

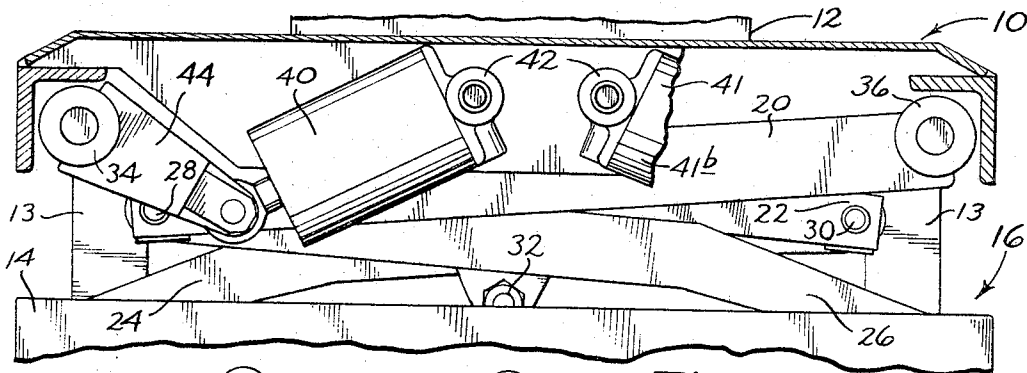
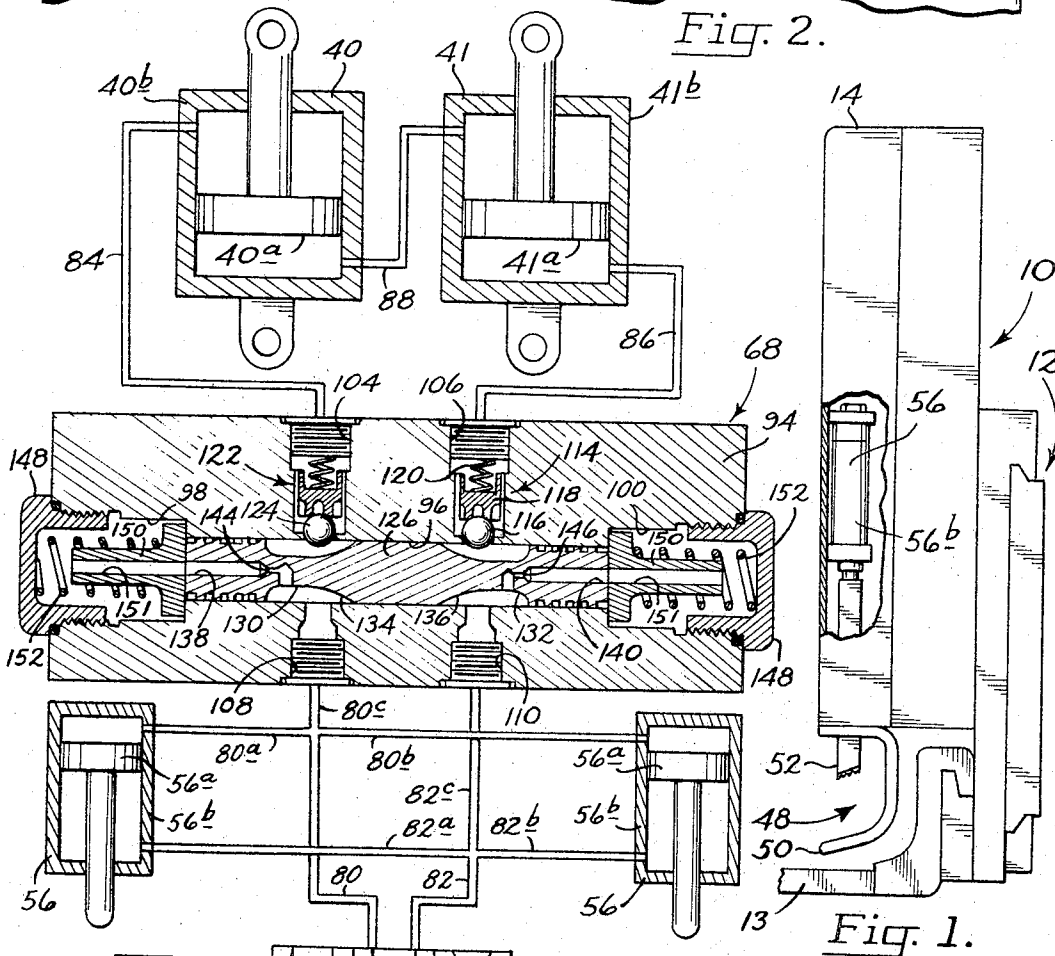
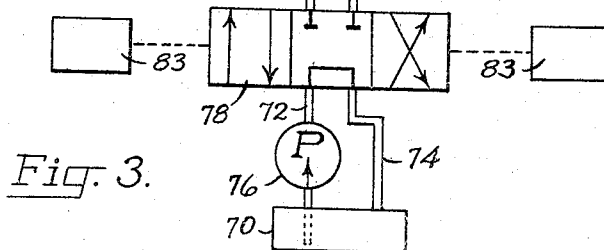
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SEQUENCER FOR HYDRAULIC MOTORS

