Sept. 28, 1971 R. S. CONABEE ET AL 3,608,435

PRESSURE CONTROLLED DIRECTIONAL SYSTEM

Filed June 30, 1969 2 Sheets-Sheet 1

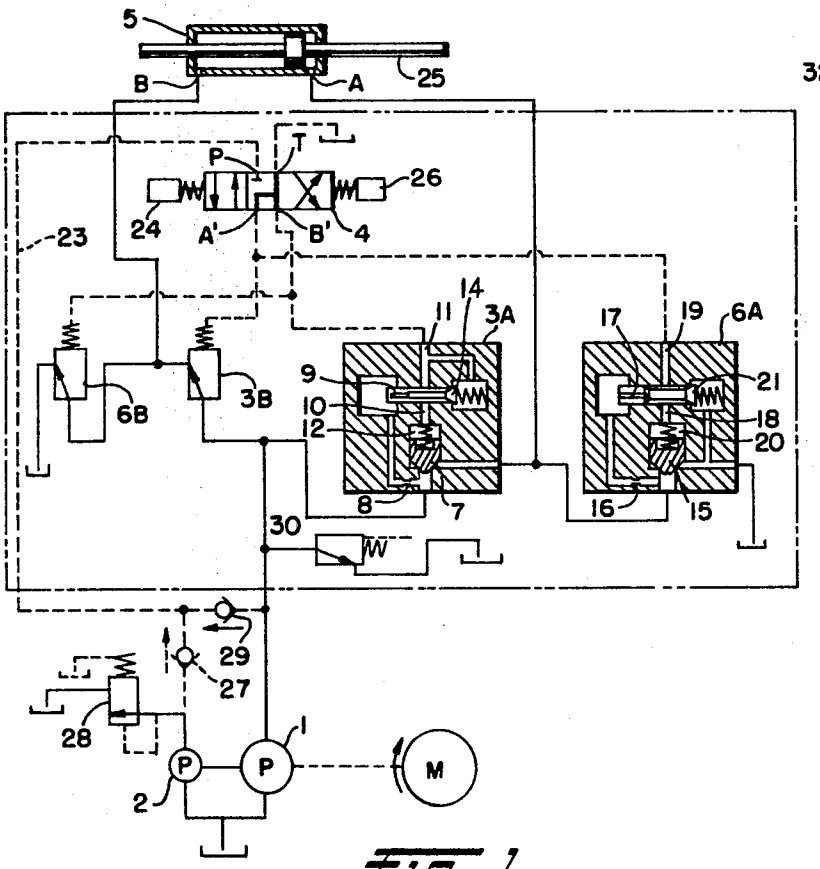


Fig. 1

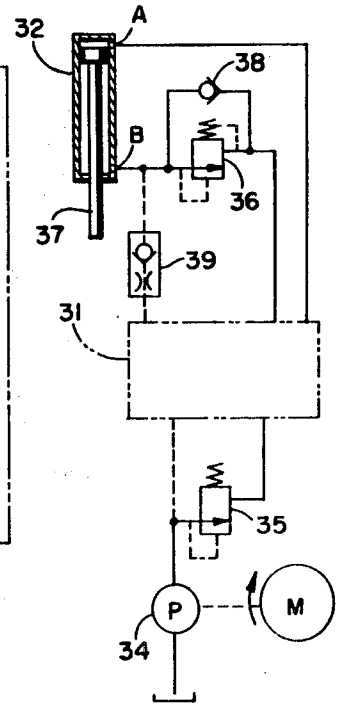


Fig. 2

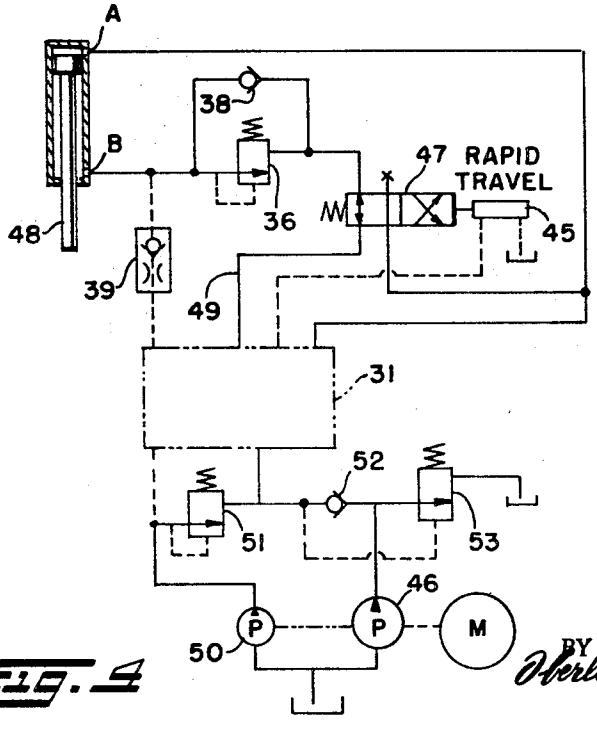


Fig. 4

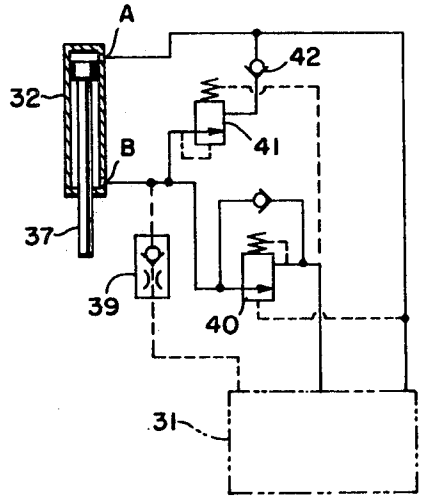


