June 21, 1966 J. D. SETTLES 3,257,598

PERIODICALLY DRIVEN ROTARY VALVE CONTROL

Filed May 13, 1963 4 Sheets-Sheet 1

Fig. 1.

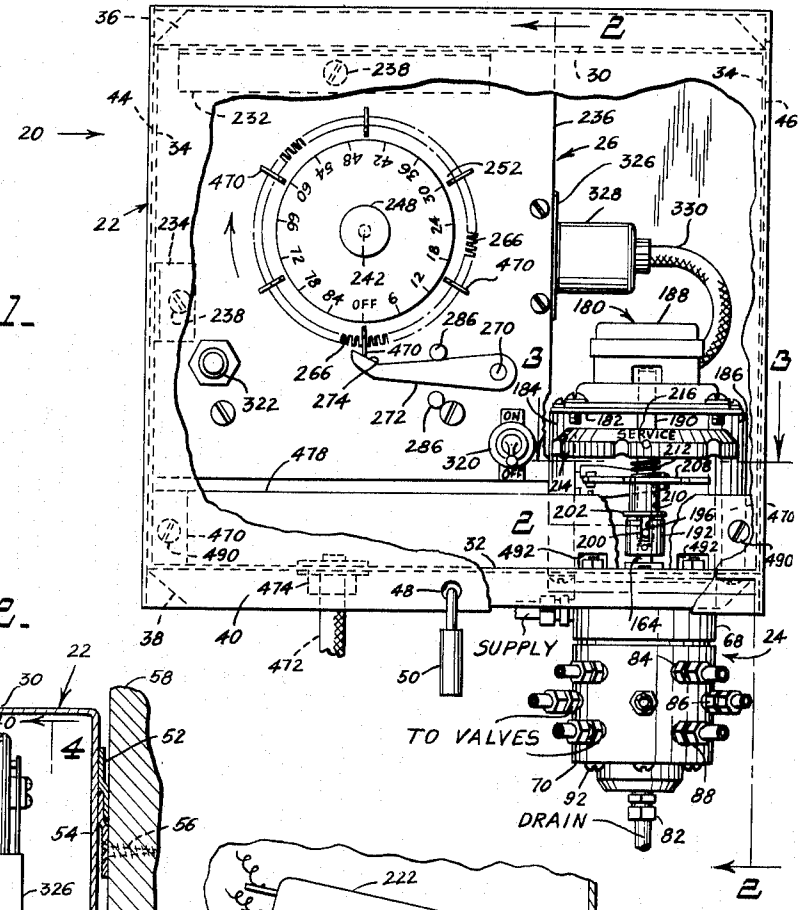
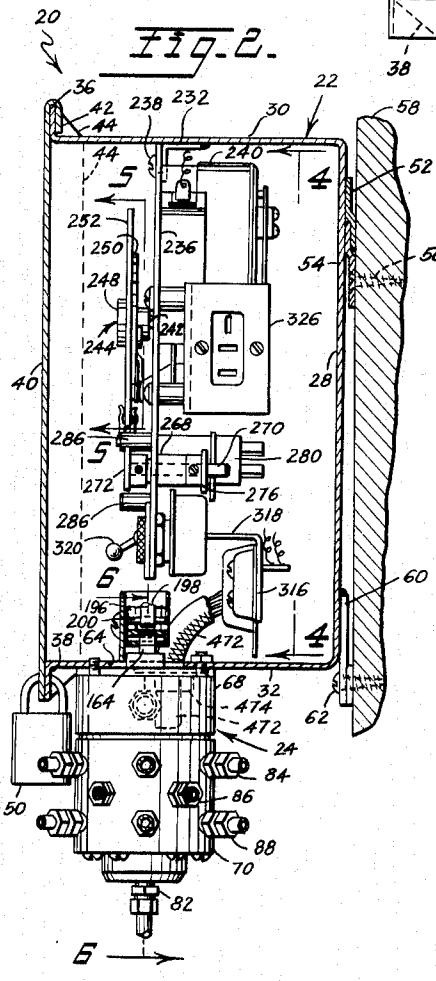


Fig. 2.



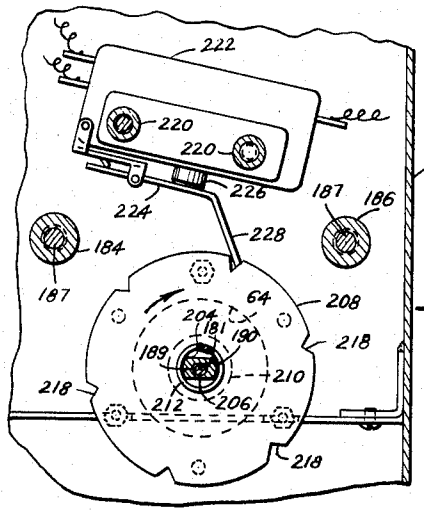


Fig. 3.

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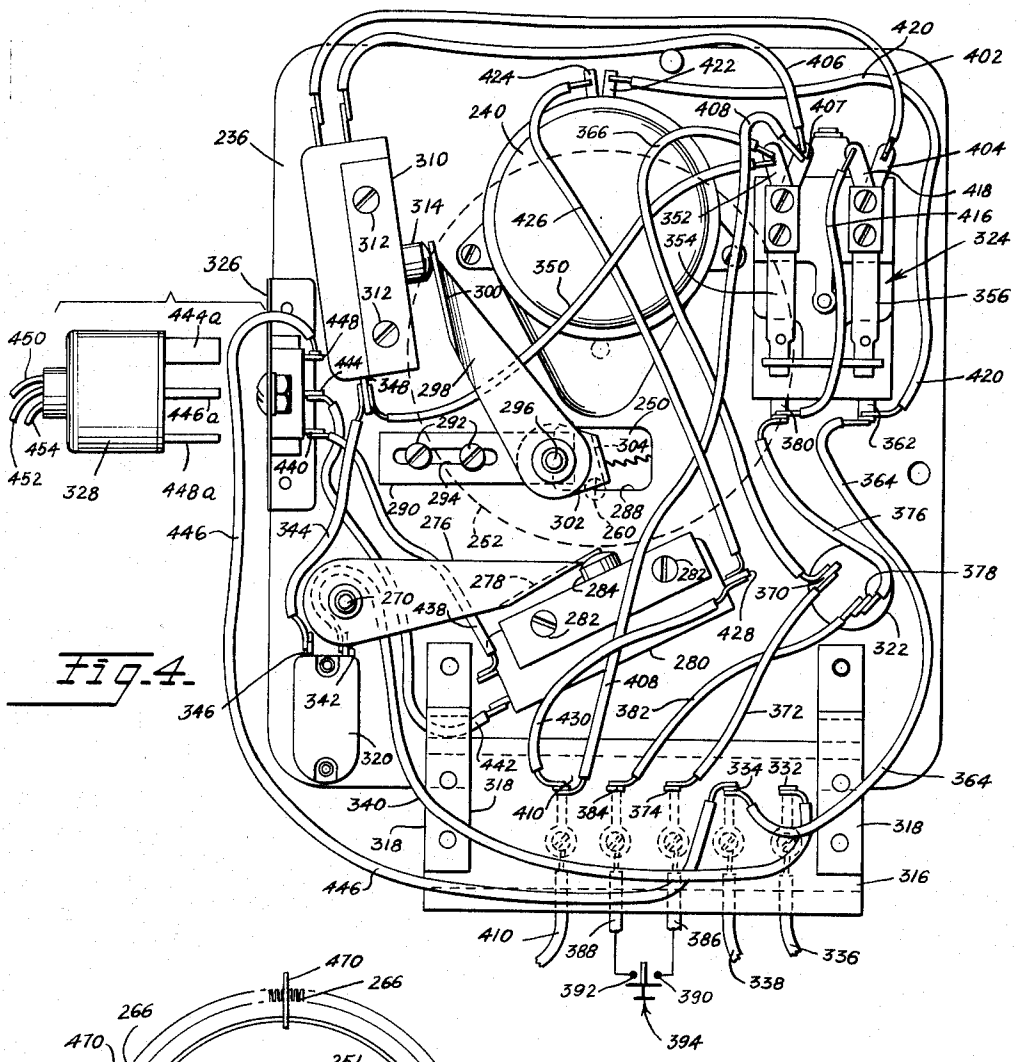


