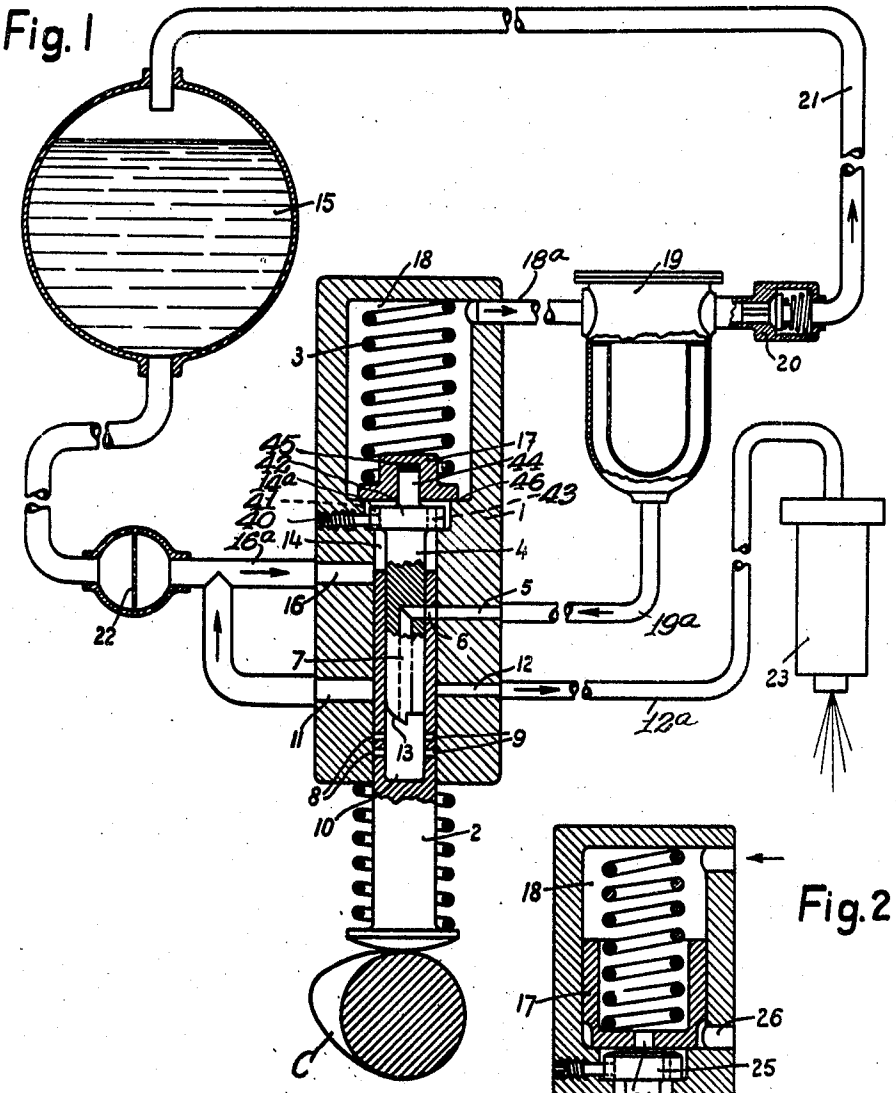
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Fig. 1



