Feb. 14, 1933. L. E. ELWELL 1,897,044

FUEL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

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Fig. 1

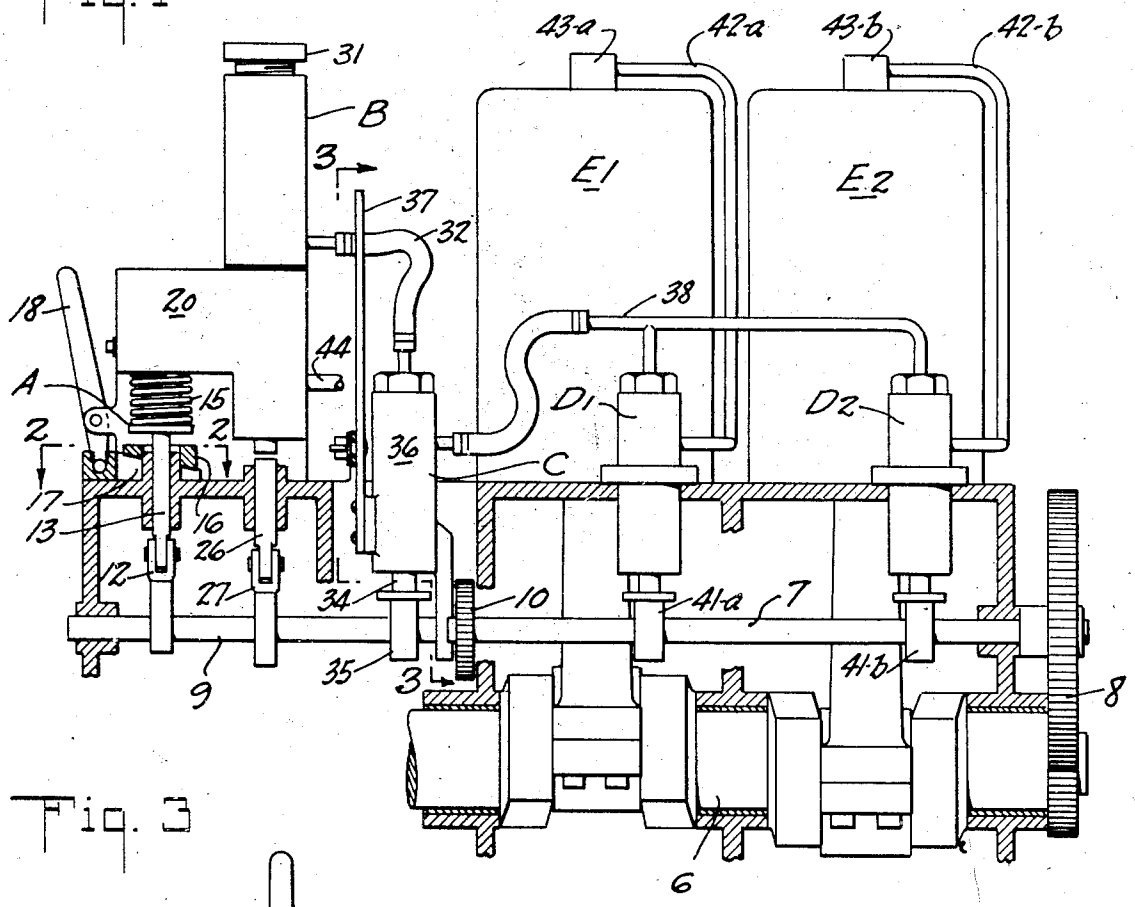

Fig. 3