Fig. 4

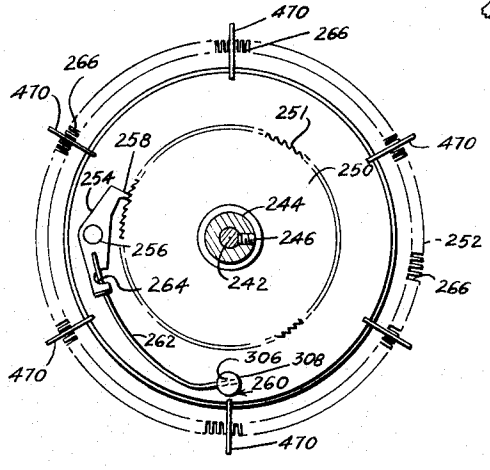


Fig. 5

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PERIODICALLY DRIVEN ROTARY VALVE CONTROL

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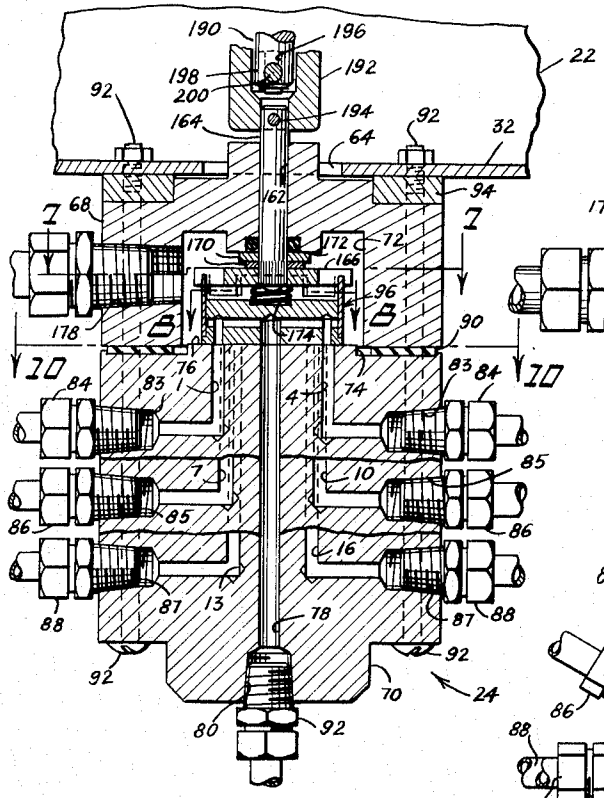


Fig. 6.

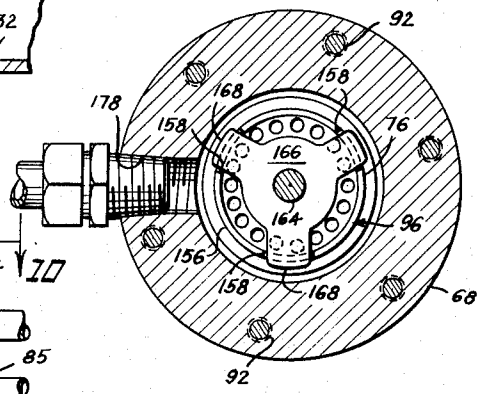


Fig. 7.

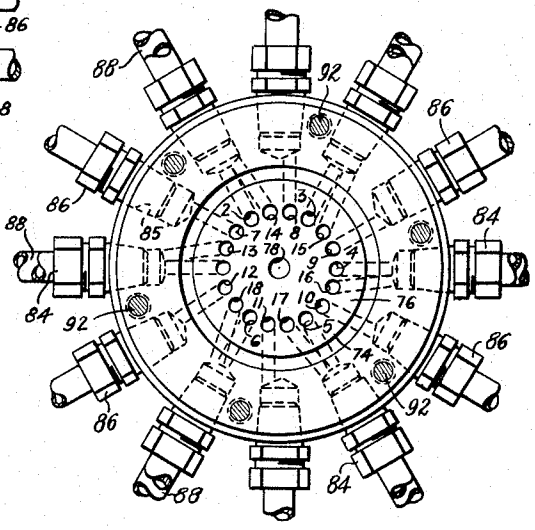


Fig. 10.

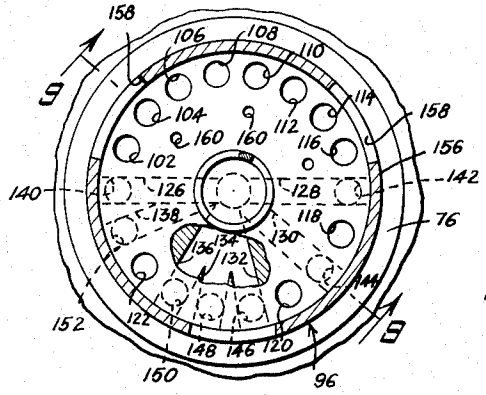


Fig. 8.

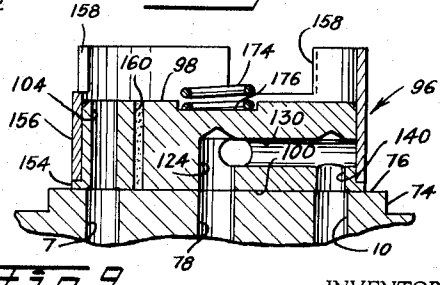


Fig. 9.

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PERIODICALLY DRIVEN ROTARY VALVE CONTROL

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Fig. 11.

PILOT POSITION	PILOT SEAT PORT NUMBERS																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	D	S	S	D	S	D	S	S	S	D	D	D	S	S	S	S	D	S
1	D	D	S	S	D	S	D	S	S	S	D	D	S	S	S	S	S	D
2	S	D	D	S	S	D	D	D	S	S	S	D	D	S	S	S	S	S
3	D	S	D	D	S	S	D	D	D	S	S	S	S	D	S	S	S	S
4	S	D	S	D	D	S	S	D	D	D	S	S	S	S	D	S	S	S
5	S	S	D	S	D	D	S	S	D	D	D	S	S	S	S	D	S	S

DISTRIBUTOR PORTS IN UPPER PLANE — DISTRIBUTOR PORTS IN INTERMEDIATE PLANE — DISTRIBUTOR PORTS IN LOWER PLANE

LEGEND
D = DRAIN
S = SUPPLY

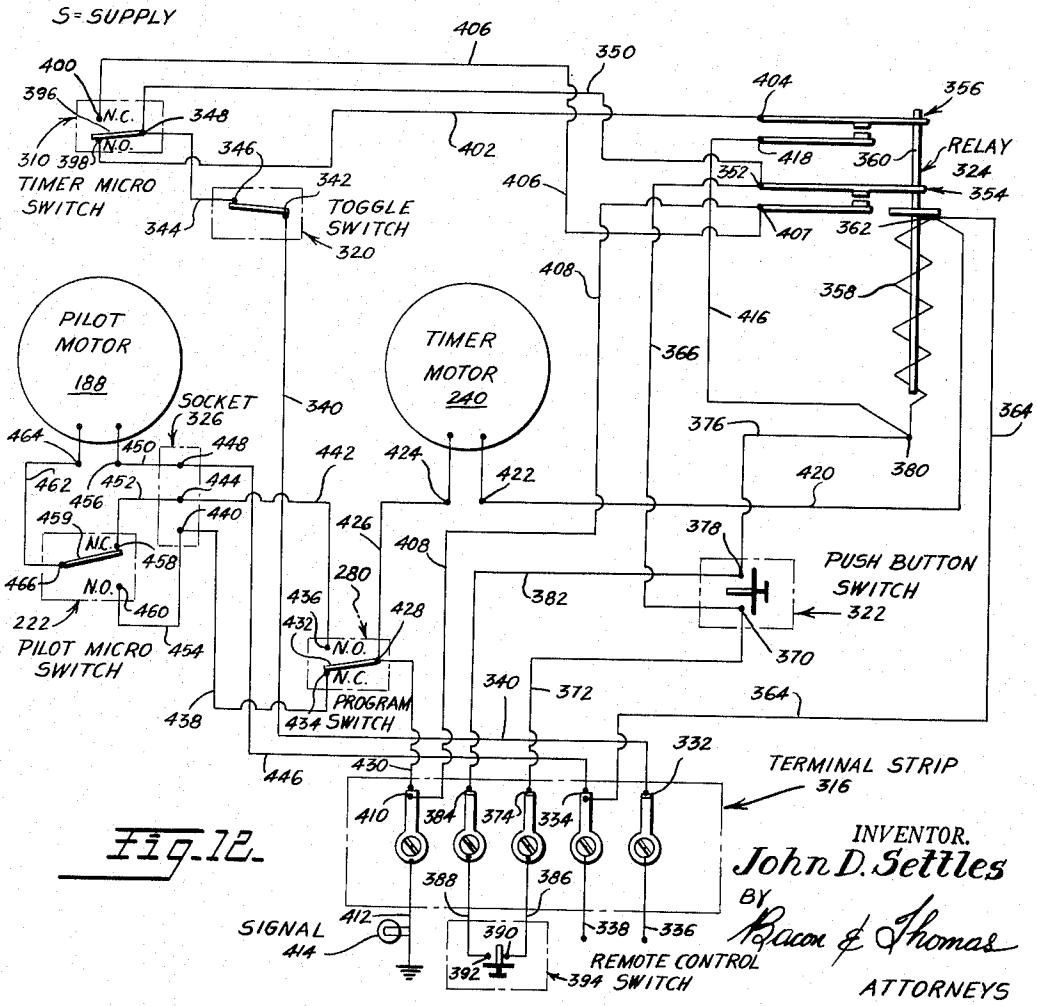


Fig. 12.