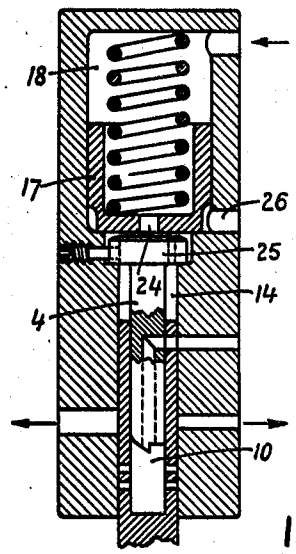


Fig. 2

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Fig. 3

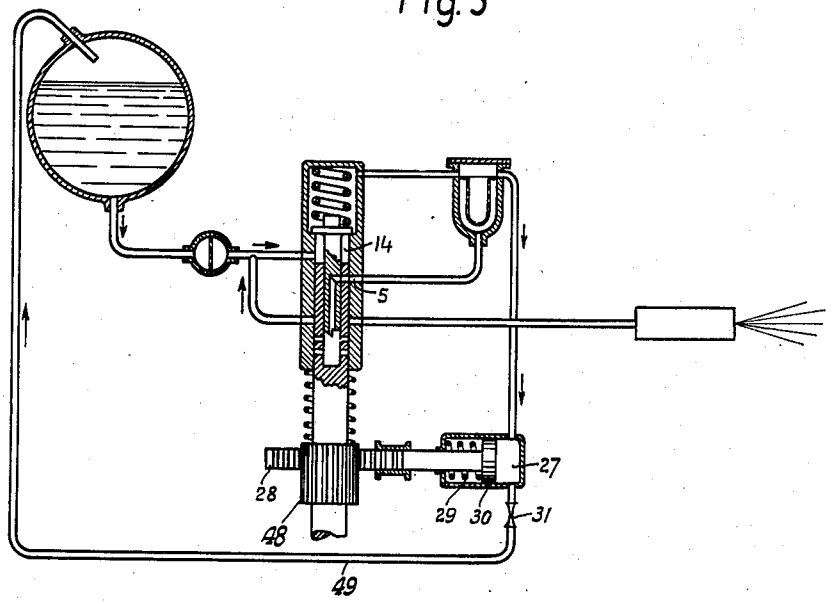
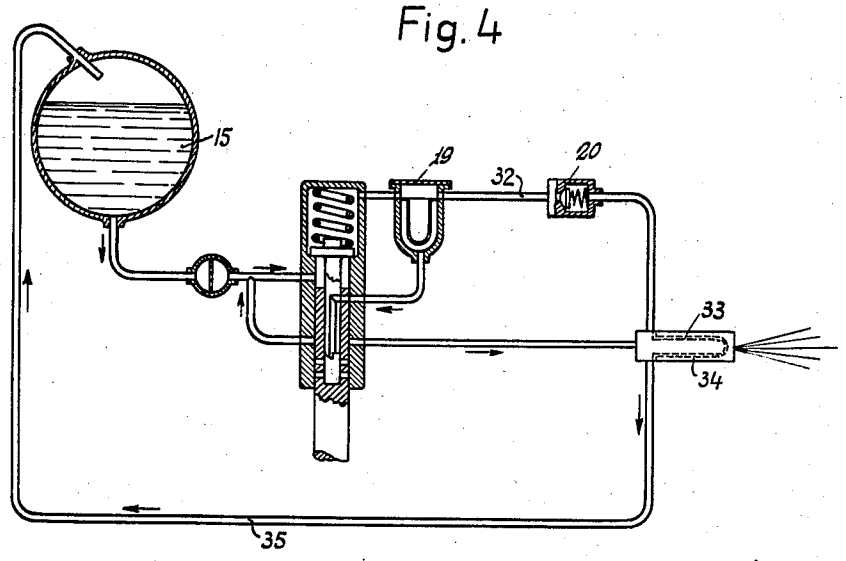


Fig. 4



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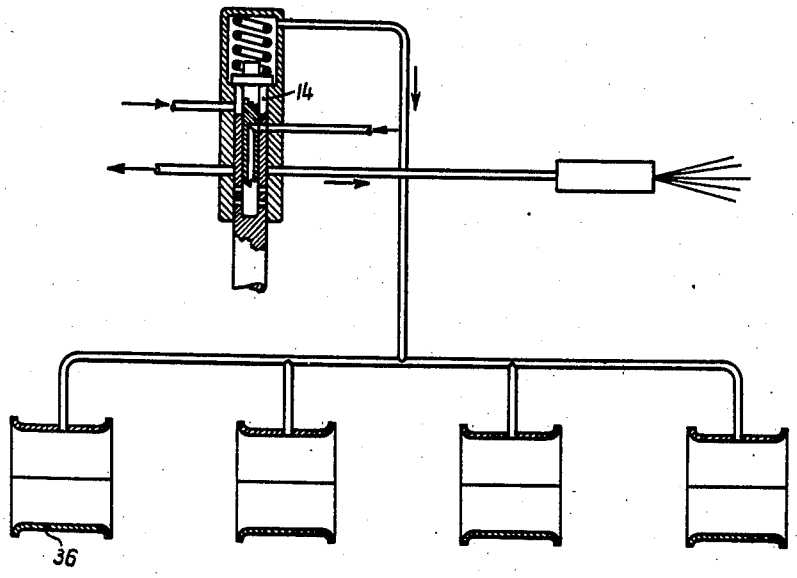
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Fig. 5



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Application August 12, 1939, Serial No. 289,742
In Germany September 2, 1938

10 Claims. (Cl. 123—139)

This invention relates to pumps of the kind comprising a positively driven piston guided in a cylinder and having an axially extending bore, which receives a spring loaded equalizing piston and therewith forms a pump chamber. This type of pump is well suited for injecting fuel into the cylinder of an internal combustion engine and may be constructed to give an intermittent injection, as described in our copending application Serial No. 189,768, filed February 10, 1938, issued July 9, 1940, as Patent No. 2,206,914.

