

April 22, 1969

H. D. YATES ET AL

3,440,434

APPARATUS FOR PROGRAMMING CYCLIC ACTUATION OF VALVES

Original Filed June 1, 1965

Sheet 1 of 8

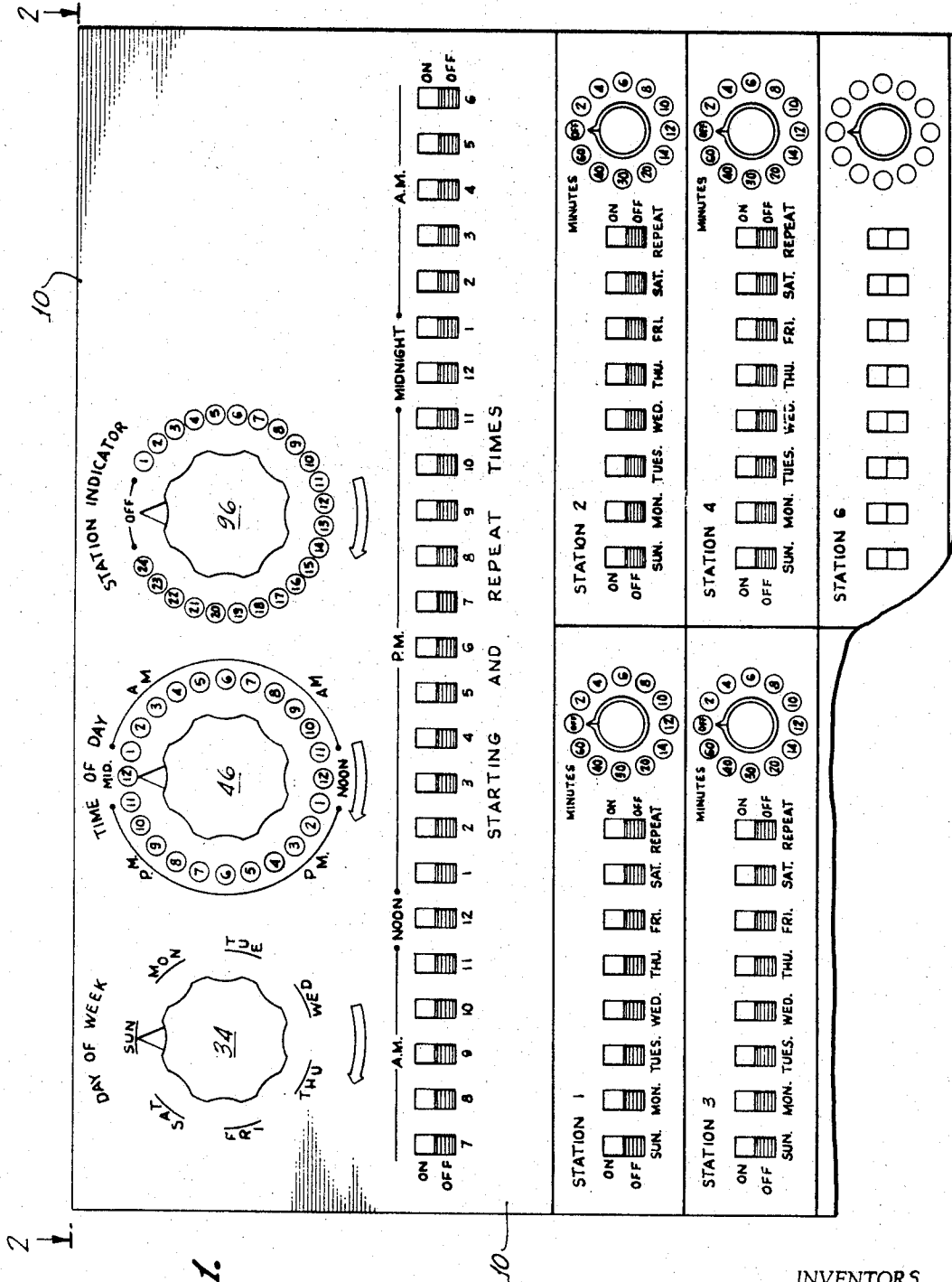


Fig. 1.