Fig. 3

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PRESSURE CONTROLLED DIRECTIONAL SYSTEM

Filed June 30, 1969 2 Sheets-Sheet 2

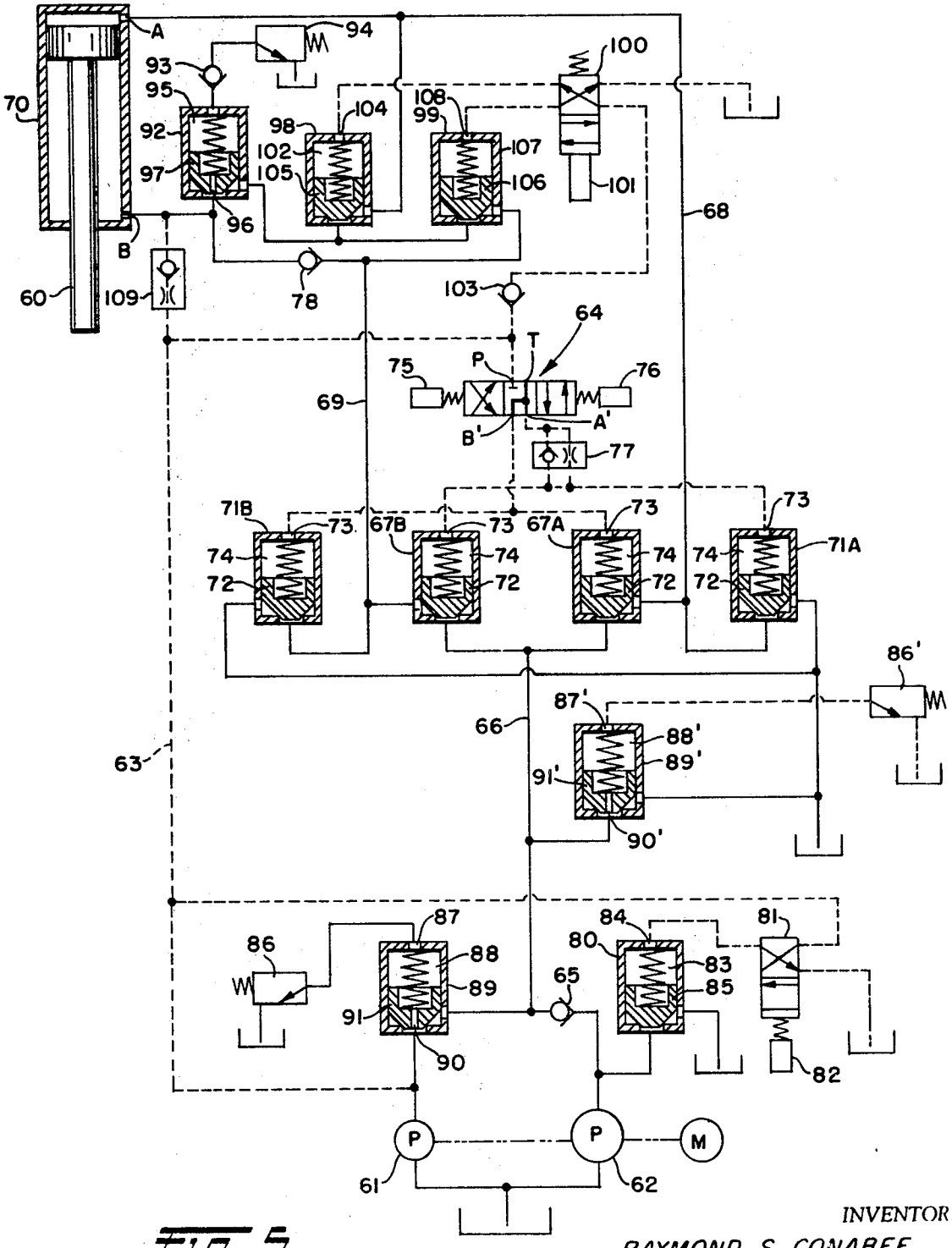


Fig. 5

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PRESSURE CONTROLLED DIRECTIONAL SYSTEM

