Sept. 11, 1945. E. MATULIONIS 2,384,760

FLUID-PRESSURE OPERATED APPARATUS

Filed April 13, 1945 3 Sheets-Sheet 1

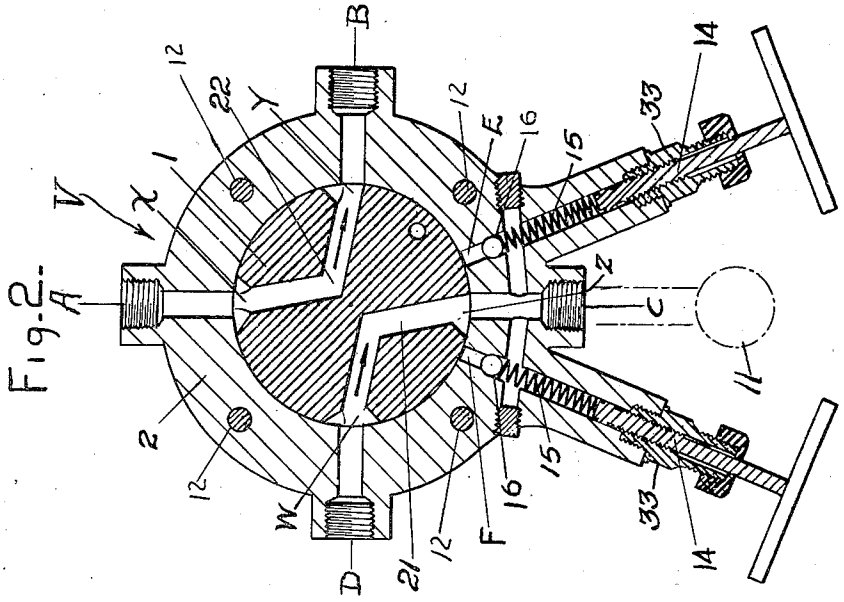


Fig. 2.

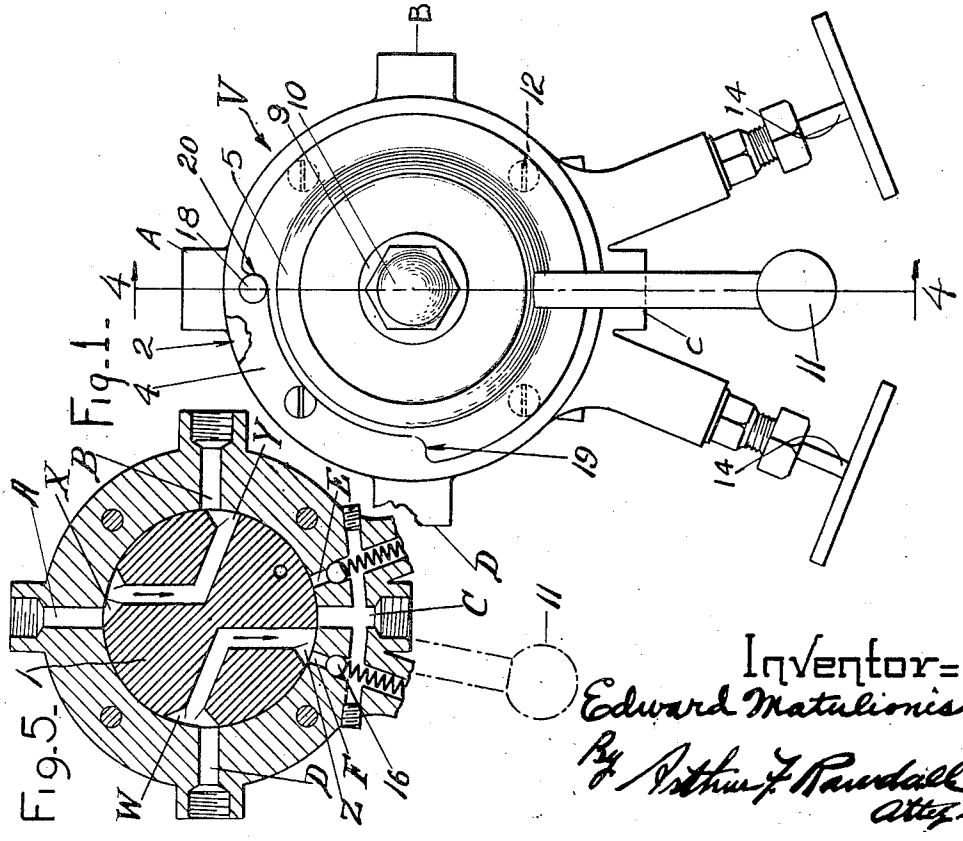


Fig. 1.