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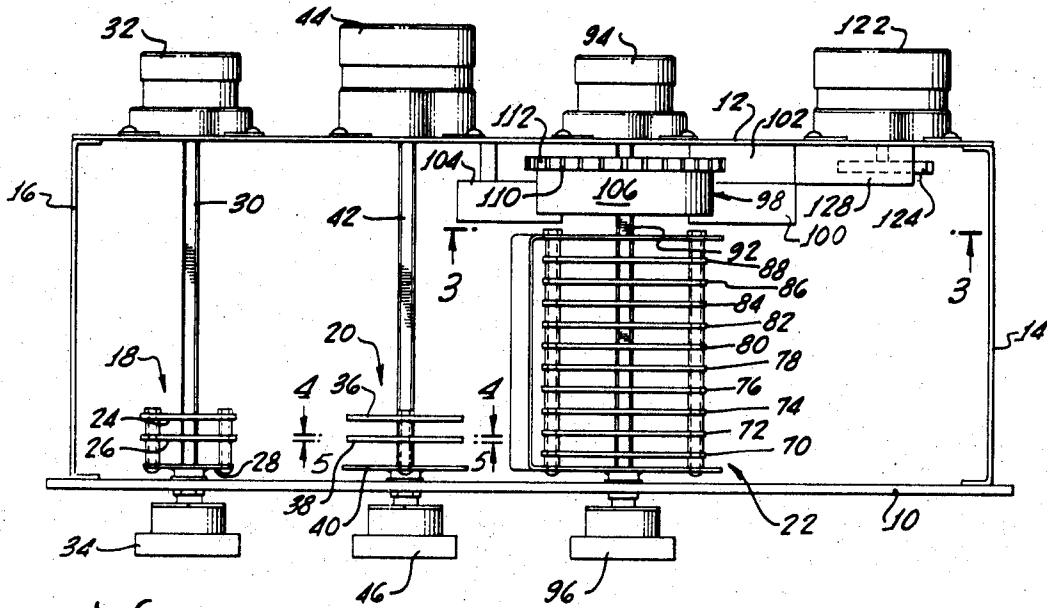


FIG. 2

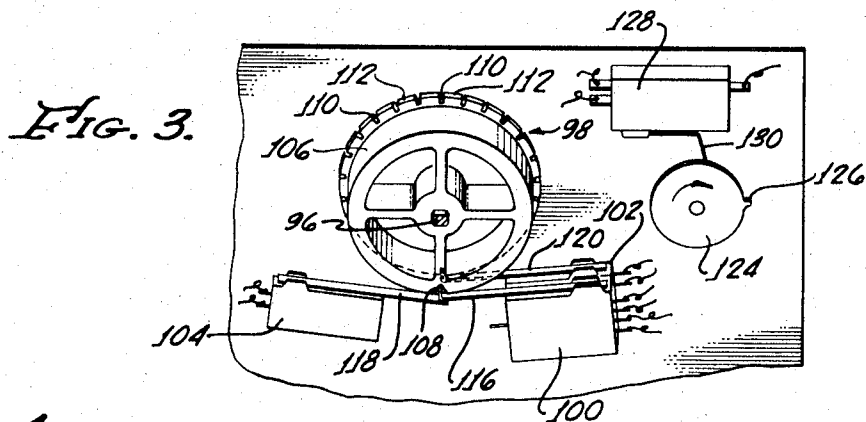
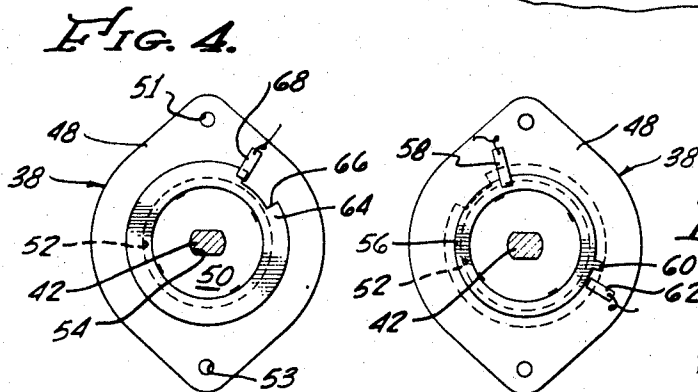


FIG. 3.



