

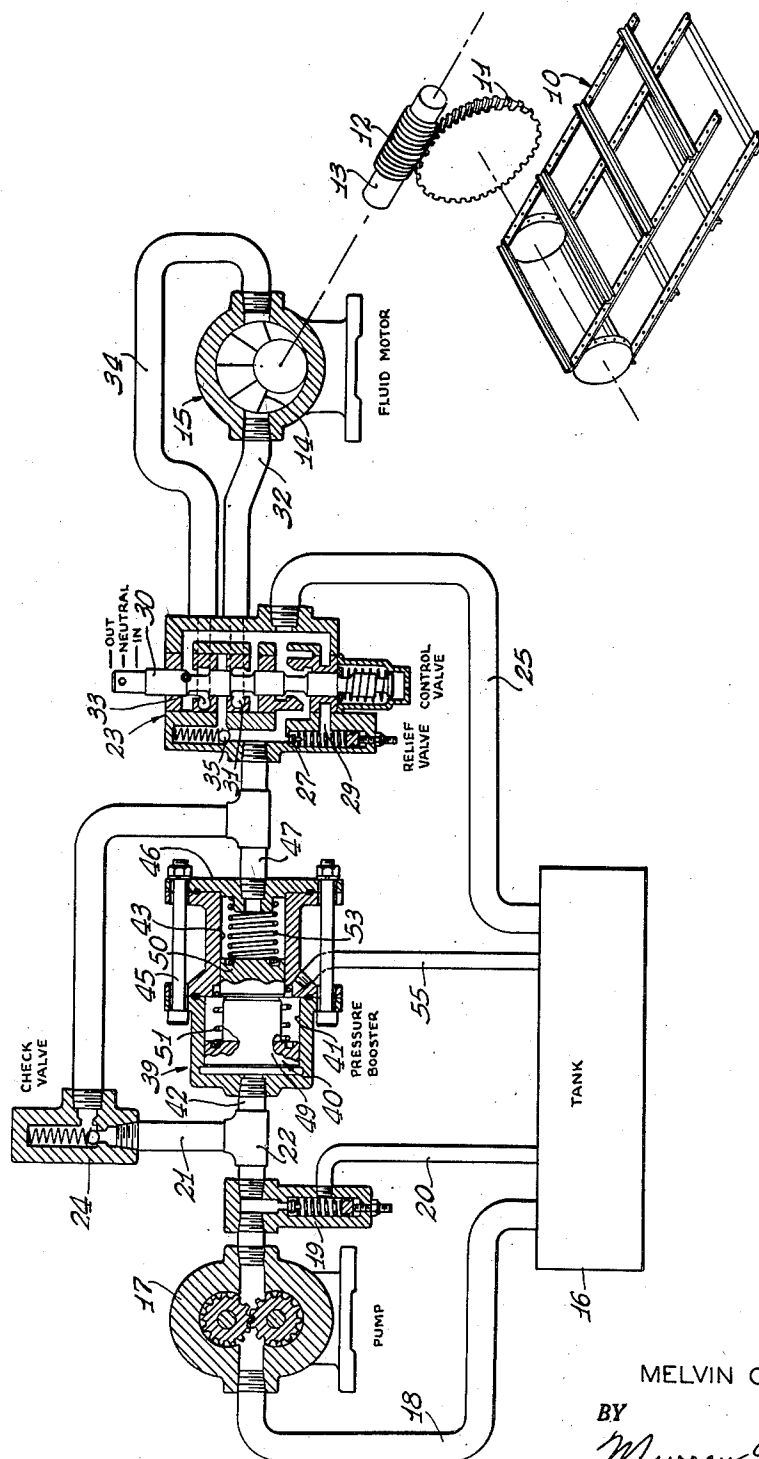
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FLUID PRESSURE OPERATED ACTUATOR BOOSTER

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FLUID PRESSURE OPERATED ACTUATOR BOOSTER

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This invention relates to fluid actuator boosters and more particularly relates to such a booster for boosting the starting torque of a fluid pressure operated actuator of a type subjected to heavy starting loads.