In such a pump there is a ring-shaped space between the pump cylinder and the equalizing piston within which reciprocates the end of the positively driven piston. In accordance with the present invention this ring-shaped space is used as a second pump chamber by providing controlled inlet and outlet means therefor. For this purpose the equalizing piston may have an annular collar coacting with a seat on the cylinder at the end of the ring-shaped chamber, to serve as a delivery valve; or a spring cap interposed between the spring and the equalizing piston may act as the delivery valve. The fluid may be sucked through a port controlled by the positively driven piston.

The pumping of a fluid, in accordance with this invention, by means of the ring-shaped stroke space of the positively driven piston, which is necessarily present in this type of pump, has the advantage that an additional pump and its drive are dispensed with. The ring-shaped stroke space is particularly suited for this purpose, because the outer and inner pistons, for their service as pistons of the injection pump, are already accurately ground and can therefore pump a second fluid without any change or further work.

In a preferred form of the invention the ring-shaped stroke space of the injection pump, sometimes hereinafter referred to as the "ring pump," is used as a feeder pump for the fuel, that is, it serves to pump the fuel from the reservoir or a conduit to the inlet of the injection pump. The leakage losses between the equalizing piston and the bore of the positively driven piston pass directly into the pump chamber of the feeder pump. Connections or channels for leading-off the leakage fuel are therefore not required on the low pressure side of the injection pump. Since the feeder pump must have a capacity at least equal to the greatest quantity pumped by the injection pump, which is to be regulated according to the load on the internal combustion engine, the excess fuel must be permitted to run off. This may take place, for example, through a pressure limit valve, the spring strength of which corresponds to the desired supply pressure. The excess fuel may also be conducted through a throttle, the flow resistance through which produces the necessary pressure in the suction chamber of the injection pump, which pressure may also be used for the regulation of the quantity of fuel to be injected. For this purpose the pressure is brought to work upon a spring loaded piston or a diaphragm, which operates the regulating member of the injection pump.

The ring-shaped stroke space can, in the same way, be used for pumping any other fluid, for example, a lubricating medium or a cooling fluid.

In the drawings are shown, more or less diagrammatically, five embodiments of the invention, which may be rearranged and combined in various ways.

Fig. 1 is a diagram of a fuel pumping system for an internal combustion engine, in accordance with the invention, showing in vertical section a pump designed for intermittent injection, in which the ring-shaped stroke space serves as a feeder pump for the injection pump;

Fig. 2 is a vertical section of a modified form of pump;

Fig. 3 is a diagram of a modified fuel pumping system, wherein the ring pump serves as a feeder pump and also as a regulating pump;

Fig. 4 is a diagram of a further modified system, wherein the ring pump supplies a liquid for cooling the fuel injection valve, in this case the fuel itself; and

Fig. 5 is a diagram of still another modification wherein the ring pump acts as a lubrication pump.

The pump shown in Fig. 1 has a piston 2 fitting in a cylinder 1 and driven positively in the usual manner by a cam *c*; also an equalizing piston 4 loaded by a spring 3 and operating in a longitudinal bore of the piston 2. The pistons are shown in the lower dead center position, that is, in the position before the beginning of the pump stroke. The fuel is drawn into the pump space 10 through a duct 5 in cylinder 1, a transverse port 6 in piston 2, and ducts 7 in the equalizing piston 4. The manner of operation of the injection pump is the same as described in our application, Serial No. 189,768. After the piston 2 in the first part of its upward movement has interrupted the connection between the ducts 5 and 7, the equalizing piston 4 is carried up against the pressure of spring 3. The transverse ports 8 and 9 of the piston 2 alternately connect the

pump space 10 with a return conduit 11, 11a and an injection conduit 12, 12a leading to a fuel injection valve 23. The piston 2 can be angularly rotated, by means not shown, to vary the position of ports 8 in relation to the inclined lower edge 13 of the equalizing piston 4, thus varying the portion of the charge in chamber 10 which escapes through return conduit 11 and consequently the quantity of fuel pumped through ports 9 and conduit 12 to the injection valve 23. The angular position of piston 4 is fixed by a screw 40, the end of which engages in a slot 41 in the periphery of a collar 42 on piston 4.

