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HYDRAULIC DRIVE

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Fig. 1.

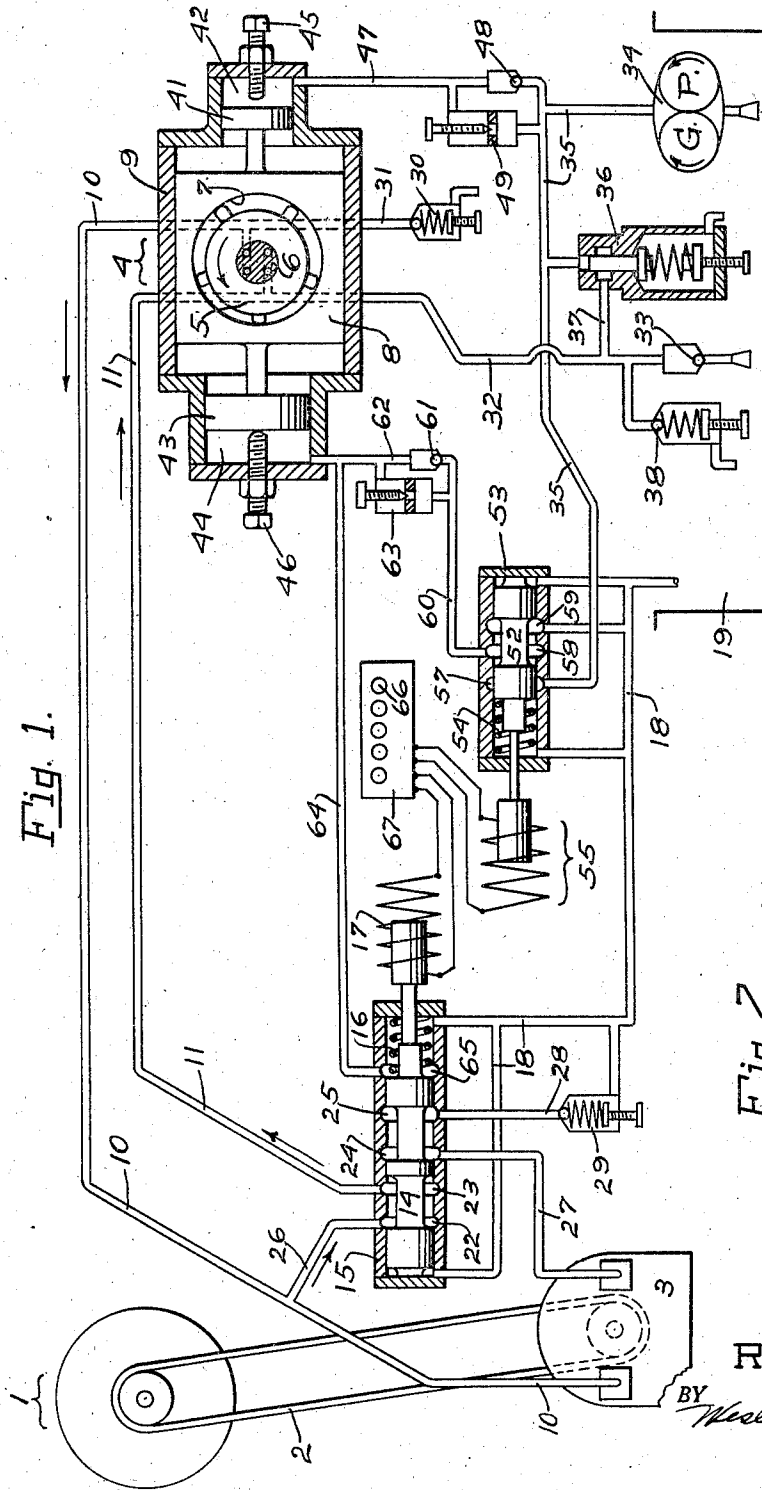


Fig. 2.

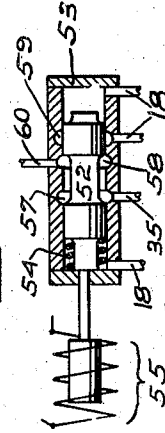
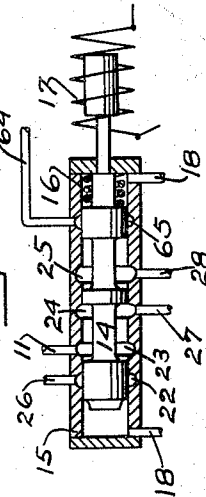


Fig. 3.



