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Kobelt

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[54] **MULTIPLE-STATION FLUID CONTROL CIRCUIT**

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[51] **Int. Cl.** **F15b 1/02n**

[58] **Field of Search** 91/427; 60/413, 371

[56] **References Cited**

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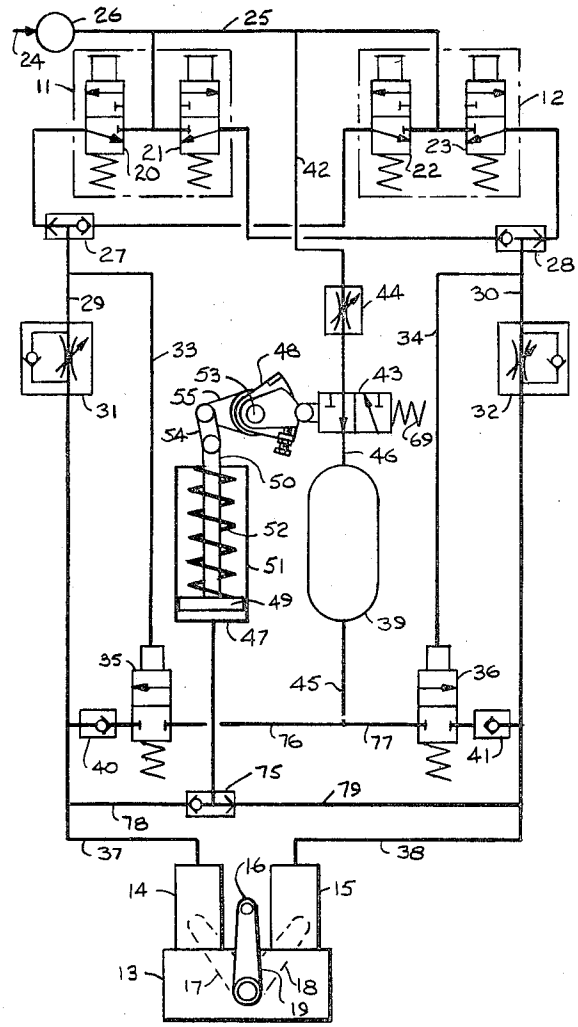
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Primary Examiner—Edgar W. Geoghegan

[57] **ABSTRACT**

This disclosure pertains to a fluid control circuit which provides remote control of a device or servo-mechanism from more than one operator station. A control circuit having a pressurized fluid source, a system of control valves, a plurality of control stations, and a controlled device, includes as essential elements a pressure proportional linear actuator, a time-delay cam assembly, and a volumetric accumulator. The time-delay cam assembly is mounted on an oscillating shaft which is actuated by the proportional linear actuator. A cam portion is pivotally mounted on the shaft, a cam actuator portion is secured to the shaft whereby the shaft and cam actuator may be oscillated through a predetermined angle by the proportional linear actuator while the cam remains in a fixed pivotal position. Once the cam actuator contacts the cam, the latter is impelled in the oscillatory direction experienced by the shaft and cam actuator. Hence, the cam in its fixed position holds a fluid control valve in one position during a predetermined time-delay and in another position subsequent to actuation by the cam actuator. Therefore, irrespective of either length or variation in distance of each control station from the controlled device, fluid from the accumulator is employed to actuate the device with uniform timing from either station and upon actuation the accumulator is exhausted thereby returning full control of the device to the control stations.