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PERIODICALLY DRIVEN ROTARY VALVE CONTROL

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Filed May 13, 1963, Ser. No. 280,060
17 Claims. (Cl. 318—443)

This invention relates generally to control systems for controlling the rotational position of rotatable mechanisms, and more particularly to a novel control system incorporating a synchronous motor and especially adaptable to position a rotary pilot valve in a fluid system controller.

Control systems of the general type to which this invention relates are commonly utilized in fluid system controllers to position a rotary pilot valve that is itself arranged to operate a plurality of remotely positioned, fluid-actuated control valves, or other fluid-operated devices. The remotely controlled valves can be positioned in a fluid distribution system, or can be utilized to control the operating cycle of a water softener, a sand filter, or similar apparatus, and the controller usually includes a timer mechanism arranged to automatically cause the pilot valve to pass through a complete operating cycle.

The controller of the present invention includes a rotary disk type multi-port, pilot valve, which is rotated by a high-torque synchronous motor. The pilot valve is ported to actuate a plurality of remotely positioned fluid-operated devices, such as fluid-operated flow control valves. A timer mechanism is associated with the pilot valve and the synchronous motor, and operates to cause the pilot valve to move through a series of positions, or steps, in a cyclic program, the time duration of each of said steps being controlled by clips inserted into a dial on the timer mechanism.

The invention further includes a novel circuit for interconnecting the timer mechanism with the synchronous motor, which circuit includes a plurality of switches arranged to be operated so that the pilot disk will be rapidly rotated from one position to the next, and precisionally positioned in each of its program positions. The circuitry also includes a manual pushbutton for starting a program cycle, and the control system is designed to cause the pilot valve to automatically go through a complete cycle once it has been started and to then be de-enerized in a service position. Further, the invention is constructed so that, in the event of power failure, the pilot valve can be operated manually to rotate the same through its normal cycle.

It is an object of this invention to provide a fluid system controller for automatically operating a plurality of remotely positioned fluid-actuated devices in a timed cyclic sequence.

Another object is to provide a control system for controlling a rotary pilot valve in a fluid system controller, said control system incorporating a synchronous motor connected and arranged in an electric circuit to quickly and precisely position said pilot valve.

Still another object is to provide a control system for a synchronous motor-driven pilot valve, said system including a timer mechanism and being constructed to automatically control the operation of said synchronous motor in response to lapsed time intervals as measured by said timer mechanism.

A further object is to provide a control system for a motor-driven pilot valve, wherein the motor is energized only while it is driving said pilot valve.

It is also an object to provide a control system incorporating a timer mechanism and a motor interconnected by an electrical circuit, and arranged to automatically de-

energize said circuit at the conclusion of an operating cycle as measured by said timer mechanism.

Another object is to provide a control system for operating a pilot valve that is economical to construct and maintain.

Additional and further objects and advantages of the invention will become apparent to those skilled in the art, as the description proceeds in connection with the accompanying drawings, wherein:

FIG. 1 is a front elevational view of the controller of the invention, with the housing cover partially broken away to show the pilot valve actuator assembly;

FIG. 2 is a vertical sectional view, taken along the line 2—2 of FIG. 1, and showing some of the details of construction of the timer mechanism of the invention;

FIG. 3 is a fragmentary, horizontal sectional view, looking downwardly, taken along the line 3—3 of FIG. 1, and showing the cam disk and its associated microswitch;

FIG. 4 is an enlarged, rear elevational view of the mechanism shown removed from its housing;

FIG. 5 is a sectional, rear elevational view of the timer disk, taken generally along the line 5—5 of FIG. 2;

FIG. 6 is a vertical sectional view, partially revolved, through the pilot valve and showing the means for securing the same to the housing;

FIG. 7 is a horizontal sectional view, taken along the line 7—7 of FIG. 6;

FIG. 8 is an enlarged, fragmentary, horizontal sectional view, taken on line 8—8 of FIG. 6, and showing in detail the porting arrangement within the pilot disk;

FIG. 9 is a vertical sectional view through the pilot disk, taken along the line 9—9 of FIG. 8;

FIG. 10 is a horizontal, sectional plan view of the top of the manifold or distributor portion of the pilot valve, taken along the line 10—10 of FIG. 6;

FIG. 11 is a tabulation showing which distributor ports are subject to "Drain" and "Supply" corresponding to various positions assumed by the ports of the rotary pilot disk as it is operated through a complete cycle; and

FIG. 12 is a schematic diagram of the novel electrical control circuit of the invention.

Referring now to the drawings, the fluid system controller of the present invention is indicated generally at 20, and includes a housing 22 within which is mounted a pilot valve 24 and a timer mechanism 26. The housing 22 includes a back panel 28 having integral top, bottom and side panels 30, 32 and 34, respectively, projecting therefrom, the top and bottom panels 30 and 32 having outwardly projecting flanges 36 and 38, respectively, thereon.

A cover plate 40 having a U-shaped bend 42 along its top edge is received over the opening defined by the top, bottom and side walls of the housing 22, the top flange 36 being received within said U-shaped bent portion. The cover plate 40 includes side flanges 44 and 46 which embrace the lateral edges of the housing 22, and the lower edge of the cover plate has an opening 48 centrally therein positioned to confront a like opening in the bottom flange 38. The cover plate 40 can thus be secured in position on the housing 22 by passing a suitable padlock 50 through said aligned openings.

The back panel 28 of the housing 22 has a transversely extending, Z-shaped bracket 52, FIG. 2, secured thereto a short distance below the top edge thereof, said bracket opening downwardly. A like-shaped bracket 54 is secured by suitable screws 56 to a wall or other suitable structure 58, and opens upwardly to receive the downwardly extending portion of the bracket 52. Thus, the cooperating brackets 52 and 54 function to hang the housing 22 upon the wall 58. A tab 60 is welded centrally to the lower

edge of the back panel **28**, and projects therebelow; said tab having an opening through which is passed a screw **62** that is mounted in the wall **58**. The tab and screw **60** and **62** function to insure that the housing **22** will remain in position on the bracket **54**.

The bottom wall **32** of the housing **22** has a circular opening **64** therein near the right-hand end of said housing, and the pilot valve **24** is secured to said bottom plate to extend below said opening. As is best shown in FIGS. 6–9, the pilot valve **24** includes a pilot disk housing **68** and a manifold or distributor body **70**, the pilot housing having a downwardly opening cylindrical chamber **72** therein confronting the upper end of said manifold.

The manifold body **70** has a raised circular boss **74** positioned concentrically about the longitudinal, vertical axis thereof, said boss having a flat top surface **76** thereon. A vertical drain port **78** is positioned concentrically about said longitudinal axis, and extends from the center of the circular surface **76** downwardly through the manifold **70** to a threaded opening **80**, within which opening a conventional fitting **82** is secured.

As is best shown in FIGS. 6 and 10, the manifold body **70** has a plurality of L-shaped ports or passages **1** through **18** therein, the upper ends of said passages terminating in the flat surface **76** and being arranged to lie on a common circle concentrically about the central axis of the drain port **78**. The passages **1** to **18** in the manifold housing are arranged in three sets of six. Passages **1** through **6** of the first set are disposed concentrically about the central axis of the port **78**, and are spaced apart a distance of 60 degrees. Passages **7** through **12** of the second series are also positioned concentrically about the port **78**, on the same radius as the passages **1** to **6**, and are spaced apart clockwise 40 degrees from their adjacent passages **1** to **6**; that is, the passage **7** is spaced 40 degrees counterclockwise from the passage **1**, and so on. The third series of passages, numbered **13** through **18**, are disposed to lie on the same circle as the other two series of passages, and are positioned to lie 20 degrees from the passages of the first two sets positioned on either side thereof.