Heretofore, fluid actuators, such as hydraulic motors of the gear and sliding vane types, have been used to drive the conveyors of shuttle cars operable in the mines underground, due primarily to the saving in space attained by the use of such a motor over that required for an electric motor. Such conveyors, however, while relatively short, form the bottom of the car and are heavily loaded and must start a three to eight ton load of coal sliding from a dead standing position when unloading the car. Since the starting torque of fluid pressure operated motors is low, the motor and conveyor frequently stall, resulting in undesirable delays in the operations of loading and unloading the conveyors.

A principal object of my invention is to provide a simple and improved form of means for boosting the starting torque of a fluid pressure operated actuator.

Another object of my invention is to provide a hydraulically actuated conveyor drive mechanism and system particularly adapted to drive conveyors, such as are used in shuttle cars used in mines underground, having means therein for momentarily boosting the pressures supplied to the hydraulic actuator, to start the actuator.

Still a further object of my invention is to provide a novel and improved fluid operated drive mechanism subjected to heavy starting torques, having means therein taking the normal pump pressure and generating a substantial overpressure therefrom upon initially starting the actuator, and then supplying the normal pump pressure to the actuator after the starting operation.

Another and more detailed object of my invention is to provide a booster for a fluid pressure operated actuator, including a cylinder in the pressure line to the actuator and having a piston therein of a larger effective area than the cross sectional area of the pressure line and biased toward the inlet side of the cylinder, together with a by-pass line by-passing the cylinder and supplying normal pressures to the actuator upon starting thereof.

Still another and more detailed object of my invention is to provide a novel and improved form of booster system for hydraulic actuators including a valve controlling operation of the actuator, a pressure line from a source of supply of fluid under pressure to the valve, a by-pass from the valve, by-passing pressure to storage when the valve is in the neutral position, and a spring biased booster cylinder in parallel with the pressure line and generating a substantial overpressure from the source and supplying this overpressure to the actuator upon the initial starting operation, and returning to its spring biased position to again generate an overpressure upon movement of the valve to a neutral position.

These and other objects of my invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawing, diagrammatically illustrating one form of fluid pressure actuating and booster system in which my invention may be embodied.

In the embodiment of my invention, illustrated in the drawing, I have diagrammatically shown a conveyor 10 of a well known form of chain and flight type, herein shown as being driven from a worm gear 11 although it need not be so driven, and may be driven in any well known manner. The worm gear 11 is shown as meshing

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with a worm 12 on a worm shaft 13, driven from an impeller 14 of a fluid motor 15.

The fluid motor 15 is herein diagrammatically shown as being a well known form of sliding vane type of motor and is used herein to particular advantage, due to its ability to take and be started upon overpressures. The motor 15 may be of any form well known to those skilled in the art, so need not herein be shown or described in detail. A source of supply for fluid under pressure to the actuator or motor 15 is shown as including a fluid storage tank 16 and a pump 17 connected with said tank through an intake line 18. The pump 17 is herein shown for illustrative purposes as being a conventional form of gear type pump, although it need not be such a pump.

The pressure side of the pump 17 has communication with a relief valve 19, shown as being a conventional spring pressed type of relief valve, adjustable to open at the desired excess pressure. A return line 20 connects the relief valve 19 with the tank 16 to return fluid thereto when said valve is in a relief position. The pressure side of the relief valve 19 is shown as communicating with a pressure line 21 by means of a T fitting 22. The pressure line 21 is shown as being connected with the stem of the T 22 and as supplying fluid under pressure to a control valve 23. A check valve 24 of a well known form of ball type check valve, is shown as being connected in the pressure line 21 to prevent fluid at an overpressure from flowing back through the pressure line 21 and passing to the tank 16 through the relief valve 19.

The control valve 23 is herein shown as being a well known form of spool type valve having a return line 25 connected thereto, and by-passing fluid back to the tank 16 when the valve is in the neutral position shown in the drawing.

At the inlet side of the control valve 23 is a relief valve 27. The relief valve 27 is a well known form of spring pressed relief valve operable to relieve pressure through a passageway 29 communicating with the return line 25, when a valve spool 30 of the valve 23 is in a blocked position, or where the pressures may be excessive, as where the conveyor may become jammed. The control valve 23 has a port or passageway 31 therein communicating with a pressure line 32 connected with the actuator 15.

