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R. OBTRESAL
HYDRAULIC DRIVE
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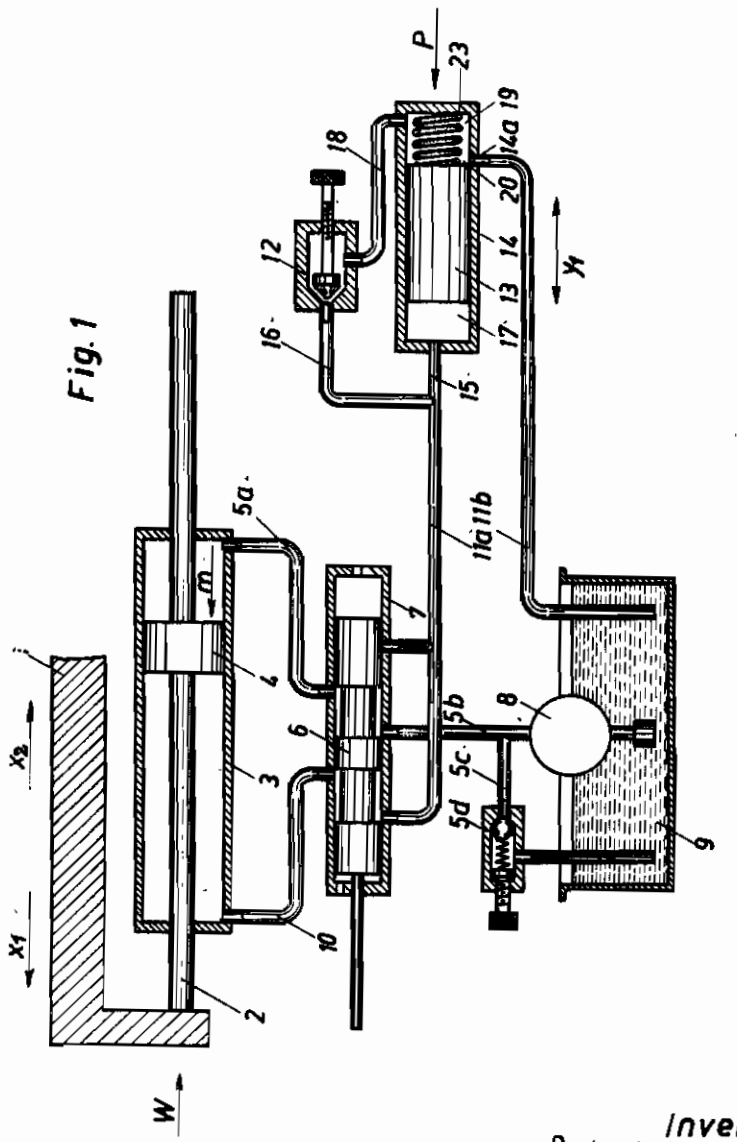
Fig. 1



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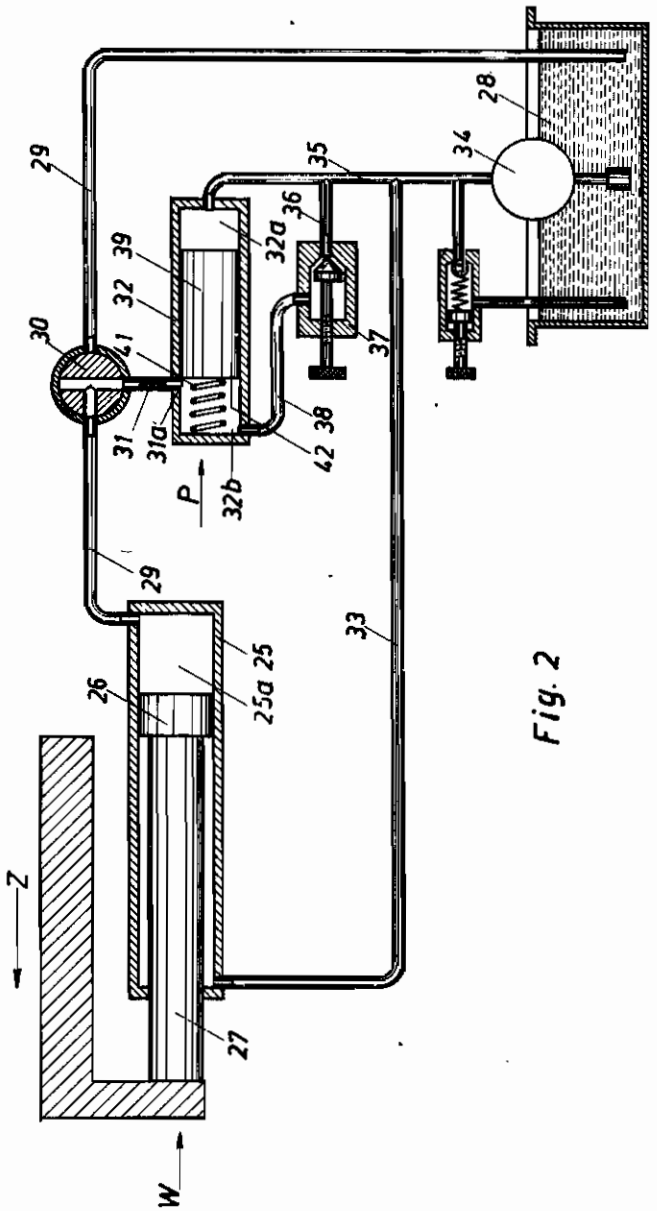

