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HYDRAULIC TRANSMISSION

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Fig. 1.

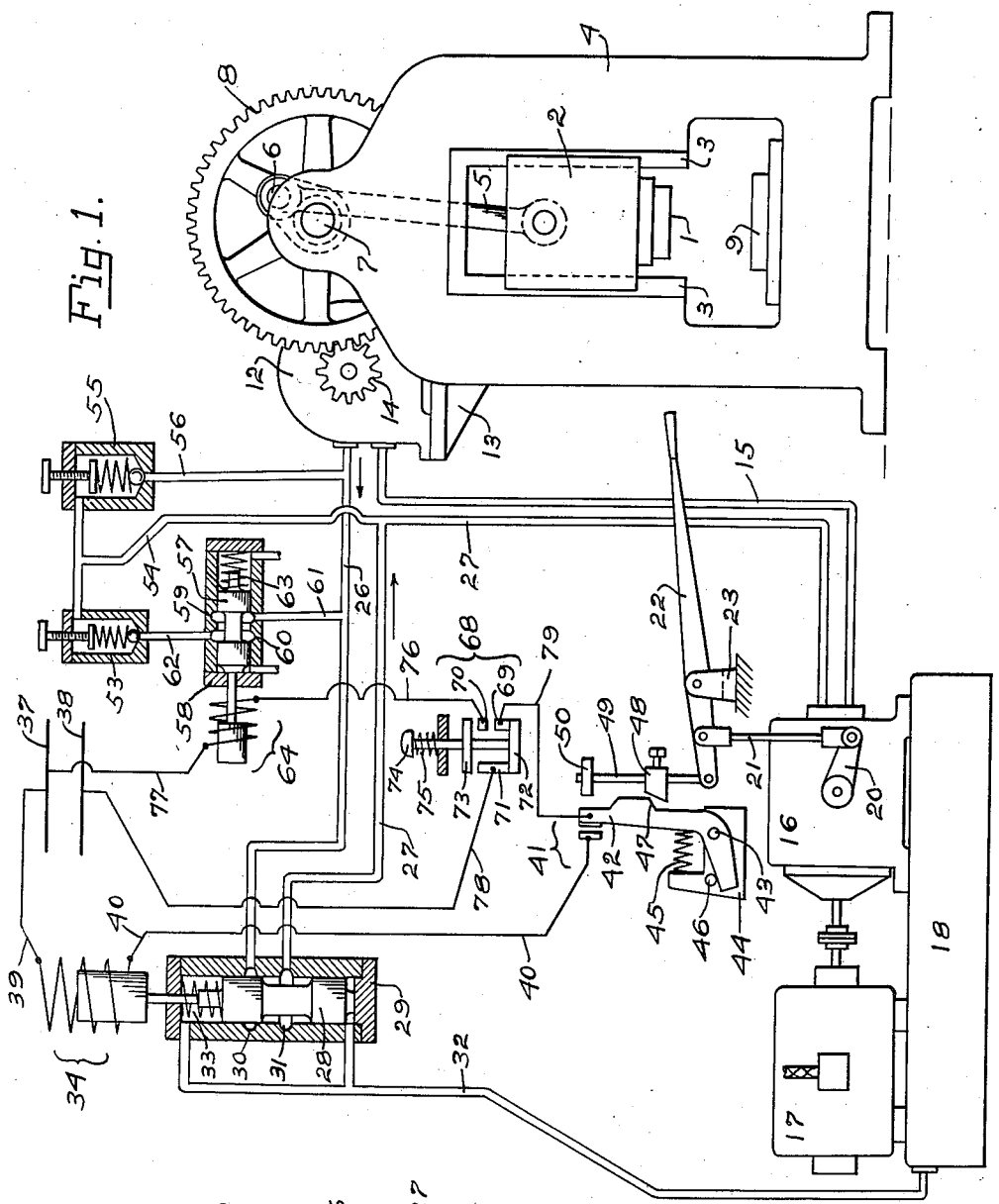
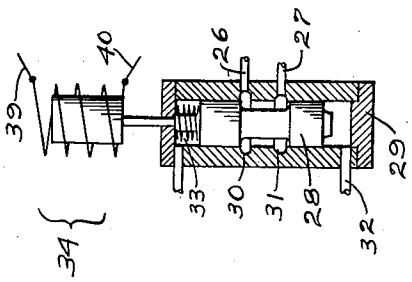


Fig. 2.



