

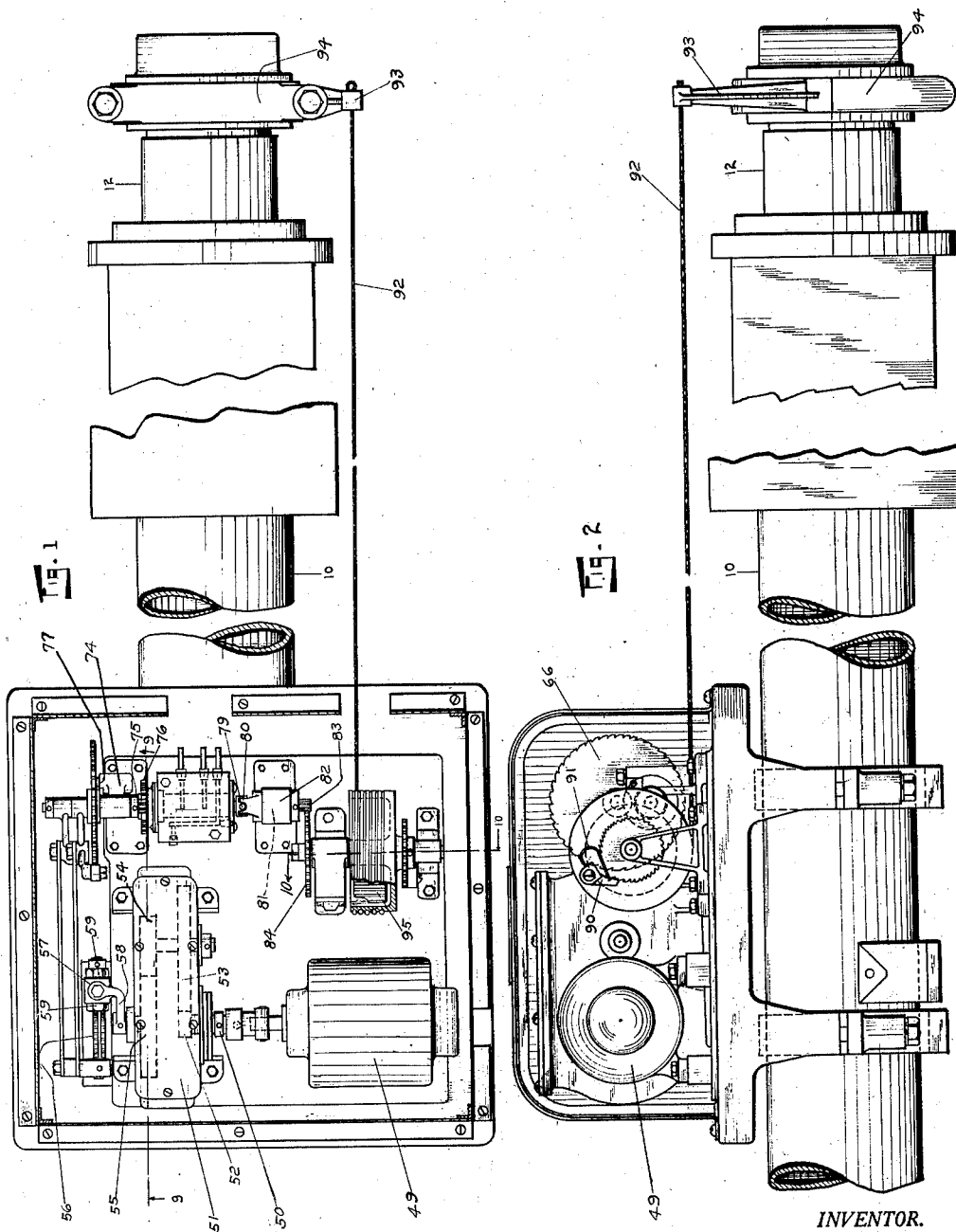
**Dec. 31, 1929.**

**W. FERRIS**

**1,741,833**

# SPEED GOVERNOR FOR HYDRAULIC DRIVES

Original Filed Aug. 3, 1925      3 Sheets-Sheet 1



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Fig. 3

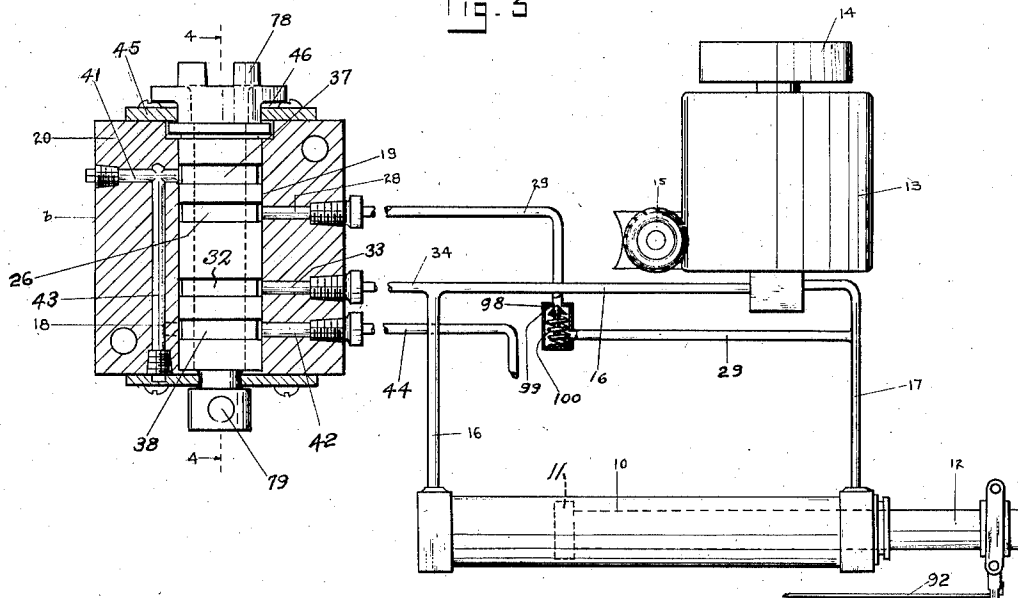


Fig. 4

