Aug. 21, 1956 O. GRIGAR 2,759,771

COMBINATION FUEL INJECTION PUMP AND FUEL INJECTION NOZZLES

Filed April 30, 1954

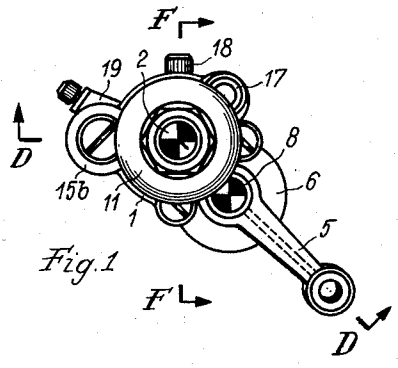


Fig. 1

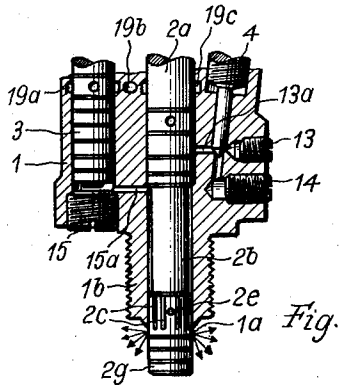


Fig. 4

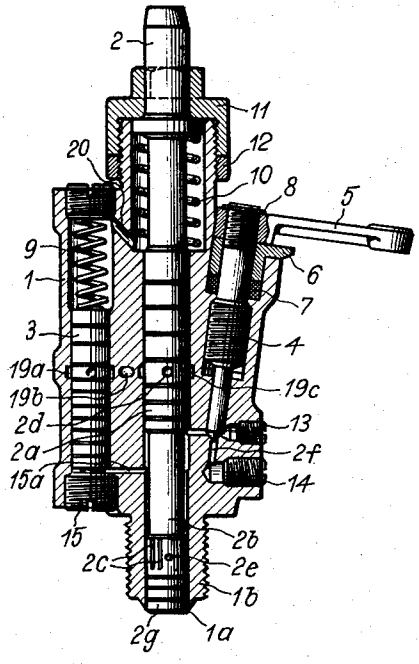


Fig. 2

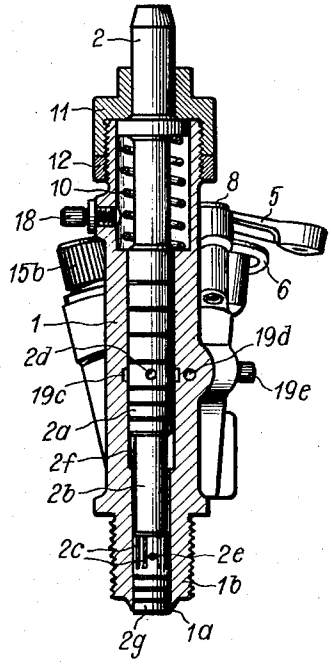


Fig. 3

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United States Patent Office 2,759,771 Patented Aug. 21, 1956

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COMBINATION FUEL INJECTION PUMP AND FUEL INJECTION NOZZLES

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Application April 30, 1954, Serial No. 426,886

Claims priority, application Switzerland May 2, 1953

5 Claims. (Cl. 299—107.2)

This invention relates to a combination fuel injection pump and fuel injection nozzles.

Fuel injection pumps for internal combustion engines and especially diesel engines have been known. So far, such fuel pumps have proved to be economical only for combustion engines of relatively high output. It is difficult to manufacture nozzles with sufficiently fine openings, and, in addition, the known nozzle constructions tend to break down. Also, the timing of the injection is influenced by the prevailing fuel pressure so that rapid periodic changes in fuel pressure may cause repeated reinjections into the combustion chamber. This causes uneven running of the engine, which at increasing speed of the motor involves the additional disadvantage of an undesired increase in fuel supply.

The primary object of my invention is to generally improve fuel injection pumps and fuel injection nozzles. The invention aims at a combination pump and nozzles, which combination will not have the disadvantages of many prior art pumps and prior art nozzles but instead will embody commercially desired important advantages, such as simpleness and sturdiness in construction, high efficiency, economy, and wide applicability.