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HYDRAULIC DRIVE

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9 Claims. (Cl. 60—53)

This invention relates to drives for machines which require to be driven at two different speeds, such as a rotary printing press which should be driven at a low speed when a web of paper is being threaded therethrough and at a high speed when the paper is being printed by the press. When changing from low speed to high speed, the press should be accelerated gradually to avoid breaking the web of paper, and it is also desirable that the press be decelerated gradually.

The present invention has as an object to provide a drive which will drive a machine at either of two predetermined speeds, which will gradually accelerate the machine from low speed to high speed and which will gradually decelerate the machine from high speed to low speed.

Another object is to provide a drive of this character which is relatively simple in construction and susceptible of close adjustment and control.

Other objects and advantages will appear from the description hereinafter given of a drive in which the invention is embodied.

According to the invention in its general aspect and as ordinarily embodied in practice, a hydraulic motor for driving a machine is energized by liquid supplied thereto from a pump having a member which is shiftable between two preset positions to cause the pump to deliver liquid at one or the other of two predetermined rates and thereby cause the motor to drive the machine at one or the other of two predetermined speeds, and means are provided for limiting the rate at which pump delivery is varied to thereby cause the speed of the machine to be gradually varied from one speed to the other.

The invention is exemplified by the hydraulic drive shown schematically in the accompanying drawing in which the views are as follows:

Fig. 1 is a diagram of the hydraulic circuit.

Fig. 2 is a view showing a start and stop valve in a position different from that shown in Fig. 1.

Fig. 3 is a view showing a control valve in a position different from that shown in Fig. 1.

Since the machine to be driven forms no part of the present invention, it has been represented by a single roller 1 and shown as being connected by a suitable drive 2 to a constant displacement rotary hydraulic motor 3. Liquid for energizing motor 3 is supplied thereto by a variable displacement pump 4 which may be of any suitable type.

The pump shown schematically in Fig. 1 is of the rolling piston type which is fully illustrated

and described in Patent No. 2,074,068. It is deemed sufficient to state herein that pump 4 has its pistons and cylinders arranged radially in a cylinder barrel 5 which rotates upon a stationary valve shaft or pintle 6 having formed therein ports and passages through which liquid flows to and from the cylinders, that the outer ends of the pistons react against an annular reaction surface 7 which in practice is formed in a separate rotatable thrust member carried by a slide block 8 but which has been shown as being formed in slide block 8, that pump 4 will discharge liquid at a rate dependent upon the distance the axis of reaction surface 7 is offset toward the right from the axis of cylinder barrel 5, and that slide block 8 is arranged in a casing 9 which permits it to be moved transversely of pintle 6 but prevents it from moving in any other direction.

Pump 4 discharges liquid into a supply channel 10 which has one of its ends in communication with the ports and passages in one side of pintle 6 and its other end connected to the inlet port of motor 3. Liquid is returned from motor 3 to pump 4 through a channel 11 which communicates with the ports and passages in the other side of pintle 6.

The delivery of liquid to motor 3 is controlled by a start and stop valve 14 which is fitted in a valve casing 15 and urged toward the left to the position shown in Fig. 1 by a helical compression spring 16 and which is adapted to be moved toward the right to the position shown in Fig. 2 by a solenoid 17 to the core of which the stem of valve 14 is connected.

In order to prevent the movement of valve 14 from being hampered by entrapped liquid or gas, the extreme ends of valve casing 15 are connected to a drain channel 18 which discharges into any suitable place such as a reservoir 19 which is ordinarily arranged in the casing of pump 4 but which for the purpose of illustration has been shown as being separate therefrom.

Valve 14 controls communication between four annular grooves or ports 22, 23, 24 and 25 which are formed in the bore of casing 15. Port 22 is connected by a channel 26 to supply channel 10 intermediate the ends thereof. Port 23 has the other end of return channel 11 connected thereto. Port 24 is connected by a channel 27 to the discharge port of motor 3. Port 25 is connected by a channel 28 to the inlet of a resistance valve 29 which functions as a brake and discharges into drain channel 18.

When valve 14 is in the position shown in Fig.