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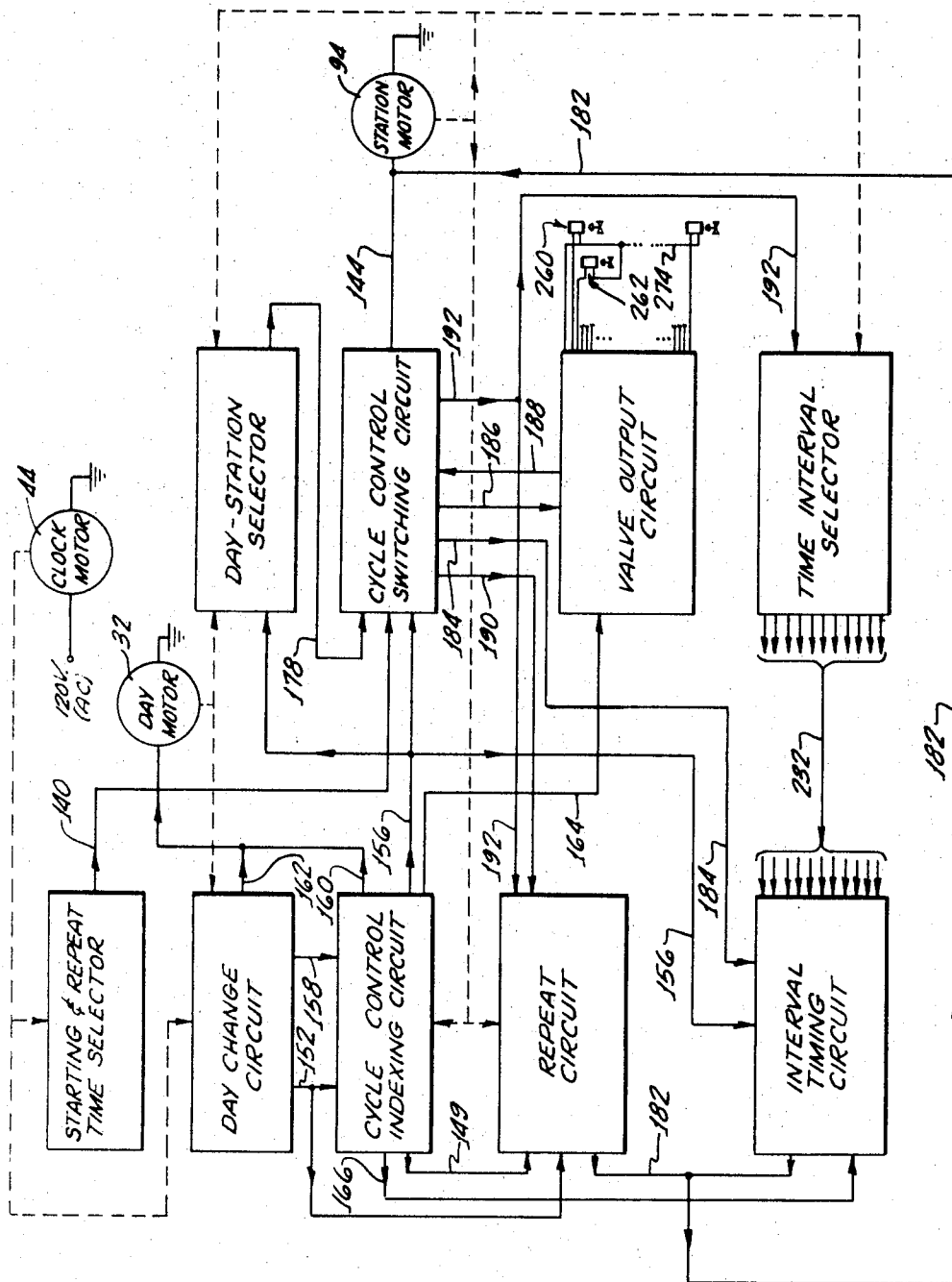


FIG. 6.

