

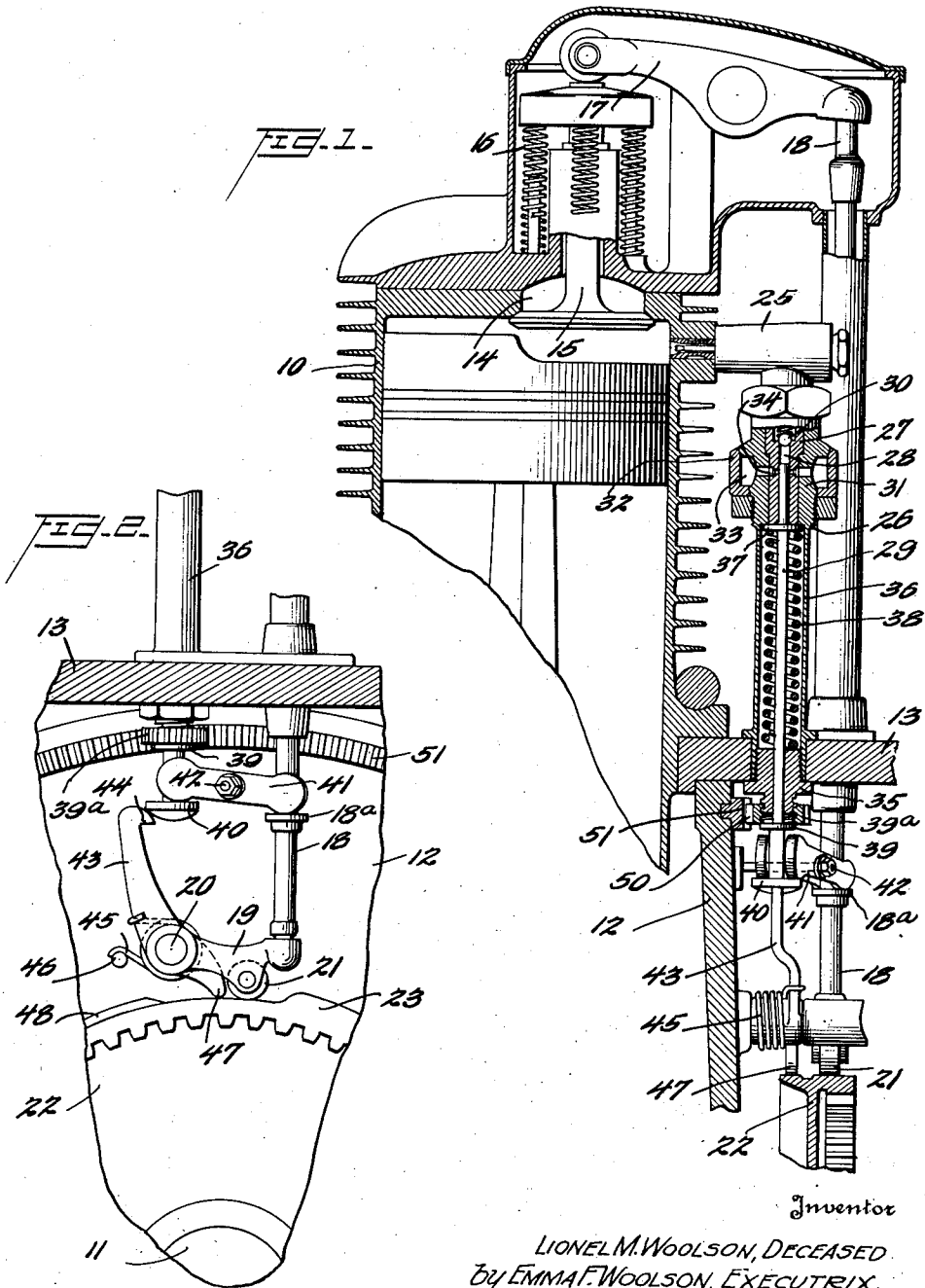
July 25, 1933.

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1,919,286

INTERNAL COMBUSTION ENGINE

Filed July 22, 1930



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INTERNAL COMBUSTION ENGINE

Application filed July 22, 1930. Serial No. 469,891.

This invention relates to internal combustion engines, and particularly to fuel injection mechanisms for engines of the Diesel type, in which liquid fuel is injected under pressure into each engine cylinder at or toward the end of the compression stroke of the associated piston.

