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(54) Connecting fuel injectors to supply pipes

(57) A metallic fuel distributor pipe 12 has branch ducts 13 of easily bendable copper connected by a screw connections 34 with respective fuel injection valves 11. A thin-walled steel bellows (40), Fig. 3 (not shown), may define the injector fuel inlet passage, the bellows being connected by a nut 36 to the branch duct 13.

Fig. 2

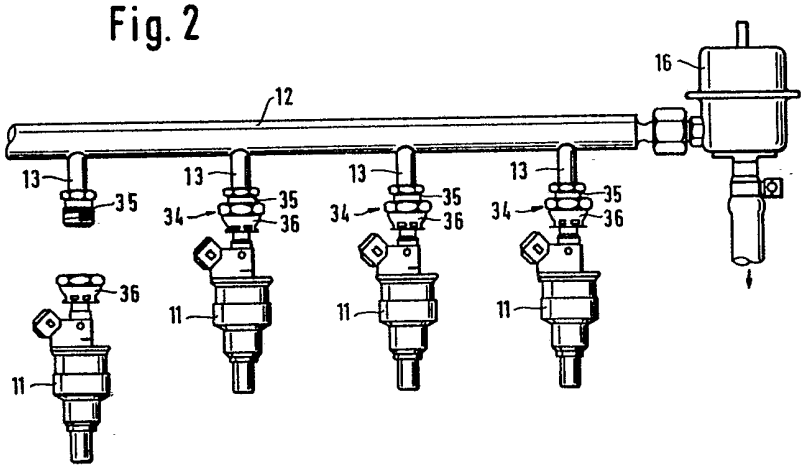

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Fig.1

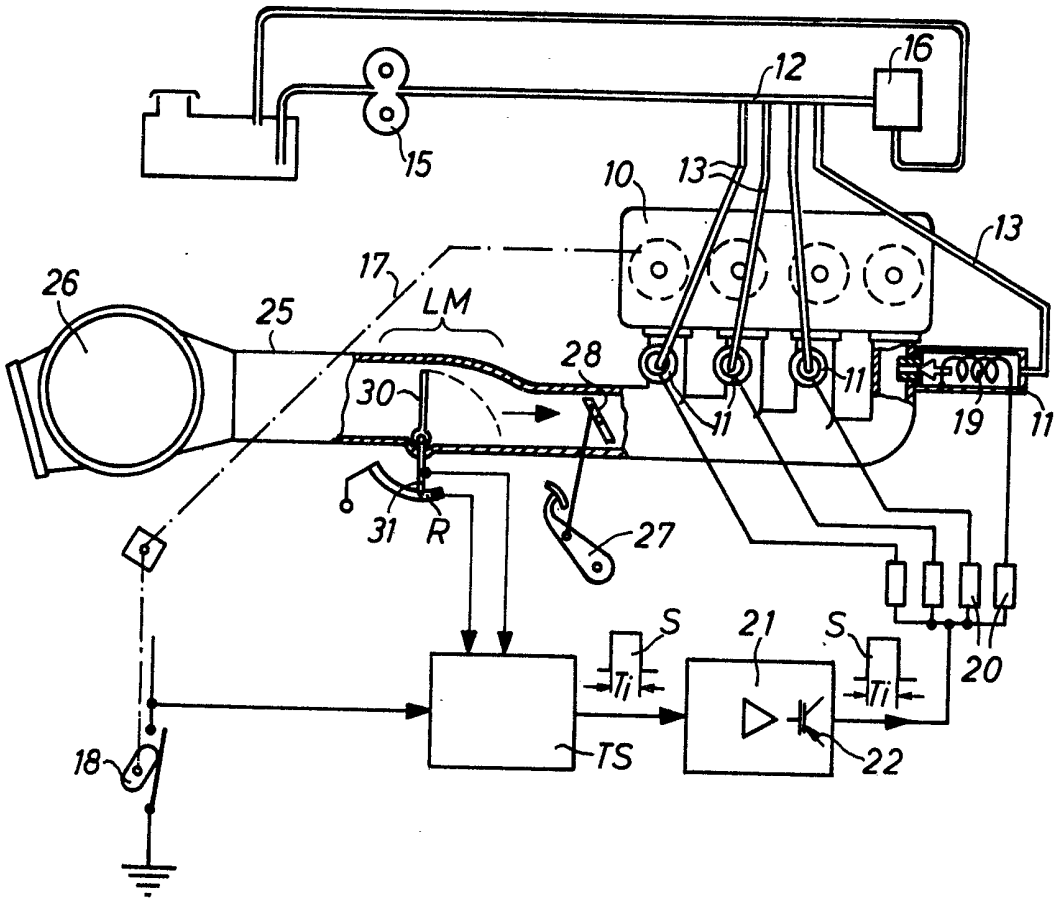
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Fig. 3

