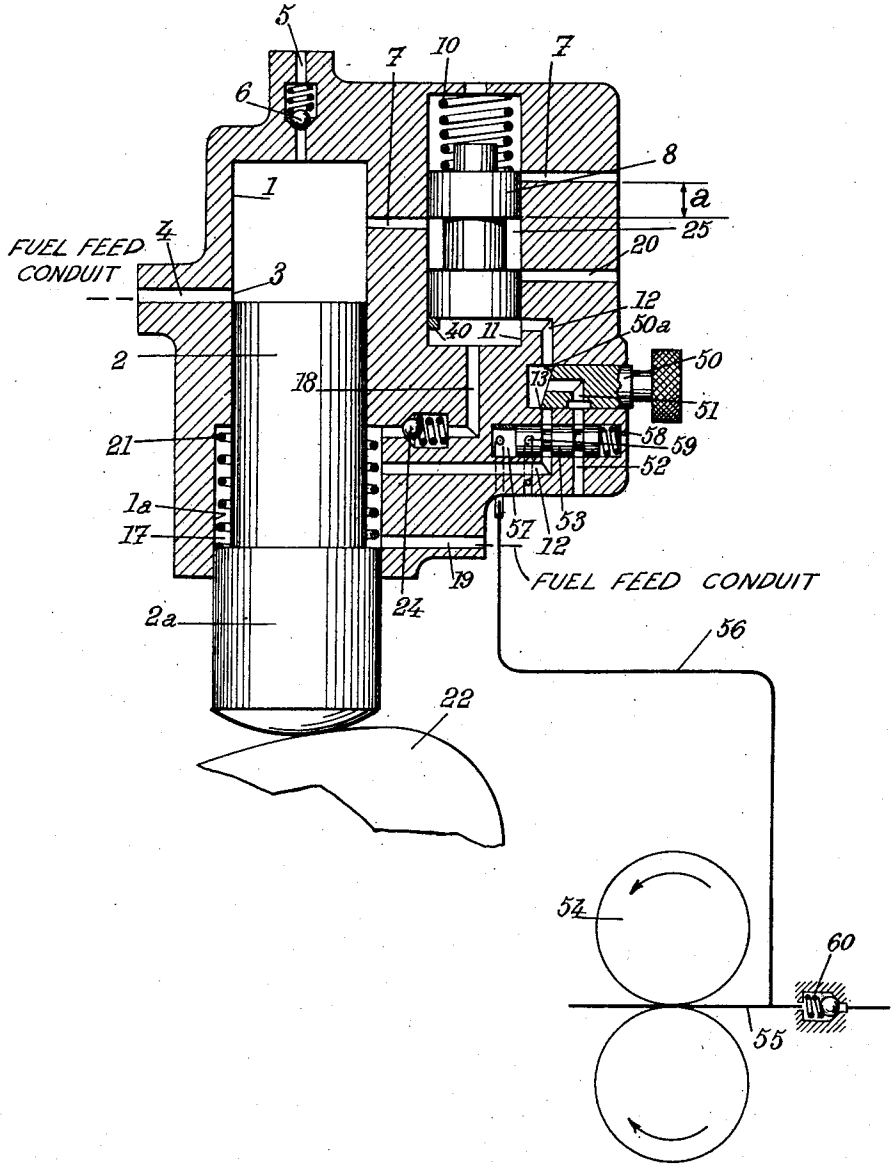
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RECIPROCATING ACTION PUMPS FOR THE INJECTION OF FUEL INTO INTERNAL COMBUSTION ENGINES

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RECIPROCATING ACTION PUMPS FOR THE INJECTION OF FUEL INTO INTERNAL COMBUSTION ENGINES

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The present invention relates to reciprocating action pumps for the injection of fuel into internal combustion engines, said pumps being of the kind where automatic regulation of the output is ensured by a part, called "shuttle member," having its outward movements produced by impulses, and in particular hydraulic impulses, the frequency of which is proportional to the speed of the internal combustion engine, whereas the return movements of said shuttle member, produced by a return spring, are braked by a throttling provided in the conduit through which must flow a liquid brought in movement by the shuttle member during its return movements.

