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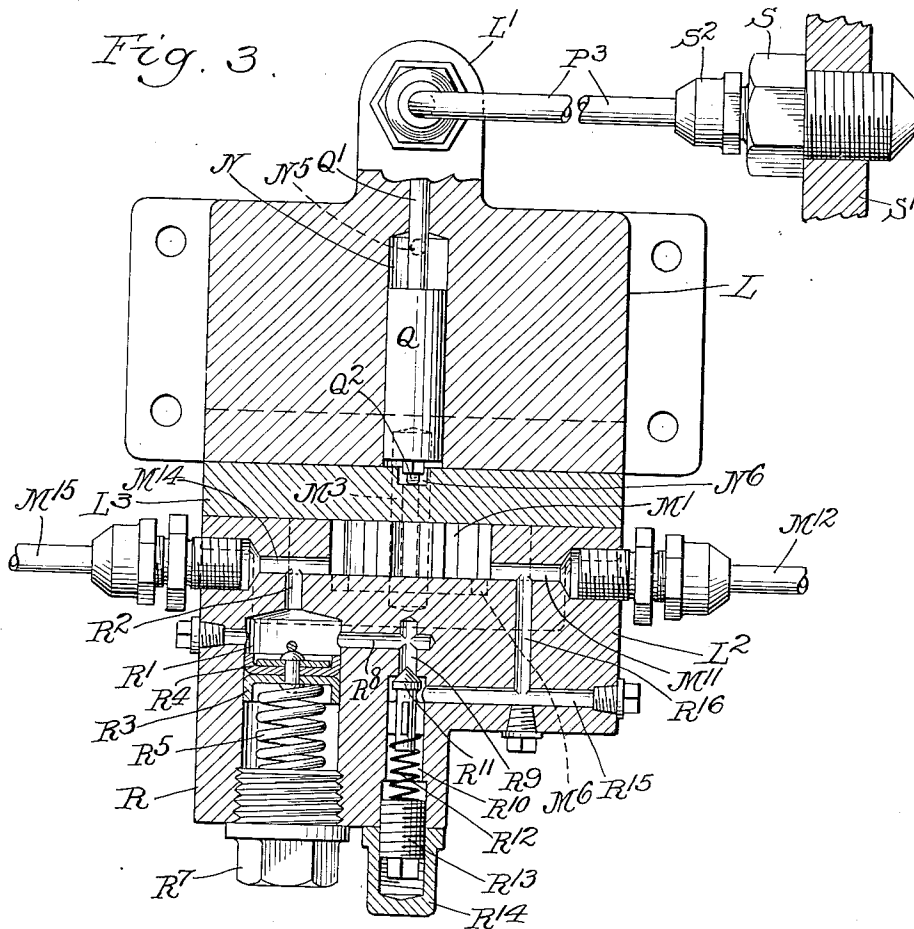
1,976,040

INJECTOR

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Fig. 3.



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1,976,040

INJECTOR

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9 Claims. (Cl. 103—45)

This invention relates to means for delivering liquid fuel under high pressure and, if desired, intermittently at very high frequency and particularly for doing so without the use of mechanical drives and especially without the use of heavily loaded drives. While the invention has many applications, it is illustrated here particularly in several forms adapted for use in connection with internal combustion engines of the injection type. By this is meant engines of the Diesel and the modified Diesel cycle in which the fuel is injected into the engine. This case is a continuation in part of copending application 116,282, filed June 16, 1926, now Patent 1,816,157, dated July 28, 1931.

An object of the invention is to provide a means for translating a steady flow of energy represented by the steady movement of a body of liquid at relatively low pressure into an intermittent delivered energy represented by the intermittent discharge of small bodies of liquid at high pressure. A particular object is to accomplish this result without the use of mechanical driving mechanism. Another object is to attain the advantages of the well known rotary pump structures in conjunction with a high pressure fuel delivery system suitable for use on a high speed internal combustion engine. Other objects will appear from time to time throughout the specification and claims.

Figure 1 is a vertical cross section of the combined rotary pump power supply, motor, and high pressure pump.

Figure 2 is an end elevation of the same structure.

Figure 3 is a detail section showing the portion of the high pressure accumulator and relief mechanism.