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SEQUENCER FOR HYDRAULIC MOTORS

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10 Claims

ABSTRACT OF THE DISCLOSURE

A device for producing sequential actuation between two fluid-operated motors supplied with pressure fluid from a common source. The motor to be actuated secondly in the sequence is connected to the source through the device, which includes a check valve normally closing off the motor exhaust, a piston which has a cam thereon mounted with the cam adjacent the check valve, and a fluid-flow passage for supplying pressure fluid against the piston, which passage receives fluid from a conduit which supplies pressure fluid to the inlet or supply side of the motor. Pressure fluid supplied against the piston causes the cam to be urged against and to open the check valve permitting actuation of the motor.

This invention relates to a sequencing device and more specifically to a device for producing sequential actuation of two fluid-operated motors supplied with pressure fluid from a common source.

In fluid-operated equipment it is often desirable to actuate a pair of fluid-operated motors in sequence. In the past such sequencing has been produced by valve means situated on the inlet or supply side of the motor which is to be operated secondly effective initially to prevent the supply of fluid to the motor with operating fluid being permitted to exhaust freely from the exhaust side of such motor. It has been found, however, that with sequencing performed in this manner, there is a tendency for fluid in the system to cavitate. Another problem in sequencing devices has been the lack of a regulated and smooth transition in the operation of the various motors which are operated in sequence.

A general object of the invention is to provide a novel sequencing device for a pair of fluid-operated motors which produces a smooth transition in the operation of the motors controlled.

Another object is to provide a novel sequencing device which controls sequence by controlling the exhaust of fluid from the second of the two motors to be actuated.

More specifically, an object of the invention is to provide a novel sequencing device which produces sequential actuation between a pair of fluid-operated motors with the device including a check valve inhibiting exhaust of fluid from the motor in the pair operated secondly, and a cam which is operable smoothly to move the check valve to an open position in response to a build up in the pressure of the fluid supplied to the inlet side of the motor first operated.

A still more specific object is to provide such a novel sequencing device, which includes a piston on which a cam surface is formed for engaging and smoothly moving the check valve to its open position on movement of the piston and a conduit for supplying pressure fluid against one end of the piston.

Another object is the provision of a novel sequencing device which produces sequencing with bidirectional motors.

In certain types of installations a pump capable of supplying a relatively large volume of pressure fluid may be present which may cause improper sequencing of two

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motors intended to be operated one after the other and controlled in response to the pressure of fluid supplied to the one motor. This is because the large volume of the pressure fluid delivered may result in a high pressure condition in the fluid supplied to the one motor before this motor has been actuated to such an extent as to meet appreciable resistance to its actuation. A further important object of the invention, therefore, is the provision, in a sequencing device, of a time delay means assuring a time delay before the second to be operated motor is actuated, regardless of the pressure condition of the fluid supplied to the first to be actuated motor.