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U.S. Cl. 91—454 12 Claims

ABSTRACT OF THE DISCLOSURE

A pressure controlled directional system for a hydraulic press motor characterized in the provision of a motor reversing valve assembly including two supply valves and two return valves which are closed when pilot pressure is conducted thereto and which are opened by fluid pressure when pilot pressure is vented therefrom, and a four-way pilot valve which selectively conducts pilot pressure to said valves and vents pilot pressure therefrom thus to actuate the press motor in opposite directions. The pilot valve is characterized in that it has a neutral position whereat all of said valves have pilot pressure vented therefrom so that they may open to conduct system pressure to the reservoir and whereat the pilot pressure inlet port thereof is blocked so that pilot pressure stands at the pilot valve preparatory to conduction to selected supply and return valves. The system herein is further characteracterized in that the supply and return valves are spring-biased against the direction of flow of fluid therethrough and in that it has a dual pump arrangement to provide for rapid actuation of the press motor in either direction by the conjoint flow of fluid from a high pressure-low volume pump and a low pressure-high volume pump.

BACKGROUND OF THE INVENTION

In general, it is well known in the art of hydraulic control of a fluid motor for a hydraulic press and the like to employ a directional control valve having an inlet port connected with a pump, a return port connected with a reservoir, and at least one motor port connected with said fluid motor, said valve being operative to selectively communicate said motor port with said inlet port or said return port. In the case of a press having a double acting fluid motor, the directional control valve is usually of the four-way open center type having a pair of motor ports alternately communicated with said inlet and return ports to effect reciprocation of the motor piston. In small hydraulic systems four-way valves of this type can be used up to rated flow capacity without objectionable shock, but in large high speed hydraulic systems conventional four way valves produce severe shocks when attempted to be used at rated flow capacity. Accordingly, in order to avoid such shock, such systems may have to be operated below the rated capacities of the four-way valves with consequent increase in cycle time, and furthermore, with spool type four-way valves, it may be necessary to decrease spool velocities during motor reversals. Thus, the maintenance of desired cycle time without shock may necessitate the use of larger four-way valves of overrated capacity or the use of separate decompression systems.

SUMMARY OF THE INVENTION

The present invention relates as indicated to a pressure controlled directional system and has as its principal object the provision of a hydraulic system for a hydraulic press and the like which enables high-speed operation without shock, despite the fact that the pressure operated valves employed in the system handle oil flow exceeding the rated capacities thereof.

Another object of this invention is to provide a pressure controlled directional system which employs pilot operated first and second valves and a pilot pressure control valve which alternately vents and pressurizes said valves so that pump pressure will open said first valve to conduct fluid to the motor while said second valve is held closed by pilot pressure and so that fluid displaced from the motor will open said second valve while said first valve is held closed by pilot pressure.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully decribed and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic piping diagram of a pressure controlled directional system for actuating the fluid motor of a double ended hydraulic press or the like;

FIGS. 2, 3 and 4 illustrate various modifications in a pressure controlled directional system according to the present invention; and

FIG. 5 is a schematic piping diagram of another pressure controlled directional system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The FIG. 1 system comprises a main pump **1** and a pilot pressure pump **2** respectively connected to the pressure inlet ports of a pair of sequence valves **3A** and **3B** and to the pressure inlet port P of a pilot pressure control valve **4**. The outlet ports of said sequence valves **3A** and **3B** are connected to the respective ports A and B of a double acting fluid motor **5** and to the respective inlet ports of a pair of relief valves **6A** and **6B**.

Each sequence valve **3A** and **3B** has a spring biased, pressure seated main valve member **7** to block flow of fluid when there is inlet pressure (via orifices **8**, **9**, and passage **10**) or pilot pressure (via pilot passages **11** and **10**) in the chamber **12** behind said main valve member **7**. When the chamber **12** is vented through the pilot passages **10** and **11**, the resulting pressure drop in chamber **12** will permit inlet pressure to move the main valve member **7** to open position to conduct fluid under pressure to one end of the fluid motor **5** (end A in the case of sequence valve **3A** and end B in the case of sequence valve **3B**). Each sequence valve **3A** and **3B** also has therein a spring biased pilot valve **14** which, when the pilot passages **10** and **11** are vented is moved to close off the orifice **9** thus to prevent leakage of fluid once the main valve member **7** has been opened as aforesaid.

Each relief valve **6A** and **6B** comprises a spring biased, pressure seated main relief valve member **15** which blocks the flow of fluid to the tank whenever there is system pressure (via orifices **16**, **17**, and passage **18**) or pilot pressure (via pilot passages **18** and **19**) in the chamber **20** behind said main valve member **15**. The pressure in the chamber **20** may be decreased by venting the pilot passages **18** and **19** whereby fluid displaced from the motor acts on the main valve member **15** and moves it to open position to allow returning fluid to flow into the tank. Each relief valve **6A** and **6B** has a spring biased pilot valve member **21** therein which opens the chamber **20** and the pilot passages **18** and **19** to the tank port should the system pressure exceed a predetermined maximum. The resulting pressure drop in chamber **20** permits such excess

pressure to open the main valve member **15** for relief therepast into the tank. After relief of excess pressure the pilot valve member **21** will be spring biased to closed position whereby the chamber **20** will again be pressurized to cause seating of the main valve member **15**.