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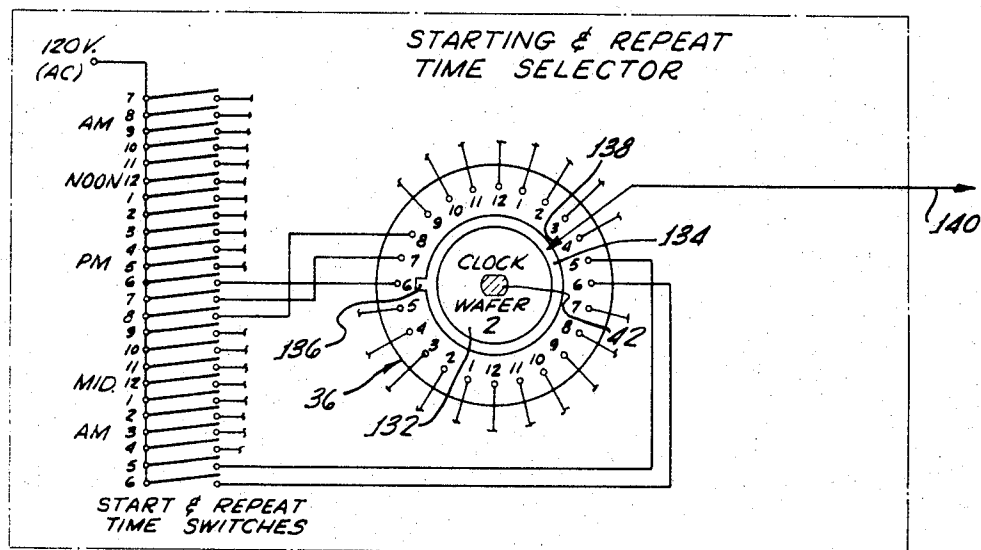


FIG. 7.

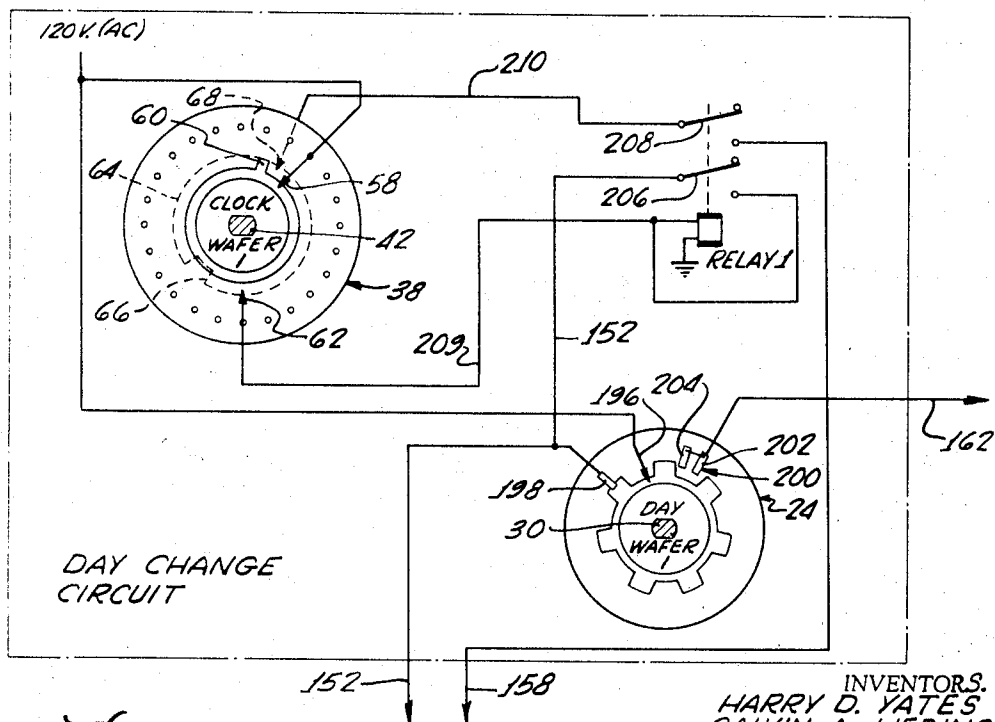


FIG. 10.