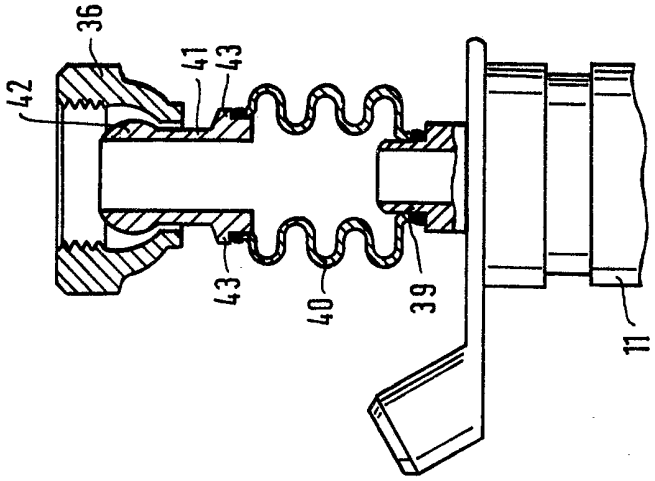
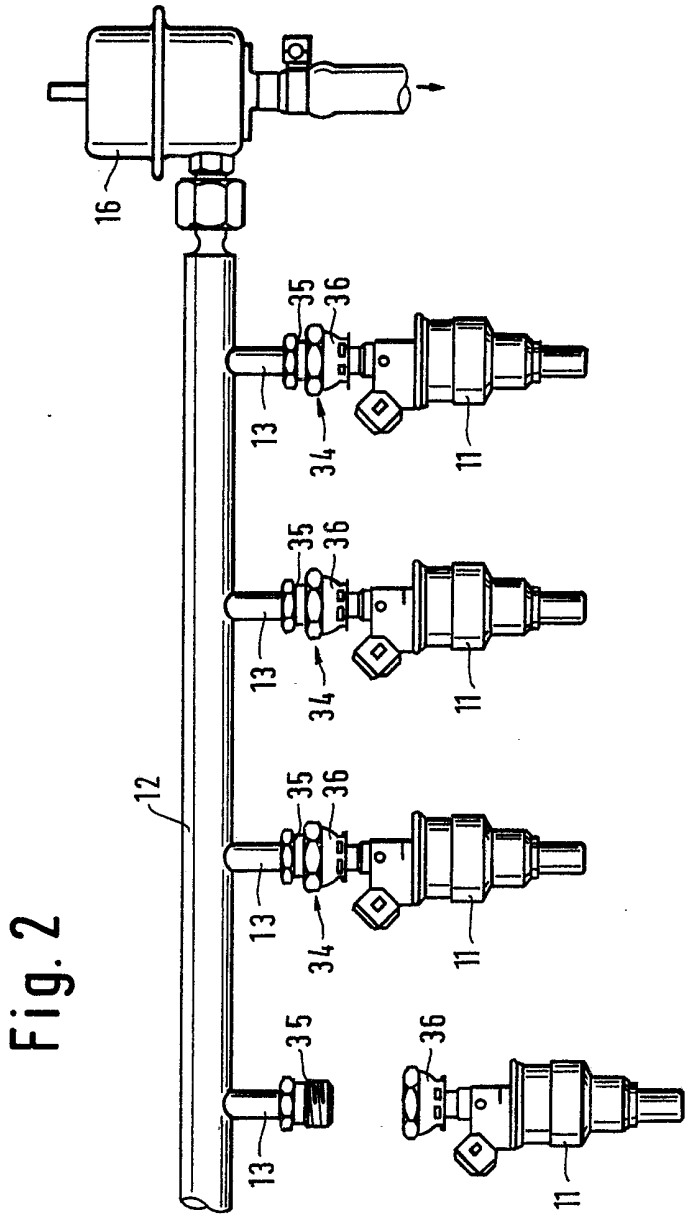


