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APPARATUS FOR FEEDING LIQUID FUEL TO INTERNAL-COMBUSTION ENGINES

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Fig. 1.

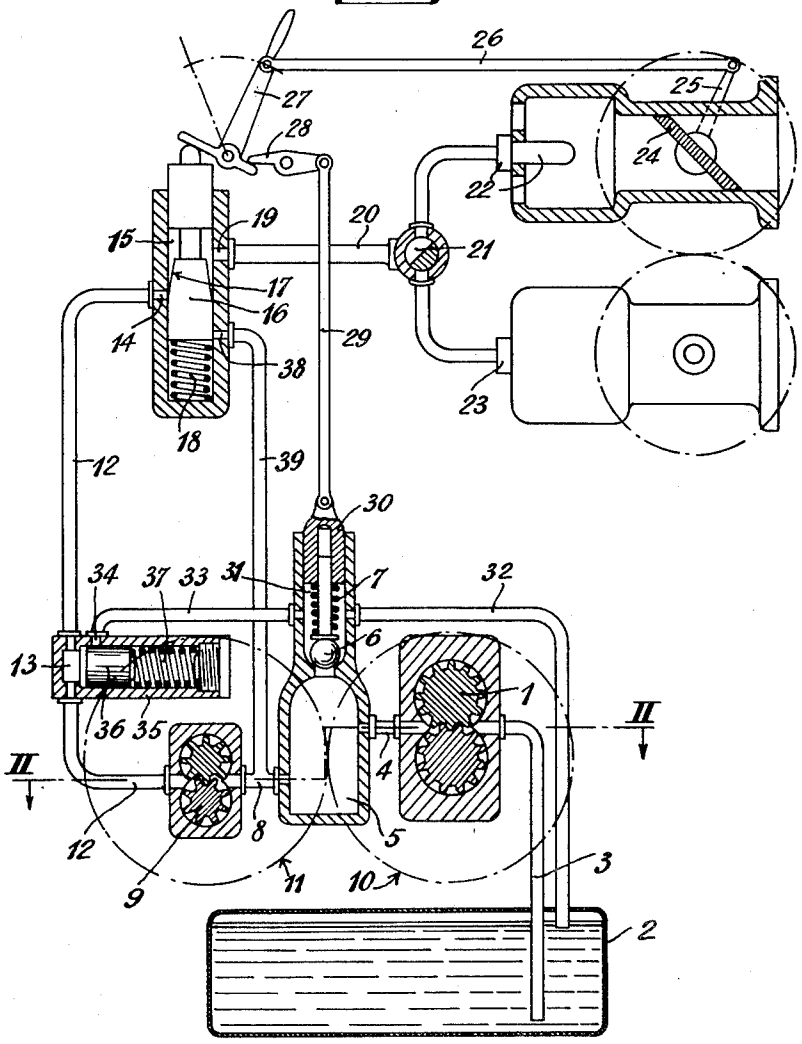
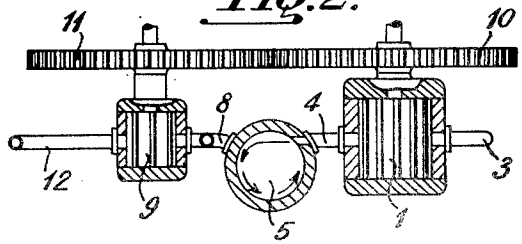


Fig. 2.



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APPARATUS FOR FEEDING LIQUID FUEL TO INTERNAL-COMBUSTION ENGINES

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5 Claims. (Cl. 261—36)

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The present invention relates to an apparatus for feeding liquid fuel to internal combustion engines, and comprises two pumps with continuous delivery, arranged in tandem and both driven at a speed proportional to that of the engine, the first of these pumps delivering fuel with a marked excess over the actual quantity required by the engine and sending it, in part, to the second pump, which regulates the exact delivery for working with the air-throttle open—i. e., with the cylinder's maximum charge of air.

The annexed drawing represents, as an example, one embodiment of the apparatus in accordance with the invention.

Figure 1 is a diagrammatic view in section of the entire apparatus.

Figure 2 is a cross-sectional view on line II—II of Figure 1.