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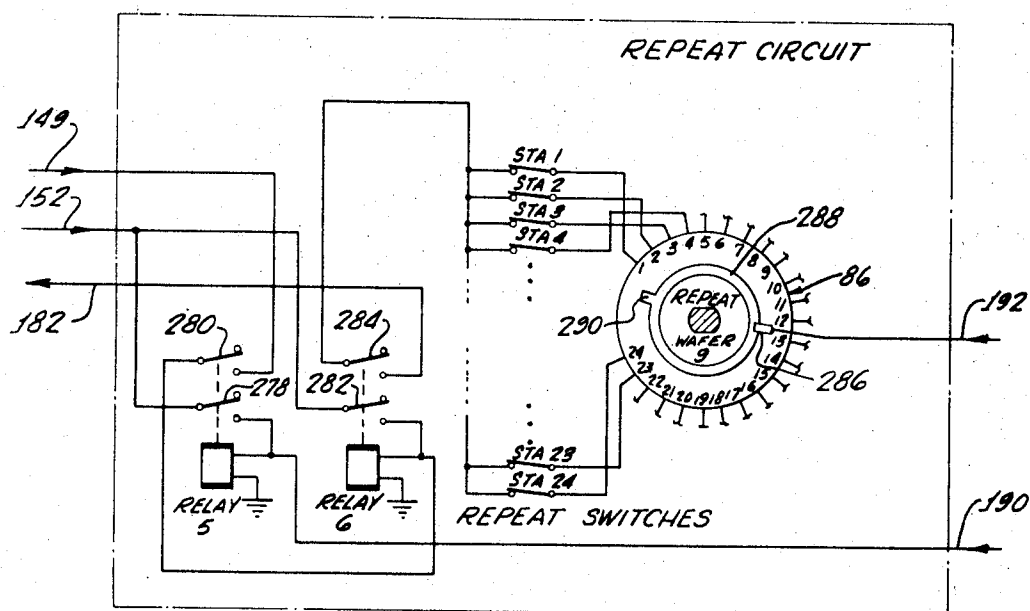
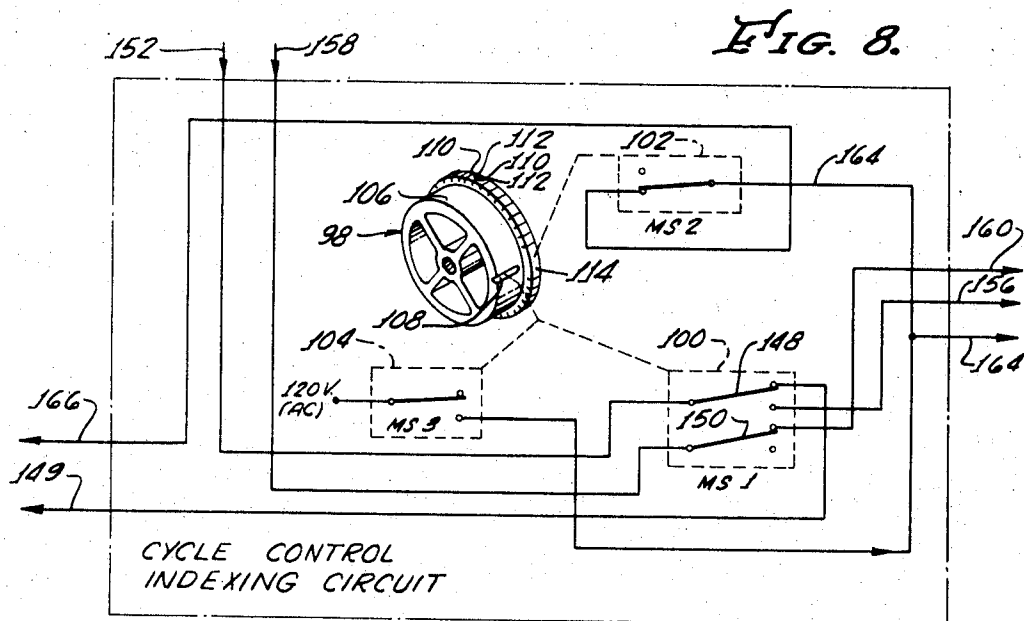


FIG. 15.