The object of this invention is to stop any delivery of the pump when the internal combustion engine fed with liquid by said pump starts running in a direction opposed to that in which it must normally run.

The invention consists chiefly in providing in said conduit a valve member which is brought, against the action of a return spring, into a position where it closes said outflow conduit, by a hydraulic impulse produced by a pump driven by the internal combustion engine when the latter starts running in a direction opposed to that in which it must normally run.

A preferred embodiment of the present invention will be hereinafter described with reference to the accompanying drawing, given merely by way of example and in which:

The only figure of the drawing diagrammatically shows in axial section the main elements of a fuel injection pump made according to the invention and combined with an auxiliary gear pump driven by the engine fed with fuel by the fuel injection pump.

The fuel injection pump includes a main cylinder 1 in which is slidably fitted a main piston 2 driven by the internal combustion engine (not shown) through a cam 22. This piston controls a port 3 through which the fuel feed conduit 4 opens into cylinder 1. This conduit 4 is fed from a pump (not shown) which constitutes what is called a "transfer pump." Cylinder 1 communicates with a delivery conduit 5 leading toward the injector or injectors of the engine, a check-valve 6 being mounted in said delivery conduit 5.

In order to obtain an automatic regulation of the delivery flow rate of the pump, that is to say of the amount of fuel which flows through conduit 5 on every cycle of the pump, as a function of the speed, and for speeds exceeding a given limit, I provide cylinder 1 with a discharge conduit 7 controlled by a shuttle member 8. This shuttle member 8 is driven through hydraulic means in one direction (outward strokes, that is to say upward strokes on the drawing), said shuttle member, at the end of said upward strokes, connecting together the two portions of conduit 7 between which it is inserted, said upward strokes of shuttle member 8 taking place during the delivery strokes of the main piston 2 (that is to say during the upward strokes in the embodiments shown by the drawing). Shuttle member 8 is returned in the opposed direction (return stroke), during every suction stroke of piston 2, by a return device against the action of a braking system which will be hereinafter disclosed. The return device is preferably constituted by a spring 10.

The hydraulic means for producing the upward strokes

of the shuttle member are constituted in such manner as to subject said shuttle member to the action of a liquid, preferably of the same nature as the fuel to be injected, delivered by an auxiliary reciprocating pump driven in synchronism with the main pump. Advantageously, as shown by the drawing, this auxiliary pump is constituted by providing the main piston 2, on the side opposed to the working face of the cylinder 1, with an extension 2*a* of larger diameter which is slidably mounted in a cylindrical bore 1*a* of corresponding diameter. The annular space 17 formed between said bore 1*a* and piston 2 is connected through a conduit 18, provided with a check-valve 24, with a cylinder 11 in which shuttle member 8 is slidably mounted. Furthermore, said annular space 17 is connected through a feed conduit 19 to a feed chamber or to a transfer pump such as above mentioned. In space 17 there is housed a spring 21 which keeps piston 2, 2*a* applied against cam 22. Auxiliary cylinder 11 is provided with a discharge conduit 20 located at such a level that it is closed, at least partly, by shuttle 8 during the same time as discharge conduit 7 is itself closed by the shuttle member, said discharge conduit 20 being wholly opened at the earliest at the time when the discharge conduit 7 is itself wholly open.

The braking system above referred to is constituted by a conduit 12 provided with a throttle passage 13 through which the shuttle member forces back liquid during the return strokes of said shuttle member.

As soon as shuttle member 8 has moved a distance *a* in the upward direction under the action of the liquid delivered by piston 2*a* into auxiliary cylinder 11, it connects, through annular groove 25, the two portions of the discharge conduit 7, which stops the delivery of fuel by piston 2 into delivery conduit 5.