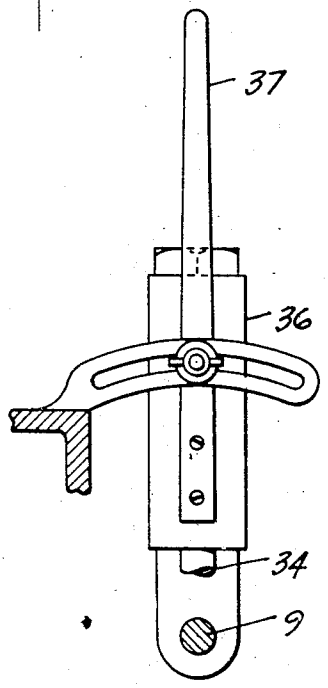

Fig. 2

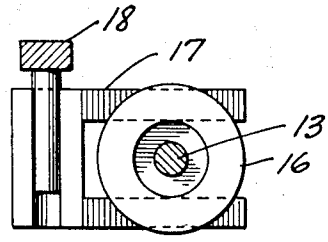

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Fig. 4

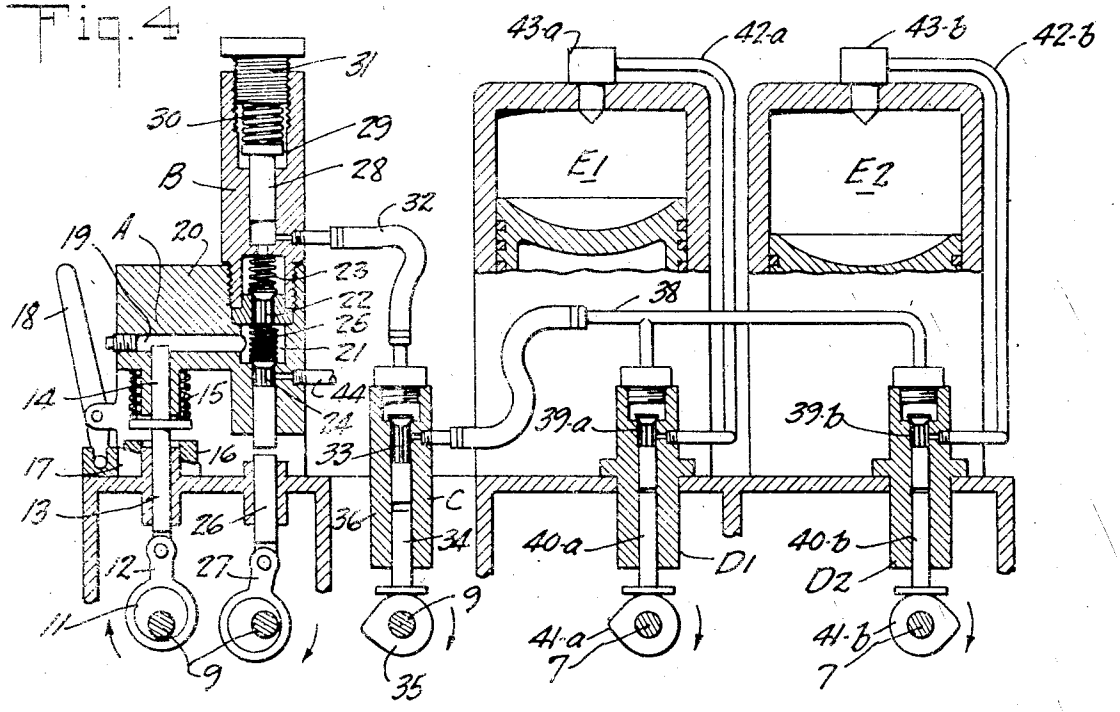
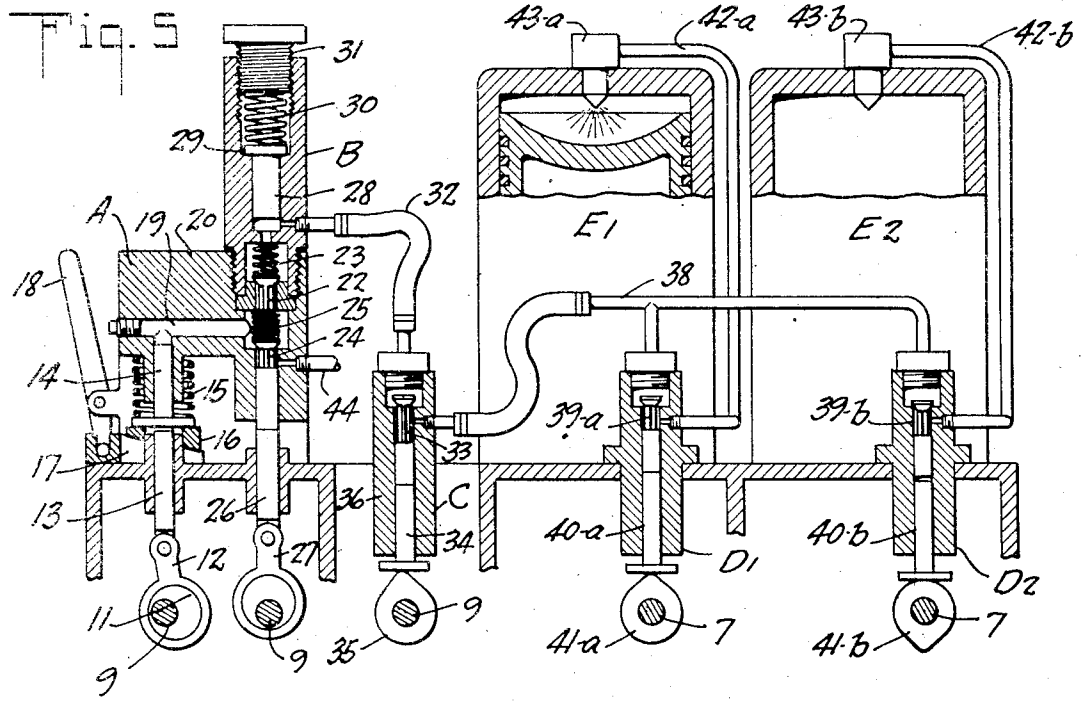