As is best shown in FIG. 6, the L-shaped passages **1** through **6** terminate at their lower ends in a top plane of threaded, horizontal bores **83**, the passages **7** through **12** terminate at their lower ends in an intermediate plane of horizontal, threaded bores **85**, and the third set of passages **13** through **18** terminate at their lower ends in a bottom plane of horizontal, threaded bores **87**. The bores **83**, **85** and **87** have tube-connecting fittings **84**, **86** and **88**, respectively, threaded therein, each of which connects its associated L-shaped passage to a fluid-operated valve, or some other fluid-operated device, positioned remotely from the fluid system controller **20**.

Disposed to rest upon the top surface of the manifold **70**, radially outwardly of the boss **74**, is an annular gasket **90** having an inner diameter somewhat greater than that of the diameter of the boss **74**, said gasket being partially received within an annular recess on said manifold member. The pilot housing **68** and the manifold body **70** are secured together by bolts **92** received within aligned bores therein, the upper ends of said bolts passing through openings in a washer **94** and in the bottom wall **32** of the housing **22**. The washer **94** is positioned in an annular recess in the top of the pilot housing **68**, and has a height slightly greater than the depth of said recess. The openings in the bottom plate **32** are positioned so that the longitudinal central axis of the pilot valve will pass through the center of the opening **64**.

Disposed within the pilot housing chamber **72** and resting upon a seat **76** is a rotary pilot disk **96**, the construction of which is best shown in FIGS. 6, 8 and 9. The pilot disk includes a cylindrical body **98** having a flat surface **100** on the bottom thereof, which surface rests upon and sealingly engages the seat surface **76** on the boss **74**. The body **98** has a plurality of circumferentially spaced, vertical pressure ports **102** through **122** therein, lying on a

radius identical to that of the circle upon which the passages **1** through **18** lie, the ports **102** through **116** being spaced apart 20 degrees. The port **118** lies 40 degrees clockwise from passage **116**, the port **120** lies 40 degrees clockwise from port **118**, and the port **122** lies 80 degrees clockwise from port **120**.

The bottom face **100** of the pilot disk body **98** has a vertical drain port **124** in the center thereof, said drain port extending only about halfway through said body. A plurality of transverse exhaust ports **126** through **138** are disposed within said body and are in communication at their inner ends with the drain port **124**, the outer ends thereof being in communication with vertical ports **140** through **152** positioned in the bottom face of the body member and lying on the same circle as is defined by the ports **102** thorugh **122**. It will be noted that the adjacent exhaust ports **132**, **134** and **136** merge into each other as shown in FIG. 8.

The port **140** is displaced 20 degrees counterclockwise from the port **102**, and the port **142** is diametrically opposite thereto. The port **144** is spaced 40 degrees clockwise from port **142**, and the port **146** is spaced clockwise 40 degrees from the port **144**. The ports **146**, **148** and **150** are spaced 20 degrees apart, and the port **152** is spaced 20 degrees counterclockwise from the port **140**. Because of the 20 degree spacing therebetween, the ports **102** through **122** and the ports **140** through **152** will become aligned with the passages **1** through **18** as the pilot disk **96** is rotated.

The transverse ports **126** through **138** extend to the periphery of the body **98**, which body has a radially extending circumferential flange **154** on the bottom thereof. A cylindrical sleeve **156** is telescoped over the body **98**, and is soldered or otherwise secured thereto to closer the outer ends of said transverse ports **126** through **138**. The sleeve **156** has three equally spaced, vertical slots **158** therein, said slots having a vertical height less than the distance which the cylinder projects above the top surface of the body member **98**. The body **98** also has a plurality of circumferentially spaced bores **160** therein positioned radially inwardly of the circle on which the ports **104** through **122** and **140** through **152** lie, said bores **160** being filled with a suitable lubricant for lubricating the mating flat seat surface **76** and the pilot disk face **100**.

The pilot housing **68** has a vertical bore **162**, FIG. 6, therethrough positioned in alignment with the drain port **78**, and a shaft **164** is rotatably received therein. The shaft **164** has driver **166** secured to the lower end thereof and provided with three equally spaced, radially projecting lugs **168**, each of which is receivable within one of the vertical slots **158**. The diameter of the driver **166** is substaintially smaller than the inner diameter of the sleeve **156**, whereby fluid may flow freely therebetween. A pair of washers **170** is positioned on the shaft **164** above the driver **166**, the upper one of said washers engaging with a resilient O-ring seal **172** received within an annular recess in a boss on the inner side of the top wall of the chamber **72**.

A compression spring **174** is positioned between the driver **166** and the pilot disk body **98**, and functions to urge said driver and its attached shaft upwardly toward the seal **172** and to urge the pilot disk **96** downwardly into engagement with the seat **76**. The top surface of the body **98** has a recess **176** positioned centrally thereof for reception of the lower end of said spring **174**, whereby the spring will remain properly positioned. A radial, threaded supply bore **178** is positioned in the side wall of the pilot housing **68**, and functions to admit a supply of operating fluid into the chamber **72**.

The pilot valve **24** is thus constructed to control as many as eighteen different fluid-actuated devices, such as fluid-operated valves, or other devices arranged in sets of six. One set of the six devices is connected with the passages **1** through **6**, a second set with the passages **7** through **12**, and the third set with passages **13** through

18. Rotation of the pilot disk 96 will alternately admit the fluid to and drain fluid from the passages 1 through 18, in the following manner.

The pilot valve disk 96 is rotated through exactly 60 degrees for every step of its program. Referring to FIGS. 8, 10 and 11, the manner in which the valve operates may be readily understood. The valve disk 96 in FIG. 8 is positioned in its zero, or "Service," position. In such position, the passage 1 is in communication with the drain 78 through the transverse port 126, the passage 7 is in communication with the chamber 72 through the port 104, and the passage 13 is in communication with said chamber through the port 102.

The pilot disk 96 is then rotated through 60 degrees. whereupon the passage 1 will be in communication with the drain 78 through the transverse port 136, the passage 7 will be in communication with said drain through transverse port 126, and the passage 13 will be in communication with the chamber 72 through the port 122. It is thus seen that as the pilot member rotates through six positions (0, 1, 2, 3, 4 and 5), spaced exactly 60 degrees apart, the various combinations tabulated in FIG. 11 will result. At each of the six positions, certain of the seat ports 1 through 18 will be connected to supply (S) and others to drain (D). By properly connecting the fluid-operated devices to said passages, various operating cycles can be obtained.

It is to be understood that the tabulation of FIG. 11 is only illustrative of the manner in which the three-plane pilot valve of the invention may be utilized to control a plurality of fluid-actuated devices. The pressure ports 102 through 122 and the exhaust ports 126 through 138 may be arranged within the contemplation of this invention to produce other desired combination of supply and drain conditions through the seat ports 1 through 18. In each instance, however, it is obvious that as the pilot member 96 rotates through 60 degrees, the three different sets of ports will simultaneously have their condition altered. The three sets of ports also make it possible to simultaneously control three different sets of remotely positioned equipment, such as three water softeners. If any port is not required in any instance, a plug is merely threaded into its outlet bore.

It will be noted that each of the supply ports in the pilot body 98 must pass over the upper end of two of the ports 1 through 18 before coming to rest over a third one of said ports during each 60 degree step of the program. In order to avoid difficulties that might otherwise arise from alternate drain and supply through the two passages over which a pilot disk supply port passes during each program step, the pilot disk 96 is rotated rapidly between its different stop positions. Further, because the circumferential spacing between the eighteen passages 1 to 18 and the passages themselves is quite small, it is necessary that the rotating pilot disk 96 be precisely indexed in each of its sequential operating positions. Unless these two conditions are satisfied, the operation of fluid-actuated members controlled by the pilot valve may overlap and create undesirable operating characteristics.

The controller, or pilot-actuator, of the invention utilizes a high-torque synchronous motor in conjunction with a novel control circuit to rotate the pilot disc 96 and to precisely position it relative to the passages 1 through 18, the pilot actuator assembly being indicated at 180 (FIGS. 1 and 3). A horizontal mounting plate 182 is supported above the bottom plate 32 on two posts 184 and 186, said posts being secured to the mounting plate 182 and the bottom housing panel 32 by screws 187. The mounting plate 182 extends over the opening 64 and has a high-torque synchronous electric motor and one-way clutch unit 188 mounted on the top thereof, said motor having an output shaft 189 (FIG. 3) that extends through an opening in said mounting plate and which is aligned with the pilot disc drive shaft 164.