The apparatus represented in the drawing includes a gear-pump 1, which is driven by the engine (not shown) and which draws in the liquid fuel from a reservoir 2 through its suction pipe 3. The discharge pipe 4 of this pump opens into a receptacle 5 forming, as will be seen farther on, a separator. This receptacle 5 is provided, at its upper part, with a port closed by a ball-valve 6, subjected to the action of a spring 7 which constantly urges it to remain in the closed position. The pipe 4 discharges tangentially into the upper region of the receptacle 5, as is seen in the drawing, in such a way that a whirling movement is imparted to the liquid delivered by the pump into the interior of this receptacle, as is indicated by means of arrows in Fig. 2. Communicating with the lower region of the receptacle 5 is a pipe 8, through which the liquid is carried from the receptacle 5 to a second gear-pump 9, which forms, as will be seen farther on, a control pump. This pump 9 is driven simultaneously with the pump 1 by means of gears 10, 11. The discharge pipe 12 of the pump 9 is fitted with a by-pass or release valve 13, connected to return to the reservoir of the liquid delivered by the pump 9 when the discharge pressure of the pump 9 exceeds a certain value.

The pipe 12 carries the liquid from the pump 9 to a port 14 opening into a cylindrical chamber 15 in which a piston 16 having a recessed conical part 17 moves. The port 14 opens opposite this conical part. The piston 16 is subjected to the action of a spring 18 bearing against the closed end of the chamber 15. The interior of this chamber is connected, through an opening 19 and a pipe 20, to a revolving distributor 21 directing the liquid alternately to the injectors 22, 23, situated in the suction pipe of two cylinders (not shown) of the engine which

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is to be fed. The air-throttle corresponding to one of these cylinders is indicated at 24. This air-throttle is coupled, through a lever 25 and a connecting-rod 26, to a regulator hand-lever 27 which regulates the position of the piston 16 inside the chamber 15. Due to the hand-lever 27 and the spring 18, as well as to the connection between this hand-lever and the throttle 24, the piston 16 may be made to cover more or less of the port 14 according to the degree of opening of the air-throttle 24 governing the induction of air to the cylinder.

The hand-lever 27 also acts upon a lever 28, connected to a rod 29 attached at its other end to the end of a piston 30 sliding in a chamber 31 in which the ball 6 and the spring 7 of the valve described above are located. It is against this piston 30 that the spring 7 bears. It should be noted that the force with which the spring 7 acts on the valve 6 varies in accordance with the position occupied by the hand-lever 27. The farther this hand-lever is moved towards the position indicated by the broken lines in the drawing the stronger this pressure is. This chamber 31 is connected with the interior of the reservoir 2 through a return pipe 32; it is also connected, through a pipe 33, with a port 34 in the side wall of a cylinder 35 of the by-pass valve 13. There is a piston 36 inside the cylinder 35, which piston is subjected, on one of its end faces, to the pressure of the liquid in the pipe 12 and, on its other end face, to the action of a spring 37. It normally occupies the position shown in the drawing, in which it closes the communication between the pipe 12 and the port 34. It should be noted, on examining the drawing, that, when the pressure in the pipe 12 rises above a given value corresponding to the setting of the spring 37, the piston 36 moves to the right and uncovers the port 34, and this establishes direct communication between the pipe 12 and the chamber 31—i. e., it puts this pipe 12 in communication with the reservoir 2 through the medium of the pipe 33 and the return pipe 32.

The by-pass valve 13 thus determines the maximum pressure that the fuel can reach. Beyond that pressure, the excess fuel is returned to the reservoir. There is thus, according to the extent to which the port 14 is open, a prescribed velocity of the engine above which the fuel is returned to the reservoir, ensuring at the same time the regulation of the delivery of the proper amount of fuel for the working of the engine with reduced torque.

The pump 1 has a delivery markedly greater than that of the pump 9. Through the influence

of the whirling movement that the liquid takes on when arriving in the receptacle 5 and through the difference in density, the vapors that this liquid contains are freed from it and move to the upper part of the receptacle 5. When the pressure in this receptacle is sufficient to raise the ball-valve 6, these vapors, as well as the excess fuel that the pump 9 cannot absorb, pass into the chamber 31 and from there return to the reservoir through the pipe 32. As the vapors contained in the fuel escape first through the valve 6, their complete separation from the fuel is thus obtained, which is very important, especially when this fuel must be divided between several cylinders, either directly or through a revolving distributor. In fact, in structures of this kind, the presence of vapor in the fuel and which easily accumulates in the form of bubbles, hinders the proper distribution of the liquid between the injectors.

The valve 6 and its spring 7 determine the feed pressure on the suction side of the control pump 9 in such a way that the latter, even if it is not perfectly joint-tight, always gives the quantity of fuel required by the engine, this pump regulating the delivery for operating the engine with the air-throttle 24 fully open.

