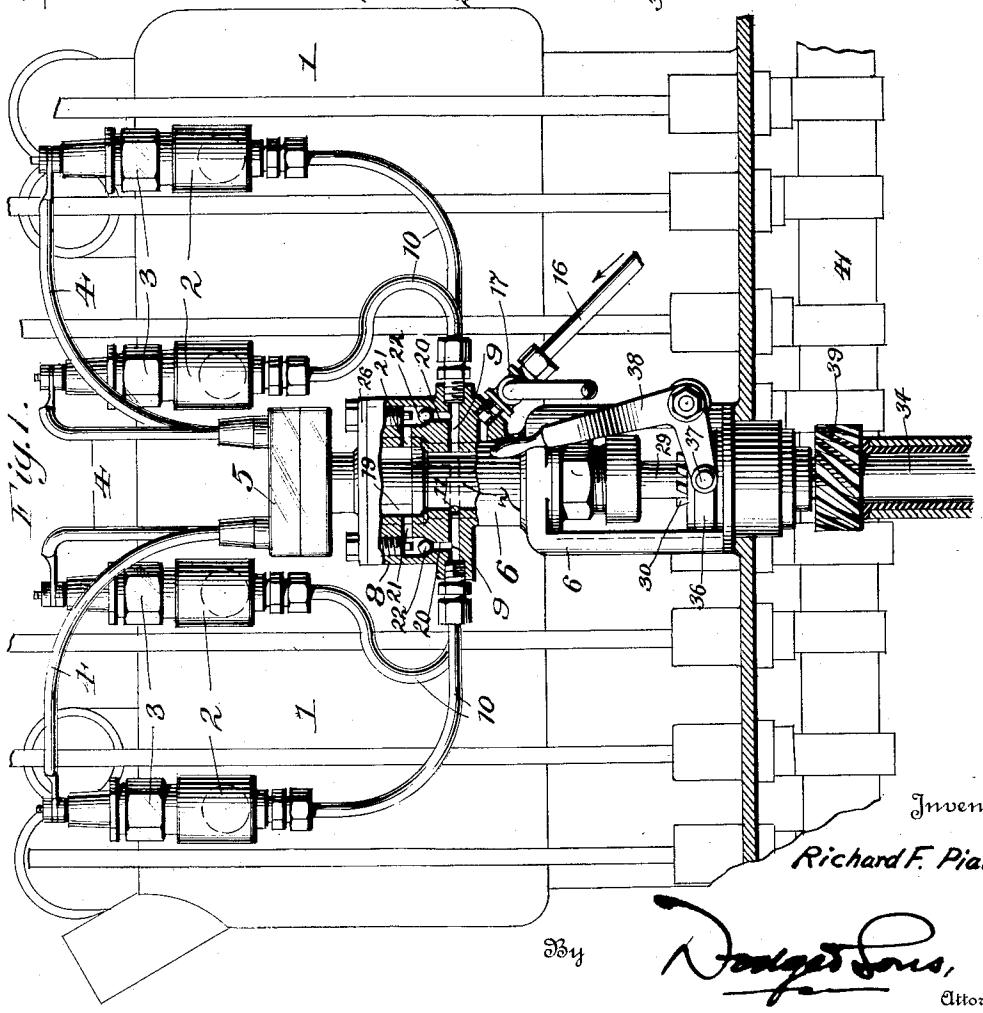


Fig. 1.