The pilot pressure control valve **4** preferably comprises a four-way closed center solenoid operated valve having a pressure port P connected to the pilot pressure supply line **23** from pilot pump **2**, a tank port T for connection with a tank, and outlet ports A' and B' which are connected respectively to the pilot passages **19** and **11** of the relief valve **6A** and sequence valve **3B** and to the pilot passages **19** and **11** of the relief valve **6B** and sequence valve **3A**. In the neutral position of said valve **4** all of the pilot passages **19** and **11** are connected to the tank port T whereby the fluid delivered by the main pump **1** may open all of the main valve members **7** and **15**, thus to conduct the fluid delivered by pump **1** to the tank.

When solenoid **24** of the valve **4** is energized, port P is connected to port A' thus to pressurize the pilot passage **11** in the sequence valve **3B** and the pilot passage **19** in the relief valve **6A** thus to urge the main valve members **7** and **15** therein to seated position. The port B' is connected to the port T thus to vent the pilot passage **11** in the sequence valve **3A** and the pilot passage **19** in the relief valve **6B**. In this way, fluid delivered by the main pump **1** unseats the main valve member **7** in the sequence valve **3A** and flows into the port A of the motor **5** and since the main valve member **15** in the relief valve **6A** and the main valve member **7** in sequence valve **3B** are at this time seated by pilot pressure, all of the fluid delivered by the pump **1** is conducted into port A of the fluid motor. As the piston **25** moves to the left the fluid displaced from port B opens the main valve member **15** in the relief valve **6B**, thus to conduct the returning fluid to the tank. When solenoid **26** is energized, port P is connected to port B' thus to pressurize the pilot passage **11** in sequence valve **3A** thus to force the main valve member **7** therein to seated position blocking flow of fluid through said sequence valve **3A** and the pilot passage **19** in the relief valve **6B** is pressurized to hold the main valve member **15** therein in closed position blocking flow of fluid through said relief valve **6B**. At the same time, the pilot passage **11** in the other sequence valve **3B** and the pilot passage **19** in the other relief valve **6A** are vented from port A' to port T whereby the fluid delivered by the main pump **1** will open the main valve member **7** in the sequence valve **3B** thus to conduct fluid under pressure into port B of the motor **5**, the relief valve **6B** at that time being blocked. The fluid displaced from the port A of the motor **5** is conducted to the tank via the relief valve **6A**.

The pilot pressure delivered by pilot pump **2** is preferably equal to or greater than the system pressure, and when the valve **4** is in neutral position, the pilot pressure stands as a static pressure through the check valve **27**, there being a sequence valve **28** upstream of the check valve **27** to conduct the pilot pump delivery to the tank whenever the pilot pressure is at a predetermined value equal to or greater than that of the system pressure. However, should the system pressure rise so as to exceed the pilot pressure as, for example, by resistance encountered by the piston **25** during movement, the check valve **29** opens so as to maintain system pressure in the pilot system. The pilot pump **2** continues to develop pilot pressure by flowing through the sequence valve **28** which is upstream of the then closed check valve **27**. The maximum system pressure may be controlled by a relief valve **30** if the limit is to be less than the relief pressure of either of the relief valves **6A** or **6B**.

If the fluid motor **5** is of the differential displacement type with, say, end A as the head end, the relief valve **6A** associated with the head end of the motor **5** may be of larger size than the other relief valve **6B** to accommodate the greater return flow or instead of that, another relief valve **6A** may be connected in parallel to the existing relief valve **6A** to handle the greater return flow.

It has been found that in the present pressure controlled directional system the valves **3A**, **3B**, **6A** and **6B**, may be used at ratings substantially above recommended maximum ratings without any shock. As a specific example, valves rated at 120 gal./min. flow have been used in the system for high speed operation at 160 gal./min. with completely shock free action.

It can be seen that if increased cycle time can be tolerrated, the port P of valve **4** may be plugged and the pilot pump **2** omitted because seating pressure in the chambers **10** and **20** may be developed from system pressure through the orifices **8** and **9** and **16** and **17**.

In FIG. 2 the valve assembly comprising sequence valves **3A** and **3B**, the relief valves **6A** and **6B**, the four-way valve **4** and the relief valve **30** are shown in the phantom rectangle **31**. In the FIG. 2 system there is shown a vertically disposed motor **32** and herein a single pump **34** supplies both system pressure (solid line) and pilot pressure (dotted line). The system pressure is supplied through a sequence valve **35** which is opened when pressure is at desired value. When the fluid motor **32** is in vertical position, the moving weight must be kept from falling when the system is in neutral position and for that purpose a counterbalance valve **36** has been added. The counterbalance valve **36** remains closed to support the moving weights. If the piston **37** is to be moved downwardly, pressure in port A will cause increase in pressure in port B sufficient to open the counterbalance valve **36** whereupon the lower end B of the cylinder will be exhausted through the unblocked relief valve **6B**. When the piston **37** is to be moved upwardly, flow into port B is through the check valve **38** which may be a part of the counterbalance valve **36**. The FIG. 2 system may, if desired, include a pilot feedback valve **39** to control neutral drift together with pressure regulation at the sequence valve **35**. The check valves **27** and **29** as shown in FIG. 1 are not required in FIG. 2.