Fig. 2



SPECIFICATION

Fuel injection system

The present invention relates to a fuel injection system. A fuel injection system is already known, in which the fuel injection valves are connected with the fuel distributor pipe through short hose pieces, the fastening of which takes place by hose clamps. This has the disadvantage that sealing problems arise at the transition between hose and injection valve and hose and fuel distributor pipe occasioned by alteration of the hose in consequence of particularly high temperature loading and temperature change. Furthermore, the danger exists that a preliminary damage of the hose structure arises through improper tightening of the hose clamps, whereby a premature ageing of the hose material takes place. Furthermore, a particularly high grade hose quality is required for reasons of safety. Furthermore, the hose connection in itself represents a high safety risk due to fire danger.

According to the present invention there is provided a fuel injection system for internal combustion engines comprising a metallic fuel distributor pipe, at least one metallic branch duct in communication with the fuel distributor pipe, and a plurality of fuel injection valves, the or each duct being connectible with a respective one of the fuel injection valves by threaded means.

This system has the advantage that the connection between the fuel distributor pipe and the fuel injection valves is insensitive to high temperatures and temperature changes and maintains a tight connection through the screw connection.

Advantageously, the branch ducts are constructed from an easily bendable metal and metallic thin-walled bellows is provided between the screw connection at the branch duct and the injection valve.

Embodiments of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 shows schematically an electrically controlled fuel injection system,

Fig. 2 shows a detail of the fuel injection system with a fuel distributor pipe and fuel injection valves, and

Fig. 3 shows a fuel injection valve connection with a bellows.

Referring now to the drawings, Fig. 1 shows an electrically controlled fuel injection system for the operation of a four-cylinder, four-stroke internal combustion engine 10. It comprises four electromagnectically actuable fuel injection valves 11, to which the fuel to be injected is supplied through a metallic fuel distributor pipe 12 and branch ducts 13, a fuel conveying pump 15 is driven by an electrical motor, a pressure regulator 16 which regulates the fuel pressure to a constant value, and electronic control equipment, which is more closely described below and which is triggered twice on each cam shaft rotation by a signal generator 18 coupled with the cam shaft 17 of the internal combustion engine. Each time it delivers a rectangular, electrical opening pulse S for the fuel injection valves 11 and the time duration T_i, indicated in the drawing, of the opening pulses determines the opening duration of the fuel injection valves and consequently the quantity of fuel which during the respective opening duration issues from the interior space of the fuel injection valves 11 standing under constant fuel pressure of 2 atmospheres of excess pressure. The magnet windings 19 of the fuel injection valves are each connected in series with a respective decoupling resistor 20 and connected to a common amplifying and output stage 21, which contains at least one output transistor which by its emitter-collector path is arranged in series with the decoupling resistor 20 and the magnet windings 19 connected to earth at one side.

In the case of mixture-compressing internal combustion engines of the illustrated kind operating with external ignition, the quantity of fuel which can be completely burnt during the next succeeding working cycle is determined by the inducted quantity of air introduced into a cylinder during a single suction stroke. For a good utilization of the internal combustion engine, it is necessary that no excess of air is present after the working cycle. In order to attain the desired stoichiometric ratio between inducted air and fuel, there is provided an air quantity meter LM which consists substantially of a baffle flap 30 operating against a spiral spring (not illustrated) and of a variable resistor R, the displaceable tap 31 of which is coupled with the baffle flap. This is located in the induction pipe 25 of the internal combustion engine in direction of flow behind the filter 26 but in front of its throttle flap 28 which is displaceable by a pedal 27. The air quantity meter LM co-operates with a transistor switching equipment TS, which at its output delivers the control pulses S for the output stage 21.