These and other objects and advantages are attained by the invention, and the same is described below in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevation view of load-handling apparatus having a horizontally extensible pusher frame and a gripper adjacent its lower end, with a portion of the pusher frame broken away to illustrate a ram for operating the gripper;

FIG. 2 is a top plan view of the load-handling apparatus of FIG. 1, showing the pusher frame extended slightly and with a portion of the load-handling apparatus broken away; and

FIG. 3 is a schematic view of the hydraulic system for operating the pusher frame and gripper, which includes a sequencing device as contemplated.

Referring now to the drawings, and first more particularly to FIGS. 1 and 2, at 10 is indicated generally a mounting frame which may be mounted on the forward end of a vehicle such as a lift truck, through an elevatable carriage as exemplified by the one partially indicated at 12. Load support forks 13 are mounted on and project forwardly from the lower portion of the mounting frame, with the rear end only of one of such forks visible in FIG. 1.

A pusher frame, indicated generally at 14, is mounted on the mounting frame through an extensible pantograph structure 16, as is best illustrated in FIG. 2. The pantograph structure comprises at least four rigid arms 20, 22, 24, 26, joined by journals such as those indicated at 28, 30 and 32. Arms 20, 22, project out from and have their rear ends joined to upright torsion shafts 34, 36, which are journaled adjacent the sides of mounting frames 10. The forward ends or arms 24, 26 are slidably received within horizontal runways (not shown) provided in the back of pusher frame 14. Similar pantograph structure is discussed in some detail in U.S. Patent 3,197,053.

With reference still to FIG. 2, adjacent the sides of mounting frame 10 are a pair of double-acting rams, also referred to as bidirectional fluid-operated motors, 40, 41 for extending and retracting pantograph structure 16 and pusher frame 14. As is seen in FIG. 3, each of rams 40, 41 includes a cylinder 40b, 41b, respectively, and a piston and rod combination 40a, 41a, respectively. Each of the rams 40, 41 has its cylinder end pivotally connected through a pivot joint 42 to the mounting frame, and its rod end pivotally connected to a lever arm 44. The lever arms, in turn, are secured to the torsion shafts mounting the arms of the pantograph. The connection of ram 41 through a lever arm to its associated torsion shaft 36 has been broken away, to illustrate the underlying securing arm 20 to shaft 36, however, it should be realized that such connection is similar to that illustrated at the left of FIG. 2 for ram 40.

On extension of the rams, the lever arms are swung away from the mounting frame causing rotation of the torsion shafts and swinging of arms 20, 22 to extend the pantograph structure to draw the pusher frame toward the mounting frame.

Mounted adjacent the bottom of the pusher frame is a gripper 48 comprising a lower jaw element 50 of C-

shaped cross section secured along its upper margin to the bottom of the pusher frame, and a vertically movable gripper element 52. Both the lower jaw and gripper elements are elongated, and extend substantially the full width of pusher frame 14. A pair of double-acting rams 56, also referred to as bidirectional fluid-operated motors, are secured within the pusher frame, with one ram adjacent each side of the pusher frame. As is best seen in FIG. 3, each of the rams 56 includes a cylinder 56b and a piston and rod combination 56a. Referring again to FIG. 1, it is seen that each ram is positioned with its rod end extending downwardly and fastened to gripper element 52. Operation of rams 56 to extend their rods moves gripper element 52 downwardly against jaw element 50 to provide gripping of any sheet such as a sheet pallet disposed therebetween.

The schematic diagram of FIG. 3 illustrates a hydraulic system for actuating rams 40, 41 and rams 56, and for producing sequential actuation therebetween, with rams 40, 41 being actuated at a time following actuation of rams 56. The system comprises a reservoir 70 which has a pair of conduits 72, 74 leading therefrom. A pump 76 in conduit 72 serves to force pressure fluid through the system while conduit 74 acts as a return line. Conduits 72, 74 are connected to one side of a control valve 78, and connected to the opposite side of the valve are a pair of conduits 80, 82.

Valve 78 is shown in its neutral position, with flow through the valve blocked as indicated by the central block in the rectangle depicting the valve. Valve 78 is operatively connected to adjusting means 83 at the ends of the valve, which may be operated to adjust the spool of the valve to produce flow through the valve as indicated by the arrows in the blocks at the ends of the rectangle representing the valve. With the valve spool adjusted to the right, conduit 72 supplies pressure fluid from the pump to conduit 80, while pressure fluid returns from conduit 82 to conduit 74. With the valve spool adjusted to the left in FIG. 3, pressure fluid is supplied to conduit 82 and returned from conduit 80.