9 Claims, 4 Drawing Figures



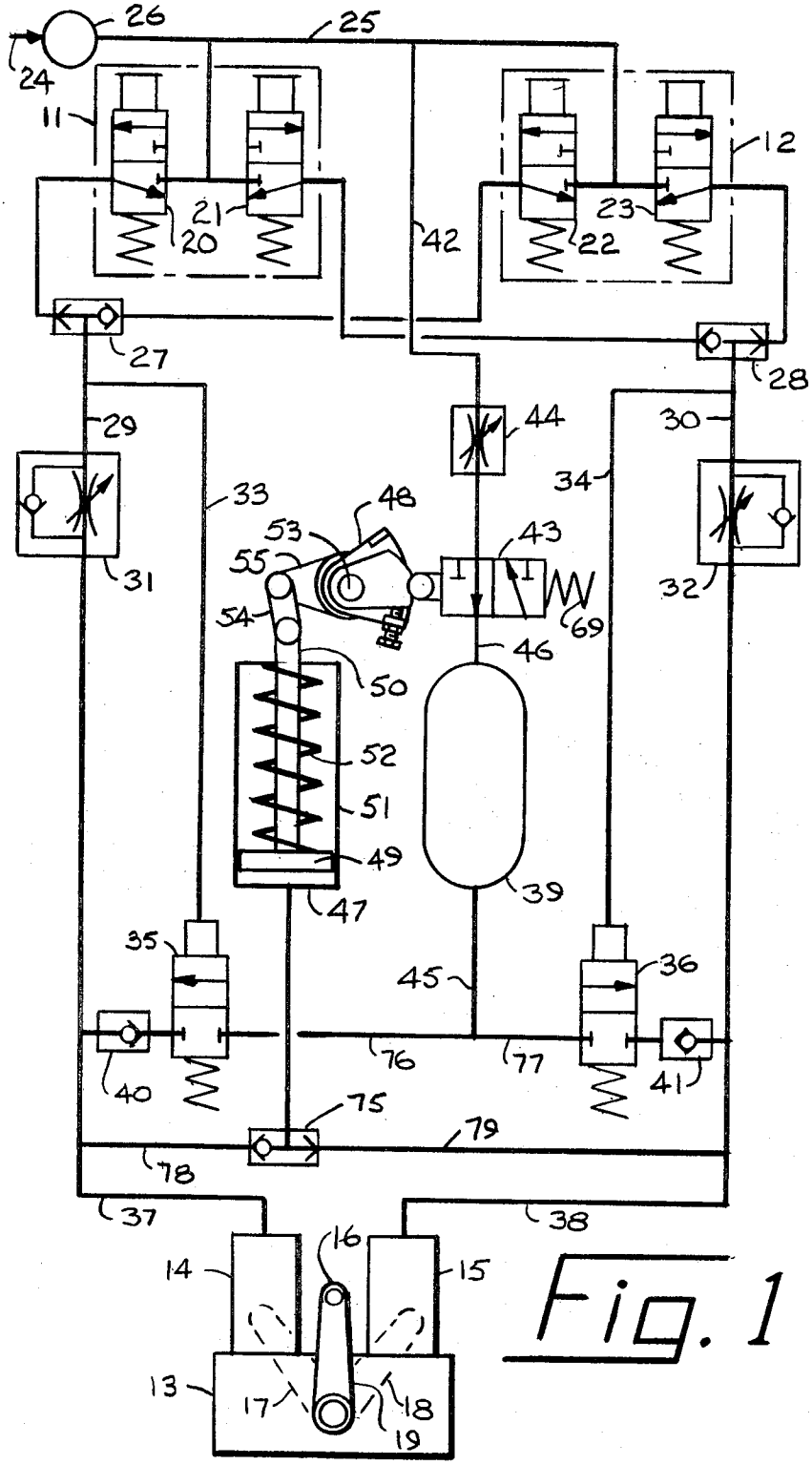

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Fig. 1

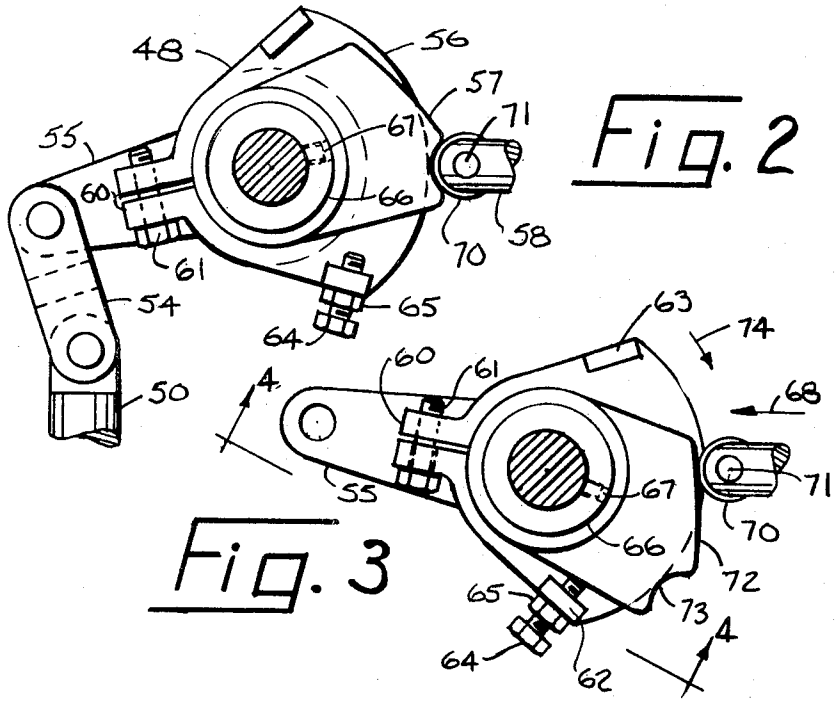


Fig. 2

Fig. 3

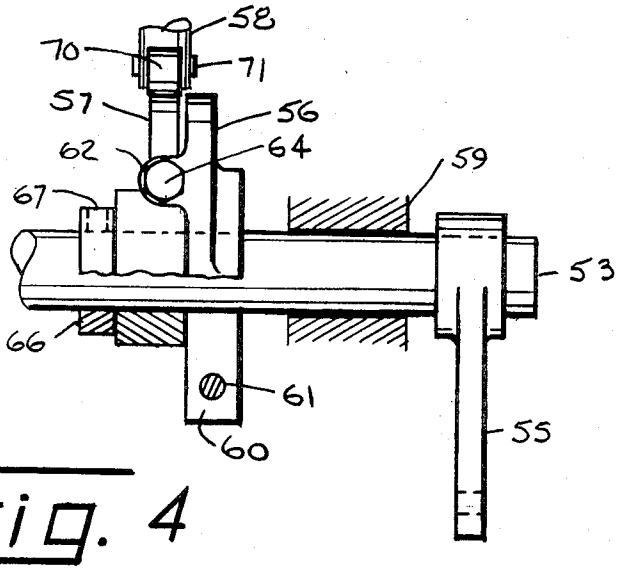


Fig. 4

MULTIPLE-STATION FLUID CONTROL CIRCUIT

This invention relates to novel structure in devices and combinations thereof which are known in the art to which they pertain as fluid control devices, fluid control circuits, fluid control systems, or are of the general character of fluid power systems which either transmit or control power through the use of a pressurized fluid within an enclosed circuit. In general, my invention relates to a fluid control circuit which provides remote control of a device or servo-mechanism. Specifically, my invention may be used to control a clutch or engine in a marine power plant installation from a location much removed therefrom, say on the bridge, such as has been illustrated in my U.S. Pat. No. 3,455,186. Whereas in the prior art relay valves have been employed to provide the necessary time delays in remotely controlling the cycling of an engine from forward to reverse, I disclose herein a much simplified fluid control circuit employing a mechanical time-delay cam which may be visually inspected and adjusted accordingly to produce a desired engine timing or valve control sequence.

