

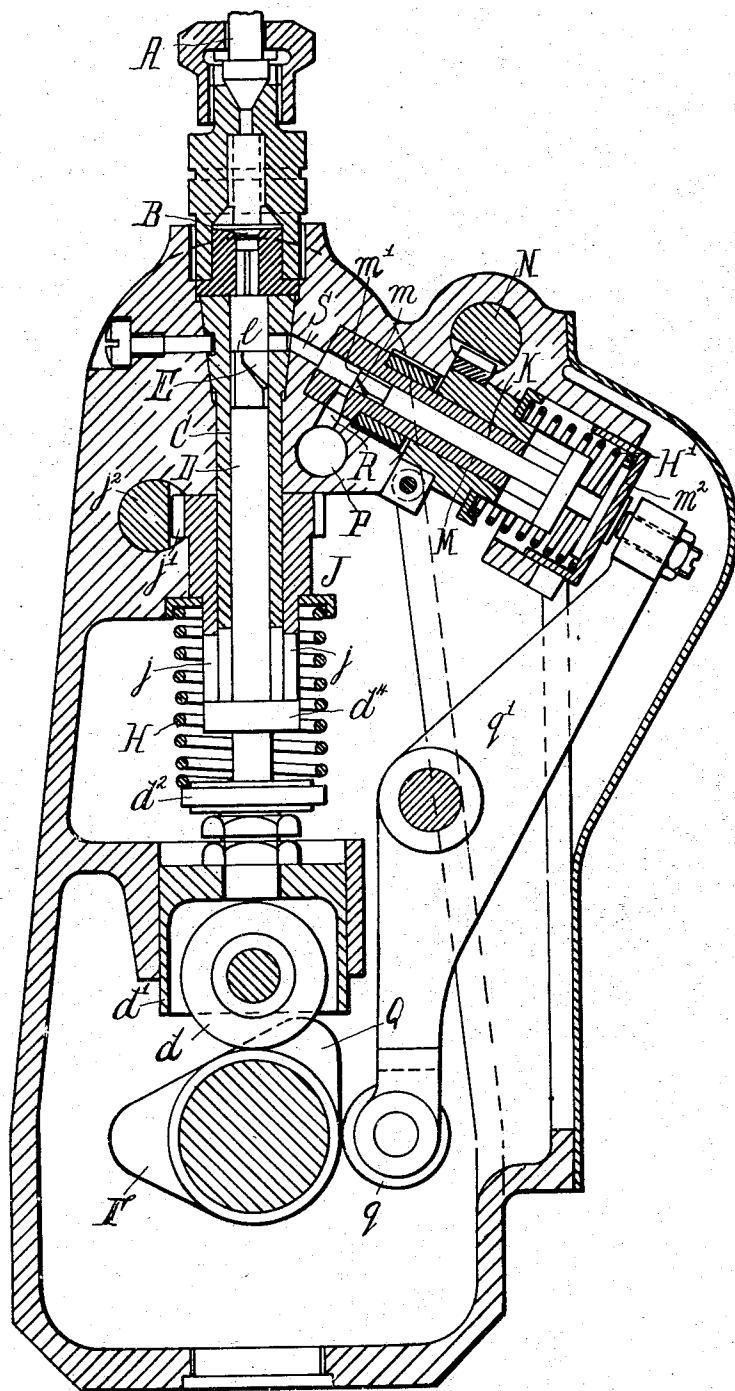
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R. F. COLELL

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INTERNAL COMBUSTION ENGINE OF THE COMPRESSION IGNITION TYPE

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INTERNAL COMBUSTION ENGINE OF THE
COMPRESSION IGNITION TYPE

Richard Friedrich Colell, Edgbaston, Birmingham, England, assignor to The Austin Motor Company, Limited, Northfield, Birmingham, England

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5 Claims. (Cl. 103-41)

The invention relates to internal combustion engines of the Diesel or compression ignition type. It is well known that such engines are subject to a defect, known as Diesel Knock, caused apparently by combustion delay, and with a view to avoiding or lessening this defect it has been proposed to arrange for the injection of a small quantity of fuel prior to the main injection, this being known as a pilot injection. It has been found that such an injection greatly lessens the effect of knock.

