

March 20, 1945.

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2,371,787

FUEL INJECTION DEVICE

Filed Sept. 3, 1940

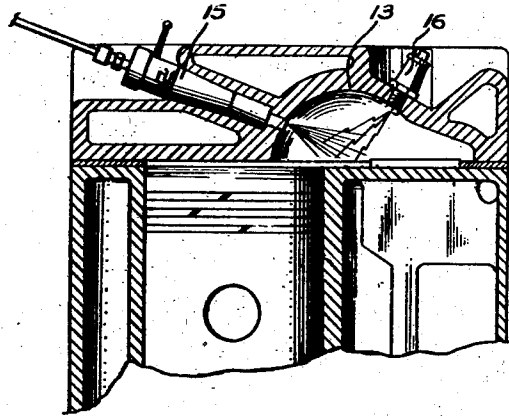


FIG. I

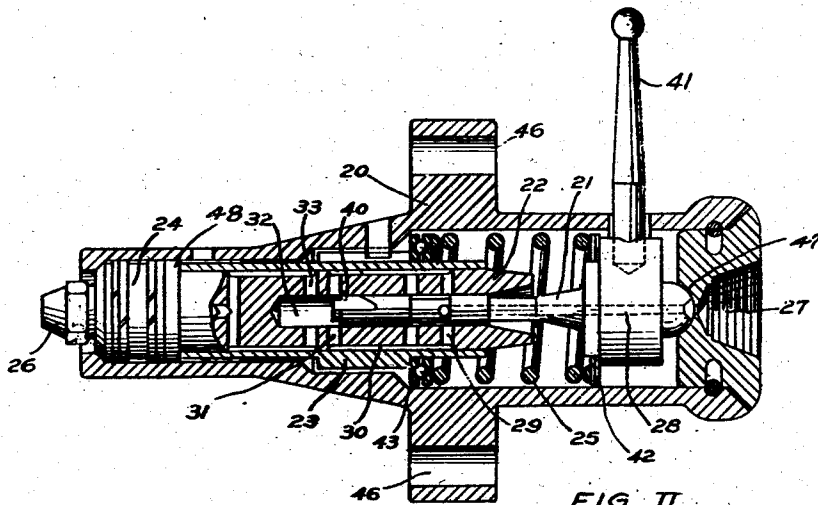


FIG. II

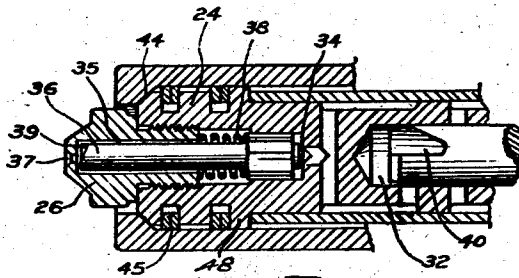


FIG. III

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UNITED STATES PATENT OFFICE

2,371,787

FUEL INJECTION DEVICE

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Application September 3, 1940, Serial No. 355,173

9 Claims. (Cl. 103—50)

This invention relates to internal combustion engines of the solid fuel injection type, and more particularly to an improvement in the fuel injecting devices in which the pump and injector form a single unit which is actuated automatically under the action of the compression pressure of the engine cylinder.

Injection devices are usually designed and adapted to internal combustion engines which do not employ ignition systems. My invention is adaptable to engines which employ ignition systems equally as well as those which do not employ external firing means. It is further adapted to both Otto and Diesel cycle engines.

This invention provides a construction of injection device which is extremely simple, efficient in operation, easy to manufacture, economical in cost, light in weight and easy to keep in adjustment.

More particularly my invention includes fuel injection apparatus comprising an adjustable plunger, a fully floating sleeve and cylinder, a metering chamber and valve, a hydraulic cushion stop for the plunger, a differential area or actuating piston adjacent to and in direct and full communication with and forming the boundary of the combustion chamber, a check valve enclosed within the actuating piston and controlling the passage which is in direct communication with the injection spray tip, and means to adjust the plunger and valve to control the quantity of fuel injected.

The primary object, therefore, is to provide an apparatus for metering and injecting a charge with extreme rapidity, necessitating a device of simple and light weight design and capable of being limited in its action by cushioning means. Another object is to provide a reliable operating mechanism in the form of an adjustable plunger and a floating sleeve and cylinder assembly, so that alignment is easily obtained. The full floating feature of my invention is particularly desirable in that it is readily adaptable to servicing, is self-aligning, and eliminates precision fitting in manufacturing. A further object is to provide an apparatus so constructed that it will not require an excessive amount of precision and accurate fabrication.

Further objects and advantages, together with the detailed construction of the invention, will be evident from the following description and drawing, in which Figure I is a typical illustration of the new method of fuel injection required by my invention; Figure II is a view in section of the injector and Figure III is an enlarged view

in section of the differential area piston, an essential part of the injector shown in Figure II.