The slot 41 and a hole 43 maintains open communication between the ring chamber 14 and the space 14a above the collar. Between the piston 4 and spring 3 is interposed a spring cap 17, which receives a pin 44 on the upper end of piston 4 in a socket 45. The bottom face of spring cap 17 seats upon a shoulder 46 of cylinder 1 adjacent the upper end of the ring chamber 14, to perform the function of a delivery valve.

The ring-shaped stroke space 14, which in Fig. 1 is used as a feeder pump, communicates, in the position of the pistons shown, with a suction duct 16 connected with a supply conduit 16a leading from a fuel reservoir 15. When the piston 2 moves upward, first the suction port 16 is covered and thereupon the spring cap 17 is raised from its seat. The fuel compressed in the ring chamber 14 passes into the chamber 18 housing the equalizing spring 3 and from there through a tube 18a into a filter 19. The filter is connected by a pipe 19a with the suction duct 5 of the injection pump. In the case of a multi-cylinder pump the individual pumps may be connected to a common filter 19, the upper space of which serves as an air chamber. Since the injection pump and the ring pump of the same cylinder act simultaneously, an equalization must be provided for in this way.

The excess fuel pumped by the ring pump, which is not taken up by the injection pump, passes through a pressure limit valve 20 and a conduit 21 back into the fuel reservoir 15. A filter 22 may be inserted in the supply conduit 16a.

In Fig. 2 the operation of the injection pump comprising the inner pump chamber 10 corresponds to that in Fig. 1. On the other hand, the ring pump is differently controlled. The ring piston 2 sucks the fuel from the spring chamber 18 through a hole 24 in the middle of the spring plate 17a, which, as in Fig. 1, has a peripheral ring surface ground to the seat 46. Between the spring cap 17a and the end 25 of the equalizing piston 4 which is remote from the pump space 10, there is, in the position shown, a small space for the entrance of the fuel. As soon as the piston 2 moves upward from the lower dead center position shown, the equalizing piston 4 is immediately carried along with it and the suction port 24 in the spring cap is immediately closed. The quantity of fuel which has been taken into the pump space 14 is thereupon pumped through the delivery valve and the port 26 to a filter (not shown) corresponding to the filter 19, thence to the pump space 10, as in Fig. 1. In the ring pumps shown in Figs. 1 and 2 only such parts are used for the control as are required for the operation of the injection pump. This has the advantage that the injection pump is dependent upon the operation of the ring pump. If the ring pump should fail for any reason, the drive of the machine will necessarily be interrupted.

The showing of the pump unit in Fig. 3 is simplified, as compared with Fig. 1. For instance, there is no separate cap interposed between the spring 3 and piston 4, the collar 42 of the piston acting both as spring cap and delivery valve. However, the operation and control can be exactly the same. Corresponding parts are therefore provided with the same reference characters. The unit is distinguished from that of Fig. 1 by the fact that the part of the fuel pumped in the ring chamber 14 which is not conducted to the suction port 5 passes through a pipe 47 to a cylinder 27, in which is a piston 30 connected with the regulating rod 28 and influenced by a spring 29. The regulating rod 28 engages a spur gear 48 on piston 2 and imparts thereto the angular adjustment which controls the quantity of fuel injected, as previously described. The back pressure built up in the regulating cylinder 27 behind a throttle 31 displaces the piston 2 according to the load and speed in such a way that a nearly uniform speed is maintained. The fuel leaving throttle 31 returns through a pipe 49 to the fuel reservoir 15.

In Fig. 4 the ring pump sucks fuel from the reservoir 15 and pumps it through filter 19 and conduit 32, in which is inserted a pressure limiting valve 20, to the cooling fluid passage 33 of a fuel injection valve 34. The heated cooling fuel returns through a conduit 35 to the fuel reservoir.

In Fig. 5 is shown how the ring chamber 14 can be used for pumping lubricating oil to the bearings 36 of the engine. The pump chamber of the injection pump and the ring pump are naturally entirely independent of each other.

The ring pump can be used for additional auxiliary purposes, such as for a control pump for the starting air valves. Furthermore, the embodiments shown in Figs. 1–4 can be combined in various ways. For example, the ring pump can pump exclusively a regulating fluid, or the regulating fluid can serve at the same time as a cooling medium.

We claim:

1. A pump comprising a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; means yieldingly pressing said inner piston into said bore; and inlet and outlet means for each of said pump chambers.

