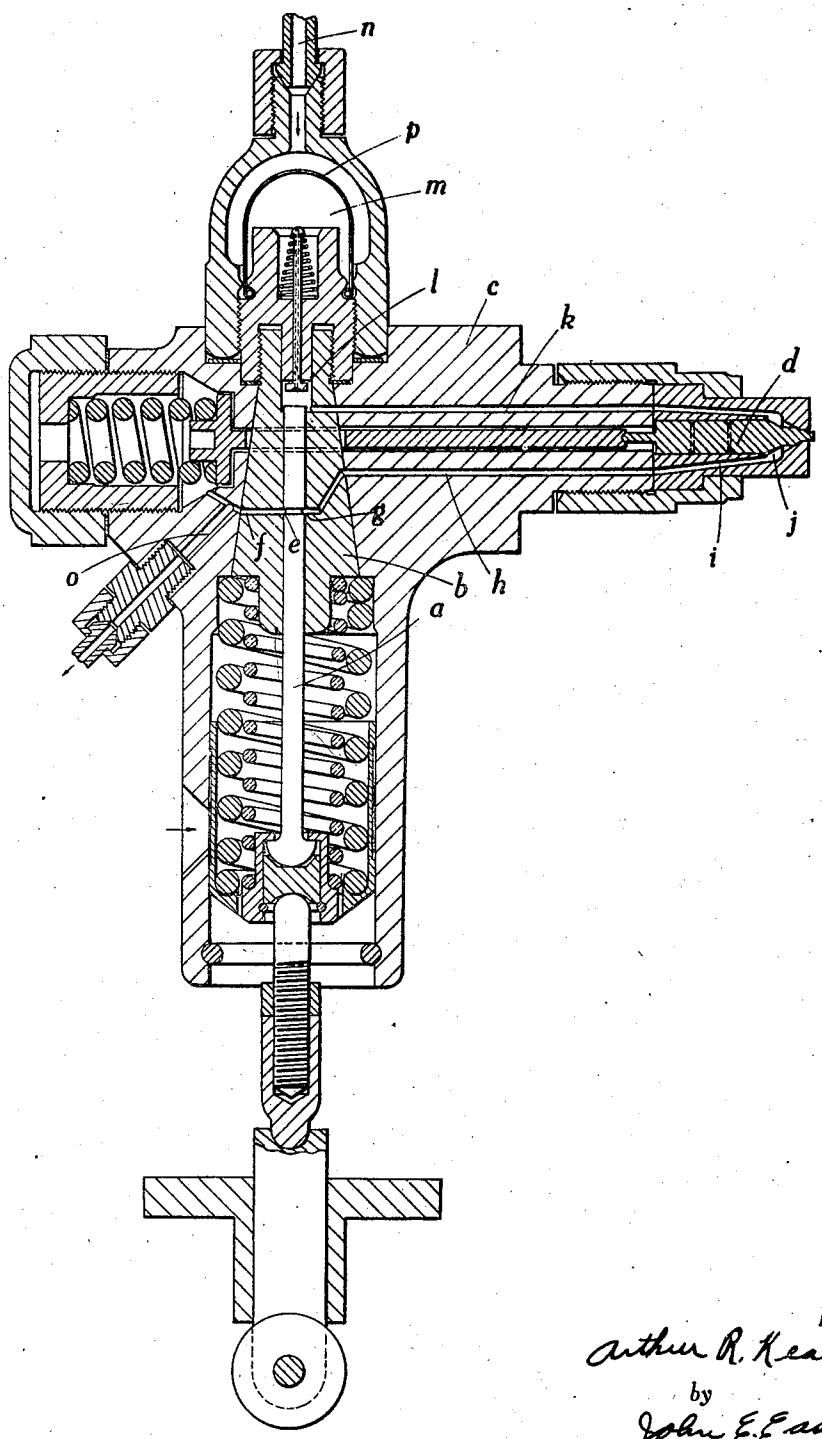
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FUEL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

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Inventor
Arthur R. Kearney
by
John E. Eastlack
Attorney

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FUEL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

Arthur Richie Kearney, Westminster, London, England

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This invention relates to fuel injection systems for internal combustion engines and has for its chief object the provision of an improved fuel-oil circuit arrangement in which freedom from air-locks is ensured.

According to the invention there is provided an improved form of fuel injection system wherein oil passages formed in the fuel pump and the injector are arranged so that during a part of the cycle of the injection system they provide for a complete non-reversing flow of the oil from the source of supply or from one part of the low pressure system through the fuel pump and injector to the nozzle tip and back to the source of supply or low pressure system.

In carrying the invention into effect according to one convenient mode, provision is made for subdividing the aforesaid cycle into three stages or periods, to wit, an idling period, a suction period and a high pressure pumping period and, during the idling period, the arrangement is such that a continuous oil passageway is provided for a complete one way flow of the oil under low pressure. For this purpose, the pump plunger is preferably provided with an annular groove which, at the end of a pumping stroke of the plunger, or at a period when the plunger is maintained in its upper-most position, registers with spill ports located at opposite sides of the plunger casing, the said spill ports being connected with oil channels or conduits which form a part of the aforesaid oil passageway.

In order that the said invention may be clearly understood and readily carried into effect the same will now be more fully described with reference to the accompanying drawing which shows one form of combined pump and injector which may be used in carrying out the invention. In the accompanying drawing, *a* indicates the pump plunger, *b* indicates the pump barrel in which the plunger is adapted to slide and *c* indicates the pump casing in which the pump barrel is fitted and on a lateral extension of which is arranged an injector fitted with a spring controlled nozzle spraying or injector valve *d*.