Fig. 5.

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Sept. 11, 1945. E. MATULIONIS 2,384,760

FLUID-PRESSURE OPERATED APPARATUS

Filed April 13, 1945 3 Sheets-Sheet 2

Fig. 4.

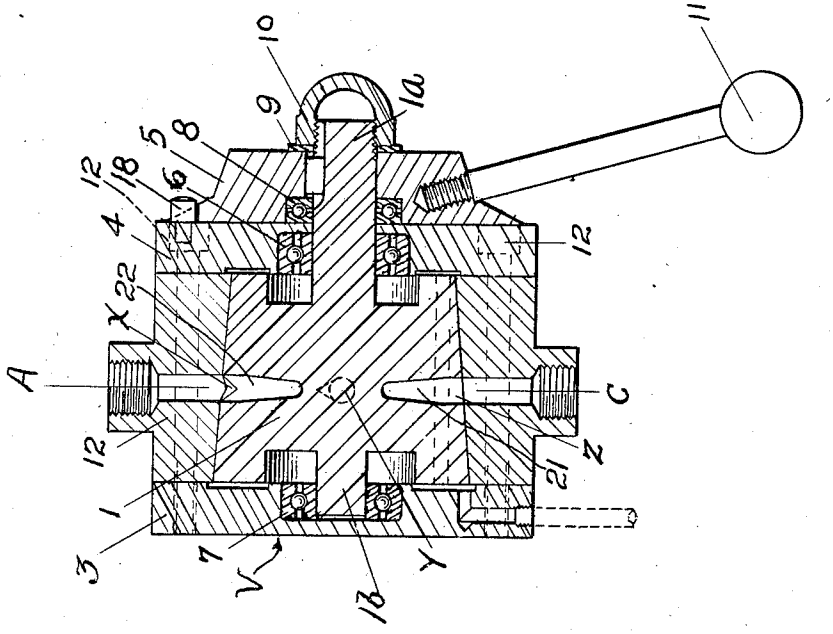
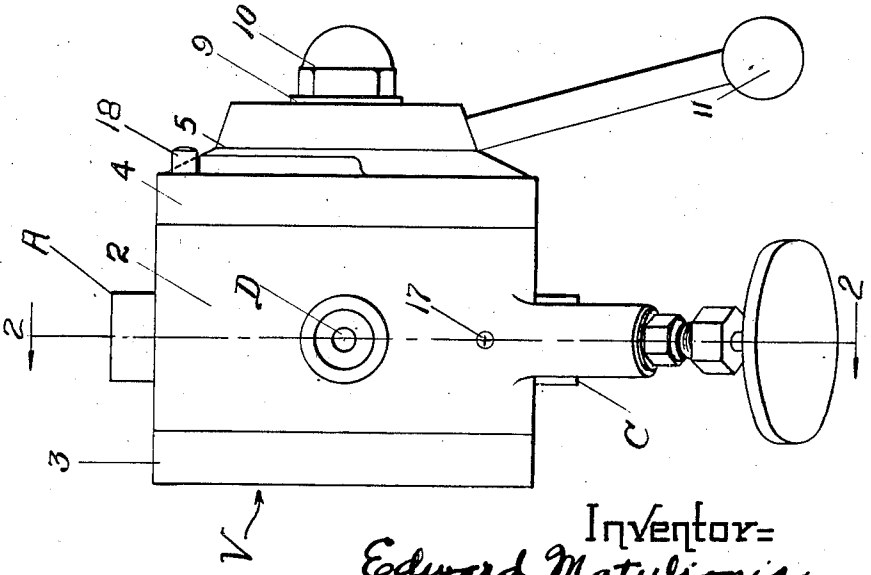


Fig. 3.



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FLUID-PRESSURE OPERATED APPARATUS

Filed April 13, 1945 3 Sheets-Sheet 3

Fig. 6.