Conduit 80 joins with branches 80a, 80b, 80c and conduit 82 joins with branches 82a, 82b, 82c, respectively. Branches 80a, 82a connect to opposite ends of ram 56 at the left of FIG. 3, while branches 80b, 82b connect to opposite ends of rams 56 illustrated at the right of FIG. 3. Branches 80c, 82c connect with one side of a sequencing device 68.

A pair of conduits 84, 86 connect at one set of ends to the side of the sequencing device opposite the side to which branches 80c, 82c connect, and connect to rams 40, 41 at their other set of ends, as illustrated in FIG. 3. Another conduit 88 interconnects opposite ends of rams 40, 41.

Sequencing device 68 comprises a casing 94 which has an elongated bore 96 therethrough. Counterbores 98, 100 are provided at opposite ends of bore 96. A first pair of spaced-apart ports 104, 106 and a second pair of spaced-apart bores 108, 110 extend through the casing, opening at inner ends to bore 96. As seen in FIG. 3, conduit 84 connects with port 104, conduit 86 connects with port 106, branch conduit 80c connects with port 108, and branch conduit 82c connects with port 110.

A check valve, also referred to as an exhaust control valve, is indicated generally at 114 within port 106. The check valve is illustrated in its normally closed position with a ball 116 seated on a restriction at the lower end of port 106 and projecting somewhat into bore 96. A keeper element 118, slidably received within port 106, is biased by a spring 120 downwardly to retain the ball in a closed position. A similarly constructed check valve 122 is provided in port 104, with a ball 124 projecting slightly into bore 96.

An elongated, reciprocable piston 126, also referred to as a fluid-pressure-responsive actuator, is positioned within bore 96 for movement longitudinally of the bore.

The piston has a pair of spaced-apart annular grooves 130, 132 formed thereabout. In the embodiment illustrated ports 104, 108 and groove 130 define a first fluid-flow passage extending through the casing between conduit 84 and branch conduit 80c, while ports 106, 110 and groove 132 define a second fluid-flow passage extending through the casing between conduit 86 and branch conduit 82c.

Annular grooves 130, 132 present cam surfaces 134, 136, respectively, which extend fully around the piston. The cam surfaces are formed so that upon shifting of the piston from its neutral position as illustrated in FIG. 3, to an actuating position to the left in FIG. 3, cam surface 134 after some movement of the actuator will contact ball 124 and smoothly urge it upwardly to open the check valve. Similarly, with the piston or actuator shifted to the right in FIG. 3, cam surface 136 comes into contact with ball 116 thence to urge it smoothly upwardly to open check valve 114.

Fluid flow passageways or branch connections 138, 140 are provided through opposite ends of piston 126. Each branch connection opens at one end to an end of the piston and at its opposite end to a side of the piston in the region of an annular groove. These branch connections are provided for introducing pressure fluid from the regions of annular grooves 130, 132 to areas adjacent the ends of the piston. Such fluid is used to shift the piston to the right or the left in the bore. Restricted throats or metering sections 144, 146 are formed in passageways 138, 140, respectively, and provide a time delay in the passage of fluid through the passageways.

End plugs 148 are screwed into threaded portions of counterbores 98, 100 to provide fluid-tight chambers adjacent opposite ends of the piston. A pair of spring retainer elements 150 having the cross sections indicated in FIG. 3 are slidably received within the counterbores and have bores 151 extending therethrough. Compression springs 152 disposed between plugs 148 and elements 150 urge the elements inwardly in their associated counterbores, to place the piston in the neutral position shown in FIG. 3.