Referring to Figure 1, L is a housing. It has a reduced portion L¹ and is provided with a cover L² and a spacer plate L³. In it is embodied a well known type of gear pump comprising the gears M M¹ mounted respectively on a driving shaft M² and a stub shaft M³. M has a perforation M⁴ and M¹ is provided with a perforation M⁵. These perforations extend through the spacer L³ and into the housing L. Formed within the cover L² is a circular groove M⁶ concentric with the gear M¹ and provided with the outlet connection M⁷. Formed concentrically with the gear M in the cover L² is a second circular groove M⁸ which is provided with an inlet connection M⁹. Communicating with the intake space M¹⁰ in the gear chamber is an inlet connection M¹¹ which is joined by means of a pipe M¹² with the connection M⁷.

In the pipe M¹² is a surge tank M¹⁶. Communicating with the compression or pumping space M¹³ in the gear chamber is an outlet or high pressure connection M¹⁴ which is joined by means of a pipe M¹⁵ to the connection M⁹.

N is a bore located within the housing L. N¹ is a reduced bore communicating with the bore N and located in the reduced portion L¹ of the housing. N² is an upper passage axially aligned with the connection M⁹. N³ is a passage connecting the passage N² to the large bore N. N⁴ is a passage in the housing L axially aligned with the connection M⁷. N⁵ is a passage joining the passage N⁴ to the bore N. N⁶ is a generally U-shaped passage lying in the spacer L³ communicating with the end of the bore N closest to the gears and having its extremities in alignment with the grooves M⁶ and M⁸. Normally the passages N², N⁴ and N⁶ are cut off from communication with the grooves. When, however, the rotation of the gears bring their perforations into alignment with one or the other passages, they are for an interval in communication with the grooves and fluid can pass into them.

O is a bore in the housing L¹ within which is located a ball valve O¹ which may be held against excessive displacement by means of a pin O². O³ is an enlarged passage communicating with the passage O and having within it a second ball valve O⁴.

P is an intake conduit from a fuel or other fluid supply and it is joined by means of a fitting P¹ and a passage P² to the bore O. P³ is an outlet conduit joined by means of a connection P⁴ to the bore O³.

Q is the larger end of a differential plunger. It is mounted for reciprocation in the bore N. Q¹ is the small end of a differential plunger and it lies within the bore N¹. Q² is an adjusting screw which may be adjusted in or out to vary the limit of movement of the plunger in the direction of the plunger toward the gears. R is an extension formed as an integral part of the cap L² containing within it a large bore R¹ which connects with the passage M¹⁴ by means of the small passage R². Lying within the bore R¹ is a spring loaded piston R³ having a leather sealing washer R⁴ upon its face. R⁵ is a spring permitting the piston R³ to yield under pressure. R⁷ is a sealing cap for the bore. R⁸ is a lateral passage connecting the bore R¹ with a smaller parallel bore R⁹. R¹⁰ is an enlargement of the bore R⁹ containing within it a pressure release valve R¹¹ held upon its seat by a spring R¹². The tension of the spring R¹² may be adjusted by the

adjusting screw R¹³. The passage is sealed against leakage by a cap R¹⁴. R¹⁵ is a lateral passage leading into the bore R¹⁰. R¹⁶ is another passage connecting the passage R¹⁵ with the inlet passage M¹¹ whereby oil which may escape through the pressure release valve may return to the suction side of the pump. S is a spray valve which may be inserted into the wall S¹ of the engine cylinder. It is attached by means of the connection S² to the pipe P³ leading from the high pressure chamber O³ of the pump.