Fig. 5



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UNITED STATES PATENT OFFICE

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FUEL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

Application filed November 3, 1930. Serial No. 493,045.

This invention relates to a fuel injection system for engines of the internal combustion type, especially those which burn fuel by highly compressed air. The invention appertains particularly to multiple cylinder engines.

The objects of this invention are to provide a system of the character described having any or all of the following features:—

(1) Fuel metering means, operating independent of the fuel timing means, and controllably adapted to supply equal fuel quantities to each cylinder of a multiple cylinder engine.

(2) Fuel injection means, controllably adapted to inject equal fuel quantities under equal fuel pressures into each cylinder of the engine.

(3) Fuel timing means, controllably adapted to introduce fuel into the engine at identical timing to each cylinder of the engine.

(4) A fuel system characterized by the outstanding feature that no cylinder of a multiple cylinder engine can differ from any other cylinder in respect to quantity of fuel injected, pressure at which fuel is injected and timing at which fuel is injected.

With the different fuel systems now commonly employed, these objects can only be approximated. There are three general types of fuel systems now commonly in use. One employs a distributor for directing the fuel to the proper cylinder, and a fuel pump which meters and times the fuel at the same time. Another system has one fuel pump for each engine cylinder which delivers, meters and times the fuel at the same time. Yet another system has one or more fuel pumps and one fuel timing valve for each engine cylinder to time the fuel injection.

The disadvantages of these systems are as follows: It is extremely difficult to meter and time the fuel by means of a pump because of the very small time interval of injection. It is even more difficult to meter and time the fuel injection where one fuel pump is employed for each cylinder of the engine. It is also difficult to have the fuel pressures and timing alike on all cylinders where a timing valve, together with its actuating mechanism, is employed for each cylinder apart from the pump.

An engine is said to be in balance when all cylinders are alike in respect to fuel quantities, fuel pressures and fuel timing. In all of the three general systems mentioned, it is not only difficult to balance the engine initially but it is impossible to maintain such balance in service.

The object of this invention is to eliminate the disadvantages of the existing systems by introducing means whereby the engine operates in perfect balance at all times.

This I accomplish by providing:

(1) A fuel metering pump, operating in synchronism with the engine but independent of the fuel timing or fuel injection, whose single duty is to pump a controllable quantity of fuel for each power stroke of the engine.