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HYDRAULIC TRANSMISSION

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10 Claims. (Cl. 60—53)

This invention relates to a hydraulic transmission of the type which includes a rotary hydraulic motor and a variable displacement pump.

A transmission of this type is sometimes employed to drive a shaft or the like which tends to overrun and drive the motor under certain conditions of operation or during a part of a revolution. For example, the crank of a crankshaft or the cam of a camshaft may oppose the movement of the shaft until the crank or cam passes dead center in respect to the load and then the load will react upon the crank or cam and tend to drive the shaft and thereby tend to cause the shaft to drive the prime mover that drives it, and also taking up all of the backlash in the gearing between the driving motor and the shaft, thus causing a sudden jerky movement.

The invention has as an object to provide means for preventing a member which is driven by the motor of a hydraulic transmission from overrunning and driving the motor.

Another object is to provide means for preventing the motor of the hydraulic transmission from being driven by the member driven thereby, other means for applying a brake load to the motor, and means for rendering either of said means effective or ineffective.

Other objects and advantages will appear from the following description of the hydraulic transmission shown schematically in the accompanying drawing in which the views are as follows:

Fig. 1 is a diagrammatic view showing the invention incorporated in a hydraulic transmission which is employed to drive a blanking press, the several parts being shown in the positions occupied when the press is idle.

Fig. 2 is a view showing a bypass valve in a position occupied when the press is in operation.

For the purpose of illustration, the invention has been shown as being employed to drive a blanking press but it is to be understood that it may as readily be employed to drive any rotating member which has a tendency to overrun during a given part of each revolution or under certain conditions of operation.

The press chosen for illustration is adapted to have an upper die 1 fixed to a platen 2 which is fitted for vertical reciprocation between guides or ways 3 carried by the frame 4 of the press. Platen 2 is connected by a link 5 to the crankpin 6 of a crankshaft 7 which is journaled in the upper end of frame 4. Shaft 7 has fixed thereon a gear wheel 8 by means of which it may be rotated to cause platen 2 to be reciprocated vertically along guides 3 to move die 1 toward and from a lower die 9 carried by frame 4.

The die carried by the platen of a press of this type is often so large and heavy that, as soon as the crankpin passes upper dead center, the combined weight of the platen and the upper die is great enough to cause the crankshaft to overrun and tend to drive the prime mover that drives it.

This tendency of the crankshaft to overrun does no harm during normal operation of the press but, before the dies are finally adjusted, it is essential that the upper die be lowered until it is just clear of the lower die, then the dies be carefully adjusted, and then the upper die be slowly lowered into the lower die for the reason that a pair of blanking dies have a very close fit one with the other and, if the upper die strikes the lower die, one or both of the dies are ruined or at least damaged. The present invention provides means for preventing overrun of the crankshaft so that the upper die may be inched toward and into the lower die as will presently appear.

Power for driving the press is transmitted thereto through a hydraulic motor 12 which has been shown arranged upon a bracket 13 carried by frame 4. Motor 12 is provided with a driving pinion 14 which meshes with gear wheel 8 so that, when motor 12 is energized, it will rotate gear wheel 8 and crankshaft 7 and thereby reciprocate platen 2.

Motor 12 is driven by liquid supplied thereto through a pressure channel 15 by a variable displacement pump 16 which has been shown as being driven by an electric motor 17 and arranged therewith upon a reservoir 18 from which pump 16 is supplied with liquid through a channel not shown.