In its simplest form, my invention employs a pressure-proportional linear actuator having a cylinder portion, piston portion, rod portion, and mechanical spring portion. The rod portion is pivotally connected to a torque arm of a cam shaft. A time-delay cam assembly is operatively mounted on the cam shaft and actuates a fluid control valve according to the movement of the cam shaft. The control valve is alternatively actuated by the cam to admit and exhaust fluid from a volumetric accumulator. Flow from the accumulator to a controlled device occurs over a relatively short distance and is controlled by a system of fluid control devices from a plurality of remote operator control stations. The pressure-proportional linear actuator oscillates the time-delay cam whereby a signal from any one of the remote operator control stations causes the accumulator immediately to energize the controlled device, then to exhaust the accumulator whereby full control is returned to the control station. Check or shutter valves interconnect the operator control stations whereby a signal from only one control station at a time may be transmitted to the controlled device and pressure-proportional linear actuator. Where more than one mode of operation of a controlled device is required, such as is the case in a forward/reverse gear actuator, shuttle valves are again used to transmit only one signal at a time to the pressure-proportional linear actuator.

Therefore, it is one object of my invention to provide a fluid control circuit which employs a single energizing volumetric accumulator actuated from a plurality of control stations.

It is another object of my invention to provide mechanical means whereby an accumulator-charge and accumulator-exhaust valve may be positively actuated, the timing thereof in a control sequence admitting of visual inspection and adjustment.

Yet a further object of my invention is to provide a fluid control circuit which employs a simplified combination of fluid control devices adapted for uniform remote control from a plurality of operation control stations.

Still another object of my invention is to provide a fluid control circuit having mechanical valve actuation

means which produce a functional, positive, and predetermined time-delay without the use of pilot operated relay valves.

Another object of my invention is to provide a fluid control circuit wherein completion of a desired actuation effect of an energizing volumetric accumulator on a controlled device simultaneously effects the exhausting of the accumulator.

These and further objects of my invention, which reside in the details of its structure and operation, will be evident from a study of the following disclosure and accompanying drawings which illustrate a preferred embodiment of the invention. This embodiment is merely exemplary and is not intended to detract from the full scope of the invention as set out in the annexed Claims.

In the drawings, wherein like numerals refer to like parts:

FIG. 1 is a schematic diagram of my invention employing for the most part fluid control device symbols which are readily understood to one skilled in the art;

FIG. 2 illustrates a side elevation of a time-delay cam assembly, looking substantially along the axis of a cam shaft, with a cam follower energizing the cam in a detent position;

FIG. 3 is another side elevation of the assembly in FIG. 2 wherein the cam follower is disengaged from its detent position;

FIG. 4 is a frontal and partially sectional elevation of the cam assembly taken along line 4—4 in FIG. 3.

Turning now to the drawings, FIG. 1 illustrates my invention of a multiple station fluid control circuit wherein a pressurized fluid source such as a gas compressor or hydraulic pump supplies the circuit with pressurized fluid in ducting 24 and 25. Fluid modifier 26 may be a filter, lubricator or pressure regulator in the case of a pneumatic circuit or a filter in the case of an hydraulic circuit.

To illustrate multiplicity of operating stations, two operator control stations 11 and 12 are disclosed. These control stations may be located substantially remote from the remainder of the elemental components of my invention; in the case of a vessel, the control stations will normally be found on the deck whereas the remainder of the control circuit components will be found in the vicinity of the engine room. For purposes of illustrating multiplicity of controlled mode, operator stations 11 and 12 each have a pair of primary control valves; 20 and 21 at station 11 and 22 and 23 at station 12. In marine installations, valves 20, 21, 22, and 23 are normally operated manually. However, these valves may also be operated remotely by fluid, mechanical, or electrical means, depending upon the requirements of a given application of my invention.