Generally, engines of the Diesel type are designed and intended to be operated at substantially uniform speeds. In such instances the fuel injection mechanism, which is actuated from some moving part of the engine, also operates at a uniform speed, with the result that uniform quantities of fuel are successively delivered to the engine cylinders in equal intervals of time. Where an engine of this type is designed and intended to operate at varying speeds, however, it is sometimes found that an engine-driven fuel injection mechanism will vary in the effectiveness with which it performs its functions; that is, at low speeds for instance, the efficiency of fuel injection falls considerably below the efficiency of the same mechanism at high speeds, the fuel not being so efficiently sprayed into the combustion space when the engine-driven fuel pump plunger ceases to move at a comparatively high velocity. As the efficiency of the engine is, in large part, dependent upon the proper injection of the liquid fuel and the instantaneous and thorough admixture of the liquid fuel with the air under compression in the cylinders, it is clear that any decreased efficiency of injection is highly undesirable.

The present invention contemplates an improvement in an engine-driven fuel injection mechanism whereby the amount of fuel injected and the time of injection remain constant regardless of the speed at which the engine is operating.

By means of the improved fuel injection mechanism hereinafter to be fully described, it is possible to efficiently operate the engine not only at maximum speed but also at much lower speed, as when starting or idling. In accordance with the invention, the fuel injection plunger or member, whatever its shape or design may be, is actuated by means of a motor, such as a spring motor, instead of being positively operated by some

engine-driven part. This motor is intermittently loaded and intermittently released by engine-driven parts and in reality comprises any simple means for translating a portion of the kinetic energy of the engine into potential energy, which potential energy is momentarily stored and finally released at the proper time by an engine-driven part. The liquid fuel plunger may be driven by any one of a number of different kinds of motors, practically the only requirement which the motor must fulfill being that it shall operate the fuel plunger at a substantially uniform rate, when released.

In the accompanying drawing one embodiment of the invention is illustrated, but it will be appreciated by those skilled in the art that the basic underlying principle of the invention is quite independent of this disclosure, which is set forth by way of example only, and that many changes in the design and arrangement of the component elements of the invention may be made without departure from the spirit and scope thereof.

In the drawing:

Figure 1 is a fragmentary view, partly in section and partly in elevation, of a portion of an internal combustion engine of which the improved fuel injection mechanism comprises a part; and

Figure 2 is a side elevation of a portion of the mechanism disclosed in Figure 1.

It will be understood that the improved fuel injection mechanism which comprises the subject matter of the invention is applicable to all types of Diesel engines, whether stationary or of the portable type. It may also be adapted for use with engines of the radial type or for use with engines in which the cylinders are in parallel relationship. In the present instance the mechanism is disclosed as comprising a portion of a Diesel engine in which the cylinders are radially disposed, particularly designed for use as a power plant for an aeroplane, the improved fuel injection mechanism being of great usefulness when incorporated in an engine of this type.

One of the cylinders of the engine is indicated at 10 and the crankshaft at 11. The

cylinders and crankshaft are supported in a suitable frame, a portion only of which is illustrated, one frame member being indicated at 12 and a second member at 13. A port 14 in the cylinder head is controlled by a valve 15 of conventional form, this valve being urged to normally closed position by springs 16. The valve is adapted to be intermittently opened by mechanism including the rocker arm 17 pivotally mounted upon the cylinder head and the push rod 18, the upper end of which operatively engages one end of the rocker 17 and the lower end of which rests in a socket in a push rod operating lever 19, which lever is pivotally mounted on a boss or short shaft 20 extending laterally from the casing member 12. Lever 19 has rotatably mounted thereon a roller 21 which runs upon the outer surface of a cam ring 22 fixed on the crankshaft 11. Cam lobes 23 on cam ring 22 are positioned to successively engage roller 21, each thereby effecting the lifting of lever 19 and push rod 18, thus opening the valve. After the engaging cam 23 has passed roller 21, the push rod is allowed to descend, and the valve is closed.

A fuel injection nozzle is indicated at 25, and a pump member for injecting fuel through this nozzle into the combustion space within the cylinder is indicated generally at 26. This pump comprises essentially a central sleeve-like member 27 having an axial cylindrical bore 28 which comprises the pump cylinder. The space 28 is connected to nozzle 25 by a conduit (not shown) so that fuel placed under pressure by upward movement of the plunger 29 is conducted directly to the nozzle.