Fig. 2

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ALIEN PROPERTY CUSTODIAN

HYDRAULIC DRIVES

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This invention relates to hydraulic drives and refers more particularly to a device regulating the speed of a drive actuated by hydraulic means. This device may be used in conjunction with all machines wherein the speed of a driven body is subjected to certain variations resulting from changes in the resistance opposing the movement of the actuated body. However, the device constituting the subject matter of the present invention is particularly applicable to machine tools, the feed movement of which is actuated by a hydraulic drive, and in which the speed of the feed movement is dependent upon the feed resistance.

An object of the present invention is to eliminate this dependency between the speed of the drive and the resistance by the provision of a special regulating device.

Another object is the provision of a regulating device for hydraulic drives of machine tools and the like which makes it possible to maintain a substantially uniform speed of the drive or of the feed movement despite changes in the resistance opposing the drive or the feed movement.

Other objects of the present invention will become apparent in the course of the following specification.

In accomplishing the objects of the present invention it was found advisable to provide a hydraulic drive having a throttle valve which is adjustable at will and which may be used for any desired step-wise variation in the speed of the drive or the feed movement.

In accordance with the present invention, this throttle valve is connected with an automatically operable regulating device which may be situated either in that part of the hydraulic circuit which supplies the operating fluid to the driving mechanism, or in that part of the circuit through which the fluid is withdrawn from the driving mechanism.

The regulating device varies the amount of fluid flowing to or from the driving mechanism depending upon the difference in fluid pressure prevailing on both sides of the throttle valve, and upon an additional force which maintains constant this difference in pressure.

By means of this regulating device, the difference in pressure between the two sides of the throttle and valve and, consequently, the amount of fluid flowing through the throttle valve are always maintained constant and entirely independent of the specific amount of pressure existing on any one side of the throttle valve. Therefore, the resistance exerted upon the movable part of the machine has no influence whatever upon this pressure difference. Since the speed of the drive is determined solely by the amount of fluid supplied to it and since this amount is maintained constant by the regulating device, the speed of the drive or of the feed movement will always remain the same irrespective of any possible variations in the resistance opposing the movement.

The invention will appear more clearly by the following detailed description when taken in connection with the accompanying drawings showing, by way of example, preferred embodiments of the inventive idea, as applied to feed drives of machine tools.

In the drawings:

Figure 1 is a diagram illustrating a hydraulic drive constructed in accordance with the principles of the present invention.

Figure 2 is a diagram showing a hydraulic drive of a somewhat different form.

Figure 1 shows a carriage 1 of a machine tool, which is reciprocable in the direction of the arrows x_1 and x_2. The carriage 1 is connected with a rod 2 which extends parallel to the direction of movement of the carriage and which carries a piston 4 intermediate its ends. The piston 4 is movable along with the rod 2 in a casing 3 through which the rod 2 extends. There is a fluid-tight seal between the adjacent surfaces of the rod 2 and the casing 3.

The fluid used to operate the hydraulic drive is situated within a container 9. A pump 8 transmits the fluid under pressure from the container 9 to a pipe 5*b*, which is connected with the pump 8.

