G. F. MURPHY.

FUEL INJECTOR FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED JULY 13, 1907.

989,026.

Patented Apr. 11, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

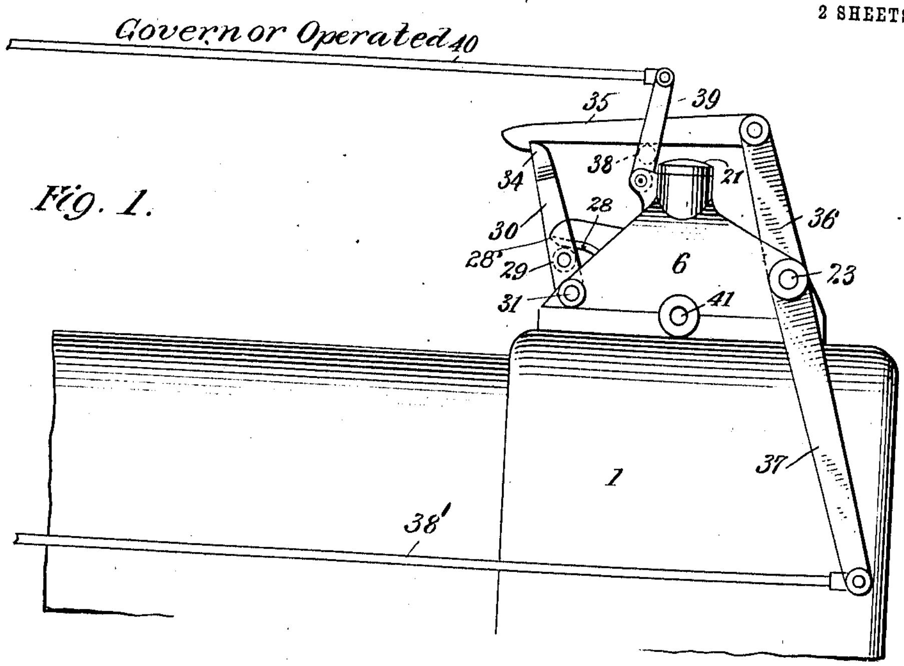


Fig. 3.

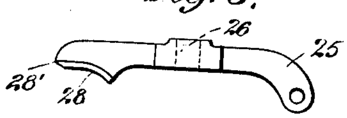


Fig. 4.

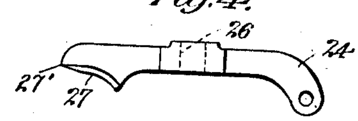
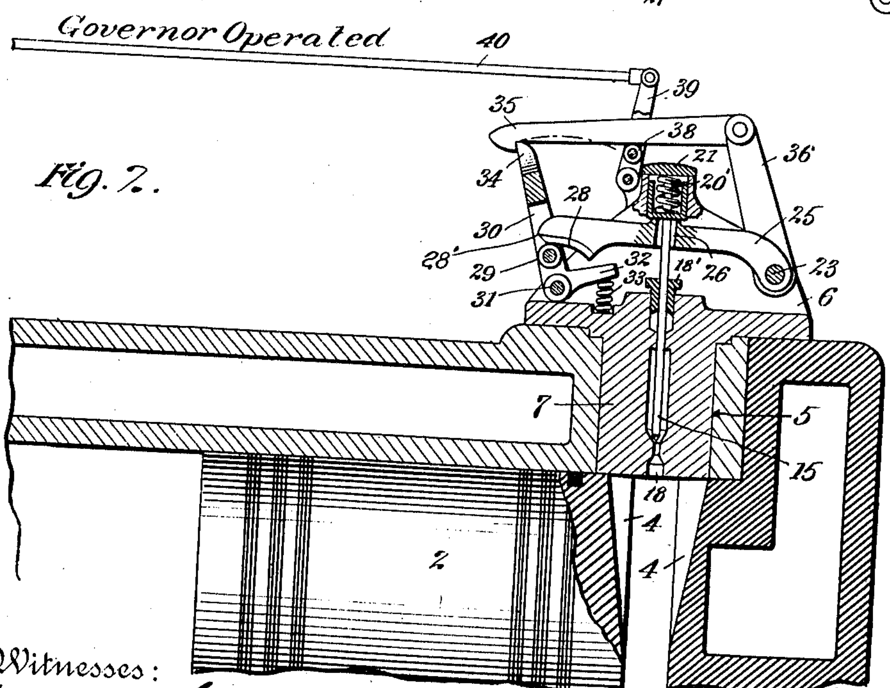


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 5.