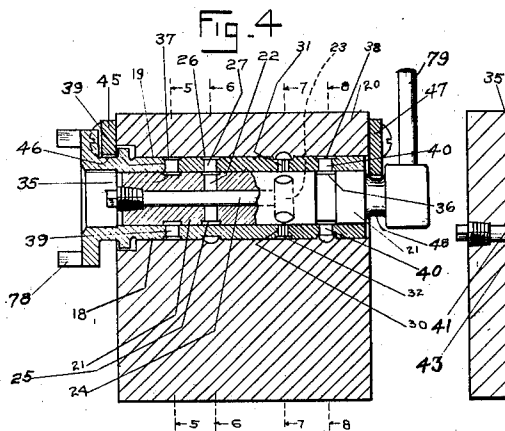


Fig. 5

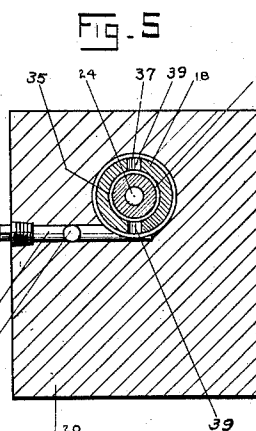


Fig. 6

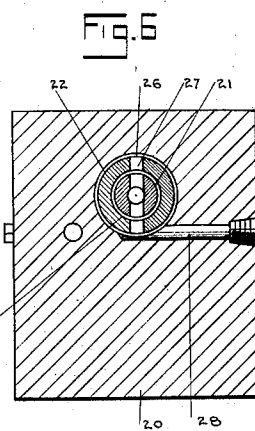


Fig. 7

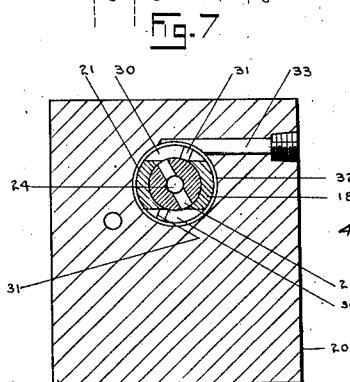
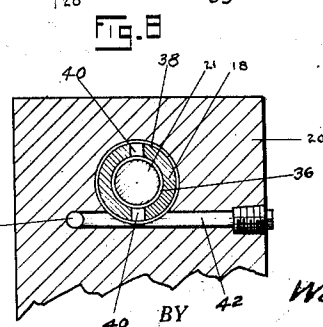


Fig. 8



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FIG. 9.