In FIG. 3 there is shown a pressure controlled directional system (utilizing a pump **34** and sequence valve **35** as in FIG. 2, for example) which is so arranged that when pressure and flow are directed to the cylinder port A, return flow at port B is blocked at the unloading valve **40** and must flow through the counterbalance valve **41** and check valve **42** to augment the pump delivery to port A. When the system pressure rises above the setting of the unloading valve **40** it opens the port B to the tank through the unblocked relief valve **6B**.

FIG. 4 shows a pressure controlled system applied to a position shift differential system with a solenoid **45** when energized along with solenoid **24** being effective initially to direct pump delivery from a main low pressure pump **46** to the cylinder port A with the fluid returning from port B being valved through the counterbalance valve **36** and the valve **47** to augment the pump **46** delivery. At a predetermined point in the stroke of the piston **48** the solenoid **45** will be de-energized to return the port B discharge to the line **49** where it returns to the tank through the unblocked relief valve **6B**. In this case a dual pump is employed including a high pressure low volume pump **50** and a low pressure large volume pump **46** and the sequence valve **51** is placed in the high pressure delivery line so that the discharge of both pumps **46** and **50** is available for rapid downward travel of the piston **48**. The FIG. 4 circuit also employs the counterbalance valve **36** to support the load in neutral position of valve **4** when the solenoid **45** is de-energized. In this case, the low pressure large volume pump **46** would discharge through the check valve **52** and rapid travel of the piston **48** may be effected through both pumps **46** and **50** when the sequence valve **3B** is unblocked and when the valve solenoid **45** is de-energized with fluid flowing through the check valve **38** of the

counterbalance valve **36**. As aforesaid the sequence valve **51** is located to be actuated by the pressure in the high pressure, low volume discharge line of the pump **50**. The reference numeral **53** denotes a relief valve for the low pressure high volume pump **46**.

The FIG. 5 system incorporates simplified pressure-controlled valving for directional control of a fluid motor, the same valving with slight changes serving as counterbalance valves, pilot operated relief valves, pump loading and unloading valves, and ordinary check valves. By way of example, the FIG. 5 system may be used in a die-casting trim press wherein it is desired that the piston or ram **60** (together with the platen and trimming die carried thereby) move down at a desired rate until such time as a decreased feed at high pressure is required for the trimming operation. Thereafter it is desired to retract the ram **60** at maximum speed to repeat the cycle.

The FIG. 5 system comprises a dual pump **61–62** of which the high pressure-low volume pump **61** supplies pilot pressure through conduit **63** to the port P of a four-way closed center pilot valve **64** and of which the low pressure-high volume pump **62** supplies system pressure through check valve **65** and conduit **66** to the inlet ports of a pair of pressure-controlled valves **67A** and **67B**. The outlet ports of said valves **67A** and **67B** are connected by conduits **68** and **69** to the respective ports A and B of the ram cylinder **70**, and to the inlet ports of another pair of pressure-controlled valves **71A** and **71B**. The outlet ports of valves **71A** and **71B** are connected as shown to the tank.

Each valve **67A**, **67B**, **71A**, and **71B** has a spring-biased, pressure seated valve member **72** therein to block flow of fluid therethrough when there is pilot pressure (via passage **73**) in the chamber **74** behind said valve member **72**. When chamber **74** is vented through the pilot passage **73**, fluid pressure will move the valve member **72** to permit flow from the inlet port to the outlet port.

The pilot pressure control valve **64** has outlet ports A′ and B′ connected to pilot passages **73** of valves **71A** and **67B** and of valves **67A** and **71B** respectively whereby when solenoid **75** is energized pilot pressure from port P to port A′ pressurizes the chambers **74** of valves **71A** and **67B** (via the check valve portion of the choke-check valve **77**) to hold the valve members **72** therein in seated position, and the chambers **74** of valves **67A** and **71B** are vented through ports B′ and T. Thus, pressure in conduit **66** opens valve **67A** to conduct fluid pressure to port A of the ram cylinder **70**, and return flow from port B (when connected directly to conduit **69**) opens valve **71B**. When solenoid **76** is energized, pilot pressure from port P to port B′ pressurizes the chambers **74** of valves **67A** and **71B** to hold them closed, and the chambers **74** of valves **71A** and **67B** are vented (via the choke portion of the choke-check valve **77**) through ports A′ and T. Thus, pressure in conduit **66** opens valve **67B** to conduct fluid pressure to port B of the ram cylinder **70** via conduit **69** and check valve **78**, and return flow from port A and conduit **68** opens valve **71A**, the opening rate being under the control of the choke portion of valve **77** to avoid rapid decompression of the cylinder **70**.

