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FUEL INJECTION MEANS

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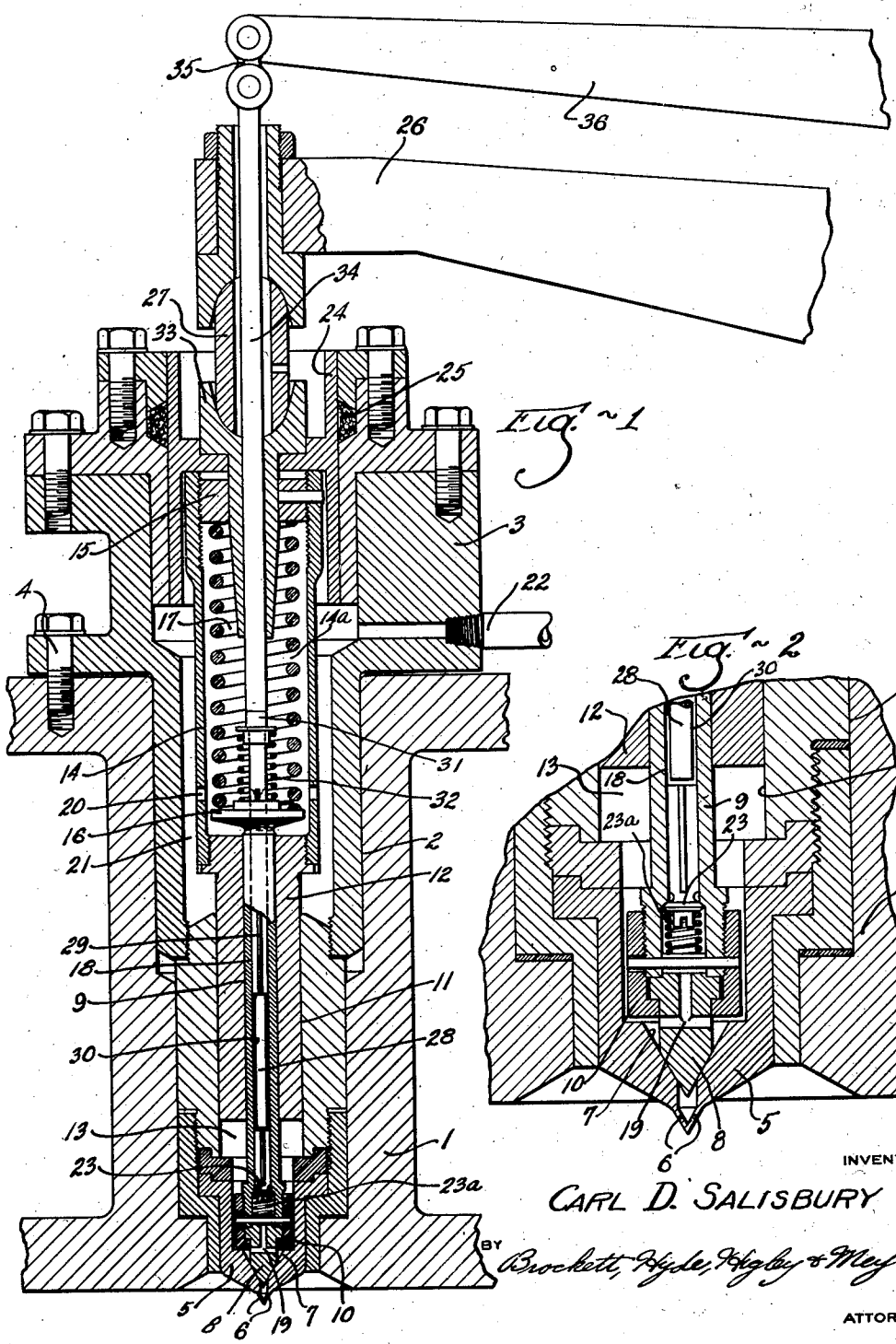

Fig. 1

Fig. 2

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FUEL INJECTION MEANS

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This invention relates to fuel injection means for internal combustion engines operating on the Diesel or a like cycle wherein liquid fuel is injected into highly compressed air in a combustion chamber.

Obviously the injection pressure of the fuel must be well above the precombustion pressure in the combustion chamber; and as the injection period must be very short, a very high pressure indeed must be attained at the injection nozzle.

Now the compressibility of a liquid is so slight as to usually be negligible. However, commercial liquid fuels have been found to be subject to compression under injection pressures.

It is the object of this invention to make the effects of compression of the fuel negligible. Briefly this is accomplished by making the expansible chamber of the injection pump means of a minimum volume, and locating this chamber as close as possible to the injection nozzle. To accomplish this, I provide that the pump inlet valve function also as the spill valve by which cutoff of injection is accomplished, and locate this valve close to the injection valve, in fact therewithin as will appear.

The exact nature of this invention together with further objects and advantages thereof will be apparent from the following description taken in connection with the accompanying drawings, in which Fig. 1 is an assembly view, in section, of an embodiment of my invention, and Fig. 2 is a similar but enlarged view showing details of the same at the nozzle.

With reference now to the drawings, 1 indicates a portion of the combustion chamber wall of an engine cylinder, the wall having inner and outer portions to provide a water jacket therebetween as will be appreciated. A through opening 2 counterbored as indicated, is provided in the wall to receive the injection means.

The injection means comprises a block 3 seating in the opening 2 and there secured as by bolts 4 to secure the nozzle 5 and the various stationary parts in the opening 2 between the nozzle and the block, made separate for convenience in assembly and access, and which together form what may be considered the body of the injection means. The nozzle 5 is provided with the usual plurality of minute injection openings 6, and has a conical inner surface 7 to provide a seat for the head portion 8 of the injection valve.