Each primary control valve pair, i.e., 20, 22, and 21, 23, must be duct connected to permit a control signal from only one valve at any one time. Therefore, shuttle valves 27 and 28 (often referred to as a double check valve with cross bleed for reversible flow) interconnect respectively valve pairs 20, 22 and 21, 23. If more than two operator control stations were required, additional shuttle valves would be employed. For instance, in the case of three operator control stations, the output of valve 27 would form input along with the input from the third station into a second shuttle valve. In general, it will be understood by one skilled in the art that the

number of shuttle valves required for each set of primary control valves will be equal to the number of control stations minus one. In the case illustrated in FIG. 1, two stations require one shuttle valve for each pair of primary control valves. One or more shuttle valves interconnecting a plurality of primary control valves may be considered as a shuttle valve system.

Output from shuttle valves 27 and 28 is duct connected respectively by ducting 29 and 30 to flow-control valves 31 and 32, and by ducting 33 and 34 to pilot portions of two-position two-way pilot operated control valves 35 and 36. Flow-control valves 31 and 32 restrict flow from while permitting free flow to, respectively, primary control valve pairs 20, 22 and 21, 23. Flow control valves 31 and 32 are interconnected by means of ducting 37 and 38 to controlled device 13. Therefore, restricted flow to and rapid flow from controlled device 13 is effected by flow-control valves 31 and 32. Controlled device 13 may be a clutch, servomechanism, or gear control (as illustrated in my U.S. Pat. No. 3,455,186).

Stations 11 and 12 may be separated substantially by distance; to eliminate the need to adjust or time two circuits, my invention employs one flow control valve for each pair of primary control valves 20, 22 and 21, 23. Furthermore, in multiple-mode operation of controlled device 13, such as in a gear control having forward, neutral, and reverse, flow from the operator control stations may vary or be of undesirable duration. To overcome this difficulty, my invention employs simplified fluid circuitry whereby output from shuttle valve-flow control pairs 27, 31 and 28, 32 control the immediate and nonvarying energization of controlled device 13 by means of stored fluid in volumetric accumulator means 39. It will be apparent to one skilled in the art that accumulator 39 may be a simple tank in the case of a pneumatic circuit or a gas filled accumulator in the case of an hydraulic circuit.

Flow from accumulator 39 is controlled by pilot-operated valves 35 and 36. Connected in series with valves 35 and 36, to permit only unidirectional flow from accumulator 39, are respectively one way check valves 40 and 41. Flow into accumulator 39 is achieved by ducting 42 and two-position three-way control valve 43. Flow control valve 44 is optional and may be used in certain timing applications where the rate of accumulator charging is to be regulated; conversely the rate of accumulator discharge in duct 45 or the rate of accumulator exhaust through duct 46 may also be regulated by the likes of valve 44, depending upon the application of my invention and as a choice of design to one skilled in the art.

From the foregoing, it will be evident that control valve 43 must be actuated in such a manner as to permit charging of accumulator 39 prior to and during energization of controlled device 13 but effect the exhausting of accumulator 39 after energizing is complete whereby to permit full control of device 13 from control stations 11 and 12. To accomplish this, I employ novel structure which combines pressure-proportional linear actuator means 47 and time-delay cam assembly 48 mounted on cam shaft 53. Linear actuator 47 comprises piston portion 49, rod portion 50, cylinder portion 51 and spring means 52. Cylinder portion 51 is fixed with respect to cam shaft 53; hence to transmit the motion of rod portion 50 to shaft 53, rod 50 is pivotally connected to link 54 which is in turn pivotally connected to torque arm 55 secured to shaft 53. Movement of rod 50 in and out of cylinder 51 causes oscillatory motion of shaft 53.

Looking now at FIGS. 2, 3, and 4, time delay cam assembly 48 incorporates a cam actuator means 56 secured to shaft 53 by means of split hub 60 and positioning bolt 61, cam means 57 pivotally mounted on shaft 53, and cam follower means 58 riding on cam means 57. Cam shaft 53 is pivotally mounted on a frame or support 59 shared also by valve 43 and linear actuator 51. Cam actuator means 56 has actuator ears 62 and 63, one of which (62) has timing adjustment bolt 64 threaded thereinto and lock-nut 65. Cam means 57 is retained in operative spaced relation with respect to cam actuator 56 and ears 62, 63 by collar 66 secured by set screw 67 to shaft 53.

