Sept. 4, 1928.

1,683,040

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WORKING OIL ENGINE

Filed Nov. 17, 1921

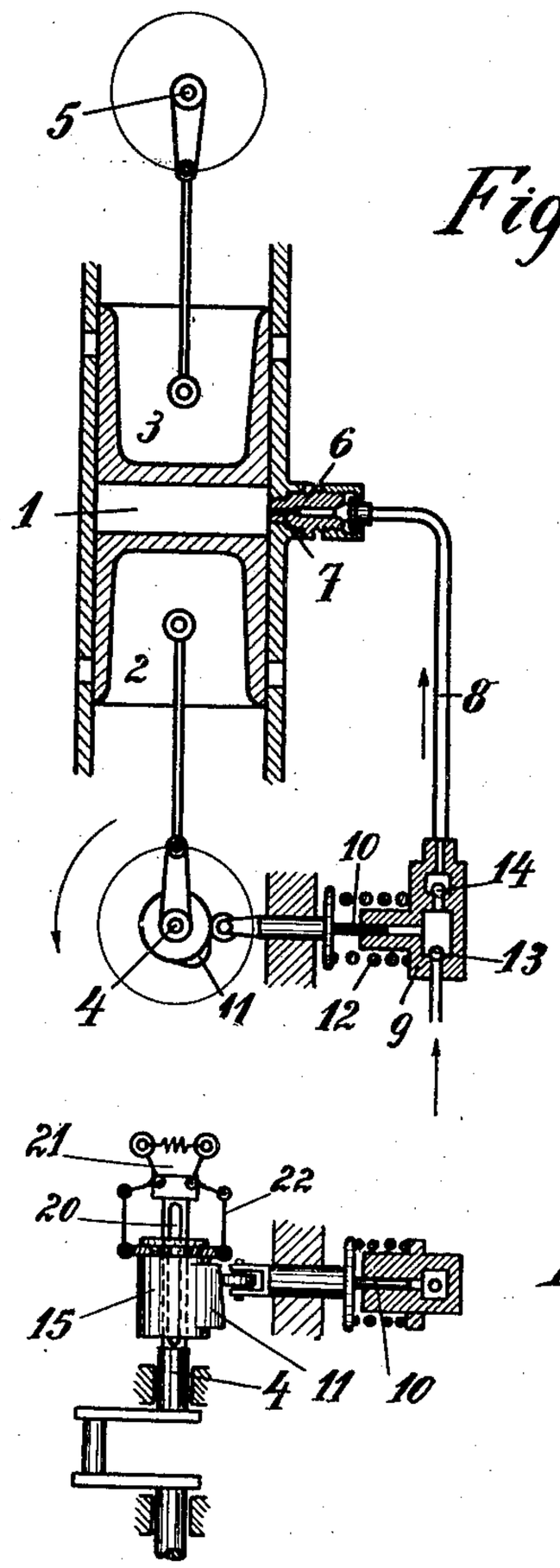

Fig.1

Fig.2

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Patented Sept. 4, 1928. 1,683,040

UNITED STATES PATENT OFFICE.

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WORKING OIL ENGINE.

Application filed November 17, 1921, Serial No. 515,983, and in Germany December 6, 1920.

My invention relates to oil engines and more especially to a method of working oil engines in which the fuel is injected without the assistance of atomizing air and is ignited by the heat of compression of the air contained in the engine.

My invention further relates to the means for carrying out the novel method. In engines of the kind described a valve like throttling member, which may act automatically or may be positively controlled, is provided at the fuel nozzle for regulating the quantity of fuel to be injected and to time the injection. This arrangement involves the drawback that an injection valve of this kind requires a separate controlling gear while on the other hand an automatic valve is apt to cause trouble, for instance by sticking.

According to my invention, these difficulties are removed by the quantity of fuel to be injected being apportioned, the injection timed and the variation of pressure in the working cylinder during combustion controlled by merely regulating the fuel pump no regulation whatever being effected and no movable parts being operated at the nozzle. Thus the fuel injecting device merely consists of a nozzle connected to the fuel delivery pipe and whose open cross-sectional area remains constant during operation, the fuel delivery pipe being in permanent communication with the combustion chamber. The size and form of the injector opening are so chosen that the high presure required for effective atomization and which amounts to several hundred atmospheres, is generated in the liquid fuel as it is being injected. Heretofore a throttling means at the end of the fuel delivery pipe was considered indispensable in engines of the kind referred to, inasmuch as the fuel supply at the point of injection must be controlled exactly. Now, the surprising fact has been found that, although many liquid fuels can be compressed to a considerable extent, yet it is possible to effect a perfectly regular transmission of the controlling operations from the point where these operations start, that is, the pump, up to the injection nozzles, which are as a rule disposed at a considerable distance from the pump. This can be explained by the further fact that with a carefully designed pump and by scrupulously avoiding all air pockets in the fuel supply pipes, no irregularities can arise in the injection between the strokes so that, after the pump has once been adjusted, injection will go on in an exactly uniform manner, even in a case where the pump is connected with the open injection nozzle by a comparatively long pipe, the content of which may be a multiple of the pump cylinder swept by the piston. In consequence thereof the pump may be arranged at any point of the engine, where it can best be actuated.

The pump according to my invention may be designed in various ways, but in all cases it is important that the pump shall not only produce pressure, but also apportion the quantity of fuel, this being effected by varying its stroke or the opening of its valves, the time and conditions of the injection being predetermined by the same means.

Preferably, the pump drive is made adjustable, while its valves are automatic.