(2) A fuel injection means for receiving the fuel discharged from the fuel metering pump and adapted to inject it at controllable fuel pressures.

(3) A fuel timing means, controllably adapted to act at the proper time, to permit the fuel to be admitted to the engine.

(4) Selective means for directing the fuel to the proper engine cylinder.

These objects are accomplished by means of the embodiment of the invention illustrated in the accompanying drawings, in which:—

Fig. 1 is an elevation partly in section of a two cylinder engine showing the structure essential to the invention; Fig. 2 is a section as seen on the line 2—2 of Fig. 1; Fig. 3 is a section as seen on the line 3—3 of Fig. 1; Fig. 4 is a schematic section showing the working conditions just before injection takes place; and Fig. 5 shows the working conditions at the end of the event at which fuel has been injected into the combustion chamber of the cylinders.

The drawings illustrate schematically the principles involved as applied to a two cylinder engine, but it is understood that the same can be applied to an engine having any number of cylinders.

In general, a fuel metering pump A is shown arranged to pump fuel to the injection ram B, from whence it is led to the timing valve C. After passing through the fuel timing valve C it passes into a fuel manifold and into the fuel selective valves D1 and D2. The fuel then passes through whichever selective valve is open and proceeds through a fuel pipe and fuel spray nozzle into the combustion chamber of an engine cylinder E1 or E2 where combustion takes place.

In detail a two cylinder two stroke cycle engine is shown having a crank shaft 6, and a shaft 7 is arranged to be driven by gears 8 from crank shaft 6 and to make one revolution for every two revolutions of the crank shaft 6. A shaft 9 is geared up by gears 10 to make one revolution for each power stroke of the engine. An eccentric 11 is mounted on shaft 9 and drives a connecting rod 12 having a push rod 13 pivotally connected thereto. Fuel metering pump plunger 14 is arranged to be acted upon by the push rod 13 on its discharge stroke and returned by spring 15 on its intake stroke. Stop 16 limits the intake stroke of plunger 14. A wedge 17 governs the position of stop 16 and is operated by a lever 18 to control the position of the wedge. Passage 19 in the body 20, permits fuel to pass between the pump plunger 14 and valve chamber 21.

A discharge valve 22 is acted upon by a spring 23 tending to seat it and intake valve 24 is acted upon by a spring 25 to return it to its seat. Intake valve 24 is positively opened by push rod 26 pivotally connected to connecting rod 27 which is driven by eccentric on shaft 9.

A fuel injection plunger 28 is arranged to be acted upon by the fuel that passes through the fuel discharge valve 22, and the stop 29 limits its stroke. Spring 30 acts upon plunger 28 and is provided with an adjustable spring seat 31. A pipe 32 directs the fuel from ram B to the fuel timing valve C. The pressure of the fuel that is trapped between the fuel discharge valve 22 and the fuel timing valve C is therefore governed by the pressure of the spring 30 acting upon the fuel injection plunger 28 and is controllable by means of the adjustable spring seat 31.

The fuel timing valve 33 is arranged to be acted upon by a push rod 34 which is actuated by the cam 35 driven by the shaft 9. The shaft 9 is arranged to make one revolution for each power stroke of the engine. The push rod 34 slides in a guide barrel 36. The barrel 36 is pivotally mounted in relation to the shaft 9 and a control 37 permits the operator to swing the guide 36 to whatever angular position it is desired to control the time at which the fuel timing valve 33 is permitted to open. Fuel manifold 38 permits the fuel to pass from the fuel timing valve 33 to the selective valves D1 and D2. Selective valves 39*a* and 39*b* are arranged to be acted upon by the push rods 40*a* and 40*b* which are actuated by cams 41*a* and 41*b* driven by the shaft 7, which is arranged to be driven from the engine and to make one revolution for two revolutions of the crank shaft in a two stroke cycle engine or one revolution for every revolution of the crank shaft in a one stroke cycle engine.

