

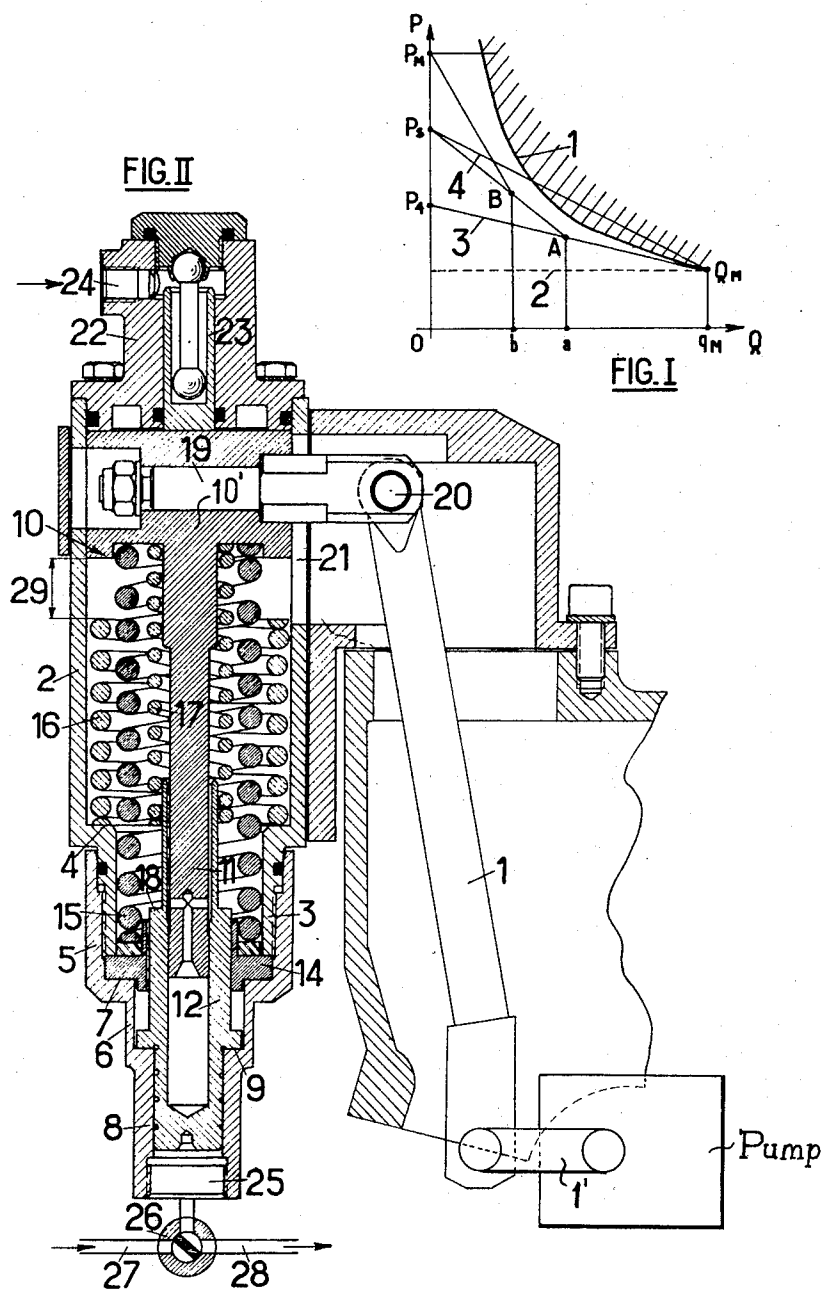
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SELF-REGULATION DEVICE FOR VARIABLE DISCHARGE PUMPS

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3,254,604 SELF-REGULATION DEVICE FOR VARIABLE DISCHARGE PUMPS

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This invention relates to the self-regulation of variable discharge pumps, that is to say pumps the cylinder capacity and consequently the delivery per revolution of which can be varied. The object of self-regulation devices is either to vary the cylinder capacity automatically in inverse proportion to the pressure in the load circuit or to maintain the said pressure constant.

The device according to the invention belongs to the first of these two types and it has the following objects:

(a) to keep substantially constant the torque to be supplied for driving the pump, thus making it possible to utilise an electric motor of substantially constant power and speed;

(b) to make it possible to obtain either the maximum delivery or the maximum pressure compatible with the mechanical characteristics of the pump;

(c) to permit operation without a hydraulic accumulator in the load circuit and to permit operation with a very low time constant;

(d) to permit two different types of operation: firstly, normal self-regulated operation not exceeding a moderate pressure imparting great endurance to the pump, and on the other hand exceptional operation at high pressure or even at maximum pressure, without however exceeding the nominal power of the driving motor, this nominal power having been determined for the normal self-regulated operation.

The objects of the invention will be better understood by reference to the accompanying FIGURE 1, which shows the diagram of the pressure P plotted against the delivery Q per cylinder volume. The pressures are shown as the ordinates and the cylinder volumes as abscissae.