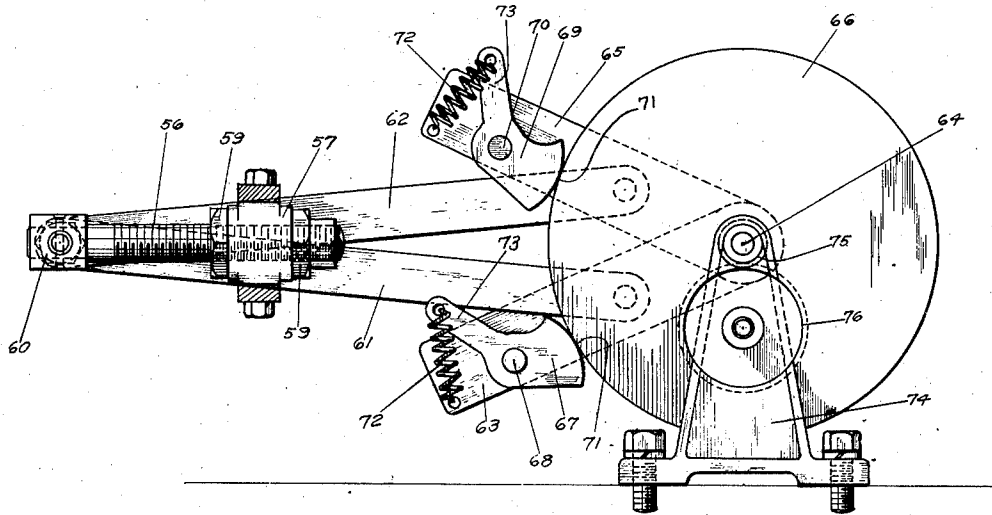
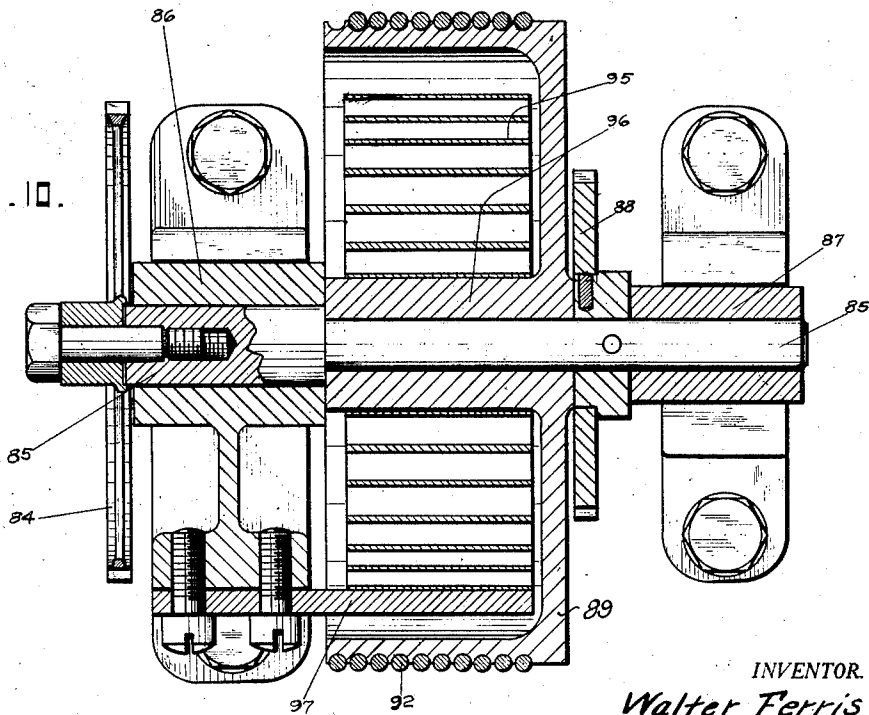


FIG. 10.



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## UNITED STATES PATENT OFFICE

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## SPEED GOVERNOR FOR HYDRAULIC DRIVES

Application filed August 3, 1925, Serial No. 47,992. Renewed November 9, 1929.

This invention relates to speed governors. In some types of mechanism, such, for instance, as kiln pushers, it is highly desirable that the movement of the driven part be accurately maintained at a definite rate over extended periods of time. To maintain such movement with the accuracy required is exceedingly difficult when the desired movement is slow, and particularly when such movement is effected by the use of a hydraulic drive.