As is best shown in FIGS. 2 and 6, the upper end of the shaft 164 has the lower end of a cylindrical collar 192 telescoped thereover and secured thereto by a pin 194, the upper end of said collar having a pair of diametrically opposed vertical slots 196 therein. The lower, cylindrical end 198 of a shaft 190 is received within the upper end of said cylindrical collar 192, and has a transevrse pin 200 extending therethrough which is received within the slots 196. The upper end of the shaft 190 has an axial, non-circular bore therein of a size to receive a non-circular end 181 of the shaft 189, FIG. 3. Thus, the shafts are secured together against relative rotation.

The pin 200 has a diameter corresponding to the width of the slots 196, and functions to transmit torque from the motor 188 to the pilot drive shaft 164. The vertically elongated slots 196 allow a degree of vertical play between the shaft 190 and the shaft 164 of the pilot valve.

The shaft 190 has a washer 202, FIG. 1, secured thereto at the upper end of the cylindrical portion 198, and the portion of the shaft 190 above said washer is flattened at 204 and 206 on its diametrically opposed sides (FIG. 3), whereby a non-circular configuration is attained. Telescopically received on the non-circular portion of the shaft 190 is a cam disk 208, said disk including a central hub portion 210 which has a non-circular axial bore therethrough corresponding in configuration and dimensions to that of the non-circular portion of the shaft 190. The cam disk can be constructed of a suitable plastic material or the like.

Disposed to rest upon the top surface of the cam disk and extending about the shaft 190 is a compression coil spring 212, the upper end of said spring engaging against the bottom of a position indicating and manual control disk 214, which is secured on the shaft 190 by a screw 216. Thus, the spring 212 functions to urge the hub on the cam disk downwardly into engagement with the washer 202.

The cam disk 208 is shown in plan view in FIG. 3, and has six V-shaped, circumferentially spaced notches 218 in the peripheral edge thereof, said notches being spaced apart a distance of 60 degrees. Positioned behind the cam disk, and supported below the mounting plate 182 by support posts 220, is a two-position microswitch 222, said microswitch having a pivoted blade 224 mounted thereon which engages a pushbutton 226 of said switch. The tip 228 of the blade 224 is inclined outwardly from the body of the microswitch, and engages the periphery of the cam disk 208. The microswitch 222, the blade 224 and the cam disk 208 are proportioned and positioned relative to each other so that the microswitch 222 will be operated in response to movement of the blade tip 228 into and out of each of the V-shaped notches 218, occurring as the cam disk rotates. The tapered walls of the notches 218 function as cam surfaces to facilitate movement of the blade tip 228, and the cam disk is designed to be rotated by the motor 188 in a clockwise direction as viewed in FIG. 3.

The notches 218, as has been mentioned, are spaced 60 degrees apart. This spacing corresponds to the 60-degree spacing between the different program positions to be assumed by the pilot disk 96. The notches 218 are positioned relative to the pilot disk so that when the microswitch blade tip 228 is received in one of said notches, the pilot disk 96 will be positioned in one of its six program positions, with the ports in the pilot disk properly aligned with their intended associated seat passages 1 through 18. It is thus seen that the number of notches 218 in the cam disk 208 must correspond to the number of program positions desired during one cycle of rotation of the pilot disk 96. Further, it is seen that the notches 218 must be related relative to the pilot disk 96 so that the microswitch 222 will be operated when the pilot disk is properly positioned in each of its six positions.

The timing motor 188 rotates at a speed of about 1 r.p.m. and thus functions to rotate the pilot disk 96 fairly

rapidly from one program position to another in ten seconds. The microswitch **222** is connected into the novel control circuit of the invention so as to cause the motor **188** to be de-energized at the instant that the pilot disk **96** is properly positioned in registration to its seat associated ports. The control disk **214** has indicia thereon to indicate the position of the cam disk **208**, and hence of the pilot disk **96**. Further, in the absence of electric power, or in the event of power failure, the control disk **214** may be turned manually to properly position the pilot disk **96**. During such manual turning, the resistance felt when the blade tip **228** is positioned within the notches **218** is sufficient to indicate to the operator that the pilot disk **96** is properly positioned relative to its associated ports. However, while the pilot valve of the invention may be manually operated, in the preferred embodiment of the invention automatic operation is attained in combination with the timer unit **26**.

Referring again to FIGS. 1 and 2, the top wall **30** and the left-hand side wall **34** of the housing **22** have angle members **232** and **234** secured thereto, respectively, upon which angle members a rectangular panel **236** is mounted with screws **238**. As is best shown in FIGS. 2 and 4, the panel **236** has an electric clock motor **240** secured thereto on the rear face thereof, the output shaft **242** of said clock motor extending through an opening in the mounting plate **236**. A hub **244** having a bore therein is mounted on the outer end of the shaft **242**, and is secured in position by a screw **246** (FIG. 5). The hub **244** has a flange **248** on its outer end, and a ratchet gear **250** fixed thereto in a position spaced from said flange **248**. The ratchet gear **250** has escapement teeth **251** on the periphery thereof.

Positioned on the cylindrical portion of the hub **244** between the flange **248** and the fixed ratchet gear **250** is a timer disk **252**, said timer disk having a central opening of a diameter corresponding to that of the hub **244**. Referring to FIG. 5, an escapement pawl **254** is pivoted intermediate its ends to the timer disk **252** by a headed pin **256**, said pawl including a tooth **258** on its forward end positioned to engage with the teeth **251** on the ratchet gear **250**. A post **260** is secured to the rear face of the timer disk **252** radially outwardly beyond the ratchet gear **250**, and one end of a wire spring **262** is attached thereto. The opposite end of the spring **262** is received within a notch **264** in the end of the escapement pawl opposite to the tooth **258**, whereby the spring **262** functions to resiliently urge the escapement tooth **258** radially inwardly into engagement with the teeth **251** on the ratchet gear **250**. It is thus apparent that the timer disk **252** may be rotated in a counterclockwise direction, as viewed in FIG. 1, relative to the hub **244**, but that it cannot be rotated in the opposite direction because of the one-way action permitted by the escapement mechanism **250, 254**.

The timer disk **252** preferably rotates once during each operating cycle of the pilot valve **24**, and is divided into equal time segments. Typically, the disk **252** will be rotated at a uniform rate once every **90** minutes by the clock motor **240**, although it is to be understood that various other periods of rotation might be utilized.

The front face of the timer disk **252** is divided into fifteen radial segments, each segment representing six minutes of time. The timer disk **252** has circumferentially spaced radial notches **266** therein throughout its periphery, said notches being spaced 3 degrees apart in FIG. 1. Thus, for the disk of FIG. 1, which rotates through 360 degrees once in every 90 minutes, each of the notches **266** will represent a time interval of three-quarters of a minute. Indicia on the front face of the timer disk **252** indicates the time intervals in minutes, in units of six, to wit, 6, 12, 18, 24, etc. An "OFF" position is indicated in alignment with the notch **266** midway between the time indicating indicia "6" and "84."

Referring now to FIGS. 1, 2 and 4, the mounting panel **236** has a bore therethrough about which is mounted, on the rear face of said panel, a sleeve **268**. A shaft **270** is rotatably received within the sleeve **268**, and projects beyond both the front and the rear face of the mounting panel. One end of a program arm **272** is secured to the portion of said shaft projecting from the front face of the panel **236**, said arm extending generally tangentially to the bottom portion of the timer disk **252**, as is best shown in FIG. 1. The free end of the arm **272** terminates directly under the center of the disk **252**, and has an upwardly inclined cam surface **274** thereon, the center portion of said cam surface being positioned directly below the center of the disk **252**.

Referring now to FIGS. 2 and 4, an actuator arm **276** is secured to the portion of the shaft **270** which extends to the rear of the panel **236**, said actuator arm having an inclined flange **278** on its free end disposed to extend substantially perpendicularly to the panel **236**. A two-position microswitch **280** is secured by screws **282** to the rear face of the panel **236** below the actuator arm **276**, with the pushbutton **284** of said microswitch being disposed to lie under and normally in engagement with the flange **278**. Thus, when the cam tip **274** of the program arm **272** is depressed, the pushbutton **284** will corresponding be depressed by the actuator arm **276**. A pair of spaced posts **286** project forwardly from the panel **236**, one on either side of the program arm **272**, and function to limit the degree of angular movement of said arm.