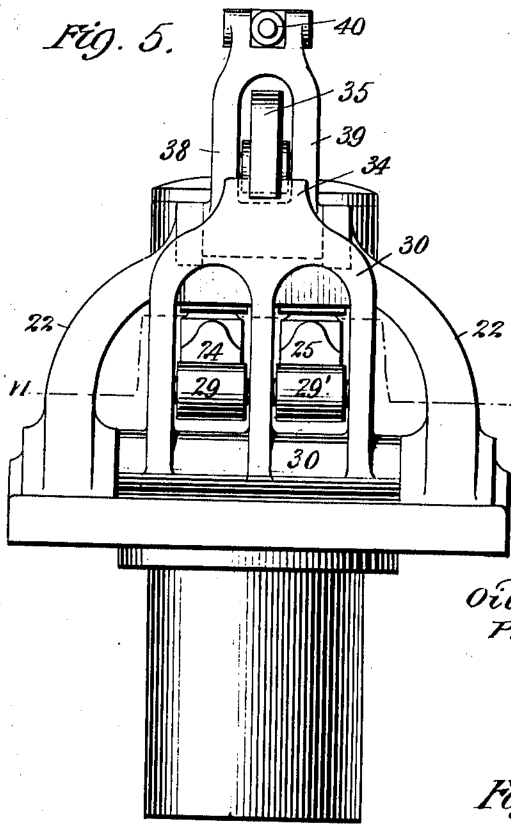


Fig. 7.

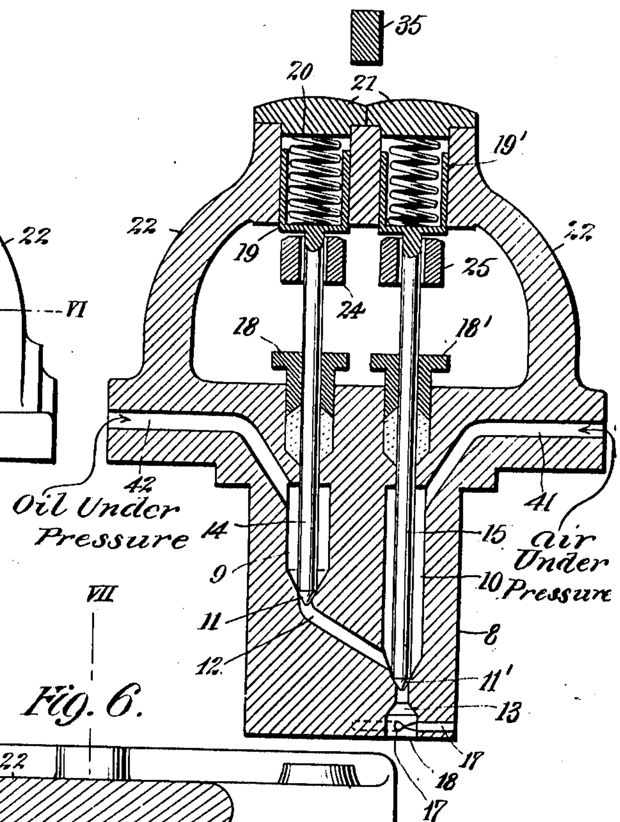


Fig. 6.

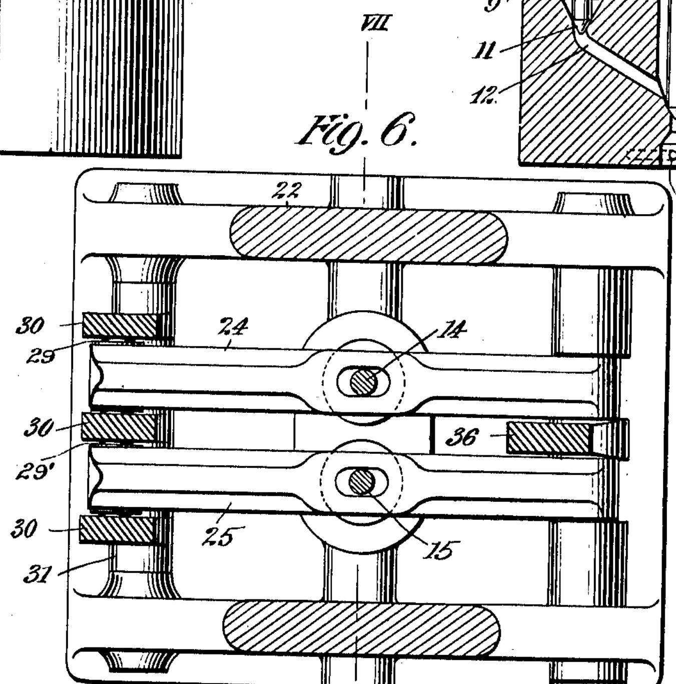
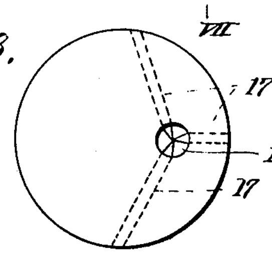