Cam follower 58 interfaces cam means 57 and is impelled in direction 68 by spring 69 of valve 43. Roller 70 is rotatably mounted on cam follower 58 by pin 71 and rolls on the peripheral contour 72 of cam means 57. Roller 70 matches substantially the contour of detent indentation 73 whereby cam follower 58 maintains cam means 57 in a position as shown in FIG. 2 irrespective of cam shaft oscillation except when actuator ear 63 impells cam means 57 in direction 74 to a position for example as shown in FIG. 3.

Positioning bolt 61 being used to locate and fix cam actuator 56 with respect to shaft 53, may also be employed to adjust the pivotal position of cam actuator 56 with respect to shaft 53. Adjusting means mounted on cam actuator 56, and comprising bolt 64 and nut 65, may be used to adjust the angular relationship between cam actuator 56 and cam means 57.

Flow from either flow control valve 32 or pilot controlled valve 36 will occur when either valve 21 or valve 23 is actuated. Likewise flow from either flow control valve 31 or pilot controlled valve 35 will occur when either valve 20 or 22 is actuated. For such a system as illustrated in FIG. 1, where more than one mode of operation of device 13 is involved, a second shuttle valve 75 is required to provide reversible flow between linear actuator 51 and device 13 and one of valve pairs 32, 36 and 31, 35. As in the previous shuttle valve system combining signals from control stations 11 and 12, a second shuttle valve system is here required which will employ a number of shuttle valves equal to the number of primary control valves at each of stations 11 and 12 less one. In the case illustrated in FIG. 1, the number of valves at each operator control station is two, hence one shuttle valve 75 is required.

Turning now to the operation of my invention, consider a controlled device 13 to have three operating modes, say forward, neutral and reverse. Considering controlled device 13 to be a gear control unit, as disclosed in my U.S. Pat. No. 3,455,186, left cylinder portion 14 controls forward, right cylinder portion 15 controls reverse, and de-energization of both of cylinders 14 and 15 provides neutral. Lever 16 in position 19 represents neutral, in position 17 represents forward, and in position 18 represents reverse.

In the valve configuration illustrated in FIG. 1, neither of valves 20, 21, 22, or 23 are actuated. Therefore, except for accumulator 39, the pressure in the control system is substantially zero or atmospheric, depending on the reference employed. Accumulator 39 is charged with fluid at a pressure substantially equal to that in duct 25; fluid at the same pressure fills duct 45 up to

valves 35 and 36. In this configuration, spring 52 maintains piston 49 and rod 50 in the withdrawn position, time-delay cam assembly 48 holds valve 43 in the accumulator-charge position. Device 13 is in the neutral position, as represented by lever 16 in position 19, and accumulator 39 is charged in preparation for a forward or reverse signal from either control station 11 or 12 as experienced in duct 33 or duct 34.

Consider now that valve 20 at station 11 is actuated to permit flow from duct 25 to shuttle valve 27. A pressure signal by-passing flow control valve 31 immediately opens valve 35 thus admitting fluid from accumulator 39 into left cylinder 14 of device 13 and lever 16 assumes forward position 17. Meanwhile, pressure in linear actuator 47 causes cam actuator means 56 to impell cam 57 in direction 74, thus exhausting accumulator 39. From this point to the end of the oscillation of cam shaft 53, the rate of movement of rod 50 and cam shaft 53 is governed by flow through flow control valve 31. It has been found that my invention, where employed to control a clutch in a marine power plant installation and where other cams such as throttle boost or throttle control cams are also installed on cam shaft 53, accumulator 39 is necessarily exhausted at a point roughly half-way through the clutch engaging cycle when the pressure in duct 37 is roughly half of that achieved ultimately by fluid flow through flow control valve 31. Reverse flow from duct 37 into accumulator 39 is prevented by check valve 40. It will be evident to one knowledgable in these matters that the exact timing of the exhaust of accumulator 39 will be predetermined by adjusting bolts 61 and 64 on time-delay cam assembly 48; the pressure achieved in duct 37 by fluid flow from accumulator 39 will be determined by the timing aforementioned, by the volume of accumulator 39, and to a lesser extent by flow control valve 44.