The panel **236** has a rectangular opening **288** (FIG. 4) therein positioned directly below the shaft of the clock motor, the horizontal center line of said opening lying a distance from the output shaft of said motor corresponding generally to the radius of the ratchet gear **250**. A horizontally extending mounting plate **290** is secured to the back face of the panel **236** by screws **292** in position so that it can be moved horizontally toward and away from the opening **288**, the mounting plate having an elongated slot **294** therein to facilitate such movement. A shaft **296** is secured to the forward end of the mounting plate **290**, and extends rearwardly normally therefrom. One end of an actuator arm **298** is mounted on the shaft **296**, and the other end of said actuator arm extends unwardly at an inclined angle and has a flange **300** on its outer end which extends perpendicularly to the panel **236**. A trip arm **302** is secured to the pivoted end of the actuator arm **298**, said trip arm including a normally projecting finger **304**, which extends forwardly through the opening **288** toward the ratchet gear **250**.

The post **260** is postioned to lie behind the "OFF" position of the timer disk. As is best shown in FIG. 5, said post **260** has a semicircular portion removed therefrom on the side facing the escapement pawl **254**, which removed portion defines a radial wall **306**; the wall **306** is positioned to bisect the notch **266** on the timer disk **252** positioned 3 degrees counterclockwise from the "OFF" position, or at the 89¼ minute position in FIG. 1. The front surface **308** of the post is left rounded, and functions as a cam surface when engaged by the finger **304**.

The post **260** is positioned a radial distance from the center of the timer disk **252** sufficient so that when the the timer disk rotates, the front curved portion of said post will engage and cam upwardly the finger portion **304** of the trip arm **302**. The semicircular cutout portion **306** on the post **260** extends axially a distance greater than the forwardly projecting length of the finger **304**, whereby when the post **260** has rotated sufficiently the finger **304** will drop off said post and will lie immediately adjacent the radial surface **306**.

Disposed to confront the upper end of the actuator arm **298** is a two-position microswitch **310**, FIG. 4, said microswitch being secured to the rear face of the panel **236** by screws **312**. The pushbutton **314** of the switch **310** is positioned to be engaged by the flange **300** on the end of said actuator arm **298**, and consequently the

switch will be operated in response to movement of the actuator arm caused by engagement of the front rounded portion of the shaft **260** with the finger **304**.

Secured to project downwardly from the lower edge of the panel **236** is a terminal strip **316**, said strip being supported in spaced relationship to the plate by angle members **318**. An "ON-OFF" master toggle switch **320** is mounted on the panel **236** below the pivoted end of the program arm **272**, and a pushbutton switch **322** is mounted on said panel to the left of said program arm, both of said switches being operable manually from the front of the panel. A relay **324** is also mounted on the rear face of the panel **236**, and said relay, the clock motor **240**, the two microswitches **280** and **310**, the pushbutton switch **322**, the toggle switch **320**, and the terminal strip **316** are all interconnected by electrical conductors in a manner fully described hereinfter. The conductors necessary to operate the assembly **180** terminate in a socket **326**, FIGS. 1 and 2, mounted along the right edge of the panel **236** that faces the pilot valve **24**, and a plug **328**, FIG. 1, mounted on the end of a cable **330** has contacts that are receivable within said socket to engage contacts therein, said plug having additional conductors connected thereto that function to electrically connect the timer motor **240** with the pilot valve motor **188**. By this arrangement, either the pilot valve unit or the timer unit can be readily removed for inspection or replacement without affecting the other.

The novel control circuit of the invention is illustrated schematically in FIG. 12, wherein is shown the timer microswitch **310**, the toggle "ON-OFF" switch **320**, the pushbutton starting switch **322**, the relay assembly **324**, etc. Thus, a pair of main terminals **332** and **334** is mounted on the terminal strip **316**. Electrical current is supplied to the terminals **332** and **334** through conductors **336** and **338**, respectively. A lead **340** connects the main terminal **332** with a supply terminal **342** of the toggle switch **320**, and a conductor **344** has one end thereof connected with the other terminal **346** of said toggle switch and extends to an input terminal **348** on the timer microswitch **310**. Another conductor **350** extends from the input terminal **348** of the timer microswitch **310** to a contact **352** of a normally open relay switch **354**. The switch **354** is one of a pair of normally open switches of the relay assembly **324**, the other relay switch being designated **356**. The switches **354** and **356** are arranged to be closed simultaneously upon energization of a relay coil **358**, which actuates an armature **360**, as will be understood by those familiar with relay structures. The relay coil **358** has one of its contacts **362** connected by a conductor **364** with the main terminal **334**.

A conductor **366** connects a contact **352** of the relay switch **354** to a terminal **370** of the pushbutton switch **322**. A lead **372** connects the same terminal **370** with a main terminal **374** on the terminal strip **316**. A conductor **376** connects the other terminal **378** of the pushbutton switch **322** with the other contact **380** of the relay coil **358**. A lead **382** connects the pushbutton terminal **378** with a main terminal **384** on the terminal strip **316**. Leads **386** and **388** extend from the main terminals **374** and **384**, respectively, to contacts **390** and **392** of an optional remote control pushbutton switch **394**.

The timer microswitch **310** has an arm **396** connected with the input terminal **348** and is movable to alternately engage N.O. (normally open) contact **398** or N.C. (normally closed) contact **400** of said switch. The N.O. contact **398** is connected by a conductor **402** with a contact **404** of the relay switch **356**. The N.C. contact **400** of the microswitch **310** is connected by a conductor **406** with a contact **407** of the relay switch **354**. The contact **407** of the relay switch **354** is connected by a conductor **408** with a main terminal **410** on the terminal strip **316**. A lead **412** extends from the main terminal **410** and may be connected with a signal light **414**, or other means for indicating that the device is in "Service."

A conductor **416** connects a contact **418** of the relay switch **356** with the contact **380** of the relay coil **358**. Another conductor **420** connects the other contact **362** of the relay coil **358** with one terminal **422** of the timer motor **240**. The other terminal **424** of the timer motor **240** is connected by a lead **426** with the input terminal **428** of the program switch **280**. A lead **430** connects said input terminal **428** with the main terminal **410** on the terminal strip **316**. The program switch **280** includes an arm **432**, connected with the input terminal **428**, which is movable to alternately engage N.C. contact **434** and N.O. contact **436** of said program switch. A conductor **438** conects the N.C. contact **434** with a contact **440** of the socket **326**, and a conductor **442** connects the N.O. contact **436** with a contact **444** on said socket. A lead **446** connects the main terminal **334** on the terminal strip **316** with a contact **448** on the socket **326**.

The pilot motor **188** and the pilot microswitch **222** have conductors **450**, **452** and **454** associated therewith, which are conected with the plug **328**, FIG. 4, having projections *444a*, *446a* and *448a* for engaging the contacts **448**, **444** and **440**, respectively, of the socket **326**. Thus, the conductor **450** establishes a connection between socket contact **448** and one terminal **456** of the pilot motor **188**; the conductor **452** provides a connection between the socket contact **444** and N.C. contact **458** of the pilot microswitch **222**; and the conductor **454** establishes a connection between socket contact **440** and N.O. contact **460** of said switch. A conductor **462** connects the other terminal **464** of the pilot motor **188** with an input terminal **466** of the pilot microswitch **222**.

The electrical circuit as schematically illustrated in FIG. 12 illustrates all of the switches corresponding to the pilot valve being in the "Service" position and the timer motor **240** in its "OFF" position. It will be understood that the control device **20** can be placed in operation by depressing either the pushbutton switch **322** on the control panel **236**, or by actuating the remote control pushbutton switch **394**. A clock or a flow meter (not shown) may be utilized in lieu of the remote switch **394**, if desired. In either event, but assuming the switch **322** is depressed, the relay coil **358** will be energized by current flow through he lead **364**, which extends to the contact **362** at one end of said coil, and through the conductor **340**, toggle switch **320**, conductors **344**, **350** and **366** supplying current to the terminal **370** of the pushbutton switch **322**, through said pushbutton switch and conductor **376** to the contact **380** at the other end of said relay coil.

Momentary actuation of the pushbutton switch **322** (with toggle switch **320** closed) will energize the relay coil **358** and the armature **360** will simultaneously close the two normally-open relay switches **354** and **356**. Upon closing of the relay switch **356**, a shunt circuit will be completed to keep the relay coil **358** energized after the pushbutton switch is released. Thus, current will always be available to the coil contact **362** through conductor **364**; and upon closing of the relay switch **356**, current will be supplied to the coil contact **380** through the toggle switch **320**, timer microswitch **310**, conductor **402**, relay switch **356** and conductor **416**. Simultaneously, closing of the relay switch **354** will establish a circuit to the timer motor **240**. Thus, electrical current is always available to the terminal **422** of the timer motor **240** through the conductors **364** and **420**. Upon closing of the relay switch **354**, current is supplied to the other terminal **424** of the timer motor through conductor **340**, toggle switch **320**, conductors **344** and **350**, relay switch **354** and conductors **408**, **430** and **426**.