The apparatus described in this embodiment of the invention may be used to advantage in handling loads supported on sheet-type pallets, with the load and pallet being pulled onto, or forced off of, the load support forks by actuation of the pusher frame and gripper. Assuming that the pusher frame is extended to the forward ends of forks 13, with the gripper opened up, the vehicle may be maneuvered to position the gripper adjacent the edge of a loaded sheet-type pallet, and the edge of the pallet after being inserted between the jaw and gripper elements may be clamped by the gripper. To move the pallet and the load onto the forks, rams 56 must be actuated initially to close the gripper, prior to actuation of rams 40, 41 to retract the pusher frame over the forks. It should also be recognized that sheet-type pallets used in such operations are often made of cardboard, and thus, once the gripper mechanism has gripped onto the pallet the initial actuation of rams 40, 41 must not be abrupt, to prevent tearing the edge of the pallet.

Describing now operation of the apparatus, to move such a pallet and load onto the forks, and assuming that valve 78 has been adjusted to produce flow through it as indicated by the left block in the valve rectangle in FIG. 3, operation of the pump supplies pressure fluid to line 80 from which it is routed to the upper ends of rams 56. Fluid is permitted to exhaust freely from the lower ends of rams 56 allowing their rod ends to extend and operate the gripper. Pressure fluid is also supplied through conduit 80c, port 108, groove 130 and port 104 to conduit 84 and the upper end of ram 40. Fluid in the lower end of ram 40 attempts to exhaust through conduit 88 and into the upper end of ram 41, while fluid in the lower end of ram 41 attempts to exhaust through conduit 86. Check valve 114 prevents such exhaust from rams 40, 41, thereby

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preventing actuation of these rams. With pressure fluid flowing to rams 56, and with their extension unimpeded (gripper element 52 not yet having moved against any resistance), fluid pressure in groove 130 is not great, and throat section 144 prevents any build up of fluid under pressure in the chamber at the left end of the piston or actuator. On the gripper element making gripping contact, extension of rams 56 is impeded, the pressure of fluid in groove 130 rises sharply, and fluid pressure builds up in the chamber at the left end of the piston. Eventually such pressure is effective to force the piston or actuator to the right, against the biasing spring 152 at the right of the piston and fluid present in the chamber at the right of the piston exhausts through branch connection 140 into branch conduit 82c. As the piston moves to the right, cam surface 136 contacts ball 116 and smoothly urges it upwardly to its open position, permitting fluid to exhaust from rams 40, 41, thus permitting actuation of these rams. Actuation of rams 40, 41 through pressure fluid supplied from conduit 84 retracts the rod ends of these rams, causing the pantograph structure to collapse, with retraction of the pusher frame.

With adjustment of control valve 78 to produce flow through the valve as indicated by the block at the right end of the rectangle representing the valve, the sequence of operation is the same, in that rams 56 are actuated before rams 40, 41. In this instance, however, the rams 56 are contracted upon being actuated and the rams 40, 41 are extended. With pressure fluid admitted through the valve to conduit 82, fluid flow is permitted past ball 116 and through port 106 to the lower end of ram 41. Exhaust from ram 41, however, is prevented since such takes place into ram 40, and exhaust from ram 40 is prevented by ball 124 controlling the flow through port 104. Fluid flow takes place through conduits 82a, 82b to the bottom ends of rams 56, and on these rams being contracted, fluid pressure builds up in the chamber at the right end of the piston or actuator in the sequencing device. Eventually the piston moves to the left against the biasing of spring 152, at the left of the piston, with cam 134 then moving ball 124 to a position opening port 104, with exhaust of fluid then being permitted through this port and into conduit 80.

The device has been found to operate very satisfactorily in the type of organization described wherein bidirectional motors are provided and it is required that there be a certain and pre-established sequence of operation in these motors. With sequencing being the result of controlling the exhaust of fluid from the motors, cavitation tendencies are minimized. With the time delay features provided in the sequencing device, assurance is had that the motor means first to be actuated is fully actuated before operation of the second to be actuated motor means. With the specific embodiment of the invention disclosed, this of course means that the pallet is firmly gripped before any retraction of the gripper. Further, operation of the second to be actuated motor means is not abrupt whereby damage to the sheet-type pallet is prevented.