The pipe 5*b* is connected with a regulating valve which includes a casing 7 and a multiple piston 6 situated within the casing. A pipe 5*a* connects the interior of the casing 7 with the interior of the casing 3 and is used to transmit fluid under pressure to the piston 4.

A pipe 5*c* is in communication with the pipe 5*b* close to the pump 8. The pipe 5*c* leads to a relief valve 5*d* which is provided with a pipe communicating with the interior of the container 9.

Fluid is withdrawn from the cylinder 3 through a return flow pipe 18 connecting the interiors of the cylinder 3 and the casing 7. The return flow circuit of the hydraulic drive also includes a pipe 11*a* one end of which has two branches which are in communication with the interior of the casing 7. The opposite end of the pipe 11*a* has two branches 15 and 16.

The branch pipe 18 leads to an adjustable

throttle valve 12, while the branch pipe 15 is in communication with the space 17 of a regulating device consisting of a cylinder 14, a piston 13 and a spring 23. The piston 13 is movable within the cylinder 14 in the direction of the arrows y_1. A pipe 18 connects the throttle valve 12 with the space 19 of the cylinder 14.

The spring 23 is situated within the space 19. The space 19 is also in communication with the opening 14a of a pipe 11b leading to the container 9. The spring 23 is compressed and one end of the spring is supported by a wall of the container 14 while its other end presses against a surface 20 of the piston 13.

The piston 13 covers a part of the opening 14a, so that a movement of the piston 13 within the container 14 will increase or decrease the operative cross sectional area of the opening 14a.

The device is operated as follows:

The pump 8 transmits fluid under pressure from the container 9 and through the pipe 5b, the regulating valve 6, 7 and the pipe 5a into the right hand space within the cylinder 3 (looking in the direction of Figure 1).

The fluid will move the piston 4 and the rod 2 connected therewith in the direction of the arrow m, thereby moving the fuel carriage in the direction of the arrow x_1.

A resistance W is opposed to this feed movement of the carriage 1 and this resistance is overcome by the pressure of the fluid acting in the direction of the arrow m.

Due to this pressure of the fluid, that part of the fluid which is situated in the left hand space of the cylinder 3 (looking in the direction of Figure 1), as caused to flow through the pipe 10 and the regulating valve 6, 7 into the pipe 11a.

Thence the fluid flows through the pipe 16 and the throttle valve 12 into the pipe 18. As already stated, the adjustment of the throttle valve determines the amount of pressure of the fluid, so that the device may be set for different speeds of the feed of the tool carriage 1.

However, these different speeds depend upon the extent of the resistance W. Due to the throttling action there is a smaller fluid pressure in the pipe 18 which connects the valve 12 with the regulating device 13, 14, than in the pipes 15 or 16. Due to the provision of the pipe 15, the pressure of the fluid in the space 17 of the cylinder 14 is the same as that in the pipe 16 on one side of the throttle valve 12. The pressure in the pipe 18 on the other side of the throttle valve 12 is the same as that in the space 19 of the container 14.

The difference in fluid pressure in spaces 17 and 19 is equalized by the force P of the spring 23, which is selected accordingly and is correspondingly tensioned.

If the force W constituting a resistance to the feed movement of the carriage, is increased, for instance, then the pressure of the fluid flowing through the pipes 11a, 15 and 16 will be diminished. Consequently, the pressure within the space 17 of the cylinder 14 will diminish also and the force P of the spring 23 will move the piston 13 to the left (looking in the direction of Figure 1). The front surface 20 of the piston 13 will open an additional portion of the cross sectional area of the opening 14a. Therefore, the amount of fluid flowing out of the space 19 and through the pipe 11b back to the container 9 will be increased. The pressure of the fluid within the space 19 will decrease until this pressure jointly with the practically constant force P of the spring 23 will become equal to the new pressure prevailing in the space 17.

Consequently, the difference in pressures prevailing in the spaces 17 and 19, as well as in the pipes 16 and 18, will remain the same despite the change in the resistance W.

Since, however, the difference in pressure prevailing at the two sides of the throttle valve 12 determines the speed of movement imparted to the piston 4, this speed will remain the same despite the change in the resistance W.

The amount of fluid flowing back of the container 9 remains the same, due to the increase in the operative surface area of the outflow opening 14a, although the extent of the drop in pressure between the space 19 and the container 9 has been changed.