2 and pump 4 is running, pump 4 will deliver liquid through channel 10 to motor 3 and cause it to drive machine 1. The liquid discharged at this time by motor 3 will flow through channel 27, valve casing 15 and channel 11 to the intake of pump 4. The pressure created by pump 4 is limited by a relief valve 30 which is connected by a channel 31 to channel 10 and discharges into reservoir 19.

When valve 14 is in the position shown in Fig. 1, channel 10 is open to channel 11 through channel 26 and valve casing 15 so that pump 4 is bypassed. The liquid discharged at this time by motor 3 passes through channel 27, valve casing 15, channel 28, brake valve 29 and drain channel 18 into reservoir 19, brake valve 29 resisting the passage of liquid therethrough and thereby functioning as a brake to decelerate motor 3 and machine 1.

The liquid discharged by motor 3 when stopping is drawn from channel 10 so that the volume returned to pump 4 through channel 11 is considerably less than the volume required to keep the pump cylinders filled. Consequently, liquid must be supplied to pump 4 from reservoir 19 to make up for the volume that passes through motor 3.

Pump 4 is supercharged by a gear pump to be presently described but, in case the volume supplied by the gear pump is insufficient to make up for the volume that passes through motor 3 when the machine is being stopped, pump 4 is able to draw liquid from reservoir 19 through a channel 32 which has one of its ends connected to the intake of pump 4 and its other end extending into reservoir 19, the lower part of channel 32 having a check valve 33 arranged therein to permit liquid to be drawn freely from reservoir 19 but preventing it from flowing in the opposite direction.

Liquid for supercharging pump 4 and for control purposes is supplied by a gear pump 34 which is ordinarily driven in unison with pump 4 and arranged in the casing thereof according to the usual practice but which for the purpose of illustration has been shown separate from pump 4 and adapted to draw liquid from reservoir 19 and discharge it into a low pressure supply channel 35.

The pressure created by gear pump 34 is limited by a relief valve 36 which has its inlet connected to channel 35 and its outlet connected by a channel 37 to suction channel 32 above check valve 33. The pressure in channel 32 is limited by a relief valve 38 which discharges into reservoir 19 and has its inlet connected to suction channel 32 at a point above check valve 33.

Gear pump 34 discharges liquid at a rate in excess of requirements except possibly when motor 3 is discharging through brake valve 29 as explained above. At all other times, the excess liquid discharged by gear pump 34 is exhausted through relief valves 36 and 38 into reservoir 19. Relief valve 38 may be of the ordinary type but it is preferably of the type that is not affected by back pressure. The arrangement is such that gear pump 34 is able to maintain at all times in channel 35 a pressure equal to the resistance of relief valve 36 and to maintain in channel 32 a pressure equal to the resistance of relief valve 38 whenever pump 4 is not drawing liquid through channel 32 from reservoir 19.

The displacement of pump 4 is adapted to be varied between a predetermined minimum and a

predetermined maximum by two servo-motors one of which is larger than the other and both of which are operated by liquid supplied by gear pump 34.

As shown, the smaller servo-motor has its piston 41 connected to slide block 8 and fitted in a cylinder 42 arranged upon one side of pump casing 9, and the larger servo-motor has its piston 43 connected to slide block 8 and fitted in a cylinder 44 arranged upon the other side of pump casing 9. The movement of slide block 8 is limited by two adjustable stop screws 45 and 46 threaded, respectively, through the end heads of cylinders 42 and 44 and adapted to engage the pistons therein.

Cylinder 42 is connected to low pressure supply channel 35 through a channel 47 and a check valve 48 which permits liquid to flow freely from channel 35 to cylinder 42 so that slide block 8 is constantly urged toward the left by the liquid acting upon piston 41. Check valve 48 prevents liquid from escaping from cylinder 42 except through an adjustable choke 49 which is connected in parallel with check valve 48 and regulates the speed at which slide block 8 may move toward the right.

The flow of liquid to and from cylinder 44 is controlled by a valve 52 which is fitted in a valve casing 53 and urged toward the right to the position shown in Fig. 1 by a helical compression spring 54 arranged between valve 52 and one end of casing 53. Valve 52 is adapted to be moved toward the left to the position shown in Fig. 3 by a solenoid 55 which has its core connected to the stem of valve 52. In order to prevent the movement of valve 52 from being hampered by entrapped liquid or gas, the extreme ends of valve casing 53 are connected to drain channel 18.