Pump 16 may be of any suitable type which has means for varying its displacement and is provided with a relief valve which will open when pump pressure becomes excessive, such as the pump shown in Patent No. 2,033,464. The pump shown in said patent has its displacement varied by a hydraulic servo-motor operated by liquid supplied thereto by an auxiliary pump under the control of a follow-up valve so that a variation in pump displacement is always proportional to the distance through which the valve is moved. The follow-up valve shown in the patent is of the reciprocating type but, in practice, a rotary valve is ordinarily employed.

For the purpose of illustration, pump 16 is shown provided with a lever 20 which controls pump displacement as by having one end there-

of connected to the valve referred to above. Lever 20 has its free end connected by a link 21 to a hand lever 22 which is pivoted intermediate its ends upon a stationary bracket 23. The arrangement is such that, when the free end of lever 22 is raised to the position shown, pump displacement will be zero and no liquid will be discharged by pump 16 into channel 15 and, when the free end of lever 22 is depressed, pump displacement will be increased from zero as the free end of lever 22 is lowered and pump 16 will discharge liquid into channel 15 at a rate dependent upon the distance the free end of lever 22 is moved from the position shown.

When pump 16 is being driven by electric motor 17 and the free end of lever 22 has been depressed, pump 16 will deliver liquid through channel 15 to hydraulic motor 12 which will discharge liquid into a channel 26, and liquid will be returned to pump 16 through a return channel 27. Free communication between channels 26 and 27 is controlled by a by-pass valve 28 which is closely fitted in a valve casing 29 having formed therein two ports 30 and 31 with which channels 26 and 27 communicate respectively. In order that valve 28 may reciprocate freely in casing 29, a drain channel 32 is connected to both ends of casing 29 and discharges into reservoir 18.

Valve 28 is urged by a spring 33 in a direction to close communication between ports 30 and 31, and it is adapted to be moved against the resistance of spring 33 in a direction to open communication between ports 30 and 31 by a solenoid 34 which has its core connected to the stem of valve 28.

Electric current for energizing solenoid 34 is supplied from a power line shown as consisting of two conductors 37 and 38. Solenoid 34 has one end of its winding connected by a conductor 39 to conductor 37 and the other end of its winding connected by a conductor 40 to the stationary contact of a normally open switch 41 the movable contact of which is connected to conductor 38 by means to be presently described.

Switch 41 is ordinarily of the snap-action type but, for the purpose of illustration, it has been shown as having its movable contact fixed to the end of a switch arm 42 which is pivoted intermediate its ends upon a pin 43 carried by a stationary bracket 44. A spring 45 arranged between switch arm 42 and an arm of bracket 44 urges the upper end of switch arm 42 in a direction to open switch 41 and hold the lower end of switch arm 42 in contact with a stop 46 carried by bracket 44.

Switch arm 42 has a cam 47 arranged thereon and adapted to be engaged by a cam 48 fixed in adjusted position upon a rod 49 which is pivoted at its lower end to hand lever 22 and has its upper end guided for vertical reciprocation by a stationary guide 50. The arrangement is such that, when the free end of lever 22 is depressed a given distance to cause pump 16 to deliver liquid through channel 15 to motor 12, cam 48 will engage cam 47 and swing switch arm 42 upon pin 43 to close switch 41, thereby energizing solenoid 34 which will shift valve 28 to open port 30 to port 31 and permit liquid discharge by motor 12 to be returned freely to pump 16. Cam 48 is ordinarily so adjusted upon rod 49 that switch 41 will not be closed until pump 16 is delivering liquid at a rate greater than a predetermined minimum rate.

It is obvious that the liquid discharged by motor 12 cannot be returned freely to pump 16 until valve 28 is shifted to open port 30 to port 31. During this time, the liquid discharged by motor 12 passes through a low pressure resistance valve 53 which has its outlet connected by a channel 54 to return channel 27. Resistance valve 53 is so adjusted that the resistance offered by it to the passage of liquid therethrough is sufficient to prevent the combined weight of die 1 and platen 2 from causing shaft 7 to overrun and drive motor 12.