One object of the present invention is the provision of a speed governor capable of accurately maintaining the movement of a slowly driven part at a definite rate over extended periods of time.

Another object is the provision of a speed governor for hydraulic drives capable of effecting an accurately timed movement of the driven part.

Other objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the drawings:

Figure 1 is a plan view of a speed governor for hydraulic drives constructed in accordance with the present invention.

Figure 2 is a side elevation of the mechanism shown in Figure 1.

Figure 3 is a horizontal sectional view of a by-pass valve, and diagrammatically illustrating its connection with the hydraulic circuit.

Figure 4 is a longitudinal sectional view taken substantially along the line 4-4 of Figure 3.

Figures 5, 6, 7 and 8 are transverse sectional views taken substantially along the lines 5-5, 6-6, 7-7 and 8-8, respectively, of Figure 4.

Figure 9 is a sectional view taken substantially along the line 9-9 of Figure 1, illustrating a ratchet mechanism employed.

Figure 10 is a sectional view, taken substantially along the line 10-10 of Figure 1.

The speed governor selected for illustration is designed for use with a variable speed, hydraulic transmission system, such, for instance, as that illustrated more or less diagrammatically in Figure 3. The system

shown comprises a hydraulic motor in the form of a power cylinder 10, piston 11 and ram 12, operated by a variable delivery, reversible flow pump 13, of a well known type. The pump is driven at constant speed from an appropriate power source (not shown) through a pulley 14, the direction of flow and the amount of fluid delivered by the pump being controlled by any appropriate means, such as a hand wheel 15. The two sides of the pump circuit are connected with the opposite sides of the cylinder 10 through pipes 16 and 17, respectively. The arrangement is such that when, by manipulation of the wheel 15, the pump is caused to deliver oil through pipe 16, the piston 11 is driven toward the right and oil discharged from the right end of the cylinder 10 passes through pipe 17 back to the pump. Similarly, when the pump is adjusted to deliver oil into the pipe 17, the piston 11 moves toward the left, and the oil discharged from the left end of the cylinder 10 is returned to the pump through pipe 16. The direction and rate of movement of the ram 12 is thus ordinarily dependent upon the direction and rate of discharge of oil from the pump.

It has been found that hydraulic drives of this character can not ordinarily be depended upon to produce and maintain a definite rate of movement of the driven member with the accuracy required for some purposes. An extremely accurate control and timing of the driven member may be had, however, by the use of a speed governor, such as will now be described.

The governor shown comprises a rotary by-pass valve in the form of a sleeve 18 closely fitted for rotation in a bore 19, provided in a valve block 20. A cylindrical core 21 is closely fitted for rotation in the sleeve 18. The core 21 contains two spaced transverse passages 22 and 23 extending therethrough and connected by a longitudinal passage 24. A peripheral groove 25 extending around the core 21 communicates with both ends of passage 22, and a similar groove 26 formed in the outer face of the sleeve 18 communicates with groove 25 through a passage 27. Groove 26 communicates with a passage 28 formed in

the block 20, which in turn is connected through a pipe 29 with the pipe 17 constituting one side of the hydraulic circuit. The sleeve 18 is provided in its opposite sides with narrow saw cuts 30 which cooperate with the ends of the transverse passage 23 in the core to effect a graduated flow of fluid therebetween. Additional passages 31 extending through the wall of the sleeve are adapted to register with the passage 23 when the core assumes a certain rotative position within the sleeve. The saw cuts 30 and passages 31 communicate with a peripheral groove 32 surrounding the sleeve. This groove 32 communicates at all times with a passage 33 formed in the block 20 which in turn is connected through a pipe 34 with the pipe 16 constituting the other side of the hydraulic circuit.

Leakage of fluid between the core and sleeve is intercepted by peripheral grooves 35 and 36 extending about the core adjacent the opposite ends thereof, and leakage of fluid between the sleeve and valve block is intercepted by peripheral grooves 37 and 38 similarly formed about the sleeve. Grooves 35 and 37 are in constant communication through passages 39 in the wall of the sleeve and grooves 36 and 38 are in constant communication through similar passages 40. A duct 41 in the valve block, communicating with groove 37, and a duct 42 in the valve block communicating with groove 38, are connected by a longitudinal passage 43 in the valve block, and duct 42 is connected to a drain pipe 44 through which fluid collected by the grooves 35, 36, 37 and 38 is discharged into a fluid reservoir or sump (not shown) ordinarily provided in the bottom of the pump casing.