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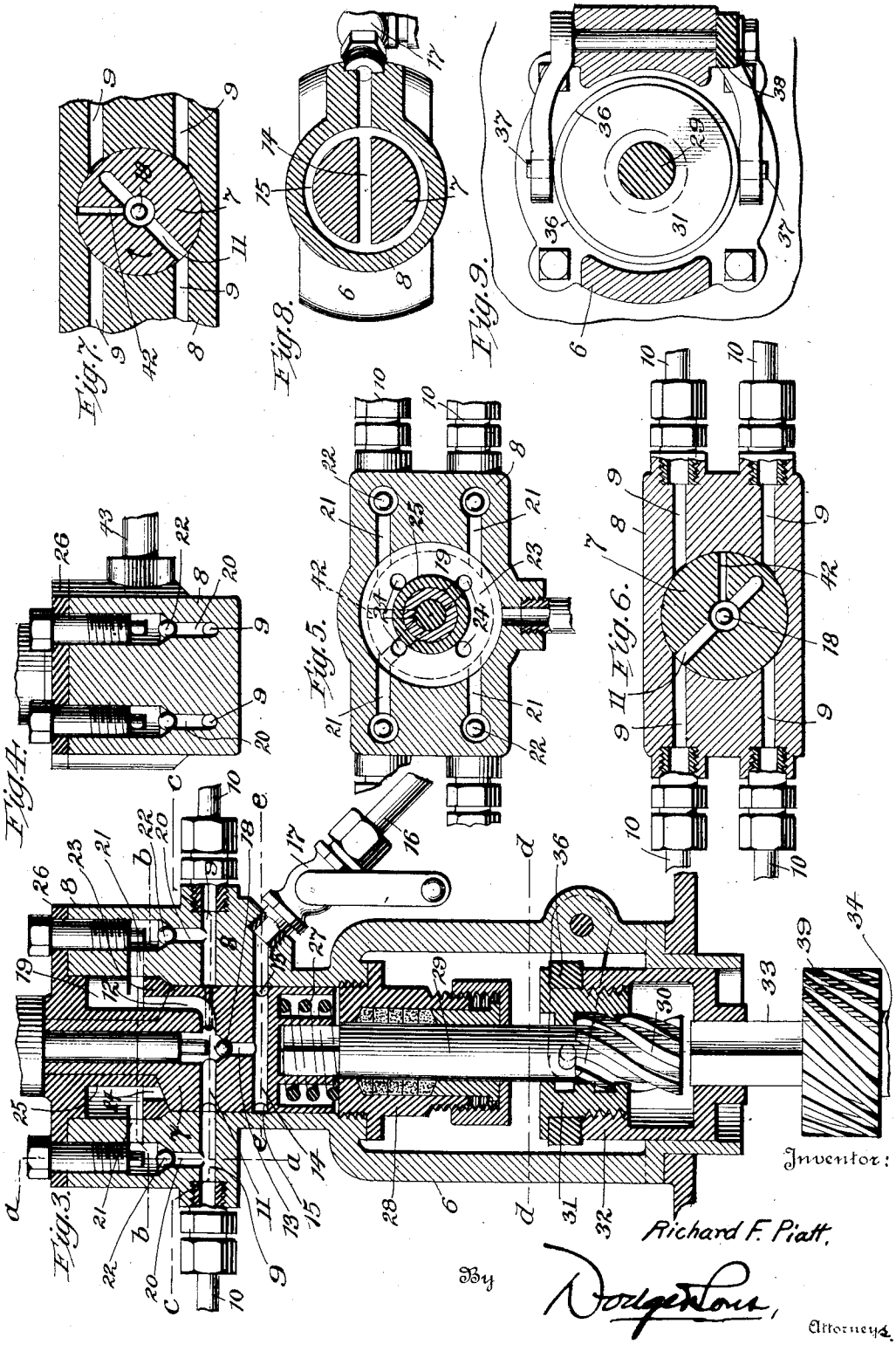
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UNITED STATES PATENT OFFICE.

RICHARD F. PIATT, OF LOUISVILLE, KENTUCKY.

METHOD OF AND APPARATUS FOR SUPPLYING FUEL TO CYLINDERS OF INTERNAL-COMBUSTION ENGINES.

Application filed November 29, 1918. Serial No. 264,598.

To all whom it may concern:

Be it known that I, RICHARD F. PIATT, a citizen of the United States, residing at Louisville in the county of Jefferson and State of Kentucky, have invented certain new and useful Methods of and Apparatus for Supplying Fuel to Cylinders of Internal-Combustion Engines, of which the following is a specification.