The fuel distributor pipe 12 with the branch ducts 13 and the fuel injection valves 11 is illustrated in Fig. 2. The branch ducts 13 are made of metallic material, especially an easily bendable material, for example copper, and soldered or welded to the fuel distributor pipe 12. Through the construction of the branch ducts 13 from an easily bendable metal, possible lateral displacements, due to bending of the branch ducts in the assembly of the injection valves to the internal combustion engine, between the connection of each branch duct 13 at the fuel distributor pipe and the installed position of the fuel injection valve 11 can be compensated. The connection between each branch duct 13 and the respective fuel injection valve 11 takes place by means of a screw connection 34. The screw connection 34 is advantageously formed by a threaded stub 35 connected with each branch duct and a box nut 36 coupled with each fuel injection valve 11. The fuel injection system is insensitive to high temperatures and temperature change, affords a

lowest possible safety risk with absolutely tight screw connection and tolerances in the installed position of the fuel injection valves 11 can be compensated through easily bendable branch ducts 13.

Illustrated in Fig. 3 is a second embodiment of a connection between the branch ducts 13 and the fuel injection valves 11. The fuel injection valve is provided with a projection 39, with which a metallic, thin-walled bellows 40 is connected, at the other end of the bellows 40 is connected with a connecting body 41, which displays a bead-shaped projection 42, over which engages a box nut 36, which co-operates with a threaded stub 35 of a branch duct 13. The connecting body 41 can display two flattenings 43 for holding during assembly or be constructed as square or hexagonal shank. The bellows 40 is preferably made of thin-walled steel and welded to the projection 39 and to the connecting body 41. Alternatively, the screw connection 36 could be so constructed that the threaded stub 35 is connected with the fuel injection valve 11 and the box nut 36 is coupled with the branch duct 13. The fuel injection system shown in Fig. 3 offers the further advantage over the embodiment shown in Fig. 2 that greater tolerances between the position of the fuel injection valves 11 and the branch ducts 13 can be compensated by the bellows 40 and working noises emanating from the fuel injection valve 11 can be damped away by yielding of the bellows 40.

CLAIMS

1. A fuel injection system for internal combustion engines comprising metallic fuel distribution pipe, at least one metallic branch duct in communication with the fuel distributor pipe, and a plurality of fuel injection valves, the or each branch duct being connectible with a respective one of the fuel injection valves by threading means.

2. A fuel injection system as claimed in claim 1, wherein the fuel distributor pipe is soldered to the or each branch duct.

3. A fuel injection system as claimed in either claim 1 or claim 2, wherein the or each branch duct comprises an easily bendable metal.

4. A fuel injection system as claimed in claim 3, wherein the or each branch duct comprises copper.

5. A fuel injection system as claimed in any one of the preceding claims, the threaded means comprising a threaded stub at the end of the or each branch duct remote from the fuel distributor pipe and a box nut coupled with the or each respective one of the fuel injection valves.

6. A fuel injection system as claimed in any one of the preceding claims, further comprising a bellows connected between a respective one of the fuel injection valves and the branch duct associated therewith.

7. A fuel injection as claimed in claim 6, wherein the bellows is connected between a projection of the respective one of the fuel injection valves and a connecting body.

8. A fuel injection system as claimed in claim 7, wherein the connecting body has a bead-shaped projection over which a box nut is engaged.

9. A fuel injection system as claimed in any one of claims 6 to 9, wherein the or each of the bellows comprises metal.

10. A fuel injection system as claimed in claim 10, wherein the or each of the bellows comprises thin-walled steel.

11. A fuel injection system as claimed in claim 8, wherein the box nut co-operates with a threaded stud coupled to the respective branch duct.

12. A fuel injection system for internal combustion engines substantially as hereinbefore described with reference to Figs. 1 and 2 of the accompanying drawings.

13. A fuel injection system for internal combustion engines substantially as hereinbefore described with reference to Fig. 3 of the accompanying drawings.

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