When piston 2, 2*a* starts moving back in the downward direction, shutle member 8, under the action of a return spring 10, also starts moving moving down in its cylinder 11 but this return movement is braked by the fact that said shuttle member must force the liquid present in the lower part of cylinder 11, through conduit 12 and past the throttled portion 13 thereof, back into cylinder 1*a*.

When the internal combustion engine and therefore also piston 2, 2*a* reach a given speed, shuttle member 8, due to said braking action, is no longer capable of reaching its lowermost position, where it is applied against an abutment 40, before piston 2, 2*a* starts back moving upwardly. Thus, the return stroke of the shuttle member is shortened and the opening of discharge conduit 7 takes place for delivery strokes of piston 2, 2*a* which are the shorter as the speed increases more and more. I thus obtain a corresponding reduction in the delivery flow rate of the pump.

In order to be able to adjust the cross-section area of the throttled portion 13 of conduit 12, the pump is provided with an adjustment member 50 adapted to rotate about its axis and having an oblique end face 50*a*. When this member 50 is rotated about its axis, the cross-section area of the throttled portion 13 of conduit 12 is varied. Furthermore, this member 50 is provided with a discharge conduit 51 extending therethrough and which, for the position of member 50 where the cross-section area of throttled passage 13 is minimum (and may be equal to zero), is placed in communication with a discharge conduit 52, thus permitting shuttle 8 to remain, during the delivery strokes of piston 2, 2*a*, in its lowermost position, so that an increased delivery flow rate of the pump is obtained, which may be useful when the internal combustion engine is being started.

It should be noted that the rotation of member 50 about its axis is, for instance, produced by the operator in charge of the engine fed by the injection pump. The minimum values of the cross-section area of the throttled passage

13 correspond to low speeds of the internal combustion engine, whereas the maximum values correspond to high speeds of this engine.

In order to stop any delivery from the fuel pump when the internal combustion engine starts running in a direction opposed to that in which it should normally run, which may in particular happen when said engine is started with an excessive lead to ignition, shuttle member 8 is to be blocked into its uppermost position where it keeps discharge conduit 7 permanently open. This result is obtained by means of a slide valve 53 which is then brought into a position where it wholly closes conduit 12, such a movement of valve 53 being produced by a hydraulic impulse supplied by a pump driven by the internal combustion engine when said engine starts running in the direction opposed to that in which it should normally run.

Of course, when there is provided, on conduit 12, a by-pass conduit 51, 52 intended to be opened just when the internal combustion engine is being started, valve member 53, in its closing position, must close not only the branch of conduit 12 through which liquid is returned from cylinder 11 to cylinder 1*a*, but also said by-pass conduit 51, 52.

Advantageously, the pump which supplies the hydraulic impulse intended to actuate valve 53 is a gear pump 54 the intake pipe 55 of which is connected, through a conduit 56, with a cylinder 57 in which the end of valve 53 is slidably mounted. As long as pump 54 runs in the normal direction indicated by the arrows it does not produce a hydraulic impulse in cylinder 57 so that a spring 58 acts upon valve 53 to keep it in the position where the grooves provided therein keep conduit 12 and conduit 52 open. On the contrary, as soon as the internal combustion engine starts running in the wrong direction and therefore causes pump 54 also to run in the direction opposed to that in which it should normally run, this pump 54 sends a hydraulic impulse into cylinder 57, which causes valve 53 to move toward the right and therefore to close conduit 12 and conduit 52. Shuttle member 8 is thus prevented, after it has been once moved, as a consequence of the delivery stroke of piston 2, 2*a*, into its uppermost position where it opens discharge conduit 7, from returning toward its lowermost position. Valve 53, when it has been brought into the position where it closes conduits 12 and 52, opens a discharge orifice 59 through which the liquid fed from the conduit 56 can escape from chamber 57.

In order to enable auxiliary pump 54 to feed liquid through conduit 56 with a sufficient pressure, when the direction of rotation of pump 54 is reversed, I provide in intake conduit 55, upstream of the point where the conduit 56 branches off therefrom, a check-valve 60 which opens in the direction toward pump 54.