In this diagram, curve 1 represents the hyperbola corresponding to a given and constant power of the motor, this hyperbola being limited on the one hand by the maximum power P_M , and on the other hand by the maximum delivery Q_M , compatible with the mechanical characteristics of the pump. This diagram shows the straight line 2 for operation at constant pressure and the curve 3 of operation with cylinder volume varying in inverse proportion to the pressure. It is observed firstly that this curve is generally a straight line, the springs used in known regulators having in practice a linear characteristic, and secondly that this straight line is tangent to the hyperbola at Q_M . Any other straight line, such as 4, which would permit better utilisation of the possibilities of the pump, is excluded by the constant power of the motor.

The invention has the aim of permitting operation according to the broken line Q_MAP_S , which more closely envelops the theoretical and ideal hyperbola and which enables the pressure P_S to be attained without penetrating into the forbidden hatched zone Z , P_S being the maximum pressure selected for normal self-regulated operation.

Another object of the invention is to permit as an exception the operation represented by a broken line such as Q_MABP_M , still without passing through the forbidden zone, that is to say still without exceeding the selected driving power.

With the first object in view, the regulator according to the invention comprises at least two springs successively opposing the reduction of delivery which the increase of pressure tends to produce, within the normal self-regulated operation zone.

With the second object in view, the regulator according to the invention comprises at least one additional spring the action of which is added to that of the self-regulation springs, through the action of a control extrinsic to the self-regulation control.

One example will be given below of the performance of the principle of the invention, although applicants do not intend that the generic scope of this invention should be limited to the features or by the features specific to the example selected for purposes of illustration.

In the accompanying drawings:

FIGURE 1 shows the pressure diagram as has been indicated, and

FIGURE 2 is an axial section of the regulator.

In FIGURE 2, the variable discharge pump has been illustrated in block form only, since it forms part of conventional technology and may be of different types; there has simply been shown the connecting rod 1 by which the regulator, designated generally by 2, acts on the movable member 1' of the pump which effects the variation of delivery.

The regulator 2 is constituted by a main cylindrical body with a portion 3 of reduced diameter, thus forming a shoulder 4.

On the part 3 is screwed the cylindrical part 5 of a second body, which itself has a part 6 of reduced diameter forming the shoulder 7 and a third part 8 of still smaller diameter, forming the shoulder 9.

Within the main body 2 the piston 10 having a head 10' and a rod 11 moves, its rod 11 being guided in a sleeve 12 which by an external flange rests on the shoulder 9.

On the sleeve 12 is a flanged sleeve 14 bearing on the shoulder 7 and serving as abutment to a first spring 15, while a second spring 16 bears on the internal shoulder 4. A third spring 17 bears on the inside face of the piston 10, as does also the spring 15.

The coil spring 17 can slide on the outside wall of the sleeve 12 and can abut against an outside shoulder 18 provided on the sleeve 12.

As shown in FIGURE 2, spring 17 has a slightly smaller inner diameter than the outer diameter of sleeve 12, so that it grips the surface of the sleeve. But spring 17 may also have a larger diameter so that it fits freely over the sleeve 12.

In the piston 10 is found a shaft 19 articulated at 20 on the connecting rod 1, an elongated slot 21 permitting the shaft 19 to pass through the body 2 of the regulator.

The body 2 is closed by a head 22 in which moves the piston 23 which through the connection 24 is in communication with the general load circuit which is fed by the pump.

At the opposite end, the sleeve 12, which penetrates into the cylindrical portion 8 of the regulator, provides a pressure chamber 25 which can be brought into communication through the medium of a three-way cock 26 either with a general load circuit through the pipe 27 or with the tank or reservoir through the pipe 28.

The spring 15 is mounted with initial tension corresponding to the maximum delivery Q_M (FIGURE 1), while the springs 16 and 17 in the position illustrated are in the relaxed condition, the spring 16 having a dead stroke 29 corresponding to the stroke $A-Q_M$ in FIGURE 1.

Operation is as follows:

As soon as the pressure in the load circuit exceeds the pressure corresponding to the maximum delivery Q_M piston 10 is actuated by the piston 23 which is exposed to the pressure in the working circuit of the pump and the spring 15 is first compressed until the piston 10 comes to bear against the spring 16.

For this first part of the travel, the representative point is moved from Q_M to A (FIGURE 1).

Beyond that point, the two springs 16 and 15 are simultaneously compressed by the action of the piston 10 and the representative point describes the straight line AP_S in FIGURE 1.

The compression continues until the piston rod 11 comes to its end position defined by the length of slot 21, as requested, or comes to bear against the bottom of the cavity provided in the sleeve 12 if the depth of the cavity is shorter than the length of the slot. This end position has been calculated to correspond to zero delivery and to the pressure P_S .

