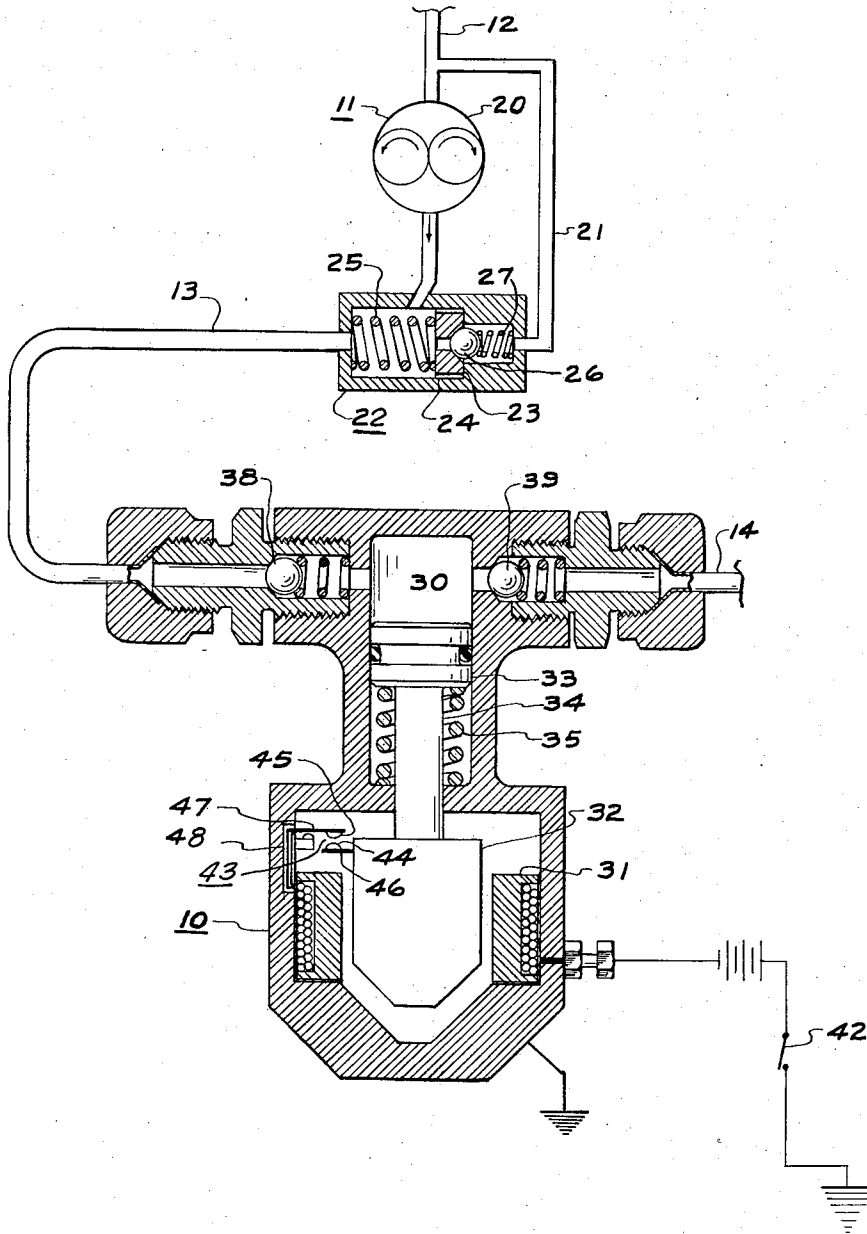


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COMBINATION ACCUMULATOR AND STARTING
PUMP FOR FUEL INJECTION SYSTEM
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COMBINATION ACCUMULATOR AND STARTING PUMP FOR FUEL INJECTION SYSTEM

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This invention relates to a combination accumulator and starting pump for fuel injection systems.

In a fuel injection system of the type used for automotive type engines and the like there is provided an engine operated distributor which is adapted to receive a liquid fuel such as gasoline under pressure from a pumping source and deliver the fuel in metered quantities through injection nozzles to the combustion chambers of the engine. In cases where an engine driven pump such as a gear pump is utilized to supply pressurized liquid fuel to the distributor, satisfactory operation is not obtained during starting of the engine. It requires several revolutions of the engine before pressure is built up in the conduit between the engine driven pump and the distributor and during this time there is not sufficient pressure available at the inlet of the distributor to discharge fuel through the fuel injection nozzles. Thus during the beginning of the starter cranking operation no fuel is supplied to the engine by the injection nozzles.

It is a main object of the invention to provide new and improved accumulator and pumping means for a fuel injection system which is operative to provide fuel to the distributor of the system very rapidly during starting of the engine at a pressure which is sufficient to overcome the resistances of the injection nozzles.

Other objects of the invention will become apparent from the following specification, the drawing related thereto, and the appended claims.

In the drawing there is shown, partly schematically, a combination accumulator and pump constructed in accordance with the invention which is adapted for use with a fuel injection system.