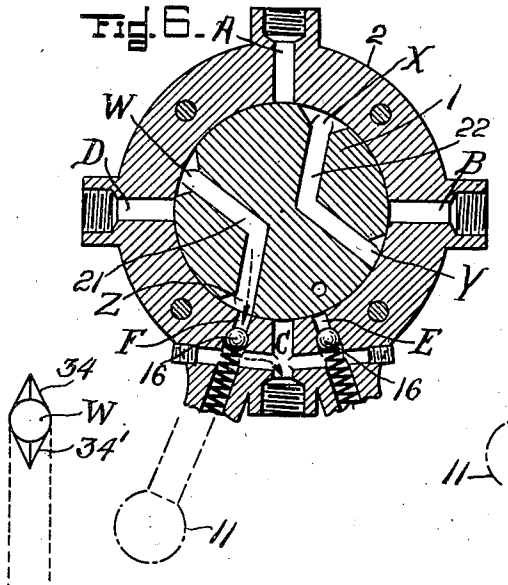


Fig. 10.

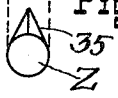


Fig. 7.

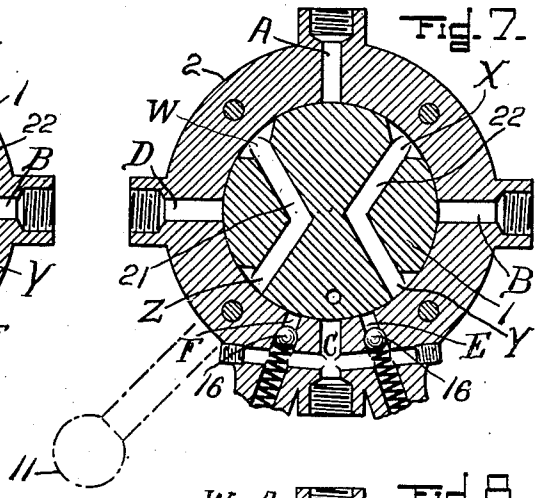


Fig. 8.

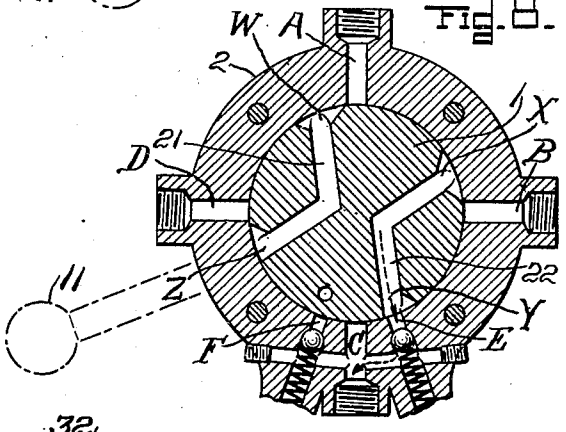


Fig. 11.

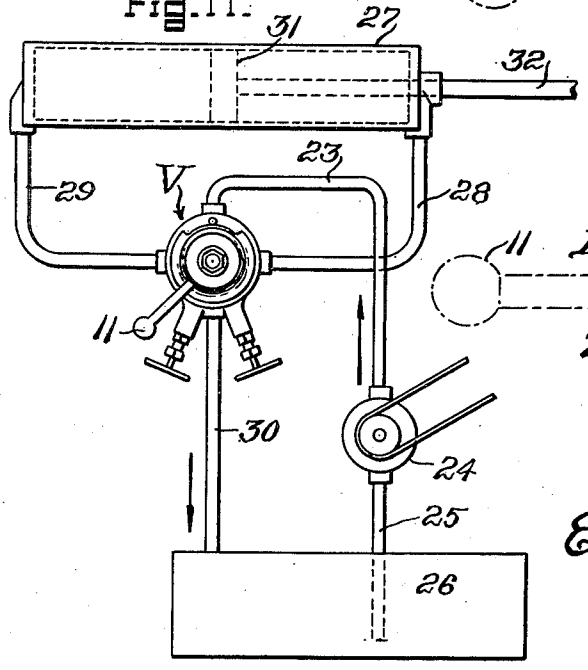
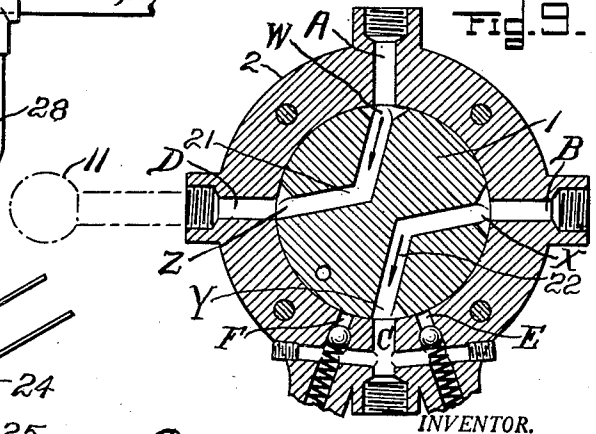


Fig. 9.