This invention pertains to internal combustion engines, and consists in a novel method of and means for delivering fuel into the cylinders of the engine. Briefly stated, such feeding is effected by withdrawing from a cylinder a small portion of the gases of combustion at explosion pressure; retaining the gas so withdrawn at as near said explosion pressure as practicable; and at the proper time utilizing the expansion of said gas to blow or force the fuel charge into the cylinder in which the next charge is to be exploded.

This mode or method of delivering fuel to cylinders of internal combustion engines may be carried out by apparatus of varying form, one of such constructions being illustrated in the accompanying drawings, in connection with which the method of feeding will be explained in detail. In these drawings:

Figure 1 is a face elevation of the apparatus applied to a four cylinder engine, with portions in section;

Fig. 2, a side view of the same, mainly in section;

Fig. 3, an enlarged sectional view of the principal working parts of the apparatus, said section being taken in the same plane as the sectional portion of Fig. 1;

Fig. 4, a section on the line *a—a* of Fig. 3;

Fig. 5, a section on the line *b—b* of Fig. 3;

Fig. 6, a section on the line *c—c* of Fig. 3;

Fig. 7, a section on the same line as Fig. 6 but with the distributer turned to the position indicated in Fig. 2;

Fig. 8, a section on the line *e—e* of Fig. 3; and

Fig. 9, a section on the line *d—d* of Fig. 3, the several sections of Figs. 5 to 9 inclusive representing the parts as viewed from above.

In the drawings 1 indicates an engine, here represented as a four cylinder four cycle internal combustion engine, but the number of cylinders and the type of engine may be varied, the invention being applicable to two cycle as well as four cycle systems. Each cylinder is provided with an ignition chamber 2, opening into the head or closed end of the cylinder, and carrying a spark plug 3 the spark points of which extend into the interior of the ignition chamber, as shown in Fig. 2. Each spark plug 3 is connected by a suitable lead or conductor 4 with a revolving timer or current distributer of any usual type, contained within a box-like head or chamber 5 mounted on the upper end of a shell or casing 6, which contains a rotating fuel distributer 7. The current distributer delivers electric current to the spark plugs in regular sequence in the well known manner, and may be of any usual type or construction. As it constitutes no part of the present invention it is not shown in the drawing.

Immediately below the head 5 is a second box or chamber 8 having a downwardly-extending cylindrical portion, and provided with channels or passages 9 each communicating by means of a pipe 10 with that cylinder of the engine to which it is to supply fuel. The several passages 9 open into a central circular chamber in which the fuel distributer 7 is mounted and rotates, and said distributer is provided with a horizontal channel or passage 11 having an upward extension or passage 12 opening through the top of the fuel distributer, and a downward extension or passage 13 opening into a second horizontal passage 14 communicating with a peripheral groove or channel 15, to which gasoline or other liquid fuel is delivered by a pipe 16 controlled by a throttle valve or cock 17. (See Fig. 3). Under this arrangement the liquid fuel supplied by pipe 16 enters channel or passage 14, flows upward through passage 13, lifting the ball or check valve 18, and filling the channel 11, whence it may be discharged into any one of the passages 9 with which the cross passage is brought into communication.

The pipes 10 through which the fuel is conveyed to the ignition chambers 2, serve also at the time of explosion of a charge in any cylinder of the series, to permit a small portion of the gases of combustion to flow back into a gas chamber 19 formed in the box 8 above the channels or passages 9. To permit such flow each channel 9 is provided with an upwardly-extending branch 20—21, guarded by an upwardly-opening

check valve 22, conveniently of ball form. Above and concentric with the fuel distributer 7 is a circular head 23, provided with a series of ports 24 spaced at equal angular distances about the axis of the distributer 7, and equal in number to the number of cylinders of the engine, so that as the distributer 7 rotates the upward extension or passage 12 of channel 11 will be caused to register successively with the ports 24, connecting each in turn with one or another engine cylinder. (See Figs. 2 and 5).

