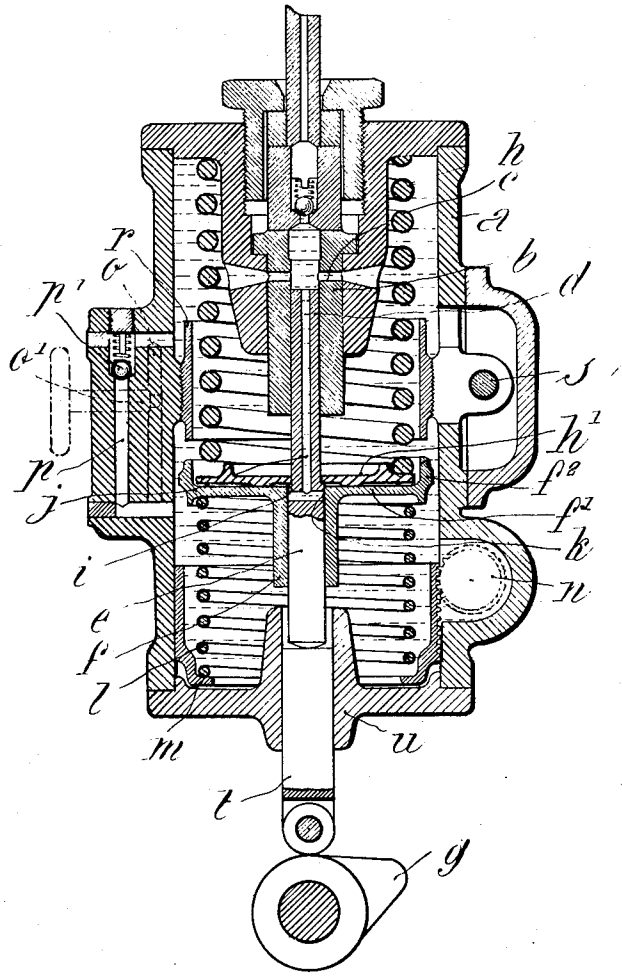
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RECIPROCATING PUMP

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RECIPROCATING PUMP

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The present invention relates to devices for regulating the rate of flow of reciprocating pumps in accordance with the velocity of their moving organs, and more especially in the case of fuel pumps for internal combustion engines. More specifically, the present invention relates to improvements in pumps of the general type disclosed in my Patent No. 1,939,603, granted December 12, 1933.

The chief object of the present invention is to provide a regulating device of the type above referred to which is better adapted to meet the requirements of actual practice than devices of the same kind used up to the present time.

According to my invention, the regulating device comprises a member movably mounted with respect to the piston or equivalent reciprocating organ of the pump and caused to move in unison with said piston, for low velocities thereof, by suitable elastic means, said member being immersed in a liquid so that, under the braking action of said liquid, it lags behind the piston at higher speeds, thus opening a pressure relief outlet for the fluid of the pump, whereby the effective delivery stroke of the pump is the shorter as its speed is higher.

Other features of my invention will result from the following detailed description thereof.

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 is a vertical axial sectional view of a fuel pump for an internal combustion engine made according to the present invention.

As shown in the drawing, this pump comprises a casing *a* forming for instance a fluidtight chamber connected with the fuel feed and adapted to enclose the whole of the mechanism that will be hereinafter described. In this casing is mounted, for instance vertically, a pump barrel *b*, which may be of any known type, arranged in such manner that the delivery of the fuel is produced by the upward stroke of the piston. This pump barrel is provided at a suitable level with at least one inlet port *c* opening into said chamber and adapted to be closed by the piston at the beginning of the upward stroke thereof, for the delivery of the fuel.

I provide a piston *d* arranged to coact with said pump barrel, the active face of said piston being of any suitable shape, for instance plane as shown in the drawing.