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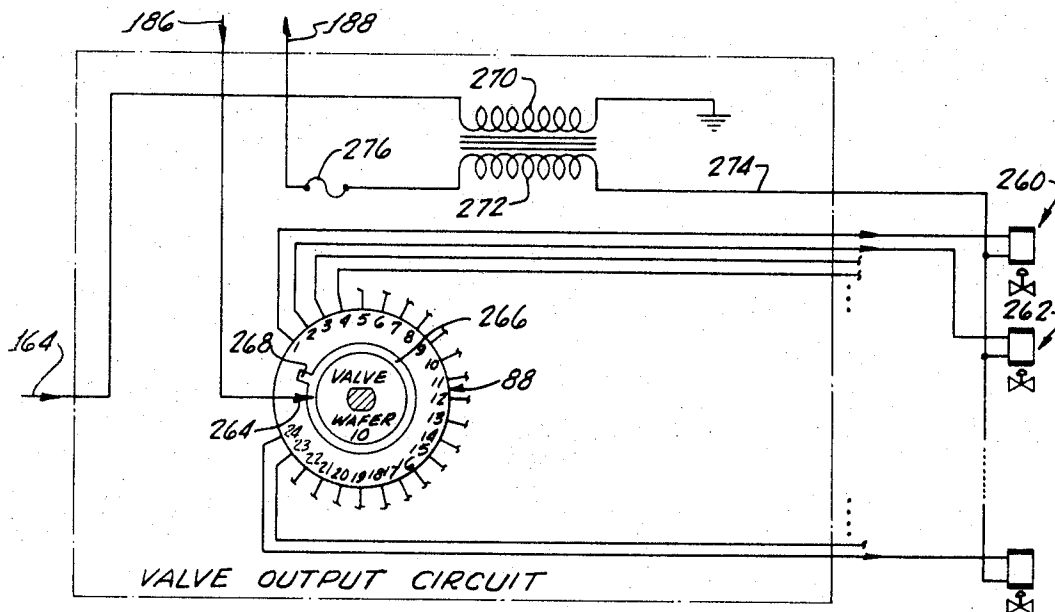
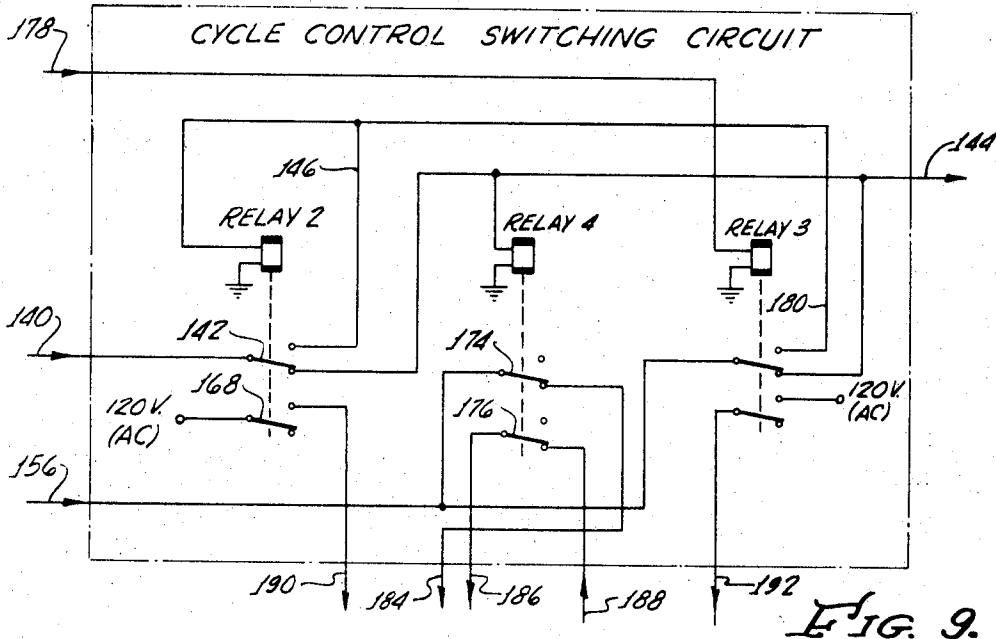
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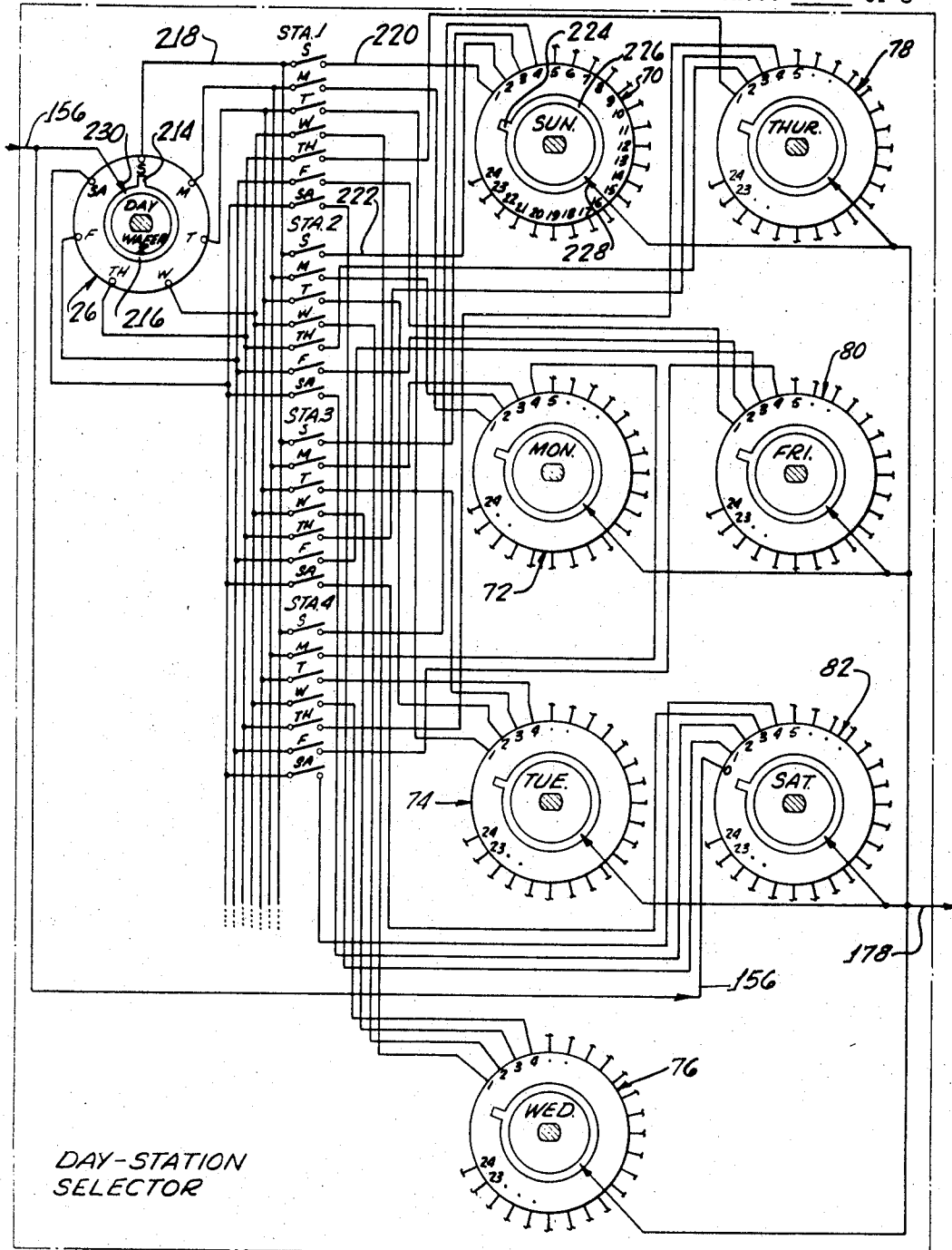