If an emergency should arise during the down stroke of platen 2, such as one or more excess sheets of material being placed between the dies, and the operator should attempt to stop the press by raising the free end of lever 22 so as to reduce pump displacement to zero and to close by-pass valve 28, the resistance of valve 53 to the passage of liquid therethrough would not be great enough to overcome the inertia of the moving press parts.

In order that the press may be quickly stopped in case of an emergency, a high pressure resistance valve 55 has its inlet connected by a channel 56 to channel 26 and its outlet connected to channel 54, and communication between the outlet of motor 12 and the inlet of low pressure resistance valve 53 is controlled by a blocking valve 57.

Resistance valve 55 should be capable of being so adjusted that the resistance offered by it to the passage of liquid therethrough is sufficient to quickly stop the press even when pump 16 is delivering liquid to motor 12, it being understood that pump 16 is provided, as previously explained, with a relief valve (not shown) through which the pump discharges whenever pump pressure exceeds a predetermined maximum.

Valve 57 is fitted in the bore of a valve casing 58 and controls communication between the two normally open ports 59 and 60 formed therein. A channel 61 connects port 59 to channel 26 and a channel 62 connects port 60 to the inlet of resistance valve 53. Valve 57 is urged by a spring 63 in a direction to open port 59 to port 60, and it is adapted to be moved in a direction to close port 59 to port 60 by a solenoid 64 the core of which is connected to the stem of valve 57.

When the invention is applied to a transmission for driving a shaft or the like which does not require that it be stopped suddenly while operating under large loads, the high pressure resistance valve, the blocking valve and the operating and control mechanisms of the blocking valve may be omitted.

Solenoid 64 is adapted to be energized by closing a switch 68 which is ordinarily of a quick acting type but which has been shown as having two stationary single contacts 69 and 70, a double stationary contact 71, two bridging contacts 72 and 73 fixed upon a stem 74 of insulating material, and a spring 75 which urges stem 74 in a direction to hold bridging contact 72 against stationary contacts 69 and 71 and to hold bridging contact 73 out of engagement with contacts 70 and 71.

Contact 70 is connected by a conductor 76 to one end of the winding of solenoid 64 the other end of which is connected by a conductor 77 to power line conductor 37, and contact 71 is connected by a conductor 78 to power line conductor 38 so that, when stem 74 is depressed until contact 73 bridges contacts 70 and 71, the circuit through the winding of solenoid 64 will be completed and solenoid 64 will shift valve 57 to a po-

sition to close communication between ports 59 and 60.

Contact 69 is connected by a conductor 79 to the movable contact of switch 41 and, since spring 75 normally holds bridging contact 72 against contacts 69 and 71, the movable contact of switch 41 is normally connected to power line conductor 38 through conductor 79, contacts 69, 72 and 71 and conductor 78 so that, when switch 41 is closed, solenoid 34 will be energized and shift by-pass valve 28 from the position shown in Fig. 1 to the position shown in Fig. 2.

Operation

Assuming that pump 16 is being driven by electric motor 17 and that the several parts are in the positions shown in the drawing, the press will operate as follows:

If the free end of lever 22 is depressed far enough to put pump 16 on short stroke but not far enough to close switch 41, pump 16 will deliver liquid at a limited rate at motor 12 which will rotate gear wheel 8 and shaft 7 and thereby cause platen 2 to descend at a slow rate. Since by-pass valve 28 is closed, the liquid discharged by motor 12 will flow through channels 26 and 61, blocking valve casing 58, channel 62, low pressure resistance valve 53 and return to pump 16 through channels 54 and 27.

Resistance valve 53 will prevent motor 12 from being driven by the combined weight of die 1 and platen 2 so that, when die 1 approaches close to die 9, the free end of lever 22 may be raised to the position shown to stop further downward movement of platen 2.