Figure I shows an engine according to my invention in which the usual pump and timer is incorporated in the design of the injector 15. The pump is operated, thus timing the injection period, by the compression pressure within the combustion chamber 13. This figure illustrates the invention in an internal combustion engine of the type which requires an ignition system as is illustrated by plug 16. It is to be understood that the injector 15 is not to be limited to such type of system but is equally adaptable to engines of the compression ignition type.

Figures II and III of the drawing illustrate the construction of the injection means, which comprises in general, a housing or body 20, an adjustable injector plunger 21, an injector cylinder 22, a cylinder sleeve 23, a differential area piston 24, a restraining spring 25 and a nozzle or spray tip 26. I prefer to construct cylinder 22 and piston 24 in a single unit. The fuel enters the injector at 27, flows through the passage 28 and out ports 29 into the area 30 which surrounds the cylinder 22. The fuel is then directed through ports 31 into the chamber 32. When the cylinder 22 is moved by means of compression pressure within the cylinder toward the inlet 27, fuel is forced out of chamber 32 through passages 33 past the valve tip 34 into the area 35 surrounding the spray valve 36 and finally leaving the injector through the nozzle or spray tip 26 at 37. The valve tip 34 is kept in the closed position by the spring 38. During the injection period, the fuel passes out of the area 35 through notches 39 cut in the valve stem 36.

The quantity of fuel which is injected is determined by the position and design of the valve 40 which forms the shape of the end of the plunger 21. I have found in my experiments that by rotating the plunger 21 by means of the lever 41, the quantity of fuel injected may be controlled within narrow limits.

The nozzle or spray tip 26, the differential area piston 24, the cylinder sleeve 23 and cylinder 22 are moved against the spring 25 by the compression pressure within the combustion chamber 13. It is recognized that the compression temperature is a maximum at the top dead center of the piston stroke which is substantially the opportune time to inject the fuel charge. Modern construction injects the fuel from five to fifteen degrees before top dead center depending primarily on the engine speed. By the design and adjustment of the spring 25, the time

of injection can be varied to suit the installation. My invention provides a simple means of varying the operating load at which the piston 24 will actuate the mechanism. I provide shims 42 of various thicknesses, which can be added or taken out in order to obtain the correct spring tension. I also provide a thrust bearing 43 which facilitates adjustment of the plunger 21 by means of the lever 41.

The piston 24 is preferably of the differential area type but not limited to such type, having a seat 44 in the body 20 of the injector unit, and preferably having dual sealing piston rings 45. As the piston moves due to compression pressure in the cylinder, the pressure acts on the area of piston exposed at the spray tip 26 and when the desired pressure is reached, it forces the piston 24 off its seat 44, thus causing the pressure to act on the total area of the piston which moves it very rapidly against the restraining spring 25, resulting in a very rapid fuel injection. The spray tip 26 is easily removed for cleaning or servicing.

It will be apparent that the chamber 32 when filled with fuel will present a cushioned limit or stop between the movement of the plunger 21 and the cylinder 22. This is particularly advantageous and is a great improvement in the art in that it eliminates the usual metallic stop, as constructed in injectors heretofore, which is subject to a great amount of wear and its accompanying service requirements. The cushioned stop is also very desirable in that it is quiet in its operation.

The injector body may be attached to the cylinder head of the engine by means of bolts through holes 46 in the body of the injector.

It is evident that according to my invention the internal movable structure of the fuel injection device, namely the adjustable injector plunger 21, the injector cylinder 22, the cylinder sleeve 23 and the differential area piston 24 are so constructed and arranged that they are automatically self-aligning, the self-aligning control points being in this illustration the circular head 47 forming a part of the injector plunger 21 and the shoulder 48 forming a part of the differential piston 24. It will be apparent that this feature is a desired one in that it simplifies the manufacturing problem and particularly the precision requirements of manufacturing. This readily makes for simplicity and economical production cost, which in turn lends itself well to mass production.

I do not wish my invention to be limited to the various details of this particular embodiment, but wish to be accorded the broad scope of my invention as defined by the following claims.

I claim:

1. In a fuel injector to be actuated by a variable fluid pressure, the combination of a housing including a fuel inlet, a differential piston device in direct and full communication with and adapted to be operated by said variable fluid pressure, said device having a fuel passage and a fuel outlet, yieldable means for actuating said piston device, a sleeve to transmit motion between said differential piston device and said yieldable means, a cylinder carried by said piston device and confined by said sleeve, said cylinder having a telescopic plunger means therein and including a chamber for fuel which is adapted to be metered by said plunger means, said plunger means having a passage to conduct fuel from said inlet to said fuel chamber and a valve

adapted to be adjusted by rotary movement of said plunger to meter fuel between said inlet and said fuel chamber.