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UNITED STATES PATENT OFFICE

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FLUID-PRESSURE OPERATED APPARATUS

Edward Matulionis, Bridgeport, Conn.

Application April 13, 1945, Serial No. 588,177

4 Claims. (Cl. 121—45)

This invention relates to improvements in fluid-operated apparatus of that class which comprises a cylinder containing a piston that is reciprocated therein by a fluid under pressure which is alternately directed into and exhausted from the opposite ends of the cylinder by means of an adjustable control valve that is operable to regulate the speed of the piston as well as to start and stop the same, such apparatus being adapted to empower a tool or other mechanism such, for example, as a milling machine.

The present invention is primarily concerned with the construction and operating characteristics of the control valve by means of which the flow of the fluid to and from the cylinder is controlled and regulated as required by the work that is being done, the object of the invention being to improve the construction and operation of said valve so that it may serve to afford better control of the piston than has been possible with the valves heretofore provided with which I am familiar.

To this end I have provided an improved control valve incorporated in an apparatus of the class described, said valve being organized and constructed so that it is operable to maintain fluid under pressure against both sides of the piston while operating at slow speeds thereby to prevent backlash and unsteadiness of the piston and ensure a steady uniform movement of the same and of the tool or other driven element at such times.

It is also a feature of the invention that the control valve is organized and constituted so as to provide for a wide range of accurately graduated speeds of the piston from zero to maximum.

In the accompanying drawings:

Figure 1 is an end elevation of my improved control valve.

Figure 2 is a sectional view of the valve taken on the line 2—2 of Fig. 3.

Figure 3 is a side elevation of the valve shown in Figs. 1 and 2.

Figure 4 is a section on line 4—4 of Fig. 1.

Figures 5, 6, 7, 8 and 9 are sectional views, on reduced scale, illustrating the operation of the valve.

Figure 10 is a detail, more or less diagrammatic, illustrating the construction of the ports of the plug of the valve.

Figure 11 shows a fluid-pressure-operated apparatus provided with my improved valve.

In the accompanying drawings my improved valve is shown at V and comprises a casing or body consisting of an intermediate section 2 (Fig. 4) formed interiorly with a conical chamber for the reception of a conical valve plug 1, and two end sections in the form of cap plates 3 and 4 fastened in position against the opposite ends of intermediate section 2 by four screws 12 (Figs. 1, 2 and 4) extending loosely through apertures formed in sections 2 and 4 and screwed into tapped holes provided in section 3. Ball bearings 6 and 7 are provided as parts of the cap sections 3 and 4 for rotatably supporting stems 1a and 1b provided at the opposite ends of the conical valve plug 1 that is fitted within section 2.

The stem 1a extends through a central aperture formed in cap section 4 to the exterior thereof where it has splined upon it the hub 5 of a radially disposed lever arm 11 by means of which valve plug 1 may be rotatively adjusted manually. A stop pin or stud 18 (Figs. 1 and 4) projecting from cap section 4 co-operates with a pair of opposed radial shoulders 19 and 20 provided on hub 5 to limit the maximum possible angular adjustment of lever 5—11 and valve plug 1 to 90 degrees.

The outer end portion of stem 1a is threaded to receive upon it a nut 10 (Figs. 3 and 4) between which and hub 5 is arranged a washer 9. This nut serves to hold the valve plug seated within its chamber and also to hold hub 5 seated against the outer race of a thrust bearing 8 and the inner race of the latter seated against the outer face of cap section 4.

The intermediate body section 2 (Figs. 2 and 4) is made with four radial main ports A, B, C and D whose inner ends all communicate with the valve chamber and are angularly spaced apart circumferentially 90 degrees. The port A is a supply port connected by a supply conduit 23 (Fig. 11) with a source of fluid under pressure herein shown as the outlet of a continuously driven pump 24 whose inlet is connected by a conduit 25 with a reservoir 26 holding a body of oil or other suitable fluid. Ports B and D are service ports connected, respectively, with the opposite ends of a cylinder 27 by conduits 28 and 29. Port C is an exhaust port through which the fluid discharged from cylinder 27 into valve V is directed into a return conduit 30 by which it is conducted back into reservoir 26. Within cylinder 27 is a piston 31 that is connected by a rod 32 with the milling machine or other device (not shown) that is to be operated.