In the drawings affixed to this specification and forming part thereof, a two stroke cycle engine embodying my invention is illustrated diagrammatically by way of example,

Fig. 1 being a partial axial section, and,

Fig. 2 a plan.

Referring to the drawings 1 is the cylinder and 2 and 3 are two pistons reciprocating therein in opposite directions and actuating the coupled shafts 4 and 5. Fuel is supplied through a nozzle 6 arranged in the wall of the combustion chamber. The narrow opening 7 required for atomization is open towards the cylinder as well as towards the fuel supply pipe 8, so that this latter pipe is in permanent communication with the combustion chamber. The supplying, apportioning and compressing of the fuel and the timing of the injection are effected by the fuel pump 9, whose piston 10 is directly propelled by a cam 11 on shaft 4 and pulled back by a spring 12. The pump is further provided with the usual suction and delivery valves 13 and 14, respectively. The regulation of the quantity of fuel injected and the timing of the injection can be effected by varying the lift and periods of stroke of the pump piston for example by means of a conical cam adapted to be displaced axially on its shaft. By employing

a cam of suitable configuration beginning and end of the piston stroke and in consequence thereof the periods of injection, the variations of pressure within the pump and the form of the combustion curve can be adapted to the conditions of operation required in each individual case.

A device of this kind is disclosed in Fig. 2 which shows the shaft 4 with the cam body 15 fixed to its free end and secured against rotation by means of the key 20, said cam body being however adapted to be readily displaced and carrying a tapering cam 11 which serves to actuate the pump piston 10. At the end of shaft 4 there is arranged a centrifugal governor 21 which, on the number of revolutions changing, axially displaces the cam body 15 by aid of rods 22, whereby a higher or lower point of the cam, according to the number of revolutions and the load on the engine, respectively, is carried in front of the pump piston, thus causing more or less fuel to be fed into the engine cylinder.

In designing and arranging the pump and the fuel supply pipe, care should be taken to avoid all air pockets inasmuch as they would disturb the positive connection between the operation of the pump and the injection of fuel in the cylinder.

As appears from the drawing, an engine designed in accordance with the present invention is particularly simple, no movable parts whatever being connected with the cylinder and the only control member requiring to be operated in synchronism with the engine, viz, the pump, being actuated directly from the crank shaft of the engine.

This simplification offers particular advantages in multi-cylinder engines, where the fuel pumps can be combined in a single casting and can be regulated in common. Although such an arrangement requires fuel delivery pipes, yet regular operation is rendered possible by the invention.

I claim:

1. The method of operating oil engines of the solid injection type which consists in compressing air in the working cylinder to ignition temperature of the fuel, pumping liquid fuel in attenuated condition directly into the compressed air in substantially constant timed relation to the commencement of the working stroke of the piston so as to ignite said fuel, and regulating the period of combustion exclusively by means of the fuel delivery pump.

2. The method of operating oil engines of the solid injection type which consists in compressing air in the working cylinder to ignition temperature of the fuel, pumping liquid fuel directly into the compressed air during the working stroke of the piston in such manner as to cause ignition of said fuel substantially coincident with the commencement of the working stroke for all load conditions, and maintaining the period of combustion throughout the period of injection through the pumping means, according to variable load conditions.

3. The method of operating oil engines of the solid injection type which consists in compressing air in the working cylinder to ignition temperature of the fuel, thereafter pumping liquid fuel under high compression directly into the compressed air so as to atomize and ignite said fuel immediately upon its entrance into the cylinder, and regulating the pumping means to apportion the fuel and control the period of injection of the fuel in proportion to varying load conditions.

4. The method of operating oil engines of the solid injection type which consists in compressing air in the working cylinder to ignition temperature of the fuel, pumping liquid fuel directly into the compressed air so as to ignite said fuel upon its entrance into the cylinder, and regulating the pumping means to apportion the fuel and simultaneously control the period of injection and combustion of the fuel.

5. An oil engine of the solid injection type comprising in combination a working cylinder and piston arranged to reciprocate therein in such manner as to compress the air in said cylinder up to ignition temperature of the fuel, a fuel pump, a normally open fuel passage leading to the cylinder therefrom, and means for actuating said pump during working stroke of the piston to introduce the fuel directly into the cylinder, said means alone apportioning the quantity of fuel injected and controlling the period of combustion and being arranged to initiate the injection substantially coincident with the commencement of the working stroke of the piston aforesaid.

6. An oil engine of the solid injection type comprising in combination a working cylinder and piston arranged to reciprocate therein in such manner as to compress the air in said cylinder up to ignition temperature of the fuel, a high pressure fuel pump, and engine operated means for actuating said pump during working stroke of the piston to introduce the fuel directly into the cylinder, said means being operable to initiate the injection substantially at the same point of the crank circle under all loads and to vary the effective stroke of the pump according to changing load conditions to thereby regulate the quantity of fuel injected and the period of combustion to accord with the period of injection.

7. An oil engine comprising in combination a working cylinder, a piston arranged to reciprocate therein in such manner as to compress the air in said cylinder up to ignition temperature of the fuel, a high pressure fuel pump, a fuel conduit leading from said pump directly to an unobstructed opening in the wall of said cylinder, and engine operated means coacting with said pump including a

cam slidably mounted on the engine crank shaft having its operative surface arranged to initiate operation of the fuel pump substantially coincident with the commencement of the working stroke of the engine piston and shiftable during operation of the engine to vary the effective stroke of said pump without varying the point of initiation of its operation, said pumping means being thereby arranged to place said fuel under pressure, apportion the fuel injected, and control the period of injection and combustion.

In testimony whereof I affix my signature.

HUGO JUNKERS.