The injection valve likewise comprises an assembly of a number of rigidly associated parts including a hollow stem portion 9 associated with the head portion 8 by a cap 10 turned onto and pinned with the stem 9 as indicated; the purposes of such arrangement being that the valve head 8 may have slight lateral motion to accurately seat, that access may be had to the hollow of the stem 9, and that the cap 10 may be secured in adjusted position.

The body of the injection means has a bore 11 about the stem portion 9 of the injection valve and an injection plunger 12 is arranged to slide therein, the plunger having a bore to receive the stem 9. The plunger extends adjacent the nozzle to provide an expansible chamber 13, annular about the stem 9 and immediately adjacent the nozzle 5. At its opposite end the plunger 12 includes a sleeve 14 capped as at 15. The stem 9 of the injection valve extends within the hollow 14*a* of the sleeve 14 and is there provided with a head 16. A compression spring 17 is arranged to bear between the cap 15 and the head 16, to urge the plunger 12 outwardly from the nozzle and also urge the injection valve to seat within the nozzle.

The injection valve stem 9 is provided with a central through bore 18, and the injection valve head 8 is T-bored as at 19, the bores 18 and 19 together providing a passage opening leading from the expansible chamber 13 into the hollow 14*a* of the plunger. The sleeve 14 has transverse openings 20 leading to an annular clearance opening 21 thereabout, and fuel supply connection as at 22 is provided for this annular space 21. Thus fuel from the connection 22 will find its way to the expansible chamber 12 by way of the chamber 21, openings 20 in the sleeve 14, chamber 14*a*, bore 18 in the injection valve stem, and bores 19 in the injection valve head.

The bore 18 is enlarged at the valve head

end of the stem 9 to provide a seat for a valve 23 against which the valve is yieldably urged by a spring 23*a*. The arrangement will be recognized as that of a check valve allowing inlet to the expansible chamber 13 but preventing egress therefrom. It will be apparent that upon upward or outward strokes of the plunger 12 flow of fuel will be induced past the valve 23 into the expansible chamber 13; but on opposite strokes of the plunger egress past the valve 23 will be prevented and pressure built up in the chamber 13. Since the sectional area of the injection valve stem 9 is greater than the area of the opening closed by the valve, the unbalanced pressure effect upon the injection valve will cause unseating of this valve against the action of the spring 17, and injection of fuel through the nozzle and into the combustion chamber will follow.

A cross head guide 24 is provided in the block 3 adjacent the outer end of the sleeve 14 to bear against the latter, and packing as at 25 is provided to prevent leakage of the fuel past this guide. A plunger actuating arm 26 arranged to move in properly timed relation with the other engine parts, extends over the guide 24 and has actuating connection therewith through a push rod 27 so that downward or working strokes of the plunger may be effected through forces acting through the push rod 27. The plunger under the action of the spring 17 will follow the push rod on its outward strokes.

It will be observed that only in the chamber 13 is the fuel subjected to pressures as high as required for injection, the fuel pressure in other parts of the system being only that necessary to cause it to enter the chamber 13 on outward strokes of the plunger.

That cutoff of injection may be had before the plunger 12 completes its working stroke, I arrange for opening of the inlet valve 23 under variably timed control. To this end I arrange a rod 28 within the bore 18 of the injection valve stem 9. This rod is fluted or otherwise deformed as at 29 and turned down as at 30 to allow passage therepast through the bore 18. The rod extends at one end adjacent to the valve 23, and at its opposite end carries a head 31. A compression spring 32 is arranged between the head 31 of the rod 28 and the head 16 of the injection valve, to yieldably urge the rod 28 from the valve 23. A guide 33 is mounted in the cross head 24 to carry an actuating stem 34 for the rod 28 and thus for the valve 23; the arm 26 and the push rod 27 having suitable clearance openings. One end of the stem 34 extends adjacent the head 31 of the rod 28.

The opposite end of the stem 34 has connection as by a link 35 with an actuating arm 36. This arm 36 in turn has actuating connection through suitable gear with the other moving engine parts whereby the stem 34 will be depressed to open the valve 23 at variable times during the working stroke of the plunger 12. In other words, by this arrangement the valve 23 may be timed under operator control to open as a spill valve and thus control the amount of injection. When the spill valve is opened, continued motion of the plunger will of course back up the fuel from the expansible valve toward the connection 22 allowing the injection valve to immediately reseat.

What I claim is:

1. Fuel injection apparatus of the class described comprising a body having a nozzle portion, an injection plunger movable in the body to provide an expansible chamber adjacent said nozzle portion, said plunger having a bore, an injection valve seating within said nozzle and having a stem portion slidable in said bore, said injection valve having a passage leading from said chamber through said plunger, inlet valve means carried by said injection valve and arranged for automatic operation as a check valve to allow flow through said passage only toward said chamber, and actuating means for said inlet valve to cause opening thereof as a spill valve.

2. Fuel injection apparatus of the class described comprising a body having a nozzle portion, an injection plunger movable in the body to provide an expansible chamber adjacent said nozzle portion, said plunger having a bore, an injection valve seating within said nozzle and having a stem portion slidable in said bore, said injection valve having a passage leading from said chamber through said plunger, inlet valve means carried by said injection valve and arranged for automatic operation as a check valve to allow flow through said passage only toward said chamber, actuating means for said inlet valve to cause opening thereof as a spill valve, and actuating means for said plunger, said inlet valve actuating means extending through said plunger actuating means.

In testimony whereof I hereby affix my signature.

CARL D. SALISBURY.