At opposite sides of the main exhaust port C are provided two supplemental exhaust ports E and F (Fig. 2) whose inlet ends communicate with the chamber of body section 2 in close

proximity to the inlet end of main exhaust port C and whose outlet ends communicate with the latter. Between the opposite ends thereof each supplemental exhaust port E and F is provided with a seat for a check valve 16, herein shown as a steel ball, that is held closed on said seat by a spring 15, said check valve closing toward valve plug 1. The outer end of each spring 15 is seated against the inner end of an adjustable abutment screw 14 having threaded engagement with an interiorly threaded stuffing box member 33 forming a fixed part of the body section 2, said abutment screw being manually adjusted to occupy a position where its spring 15 is under a substantial predetermined degree of compression that is substantially less than the pressure of the piston-actuating fluid.

The valve plug 1 is constructed with two ports 21 and 22 extending transversely therethrough at opposite sides of the axis of said plug and provided, respectively, with inlet ends W and X which are peculiarly shaped and disposed 90 degrees apart, circumferentially. The port 21 is provided with an outlet end Z that is disposed 90 degrees, circumferentially, away from the inlet end W of said port, while the port 22 is likewise provided with an outlet end Y that is disposed 90 degrees, circumferentially, away from the inlet end X of said port. In other words, the opposite ends of the ports 21 and 22 are disposed at the quarters of the valve plug so that by adjusting the latter rotatively into the position shown in Fig. 2 the service port B will be connected with supply port A and service port D with exhaust port C to drive the piston 31 toward the left (Fig. 11). Or, if the plug be adjusted rotatively to occupy the position shown in Fig. 9, the service port D will be connected with the supply port A by port 21 of the plug while service port B will be connected with exhaust port C by port 22 of the plug so that the piston will be driven toward the right (Figs. 9 and 11). It will also be clear that when the plug is adjusted into a position midway between the two positions shown in Figs. 2 and 9 all ports of the plug and valve body 2 will be closed as shown in Fig. 7.

The inlet end of each port 21 and 22 is enlarged laterally by two oppositely disposed circumferential V-shaped grooves 34 and 34' (Fig. 10) while the outlet end of each of said ports is enlarged laterally by a single V-shaped groove 35 extending circumferentially toward the groove 34' at the inlet end of said port. Thus, the inlet end of each of said two ports is enlarged into a diamond or lozenge shape while the outlet end thereof is enlarged into a triangular shape. The purpose of this will presently appear.

While the piston 31 is being maintained at rest the lever arm 11 occupies the position shown by full lines in Fig. 11 and by dotted lines in Fig. 7 where all of the ports of the valve and body are closed.

When the piston is to be driven full speed toward the left the lever arm 11 is swung contraclockwise from the position shown in Fig. 11 into the position shown by dotted lines in Fig. 2 where service port B is connected with supply port A by plug port 22 and service port D is connected with exhaust port C by plug port 21. Now, when it becomes necessary to slow down the piston without stopping the same completely, the lever arm 11 is swung clock-wise into the dotted line position shown in Fig. 5 where service port B continues to be connected with supply port A by plug port 22 through the V-shaped grooves 34 and 35 of the latter, while the inlet end W of plug port 21 continues in communication with service port D through its V-shaped groove 34' and the outlet end of said plug port 21 is in communication with supplemental exhaust port F through its V-shaped groove 35. Under these conditions the fluid exhausted from the cylinder and directed into exhaust port F will displace the ball check 16 of the latter downwardly against the pressure of its spring 15 and discharge into return port C. The yielding resistance offered by spring-pressed ball check 16 thus acts to impose a back pressure upon the exhaust side of the piston which not only contributes to the slowing down of the latter but also serves to prevent the objectionable backlash referred to above while operating at slow speeds.