Said piston *d* is provided, at its end opposed to said active face, with a prolonged part *e*, for instance cylindrical and coaxial with the pump barrel, said prolonged part being so arranged and positioned that, when the piston reciprocates in the pump barrel, the prolonged part *e* always remains outside of said pump barrel.

I provide a sleeve *f* adapted to engage on said prolonged part *e*, said sleeve being advantageously bored so as to fit in a snug manner on said prolonged part *e*, with a fluidtight fit.

Piston *d* is provided with means for pushing it toward its operating or driving organ (cam *g* in the example shown in the drawing). These means consist for instance, as illustrated, of a mere spiral spring *h* bearing at its upper end against the top of casing *a* and at its lower end against a disc h^1 carried by piston *d*. As shown in the drawing, this disc h^1 bears against a shoulder *i* provided on piston *d* close to the prolonged part *e* thereof.

Piston *d* is provided with a conduit *j* opening at one end into the active face of said piston and connected at the other end with a port *k* opening into the wall of prolonged part *e* so as to coact with sleeve *f*. It will be hereinafter explained how the position of this port is determined.

I provide, according to my invention, a member tending to move in unison with the pump piston. The surface of this member and its connection with said sleeve must be such that, under the effect of the hydraulic braking to which it is subjected by the fuel that fills casing *a* and in which, accordingly, said member is immersed, there takes place, as soon as the velocity that tends to be imparted to it for a given period of the cycle exceeds a certain value, a relative displacement of sleeve *f* and of the prolonged part *e* of the piston which uncovers port *k* and therefore opens a relief outlet, whereby the delivery is stopped earlier as the velocity of the piston is higher.

According to the nature of the movement imparted to the piston *d* of the pump, the portion of the cycle for which the velocity imparted to the mass that is utilized acts for adjusting the rate of delivery may be chosen to correspond either with the upward stroke of the piston (delivery stroke) or to its downward stroke (suction stroke). As a matter of fact, theoretically, it is advantageous, in order to obtain a better regulation, to choose the period for which the velocities of the piston are highest. Now, in most of the mechanisms of this type, the velocities of the piston as it is moving upwardly are sufficient for obtaining a good regulation. However it may occur in some cases that the velocities of the piston in the course of its upward stroke are insufficient so that it is

necessary to utilize for the regulation the periods for which the piston is moving downwardly.

It will be assumed, first, that the regulating device is to act under the influence of the velocities of the piston in the course of its upward stroke, either because the pump is actuated through a rotary cam the outline of which can be determined at will, or because it is actuated by an oscillating cam the movement of which in the direction corresponding to the delivery of the pump is sufficiently rapid.

In this case according to the embodiment shown in the drawing, sleeve f is provided with a radially extending surface f^1 which is preferably rigidly connected to said sleeve.

Surface f^1 is for instance given the shape of a disc of a diameter greater than that of disc h^1 and it is so positioned on sleeve f that when said sleeve is in its upper position surface f^1 is in contact with disc h^1.

Advantageously, disc f^1 is provided with a cylindrical flange f^2 capable of engaging with a certain play on disc h^1. These discs f^1 and h^1 are so arranged that when they are pushed, even suddenly, toward each other, the liquid interposed between them acts as a hydraulic shock-absorber.

The walls of the casing in which surface f^1 is moving are given a shape such that there remains, between said surface (that is to say its flange f^2) and said walls, a passage of suitable cross section, either constant or variable in accordance with the position of sleeve f.

According to my invention, sleeve f is subjected to the action of elastic means tending to maintain it applied against a stop (consisting for instance of disc h^1 itself in the example shown in the drawing) disposed, with respect to said sleeve f on the same side as the head of piston d. In the embodiment shown in the drawing, these elastic means consist of a mere spiral spring l bearing at its lower end against the bottom of casing a and at its upper end against surface f^1.

Advantageously, this spring l does not bear directly on the bottom of casing a. For instance, as shown in the drawing, I provide a support m capable of being moved either upwardly or downwardly with respect to said casing so as to make it possible to adjust the action of spring l.