This is how the first pump co-operates with the second to produce a correction in the feeding of the engine: For so long as the pressure created by the first pump is higher than the one that the second pump must produce for the feeding of the engine, the lack of tightness of this second pump has no effect in the way of a decrease in the delivery, since, on the contrary, a certain excess of fuel may then pass through the second pump. This is important for facilitating the passage from idling to running under load. In fact, as long as the engine is merely idling and the piston 16 induces, by the partial closing of the port 14, a high pressure on the discharge side of the second pump, the delivery from the latter can scarcely be affected by reason of the lack of tightness other than in the way of a decrease. Now, when the engine is merely idling, the sides of the pipe which brings the mixture to the suction valves have a tendency to become dry owing to the partial vacuum existing inside it. For the purpose of accelerating the speed of the engine, as soon as the air-throttle 24 is opened and at the same time as the piston 16 also is brought into the open position, the pressure on the discharge side of the second pump decreases and that which exists on the intake side of the pump determines the despatch through this pump. Because the pump is not joint-tight, it is desirable to supply an excess of fuel which moistens the sides of the suction pipe, thus avoiding the weakening of the mixture and allowing the engine to accelerate promptly.

As soon as the engine is turning more rapidly, a state of higher pressure is established on the discharge side of the second pump, and the excess of delivery due to the lack of tightness disappears, since the pressure on the intake side becomes feebler than that on the discharge side.

As has been seen above, the piston 30 governed by the hand-lever 27 regulates the pressure which keeps the valve 6 on its seat and which depends on the pressure in the pipe 12. The object of this arrangement is to properly divide the work between the two pumps in tandem. Thus, in operating the hand-lever 27, the pressure on the intake side of the control pump is increased at the same time as the pressure on the discharge side of this pump increases, because of the higher number of revolutions, and the requisite division of the work between the two pumps is thus ensured.

Due to the conical part 17 of the piston 16, the width of the passage open to the liquid entering through the port 14 remains practically proportional to the shifting of the piston. In view of the fact that the slope of the cone may be very slight, a very fine adjustment in the passage control of the liquid may be obtained and which can hardly be obtained with the usual taps. The piston 16 uncovers a port 38 when this piston is pushed right home against the spring 18 by moving the hand-lever 27 to the left in the drawing. This port 38 is in communication with a pipe 39 which is directly joined to the pipe 8 connecting the vessel 5 of the separator to the control pump 9. The object of this arrangement is the following: when it is desired to start the engine, especially in cold weather, it is necessary, so as to facilitate this operation, to supply the engine with much excess fuel. To achieve this, due to the arrangement just described, it suffices to bring the hand-lever 27 beyond its normal fully-open position (indicated by the broken lines) so that the conical part 17 of this piston 16 uncovers the port 38. The amount of liquid then required and which the control pump cannot supply is furnished by the first pump by way of the pipe 39.

What I claim is:

1. An apparatus for feeding liquid fuel to an internal combustion engine having a liquid fuel supply pipe and an air conduit provided with a throttle valve comprising two continuous delivery pumps both driven at a rotary speed proportional to the rotary speed of the engine, one of said pumps having a flow capacity much greater than that of the other, a fuel reservoir, a conduit interposed between the reservoir and the pump of greater capacity for the supply of fuel thereto, means connecting said pumps for the flow of fuel from the discharge of the pump of greater capacity to the intake of the other pump, conduit means for the flow of fuel from the discharge of the pump of lower capacity to the liquid fuel supply pipe of the engine, said means connecting said pumps for the flow of fuel from one to the other including a vapor separator, and means for returning to the reservoir the fuel supplied by the pump of greater capacity in excess of that pumped by the pump of lower capacity along with the vapor separated from the fuel in said separator, and a spring loaded valve associated with said vapor separator for opposing the flow of gas and fuel from the separator to the reservoir, means for varying the load on the spring loaded valve, and means operable in synchronism with the throttle valve for actuating the means for varying the load on the spring loaded valve to increase the load on the spring loaded valve as the throttle is opened.

2. An apparatus for feeding liquid fuel to an internal combustion engine having a liquid fuel supply pipe and an air conduit provided with a throttle valve comprising two continuous delivery pumps both driven at a rotary speed proportional to the rotary speed of the engine, one of said pumps having a flow capacity much greater than that of the other, a fuel reservoir, a conduit interposed between the reservoir and the pump of greater capacity for the supply of fuel thereto, means connecting said pumps for the flow of fuel from the discharge of the pump of greater

capacity to the intake of the other pump, conduit means for the flow of fuel from the discharge of the pump of lower capacity to the liquid fuel supply pipe of the engine, and means for returning to the reservoir the fuel supplied by the pump of greater capacity in excess of that pumped by the pump of lower capacity, a control valve interposed between the discharge of the pump of lower capacity and the fuel supply pipe of the engine, said valve having a casing having an inlet port for receiving the discharge from the pump of lower capacity, a second inlet port communicating with the discharge of the pump of larger capacity and a discharge port communicating with said fuel supply pipe, and a valve body in said casing having a portion cooperating with said inlet ports to cover and uncover the same, means for displacing said valve body to first fully uncover said inlet port and upon further movement to uncover said second inlet port.