Adjacent the pump **62** is an unloading valve **80** controlled by solenoid pilot valve **81** so that when solenoid **82** is de-energized, the chamber **83** is vented through pilot passage **84** to open valve member **85** thus to unload pump **62**. When solenoid **82** is energized, pilot pressure through valve **81** and pilot passage **84** pressurizes chamber **83** to hold valve member **85** in closed position for supply of system pressure through check valve **65** and conduit **66** to open the then vented valve **67A** or **67B**. It is to be noted that the valve **80** and valve member **85** may be identical in construction to the valves **67A**, **67B**, **71A**, and **71B** and the valve members **72** therein.

Adjacent the pump **61** is a pilot operated relief valve assembly comprising a pilot relief valve **86** which when open bleeds fluid through pilot passage **87** and chamber **88** of the valve **89** faster than fluid can be replenished through the orifice **90** in the pressure seated, spring-biased valve member **91**. Thus, the ram **60** may be raised or lowered by the conjoint discharge of both pumps **61** and **62**. As evident, the valve **89** and valve member **91** may be the same as valves **67A**, **67B**, **71A** and **71B** and the valve members **72** therein, except that valve member **91** has the orifice **90** therein.

The system supply conduit **66** also has a system relief valve assembly **88′–86′** which is the same as the valve assembly **88–86** just described except that the pilot relief valve **86′** will have a higher pressure relief setting than pilot relief valve **86**.

To prevent downward drift of ram **60** under the influence of its own weight and the weights of the platen, die etc. thereon, there is provided a pilot operated relief valve **92** which is held in closed position so long as there is no flow of fluid through the check valve **93** and the pilot relief valve **94** from the chamber **95** which is in communication with port B via the orifice **96** in valve member **97**. The pilot relief valve **94** will be set to open at a pressure which will support the ram load against downward drift. As evident, when the ram **60** is to be moved downwardly the pressure in port B of the cylinder **70** will increase so that pilot relief valve **94** will be opened to vent fluid faster from chamber **95** than it can be replenished through orifice **96** in valve member **97**. In this way the valve **92** is opened to permit return flow.

When valve **92** is opened as aforesaid, the return flow from port B opens either unloading valve **98** or **99** depending on the position of the solenoid operated pilot valve **100**. When the solenoid **101** of the pilot valve **100** is de-energized (FIG. 5 position of pilot valve **100**) pilot pressure in chamber **102** of valve **98** via check valve **103**, pilot valve **100**, and pilot passage **104** holds the valve member **105** in closed position. At this time, return flow from port B moves the valve member **106** to open position because the chamber **107** is vented through pilot passage **108** and pilot valve **100** whereby return is conducted to the reservoir via conduit **69** and the open valve **71B**.

When solenoid **101** is energized, pilot pressure in chamber **107** of valve **99** holds the valve member **106** in closed position while the chamber **102** of valve **98** is vented. Thus, return flow moves valve member **105** to open position for augmenting the flow of fluid in conduit **68** into port A of cylinder **70**.

Assuming that the ram **60** is in raised position as shown and that pilot valves **64**, **81** and **100** are in the positions shown in FIG. 5, the pressure control valve members **74** will all be vented through the pilot valve **64** so that valves **67A** and **71A** or valves **67B** and **71B** may open by flow of fluid from pump **61** through relief valve **89** to maintain pilot pressure in conduit **63**; pump **62** is unloaded by opening of valve **80** by venting the chamber **83** through pilot valve **81**; and valve **98** is held closed by pilot pressure in chamber **102**. The ram **60** is, at this time, held in raised position by ram pressure in the chamber **95** of valve **92**. However, to prevent ram drift as by leakage, oil is supplied to port B through the choke-check valve **109** from the pilot pressure conduit **63**.

To initiate downward movement of ram **60**, solenoids **75**, **82** and **101** are energized whereby, (a) chambers **74** of valves **71A** and **67B** are pressurized to hold said valves closed and chambers **74** of valves **67A** and **71B** are vented; (b) chamber **83** of unloading valve **80** is pressurized to close said unloading valve **80**; and (c) chambers **107** and **102** of valves **99** and **98** are respectively pressurized and vented. Rapid descent of the ram **60** is thus achieved by delivery of fluid from both pumps **61** and **62** to port A of cylinder **70** via conduit **66**, open valve **67A**, and conduit **68**. In addition, return pressure in port B opens valves **92** and **98** whereby return flow

through valves **92** and **98** augments the delivery of pumps **61** and **62** to port A.

As the ram **60** approaches the feed limit, solenoids **82** and **101** are de-energized respectively (a) to permit opening of the unloading valve **80** and (b) to close the valve **98** and to open the valve **99** for continued return flow through conduit **69** and valve **71B**. In a die casting trim press, the trim operation then occurs by flow of high pressure oil from pump **61** into port A via conduit **66**, valve **67A** and conduit **68**.