The use and operation of my invention is as follows:

A relatively heavy oil, suitable for use in any of the common types of gear pumps, is placed in the surge tank M¹⁶. Upon rotation of the gears steady suction is created, for example in the passage M¹⁰, and a steady pressure is created in passage M¹⁴ within the capacity of the pump. The pressure on the driving oil in M¹⁴ will extend through the pipe M¹⁵ and into the channel M⁸. A distributing port M⁴ is drilled in the gear M. As this gear rotates this port will come into register with the mating opening in L³ and consequently with the passages N² and N³. This will permit the oil under pressure to act upon the reduced area of the motor piston Q causing it to move toward the gears, withdrawing the high pressure plunger Q¹ with it and causing a suction stroke in the high pressure pump. This suction stroke causes the discharge valve O⁴ to seat and the suction valve O¹ to lift in a conventional manner permitting the chamber to fill with liquid fuel. Coincident with the registration of the port M⁴ with its respective passages, the port M⁵ in the other gear registers also with the U-shaped passage N⁶ in the spacer L³. This permits oil previously lying behind the motor piston Q to be discharged into the channel M⁶ from thence into the passage M⁷ and so back in the surge tank M¹⁶, thus completing a cycle of the driving liquid. The power stroke of the motor piston Q is caused by a reversal of the above steps, namely, the port M⁴ registers with the channel N⁶. High pressure oil is then admitted from the channel M through the port and passage to the power side of the piston driving it forward and thereby driving a pump plunger Q¹ forward causing a high pressure discharge to take place in the pump chamber, the valve O¹ seating and the valve O⁴ lifting, the liquid, fuel oil for example, being then delivered to the fuel valve S in the engine. The driving oil which was used to cause the suction stroke of the motor piston can be expelled through the passages N⁵, N⁴, the port M⁵ in the gear which has then come into register, and finally the passage M⁷ into the surge tank M¹⁶. It is to be noted that the pump plunger Q¹ is of considerably smaller diameter than the motor piston Q. Consequently any unit pressure developed upon the driving oil will be multiplied substantially in inverse ratio to the diameters of the plunger and piston upon the fuel oil which is pumped by the plunger Q¹.

The purpose of the hydraulic accumulator and its associated pressure relief valve is, first, to absorb the steady delivery caused by the steady rotation of the gear pump as it is fed to an intermittent output circuit. It is obvious that the hydraulic motor piston only receives oil during a relatively small portion of one complete revolution of the gears. During the time that the control port is out of register with the motor passages the oil will be continued to be fed by the gears and will pass into the chamber R¹ gradually com-

pressing the spring loaded piston R³. When a high pressure port registers with the motor passage the oil so held in the accumulator R¹ will be delivered in addition to the steady supply from the gears to provide the necessary quantity of oil under pressure. The pressure relief valve R¹¹ serves not only to control the operating pressures in the circuit but also to take care of any accidental stoppages which would cause an undue pressure rise.

It will be seen that this system permits the relatively cheap and simple structure of a gear pump operating with a liquid particularly chosen for such purpose to develop, finally, an intermittent high pressure upon light, non-viscous fuels, such as fuel oils, which will be high enough to operate satisfactorily an atomizing nozzle in a high speed engine. This transfer of energy from low pressure to high pressure and from steady to intermittent is accomplished without the use of mechanical linkages. It is a well known fact that mechanical linkages are unsuited for use in high speed high pressure injection engines.

Although in the form shown there is but one combined motor pump unit, the structure lends itself equally well to a multiplicity of such units, all operating from the same power supply, namely, a rotary oil pump. It will be understood that the invention may take the form of such a multiple pump or other equivalent forms of the structure embodying the same principle, the showing here being largely diagrammatic.

I claim:

1. In a hydraulic transmission system comprising a low pressure rotary pump, a motor cylinder, a closed liquid circuit including said pump and cylinder, a piston adapted to be reciprocated in the cylinder by the driving liquid from the rotary pump, a pump cylinder, a piston therein directly connected to and of smaller diameter than the motor piston, a high pressure circuit including said pump cylinder, whereby the low pressure in the rotary pump circuit is converted into intermittent high pressure in the reciprocating pump circuit.

2. In a hydraulic transmission system comprising a low pressure rotary pump adapted to discharge driving liquid at a constant, relatively low pressure, substantially independent of the quantity of liquid discharged by it within its working range, a motor cylinder, a closed liquid circuit including said pump and cylinder, a piston adapted to be reciprocated in the cylinder by the driving liquid from the rotary pump, a pump cylinder, a piston therein directly connected to and of smaller diameter than the motor piston, a high pressure circuit including said pump cylinder, whereby the constant low pressure in the rotary pump circuit is converted into intermittent high pressure in the reciprocating pump circuit.