The dies may then be adjusted to aline with each other and then lever 22 may be manipulated to lower die 1 slowly into die 9. After the dies have been firmly fastened in adjusted position, platen 2 may be raised by operating lever 22.

Thereafter, the material to be operated upon may be placed upon die 9 and then the free end of lever 22 may be quickly depressed to put pump 16 on long stroke and substantially simultaneously close switch 41 so that solenoid 34 is energized and moves by-pass valve 28 to the position shown in Fig. 2. Pump 16 will then deliver liquid to motor 12 at the rate required to cause motor 12 to drive the press at the desired speed, and the liquid discharged by motor 12 will be returned freely to pump 16 through channel 26, by-pass valve casing 29 and channel 27.

If it should be desired to stop the press suddenly, the operator would depress the stem 74 of emergency switch 68 and thereby move contact 72 out of engagement with contacts 69 and 71 and move contact 73 against contacts 70 and 71 to cause the solenoid 34 to be deenergized and solenoid 64 to be energized.

Solenoid 34 being deenergized would permit spring 33 to shift by-pass valve 28 to close port 30 to port 31 as shown in Fig. 1, so that liquid could not pass freely from channel 26 into channel 27, and solenoid 64 would shift blocking valve 57 to close port 60 to port 59 so that liquid could not escape through low pressure resistance valve 53, thereby forcing all liquid discharged by motor 12 to pass through high pressure resistance valve 55 which has sufficient resistance to stop the press. The operator, of course, should operate lever 22 to reduce pump displacement to zero as soon as possible after operating emergency switch 68.

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

The invention is hereby claimed as follows:

1. The combination, with a shaft having a tendency to overrun during at least a part of a revolution, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a resistance valve connected into one part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, means for varying the displacement of said pump to thereby vary the speed of said motor, a by-pass valve, and means responsive to movement of said displacement varying means beyond a predetermined point for operating said by-pass valve to by-pass liquid around said resistance valve.

2. The combination, with a shaft having a tendency to overrun during at least a part of a revolution, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a resistance valve connected into one part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a valve for by-passing liquid around said resistance valve, a solenoid for operating said by-pass valve, means for varying pump displacement to thereby vary the speed of said motor, means including a switch for energizing said solenoid, and means responsive to movement of said displacement varying means beyond a predetermined point for operating said switch.

3. The combination, with a shaft having a tendency to overrun during at least a part of a revolution, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a resistance valve connected into one part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a normally closed by-pass valve connected into another part of the return side of said circuit and adapted when open to by-pass around said resistance valve the liquid discharged by said motor, means for varying the displacement of said pump from zero to maximum to thereby vary the speed of said motor, and means responsive to movement of said displacement varying means a predetermined distance beyond its zero displacement position for opening said by-pass valve.

4. The combination, with a shaft having a tendency to overrun during at least a part of a revolution, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a resistance valve connected into one part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a normally

closed by-pass valve connected into another part of the return side of said circuit and adapted when open to by-pass around said resistance valve the liquid discharged by said motor, means for varying the displacement of said pump from zero to maximum to thereby vary the speed of said motor, electromagnetic means for opening said by-pass valve, a switch for controlling said electromagnetic means, and means responsive to movement of said displacement varying means a predetermined distance beyond its zero displacement position for operating said switch.

5. The combination, with a shaft having a tendency to overrun, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a low pressure resistance valve connected into a part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a high pressure resistance valve connected in parallel with said valve to provide a high resistance to the discharge of liquid from said motor and thereby function as a brake to stop said motor and said shaft, a by-pass valve connected into another part of said return side for by-passing around said resistance valves the liquid discharged by said motor, and a plurality of means selectively operable for directing the liquid discharged by said motor through said by-pass valve or one or the other of said resistance valves selectively.