In like manner, it can readily be shown that actuation of primary control valve 21 at operator station 11 will cause fluid from duct 25 to flow through shuttle valve 28, flow control valve 32, pilot duct 34, duct 45, valves 36 and 41, and ultimately duct 38 into right cylinder 15 of device 13, thereby causing lever 16 to assume reverse position 18. Further, actuation of valve 22 at station 12 ultimately causes lever 16 to assume forward position 17, and actuation of valve 23 causes lever 16 to assume reverse position 18. Clearly, de-actuation of all of valves 20, 21, 22, and 23 causes fluid from ducts 37 and 38 to be fully exhausted, lever 16 thence assuming neutral position 19.

It is believed that my invention of a multiple-station fluid control circuit will have been clearly understood from the foregoing detailed description of my now preferred and illustrated embodiment. Various modifications, changes, additions, and equivalents may be resorted to in view of these teachings by one skilled in this art without departing from the spirit of my invention. For instance, additional flow control valves the likes of valves 31 41 might be sensible installed in any of ducts 33, 34, 46, 45, 76, 77, 78, or 79, depending on the nature and requirements of controlled device 13. Therefore, whereas a choice between such variations, modifications, changes, additions, and equivalents falling within the true scope of my invention will depend largely upon the circumstances in which my invention is used, it is my express intention that no limitations be implied and that the hereto annexed Claims be given the broadest interpretation to which the language fairly admits.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A multiple-station fluid control circuit comprising a pressurized fluid source, a plurality of operator control stations, a fluid controlled device, a system of fluid control valves and ducting interconnecting said plurality of operator control stations and said fluid controlled device and said pressurized fluid source, a pressure-proportional linear actuator means duct connected to said system of fluid control valves and ducting, an oscillating cam shaft operatively mounted with respect to and operatively connected to said pressure-proportional linear actuator means, a time-delay cam assembly operatively mounted on said oscillating cam shaft, volumetric accumulator means duct connected to said system of fluid control valves and ducting, said time-delay cam assembly maintaining an accumulator control valve in an accumulator-charge position as said pressure-proportional linear actuator means actuates said oscillating cam shaft through a predetermined pivotal time-delay angle, said time-delay cam assembly ultimately actuating said accumulator control valve into an accumulator-exhaust position at a predetermined pivotal position of said oscillating cam shaft.

2. A multiple-station fluid control circuit as defined in claim 1, wherein said time-delay cam assembly comprises a cam means pivotally mounted on said cam shaft, cam actuator means secured to said cam shaft in operative spaced relation to said cam means, cam follower means operatively mounted on said accumulator control valve, detent means operatively mounted with respect to said cam means, whereby said detent means maintains said cam means in a fixed position correlative to said accumulator-charge position of said accumulator control valve.

3. A multiple station fluid control circuit as defined in claim 1 wherein said time-delay cam assembly comprises a cam means pivotally mounted on said cam shaft, cam actuator means secured to said cam shaft in operative spaced relation to said cam means, cam follower means operatively mounted on said accumulator control valve, said cam means having a detent indentation of contour substantially matching that of said cam follower means, whereby said cam follower means maintains said cam means in a fixed position correlative to said accumulator-charge position of said accumulator control valve.