Both the sleeve 18 and the core 21 of the valve are rotatable within the stationary block 20, the sleeve being retained in position therein by a plate 45 removably fixed to one end of the block and engaging a peripheral channel 46 formed about the projecting end of the sleeve. The core 21 is similarly retained in position within the block by a plate 47 removably fixed to the other end of the block and engaging a channel 48 formed about the projecting end of the core.

The by-pass valve is placed under the joint control of the ram 12 and a timing mechanism which is designed to operate at definite predetermined speeds irrespective of the speed or load upon the ram. In this instance, the core 21 is mechanically connected to and driven by the ram so that its speed of rotation is proportional to the speed of the ram, and the sleeve 18 is rotated at predetermined speeds by the timing mechanism.

Timing mechanisms for this purpose may assume various forms but that shown comprises a pilot element in the form of a constant speed electric motor 49 of standard

type. The motor is directly connected to the drive shaft 50 of a double speed reduction gear set 51 of standard construction. The gear set shown comprises a pinion 52 fixed to the drive shaft 50 and meshing with a gear 53. Gear 53 drives a pinion 54 in mesh with a gear on the driven shaft 55. An appropriate form of variable speed transmission mechanism is interposed between the gear set and the sleeve 18 of the by-pass valve.

This transmission mechanism is shown in Figures 1 and 9. It includes a variable stroke crank in the form of a threaded crank arm 56 adjustably fixed in a hollow boss 57 carried by a rigid arm 58 fixed to the end of the driven shaft 55. The arm 56 is fixed in any position of adjustment by a pair of nuts 59 thereon arranged to bear against the opposite ends of the boss 57. The arm 56 carries a crank pin 60 at the outer end thereof. The arrangement is such that by a lengthwise adjustment of the arm 56 in the boss 57 the crank pin 60 may be positioned any desired distance from the axis of rotation of the shaft 55. A pair of links 61 and 62 are each connected at one end with the crank pin 60. Link 61 is connected at its other end to a lever 63 mounted to oscillate upon a shaft 64 beneath the axis thereof and link 62 is connected at its other end to a lever 65 mounted to oscillate upon the shaft 64 above the axis thereof. A disk 66 is fixed to the shaft 64 adjacent the levers 63 and 65. A dog 67 is rockably supported upon a pivot pin 68 carried by lever 63 and a similar dog 69 is rockably supported upon a pivot pin 70 carried by lever 65. Each dog is formed with a cam face 71 yieldably retained in contact with the periphery of the disk 66 under the influence of a light tension spring 72, connecting the tail 73 of each dog with its supporting lever. The cam face 71 of each dog is so shaped as to be clamped into driving engagement with the periphery of the disk during each counter-clockwise swing of the supporting lever and to drag over the periphery of the disk during each clockwise swing of the lever. Thus, during rotation of the crank arm 56 about the axis of shaft 55, the crank pin 60, through the links 61 and 62, causes the levers 63 and 65 to oscillate about the axis of shaft 64 through arcs whose length are dependent upon the position of adjustment of the arm 56 in the boss 57. As both levers oscillate toward the right dog 67 forces the disk to rotate in a counter-clockwise direction while dog 69 slips about the periphery of the disk in a clockwise direction. Then as the levers reverse their swing so as to oscillate toward the left, dog 69 comes into play to again rotate the disk in a counter-clockwise direction while dog 67 moves about the periphery of the disk in a clockwise direction. The disk is thus rotated in one direction at a rate dependent upon the posi-

tion of the crank pin 60 with respect to the axis of shaft 55.

The shaft 64 carrying the disk 66 is journaled in an appropriate fixed bracket 74 and carries a pinion 75 fixed thereto. The pinion 75 meshes with a gear 76 mounted upon a stub shaft journaled in the bracket 74. A spring pressed pin 77 mounted in the bracket 74 bears at all times against the face of the disk 66 so as to frictionally resist rotation of the disk except under the influence of the dogs 67 and 69. A coupling 78 of standard form provided on the projecting end of the sleeve 18 of the valve is engaged in driving relation with the gear 76 so as to cause the sleeve to rotate therewith. The sleeve of the valve is thus rotated in a clockwise direction (Figures 5 to 8) at a predetermined rate dependent upon the adjustment of the crank arm 56.