This support m is given the form of a piston capable of sliding vertically in the casing and the vertical displacements of this support m are controlled by means of a pinion n the spindle of which extends through the wall of the casing and which meshes with a rack provided in the outer wall of piston m. Of course, the spindle of pinion n carries an operating lever capable of being fixed in as many positions as it is desired.

Advantageously, I provide my device with means for adjusting the section of flow afforded to the liquid between the upper chamber, located above surface f^1, and the lower chamber located under said surface. These means may consist of a device for varying the space existing between edge f^2 and the walls of the casing. However, advantageously, as shown in the drawing, these means consist of a by-pass O which can be more or less stopped by a needle valve O^1 adjustable from the outside.

Preferably I provide between these upper and lower chambers of casing a a device for facilitating the flow of the liquid from the lower to the upper chamber (when surface f^1 is moving downwardly). In the embodiment shown in the drawing, the device in question includes a by-pass p provided with a check valve p^1 preventing or slowing down the flow of liquid from the upper toward the lower chamber of casing a. This by-pass p might of course be combined with by-pass O, for instance by replacing needle valve O^1 by means for preventing to a variable degree the full closing of valve p^1.

The position of port k is determined in the following manner:

The compression of spring l, the area of surface f^1 and the different sections of flow afforded to the liquid for passing from one chamber of casing a into the other having been suitably chosen, if it be supposed that the pump is working in connection with an engine running at a very low speed of revolution as compared to its maximum speed of revolution (for instance half this speed), the liquid will be capable of flowing without great resistance from the upper chamber to the lower chamber of the casing and sleeve f will remain constantly applied against its stop on piston d (disc h^1).

If now, the speed of revolution of the engine progressively increases, the instantaneous velocities of piston d at different times of the delivery stroke will correspondingly increase and a time will come when, in the course of the upward stroke of the piston, the hydraulic braking exerted on surface f^1 will cause sleeve f to move away from its shoulder i, coming back into contact with it only at the end of the upstroke or even in the course of the downstroke, the relative displacement of discs h^1 and f^1 increasing as the speed of revolution of the engine increases.

Starting from these considerations, it will be easy to determine, even experimentally, the position of port k on the prolonged part e of the piston in order that, when the engine tends to race, this port may be uncovered sufficiently early by the wall of sleeve f for permitting the outlet of the fuel from the pump chamber through said port, whereby the delivery of the pump is stopped a certain time before the normal end of the upstroke of the piston, thus slowing down the engine due to the decrease of the rate of feed.

Of course, the end of the delivery stroke of the pump, which corresponds to the opening of port k, will take place later as spring l is more compressed and by-pass O is more fully opened by needle valve O^1. Consequently, owing to the device permitting adjustment of the position of support m in a vertical direction, and also of needle valve O^1, it is possible to vary the maximum speed of the engine.

Furthermore, I advantageously provide a stop capable of limiting, at the end of the upward stroke of the piston, the upward displacement of sleeve f, so that after sleeve f has been stopped in this position, piston d keeps moving upwardly until it reaches the end of its stroke, thus causing port k to be uncovered, which fixes an absolute maximum of the fuel feed rate.

In the embodiment shown in the drawing, this stopping device consists of a cylindrical element r fixed to casing a on the inside thereof so that its lower edge is located across the vertical path of a point of surface f^1 (for instance a point of flange f^2), thus stopping said surface f^1 at the desired time.

Of course this stop r may be made adjustable in position so as to permit of varying the limit working conditions of the engine. Stop r may for instance be mounted as support m above re-

ferred to. Or, as shown in the drawing, element *r* may be screwed in the frame of the device, said element being locked in the desired position for instance by tightening the frame by means of a bolt *s* at the level of the portion of the frame in which element *r* is secured.