The hydraulic drive shown in Figure 2 of the drawings includes a cylinder 25 containing a piston 26 which is connected on one side with a piston rod 27, so that the two side surfaces of the piston 26 are of different size. The comparatively wide piston rod 27 extends through a suitable opening formed in the cylinder 25 and is attached to the carriage of the machine tool.

The fluid used to operate the piston 26 is circulated by a pump 34 situated within a container 28. A pipe 35 connected to the pump 34 is provided with a branch pipe 36 which leads to a regulatable throttle valve 37. The pipe 35 communicates with the space 32a within a cylinder 32 of the regulating device. The cylinder 32 contains a piston 39 which is loaded by a spring 41. Consequently, in this construction the regulating device 32, 39 is inserted in that part of the hydraulic circuit which transmits fluid under pressure to the cylinder 25.

A pipe 31 connects the space 32b within the container 32 with a three way cock or change over valve 30. The valve 30 is connected with the space 25a within the cylinder 25 by a pipe 29 and has a valve body provided with three passages which connect the pipe 29 with the pipe 31 in the position shown in Figure 2. The other end of the cylinder 25 is in communication with the pipe 35 by a return flow pipe 33. Another pipe 29a leads from the valve 30 to the interior of the container 28 for the fluid.

The throttle valve 37 is connected with the space 32b within the cylinder 32 by the pipe 38.

The regulating device 32, 39 includes a spring 41 which presses against the piston 39 and which maintains the piston in a position in which it partly covers the opening 31a of the pipe 31.

The device is operated as follows:

The pump 34 causes a flow of liquid under pressure through the pipe 35, the pipe 36, the throttle valve 37, the pipe 38, the space 32b within the container 32, the pipe 31, the valve 30 and the pipe 29 into the space 25a of the cylinder 25.

The pipe 33 is provided with a suitable non-return valve which is not shown in the drawings.

The fluid under pressure within the space 25a moves the piston 26, the piston rod 27 and the tool carriage connected therewith in the direction of the arrow Z. The speed of this movement is determined by the position of the throttle valve 37. The difference in fluid pressures prevailing on both sides of the throttle valve 37 determines the amount of the liquid which operates within the cylinder 25.

If the resistance W opposed to the movement of the tool carriage remains unchanged, a fluid pressure will arise within the space 25a and in the pipes 29 and 31, which is necessary to over-

come the resistance W and the pressure exerted upon the annular surface of the piston **29** around the piston rod **27**.

The pump **34** transmits the fluid under a higher pressure through the pipes **35** and **36** and into the space **32***a* within the cylinder **32**. This higher pressure, which is also exerted upon the adjacent surface of the piston **39**, is balanced by the force P of the spring **41** and the pressure of the fluid upon the surface **42** of the piston **39**, so that the piston **39** is maintained in the illustrated position. There is an equilibrium when fluid pressure in the space **32***a* to the right of the piston **39** (looking in the direction of Figure 2) is equal to the force P of the spring **41** plus fluid pressure in the space **32***b* to the left of the piston **39**.

In the illustrated position, the edge of the surface **42** of the piston **39** covers a portion of the opening **31***a* of the pipe **31**. Any movement of the piston **39** will change, therefore, the operative cross sectional area of the opening **31***a*. The area of the opening **31***a* is varied depending upon the resistance opposing the movement of the piston **26** and, consequently, the fluid pressure in the pipes **29** and **31**.

If, for instance, the resistance W exerted upon the piston **26** is increased, then the pressure of the fluid in the pipes **29**, **31**, and **38** is increased also. The piston **39** is then moved to the right (looking in the direction of Fig. 2), so that the operative area of the opening **31***a* is increased, and the already existing difference in pressures prevailing in the space **32***b* and in the pipes **29** and **31**, is diminished. However, the difference in pressures prevailing in the pipe **38** and in the pipe **36** remains the same, so that the amount of fluid flowing through the throttle valve **37** and, consequently, the speed of movement of the piston **26** are not changed.

If the resistance W becomes smaller, the piston **39** will move to the left and in that case also the difference in pressures prevailing in the pipe **38** and in the pipe **36** will not change. The amount of the flowing fluid will remain the same due to the change in the operative cross sectional area of the opening **31***a*, despite the change in the difference in pressures prevailing in the spaces **32***b* and **25***a*.

It is apparent that the specific illustrations shown above have been given by way of illustration and not by way of limitation and that the structures above described are subject to wide variation and modification without departing from scope or intent of the invention. All of such variations and modifications are to be included within the scope of the present invention.

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