After the timer disc **252** has rotated through but a few degrees, which in time requires less than a minute, the microswitch **310** will be released and the arm **396** thereof will move from N.O. contact **398** to N.C. contact **400**, whereby current flow to the relay coil **358** will be discontinued and the relay switches **354** and **356** will open.

However, because of the arm **396** immediately establishing contact with the N.C. contact **400**, current flow to the clock motor **240** will suffer no measurable interruption since a circuit to said motor will be established through the conductors **406**, **408**, **430** and **426**. The arm **396** will remain in contact with N.C. contact **400** until the timer disc **252** has rotated through 360 degrees and the timed program has been completed, at which time it will be returned to the "Service" position shown in FIG. 12 by the interaction of the post **260** and the finger **304**; when the arm **396** is returned to its original position, current flow to the timer motor **240** and conductor **406** will be broken, and the circuit will become inactive.

It should be noted that the relay coil **358** is energized for less than one minute during the timed program, wherefor no substantial build-up will occur, and the life of the relay will be greater than if the period of current flow were longer.

The arm **432** of the program microswitch **280** normally engages N.C. contact **434** when the pushbutton **284** thereof is not depressed, which condition occurs when the program arm **272** is in engagement with the upper one of the restricting posts **286**, FIG. 1. Similarly, the arm **459** of the pilot microswitch **222** is normally in contact with the N.C. contact **458**, which condition occurs when the blade tip **228** is received within one of the cam notches **218**. Thus, when the program and pilot microswitches **280** and **222**, respectively, are in their normal state, as shown in FIG. 12, no current will flow to the pilot motor **188** and the pilot disc **96** will remain stationary.

The program microswitch **280** is actuated in response to downward pivoting movement of the program arm **272**, which arm is itself actuated by interaction between the cam tip **274** thereof and the program clips **470** (FIG. 1) mounted on the rotating timer disc **252**.

The clips **470** are bifurcated, and are receivable within the radial notches **266** on the periphery of the timer disc **252**. Each clip **470** projects radially from the outer periphery of the disc **252** a sufficient distance such that when a clip is moved clockwise over the cam surface on the free end of the actuator arm **272**, said arm will pivot downwardly sufficiently to actuate the program switch **280**, whereby the arm **432** thereof will momentarily shift from N.C. contact **434** to N.O. contact **436**. As soon as the timer disc **252** has rotated sufficiently to cause the clip **470** to ride off the tip of the actuator arm **272**, the arm **432** will again return to N.C. contact **434**.

During the brief period when the arm **432** establishes a circuit between supply terminal **428** and N.O. contact **436**, current will flow through conductor **442** to the N.C. contact **458** of the pilot microswitch **222** and thence through switch arm **459** to the lead **462**. Thus, the pilot motor **188** will be actuated, and the output shaft thereof will revolve, carrying the pilot disc **96** and the cam disc **208** therewith. As the cam disc **208** begins to revolve, the blade tip **228** of the pilot microswitch **22** will begin to ride out of the cam notch **218** within which it is disposed. After the cam disc **208** has been revolved a sufficient angular distance, for example about 2 degrees, the blade **224** will have been moved toward the switch **222** a sufficient distance to cause the arm **459** to swing to the terminal contact **460**.

After the arm **459** swings to the N.O. contact **460**, and for so long as the arm **432** of the program switch **280** remains against N.O. contact **436**, no further flow of current to the pilot motor **188** can occur. Thus, the motor **188** will stop and will hold the cam disc **208** and the pilot valve **96** in their 2 degree, partially revolved position. The arm **432** will remain in contact with N.O. contact **436** only for so long as the program clip **470** dwells on the free end of the program arm **272**, which dwell is typically but a fraction of a minute in duration. After the clip **470** rides off the program arm **272**, switch arm **432** will revert to the N.C. contact **434**.

When the switch arm **432** establishes contact with the N.C. contact **434**, and with the switch arm **459** in contact with the terminal **460**, current will again flow to the pilot motor **188** to assume rotation of the pilot disc **96**, with the tip **28** of the blade **224** riding on the continuous smooth rim portion of the cam disc **208** until the next notch **218** is reached. The blade tip **228** will enter such notch, and the switch arm **459** will immediately swing to N.C. contact **458**, interrupting the flow of current to the pilot motor **188**. The pilot motor **188** will then stop and the pilot disc **96** will be properly positioned in its new station relative to the seat ports **1** through **18**. The pilot disc **96** will remain in this position until the program switch **280** is again actuated, or until manually revolved by the control disc **214**.

As has been described hereinabove, the pilot valve disc **96** has six stations, starting with the 0 or "Service" position, the remaining stations being numbered 1, 2, 3, 4 and 5, respectively. The cam disc **208** correspondingly has six notches **218** therein, one for each of the pilot disc positions 0 to 5. Thus, if the pilot disc **96** is to be rotated from its 0 or "Service" position, through positions 1 to 5, and back to its "Service" position during a single rotation of the timer disc, six program clips **470** must be mounted on the timer disc **252**.

Once the timer motor **240** has been started and the timer disc **252** has rotated sufficiently to open the timer microswitch **310** and allow its switch arm **396** to swing to N.C. contact **400**, current will be constantly available to the conductor **406**. Thus, as the timer disc **252** rotates and each clip **470** encounters the program arm **272**, the pilot volve disc **96** will be automatically rotated through 60 degrees in the manner described hereinabove, to its next position. The angular spacing between the program clips **470** will determine the amount of time that the pilot valve disc **96** remains in each station of its program cycle.

The sixth program clip, which returns the pilot valve disc **96** to its 0 or "Service" position, is placed counterclockwise from the 90 minute, or "OFF" position, whereby the pilot valve disc **96** will be placed in its "Service" position before the post **260** actuates the timer microswitch **310** to swing the switch arm **396** back to the N.O. contact **398**. After the microswitch **310** has been so actuated, the entire circuit will be de-energized until the pushbutton switch **322** (or the remote control switch **394**) is again momentarily closed to start a new cycle of operation. The "ON-OFF" toggle switch **320** may, of course, be used to deenergize the entire circuit at any desired time during the operating cycle. As has been indicated hereinbefore, the signal **414** is actuated during the period of time that the timer motor **240** is energized.

The manner in which the cam disc **208** is mounted makes it possible to rotate said disc between stations without actuating the pilot microswitch **222**. To effect such rotation, the cam disc **208** is urged upwardly on its shaft against the force of the spring **212** until said disc is above the blade **228**. The shaft **190** can then be manually rotated by manipulating the control disc **214**, without affecting the pilot switch **222**.

The various conductors leading into the terminal strip **316** from the exterior of the housing **22** may be contained in a single cable **472** and passed through a suitable opening in the lower wall **32**, said opening preferably having a grommet **474** fitted therein. Further, the side walls **34** have angle members **476** welded thereto at the bottom thereof and a protective strip **478** is detachably secured thereto by screws **490**, said strip having a pair of rectangular notches **492** in its bottom edge positioned to confront the upper ends of the bolts **92**.

While the pilot valve shown herein utilizes six stations, it is to be understood that a pilot valve incorporating a greater or smaller number of stations is within the teachings of the invention. In such instances, the cam

disk **208** would need to be suitably modified, and the number of program clips **470** would have to be changed to correspond thereto. Further, the 60 degree angular spacing between the pilot valve stations can also be readily changed, with corresponding changes in the cam disk.

The escapement mechanism on the timer dial or disc **252** makes it possible to manually return said disc to its "OFF" position at any time, whereby the time cycle may be readily accelerated and the timer switch **310** actuated to de-energize the control circuit. It has been found that the best manner for setting the timer dial **252** in its initial "OFF" position is to first slip the toggle switch **320** to "OFF," and to then manually rotate the timer dial to within a few degrees of "OFF." The toggle switch **320** is then turned "ON," and the timer, or clock, motor **240** will operate to further rotate the timer dial **252** until post **260** actuates switch **310** to interrupt the flow of current to the timer motor **240**. The timer dial **252** is then properly positioned to begin an operating cycle.