A non-return valve 30 permits upward flow of the liquid fuel but prevents return of the same due to any high pressure which may exist in the cylinder. Surrounding member 27 is a barrel member 31, and mounted on member 31 is a third member 32, members 31 and 32 enclosing between them a space 33 which is in communication with a source of liquid fuel under light pressure. Members 27 and 31 are provided with registering ports providing conduits 34, by means of which fluid may flow from space 33 inwardly into pump chamber 28 when the upper end of plunger 29 has been withdrawn to a point below the level of conduits 34.

Upon the upward stroke of the plunger, a certain definite quantity of fuel is trapped in the pump chamber 28 when the pump plunger has reached such position that the conduits 34 are closed, and, upon continued upward movement of the plunger, the entrapped fuel is placed under high compression, the check valve 30 is raised, and a quantity of fuel is injected into the cylinder.

It will be observed that the plunger 29 is an elongated rod-like member which extends generally parallel to the valve pusher rod 18.

Its upper end has a close sliding fit with the wall of chamber 28, and its lower end slidably engages the wall of a cylindrical aperture which extends through a plug 35. This plug is threaded into the lower end of a light tubular casing or housing 36, the upper end of which is preferably formed integral with member 31, and the lower end of which fits closely into a circular aperture formed in the substantially horizontally extending member 13 of the casing. Toward its upper end, plunger 29 is provided with an annular collar 37 which constitutes an abutment for one end of spring 38. Spring 38 is a coiled spring normally under compression, its lower end being seated upon the upper surface of plug 35.

The lower end of the fuel injection plunger 29 is enlarged and provided with two spaced annular flanges or collars 39 and 40, respectively. Collar 39 comprises a stop, limiting the upward movement of the plunger by contacting with an adjustable stop member 39^a which is threaded upon an axial, externally threaded, downwardly projecting, spindle-like portion of plug 35. Upon the upper surface of the lower terminal flange 40 of the plunger rests the ends of two parallel rocker arms 41, mounted to rock upon a fixed spindle 42 projecting laterally from the frame member 12, the opposite ends of rocking levers 41 resting upon the upper surface of a flange 18^a fixed upon or formed integrally with the push rod 18.

It will be obvious that upward movement of the push rod 18 will cause downward movement of plunger 29 and compression of spring 38. In its downward movement the lower surface of the enlargement 40 of the plunger, which is rounded for the purpose, thrusts aside the upper end of a pivoted sear or locking member 43, and, after the plunger has descended a predetermined distance, the laterally extending catch portion 44 of this sear snaps over the upper edge of enlargement 40 and engages the upper surface thereof, thus locking the plunger 29 in the lowered position to which it has just been moved.

Sear 43 is mounted to rock upon boss 20 and is normally urged in plunger locking direction by means of a spring 45, one end of which engages the sear and the other end of which bears against a pin 46 fixed in frame member 12. The lower tip end 47 of the sear rests upon the upper surface of cam ring 22, driven from the crankshaft, and is in position to be successively engaged by a series of cams 48 thereon. Engagement of a cam 48 with end 47 of sear 43 results in anticlockwise movement of the sear and disengagement of the sear and member 40, thus effecting the release of the plunger, whereupon it is immediately driven upward in fuel feeding direction by the spring 38.

The cams upon the cam ring 22 are so arranged that the spring 38 is placed under

stress at any suitable time prior to the instant when the fuel is to be injected, and the sear is released at the exact instant when it is desired that the fuel shall be introduced into the cylinder. It is obvious that the time of movement of plunger 29 on its fuel injection stroke is dependent entirely upon the action of spring 38 and entirely independent of the speed of rotation of the crankshaft. As a result, ideal conditions of fuel injection are realized, whether the engine itself is operating at high speed and under load or whether it is being started or run idly at low speeds. Maximum efficiency of the engine is therefore realized for all engine speeds.

The adjustable stop 39^a, which, as has previously been explained, may be raised or lowered by rotating the same upon the threaded axle extension of plug 35, is exteriorly toothed as at 50, and the teeth thereof are in mesh with the teeth of a ring 51 disposed concentrically of the crankshaft and slidably fitted in a groove formed in the frame of crank case member 12. Angular adjustment of ring 51 by any suitable means, therefore, effects adjustment of stop 39^a axially of the plunger 29, and hence the stroke of the plunger may be varied at will to modify, as desired, the quantity of fuel injected into the cylinder at each plunger stroke.