6. The combination, with a shaft having a tendency to overrun, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a low pressure resistance valve connected into a part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a high pressure resistance valve connected in parallel with said valve to provide a high resistance to the discharge of liquid from said motor and thereby function as a brake to stop said motor and said shaft, a by-pass valve connected into another part of said return side for by-passing around said resistance valves the liquid discharged by said motor, means for varying the displacement of said pump to thereby vary the speed of said motor, means responsive to movement of said displacement varying means beyond a predetermined point for operating said by-pass valve, and means for blocking said low pressure resistance valve.

7. The combination, with a shaft having a tendency to overrun, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a low pressure resistance valve connected into a part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a high pressure resistance valve connected in parallel with said valve to provide a high resistance to the discharge of liquid from said motor and thereby function as a brake to stop said motor and said shaft, a normally closed by-pass valve connected into another part of said return side and adapted when open to by-pass around said resistance valves the liquid discharged by said motor, means for opening said by-pass valve, a normally open blocking valve connected between the inlet of said low pressure resistance valve and the outlet of said motor and adapted when closed to prevent liquid from passing through said low pressure resistance valve, and means for closing said by-pass valve and said blocking valve simultaneously.

8. The combination, with a shaft having a tendency to overrun, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a low pressure resistance valve connected into a part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a high pressure resistance valve connected in parallel with said valve to provide a high resistance to the discharge of liquid from said motor and thereby function as a brake to stop said motor and said shaft, a normally closed by-pass valve connected into another part of said return side and adapted when open to by-pass around said resistance valves the liquid discharged by said motor, electromagnetic means for opening said by-pass valve, means for varying the displacement of said pump to thereby vary the speed of said motor, means for energizing said electromagnetic means including a switch, and means for operating said switch in response to movement of said displacement varying means beyond a predetermined point, and means for blocking said low pressure resistance valve.

9. The combination, with a shaft having a tendency to overrun, of a hydraulic motor connected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a low pressure resistance valve connected into a part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a high pressure resistance valve connected in parallel with said valve to provide a high resistance to the discharge of liquid from said motor and thereby function as a brake to stop said motor and said shaft, a normally closed by-pass valve connected into another part of said return side and adapted when open to by-pass around said resistance valves the liquid discharged by said motor, a first electromagnetic means for opening said by-pass valve, means for energizing said electromagnetic means to thereby open said by-pass valve, a normally open blocking valve connected between the inlet of said low pressure resistance valve and the outlet of said motor and adapted when closed to prevent liquid from passing through said low pressure resistance valve, a second electromagnetic means for closing said blocking valve, and a single means for de-energizing said first electromagnetic means and energizing said second electromagnetic means to thereby close said by-pass valve and said blocking valve simultaneously.

10. The combination, with a shaft having a tendency to overrun, of a hydraulic motor con-

nected to said shaft to drive the same, a power driven pump for supplying motive liquid to said motor to energize the same, fluid channels connecting said pump and said motor and forming therewith a hydraulic circuit having pressure and return sides, a low pressure resistance valve connected into a part of the return side of said circuit to resist the discharge of liquid from said motor and thereby prevent said shaft from overrunning, a high pressure resistance valve connected in parallel with said valve to provide a high resistance to the discharge of liquid from said motor and thereby function as a brake to stop said motor and said shaft, a normally closed by-pass valve connected into another part of said return side and adapted when open to by-pass around said resistance valves the liquid discharged by said motor, means for varying the displacement of said pump to thereby vary the speed of said motor, a first electromagnetic means for opening said by-pass valve, means for energizing said electromagnetic means including a switch, means for operating said switch in response to movement of said displacement varying means beyond a predetermined point, a normally open blocking valve connected between the inlet of said low pressure resistance valve and the outlet of said motor and adapted when closed to prevent liquid from passing through said low pressure resistance valve, a second electromagnetic means for closing said blocking valve, and a single means for denergizing said first electromagnetic means and energizing said second electromagnetic means to thereby close said by-pass valve and said blocking valve simultaneously.

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