Explaining further the time delay features incorporated in the present invention, if pump 76 supplying fluid under pressure is a relatively large volume pump, a condition may arise in rams or motors 56 wherein the pressure of fluid supplied the rams and in the lines supplying them (as in lines 80a, 80b) rise sharply even before such rams have extended to such an extent as to come against appreciable resistance to movement. This pressure rise could cause premature actuation of rams 40, 41 if not prevented by the time delay features realized by the inclusion of metering channels 144, 146.

While there has been described an embodiment of the invention, variations and modifications are possible without departing therefrom. It is desired to cover all such modifications and variations as would be apparent to one skilled in the art, and that come within the scope of the appended claims.

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It is claimed and desired to secure by Letters Patent:

1. In combination with apparatus including a source of fluid under pressure and first and second fluid-operated motors each having a pair of conduits for handling fluid supplied and exhausted therefrom,

sequencing means operable to produce actuation of the second motor after actuation of the first as indicated by an increase in the pressure of fluid supplied to the first motor comprising,

an exhaust control valve normally closing off the conduit providing for the exhaust of fluid from the second motor,

a fluid-pressure-responsive actuator shiftable between a nonactuating and an actuating position and operable in the latter position to open said exhaust control valve, and

fluid passage means connecting with the conduits supplying fluid to the first motor for introducing fluid at a pressure related to the pressure of fluid supplied the first motor against said pressure-responsive actuator to produce shifting of the actuator.

2. The combination of claim 1, wherein the motors are bidirectional with conduits functioning to supply fluid to the motors with the motors operated in one direction functioning to exhaust fluid with the motors operated in the reverse direction, and said exhaust control valve is a check valve which closes the conduit providing for the exhaust of fluid from the second motor with the second motor run in one direction but opens such conduit with the second motor run in the reverse direction.

3. The combination of claim 1, wherein the motors are bidirectional with the conduits functioning to supply fluid to the motors with the motors run in one direction functioning to exhaust fluid with the motors run in the reverse direction, the sequencing means produces actuation of the second motor after actuation of the first with the motors run in either direction, and the sequencing means comprises a pair of exhaust control valves, one for each of the pair of conduits that handle fluid supplied and exhausted from the second motor, each of said exhaust control valves being a check valve which closes its associated conduit when such provides for the exhaust of fluid from the second motor with the second motor run in one direction but opens such conduit with the second motor run in the reverse direction.

4. The combination of claim 3, wherein the fluid-pressure-responsive actuator is operable to open each of the exhaust control valves.

5. The combination of claim 1, wherein said fluid passage means includes time delay means delaying shifting of said actuator into an actuating position by fluid under pressure introduced by the fluid passage means.

6. The combination of claim 3, wherein said sequencing means further comprises a casing having a bore therein, and wherein said actuator comprises an elongated, relatively reciprocable piston mounted in said bore, and said fluid passage means for introducing pressure fluid against said actuator comprises passage means for introducing fluid against opposite ends of said piston.

7. The combination of claim 6, wherein said passage means for introducing fluid against opposite ends of said piston includes a metering section for delaying shifting of said actuator into an actuating position.

8. The combination of claim 7, wherein said piston includes cam means operable following displacement of said piston in one direction to open one of said exhaust control valves, and operable following displacement of said piston in another direction to open the other of said exhaust control valves.

9. The combination of claim 8, wherein said sequencing means further comprises means biasing said piston toward its nonactuating position, with said exhaust control valves in said nonactuating position normally being closed.

10. The combination of claim 7, wherein said passage means for introducing fluid against opposite ends of the

piston comprises a bore defined through each of the opposite ends of said piston.

References Cited

UNITED STATES PATENTS

2,355,039	8/1944	Eves	170—160.32
3,129,720	4/1964	Allen et al.	137—490
3,274,902	9/1966	Klechner	91—420
3,422,727	1/1969	Pearson	91—413
2,308,727	1/1943	Temple	91—411 X
2,462,580	2/1949	Watson	91—411 X

3,233,525	2/1966	Stacey	91—412
3,407,951	10/1968	Faust et al.	91—413

FOREIGN PATENTS

5	1,176,987	12/1958	France.
	1,227,434	3/1960	France.

EVERETTE A. POWELL, Jr., Primary Examiner

U.S. Cl. X.R.

10 91—412