Fig. 8.



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UNITED STATES PATENT OFFICE.

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FUEL-INJECTOR FOR INTERNAL-COMBUSTION ENGINES.

989,026. Specification of Letters Patent. Patented Apr. 11, 1911.

Application filed July 13, 1907. Serial No. 383,570.

To all whom it may concern:

Be it known that I, GEORGE F. MURPHY, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Fuel-Injectors for Internal-Combustion Engines, of which the following is a full, clear, and exact description.

My invention relates to internal combustion engines, and particularly of that type in which liquid fuel is injected into a cylinder in which pure air has been highly compressed.

The present invention relates particularly to a form of oil injection mechanism by which engines of this class may be controlled as evenly and perfectly as the best steam engines having a governor controlled cut-off.

The invention consists therefore in the features of construction and combination as hereinafter set forth and shown, and finally particularly pointed out in the appended claims.

In the drawings: Figure 1 is a side elevation of an oil injection mechanism embodying the principles of my invention in place upon the cylinder of an engine; Fig. 2 is a sectional view of the same; Figs. 3 and 4 are detail views showing certain cam levers or parts; Fig. 5 is a view of the oil injection mechanism removed from the cylinder and looking from the left in Fig. 1; Fig. 6 is a horizontal sectional view of the same on the line VI—VI of Fig. 5; Fig. 7 is a vertical sectional view on the line VII—VII of Fig. 6; Fig. 8 is a detail view showing the appearance of the bottom end or face of the oil injection mechanism.

The general principle of operation of the fuel injection engine is based on the fact that if air is compressed to a very high degree, say 30 or 35 atmospheres, the temperature thereof becomes so elevated that any ordinary oil or fuel injected therein or subjected thereto, becomes ignited and burns, adding its heat and energy to the compressed air. In ordinary practice, the pure air is compressed in a cylinder to about 35 atmosphere pressure, and oil is thereupon injected at the beginning of the expansion stroke of the piston. The oil burns or combines with the air almost instantly when injected, so that the rate of combustion is determined by the rate of injection of the oil. When the oil supply is cut off, the combustion ceases and thereafter the expansion merely takes place adiabatically as in a steam engine. The period of the oil cut-off relative to the engine stroke is therefore somewhat analogous to the cut-off of steam in a steam engine, and may conveniently be controlled by a governor. The mechanism for injecting and cutting off the oil should be very perfect, since the slightest deviation from the feed of exactly correct quantities at exactly the right time, produces a very great disturbance on the operation of the engine. The present invention therefore aims to secure the very greatest exactness in the feed control and cut off of the oil supply.

Referring to the drawings in which like parts are designated by the same reference sign, 1 indicates the cylinder of an engine, which may be of any suitable character, as, for example, described in my co-pending application, Serial No. 381,920, filed July 2, 1907; 2 denotes the piston movable therein and approaching the head 3 of the cylinder very closely in its movement so that the space into which the air may be compressed is extremely restricted, and whereby the compression is elevated to a very high degree. The piston 2 and the head 3 may be cut away slightly at 4 so as to provide a convenient cavity or chamber into which the oil from the injector is received. At a point communicating with the recesses 4 there is provided a hole 5, through the wall of the cylinder.

6 denotes a frame or casing adapted to be received on top of the cylinder and having a protuberance 7, which fits tightly in the hole 5. This frame or casing may be secured on the cylinder in any suitable way.

Within the protuberance 7, of the frame 6, there are provided two separate chambers or cavities 9 and 10, each of which is tapered at its lower end to form valve seats 11, 11′. The cavity 9 communicates with the cavity 10 by a passage 12, while the cavity 10 communicates with the cylinder of the engine through a passage 13.