The circular head 23 is formed upon the lower end of a sleeve 25 extending downward from the cap or cover 26 of box or casing 8, and the upper surface of the distributer 7 is pressed into and maintained in close contact with the head 23 by means of a helical spring 27 located beneath the distributer, and supported upon a nipple 28 screwed into the lower end of the circular chamber 8 in which the distributer rotates. The nipple 28 constitutes the shell or body of a packing gland through which passes a vertical spindle 29, the upper end of which is made of polygonal form to enter a socket of like form in the lower end of the body of distributer 7. The lower portion of said spindle 29 is formed or furnished with a quick-pitch screw 30, which is surrounded by a nut 31 tapped or threaded to receive and fit said screw. The exterior of the nut 31 is threaded in its lower portion, and is screwed into a hollow shell 32 having at its lower end a polygonal opening to receive the correspondingly shaped upper extremity 33 of a shaft or arbor 34, the shell 32 being mounted and rotating in a bushing 35 integral with casing 6, and seated in an opening in the frame of the engine.

The nut 31 is provided at its upper end with a circumferential flange between which and the upper end of shell 32 is an annular channel or seat, formed to receive a hoop or ring 36, which is provided at diametrically opposite points with studs or pins 37. An elbow lever 38 fulcrumed upon the shell or casing 6 of the structure, is forked at its lower end to straddle the ring 36, and its arms are perforated to receive the pins or studs 37, so that by rocking the lever upon its fulcrum the ring 36 and consequently the nut 31 and shell 32, may be raised or lowered as desired. The effect of such raising or lowering is to partially rotate the spindle 29, and thereby correspondingly to partially rotate the fuel distributer 7, thus causing the fuel passage 11 of said distributer to assume a different angular relation to the axis of the shaft or arbor 34. The polygonal form of the upper end 33 of shaft 34 and the socket of shell 32, permits the latter to rise and fall under the movements of lever 38 without varying the angular relation of said shell and nut 31 to said shaft 34. Owing to the quick pitch of screw 30 the screw and nut afford a driving connection between spindle 29 and shaft 34, permitting, nevertheless, a vertical adjustment of the nut and a consequent partial rotation of spindle 29 and the parts carried by it, to vary their angular relation to shaft 34.

Rotary motion is imparted to shaft 34 by means of pinions 39 and 40, preferably spiral pinions as shown in Figs. 1, 2 and 3, the pinion 40 being carried by the cam-shaft 41, which under the construction illustrated, imparts motion in proper timed relation to the valves of the several engine cylinders.

Upon referring to Figs. 5, 6 and 7 it will be seen that there is a small vent passage or lateral branch 42, opening from fuel passage 11 to the circumference of the fuel distributer 7, and consequently communicating successively with the passages 9 as the distributer rotates. The purpose of this branch passage will appear in the description of the operation of the engine, which follows. For convenience of explanation I refer to the several cylinders in sequence as A, B, C and D, beginning anywhere in the series.

With this understanding and assuming that the charge in cylinder A is just being exploded and that cylinder B is next to receive its fuel charge, the pipe 10 communicating with cylinder A will permit a backflow from the cylinder to gas chamber 19, of a small percentage of the gases of combustion at explosion pressure. This gas, entering chamber 19 is trapped or held therein by the immediate seating of the check valve 22 controlling the passage with which said pipe 10 connects. As the distributer 7 rotates, its passage 12 will register with that one of the ports 24 which connects with the passage 9 and pipe 10 communicating with cylinder B, and the gas until then confined in chamber 19 will flow through such port 24 into passage 12 and force before it the fuel contained in passage 11, driving the same through passage 9 and pipe 10 into the ignition chamber 2 of cylinder B.

An independent air supply is drawn in at each induction stroke of each piston, and the liquid fuel forced by the gas pressure from chamber 19 into the ignition chamber will be sprayed into and thoroughly commingled with the air, thus making a combustible or explosive mixture which will be readily ignited upon the production of the spark in the ignition chamber, suitably timed by the current distributer or timer. This current distributer may be carried by the upper end of the fuel distributer, or by a stem fitted into and rotating with the same.