3. In a hydraulic transmission system comprising a low pressure rotary pump, a motor cylinder, a closed liquid circuit including said pump and cylinder adapted to contain a relatively viscous driving liquid, a piston arranged to be reciprocated in the cylinder by the driving liquid from the rotary pump, a pump cylinder, a piston therein connected to and of smaller diameter than the motor piston, a high pressure circuit including said pump cylinder and adapted to contain an open high pressure circuit including said pump cylinder adapted to pump relatively non-viscous liquid, whereby the low pressure in the rotary pump circuit is converted into inter-

mittent high pressure in the reciprocating pump circuit.

4. In a hydraulic transmission system comprising a low pressure rotary pump, a motor cylinder, a closed liquid circuit including said pump and cylinder adapted to contain a relatively viscous driving liquid, a piston arranged to be reciprocated in the cylinder by the driving liquid from the rotary pump, a pump cylinder, a piston therein directly connected to and of smaller diameter than the motor piston, a high pressure circuit including said pump cylinder and adapted to contain an open high pressure circuit including said pump cylinder adapted to pump relatively non-viscous liquid, whereby the low pressure in the rotary pump circuit is converted into intermittent high pressure in the reciprocating pump circuit.

5. In a hydraulic transmission system comprising a low pressure rotary pump adapted to discharge driving liquid at a constant, relatively low pressure, substantially independent of the quantity of liquid discharged by it within its working range, a motor cylinder, a closed liquid circuit including said pump and cylinder adapted to contain a relatively viscous driving liquid, a piston arranged to be reciprocated in the cylinder by the driving liquid from the rotary pump, a pump cylinder, a piston therein connected to and of smaller diameter than the motor piston, a high pressure circuit including said pump cylinder and adapted to contain an open high pressure circuit including said pump cylinder adapted to pump relatively non-viscous liquid, whereby the constant low pressure in the rotary pump circuit is converted into intermittent high pressure in the reciprocating pump circuit.

6. In a hydraulic transmission system, a continuous delivery low pressure pump adapted to supply low pressure driving liquid at constant pressure substantially independent of the quantity of liquid discharged by it within its working range, a high pressure pump adapted to deliver liquid intermittently at high pressure, transfer means associated with both of said pumps, said means including a double acting hydraulic motor piston and a high pressure reciprocating pump piston attached thereto, and of smaller diameter than the motor piston, valve means for admitting and discharging driving liquid to and from said motor piston whereby said motor piston

and the attached high pressure piston are caused to perform alternate power and return strokes.

7. In a hydraulic transmission system, a low pressure pump adapted to deliver a non-fluctuating, impulse free supply of low pressure driving liquid at constant pressure substantially independent of the quantity of liquid discharged by it within its working range, a high pressure pump adapted to deliver liquid intermittently at high pressure, transfer means associated with both of said pumps, said means including a double acting hydraulic motor piston and a high pressure reciprocating pump piston attached thereto, and of smaller diameter than the motor piston, valve means for admitting and discharging driving liquid to and from said motor piston whereby said motor piston and the attached high pressure piston are caused to form alternate power and return strokes, and whereby said steady low pressure input is converted into intermittent high pressure output.

8. In combination in a compound hydraulic pump, a high pressure pump including a housing, a pump plunger and intake and discharge valves associated therewith, a hydraulic motor piston directly connected to said high pressure plunger, a housing containing said motor piston, ducts in said housing arranged to lead driving liquid to, and to discharge spent driving liquid from each side of said piston, means adapted to admit and discharge driving liquid to and from said passages, means for supplying a steady flow of relatively low pressure driving liquid, said means including a pair of rotating gears.

9. In a combination in a compound hydraulic pump, a high pressure pump including a housing, a pump plunger and intake and discharge valves associated therewith adapted to pump relatively non-viscous liquid, a hydraulic motor piston directly connected to said high pressure plunger, a housing containing said motor piston, ducts in said housing arranged to lead relatively viscous driving liquid to, and to discharge spent driving liquid from each side of said piston, means adapted to admit and discharge driving liquid to and from said passages, means for supplying a steady flow of relatively low pressure viscous driving liquid, said means including a pair of rotating gears.

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