To effect such pilot injection, it has been proposed to provide two separate fuel injection pumps delivering fuel to two separate nozzles and through two separate non-return valves, but such arrangement involves the use of a large number of additional parts with increased expense and weight. It has also been proposed to provide two fuel pumps supplying fuel to a common nozzle; but this does not greatly simplify the construction and necessitates a large volume of fuel between the pumps and the nozzle, and necessitates two non-return valves. It has also been proposed to provide only a single fuel pump supplying fuel to a single nozzle; but this necessitates the use of two operative surfaces on a single cam which is unsatisfactory as it does not leave sufficient time for two consecutive injections and a pause between.

According to this invention, two pump cylinders each having a suction port are used, a main pump cylinder for the main charge and a pilot pump cylinder for the pilot charge, and the two pumps are connected in such a way that the one pump delivers its charge through the suction port of the other, from where it flows to the nozzle via the non-return valve. Thus there is a first pump, fuel from which passes through the cylinder of a second pump, but either of these may be the main pump.

The supply of fuel to the second pump cylinder passes through the delivery port of the first pump cylinder, via the cylinder and suction port of the first pump, the piston of the latter pump being arranged to move forward just prior to, or just after, the forward movement of the second piston, and in such a way that the second piston can displace fuel backwards into the suction chamber through the first pump.

A convenient embodiment of the invention is described with reference to the drawing herewith which is a vertical section illustrating the fuel injection system of a compression ignition engine, said system being arranged according to the invention.

In this drawing A is the pipe leading to the fuel injection nozzle, B the non-return valve and C the main fuel pump cylinder in which works the main piston D having a head E the lower edge of which is of the usual helical form. A groove e connects the lower side of the head E with the space above the head E. The piston D is moved upwardly by a cam F through the medium of a roller d turnably mounted in a slide d^1 to which the bottom end of the piston is secured. The piston is returned by a coil spring H pressing downwardly on a collar d^2 secured on, or integral with, the piston. The latter is also provided with a pair of arms d^4 working in a pair of slots j in a turnable sleeve J which has, at its upper end, spur teeth j^1 engaging with a rack j^2 moved by the engine governor, whereby the latter acts to rotate the main piston, all these parts being usual practice.

K is the cylinder of the pilot pump in which works the pilot piston M having a head m which also has its lower edge of helical form. It also has a groove m^1 connecting the space above the head to the space below. The pilot piston is rotated similarly as is the main piston by a rack N which may be hand or governor controlled. The pilot piston is operated by a cam Q through the medium of a roller q and double-armed lever q^1 , and is returned by a coil spring H^1 bearing downwardly on the bottom of a cup m^2 secured to the lower end of the pilot piston.

P is the passage or chamber to which the fuel oil is supplied and from which a port R leads to the pilot cylinder K through the wall thereof. S is a second port leading from the upper end of the pilot cylinder to the main cylinder C also through the wall thereof.

The operation is as follows:

The pilot cam operates first and rocks the lever q^1 thus causing the pilot piston to move up. As the space above it is full of fuel, the piston at first causes fuel to flow back to the chamber P, but the piston head in advancing covers the port R when the fuel, having no escape, is forced up through the port S and thence through the main cylinder C to the non-return valve B and so to the fuel nozzle in the engine cylinder (not shown). As soon as the bottom edge of the head of the piston M passes the bottom of the port R the pilot injection is finished and fuel can flow back via the groove m to the chamber P. Meantime, the cam F has commenced to raise the main piston D and its head E moves to close the port S; but since the head of the piston M has reopened the port R, the piston D can, at first, re-

turn fuel through the ports S and R to the chamber P. As soon, however, as the head E closes the port S, the fuel cannot flow back, and therefore, further movement of the main piston forces fuel past the non-return valve for the main charge. As soon as the bottom edge of the head E passes the bottom of the port S, the main injection is finished, and the fuel can flow back to the chamber P via the port e, cylinder K and port R, this latter being still open. Each piston head in passing back over its respective port will cause a certain amount of vacuum in the space above; but this will be rapidly filled up as soon as both piston heads reopen the ports of their respective cylinder.

It will now be clear that the cylinder K may, if desired, be the larger cylinder and act as the main pump cylinder, but in such case the other piston then acting as the pilot piston, must be that which moves forward first, the cams being so placed as to conform to this condition.