Instead of the spring disclosed as a suitable means for actuating the plunger in its fuel injection direction, any other suitable type of motor may be employed. The function of the motor is to store momentarily a portion of the kinetic energy of motion of some moving portion of the engine, that is, to translate this kinetic energy into potential energy, which energy is released at the proper instant, preferably by some other motor-driven part. It will be readily apparent that, instead of the spring disclosed by way of example, other types of motors may be chosen, and it will also be obvious that the invention is in nowise limited to any particular mechanism for loading or releasing the motor. Adaptation of the invention to engines of different types will require considerable modification of its component elements, but many modifications may be made without departure from the spirit and scope of the appended claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:—

1. In an internal combustion engine, in combination, a fuel injection member, a motor in which energy may be stored, means actuated by a moving part of the engine for imparting energy to the motor, means for maintaining said motor in energy storing condition, which means is adapted to be operated by an engine-driven part to release said motor irrespective of the condition of the energy imparting means, and means oper-

atively connecting said motor and fuel injection member whereby said member is operated when the motor is released.

2. In an internal combustion engine, in combination, a fuel injection member, a motor operatively connected thereto for continuously urging the same in fuel feeding direction, an intermittently operated engine part for loading the motor, and separate means whereby the motor may be released by a moving part of the engine, and the fuel injection member thereby operated.

3. In an internal combustion engine, in combination, a fuel injection member, means connected to said member for translating a portion of the kinetic energy of a moving part of the engine into potential energy, second means for holding said first means stationary and preventing release of said potential energy, and mechanism actuated by a moving part of the engine for effecting the timed actuation of said second means and the actuation of said member by the potential energy stored in said first mentioned means.

4. The combination with the cylinder of an internal combustion engine of means for intermittently injecting identical quantities of fuel therein in equal intervals of time, said means comprising a plunger, resilient means associated with the plunger and adapted to move the same in fuel feeding direction, means for stressing the resilient member, a device for holding the resilient member stationary and in stressed condition, and means for actuating said device and effecting the release of said resilient member.

5. In an internal combustion engine, in combination, a fuel injection member, a motor operatively connected thereto for always urging the same in fuel feeding direction, a motor loading member movably supported on the frame, and mechanism associated with the motor and engine whereby said motor loading member is intermittently actuated by energy derived from the engine to load the motor, locked in loaded condition, and released by an engine-driven part.

6. In an internal combustion engine, in combination, a fuel injection member, and stationary means associated with said member for absorbing energy from a moving part of the engine, storing the same momentarily and releasing such energy to effect actuation of the member in fuel feeding direction.

7. The combination with the fuel injection member of an internal combustion engine of a motor mounted on the engine frame for actuating the same in fuel feeding direction, and independent engine actuated means for loading and effecting the release of said motor.

8. In an internal combustion engine, in combination, a fuel injection plunger, a spring for continuously urging the said member in fuel injection direction, engine

operated means for loading said spring, an automatic device for locking said plunger in retracted position with said spring under stress, and separate engine actuated means 5 for actuating said device and effecting the release of said spring.

9. The combination set forth in claim 8 in which the plunger is disposed radially of the crankshaft and cams driven by the crank- 10 shaft effect the operation of the spring loading means and the release of the spring locking devices.

10. In an internal combustion engine, in combination, a crankshaft, a cylinder dis- 15 posed radially thereto, a valve controlled port in the cylinder wall, a radially disposed push rod connected to said valve, a cam ring mounted on the crankshaft for actuating said push rod, a fuel injection plunger, a spring for urging said plunger in fuel 20 delivery direction, a connection between the push rod and plunger whereby the latter is retracted when the former is moved in one

direction, thus stressing the spring, a device for locking the plunger in retracted position with the spring under stress, and engine operated means for actuating said locking de- 70 vice and effecting the release of said plunger, whereupon the plunger is moved on its fuel injection stroke by said spring.

11. The combination set forth in claim 10 in which the connection between the push rod and plunger comprises a lever mounted 75 to rock about a fixed axis, the ends of said lever engaging the push rod and plunger, respectively.

12. The combination set forth in claim 10 in which the push rod and spring releasing 80 mechanisms are both actuated by a common engine part, which is driven by the crankshaft.

EMMA F. WOOLSON, 85
Executrix of the Estate of Lionel M. Woolson, Deceased.

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