3. An apparatus for feeding liquid fuel to an internal combustion engine having a liquid fuel supply pipe and an air conduit provided with a throttle valve comprising two continuous delivery pumps both driven at a rotary speed proportional to the rotary speed of the engine, one of said pumps having a flow capacity much greater than that of the other, a fuel reservoir, a conduit interposed between the reservoir and the pump of greater capacity for the supply of fuel thereto, means connecting said pumps for the flow of fuel from the discharge of the pump of greater capacity to the intake of the other pump, conduit means for the flow of fuel from the discharge of the pump of lower capacity to the liquid fuel supply pipe of the engine, said means connecting said pumps for the flow of fuel from one to the other including a vapor separator, and means for returning to the reservoir the fuel supplied by the pump of greater capacity in excess of that pumped by the pump of lower capacity along with the vapor separated from the fuel in said separator and a spring loaded valve associated with said vapor separator for opposing the flow of vapor and fuel from the separator to the reservoir, a control valve interposed between the discharge of the pump of lower capacity and the fuel supply pipe of the engine, said valve having a casing having an inlet port for receiving the discharge from the pump of lower capacity, a second inlet port communicating with the discharge of the pump of larger capacity and a discharge port communicating with said fuel supply pipe, and means in said casing operable to first fully uncover said inlet port and upon further movement to uncover said second inlet port, means for varying the load on the spring loaded valve, and means operable in synchronism with the throttle valve for actuating the means for varying the load on the spring loaded valve to increase the load on the valve as the throttle is opened and for actuating the control valve to uncover the second inlet port upon full opening of the throttle valve and upon maximum loading of the spring loaded valve.

4. An apparatus for feeding liquid fuel to an internal combustion engine having a liquid fuel supply pipe and an air conduit provided with a throttle valve for the formation of a combustible mixture, comprising two gear pumps both driven at a rotary speed proportional to the rotary speed of the engine, one of the said pumps having a flow capacity much greater than that of the other and the pump of lower capacity having a flow capacity corresponding approximately to the fuel consumption of the engine at full load, a fuel reservoir, a conduit interposed between the reservoir and the pump of greater capacity for the supply of fuel thereto, means connecting said pump of greater capacity to the pump of lower capacity, means for regulating the pressure in said means connecting the pumps to ensure a full delivery of the pump of lower capacity, means for the flow of fuel from the discharge of the pump of lower capacity to the liquid fuel supply pipe of the engine for the formation of the combustible mixture, and means for returning to the reservoir the fuel supplied by the pump of greater capacity in excess of that pumped by the pump of lower capacity, said means for regulating the pressure including a chamber and a spring loaded valve associated with said chamber for opposing the flow of fuel from the chamber to the reservoir.

5. An apparatus for feeding liquid fuel to an internal combustion engine having a liquid fuel supply pipe and an air conduit provided with a throttle valve for the formation of a combustible mixture, comprising two gear pumps both driven at a rotary speed proportional to the rotary speed of the engine, one of the said pumps having a flow capacity much greater than that of the other and the pump of lower capacity having a flow capacity corresponding approximately to the fuel consumption of the engine at full load, a fuel reservoir, a conduit interposed between the reservoir and the pump of greater capacity for the supply of fuel thereto, means connecting said pump of greater capacity to the pump of lower capacity, means for regulating the pressure in said means connecting the pumps to ensure a full delivery of the pump of lower capacity, means for the flow of fuel from the discharge of the pump of lower capacity to the liquid fuel supply pipe of the engine for the formation of the combustible mixture, and means for returning to the reservoir the fuel supplied by the pump of greater capacity in excess of that pumped by the pump of lower capacity, said means for regulating the pressure including a chamber and a spring loaded valve associated with said chamber for opposing the flow of fuel from the chamber to the reservoir, means for varying the load on the spring loaded valve, means operable in synchronism with the throttle valve for actuating the means for varying the load on the spring loaded valve to increase the load of the spring loaded valve as the throttle is opened, said means for the flow of fuel from the discharge of the pump of lower capacity to the liquid fuel supply pipe of the motor including a valve, means operable in synchronism with the throttle valve to increase the opening of said valve as the throttle is opened, and a loaded discharge valve between the pump of lower capacity and said valve.

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