To initiate rapid upward movement of ram **60**, solenoid **75** is de-energized and solenoids **76** and **82** are energized, respectively, (a) to vent the chambers **74** of valves **67B** and **71A** for flow of system pressure to port B via conduit **66**, valve **67B**, conduit **69** and check valve **78** and for return flow from port A through conduit **68** and valve **71A**; and (b) to close the unloading valve **80** so that pump **62** augments the delivery of pump **61**. In a die casting trim press, initial slow pullout may be achieved by energizing solenoid **82** after solenoid **76** has been energized whereby only pump **61** will deliver fluid to port B during the time that solenoid **82** remains de-energized. When the solenoid **75** is de-energized at the end of the high pressure work stroke of the ram **60**, the choke-check valve **77** avoids rapid decompression of the cylinder **70**.

When the ram **60** reaches its upper position, the solenoids **76** and **82** are de-energized whereby the pilot valves **64** and **81** return to the neutral positions as shown in FIG. 5. The ram **60** then remains in its upper position and downward drift thereof is prevented by the valve **92** and the choke-check valve **109**.

In the FIG. 5 system, the check valves **65**, **78**, **93** and **103** may, if desired, be of the same form as valves **67A**, **67B**, **71A** and **71B**, except that the pilot passages **73** will be plugged and the valve members **72** will have openings communicating the chambers **74** with the outlet ports.

We, therefore, particularly point out and distinctly claim as our invention:

1. In a pressure controlled directional system of the type wherein a valve assembly is selectively operative to conduct fluid under pressure from a pump means to a fluid motor port or to conduct return flow of fluid from said motor port to a reservoir; said valve assembly comprising supply and return valves having inlet and outlet ports respectively communicating with said pump means and said motor port and with said motor port and said reservoir, and each of said supply and return valves having a valve member movable therein and having a first area on one side exposed to fluid pressure in said inlet port and a second larger area on the opposite side exposed to pilot pressure to close said valve; control means having communication with said pump means and said reservoir selectively to conduct pilot pressure therethrough into one valve to close it while pilot pressure in the other valve is vented to said reservoir via said control means whereby inlet pressure acting on said first area opens said other valve for flow of fluid to or from said motor port according to whether said other valve is said supply valve or said return valve and wherein said control means has a neutral position at which the pilot pressure in both valves is vented to said reservoir so that both valves are opened for flow of fluid from said pump means to said reservoir.

2. The system of claim **1** wherein said control means comprises a control valve having a control valve member selectively movable to supply or vent pilot pressure to or from said supply and return valves.

3. In a pressure controlled directional system of the type wherein a reversing valve assembly is selectively operative to conduct fluid under pressure from a pump means to either end of a double-acting fluid motor and to conduct return flow from the other end of said motor to a reservoir; said valve assembly comprising two supply valves to supply fluid under pressure from said pump means to the respective ends of said motor and two return valves to conduct return flow from the respective ends of said motor to said reservoir; each valve being of the pressure-seated type wherein pilot pressure therewithin closes said valve and wherein the reduction of pilot pressure therewithin permits opening thereof for flow of fluid to said motor or return flow of fluid from said motor; a four-way valve having a pilot pressure port in communication with said pump means, a reservoir port in communication with said reservoir, and two control ports each communicated with a supply valve and a return valve associated with opposite ends of said motor, and having a valve member movable therein to alternately vent the pilot pressure of one of said supply valves to said reservoir for opening thereof to conduct fluid under pressure from said pump means into one end of said motor and to vent the pilot pressure of one of said return valves to said reservoir for opening thereof to conduct return fluid from the other end of said motor to said reservoir; said four-way valve member having a neutral position whereat both control ports are communicated with said reservoir port whereby said supply valves and said return valves are opened to conduct fluid from said pump means to said reservoir and whereat said pressure port is blocked whereby pilot pressure stands at said four-way valve preparatory to conduction through either control port.

4. The system of claim **3** wherein said pump means comprises a main pump to supply fluid under pressure to said motor through an open supply valve, and a pilot pump to supply pilot pressure to the pilot pressure port of said four-way valve; and wherein check valves between said pilot pump and pressure port and between said main pump and pressure port prevent reverse flow of fluid from said pilot pressure port annd enable supply of pilot pressure from said main pump in the event that pilot pressure is less than main pump pressure.

5. The system of claim **3** wherein a counterbalance valve between one end of said motor and the associated supply valve and return valve supports a load on said motor when said four-way valve member is in neutral position; and wherein a check valve bypasses said counterbalance valve to conduct fluid under pressure into said one end of said motor.

6. The system of claim **3** wherein an unloading valve between one end of said motor and the associated supply valve and return valve supports a load on said motor when said four-way valve is in neutral position; wherein a first check valve bypasses said unloading valve to conduct fluid under pressure into said one end of said motor; wherein a counterbalance valve and check valve between the ends of said motor also supports a load on said motor and permits return flow from said one end of said motor to flow into the other end of said motor to augment flow of fluid from said main pump via the then open supply valve until return flow pressure increases to a value to open said unloading valve.