Having fully described my invention what I claim and desire to secure by Letters Patent is:

1. In a fuel injection apparatus for use with an engine of the compression ignition type, the combination of a fuel port, a non-return valve for the fuel port, a main fuel pump cylinder, a main piston working therein, a pilot pump cylinder, a pilot piston working therein, a fuel supply chamber common to the aforesaid main fuel pump cylinder and pilot pump cylinder, each of said cylinders having a suction port, each cylinder also having a delivery port, the pilot pump cylinder being positioned in proximity to and in communication with the main fuel pump cylinder, said cylinders being alternately in communication with the aforesaid fuel supply chamber with which the aforesaid suction ports communicate, whereby the piston of the one cylinder first causes fuel to flow back in to the common fuel supply chamber, fuel being then forced to the other cylinder through the suction port thereof and from said cylinder to the non-return valve and so to the fuel port in the engine cylinder.

2. In a fuel injection apparatus for use with an engine of the compression ignition type, the combination of a fuel port, a non-return valve for the fuel port, a common fuel supply chamber, a main fuel pump cylinder, a main piston working therein, a pilot pump cylinder, a pilot piston working therein, each cylinder having a suction port, a fuel supply passage alternately in communication with the suction port of the pilot pump and with the main fuel pump cylinder, the pilot pump delivering its charge to the main pump cylinder through the suction port thereof, said fuel passing thence to said non-return valve whereby fuel passing to said main pump cylinder and destined to be pumped by the main piston passes from said fuel supply chamber through said suction port of the pilot pump cylinder and thence through such cylinder and the suction port of the main pump cylinder and whereby during the part of the forward stroke of the said main piston fuel can flow back to the aforesaid fuel supply chamber via the pilot pump cylinder.

3. In a fuel injection apparatus for use with an engine of the compression ignition type, the combination of a fuel port, a non-return valve for said port, a main fuel pump cylinder, a main

piston working therein, a pilot pump cylinder, a pilot piston working therein, each cylinder having a suction port, a fuel supply passage alternately in communication with the suction port of the pilot pump and with the main fuel pump cylinder, either of the aforesaid pumps may deliver its charge to the other pump cylinder through the suction port thereof, said fuel passing thence to said non-return valve, the fuel passing to said other pump cylinder and destined to be pumped by the piston of said other cylinder passing from said fuel supply chamber through said suction port of said first named cylinder and thence through such first named cylinder and the suction port of said other cylinder and during the part of the forward stroke of the piston of said other cylinder fuel flowing back to the aforesaid fuel supply chamber via the said first-mentioned cylinder.

4. In a fuel injection apparatus for use with an engine of the fuel injection type having, in respect of each engine cylinder, a fuel injection port and a non-return fuel valve, the combination of a main pump cylinder and a main piston working therein, a pilot pump cylinder and a pilot piston working therein, the pilot pump cylinder being positioned in proximity to the main pump cylinder, a common passage forming the outlet from the one pump cylinder and the inlet to the other pump cylinder, an outlet passage from said other pump cylinder leading to the non-return valve, a fuel supply chamber and a passage leading therefrom to the said one pump cylinder, whereby the one pump piston may, at each operation, draw a charge of fuel from said chamber and force it through the other pump cylinder to the non-return valve, and whereby said other pump piston may, at each operation, draw a charge from the said one pump cylinder and, during the first part of its forcing stroke, return a portion of the fuel to the supply chamber back through said one pump cylinder and during the latter part of its stroke force another portion of the fuel to the non-return valve.

5. In a fuel injection apparatus for use with an engine of the fuel injection type having, in respect of each engine cylinder, a fuel injection port and a non-return fuel valve, the combination of a main pump cylinder and a main piston working therein, a pilot pump cylinder and a pilot piston working therein, the pilot pump cylinder being positioned in proximity to the main pump cylinder, a common passage forming the outlet from the pilot pump cylinder and the inlet to the main pump cylinder, an outlet passage from the main pump cylinder leading to the non-return valve, a fuel supply chamber and a passage leading therefrom to the pilot pump cylinder, whereby the pilot pump piston may, at each operation, draw a charge of fuel from said chamber and force it through the main pump cylinder to the non-return valve, and whereby said main pump piston may, at each operation, draw a charge from the said pilot pump cylinder and, during the first part of its forcing stroke, return a portion of the fuel to the supply chamber back through said pilot pump cylinder and during the latter part of its stroke force another portion of the fuel to the non-return valve.

RICHARD FRIEDRICH COLELL.