14 and 15 denote needles or valves which coöperate with the valve seats 11, 11′, and close the respective passages 12 and 13. I have illustrated a construction of the passage 13, having an enlargement 18, into which radially project a plurality of pins or projections 17. The purpose of these projections is to break up and more perfectly atomize the oil jet passing therethrough. The valve members or needles 14 and 15 extend upward through their cavities 9 and 10 and through glands or stuffing boxes 18, 18′, in the frame or casing 6. At their upper ends these valve members are extended or enlarged to form cups 19, 19′, which receive the springs 20, 21′. 21 indicate abutments for these springs which are held in place by an extension 22 of the frame 6. This relation is such that in the absence of certain mechanism hereinafter described, the needle valves 14 and 15 are pressed downward on their seats 11, 11′, so as to close the passages 12 and 13 respectively.

The mechanism for raising the needle valves off their seats will be best understood from a consideration of Fig. 2. The frame 6 has a loose transverse shaft or spindle 23 therein, on which are loosely pivoted a pair of cam levers 24 and 25 (see particularly Figs. 3 and 4). These levers have openings 26 therein through which pass the needle valves 14 and 15. The upper sides of these levers are adapted to be brought to bear against the heads or enlargements 19, 19′, of the needle valves, by reason of which the needle valves may be raised off their seats. The outer ends of these levers 24, 25, are provided with the respective cam surfaces 27, 27′ and 28, 28′; cam surfaces 27, 27′ being adapted for engagement with a roller 29 and surfaces 28, 28′ being correspondingly adapted for engagement with a roller 29′, both rollers being mounted on a single rock arm 30. This rock arm is conveniently made forked or bifurcated, as shown, so as to more rigidly support the rollers, and is pivoted on a shaft 31, in the frame 6.

32 denotes a lateral extension of the rock arm which is engaged by a spring 33, to impel the rock arm normally outward, or to the left, in Figs. 1 and 2.

The rock arm 30 terminates at its outer end in the form of a lip 34, and which is adapted to be engaged by a hook 35, pivoted to a rock arm 36, fixed to the transverse shaft 23 already described. This transverse shaft has an additional crank or arm 37 thereon, extending downward from one of its ends, and by means of which it may be swung back and forth by link 38′, extending to an eccentric on the crank shaft, or any other convenient operating mechanism (not shown). In this way the shaft 23 is rocked back and forth at each revolution of the engine and the rock arm 30 is correspondingly moved under the influence of the hook 35. The engagement of the hook 35 with the rock arm 30 is only made during the forward movement of the hook, the latter being then disengaged to permit the rock arm 30 to return by its spring 33. The mechanism for this purpose preferably comprises a bifurcated swinging arm 39, having a roller 38, on which the lower surface of the hook 35 rides.

40 denotes a link extending to any convenient governor (not shown), by which the position of the arm 39 is determined and varied.

The operation is as follows: Supposing the piston 2 has moved to about the limit of its compression stroke, it becomes necessary for the oil to be injected in an amount suitable to the load of the engine at this time. The adjustment of the parts is such that the link 38′ is being pulled at this time by its eccentric, or other means (not shown), and the hook 35 is effective to draw inward the rock arm 30 so that roller 29, which is normally in engagement with cam surface 27′, is moved into engagement with cam surface 27, while roller 29′, which correspondingly is normally in engagement with cam surface 28′, is moved into engagement with cam surface 28. As apparent from Figs. 3 and 4, the cam surface 28′ is more abruptly inclined to the path of movement of the roller than is cam surface 27′. Hence when the rollers move from their initial or resting positions, and the levers 24 and 25 are thereby displaced upwardly, lever 24 will swing upwardly more slowly than will lever 25 and will therefore contact with and begin to raise cup 19 after cup 19′ has been raised by its lever 25. In other words, lever 25 in raising lifts needle valve 15 and lever 24 lifts needle valve 14, but valve 15 is invariably lifted from its seat 11′ before valve 14 is moved from its seat 11. The chamber or cavity 10 is in permanent communication with the air pressure reservoir through a duct or passage 41, so that the instant valve 15 is raised air flows through port 11′. Flow of air alone, however, continues for but a brief interval since the cavity 9, in which is disposed the valve 14, is in permanent communication with an oil pressure reservoir through a duct or passage 42 and when valve 14 raises, as it does immediately after valve 15 has been raised, oil will flow through port 11, and passage 12 and will be entrained with the air passing through port 11′ and immediately driven into the engine cylinder. It is evident that the pressures in the oil and air reservoirs must be higher than the compression in the cylinder in order to secure this result. The current of air breaks up or atomizes the oil jet, which action is assisted and increased by the pins or projections 17 in the passage 18. This is important, because the oil should be immediately burned or consumed in the engine cylinder, and for this purpose it is necessary to have the oil injected in a finely divided or atomized condition. As the hook 35 continues its forward movement (to the right), the rock arm 30 swings through an arc, as shown in dotted lines in Fig. 2. The hook 35 oscillates slightly in a vertical plane to accommodate this movement which it can do on account of its pivotal connection with the arm 36 and the slotted character of the swinging arm 39. At the end of the movement, however, the hook 35 bears against and rides upon the roller 38, and as the forward movement of arm 36 continues, the hook is tripped off the edge of the lip 34. The rock arm 30 immediately returns with a very abrupt movement under the impulse of its spring 33, and the needle valves 14 and 15 quickly close upon their seats. But it is evident that the needle valve 15 will never close until 14 has properly seated itself. This is insured by the character of the cam faces 27 and 28 which tend to produce a closure of the oil valve slightly in advance of the air valve. In other words, the air valve is always allowing air to pass into the cylinder when the oil valve is opened, while it is being held open, and when it is closed. Accordingly, it is impossible for any oil to collect in the passage 10 since such oil would be instantly blown out of this passage and into the cylinder by the current of air which is always flowing therethrough when the oil valve is open.