7. The system of claim **3** wherein a rapid travel valve between the ends of said motor is operative selectively to conduct return flow from one end of said motor to said reservoir via said valve assembly or to the other end of said motor to augment the flow from said pump means.

8. A reversing valve assembly for a double-acting fluid motor comprising two pairs of valves, each valve being operative in response to a change of pilot pressure supplied to said valve, one pair of valves being supply valves having inlet ports for connection with a fluid pressure source and outlet ports for connection to the respective ends of a double-acting fluid motor, and the other pair of valves being return valves having inlet ports for connection to the respective ends of such motor and outlet ports for connection to a reservoir; each valve having a valve member which prevents or permits flow of fluid through said valve according to whether pilot pressure acting thereon is of high or low magnitude; and a four-way closed center pilot pressure control valve having a

pilot pressure inlet port, a reservoir port, and a pair of control ports respectively connected to a supply valve and to a return valve associated with opposite ends of such motor, and having a control valve member movable therein from a neutral position whereat said pilot pressure inlet port is blocked and both control ports are communicated with said reservoir port whereby to permit opening of both supply valves and both return valves for flow of fluid from said pressure source to the reservoir to operating positions selectively communicating said control ports with said pilot pressure inlet port and with said reservoir port thus to establish pilot pressure of high or lower magnitude in said supply and return valves so that fluid under pressure through an open supply valve is conducted to one end of the motor and that return flow from the other end of the motor passes through the open return valve.

9. In a pressure controlled directional system of the type wherein a reversing valve assembly is selectively operative to conduct fluid under pressure from a pump means to either the rod or head end of a differential displacement double-acting fluid motor and to conduct return flow from the other end of said motor to a reservoir; said valve assembly comprising two supply valves to supply fluid under pressure from said pump means to the respective ends of said motor and two return valves to conduct return flow from the respective ends of said motor to said reservoir; each valve being of the pressure-seated type wherein pilot pressure therewithin closes said valve and wherein the reduction of pilot pressure therewithin permits opening thereof for flow of fluid to said motor or return flow of fluid from said motor; a four-way valve having a pilot pressure port in communication with said pump means, a reservoir port in communication with said reservoir, and two control ports each communicated with a supply valve and a return valve associated with opposite ends of said motor, and having a valve member movable therein to alternately vent the pilot pressure of one of said supply valves to said reservoir for opening thereof to conduct fluid under pressure from said pump means into one end of said motor and to vent the pilot pressure of one of said return valves to said reservoir for opening thereof to conduct return fluid from the other end of said motor to said reservoir; first and second unloading valves each substantially the same as said supply and return valves respectively connected between the ends of said motor for return flow of fluid from the rod end of said motor to the head end via said first unloading valve when the latter is open and between the rod end of said motor and the associated supply valve and return valve for return flow of fluid through the latter when said second unloading valve is open; a check valve for bypassing said unloading valves to conduct fluid under pressure to the rod end of said motor; a pilot valve for selectively bleeding fluid from the chamber of either unloading valve and conducting pilot pressure to the chamber of the other unloading valve whereby when said second unloading valve is closed by pilot pressure, return flow of fluid from the rod end of said motor flows through said first unloading valve to augment flow of fluid from said pump means to the head end of said motor and whereby when said first unloading valve is closed by pilot pressure, return flow of fluid from the rod end of said motor flows through said second unloading valve to the associated return valve.

10. The system of claim **9** wherein said four-way valve member is movable to a neutral position to vent the pilot pressure of both supply valves and both return valves to said reservoir for opening thereof to conduct fluid under pressure from said pump means to said reservoir; wherein a pilot operated relief valve between the rod end of said motor and the associated supply valve and return valve supports a load on said motor when said four-way valve member is in neutral position; and wherein said check valve bypasses said pilot operated relief valve to conduct fluid under pressure into the rod end of said motor when the associated supply valve is open; said pilot operated relief valve, when open, conducting return flow of fluid from the rod end of said motor through whichever unloading valve is open.

11. The system of claim **9** wherein said pump means comprises a dual pump including high pressure-low volume pump to supply pilot pressure to said four-way valve, and a low pressure-high volume pump to supply fluid pressure through a check valve for rapid actuation of said motor; and wherein a relief valve communicates with said high pressure-low volume pump such that when it is opened by an associated pilot relief valve it conducts high pressure fluid to said motor.

12. The system of claim **11** wherein an unloading valve substantially the same as said supply and return valves is operative, when open, to conduct fluid delivered by said low pressure-high volume pump to said reservoir thus to unload said pump and, when closed, to block communication of said low pressure-high volume pump with said reservoir thus to load said pump; and wherein an associated control valve conducts pilot pressure to said unloading valve to close it or vents said pilot pressure from said unloading valve to permit opening thereof.

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91—461