One object of my invention is to provide a combination fuel injection pump and nozzles.

Another object of the present invention is to provide a combination pump and nozzles of the referred to kind, which will deliver both large and very small amounts of fuel at any rotary speed equally well.

A further object of this invention is to provide a combination fuel injection pump and nozzles, which is suitable for two-stroke and four-stroke cycle engines, for combustion turbines, as an ignition injector for semi-diesel (Otto-Diesel) engines, as a fuel atomizer for furnaces using liquid fuels, as a countercurrent condenser, for instance, for steam turbines, etc.

To the accomplishment of the foregoing and other objects which will appear hereinafter, my invention consists in the apparatus elements and their relation one to the other, as are more particularly described in the specification and sought to be defined in the claims.

The specification is accompanied by a drawing in which:

Fig. 1 is a plan view of a combination fuel injection pump and fuel injection nozzles, embodying features of my invention;

Fig. 2 is a longitudinal section taken in the plane of the line D—D of Fig. 1;

Fig. 3 is a longitudinal section taken in the plane of the line F—F of Fig. 1; and

Fig. 4 is a fragmentary longitudinal section corresponding to that shown in Fig. 2 but illustrating a different working position.

Referring to the drawing, the combination pump and nozzles, selected for illustration, is constructed to be individually associated with each working cylinder of a

two-stroke or four-stroke internal combustion engine, or with the combustion chambers of combustion turbines.

The apparatus includes a body **1** and a plunger **2** having parts of different cross sections. The part **2***a* of the plunger, which has a larger diameter than the part **2***b*, forms the plunger proper. Fuel enters at **17** (see Fig. 1) and passes through **13***a* (Fig. 4) into the barrel of the body **1**. The fuel supply is controlled by a valve **4** which is sealed by means of a gasket **7** and a packing **6**, and may be rotated by means of a lever **5**. It is secured by a spring washer **8**. The lever **5** serves to meter the fuel supply. The free end or lower portion **2***g* of the plunger **2** is provided with fine longitudinally extending grooves **2***c* which are partially exposed when the plunger is in its lowest position (see Fig. 4). Instead of longitudinally extending grooves, helically winding grooves may be provided as well. The grooves **2***c* act as nozzles and cooperate with a piston **3** and a coil spring **9**. The piston **3** reciprocates in a fuel storage chamber. Fuel under pressure is forced through the nozzles which deliver a fog of fuel in the form of a fan into a combustion chamber. The operation of the differential plunger **2** can readily be predetermined as to timing and the relation of crankshaft position and moment of injection.

The differential plunger may be operated, for instance, directly from a camshaft or over a rocker arm and push rod. The plunger is returned by a helical spring **10**, and the stroke of the plunger is limited by a cap nut **11** which, in turn, is secured in its position by a lock nut **12**. The fuel conduit **13***a* is sealed by plugs **13** and **14**.

The piston **3** is operated by the fuel pressure over the connecting duct **15***a* as well as by the action of the helical spring **9**. The cylinder space in which the piston moves, and the helical spring is accommodated, is closed at its ends by a plug **15** and **15***b*, respectively.

The fuel injection pump and the injection nozzles are continuously lubricated, oil being admitted through a connection piece **19** (Fig. 1) to the annular space **19***a*, and thence through the duct **19***b* to another annular space **19***c*, from where the oil passes through duct **19***d* (Fig. 3) and through the connection piece **19***e* back to the oil tank (not shown).

The plunger **2** is provided with transversely extending holes **2***d* which, with the differential plunger in its top position, are on the level of the annular space **19***c*. The oil required for lubrication passes from the holes **2***d* through a longitudinal bore in the plunger to the nozzle body **2***g*. There, the oil emerges through one of the transverse bores **2***e* and thus lubricates the nozzle body. The oil that collects from the pressure regulator **3** and the differential plunger is returned through the duct **20** to the drain **18**.