Valve casing 53 has three annular grooves or ports 57, 58 and 59 formed in the wall of its bore intermediate the ends thereof. Port 57 has supply channel 35 connected thereto. Port 59 is connected to drain channel 18. Port 58 is arranged between ports 57 and 59 and connected to cylinder 44 by a channel 60, a check valve 61 and a channel 62.

Check valve 61 permits liquid to flow freely to cylinder 44 but prevents it from escaping from cylinder 44 except through an adjustable choke 63 which has its inlet connected to channel 62 and its outlet connected to channel 60. Choke 63 limits the rate at which liquid may escape from cylinder 44 and thereby limits the rate at which slide block 8 may move toward the left.

Instead of arranging check valves 48 and 61 and chokes 49 and 63 as shown, the positions thereof may be reversed so that the movement of slide block 8 would be controlled by throttling the flow of liquid to cylinders 42 and 44 and liquid could escape freely therefrom.

Brake valve 29 has sufficient resistance to cause motor 3 and machine 1 to stop very quickly after valve 14 has been shifted to the position shown in Fig. 1, and choke 63 causes slide block 8 to move slowly from its maximum displacement position to its minimum displacement position. Therefore, if the operator should restart the machine immediately after stopping it, slide block 8 might not have reached its minimum displacement position and pump 4 might be delivering liquid at a rate high enough to cause motor 3 to start machine 1 so quickly that the paper would be broken.

In order to avoid this danger, provision is

made for causing slide block 8 to be moved to its minimum displacement position substantially instantaneously when valve 14 is operated to stop the machine.

As shown, channel 62 is connected by a channel 64 to a port 65 which is formed in the bore of valve casing 15 and controlled by valve 14. The arrangement is such that, when valve 14 is in the position shown in Fig. 2, port 65 is blocked so that no liquid can escape from cylinder 44 through channel 64 and the movement of slide block 8 is controlled by valve 52 but, when valve 14 is in the position shown in Fig. 1, port 65 is open to drain channel 18 so that liquid may escape freely from cylinder 44 through channels 62 and 64, valve casing 15 and drain channel 18 into reservoir 19, thereby permitting piston 41 to move slide block 8 to its minimum displacement position substantially instantaneously.

Operation

Assuming that valves 14 and 52 are in the positions shown in Fig. 1 and that pumps 4 and 34 are running, the drive will operate as follows:

Pressure from gear pump 34 will extend to cylinder 42 and cause piston 41 to hold piston 43 against adjusting screw 46 in which position of slide block 8 pump 4 will discharge liquid at a predetermined minimum rate as determined by the adjustment of screw 46, and the liquid discharged by pump 4 will flow through channels 10 and 26, valve casing 15 and channel 11 to the intake of pump 4 so that motor 3 will remain idle.

When solenoid 17 is energized, it will shift valve 14 from the position shown in Fig. 1 to the position shown in Fig. 2 and then liquid from pump 4 will flow through channel 10 to motor 3 and cause it to drive machine 1 at a slow speed appropriate for threading a web of paper through a printing press, the speed being determined by the adjustment of screw 46.

Then when solenoid 55 is energized, it will shift valve 52 from the position shown in Fig. 1 to the position shown in Fig. 3 so that port 57 is opened to port 58 and port 59 is blocked. Liquid from gear pump 34 may then flow through channel 35, valve casing 53, channel 60, check valve 61 and channel 62 to cylinder 44. Since cylinder 44 is larger than cylinder 42, the force exerted by the liquid upon piston 43 will cause it to move slide block 8 toward the right to increase pump displacement to maximum as determined by the adjustment of screw 46. Slide block 8 in moving toward the right will cause piston 41 to expel liquid from cylinder 42 through channel 47 and choke 49 into channel 35.

Choke 49 will limit the rate of flow there-through and thereby cause slide block 8 to move at a limited rate so that pump displacement and delivery are gradually increased from the predetermined minimum to the predetermined maximum with the result that motor 3 is caused to gradually accelerate machine 1 from a slow speed to a predetermined high speed.

If for any reason, such as for the purpose of inspection or to splice in a web of paper from a new roll, it is desired to decelerate machine 1 to its minimum speed, solenoid 55 may be deenergized to permit spring 54 to shift valve 52 to the position shown in Fig. 1 to thereby open cylinder 44 to drain so that the liquid delivered by gear pump 34 to cylinder 42 can cause piston

41 to move slide block 8 toward the left to reduce the displacement of pump 4 to minimum.