In order that the fuel may be freely drawn into the passage 11 at proper times, it is necessary to vent said passage, or relieve

the same of the presence of the gases of combustion, of which some portion will remain in passage 11 after each projection of fuel into a cylinder, and it is for this purpose that the vent passage 42 is provided. This passage is so positioned with relation to the passage 11 and channels 9, that at the instant that the intake stroke of the piston of any given cylinder is occurring, the vent passage 42 shall communicate with the passage 9 and pipe 10 of that particular cylinder, with the result not only of withdrawing the gases from fuel passage 11, but also of creating a partial vacuum in channel or passage 11, and thereby inducing an inflow of liquid fuel through pipe 16 into the passage 11. At all times except during the brief periods when the mouth of vent 42 is crossing one or another of the passages 9, its outer end is sealed by the solid walls of the box or casing 8.

The partial rotation of the fuel distributer through the use of the quick-pitch screw 30 and nut 31 serves to advance or retard the introduction of the fuel into the cylinder.

The drawings illustrate the parts in extreme retarded position. Under this adjustment the crank connected with the piston of the cylinder to be fired will have moved the piston to the extreme of its inward travel, and reached a point 45° beyond the vertical axis of the cylinder before the fuel is injected. It may, however, be advanced so as to introduce the fuel charge when the crank is 45° to the other side of the vertical axis of the cylinder, or in other words, within 45° of its highest position in moving toward such extreme position. It may of course be set to any intermediate adjustment.

The electric igniter should cause the spark to occur just after the passage 11 has closed and cut off the connection between gas chamber 19 and the cylinder to be fired.

When a compressed air tank is provided for starting the engine, it is connected by a pipe 43 with the gas chamber 19, and provided with a cock which may be opened in order to establish pressure in said chamber 19.

If a crank connected with one of the pistons be not more than 30° past its extreme upward throw, advancing the fuel distributer 30° from its retarded position and then retarding to the extreme limit, will cause the charge to be blown into the cylinder and ignition to occur.

I contemplate increasing the range of adjustment to 180° between extremes, in which case the device will operate regardless of the position of the piston provided the crank be not on the dead center, a position in which, in practice, it rarely if ever stops.

The pipes 10 in conjunction with the ignition chambers 2, constitute an important part of the system, for the reason that no matter how much the engine may be throttled down, the mixture in these pipes and chambers will always be rich enough to ignite, and it cannot be too rich within working limits, since at some point the dilution of too rich a charge in a pipe and chamber would occur from the air in the cylinder, provided the spark be continued over a considerable range, say 45°. This range may be assured by suitably lengthening the electric contacts of the timer.

The foregoing description pertains to engines in which the compression is kept below the point where preignition would occur. It is, however, applicable also to engines having a high compression, say 150 or 160 pounds. Under existing practice it would probably be advisable not to carry the compression materially above 160 pounds, as the explosion pressure would in such event be above 600 pounds, which is, according to present practice, a rather high pressure. I do not, however, limit myself to any particular range of pressure, since heavier pressures may be utilized if the engine be specially designed therefor. When used with engines having a compression of 160 pounds or thereabout, and in which, when heated, the charge is ignited by the compression pressure, a check valve will be inserted to protect the passage 11, and the opening and closing of this passage must in such event, occur within a very few degrees. This will require a distributer of relatively large diameter. The spark plugs will in such case be retained for starting purposes.

When gasoline is employed as the liquid fuel the heat contained in the burnt gas is sufficient, when the gas is released from chamber 19 and mingled with the gasoline in carrying the latter to the ignition tubes or pipes, to thoroughly vaporize the gasoline, thereby providing a proper mixture for perfect combustion. When kerosene or heavier oils are used, the vaporization will be equally good provided the kerosene or oil be previously heated, as may be done by passing it through a coil heated by the exhaust gases or otherwise.

The slight loss incident to withdrawing a small percentage of the burned gases at explosion pressure is more than offset by providing the engine with inlet valves affording a free intake of unheated air, so that a pressure in the neighborhood of 14 pounds absolute in the cylinder at the commencement of the compression stroke may be attained. This is materially higher than is practicable with carbureters.

A wide speed variation is practicable, as the pipes 10 and chambers 2 enable very weak mixtures to be ignited.

While the foregoing description is based

upon a four cycle engine, the invention is applicable to and possesses special advantages with engines of the two cycle type, in that it affords a flexibility which two cycle engines supplied with fuel by a carbureter, have always lacked.