In the drawing a combination accumulator and pump unit 10 is shown with a conventional engine driven gear pump 11 of a type commonly used in fuel injection systems for internal combustion engines. In general the gear pump 11 draws fuel through the inlet 12 thereof from a source which is not shown and delivers the fuel under pressure through the outlet 13 thereof to the accumulator and pump unit 10. From the unit 10 the fuel is supplied through a conduit 14 to a fuel distributor (not shown) which distributes the fuel in metered quantities to injection nozzles (not shown) which service the cylinders of an engine.

When a fuel distributor of an injection system receives fuel directly from an engine driven pump such as rear pump 11, unsatisfactory operation is encountered during starting of the engine. It requires several revolutions of the engine before a pump geared to the engine can build up enough pressure to overcome the resistances of the injection nozzles which receive fuel from the fuel distributor. During the first several revolutions of the engine while the fuel pressure is being built up between an engine driven pump and the injection nozzles, the engine is not being supplied with any fuel.

A primary function of the combination accumulator and pump unit 10 is to very rapidly supply fuel to a fuel distributor at a pressure which is sufficient to overcome the opening pressure of the injection nozzles during the

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starting operation of the engine. The unit 10 normally functions as a pump only during the starting operation of the engine when the engine is not turning over fast enough for the engine driven pump 11 to establish and maintain a predetermined pressure which is sufficient to overcome the resistances of the injection nozzles. When the normal operating pressure is being maintained by engine driven pump 11 the unit 10 becomes inoperative as a pump and begins functioning as an accumulator to even out the pressure fluctuations in the fuel supplied by engine driven pump 11.

Reference is now made to the construction of the illustrated embodiment of the invention.

Engine driven gear pump 11 has a casing 20 in which pumping elements are rotatably mounted. A by-pass or shunt conduit 21 is provided between the inlet and outlet of the gear pump. At the outlet of the gear pump 11 there is provided valve means 22 having the dual function of limiting the maximum pressure of the fuel supplied by pump 11 and to permit the unit 10 to draw fuel from the fuel source through shunt conduit 21. Valve means 22 is provided with upper and lower communicating cylindrical bores with the lower bore being of smaller diameter. A valve member 23 having a central opening and axially extending grooves 24 in the periphery thereof is slidably disposed in the upper bore and adapted to seat on the counter of the lower bore. A spring 25 biases valve member 23 towards a seated position and when member 23 is seated, the grooves 24 are sealed with regard to the flow of fuel between the upper and lower bores. A ball 26 is biased towards a seated position with respect to the central opening of valve member 23 by a spring 27 which exerts somewhat less force than spring 25.

In the operation of valve means 22 the biasing force of spring 27 is selected so that fuel supplied by gear pump 11 is limited to a predetermined pressure. When the predetermined pressure tends to be exceeded, fuel is by-passed from the outlet of pump 11 to the inlet thereof through shunt conduit 21.

When gear pump 11 is operating too slow to supply fuel at a desired pressure, a suction is exerted in the outlet conduit 13 by the accumulator and pump unit 10 as will be described further on. This suction is effective to cause valve member 23 to become unseated and expose the grooves 24 thereof to the lower bore of valve means 22. With valve member 23 unseated, fuel is by-passed around gear pump 11 and is drawn to the combination accumulator and pump unit 10 through shunt conduit 21.

The accumulator and pump unit 10 comprises a fluid pressure device having an expansible chamber 30 and motor means which includes an electromagnet 31 and an armature 32. The motor means is illustrated as being a solenoid device. The fluid pressure device is illustrated as being a piston and cylinder arrangement with a piston 33 being a moveable element which is actuable to expand and contract the expansible chamber 30. A rod 34 connects piston 33 to the armature 32 of the solenoid. A spring 35 is provided for resiliently biasing piston 33 in a direction to effect contraction of the expansible chamber 30. The fluid pressure device could also comprise a diaphragm or bellows arrangement within the scope of the invention.

The fuel intake conduit for expansible chamber 30 has a check valve 38 associated therewith and the fuel exhaust conduit has a check valve 39 associated therewith.

Electromagnet 31 is provided with electrical circuit means which includes a manually operated switch 42, which may be the ignition switch of an automotive engine. Switch means 43 are provided which include a contact 44, which is fixedly attached to and moveable with armature 32 and piston 33, and a contact 45 which

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is resiliently mounted with respect to the casing of the unit 10. Switch means 43 is preferably provided with a time delay feature and to facilitate this a rigid or nonflexible support 46 is provided for contact 44 and a resilient support 47 is provided for contact 45. The engagement of contacts 44 and 45 when piston 33 moves in a direction to contract expandable chamber 30 causes bending of resilient support 47 such that contacts 44 and 45 are maintained in engagement for a predetermined portion of the travel of piston 33. When piston 33 moves in a direction to expand chamber 30 the contacts 44 and 45 remain in engagement until the return movement of support 47 is arrested by a stop 48 which is attached to the casing of unit 10.