During this travel the spring 17 slides along the sleeve 12 until it comes to bear against the shoulder 18.

During these operations the pressure chamber 25 has been assumed to be in communication with the reservoir through the cock 26 in the position illustrated; the spring 17 has remained inoperative.

The stroke which has just been described corresponds to the self regulation stroke, represented by $Q_M AP_S$ in FIGURE 1.

If exceptionally it is desired to attain a pressure higher than P_S , up to the maximum pressure P_M permitted by the mechanical characteristics of the pump, the cock 26 is so operated as to bring the chamber 25 into communication with the general circuit under pressure; the pressure thus acts on the bottom face of the sleeve 12, which acts as a piston and compresses the spring 17 as far as a position of equilibrium, which may for example be the position in which it bears against the stop 14.

In these circumstances the rod 11 will reach the bottom of the cavity of the sleeve 12 much sooner. This position will correspond to the point B in FIGURE 1.

As the pressure increases at 24, the three springs 15, 16, 17 are compressed, spring 17 being compressed until piston rod 11 reaches the bottom of the slot in sleeve 12. As seen in FIGURE 2, the slot in sleeve 12 is longer than the distance from the end of spring 17 to shoulder 18.

The representative point in FIGURE 1 then describes the straight line BP_M .

The three-way cock 26 can be controlled either manually or automatically.

Manual control may be exercised by a separate control lever, or by the control lever proper which at the end of the stroke can act directly or indirectly on the three-way cock.

The control of the cock 26 may be automatic and result from the registration of the desired movement. If the registration should show an abnormal discrepancy, this discrepancy may be detected and operate the three-way cock in order to increase the pressure of the pump.

Finally, the following possible applications of the invention will be cited in reference to hydraulic regulators connected to a pump constituting the pressure source;

The transmission of power in vehicles for passing over very steep slopes;

The control of receivers requiring high exceptional torques;

The control of tank turrets in order to permit rotation on steep slopes when the turrets are not balanced.

What I claim is:

1. A self regulating device for controlling the cylinder capacity of a variable discharge pump in response to excess pressures in a load circuit comprising in combination:

a casing,

means to connect said casing at one end with said load circuit,

piston means slidably received in said casing and having a piston rod and a piston head, said piston head being responsive to said pressure fluid at said one end,

piston stop means mounted in the other end of said casing,

said piston stop means having an inner sleeve portion defining a cylinder chamber for receiving the inner end of said piston rod,

abutment means in said casing,

first spring means engaged between said abutment means and said piston head,

said first spring means being compressed proportionately to a predetermined pump discharge,

spring abutment means in said casing,

second spring means supported on said spring abutment means and spaced from said piston head,

and connecting means extending between said piston head and said variable discharge pump for reducing the cylinder capacity of the pump upon actuation of said piston head away from said closure means.

2. A self regulating device according to claim 1 wherein said piston stop means is arranged slidably in said casing and including a flange on said piston stop means, said flange engaging said abutment means to limit the inward movement of said piston stop means.

3. The device according to claim 2 including a pressure chamber at the outer end of said piston stop means, a pressure responsive and valve means for connecting said pressure chamber selectively to said load circuit and to said pressure reservoir for sliding said piston stop means in said casing to vary the position of said last named means relative to said piston means.

4. The device according to claim 1 including third spring means mounted in said casing around said piston rod,

said inner sleeve of said piston stop means having a reduced inner end portion forming an abutment shoulder,

said third spring means extending between said abutment shoulder and said piston head and having a length less than the distance between said piston head and said abutment shoulder and adapted to be compressed after said first and second spring means have been successively compressed upon actuation of said piston means.

5. The device as defined in claim 1 wherein the depth of said cylinder chamber of said inner sleeve portion receiving the inner end of said piston rod determines the maximum compression of said spring means.

6. A self regulating device for controlling the cylinder capacity of a variable discharge pump in response to excess pressures in the load circuit comprising in combination:

a casing,

piston means slidably received in said casing and having a piston rod and a piston head,

closure means at one end of said casing and engaged by said piston head in the position of said piston means, corresponding to a normal pressure in said load circuit,

said closure means having bore means connected to said load circuit and containing an operating member engaging said piston head, for actuating said piston means in response to excess pressures in said load circuit,

piston stop means slidably mounted in the other end of said casing,

said piston stop means having an inner sleeve portion defining a cylinder chamber for receiving the inner end of said piston rod,

flange means on said piston stop means,

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abutment means on said casing for engaging said flange means to limit the inward movement of said piston stop means,

first spring means engaged between said abutment means and said piston head,

said first spring means being compressed proportionately to a predetermined pump discharge,

spring abutment means in said casing,

second spring means supported on said spring abutment means and spaced from said piston head,

and connecting means extending between said piston head and said variable discharge pump for reducing the cylinder capacity of the pump upon actuation of said piston head away from said closure means.

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