The passage 11 of the fuel distributer constitutes a fuel chamber, and can be properly proportioned to provide a charge-measuring chamber, insuring a uniform charge of fuel so long as the cock or valve 17 is fully opened. Less than the normal charge may of course be secured by adjustment of said valve.

The pipes 10 afford a convenient connection between the engine cylinders and the gas chamber 19, but any form of conduit may of course be employed.

The terms shaft, spindle, and arbor, are commonly used interchangeably, and are so used in this description.

It is obvious that, by reason of closing the inlet of the gas-compressing channel before opening the outlet, and vice versa, fuel may be fed to a single cylinder engine by my method.

Having thus described my invention what I claim is:

1. The method of supplying fuel to an internal combustion engine cylinder, which consists in withdrawing from a cylinder at the moment of explosion of its charge, a portion of the explosion gases; delivering the same into a channel containing liquid fuel and capable of being placed in communication with a cylinder to be charged; closing, by a positive and unyielding barrier, communication between said channel and the cylinder from which the gases are withdrawn, and maintaining such closure until the succeeding compression stroke in the cylinder to be charged is about completed; opening communication between said channel and the cylinder to be charged as such compression is about completed; and through the pressure and expansion of the gas in the channel, forcing the fuel into the cylinder to be charged.

2. The method of supplying fuel to the cylinders of an internal combustion engine, which consists in withdrawing from a cylinder at the moment of explosion of its charge, a portion of the gases of such explosion; delivering the same into a channel having communication with a fuel reservoir; closing communication of said channel with the first-named cylinder, and as the compression stroke in a succeeding cylinder nears completion, opening communication between the channel and such second cylinder; and through the unaided pressure and expansion of the gases contained in the channel, forcing fuel into the second cylinder.

3. The method of supplying fuel to the cylinders of an internal combustion engine in proper time and sequence, which consists in withdrawing from each cylinder at the moment of explosion of its charge, a portion of the explosion gases; confining the gases so withdrawn; establishing communication between the confined gases, the cylinder to be fired, and the fuel supply, and through the unaided pressure and expansion of the gas, forcing said fuel into the cylinder next to be fired; connection between the gas-confining chamber, the fuel supply, and the respective cylinders being made in regular sequence.

4. In combination with a plurality of engine cylinders, a fuel-feeding apparatus therefor, comprising a gas-confining chamber having a series of ports corresponding in number with the engine cylinders; conduits connecting the several cylinders with said chamber; check valves between said chamber and the cylinders, opening toward the gas chamber; a fuel distributer having a passage adapted to register simultaneously with one of the ports of the gas chamber and with one of the conduits connecting said chamber and the engine cylinders; and a fuel supply communicating with the fuel distributer, the arrangement being such that as the fuel distributer moves the above-named connections shall be made between the gas chamber and the several cylinders in succession; whereby the gas stored in the chamber is caused by its expansion to force before it and into each cylinder in succession, fuel contained in the fuel distributer.

5. In combination with an engine having a plurality of cylinders, a fuel chamber and a gas chamber communicating with said cylinders; a fuel supply communicating with the fuel chamber; and a fuel distributer serving to establish communication between the gas chamber and the fuel chamber, and between the fuel chamber and the engine cylinders in sequence; whereby gas at explosion pressure is delivered into the gas chamber and from the gas chamber into the fuel chamber, and finally into the respective cylinders of the engine, carrying with it fuel from the fuel chamber.

6. In combination with an engine having a plurality of cylinders and pistons, a fuel chamber and a gas chamber communicating with said cylinders; a fuel supply communicating with the fuel chamber; a fuel distributer serving to establish communication between the gas chamber and the fuel chamber and between the fuel chamber and the engine cylinders in sequence; a driving shaft for said fuel distributer; and connections between the fuel distributer and its driving shaft, serving to vary the angular adjustment of the distributer relatively to its driving shaft; whereby gas at explosion pressure is delivered into the gas chamber and from the gas chamber into the fuel cham-

ber, and finally into the respective cylinders of the engine, carrying with it fuel from the fuel chamber, and the time of delivery of the fuel to the cylinders is advanced or retarded relatively to the positions of the pistons in the respective cylinders.