In the above description the roller 38, on which the hook 35 rides, has been treated as if stationary. The position of this roller is, however, varied by the angular position of the swinging arm 39 controlled by the governor rod 40. As the governor rod is pulled toward the left in Figs. 1 and 2, it is clear that the roller 38 is slightly elevated, and the hook 35 tripped off of the lip 34 at an earlier point in the stroke of the engine. The point of cut-off of the oil injection in the cylinder is therefore varied by the engine governor.

It will be observed that the cut-off of the oil supply is exceedingly abrupt, since all of the oil controlling parts are of comparatively small and light construction, and are assisted in their movement by a number of controlling springs, as well as the force of gravity. The springs 20 and 20′ are very strong since they have to resist the pressure of the gases in the cylinder, so that these springs impel the needle valves downward quickly on their seats. As the cam levers 24 and 25 are free to drop by their own weight these oppose no resistance to the closing of the needle valves. If the pressure in the oil reservoir is different from that in the air reservoir, no effect on the operation is produced, because the two passages 41 and 42 are never open to one another, except at the time when they are both in communication with the cylinder. At this time the preponderating pressures in the oil and air reservoirs insure a proper flow from each to the cylinder. The needle valve 14 invariably closes the communication between the passages 41 and 42 before the needle 15 has shut off the communication from the cylinder, so that under no circumstances can the oil flow into the air reservoir or the air flow into the oil reservoir. These last named considerations are extremely important ones in practice, since at the pressure used, a drop or two of oil getting into the air reservoir would burn and might cause an extremely disastrous explosion.

In normal running the engine operates somewhat analogously to a steam engine, the cut-off occurring at a point depending on the engine load. As in steam engines, the sharpness of the cut-off is important from the standpoint of efficiency. It is evident that these various features as well as a very uniform feed of the oil, are secured by my above described mechanism.

What I claim, is:—

1. In a fuel injector for an internal combustion engine, means acting to initially admit air and afterward liquid fuel under pressure to the engine cylinder, and governor-controlled devices acting on said means to invariably cut off the liquid fuel at a point in the engine stroke earlier than the cut-off of the air.

2. In a fuel injector for an internal combustion engine, a part having a chamber opening into the engine cylinder, a needle valve closing inwardly toward the cylinder and spring impelled into a relation to close such opening, means for raising said valve off the opening, and means for releasing the needle valve to close said opening.

3. In a fuel injector for an internal combustion engine, a part having an opening for admitting liquid fuel to the engine cylinder, a needle valve for closing said opening, a spring directly engaging the needle valve to move it into closing relation, a cam lever for raising said needle valve off its seat, and means movable out of engagement with said cam lever to permit an abrupt closing movement of the valve.

4. In a fuel injector for an internal com-

bustion engine, means for feeding oil to the engine cylinder, a needle valve for cutting off the feed of oil, a spring for impelling such needle valve into cut-off relation, a cam lever pivoted to engage said needle valve and raise it off its seat, a rock arm engaging said cam lever, and means for oscillating said rock arm.