It is thus seen that a program controller has been provided which is uncomplicated and economical to construct, and which readily fulfills the objects set forth for the invention.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. Fluid distribution control means, comprising a housing including a cover having a chamber for operating fluid under pressure, a fluid distribution base having a seat confronting said chamber, and rotatable member in said chamber engaged with said seat and rotatable thereon between a plurality of operative positions, said fluid distribution base having a plurality of sets of ports all terminating at one end thereof in said seat with adjacent ports belonging to different sets, the other end of the ports of each set being disposed in a different plane, said rotatable member having certain pressure ports and certain drain ports simultaneously registrable with certain of said seat ports of each set in each operative position of said rotatable member, and said certain pressure and drain ports in said rotatable member being arranged to pass across certain of said ports in said seat as said rotatable member is rotated from one operative position to another operative position; and a control system for successively and relatively rapidly rotating said rotatable member from one operative position to the next by relatively rapidly moving the same across a plurality of successive ports in said seat corresponding in number to the number of sets of ports in said seat, said control means including an electrically-operated timer mechanism, an electrical circuit containing said timer mechanism, a motor connected in said circuit, drive means connecting said motor to said rotatable member, cam means driven by said drive means and rotatable with said rotatable member, and switch means connected in said circuit and operable alternately by said timer mechanism and said cam means for energizing said motor to rotate said rotatable member from one operative position to another, said switch means being constructed and arranged to be operated by said timer mechanism to energize said motor and initiate rotation of said rotatable member from one operative position to the next successive operating position thereof, and to be operated by said cam means to de-energize said motor and thus stop rotation of said rotatable member when said rotatable member attains an operative position.

2. A control system for intermittently driving a rotatable mechanism between successive operational positions, comprising: an electrically-operated timer mechanism; an electrical circuit containing said timer mechanism; a motor connected in said circuit; driving means for connecting said motor to said rotatable mechanism; cam means driven by said driving means and rotatable with said rotatable mechanism; and switch means connected in said circuit and operable alternately by said timer mechanism and said cam means for energizing said motor to rotate said rotatable mechanism from one operational position to another, said switch means being constructed and arranged to be operated by said timer mechanism to energize said motor and initiate rotation of said rotatable mechanism from one operational position to the next successive operational position thereof, and to be operated by said cam means to de-energize said motor and thus stop rotation of said rotatable mechanism when said rotatable mechanism attains an operational position, said switch means including: a first, two-position switch connected in said circuit and operable by said timer mechanism; and a second, two-position switch connected in said circuit in series with said first switch between said first switch and said motor and operable by said cam means, said first and said second switches being arranged to be operated in alternation to energize said motor when said first switch is operated by said timer mechanism, to de-energize said motor while said first switch is being operated by said timer mechanism and said second switch is being operated by said cam means, to energize said motor after said first switch ceases to be operated by said timer mechanism and while said second switch is operated by said cam means, and to de-energize said motor when both of said switches have ceased to be operated.

3. A control system as recited in claim **2**, wherein said timer mechanism includes: a clock motor connected in said circuit; a timer disk driven by said clock motor and having at least one radially projecting element thereon; and an actuator arm pivotally mounted adjacent said timer disk in position to be engaged by said element, said actuator arm being arranged to operate said first switch when said actuator arm is engaged by said element.

4. A control system as recited in claim **3**, including additionally: a normally-closed switch in said circuit; means on said timer disk to open said normally closed switch to thereby de-energize said circuit; and relay switch means connected in said circuit to provide a shunt across said normally closed switch, said relay switch means including a normally-open relay switch connected in said circuit; and a normally-open starting switch connected in said circuit and operable to energize and close said relay switch.

5. A control system for intermittently driving a rotatable mechanism between successive operative positions, comprising: an electric circuit; an electrically-operated timer mechanism connected in said circuit; a motor connected in said circuit; drive means for connecting said motor with said rotatable mechanism; cam means driven by said drive means and rotatable with said rotatable mechanism; a first, two-position switch connected in said circuit and operable by said timer mechanism to move between a first position and a second position; and a second, two-position switch connected in said circuit and operable by said cam means to move between a first and a second position, said second switch being connected in said circuit in series between said motor and said first switch to establish a flow of current to said motor when said first switch is in its second position and said second switch is in its first position, to interrupt said current flow when both of said switches are in their second positions, to re-establish said current flow when said first switch returns to its first position and said second switch is in its second position, and to interrupt said current flow when both of said switches are in their first positions.

6. A control system as recited in claim **5**, wherein said timer mechanism includes: a clock motor connected in said circuit; a timer disk rotatably driven by said clock motor, and having at least one radially projecting element mounted on the periphery thereof; an actuator arm pivot-

ally mounted adjacent said timer disk in position to be engaged by said radially projecting element, said actuator arm being arranged to operate said first switch when engaged by said element; a normally-closed switch connected in said circuit to control the flow of current to said first-mentioned motor, said clock motor, and said first and said second switches; and means operable by said timer disk to open said normally-closed switch when said timer disk assumes a preselected rotary position, whereby to de-energize said circuit.

7. A control system as recited in claim **6**, including additionally: an axially projecting element on said timer disk; and wherein said means operable to open said normally closed switch comprises: an actuator arm assembly pivotally mounted adjacent said timer disk and said normally closed switch, and operable when engaged by said axially projecting element to open said normally-closed switch.

8. A control system as recited in claim **6**, including additionally: switch means connected in said circuit and operable to shunt across said normally-closed switch, whereby to energize said circuit when said normally-closed switch is open.

9. A control system as recited in claim **8**, wherein said shunt switch means includes: a normally-open relay switch connected in said circuit; and a normally-open starting switch connected in said circuit and operable to energize and close said relay switch.

10. A control system as recited in claim **5**, wherein said rotatable mechanism comprises a multi-port, multi-position pilot valve, including a rotable pilot disk connected by said drive means to said motor, and rotatable between a plurality of operative positions.

11. A control system as recited in claim **5**, including additionally, means on said drive means operable manually to rotate said mechanism, and to indicate the position of said cam means.

12. A control system for driving a rotatable pilot valve between successive operative positions, said pilot valve including a rotary driven member rotatable from an initial position through a predetermined number of positions and returnable to said initial position, comprising: an electric circuit; an electrically-operated timer mechanism connected in said circuit; a motor connected in said circuit; drive means for connecting said motor to an associated rotary driven pilot valve member; cam means driven by said drive means and rotatable with said associated rotary driven pilot valve member; a first, two-position switch connected in said circuit and operable by said timer mechanism to move from a first position to a second position and return once for each predetermined position of an associated rotary driven pilot valve member; and a second, two-position switch connected in said circuit and positioned adjacent said cam means, and movable by said cam means from a first position to a second position and return once for each predetermined position of an associated rotary driven pilot valve member, said second switch being connected in said circuit in series between said motor and said first switch to establish a flow of current to said motor when said first switch is in its second position and said second switch is in its first position, to interrupt said current flow when both of said switches are in their second positions, to re-establish said current flow when said first switch returns to its first position and said second switch is in its second position, and to interrupt said current flow when both of said switches are in their first positions.

13. A control system as recited in claim **12**, wherein said first and said second switches are both resiliently biased toward their first positions.

14. A control system as recited in claim **13**, wherein said timer mechanism includes: a clock motor connected in said circuit; a timer disk rotatably driven by said clock motor and arranged to rotate from an initial position through 360 degrees, said timer disk having at least radially projecting element mounted on the periphery thereof; an actuator arm pivotally mounted adjacent said timer disk in position to be engaged by said radially projecting element during rotation of said disk, said actuator arm being arranged to move said first switch to its second position when said actuator arm is engaged by said element; a normally closed switch connected in said circuit to control the flow of current to said first-mentioned motor, said clock motor, and said first and said second switches; and means operable by said timer disk to open said normally-closed switch when said timer disk assumes said initial position, whereby to de-energize said circuit.

15. A control system as recited in claim **14**, including additionally: switch means connected in said circuit and operable to shunt across said normally-open switch, whereby to energize said circuit when said normally-closed switch is open.

16. A control system as recited in claim **15**, wherein said shunt switch means includes: a normally-open relay switch connected in said circuit; and a normally-open starting switch connected in said circuit and operable to energize and close said relay switch.

17. A control system as recited in claim **12**, including additionally means on said drive means operable manually to rotate an associated rotary driven pilot valve member, and means operable manually to effect disengagement of said cam means from said second switch during manual rotation of said rotary driven member.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,257,598 June 21, 1966

John D. Settles

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 34, for "closer" read -- close --; column 8, line 43, for "unwardly" read -- upwardly --; column 10, line 43, for "he" read -- the --; column 13, line 34, after "and" insert -- a --; column 16, line 15, after "least" insert -- one --.

Signed and sealed this 22nd day of August 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
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