2. In a fuel injector to be actuated by a variable fluid pressure, a combination of a housing including a fuel inlet, a piston device including a fuel outlet in direct and full communication with and adapted to be operated by said variable fluid pressure, said device having a passage to conduct fuel to said outlet, yieldable means for actuating said piston device, a sleeve and cylinder disposed within said yieldable means carried by said piston device, and a plunger means telescopic within said cylinder to form a fuel chamber said plunger means and fuel chamber forming a hydraulic cushion for movement between said cylinder and said plunger, said plunger means having a passage to conduct fuel from said inlet to said fuel chamber and including a valve adapted to be adjusted by rotary movement to meter fuel between said inlet and said fuel chamber.

3. A fuel injecting device comprising in combination, a housing including a fuel inlet, a piston device including a fuel passage and outlet, yieldable means for actuating said piston device, a sleeve and constant stroke cylinder disposed within said yieldable means carried by said piston device, a plunger means telescopic within said cylinder to form a fuel chamber, said plunger means including a passage to conduct fuel from said inlet to said fuel chamber and having a valve adapted to be adjusted by rotary movement of said telescopic plunger means to meter fuel between said inlet and said fuel chamber; said plunger means and fuel chamber forming a hydraulic cushion for limiting the relative movement between said cylinder and said plunger.

4. A fuel injecting device to be actuated by a variable fluid pressure comprising a housing with a fuel inlet, a piston device to be actuated and controlled by said variable fluid pressure having a fuel passage and outlet, yieldable means for actuating said piston device, a sleeve to transmit motion between said piston device and said yieldable means, a constant stroke cylinder carried by said piston device and confined by said sleeve, a plunger means telescopic within said cylinder to form a fuel chamber, said plunger means including a fuel passage to conduct fuel from said fuel inlet to said fuel chamber and a valve adapted to be adjusted by rotary movement of said telescopic plunger means to meter fuel from said inlet to said fuel chamber, said plunger means and fuel chamber forming a hydraulic cushion for limiting the relative movement between said cylinder and said plunger.

5. A fuel injecting device comprising a housing having a fuel passage and fuel inlet, a piston device having a fuel outlet, said device being actuated and controlled by a variable fluid pressure, yieldable means for actuating said piston device, a sleeve and cylinder disposed within said yieldable means carried by said piston device, and a plunger means telescopic within said cylinder, said plunger means including a fuel passage to conduct fuel from said fuel inlet to said fuel chamber and having a valve adapted to be adjusted by rotary movement to meter fuel between said inlet and said outlet, said plunger means and cylinder forming a hydraulic cushion for limiting the relative movement between said cylinder and said plunger.

6. A fuel injecting device comprising a housing having a fuel inlet, a piston device having a fuel passage and fuel outlet, said device be-

ing actuated and controlled by a variable fluid pressure and having a shoulder adapted to contact said housing, yieldable means for actuating said piston device, a sleeve and cylinder disposed within said yieldable means carried by said piston device, and a plunger means telescopic within said cylinder to form a fuel chamber, said plunger means having an adjustable point of contact with said housing and including a fuel passage to conduct fuel from said fuel inlet to said fuel chamber and a valve to meter fuel between said inlet and said fuel chamber, said piston, sleeve, cylinder and plunger being so constructed and arranged about said shoulder and said adjustable point of contact that positive self-alignment within said housing is assured.

7. A fuel injecting device comprising a housing having a fuel inlet, a piston device having a fuel outlet, said device being actuated and controlled by a variable fluid pressure and having passages to supply fuel to said outlet, yieldable means for actuating said piston device, a sleeve carried by said piston device, a constant stroke cylinder confined within said sleeve, and a plunger means telescopic within said cylinder to form a fuel chamber, said plunger means having a fuel passage to conduct fuel from said inlet to said chamber and including a rotary type valve to meter fuel between said inlet and said fuel chamber, said piston, sleeve, constant stroke cylinder, and plunger being so arranged and constructed to automatically seek self-alignment within said housing.

8. A fuel injecting device comprising a housing having a fuel inlet, a piston device having a fuel outlet, passages to supply fuel from said

inlet to said outlet, said device being actuated and controlled by a variable fluid pressure and having a shoulder adapted to contact said housing, yieldable means for actuating said piston device, a sleeve and cylinder disposed within said yieldable means carried by said piston device, and a plunger means telescopic within said cylinder to form a fuel chamber, said plunger means having a valve adapted to be adjusted by rotary movement to meter fuel between said inlet and said fuel chamber, said plunger means being so constructed and arranged in relation to said piston, sleeve, and cylinder, that positive self-alignment within said housing is assured.

9. A fuel injecting device comprising a housing having a fuel inlet, a piston device including a fuel outlet and having a shoulder adapted to contact said housing, passages to supply fuel from said inlet to said outlet, yieldable means for actuating said piston device, a cylinder disposed within said yieldable means carried by said piston device, a plunger telescopic within said cylinder and having an alignable point of contact with said housing and said fuel inlet, said plunger including valve adapted to be adjusted by rotary movement to meter fuel between said inlet and said fuel chamber, and a hydraulic cushion stop means formed by the chamber between said plunger and said cylinder, said piston device, cylinder and plunger means being so arranged and constructed about said shoulder and said alignable point of contact to provide positive self-alignment within said housing.

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