Advantageously, the lower chamber of casing *a* is closed by a push-piece *t* slidable with a fluid-tight fit in a guide *u*, said push-piece being for instance directly acted upon by cam *g*.

If it be supposed, now, that the adjusting device according to the present invention should work under the effect of the accelerations obtained when the piston is moving in a downward direction, I may utilize, for interposition between surface f^1 and sleeve *f*, a system such that, in the course of the downward stroke of the piston, surface f^1 is given a certain relative displacement with respect to sleeve *f*, said displacement depending on the velocity of the piston, and that, in the course of the upward stroke of the piston, this displacement is at least partly maintained, whereby, when surface f^1 comes into contact with the corresponding stop, sleeve *f* uncovers ports *k*, at a time depending on the importance of this relative displacement.

In both of the cases above considered, it is of advantage to provide a conduit connecting directly the chamber located above surface f^1 with the inlet ports *c*. With such an arrangement, during the downstroke of the pump piston, the pump will be fed under pressure, due to the temporary increase of pressure due to the downward displacement of surface f^1.

The device according to the present invention and an embodiment of which has been above described with reference to the accompanying drawing is both simpler and stronger than those used for the same purpose up to this time.

It will be readily understood that such a device which works under the effect of a hydraulic braking is but little perturbed by the friction existing between sleeve *f* and the prolonged part *e* of the pump piston.

In the case of a multicylinder engine, the differences existing, due to this friction, between the different pumps shall have a negligible influence on the working of the cylinders, and it will be possible to adjust these cylinders by displacing simultaneously, either manually or by means of a centrifugal governor, the respective needle valves O^1 of the pumps.

Of course, the device above described could be used in connection with pumps of other types than that illustrated in the drawing, such as capsule pumps or deformable membrane pumps.

As for surface f^1 it is not necessarily mounted on a prolonged part of the piston but it might be mounted on any other organ operatively connected with said piston, such an oscillating rod pivoted to a fixed point of the frame and slidably and pivotally connected to the rod of piston *d*.

Of course the pump might be driven by any other mechanism than a cam.

The rate of flow of the pump might be regulated in accordance with the velocity of any organ distinct from the piston but operatively connected therewith.

Generally speaking, while I have in the above description disclosed what I deem to be a practical and efficient embodiment 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 my invention as comprehended within the scope of the invention.

What I claim is:

1. In a reciprocating pump, a displacement chamber, a pumping element reciprocating therein, a member for actuating said pumping element, inlet and outlet ducts associated with the displacement chamber, and means for reducing the effective displacement of said pumping element at high rates of reciprocation, said means comprising a relief passage in said pumping element in communication with the displacement chamber, a chamber containing a liquid, and a member for opening said relief passage at high rates of reciprocation, said member being always submerged in the liquid of said chamber and yieldably reciprocable in unison with said pumping element and operative, when substantially unimpeded in said movement, to maintain said relief passage closed, said member being transversely disposed within said chamber, the transverse cross sectional area of said member being sufficiently large so that the member will be damped by the fluid in the chamber against unimpeded movement in unison with said pumping element when the latter is reciprocated at speeds in excess of a predetermined rate, whereby relative motion occurs between said member and the pumping element and results in opening said relief passage.

2. In a reciprocating pump, a displacement chamber, a pumping element reciprocating therein, a member for actuating said pumping element, inlet and outlet ducts associated with the displacement chamber, and means for reducing the effective displacement of said pumping element at high rates of reciprocation, said means comprising a relief passage in said pumping element in communication with the displacement chamber, a chamber containing a liquid, and a member for opening said relief passage at high rates of reciprocation, said member being always submerged in the liquid of said chamber and yieldably reciprocable in unison with said pumping element and operative, when substantially unimpeded in said movement, to maintain said relief passage closed, said member being transversely disposed within said chamber, the transverse cross sectional area of said member being sufficiently large so that the member will be damped by the fluid in the chamber against unimpeded movement in unison with said pumping element when the latter is reciprocated at speeds in excess of a predetermined rate, whereby relative motion occurs between said member and the pumping element and results in opening said relief passage, and means consisting of a valved duct for by-passing liquid from one side of said transverse member to the other and reducing the damping effect thereon during the intake cycle.