The core 21 of the valve is provided at its projecting end with a transverse pin 79 engaged with a coupling element 80 fixed to the end of a shaft 81 journaled in a fixed bracket 82. The other end of shaft 81 carries a pinion 83 in mesh with a gear 84 fixed to a shaft 85 journaled in fixed bearings 86 and 87. A ratchet wheel 88 is fixed to shaft 85 adjacent the bearing 87, and a hollow drum 89 is rotatably mounted on the shaft 85 between the bearing 86 and wheel 88. A pivoted pawl 90 carried by the drum is yieldably retained in engagement with the teeth of the wheel 88 by a spring 91. The arrangement is such that when the drum is rotated in a counter-clockwise direction (Figure 2) similar rotation is imparted to the shaft 85 through the pawl and ratchet wheel, but the drum is free to rotate in a clockwise direction without disturbing the ratchet wheel or shaft 85.

The drum 89 is connected to and operated by the ram 12 through a cable 92. This cable is shown connected at one end to a post 93 carried by a split collar 94 fixed to the ram 12. The other end of the cable is anchored to and wrapped about the drum. The cable 92 is maintained under tension by a coil spring 95 within the drum. This spring is anchored at one end to the hub 96 of the drum and at its other end to a bracket arm 97 fixed to the bearing bracket 86, so that the spring tends to rotate the drum in a clockwise direction (Figure 2). It will thus be understood that as the ram 12 travels toward the right (Figures 1, 2 and 3) the drum 89 is rotated in a counter-clockwise direction under the pull of the cable 92 and against the tension in the spring 95, at a rate corresponding to the movement of the ram. This rotation is transmitted through the ratchet wheel 88, shaft 85, gear 84, pinion 83 and shaft 81 to the core 21 of the valve so that the core is rotated in a clockwise direction at a rate dependent upon the speed of the ram.

In operation, the pump 13 is so adjusted as to deliver a driving liquid to the pipe 16 at a rate slightly in excess of that required by the cylinder to effect movement of the ram 12 toward the right at the desired rate of speed, and the timing mechanism is so adjusted as to effect rotation of the sleeve 18 of the valve at a rate equal to the rate of rotation of the core 21 at the desired speed of the ram. Then as the ram advances toward the right the core 21, actuated thereby and rotating with the sleeve 18, will assume an angular position within the sleeve, somewhat as shown in Figure 7, in which the transverse passage 23 in the core is in partial communication with the saw cuts 30 in the sleeve, thus providing a by-pass for small quantities of fluid from pipe 34 to pipe 29. So long as the ram maintains the desired rate of speed this relation between the core and sleeve is maintained and the amount of fluid by-passed through the valve is substantially equal to the excess of fluid delivered by the pump into the pipe 16. Should the ram, however, tend to fall below the desired speed the speed of rotation of the core will be immediately reduced, with the result that the core will rotate slightly in a counter-clockwise direction with respect to the sleeve and the communication between the transverse passage 23 and saw cuts 30 will be decreased, causing a corresponding decrease in the amount of fluid by-passed through the valve, a resultant increase of fluid delivered to the cylinder, and consequent increase in the speed of the ram to normal. An increase in speed of the ram above normal will result in an immediate increase in the rate of rotation of the core, causing the core to rotate slightly in a clockwise direction relative to the sleeve and increasing the communication between passage 23 and saw cuts 30. This obviously effects an increase in the amount of fluid by-passed through the valve and reduces the speed of the ram. It will thus be noted that the valve responds immediately to any fluctuations in the speed of the ram to effect return thereof to the rated normal speed. Any marked reduction in the speed of the ram will result in relative rotation between the core and sleeve of the valve until the passage 23 no longer communicates with the saw cuts 30, no fluid is by-passed, and the cylinder receives the entire discharge of the pump. With extremely great increases in the speed of the ram relative rotation between the core and sleeve may be such as to effect registration between the passage 23 and ports 31 in which event the major portion of the pump discharge may pass through the valve.