5. In a fuel injector for an internal combustion engine, means for feeding oil to the engine cylinder, a needle valve for cutting off the feed of oil, a spring for impelling such needle valve into cut-off relation, a cam lever pivoted to engage said needle valve and raise it off its seat, a rock arm engaging said cam lever, a hook for oscillating said rock arm, and means for tripping said hook from its engagement with the rock arm.

6. In a fuel injector for an internal combustion engine, means for feeding oil to the engine cylinder, a needle valve for cutting off the feed of oil, a spring for impelling such needle valve into cut-off relation, a cam lever pivoted to engage said needle valve and raise it off its seat, a rock arm engaging said cam lever, a hook for oscillating said rock arm, and governor controlled means for tripping said hook from its engagement with the rock arm.

7. In a fuel injector for an internal combustion engine, a pair of valves for controlling air and liquid fuel respectively, separate cam levers for raising said valves off their seats, and a single means engaging said cam levers to move them into engaging relation to the valves.

8. In a fuel injector for an internal combustion engine, a pair of valves for controlling the admission of fuel under pressure and air under pressure to the cylinder, means for tripping said valves successively into closing relation, and governor controlled means for determining the point of such action with respect to the engine stroke.

9. In a fuel injector for an internal combustion engine, valves for controlling the admission of air and liquid fuel to the cylinder, springs for impelling said valves into closing relation, means for raising said valves into opening relation, and governor controlled means for releasing both valves, whereby they close on their seats with an abrupt movement.

10. In a fuel injector for an internal combustion engine, a frame having a cylindrical protuberance adapted to fit in the wall of the engine cylinder, chambers in said protuberance communicating with sources of oil and air under pressure, respectively, needle valves in said chambers for controlling the flow therefrom to the engine cylinder, springs for impelling said needle valves into closing relation, separate cam levers for raising the needle valves off their seats, and cam means for lifting the needle valves in opposition to said springs.

11. In a fuel injector for an internal combustion engine, a frame having a cylindrical protuberance adapted to fit in the wall of the engine cylinder, chambers in said protuberance communicating with sources of oil and air under pressure respectively, needle valves in said chambers for controlling the flow therefrom to the engine cylinder, springs for impelling said needle valves into closing relation, separate cam levers for raising the needle valves off their seats, cam means for lifting the needle valves in opposition to said springs, and governor controlled means for tripping said cam means to permit the needle valves to close abruptly.

12. In a fuel injector for an internal combustion engine, a valve for controlling the admission of liquid fuel to the engine cylinder, a cam lever for raising said valve off its seat, a rock arm having a roller engaging said cam lever, an arm having a hook engaging said rock arm, and means for oscillating said hook arm.

13. In a fuel injector for an internal combustion engine, a valve for controlling the admission of liquid fuel to the engine cylinder, a cam lever for raising said valve off its seat, a rock arm having a roller engaging said cam lever, an arm having a hook engaging said rock arm, means for oscillating said hook arm, and means engaging said hook to lift it from its engagement with the rock arm whereby the needle valve closes with an abrupt movement.

14. In a fuel injector for an internal combustion engine, a needle valve for controlling the admission of fuel to the cylinder, a spring for impelling said needle valve into closing relation, a cam lever for raising the needle valve, an outwardly spring impelled rock arm engaging said cam lever, means having a hook engaging said rock arm and having an oscillating movement, and governor controlled means for lifting the hook and tripping it from its engagement with said rock arm.

15. In a fuel injector for an internal combustion engine, a frame having an air passage leading to the engine cylinder and having an oil passage leading to the air passage, separate closing means adapted to be tripped to close said passages, and governor controlled means for tripping said separate means successively into action.

16. In a fuel injector for an internal combustion engine, a valve for controlling the admission of fuel under pressure to the cylinder, means for raising said valve off its seat and maintaining it raised a constant predetermined distance during a portion of

the forward engine stroke, and governor controlled means acting at variable points in such portion of the engine stroke for tripping said valve into closing relation, the distance said valve is raised off its seat at the moment of closing being the same for all points of cut-off.

17. In a fuel injector for an internal combustion engine, a part having a passage for the flow of liquid fuel, said passage having pins or protuberances projecting radially therein, whereby the flow is broken up and the liquid fuel atomized.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

GEORGE F. MURPHY.

Witnesses:
WALDO M. CHAPIN,
JAMES D'ANTONIO.