In the operation of the accumulator and pump unit 10 the switch means 43 is closed when the engine of the vehicle is not operating by reason of the piston 33 being biased by spring 35 to a position where expandable chamber 30 is contracted. In starting the engine the ignition switch, which corresponds to switch 42, is closed and causes current to flow in the circuit in which electromagnet 31 is disposed. This causes a pull to be exerted on armature 32 and piston 33 against the biasing of spring 35 in a direction which causes expandable chamber 30 to expand and draw fuel into the chamber through check valve 38. The switch means 43 remains closed for a portion of the stroke of piston 33 and then opens and remains open during the remaining portion of the stroke. Spring 35 halts the movement of piston 33 and forces the piston in the opposite direction so as to discharge the fuel through check valve 39 and again cause the switch means 43 to close when piston 33 reaches a predetermined point as it travels in a direction to contract the expandable chamber 30. This again actuates the electromagnet and the cycle is repeated.

The above described pumping operation of the accumulator and pump unit 10 occurs when the switch 42 is closed and before cranking of the engine begins. The operation continues during the cranking of the engine until such time that the gear pump 11 delivers fuel under sufficient pressure to force piston 33 in a direction towards expanding expandable chamber 30 against the biasing force of spring 35. The pressure developed by gear pump 11 causes piston 33 to be maintained in a position so that the switch contact 44 connected to the piston is away from the switch contact 45 and the circuit for the electromagnet 31 is maintained open. The spring 35 then balances the pressure supplied by gear pump 11, and exerted against piston 33, and the unit 10 functions as an accumulator with the fluctuations in the pressure of the fuel being smoothed by the spring loaded piston 33. If the pressure developed by gear pump 11 drops to a predetermined value the spring 35 forces the piston 33 in a direction toward contracting the expandable chamber 30 until the contact 44 carried by armature 32 engages contact 45 and causes actuation of electromagnet 31. The unit will then begin its pumping action as described above until a predetermined normal operating pressure is again developed by gear pump 11.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment of the invention is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

It is claimed and desired to secure by Letters Patent:

1. A fuel feeding system for an internal combustion engine comprising a fluid pressure device having an expandable chamber, electromagnetic means for operating said fluid pressure device, fuel intake and exhaust conduits for said chamber having respective intake and exhaust check valve means, electric circuit means for ener-

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gizing said electromagnetic means, means operably connected to said fluid pressure device for completing said circuit means at a predetermined point during contraction of said chamber, resilient means for exerting a biasing force to effect contraction of said chamber, a fuel pump adapted to be driven by said engine and adapted to deliver fuel from a source of fuel to said fluid pressure device, conduit means from said pump to said fluid pressure device, shunt conduit means shunting said pump, and check valve means in said shunt conduit.

2. A fuel feeding system for an internal combustion engine comprising a fluid pressure device having an expandable chamber with a moveable element which is actuatable to expand and contract the chamber, an electromagnet and an armature connected to said moveable element, fuel intake and exhaust conduits for said chamber having respective intake and exhaust check valve means, electric circuit means for energizing said electromagnet, means connected to said moveable element for completing said circuit means at a predetermined point when said moveable element is moved in a direction towards contracting said chamber, resilient means biasing said moveable element in a direction to contract said chamber, a fuel pump adapted to be driven by said engine and adapted to deliver fuel from a source of fuel to said fluid pressure device, conduit means from said pump to said fluid pressure device, shunt conduit means shunting said pump, and check valve means in said shunt conduit.

3. A fuel feeding system for an internal combustion engine comprising a fluid pressure device having an expandable chamber with a cylinder and a piston disposed in the cylinder, an electromagnet and an armature connected to said piston, fuel intake and exhaust conduits for said chamber having respective intake and exhaust check valve means, electric circuit means for energizing said electromagnet, means connected to said piston for completing said circuit means at a predetermined point when said piston is moved in a direction towards contracting said chamber, resilient means biasing said piston in a direction to contract said chamber, a fuel pump adapted to be driven by said engine and adapted to deliver fuel from a source of fuel to said fluid pressure device, conduit means from said pump to said fluid pressure device, shunt conduit means shunting said pump, and check valve means in said shunt conduit.

4. A fuel feeding system for an internal combustion engine comprising a fluid pressure device having an expandable chamber with a cylinder and a piston disposed in the cylinder, an electromagnet and an armature connected to said piston, fuel intake and exhaust conduits for said chamber having respective intake and exhaust check valve means, electric circuit means for energizing said electromagnet, switch means connected to said piston for completing said circuit means at a predetermined point when said piston is moved in a direction towards contracting said chamber, resilient means biasing said piston in a direction to contract said chamber, said piston being responsive to fluid pressure and said electromagnet to move said piston in a direction towards expanding said chamber, a fuel pump adapted to be driven by said engine and adapted to deliver fuel from a source of fuel to said fluid pressure device, conduit means from said pump to said fluid pressure device, shunt conduit means shunting said pump, and check valve means in said shunt conduit.

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