4. A multiple-station fluid control circuit as defined in claim 1 wherein said time-delay cam assembly comprises a cam means pivotally mounted on said cam shaft, cam actuator means secured to said cam shaft in operative spaced relation to said cam means, adjustment means provided on said cam actuator means whereby to permit angular timing adjustment of said cam actuator means with respect to said cam shaft.

5. A multiple-station fluid control circuit as defined in claim 1 wherein said time-delay cam asembly comprises a cam means pivotally mounted on said cam shaft, cam actuator means secured to said cam shaft in operative spaced relation to said cam means, adjustment means provided on said cam means whereby to permit angular timing adjustment of said cam means with respect to said cam actuator means.

6. A multiple-station fluid control circuit as defined in claim 1 wherein said time-delay cam assembly comprises a cam means pivotally mounted on said cam shaft, cam actuator means secured to said cam shaft in operative spaced relation to said cam means, adjustment means provided on said cam actuator means whereby to permit angular timing adjustment of said cam means with respect to said cam actuator means.

7. A multiple-station fluid control circuit as defined in claim 1 wherein said system of fluid control valves and ducting includes at each of said operator control stations a primary control valve, a shuttle valve system permitting flow to and from only one of said primary control valves at any one time, said shuttle valve system duct connected to a pilot portion of a two-position two-way pilot-operated control valve and to a flow-control valve, said flow-control valve restricting flow from and permitting free-flow to said shuttle valve system, a one-way check valve and said two-position two-way pilot operated control valve duct connected in series whereby to permit unidirectional flow from said volumetric accumulator means to said fluid controlled device and said pressure-proportional linear actuator means, said fluid controlled device duct connected for reversible flow to said flow-control valve.

8. A multiple-station fluid control circuit as defined in claim 1 wherein said fluid controlled device has a plurality of operating modes, said system of fluid control valves and ducting including at each of said plurality of operator control stations one primary control valve for each of said pluralty of operating modes, a first shuttle valve system for each of said plurality of operating modes permitting flow to and from only one of said primary control valves at any time, each of said first shuttle valve systems duct connected to a pilot portion of a two-position two-way pilot-operated control valve and to a flow-control valve, said flow-control valve restricting flow from and permitting free-flow to its interconnected first shuttle valve system, a one-way check valve and said two-position two-way pilot-operated control valve duct connected in series whereby to permit unidirectional flow from said volumetric accumulator means to said fluid controlled device and to a second shuttle valve system, said pressure-proportional linear actuator means duct connected to said second shuttle valve system whereby to permit reversible flow between one of said flow-control valves and said pressure-proportional linear actuator.

9. A multiple-station fluid control circuit comprising a pressurized fluid source, a plurality of operator control stations, a fluid controlled device, a primary pneumatic control valve at each of said operator control stations duct connected to said pressurized fluid source, output from each of said primary fluid control valves duct connected to a shuttle valve system whereby flow to and from only one of said primary control valves is permitted at any time, a pressure-proportional linear actuator means operatively connected to an oscillating cam shaft, a time-delay cam assembly operatively mounted on said oscillating cam shaft, volumetric accumulator means duct connected to an accumulator control valve, said acumulator control valve duct connected to said pressurized fluid source, said time-delay cam assembly maintaining said accumulator control valve in an accumulator-charge position as said pressure-proportional linear actuator means actuates said oscillating cam shaft through a predetermined pivotal time-delay angle, said time-delay cam assembly ultimately actuating said accumulator control valve into an accumulator-exhaust position at a predetermined pivotal position of said oscillating cam shaft, said shuttle valve system duct connected to a flow-control valve and to the pilot portion of a two-position two-way pilot-operated control valve, said volumetric accumulator means duct connected in series to said pilot-operated control valve and to a one-way check valve for unidirectional flow therefrom to said pressure-proportional linear actuator means and to said fluid controlled device, said flow-control valve duct connected for reversible flow to said fluid controlled device and to said pressure-proportional linear actuator means.

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