Slide block 8 in moving toward the left will cause piston 43 to expel liquid from cylinder 44 through channel 62, choke 63, channel 60, valve casing 53 and drain channel 18 into reservoir 19. Choke 63 will limit the rate at which slide block 8 is moved toward the left. Consequently, the volumetric delivery of pump 4 will be gradually reduced from the predetermined maximum to the predetermined minimum and thereby cause motor 3 and machine 1 to be gradually decelerated from high speed to low speed.

When it is desired to stop the machine, solenoid 17 is deenergized and spring 16 will shift valve 14 to the position shown in Fig. 1, thereby bypassing pump 4 and causing motor 3 to discharge through brake valve 29 as previously explained.

Shifting valve 14 to its Fig. 1 position opens channel 64 to drain channel 18 so that slide block 8 may be quickly shifted to its minimum displacement position by gear pump liquid acting on piston 41. However, if valve 52 remained in its Fig. 3 position, gear pump supply channel 35 would be open to drain through valve casing 53, channel 60, check valve 61, channels 62 and 64 and valve casing 15. Therefore, in order to prevent the loss of gear pump liquid and to enable gear pump 34 to create pressure to operate servo-motor 41—42, solenoids 17 and 55 are deenergized simultaneously by operating a single push button switch 66 arranged in a control panel 67.

The invention herein set forth is susceptible of various modifications without departing from the scope thereof as hereafter claimed.

The invention is hereby claimed as follows:

1. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same, hydraulic servo-motor means for varying the volumetric delivery of said pump between two predetermined rates to thereby cause said motor to drive said machine either at a predetermined minimum speed or at a predetermined maximum speed, means for supplying liquid to said servo-motor means to energize the same, means for controlling the operation of said servo-motor means; choke means for limiting the rate of operation of said servo-motor means to thereby cause the delivery of said pump to be gradually varied from one to the other of said rates, a valve for bypassing liquid around said choke means to thereby enable said servo-motor means to quickly vary the delivery of said pump from one to the other of said rates, and means for operating said valve to render said choke means effective or ineffective.

2. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same, hydraulic servo-motor means for varying the volumetric delivery of said pump between two predetermined rates to thereby cause said motor to drive said machine either at a predetermined minimum speed or at a predetermined maximum speed, means for supplying liquid to said servo-motor means to energize the same, means for controlling the operation of said servo-motor means, choke means for limiting the rate of operation of said servo-motor means to thereby cause the delivery of said pump to

be gradually varied from one to the other of said rates, means for short circuiting said pump, and means operated in unison with said short circuiting means for bypassing liquid around said choke means to thereby enable said servo-motor means to quickly vary the delivery of said pump from one to the other of said rates.

3. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same, hydraulic servo-motor means for varying the volumetric delivery of said pump between two predetermined rates to thereby cause said motor to drive said machine either at a predetermined minimum speed or at a predetermined maximum speed, means for supplying liquid to said servo-motor means to energize the same, means for controlling the operation of said servo-motor means, choke means for limiting the rate of operation of said servo-motor means to thereby cause the delivery of said pump to be gradually varied from one to the other of said rates, and a valve for controlling operation of said motor and for bypassing liquid around said choke means to thereby enable said servo-motor means to quickly vary the delivery of said pump from one to the other of said rates.

4. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same, hydraulic servo-motor means for varying the volumetric delivery of said pump between two predetermined rates to thereby cause said motor to drive said machine either at a predetermined minimum speed or at a predetermined maximum speed, means for supplying liquid to said servo-motor means to energize the same, a valve for controlling the operation of said servo-motor means, choke means for limiting the rate of operation of said servo-motor means to thereby cause the delivery of said pump to be gradually varied from one to the other of said rates, a valve for controlling operation of said motor and for bypassing liquid around said choke means to thereby enable said servo-motor means to quickly vary the delivery of said pump from one to the other of said rates, and means for operating both of said valves simultaneously.