FIG. 11.

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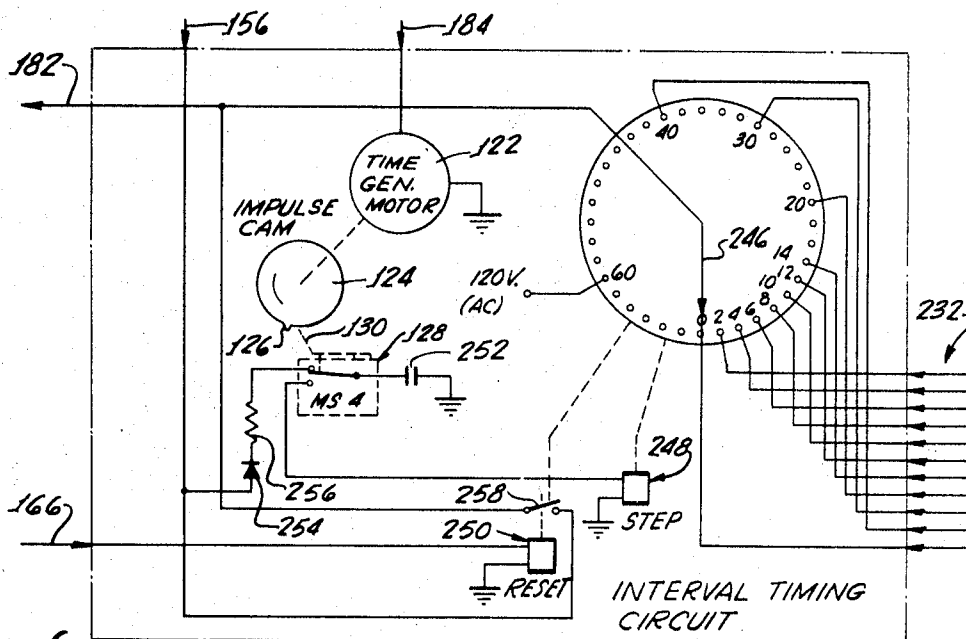


FIG. 13.