The combination fuel injection pump and injection nozzles operates as follows:

The differential plunger moves into its highest position, thereby creating a vacuum in the annular space **2***f* into which space fuel is sucked, filling at the same time the connecting duct **15***a*. During the downward or working strokes of the plunger **2** the pressure in the pump cylinder increases and causes fuel to flow through the duct **15***a* and to act upon the front surface of the piston **3**. The latter is caused to move upward under the influence of the fuel pressure and against the action of the spring **9**. Towards the end of the working strokes, as the pressure in the pump cylinder decreases, piston **3**, under the pressure of the spring **9**, forces fuel stored in the storage chamber back into the pump cylinder. When the fine grooves **2***c* of the nozzle **2***g* become exposed beyond the threaded lower end **1***b* of the body **1**, fuel is sprayed into the combustion space as a fog. The amount of fuel required is regulated by the rotary valve **4**.

Heat generated at the cylinder head and at the fuel injection pump is of beneficial effect because a vapor cushion formed by the evaporation of the fuel is without unfavorable influence on the operation of the engine. This is due to the fact that the injection nozzles are opened and closed by positively guided motions. If combustion engines operate with separate means for ignition, the fuel is injected when valves and ducts are closed.

With a two or four-stroke combustion engine, the apparatus of the invention may be adapted for all kinds of fuel. Fuel, such as gasoline, which is injected directly into the combustion chamber need not be given special anti-knock properties.

It is believed that the construction and operation of the apparatus of the present invention, as well as the many advantages thereof, will be understood from the foregoing detailed description. Some of these advantages are reviewed hereinafter.

The apparatus is simple and sturdy and operates without valves. It is suited to deliver large as well as small amounts of fuels (as small as 0.7 mm.^{3} per stroke).

The possibility of handling very small amounts of fuel makes it possible to use the apparatus of the invention as an ignition injector for easily flammable fuels. This permits the development of combustion engines of all kinds, even of those with a cylinder volume of less than 200 cubic centimeters, for use of fuels of relatively high heat of ignition at moderate compression ratios (ring system). The injected ignition fuel forms an ignition flame several hundred times larger than the spark from an electric spark plug, and furnishes additional heat, which not only eliminates the disadvantages of delayed ignition, but also permits higher rotary speed. Such combustion engines operate at a very high efficiency.

The provision of grooves to serve as nozzles has the advantage that the fuel is injected into the combustion space in streams, the direction of which changes during the injection.

The predetermined rhythm of the injections ensures smooth running of the engine at any speed.

It will be apparent that while I have shown and described my invention in a single form only, many changes and modifications may be made without departing from the spirit of the invention defined in the following claims.

I claim:

1. Combination fuel injection pump and fuel injection nozzles, comprising a body, a pump cylinder provided in the body, a plunger to reciprocate within the cylinder, fuel conveying means leading to the cylinder, valve means controlling the fuel supply, at least a single fuel storage chamber likewise provided in the body, fuel conduit means connecting the cylinder and the storage chamber, a piston reciprocating within said chamber, compression spring means housed within the chamber and acting upon the piston to force stored fuel back into the cylinder, grooves provided on the lower end portion of the plunger and serving as nozzles, the groovelike nozzles being free to deliver a fuel spray into a combustion space when the plunger moves into its lowest position.

2. In the apparatus according to claim 1, the plunger including two portions of different diameters, there being an annular space between the smaller diameter portion of the plunger and the pump cylinder, said fuel conveying means opening into said annular space when the plunger is in its highest position.

3. In the apparatus according to claim 1, the spring means bearing against the piston at the latter's upper end, the fuel conduit means being provided at the downward end of the cylinder and permitting the discharge of the stored fuel during the downward stroke of the plunger until the nozzles are free to deliver the fuel spray.

4. In the apparatus according to claim 1, said grooves extending longitudinally.

5. The apparatus according to claim 1, forming a unit to be individually associated with each working cylinder or combustion chamber of an internal combustion engine and a combustion turbine, respectively, comprising means to secure the apparatus to the engine or turbine and to operatively connect the apparatus to the respective combustion space.

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