3. In a reciprocating pump, a displacement chamber, a pumping element reciprocating therein, a member for actuating said pumping element, inlet and outlet ducts associated with the displacement chamber, and means for reducing the effective displacement of said pumping element at high rates of reciprocation, said means comprising a relief passage in said pumping element in communication with the displacement chamber, a closed chamber substantially filled with liquid, and a member for opening said relief passage at high rates of reciprocation, said member being yieldably reciprocable in unison with

said pumping element and operative, when substantially unimpeded in said movement, to maintain said relief passage closed, said member being transversely disposed within said chamber, the transverse cross sectional area of said member being sufficiently large so that the member will be damped by the fluid in the chamber against unimpeded movement in unison with said pumping element when the latter is reciprocated at speeds in excess of a predetermined rate, whereby relative motion occurs between said member and the pumping element and results in opening said relief passage, means consisting of a valved duct for by-passing liquid from one side of said transverse member to the other and reducing the damping effect thereon during the intake cycle, and means for manually varying the damping effect of the fluid within said chamber to vary the effectiveness of said relief passage, said means comprising a manually adjustable valve controlling a duct for by-passing liquid from either side to the other side of said transverse member.

4. In a reciprocating pump, a displacement chamber, a pumping element reciprocating therein, an extension on said pumping element, said extension having a relief passage therein in connection with the displacement chamber, inlet and outlet ducts associated with the displacement chamber, and means for reducing the effective displacement of said pumping element at high rates of reciprocation, said means including said relief passage, a chamber containing a liquid, and means for opening said relief passage at high rates of reciprocation, said last named means consisting of a member disposed transversely within the chamber and slidably mounted on said extension to control said passage, a stop on the pumping element, a spring for restraining movement of said member in one direction and for urging said member against said stop, said member being always submerged in the liquid of said chamber and reciprocable in unison with said pumping element and operative when substantially unimpeded in movement in the other direction by the liquid in the chamber to maintain said relief passage in closed position, the transverse cross sectional area of said member being sufficiently large so that the member will be damped by fluid pressure against unimpeded movement in unison with said pumping element when the latter is reciprocated at speeds in excess of a predetermined rate, whereby relative motion occurs between said member and said pumping element and results in opening said relief passage.

5. In a reciprocating pump as defined in claim 4, means for regulating the tension of said spring.

6. In a reciprocating pump, a displacement chamber, a pumping element reciprocating therein, an extension on said pumping element, said extension having a relief passage therein in connection with the displacement chamber, inlet and outlet ducts associated with the displacement chamber, and means for reducing the effective displacement of said pumping element at high rates of reciprocation, said means including said relief passage, a chamber containing a liquid, and means for opening said relief passage at high rates of reciprocation, said last named means consisting of a member disposed transversely within the chamber and slidably mounted on said extension to control said passage, a stop on the pumping element, a spring for restraining movement of said member in one direction and for urging said member against said stop, said member being always submerged in the liquid of said chamber and reciprocable in unison with said pumping element and operative when substantially unimpeded in movement in the other direction by the liquid in the chamber to maintain said relief passage in closed position, the transverse cross sectional area of said member being sufficiently large so that the member will be damped by fluid pressure against unimpeded movement in unison with said pumping element when the latter is reciprocated at speeds in excess of a predetermined rate, whereby relative motion occurs between said member and said pumping element and results in opening said relief passage, and an abutment member within said chamber for limiting the maximum movement of said member in said other direction to limit the absolute maximum quantity of liquid supplied.

7. In a reciprocating pump as defined in claim 6, means for regulating the position of said abutment member.

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