7. An internal combustion engine comprising, in combination, a plurality of cylinders and pistons; a gas chamber distinct from the cylinders and provided with a series of discharge ports spaced at equal distances one from another and equal in number to the engine cylinders; conduits connecting the respective cylinders with said gas chamber, and each provided with a check valve opening toward the gas chamber; a rotary fuel distributer having a passage adapted to register successively with the conduits communicating with the several cylinders and with the discharge ports of the gas chamber; a fuel inlet communicating with the passage of the fuel distributer; a spindle carrying the rotary fuel distributer; a shaft geared to rotate in timed relation to the movements of the several pistons of the engine; and a driving connection between the fuel distributer spindle and the driven shaft.

8. An internal combustion engine comprising, in combination, a plurality of cylinders and pistons; a gas chamber distinct from the cylinders and provided with a series of discharge ports spaced at equal distances one from another and equal in number to the engine cylinders; conduits connecting the respective cylinders with said gas chamber, and each provided with a check valve opening toward the gas chamber; a rotary fuel distributer having a passage adapted to register successively with the conduits communicating with the several cylinders and with the discharge ports of the gas chamber; a fuel inlet communicating with the passage of the fuel distributer; a spindle carrying the rotary fuel distributer; a shaft geared to rotate in timed relation to the movements of the several pistons of the engine; and a driving connection between the fuel distributer spindle and the driving shaft, adapted to vary the angular relation of the passage in the fuel distributer to the driving shaft.

9. An internal combustion engine comprising, in combination, a plurality of cylinders and pistons; a gas chamber distinct from the cylinders and provided with a series of discharge ports spaced at equal distances one from another and equal in number to the engine cylinders; conduits connecting the respective cylinders with said gas chamber, and each provided with a check valve opening toward the gas chamber; a rotary fuel distributer having a passage adapted to register successively with the conduits communicating with the several cylinders and with the discharge ports of the gas chamber; a fuel inlet communicating with the passage of the fuel distributer; a spindle carrying the rotary fuel distributer and provided with a quick-pitch thread; a shaft geared to rotate in timed relation to the movements of the several pistons of the engine; a nut tapped to receive the quick-pitch thread of the spindle and connected to slide upon but rotate with said spindle and a lever for moving said nut relatively to the screw, and thereby imparting rotary adjustment to the fuel distributer relatively to the driving shaft.

10. An internal combustion engine comprising, in combination, a plurality of cylinders and pistons; a gas chamber distinct from the cylinders and provided with a series of discharge ports spaced at equal distances one from another and equal in number to the engine cylinders, conduits connecting the respective cylinders with said gas chamber, and each provided with a check valve opening toward the gas chamber; a rotary fuel distributer having a passage adapted to register successively with the conduits communicating with the several cylinders and with the discharge ports of the gas chamber, and provided with a vent adapted to communicate successively with the conduits connecting the respective cylinders with the gas chamber; and a fuel inlet communicating with the passage of the fuel distributer, said vent being so positioned relatively to said fuel passage as to connect the same successively with each cylinder at the moment of the induction stroke thereof; whereby any gas contained in the passage of the fuel distributer is withdrawn and an inflow of fuel to said passage is induced.

11. An internal combustion engine comprising, in combination, a plurality of cylinders and pistons; a gas chamber distinct from the cylinders and provided with a series of discharge ports spaced at equal distances one from another and equal in number to the engine cylinders; conduits connecting the respective cylinders with said gas chamber, and each provided with a check valve opening toward the gas chamber; a rotary fuel distributer having a passage adapted to register successively with the conduits communicating with the several cylinders and with the discharge ports of the gas chamber; a fuel inlet communicating with the passage of the fuel distributer; a spindle carrying the rotary fuel distributer and permitting axial movement of the latter relatively to the spindle; and a spring serving to press and hold the fuel distributer in contact with the ported wall of the gas chamber.

In testimony whereof I have signed my name to this specification.

RICHARD F. PIATT.