Fuel pipes 42*a* and 42*b* allow the fuel to pass from the selective valves 39*a* aand 39*b* through the fuel spray nozzles 43*a* and 43*b* and into the combustion chamber of the engine cylinders. Engine cylinder E1 and its engine piston are schematically shown in Fig. 5 to indicate the firing position of the piston with reference to the fuel injection system herein described. Intake pipe 44 connects the intake of the fuel metering pump with the fuel tank or other suitable source of fuel supply.

Fig. 4 illustrates the condition of the fuel injection system just before injection takes place. The fuel metering pump plunger 14 has just reached the end of its discharge stroke, having been acted upon by the push rod 13. The inlet valve 24 has been mechanically closed by the spring 25 and pressure exerted by the plunger. Fuel has been forced through the discharge valve 22 into the ram chamber, and the timing valve 33 having been closed throughout the discharge stroke of the fuel metering pump plunger 14, the fuel has acted upon the injection ram 28, compressing the spring 30.

It is evident that the displacement of the fuel injection ram 28 is exactly equal to the displacement of the fuel metering pump plunger 14, and the pressure of the fuel trapped between the fuel discharge valve 22 and the fuel timing valve 33 is determined by the stress of spring 30. Therefore, any fuel pressures desired may be obtained and controlled by loading the spring 30 by means of the adjustable spring seat 31.

Fig. 5 illustrates the condition of the fuel injection system just at the end of the fuel injection into the combustion chamber of cylinder E1. The selective valve 39*a* has been lifted slightly ahead of the timing valve 33. Obviously, as soon as the fuel timing valve 33 lifts, the spring 30 acting on ram plunger 28 forces the fuel into the combustion chamber of cylinder E1 until the fuel ram 28 is stopped by the stop 29. Fig. 5 also shows the intake valve 24 of the fuel metering pump held open by the push rod 26 during the intake stroke of the fuel metering pump. The fuel metering pump is therefore provided with positive mechanically operated valves and its stroke is positively controllable.

From the foregoing, it is apparent the different cylinders can not get out of balance or out of adjustment with reference to fuel quantities, fuel timing or fuel pressures.

The mechanically operated intake valve of the fuel metering pump has very distinct advantages. By mechanically holding the intake valve open, the fuel has no restrictions in entering the pump and the heavy return spring 25 insures the seating of the intake valve 24 before the discharge stroke begins, thus insuring an efficient high speed pump.

Although only one fuel metering pump is shown, it is obvious that more than one pump may be used, if desired, especially on very high speed engines where the fuel velocities through the pump might become two great for only one pump to handle. In such a case two pumps, each running at one half the speed of the pump described could be employed. In fact any number of pumps desired could be used.

It is also apparent that more than one fuel injection ram and timing valve may be employed. In fact on a very high speed engine having a large number of cylinders, it might be found advisable to use a dual fuel system.

What I claim is:—

1. In combination with a multiple cylinder internal combustion engine having a fuel manifold: a liquid fuel injection system comprising a metering fuel pump; a receiver chamber for delivery thereto of fuel from said pump, means urging expulsion of fuel from said chamber; a timing valve to release fuel for delivery from said chamber to said manifold; selector mechanism for directing fuel from said manifold to the cylinder; and means operated by said engine to actuate in seriatim said pump and said selector mechanism, and said timing valve whereby to deliver a metered quantity of fuel to the receiving chamber and release it by means of the timing valve to the engine at a selected time.

2. In combination with a multiple cylinder internal combustion engine having a fuel manifold: a liquid fuel injection system comprising a metering fuel pump having adjustable means to selectively predetermine the charge delivered therefrom; a receiver chamber for delivery thereto of fuel from said pump, means urging expulsion of fuel from said chamber; a timing valve to release fuel for delivery from said chamber to said manifold; selector mechanism for directing fuel from said manifold to the cylinders; and means operated by said engine to actuate in seriatim said pump and said selector mechanism and said timing valve whereby to deliver a metered quantity of fuel to the engine at a selected time, said timing valve being adjustably connected to said means to enable variation of the time at which the fuel release event occurs.

In witness that I claim the foregoing I have hereunto subscribed my name this third day of October, 1930.

LLOYD E. ELWELL.