It will be observed that the pump plunger is provided with an annular groove *e* which is so arranged that, at the end of a pumping stroke of the plunger, or at a period when the plunger is maintained in its uppermost position or substantially so, it registers with a pair of spill ports *f* and *g* formed in the pump barrel and arranged one at each side thereof. The spill port *g* is in communication with a channel *h* in the pump casing, which channel is in communication with another channel *i* formed in the injector and extending to an annular space *j* provided around the aforesaid injector valve adjacent the injector valve seating. The annular space *j* is also interconnected with the space in the pump barrel above the pump plunger by a fuel delivering passage *k* formed in part in the pump casing and in part in the injector so that the passage *k*, the annular space *j* and the passages *h* and *i* together form what is substantially a horizontally disposed U-shaped passageway. Disposed above the pump plunger is a spring controlled non-return fuel inlet valve *l* for controlling the passage of fuel under low pressure from a filtering chamber *m* to the pump barrel, the arrangement being such that the inlet valve is adapted to be opened during the downward or suction stroke of the plunger and when the plunger is in the position shown.

The filtering chamber is suitably connected by a conduit *n* with the low pressure source of fuel supply and the spill port *f* is connected by a passage *o* leading to the low pressure system or back to the source of supply.

From the foregoing, it will be seen that the aforesaid substantially U-shaped passageway is subjected alternately to low oil pressure and high oil pressure. When the pump plunger is in a position such as that shown in which its annular groove *e* is in registration with the spill ports *f* and *g*, the said passageway will be subjected to low oil pressure, e. g. a pressure of the order of two lbs. per square inch, and the oil can then pass from the supply tank or other source of supply and through the inlet valve and into the aforesaid U-shaped passage. In passing through the latter, the oil is led around and immediately adjacent to the seat of the nozzle spraying or injector valve which, at this stage, is closed by spring pressure in excess of the pressure of the order of two lbs. per square inch, and then passes through the passages *i* and *h* to the spill port *g*, along the annular groove *e* and through the spill port *f* into the low pressure system or back to the source of supply.

During the suction period, the plunger moves downwardly away from the inlet valve which remains open and the annular groove in the plunger is moved out of registration with the spill ports with the result that the spill ports are closed and the continuous flow of the oil back to the supply tank is interrupted. Similarly, during the pumping period provided by the return movement of the plunger, the spill ports are closed as is also the inlet valve and the said pas-

sageway is subjected to high oil pressure which overcomes and opens the spring controlled injector valve *d* generating a finely divided spray of oil when escaping through the opened injector valve. The injector valve remains open and the spraying of oil continues until the annular groove *e* again registers with the spill ports *f* and *g* which results in a sudden loss of oil pressure causing the injector valve to close sharply and it follows that the continuous one-way passage for the flow of oil under low pressure is again opened. By such an arrangement, freedom from air-locks is ensured.

When the invention is applied to fuel injection systems using a combined pump and injector, the aforesaid passages may be formed entirely within the pump and the injector in which case there are no pipe-lines under high pressure. The invention is also applicable to systems employing an injector which is separate from the pump but, in this case, the passages in the pump must be connected with the passages in the injector by pipe lines which are capable of withstanding high pressure during the pumping stroke and which can be utilised for the one-way flow of oil under low pressure during the aforesaid idling period.

The oil is preferably pumped by a low pressure pump from the storage tank to the fuel injector pump but, in some instances, it may be supplied under gravity pressure. Preferably, the oil is caused to pass through one or more filters of known form and, if desired, a filtering element such as that shown at *p* may be arranged in the upper part of the pump. Any known form of nozzle tip may be used for finely dividing the fuel to form a spray or to atomise the fuel as it emerges therefrom.

Having thus described my said invention what I claim as new therein and desire to secure by Letters Patent is:

1. Fuel injecting means comprising a casing having a pump including a barrel and an injector including a valve, a plunger slidably mounted in the barrel, said barrel having a compression space for cooperation with one end of the plunger and said plunger having an annular groove spaced from said end thereof, said injector having a fuel supply line leading thereto from said compression space and further having a fuel return line leading therefrom to the peripheral face of the plunger, said return line being in communication with said annular groove when the pump ends its compression stroke, said casing further having a low pressure space adapted to receive fuel from a source of supply and having an outlet passage leading to said compression space, and a non-return valve controlling said outlet passage, said barrel further having an outlet port so located as to register with the annular groove when the latter is in communication with said fuel return line and adapted to return fuel discharged therethrough to said source of supply whereby provision is made for conducting fuel through the injector in a one-way open circuit at low pressure following the compression stroke of the pump to carry off any air trapped in said fuel lines.

2. Fuel injecting means comprising a casing having a pump including a barrel and an injector including a valve, a plunger slidably mounted in the barrel, said barrel having a compression space for cooperation with one end of the plunger and said plunger having an annular groove spaced from said end thereof, said barrel, casing and injector being formed with a fuel delivery channel extending from said compression space to said valve and further being formed with a fuel return channel extending from the valve to the peripheral face of the plunger, said return channel being in communication with said annular groove when the pump ends its compression stroke, said casing further having a relatively large filter chamber adapted to receive fuel from a source of supply and having an outlet passage leading to said compression space, and a non-return valve controlling said outlet passage, said barrel further having an outlet port so located as to register with the annular groove when the latter is in communication with said fuel return channel and adapted to return fuel discharged therethrough to said source of supply whereby provision is made for conducting fuel through the injector in a one-way open circuit at low pressure following the compression stroke of the pump to carry off any air trapped in said channels.

ARTHUR RICHIE KEARNEY.