The control valve 23 also has a port or passageway 33 therein connected with a line 34 connected with the opposite side of the actuator 15 from the line 32. The lines 32 and 34 may either be pressure or return lines, and when the valve spool 30 is in an extreme out position, fluid under pressure will be supplied past a check valve 35 through the port 31 and pressure line 32, to operate the actuator 15 and conveyor 10 in one direction. In this position of the valve spool 30, return fluid may flow through the line 34, passageway 33, a passageway 36, and out through the return passageway 25, back to the tank 16. When the valve spool 30 is in extreme in position, fluid will be supplied under pressure through the port or passageway 33 and pressure line 34 to reverse the direction of rotation of the motor 15, and will be returned to the tank 16 through the line 32, through a port or passageway 31 to the return passageway 36 and the return line 25.

Under normal operating conditions, after the motor 15 has started, pressure is supplied to operate the actuator 15 from the pump 17 through the pressure line 21, check valve 24, control valve 23 and through either the lines 32 or 34, depending upon the desired direction of rotation of the motor. This will supply fluid under pump pressure to the motor 15 to operate said motor and to drive the conveyor.

A means has been provided to use the normal pump pressure and initially boost the pressure supplied the fluid motor 15 to start said motor and then supply pressure to said motor at normal pump pressure through the pressure line 21. This boosting means is shown as comprising a fluid booster pump, such as a stepped cylinder 39 having a stepped piston 40 movable therein. As herein shown, the cylinder 39 has an enlarged diameter portion 41 connected at its head or inlet end with the pressure line 20 through a pressure line 42 connected with the cross of the T fitting 22. Said cylinder likewise

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has a reduced diameter outlet portion 43 communicating with and forming a continuation of the enlarged diameter inlet portion thereof. The reduced diameter outlet portion 43 is shown as being secured at its inner end to the inlet portion as by tie bolts 45, 45 and nuts threaded thereon, which also secure an outlet head 46 to the outlet end of said reduced diameter portion of said booster cylinder. A pipe 47 is herein shown as connecting the outlet head with the pressure line 21, to supply fluid at a boosted pressure to said pressure line.

The piston 40 is likewise shown as being in effect two connected pistons which may either be integral or separate. A relatively large diameter piston 49 is movable within the enlarged diameter portion 41 of the cylinder 39 and as having a reduced diameter charging piston 50 extending therefrom and movable within the reduced diameter portion 43 of the cylinder 39. A spring 51 is shown as being interposed between the inner end of the reduced diameter portion of the cylinder 39 and the enlarged piston 49, to urge said piston toward the inlet end of the cylinder 39. Another spring 53 is shown as being interposed between the outlet head 46 of the cylinder 39 and the end of the reduced diameter piston 50, to aid the spring 51 in biasing the piston 40 toward the inlet end of the cylinder 39. A return line 55 is shown as being connected from the inner end of the reduced diameter portion 43 of the cylinder 39 to take care of fluid that may leak by the enlarged diameter piston 49.

The stepped cylinder 39 thus has a piston 49 therein actuatable by pressure from the pump 17 and directly in communication with the pressure line 42. The effective area of this piston is many times the cross sectional area of the pressure line 42, and fluid under pressure acting thereon moves the smaller piston 50 along the reduced diameter portion 43 of the cylinder, which piston also is of a substantially larger effective area than the cross sectional area of the pressure line. The piston 40 is thus acted on by normal pump pressure and generates a substantial starting overpressure and supplies this starting overpressure to start the actuator 15.

In the present instance, the ratios between the effective area of the piston 49 and the smaller piston 50, with respect to the cross sectional area of the pressure line 21, are such that the piston 50 will generate a starting pressure for the actuator 15 of substantially twice normal pump pressure. Assuming, for example, that the pump output is available at one thousand pounds per square inch, the small piston 50 will momentarily furnish substantially two thousand pounds pressure per square inch for a period long enough to operate the fluid motor at least one revolution, and start it under load, it being found that all that is necessary to start the motor under load is to rotate it at overpressure for one revolution.

Upon starting of the actuator or fluid motor 15, fluid under pressure acting on the large piston 49 will move said piston against its spring bias, when the control valve 23 is positioned in either of its on positions, to drive the actuator 15 in one direction or another depending upon the position of the control valve 23. When subjected to pressure from the pump 17, the piston 40 will travel the full length of its stroke against the springs 51 and 53 and will then stop. At this point, fluid under pressure will be supplied to the control valve 23, to operate the actuator 15 through the pressure line 21 in parallel with the cylinder 39 and the piston 40 will remain at the end, its stroke as long as the control valve 23 is in either of its on positions.