It will be clear that the degree of back pressure thus produced upon the exhaust side of the piston while the latter is in motion, and therefore the reduced speed of the piston, can be varied or regulated by adjustment of the outlet end of plug port 21 back and forth between the inner ends of the two ports C and F. That is to say, adjustment of lever arm 11 back and forth between the two positions thereof indicated in Figs. 2 and 5 without fully registering the outlet end Z of plug port 21 with exhaust port C, will vary the reduced speed at which the piston is driven, the V-shape of the groove 35 of said outlet end providing for minute graduations of the speed. It will also be clear that during such manipulation of the valve plug 1 the V-groove 34' of port 21 continues in register with service port D while at the same time the V-grooves of plug port 22 continue in register with supply port A and service port B.

It is also true that when lever arm 11 is swung clockwise from the position indicated in Fig. 5 past the position indicated in Fig. 6 and into the position indicated in Fig. 7 and shown by full lines in Fig. 11, all valve ports are closed and the piston is stopped with fluid pressure imposed upon both sides thereof thereby preventing objectionable looseness thereof.

To drive the piston in the opposite direction, viz., from left to right (Fig. 11) the lever arm 11 is swung clockwise from the position shown in Figs. 7 and 11 into the position shown in Fig. 9 where service port D is connected with supply port A by plug port 21 and service port B is connected with exhaust port C by plug port 22. Thereafter, through adjustment of lever arm 11 in a contra-clockwise direction the valve plug 1 can be utilized to slow down and/or stop the movement of the piston from left to right in substantially the same manner, relatively to exhaust ports C and E, as above described in connection with movement of the piston from right to left.

In Fig. 5 the lever arm 11 occupies a position half-way between the positions thereof indicated in Figs. 2 and 6 and to bring the outlet end of port 22 from the position shown in Fig. 9 into a position, relatively to its exhaust port E, corresponding with the relationship between plug port 21 and its exhaust port F shown in Fig. 5, the lever arm 11 is adjusted contraclockwise from the position shown in Fig. 9 half-way toward the position of said arm indicated in Fig. 8.

What I claim is:

1. A fluid-pressure operated apparatus having, in combination, a cylinder; a piston within said cylinder; a source of fluid under pressure; a control valve comprising a body made with a chamber and having four ports communicating with

said chamber at the quarters thereof including a supply port connected with said source, two oppositely disposed service ports connected with the interior of the cylinder adjacent to the opposite ends thereof, and a main exhaust port disposed opposite said supply port, and also having two constricted supplemental exhaust ports whose inlet ends communicate with said chamber at opposite sides of and in proximity to said main exhaust port and a valve plug rotatably mounted within said chamber made with two ports extending transversely therethrough with their opposite ends disposed at the quarters of said valve plug to cooperate with the ports of said body, each of said constricted supplemental exhaust ports serving to occasion a speed-reducing and piston-steadying back pressure upon the exhaust side of said piston when said plug is adjusted to shift the outlet end of one of said plug ports away from said main exhaust port and into register with the inlet end of said supplemental exhaust port while the piston is in motion.

2. A fluid-pressure operated apparatus having, in combination, a cylinder; a piston within said cylinder; a source of fluid under pressure; a control valve comprising a body made with a chamber and having four ports communicating with said chamber at the quarters thereof including a supply port connected with said source of fluid under pressure, two oppositely disposed service ports connected with the interior of the cylinder at the opposite ends thereof, and a main exhaust port disposed opposite said supply port, and also having two supplemental exhaust ports whose inlet ends communicate with said chamber at opposite sides of and in proximity to said main exhaust port; a valve plug rotatably mounted within said chamber made with two ports extending transversely therethrough with their opposite ends disposed at the quarters of said valve plug to cooperate with the ports of said body, and means operable to yieldingly oppose movement of the fluid through each of said supplemental exhaust ports when the outlet end of one of said plug ports is moved into register with the inlet end of said supplemental exhaust port while the piston is in motion thereby to impose a speed-reducing and piston-steadying back pressure upon the exhaust side of said piston.

3. A fluid-pressure operated apparatus constructed in accordance with claim 2 and wherein said last-mentioned means consists of a spring-pressed check valve provided within each supplemental exhaust port, said check valve opening away from said chamber.

4. A fluid-pressure operated apparatus constructed in accordance with claim 2 and wherein the inlet end of each of said two ports of the plug is provided at opposite sides thereof with V-shaped grooves extending therefrom circumferentially in opposite directions and wherein the outlet end of each of said two ports is provided at one side thereof with a V-shaped groove therefrom circumferentially toward the proximate inlet end of said port, some of the grooves of both of said two ports serving to maintain communication with said supply and service ports while said plug is being adjusted within predetermined limits to vary the reduced speed at which the piston is driven.

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