5. A hydraulic drive, comprising a hydraulic motor, a pump hydraulically connected to said motor for supplying liquid thereto to energize the same and having a member for varying its displacement, servo-motor means for shifting said member between two preset limits to thereby vary pump delivery between two predetermined rates, means for supplying motive liquid to said servo-motor means to energize the same, means for controlling the operation of said servo-motor means, choke means for limiting the rate at which said servo-motor means can shift said member to thereby cause pump delivery to be gradually varied from one to the other of said rates, a valve for bypassing liquid around said choke means during movement of said member in one direction to enable said servo-motor means to shift said member at high speed in said direction and thereby quickly vary pump delivery from the higher to the lower of said rates, and means for operating said valve to render said choke effective or ineffective.

6. A hydraulic drive, comprising a hydraulic motor, a pump hydraulically connected to said motor for supplying liquid thereto to energize

the same and having a member for varying its displacement, servo-motor means for shifting said member between two preset limits to thereby vary pump delivery between two predetermined rates, means for supplying motive liquid to said servo-motor means to energize the same, means for controlling the operation of said servo-motor means, choke means for limiting the rate at which said servo-motor means can shift said member to thereby cause pump delivery to be gradually varied from one to the other of said rates, means for short circuiting said pump, and means operable in unison with said short circuiting means for bypassing liquid around said choke means during movement of said member in one direction to enable said servo-motor means to shift said member at high speed in said direction and thereby quickly vary pump delivery from the higher to the lower of said rates.

7. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same and having a member shiftable in opposite directions to vary the volumetric delivery of said pump between a predetermined maximum and a predetermined minimum, two hydraulic servo-motors for shifting said member in one direction or the other to vary the volumetric delivery of said pump between two predetermined rates and thereby cause said motor to drive said machine either at a predetermined minimum speed or at a predetermined maximum speed, means for supplying motive liquid to said servo-motors, means for controlling the operation of said servo-motors, choke means for limiting the rate of operation of said servo-motors so as to gradually change pump delivery from one to the other of said rates and thereby cause the speed of said machine to be gradually varied from one to the other of said predetermined speeds, means for bypassing said pump and simultaneously applying a brake load to said motor, and means co-acting with the last mentioned means for connecting one of said servo-motors to drain to thereby enable the other servo-motor to reduce pump displacement to the minimum substantially simultaneously with the application of a brake load to said motor.

8. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same and having a member shiftable in opposite directions to vary the volumetric delivery of said pump between a predetermined maximum and a predetermined minimum, two hydraulic servo-motors for shifting said member in one direction or the other to vary the volumetric delivery of said pump between two predetermined rates and thereby cause said motor to drive said machine either at a predetermined minimum speed or at a predetermined maximum speed, means for supplying motive liquid to said servo-motors, means for controlling the operation of said servo-motors, choke means for limiting the rate of operation of said servo-motors so as to gradually change pump delivery from one to the other of said rates and thereby cause the speed of said machine to be gradually varied from one to the other of said predetermined speeds, a brake valve, and a start and stop valve operable either to direct liquid from said pump to said motor and from said motor to said pump or to bypass said pump and direct liquid from said motor to said brake

valve, said start and stop valve when shifted to a position to bypass said pump being also adapted to connect one of said servo-motors to drain to thereby enable the other servo-motor to reduce pump displacement to minimum substantially instantaneously.

9. A drive for operating a machine at predetermined speeds, comprising a hydraulic motor for driving said machine, a pump for supplying liquid to said motor to energize the same and having a member shiftable in opposite directions to vary the volumetric delivery of said pump between a predetermined minimum and a predetermined maximum, a source of constant pressure liquid, a small servo-motor connected to said source and constantly urging said member in a direction toward minimum delivery position, a large servo-motor for moving said member in the opposite direction toward maximum delivery position, means including a valve for either connecting said large servo-motor to drain to enable said small servo-motor to move said member in said direction or for connecting said large servo-

motor to said source to enable it to move said member in said opposite direction whereby the delivery of said pump is varied between two predetermined rates and said motor is caused to drive said machine either at a predetermined maximum speed or at a predetermined minimum speed, a choke connected to each of said servo-motors for limiting the rate at which liquid may escape therefrom to thereby cause said servo-motors to gradually vary pump displacement with the resultant gradual variation in the speed of said machine, a brake valve for applying a brake load to said motor, and a start and stop valve operable either to direct liquid from said pump to said motor and from said motor to said pump or to bypass said pump and direct liquid from said motor through said brake valve and simultaneously connect said larger servo-motor directly to drain to thereby enable said small servo-motor to reduce pump displacement to minimum substantially simultaneously with the application of a brake load to said motor.

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