As soon, however, as the control valve is moved to a neutral position, pressure in the pressure line 21 will be relieved through the return line 25, reducing the pressure therein and also reducing the pressure effective to hold the piston 40 at the outlet side of the cylinder 39. The springs 51 and 53 will then return the piston 40 to the inlet side of the cylinder 39 and reposition it for again boosting and starting the actuator motor 15. During this repositioning or recocking process, fluid will be passed through the check valve 24 from the left hand side of the booster 39 to the right hand side thereof, but since the amount of fluid displaced by the large piston 49 is greater than can be taken care of by the small piston 50, the excess must be dumped into the tank 16 through the control valve 23 and return line 25 connected with the by-pass passageway of said control valve and by-passing fluid to said return line whenever the valve is in a neutral position.

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It may be seen from the foregoing that a simplified form of booster has been provided for starting a fluid motor under heavy torque loads, which utilizes the normal pump output pressure to generate an overpressure for a sufficient length of time to start the motor.

It may further be seen that this system comprises a booster cylinder in a pressure line to the pump having two pistons of different effective areas therein, the piston of larger effective area being at the intake of the booster cylinder and the piston of smaller effective area being at the outlet thereof and momentarily boosting the pressure supplied by the pump without affecting operation of the pump or by-passing the boosted pressure back to the tank. This is attained by the pressure line 21 passing around the booster cylinder and the check valve 24 therein preventing the back flow of fluid at an overpressure and directing it toward the fluid motor.

It may further be seen that once the fluid actuator is started, the booster will be ineffective to boost the pressure of the actuator until pressure on the actuator is relieved, as when the control valve is turned to a neutral position, and that when the control valve is turned to a neutral position, the fluid displaced from the larger diameter cylinder is dumped to the tank through the control valve, thus relieving the pressure on the inlet side of the booster cylinder and accommodating the piston 40 therein to recock itself for the next starting operation.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. In a fluid operated drive mechanism for conveyors and the like, a rotatable fluid operated actuator of a type having a low starting torque, a source of fluid under pressure, a pressure line from said source of fluid under pressure to said actuator, a check valve in said pressure line, and means utilizing the normal output pressure of said source to boost the pressure supply to said actuator including a booster pump in parallel with said pressure line on the upstream side of said check valve and having piston means therein having one end actuated by the pressure in said pressure line and of a larger effective area than the cross-sectional area of said pressure line, and having an opposite end of a smaller effective area than said one end and of a larger effective area than the cross-sectional area of said pressure line and acting on fluid under pressure in said line and generating an over-pressure in said pressure line for initially boosting the pressure at the intake of said actuator.

2. In a fluid operated drive mechanism for conveyors and the like, a rotatable fluid operated actuator of a type having a low starting torque, a source of fluid under pressure, a pressure line from said source to said actuator, and means utilizing the pressure normally supplied by said source and generating an over-pressure to said actuator comprising a stepped booster cylinder connected in parallel with said pressure line and having its larger diameter portion in direct communication with said source and having a stepped piston therein, the smaller diameter portion of which is in direct communication with said fluid actuator and initially supplies fluid to said actuator at a boosted pressure and a check valve in said pressure line effective to block the back flow of fluid to the large diameter portion of said booster cylinder.

3. In a fluid operated drive mechanism for conveyors and the like, a rotatable fluid operated actuator of a type having a low starting torque, a source of fluid under pressure, a pressure line from said source to said actuator, and means utilizing the pressure from said source and generating an over-pressure to boost said actuator comprising a stepped booster cylinder connected in parallel with said pressure line with the larger diameter end thereof in direct communication with said source and the smaller diameter end thereof in communication with said fluid actuator, a stepped piston in said actuator, a spring biasing said piston toward the inlet end of said cylinder, and a check valve in said pressure line effective to block the passage of fluid at a boosted pressure back to said pump.