In the embodiment of the invention shown no attempt is made to govern the speed of the ram during the return stroke thereof, toward the left, and provision is preferably made for rendering the by-pass valve in-

effective upon the hydraulic circuit during such movement of the ram. This may be accomplished by inserting a check valve of standard form within the by-pass circuit.

- 5 Such a valve is shown inserted in the pipe line 29. Thus valve comprises the usual casing 98 having a valve seat 99 cooperating with a spring loaded valve 100. The valve permits a free flow of fluid toward the right in pipe 29 so that during the advance stroke of the ram fluid passing through the by-pass valve is free to pass through pipe 29 to the pipe 17 constituting the return side of the circuit. The valve prevents passage of fluid toward the left through pipe 29, however, so that, when the pump is reversed and delivers into the pipe 17 to effect a return stroke of the ram, the fluid under pressure in the pipe 17 is not admitted to the by-pass valve, and the by-pass valve is effectively cut out of the circuit.

Various changes may be made in the embodiment of the invention hereinabove specifically described, without departing from or sacrificing any of the advantages of the invention as defined in the appended claims.

I claim:

1. The combination of a driven member, a piston and cylinder for driving said member, a pump for delivering a driving liquid to said cylinder to effect a rectilinear advance of said member, a rotary element actuated in response to the advance of said member, a pilot member operating at constant speed, a second element, ratchet mechanism between said pilot member and said second element adjustable to operate the latter at selected speeds, and means under the joint control of said elements for controlling the rate of advance of said driven member.

2. The combination of a driven member, a piston and cylinder for driving the same, a pump, hydraulic connections between said pump and cylinder, a pilot member driven at constant speed, a by-pass valve associated with said connections and under the joint control of said driven and pilot members to effect movement of said driven member at a uniform rate.

3. In combination a driven member, means including a hydraulic circuit for driving said member, a by-pass valve connected across said circuit, a pilot member driven at predetermined speeds, and valve operating means under the control of said pilot and driven members for maintaining a definite speed relation therebetween.

4. In combination a driven member, a pump, means including a hydraulic circuit actuated by fluid delivered by said pump for driving said member, a pilot member driven at predetermined speeds, and a by-pass valve connected with said circuit and under the joint control of said pilot and driven mem-

bers for controlling the speed of operation of said driving means.

5. In a hydraulic transmission the combination of a hydraulic motor, a pump for delivering a driving liquid to said motor to operate the same in either direction, speed governing mechanism operable to render the speed of said motor constant in one direction, and means for rendering said mechanism ineffective during operation of said motor in the opposite direction.

6. In a hydraulic transmission the combination of a hydraulic motor, a pump for delivering a driving liquid to said motor to operate the same in either direction, a pilot member operating at constant speed, means under the joint control of the pilot member and motor to maintain a constant speed relation therebetween when said motor is operating in one direction, and means operable to render said last named means ineffective during operation of said motor in the opposite direction.

7. In combination a driven member, hydraulic means for driving said member, and a by-pass valve associated with said hydraulic means for maintaining the rate of movement of said member substantially constant, said valve comprising two cooperating relatively movable elements, means for driving one of said elements at a predetermined rate, and means for driving the other of said elements at a rate corresponding to the rate of movement of said member.

8. In combination a driven member, hydraulic means for driving said member, and a by-pass valve associated with said hydraulic means for maintaining the rate of movement of said member substantially constant, said valve including two rotary elements, one comprising a plug having a passage therein, and the other comprising a sleeve for controlling the flow of liquid through said passage, means for driving one of said elements at a predetermined speed, and means for driving the other at a rate corresponding to the rate of movement of said member.

9. In combination a driven member, hydraulic means for driving said member, and a by-pass valve associated with said hydraulic means for maintaining the rate of movement of said member substantially constant, said valve including a plug having a passage therein and a sleeve surrounding said plug and having a narrow slot for controlling said passage, and means responsive to slight variations in the rate of movement of said member for effecting a relative adjustment between said plug and sleeve.

10. In combination a driven member, a valve having two relatively movable elements, means for driving one of said elements at a predetermined rate, means for varying the rate of movement of said ele-

ment, means for driving the other of said elements at a rate corresponding to the rate of movement of said member, and fluid connections controlled by the relative positions between said elements for controlling the rate of movement of said member.

In witness whereof, I hereunto subscribe my name this 13th day of February, 1925.

WALTER FERRIS.

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