Gear pump 54 may be for instance the transfer pump above referred to and which has its output connected with conduits 4 and 19. According to a preferred embodiment of the present invention, this pump 54 belongs to a hydraulic speed governor.

In the embodiment which has just been described, the shuttle member keeps in the open state a discharge conduit 7 connected with the cylinder 1 of the pump (said discharge conduit might also be connected with delivery conduit 5) and thus prevents any flow of fuel toward the injector or injectors as soon as the internal combustion engine starts running in a direction opposed to that in which it should run.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. For use with an internal combustion engine, a reciprocating action fuel pump which comprises, in combination, a pump cylinder, a piston adapted to cooperate with said cylinder mounted for reciprocating movement therein, so as to limit therewith a variable volume working space, the movements of said piston in said cylinder in the direction for which the volume of said working space is reduced being called delivery strokes, a casing rigid with said cylinder, a shuttle member fitting movably in said casing so as to limit with the inner wall thereof a variable volume chamber, means for constantly keeping said chamber filled with liquid, the movements of said shuttle member in said casing in the direction for which the volume of said chamber is increased being called outward strokes and the movements of said shuttle member in the opposed direction being called return strokes, means operative by said piston for producing outward strokes of said shuttle member in synchronism with the delivery strokes of said piston, resilient means interposed between said casing and said shuttle member for urging said shuttle member in the direction to produce the return strokes of said shuttle member, a fuel delivery conduit leading to the internal combustion engine to be fed by the pump, a fuel circulation circuit including said working space of said cylinder and leading to said delivery conduit, said casing being connected with said fuel circulation circuit so that said shuttle member controls, in accordance with the amplitude of its reciprocating movement in said casing, the amount of fuel fed to said delivery conduit on every delivery stroke of said piston, a conduit starting from said variable volume chamber for the outflow of liquid therefrom during the return strokes of said shuttle member, means in said liquid outflow conduit for throttling a portion thereof to slow down said liquid outflow and thus to exert on said shuttle member, during its return strokes, a braking action such that, for speeds of operation of the pump above a given value, said shuttle member return strokes are the shorter as the speed of operation of the pump is higher, a hydraulically controlled valve mounted in said liquid outflow conduit for controlling the flow of liquid therethrough, resilient means operatively engaging said valve for urging said valve toward conduit opening position, hydraulic means for moving said valve into conduit closing position in response to a hydraulic impulse transmitted to said hydraulic means and pumping means driven by the internal combustion engine to be fed by the pump, said pumping means being arranged to send a hydraulic impulse to said valve when said internal combustion engine starts running in the direction opposed to that in which it is to run normally.

2. A pump according to claim 1 further including a by-pass conduit leading out from said variable volume chamber of said casing, means for adjusting the cross-section area of said outflow conduit throttled portion, said adjusting means being capable of controlling said by-pass conduit so as normally to keep it closed and to open it only when said throttle portion cross-section area is minimum, said hydraulically controlled valve being mounted to close said bypass conduit at the same time as it closes said liquid outflow conduit.

3. A pump according to claim 1 comprising means forming a cylindrical housing closed at one end and fixed with respect to said liquid outflow conduit, said hydraulically controlled valve being a slide valve fitting slidably in said housing, said closed end of said housing and the corresponding end of said slide valve limiting between them a variable volume space, said pumping means consisting of a continuous rotation auxiliary pump having a pipe which constitutes its intake pipe when said auxiliary pump is driven by said internal combustion engine running in its normal direction, conduit means for connecting said pipe with said variable volume space and a check-valve in said pipe opening toward said auxiliary

pump and located in the portion of said pipe, acting as intake pipe, upstream of the point where said conduit means branch off therefrom, whereby, in case of said engine running in the reverse direction, said auxiliary pump is reversed and then sends a hydraulic impulse through said conduit means to said variable volume space of said housing.

4. A pump according to claim 3 in which said housing is provided, in the wall thereof cleared by said slide valve when it is in the outflow conduit closing position, with a discharge orifice for the liquid delivered by said auxiliary pump.

No references cited.