2. A pump comprising a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; a spring pressing said inner piston into said bore; a delivery valve controlling said ring-shaped pump chamber, comprising a member movable with said inner piston against the action of said spring; inlet means for said ring-shaped pump chamber; and inlet and outlet means for said inner pump chamber.

3. A pump comprising a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; a spring pressing said inner piston

into said bore; said cylinder having an annular seat adjacent one end of said ring-shaped pump chamber and said inner piston having an annular shoulder coacting with said seat to form a delivery valve for said ring-shaped pump chamber; inlet means for said ring-shaped pump chamber; and inlet and outlet means for said inner pump chamber.

4. A pump comprising a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; a spring pressing said inner piston into said bore; a spring cap interposed between said spring and said inner piston; said cylinder having a valve seat adjacent one end of said ring-shaped pump chamber against which said spring cap seats to form a delivery valve for said ring-shaped pump chamber; inlet means for said ring-shaped pump chamber; and inlet and outlet means for said inner pump chamber.

5. A pump comprising a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; a spring pressing said inner piston into said bore; said cylinder having an extension forming a chamber around said spring; a spring cap interposed between said spring and said inner piston; said cylinder having a valve seat adjacent one end of said ring-shaped pump chamber against which said spring cap seats to form a delivery valve for said ring-shaped pump chamber; means for conducting a liquid into said spring chamber; said spring cap having an aperture to admit liquid from said spring chamber into said ring-shaped chamber; said inner piston being spaced from said spring cap in one end position and being adapted to close said aperture in said spring cap, upon moving into contact with said spring cap; and inlet and outlet means for said inner pump chamber.

6. A pump as described in claim 1, in combination with a liquid reservoir; a conduit connecting said reservoir with the inlet means of said ring-shaped pump chamber; and a conduit connecting the outlet means of said ring-shaped pump chamber with the inlet means of said inner pump chamber.

7. A pump as described in claim 1, in combination with a liquid reservoir; a conduit connecting said reservoir with the inlet means of said ring-shaped pump chamber; a conduit connecting the outlet means of said ring-shaped pump chamber with the inlet means of said inner pump chamber; and means for returning excess liquid from said last mentioned conduit to said reservoir.

8. In a pumping device for an internal combustion engine, a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; means yieldingly pressing said inner piston into said bore; inlet and outlet means for each of said pump chambers; a fuel reservoir; a conduit connecting said reservoir with the inlet means of said ring-shaped pump chamber; a fuel injection valve; a conduit connecting the outlet means of said inner pump chamber with said fuel injection valve; conduit means connecting the outlet means of said ring-shaped pump chamber with the inlet means of said inner pump chamber; means for regulating the amount of fuel pumped to said fuel injection valve from said inner pump chamber; means for diverting from said conduit means fuel pumped from said ring-shaped pump chamber in excess of that pumped from said inner pump chamber; a conduit for returning said excess fuel to said reservoir; a throttle in said last mentioned conduit; and pressure responsive means interposed in said last mentioned conduit behind said throttle controlling said regulating means.

9. In a pumping device for an internal combustion engine, a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; means yieldingly pressing said inner piston into said bore; inlet and outlet means for each of said pump chambers; a fuel reservoir; a conduit connecting said reservoir with the inlet means of said ring-shaped pump chamber; a fuel injection valve; a conduit connecting the outlet means of said inner pump chamber with said fuel injection valve; conduit means connecting the outlet means of said ring-shaped pump chamber with the inlet means of said inner pump chamber; means for returning fuel from said conduit means to said reservoir; and a pressure limiting valve controlling the diversion of fuel through said last means to said reservoir.

10. In a pumping device for an internal combustion engine, a cylinder; a piston fitting in said cylinder having an open ended axially extending bore; an inner piston fitting in said bore; said pistons forming an inner pump chamber within said bore and, in conjunction with said cylinder, forming a second ring-shaped pump chamber; means for positively reciprocating said first piston; means yieldingly pressing said inner piston into said bore; inlet and outlet means for each of said pump chambers; a fuel reservoir; means for conveying fuel from said reservoir to the inlet means of said ring-shaped pump chamber; means for conveying fuel from the outlet means of said ring-shaped pump chamber to the inlet means of said inner pump chamber; a fuel injection valve comprising a fuel injecting passage and a cooling-fluid passage; means for conveying fuel from the outlet means of said ring-shaped pump chamber to said cooling-fluid passage of said injection valve; and means for conveying fuel from the outlet means of said inner pump chamber to said fuel injecting passage of said fuel injecting valve.

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