4. In a fluid operated drive mechanism particularly adapted to drive devices requiring a high starting torque, a fluid operated actuator, a source of fluid under pressure, a pressure line from said source having a relief valve

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therein, a control valve in said pressure line controlling operation of said actuator, a booster cylinder connected in said pressure line between said relief valve and said control valve and having a piston therein of a larger effective area than the cross sectional area of said pressure line and subject to the pressure of fluid from said source and also having a second piston therein operated by said first piston, of a smaller effective area than said first piston and of a larger effective area than said pressure line and generating an over-pressure for supply to said actuator, a by-pass pressure line connected in said pressure line on opposite ends of said cylinder and by-passing said cylinder, and a check valve in said by-pass line blocking the back-flow of fluid under pressure generated by said second piston and preventing the dumping of pressure through said relief valve.

5. In a fluid operated drive mechanism, particularly adapted to drive devices requiring a high starting torque, a fluid operated actuator, a source of fluid under pressure including a tank and a pump connected therewith, a relief valve on the output side of said pump, a control valve controlling operation of said actuator, a booster cylinder connected with the output side of said pump and with said relief valve, said booster cylinder having an enlarged diameter intake side in direct communication with the output side of said pump and a smaller diameter portion in direct communication with said control valve and having a stepped piston movable therein generating an over-pressure from the normal pressure supplied by said pump, a spring biasing said piston toward the intake side of said cylinder, a by-pass line connected between said intake side of said booster cylinder and said control valve and by-passing fluid around said booster cylinder when said piston has reached the end of its stroke, a check valve in said by-pass line blocking the back-flow of pressure to said relief valve, and a return passageway from said control valve to said tank, and connected through said control valve to said by-pass line and the high pressure of said stepped piston, and relieving pressure therefrom and returning fluid under pressure to said tank upon movement of said control valve to a neutral position and accommodating said booster piston to recock itself to again boost the pressure supply to said actuator upon starting thereof.

6. In a fluid pressure motor starting system, operable to start fluid motors having a low starting torque and capable of starting upon overpressures, a rotatable fluid operated motor, a fluid storage tank, a pump connected therewith, a control valve controlling operation of said fluid motor and having neutral and on positions, a pressure line from said pump to said control valve, a booster pump connected in parallel with said pressure line, said booster pump having two pistons of different effective areas therein, the piston of larger effective area

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being acted on directly by pressure from said first pump and the piston of smaller effective area having a larger effective area than the cross-sectional area of said pressure line and boosting the pressure of fluid supplied to said control valve through said pressure line upon movement of said valve from a neutral to an on position, spring means biasing said pistons in a return position toward the intake side of said booster pump, a check valve in said pressure line preventing the backing up of pressure to said first pump upon the boosting operation of said booster pump, and a return line connected through the neutral position of said control valve to said tank to relieve pressure from said pressure line and booster pump and accommodate said booster pump to recock itself upon the turning of said control valve to a neutral position.

7. In a fluid pressure system operable to start fluid motors of low starting torque and capable of starting upon overpressures, a rotatable fluid operated motor, a fluid storage tank, a pump connected therewith, a relief valve at the output side of said pump, a return line from said relief valve to said tank, a control valve controlling operation of said fluid motor and having neutral and on positions, a pressure line from said output side of said pump to said control valve, a booster pump connected in parallel with said pressure line, said booster pump being actuated by fluid pressure at its intake side from said first pump and including two pistons of different effective areas, the piston of larger effective area being acted on directly by pressure from said first mentioned pump and the piston of smaller effective area having a larger effective area than the cross-sectional area of said pressure line and boosting the pressure of fluid supplied to said control valve upon movement thereof from a neutral to an on position, spring means biasing said pistons in a return position toward the intake side of said booster pump upon a predetermined reduction in pressure in said pressure line, a by-pass line connected from said control valve to said tank and by-passing fluid to said tank when said control valve is in a neutral position, and accommodating said pistons to recock themselves by the action of said spring means, and a check valve in said pressure line preventing the backing up of pressure to said relief valve upon the operation of said booster pump.

References Cited in the file of this patent

UNITED STATES PATENTS

1,927,085	Dinzl	Sept. 19, 1933
1,937,077	West	Nov. 28, 1933
1,970,999	Ferris et al.	Aug. 21, 1934
2,351,872	Parker	June 20, 1944
2,580,353	Hunt	Dec. 25, 1951