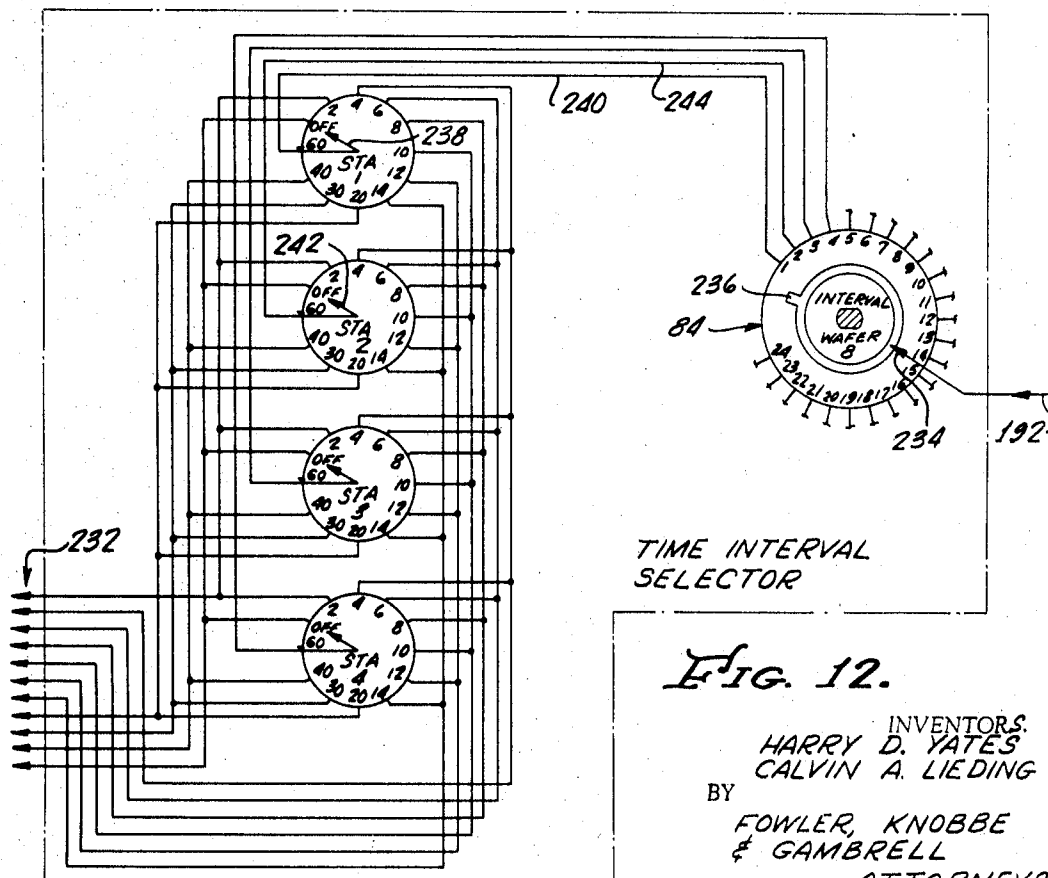


FIG. 12.

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APPARATUS FOR PROGRAMMING CYCLIC ACTUATION OF VALVES

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Continuation of application Ser. No. 460,007, June 1, 1965. This application Feb. 26, 1968, Ser. No. 708,429

Int. Cl. H02j 1/00, 3/00, 3/14

U.S. Cl. 307—41

11 Claims

ABSTRACT OF THE DISCLOSURE

An automatic valve control apparatus for programming the cyclic actuation of a plurality of valves includes a control station for each valve each control station having a plurality of manually operable "day" switches corresponding to the day of the week for selecting the days of the week on which the associated valve is to be actuated, a manually operable "time interval" switch for selecting any of a plurality of time intervals for which the valve is to remain actuated and a manually operable "repeat" switch for selecting whether or not the valve is to be actuated during the repeat cycles on the same day. Associated with the control stations as a group is a set of manually operable "start and repeat time" switches corresponding to the hours of the day. An automatic control means responsive to the manual settings of the "day," "time interval" and "repeat" switches of each control station and to the manual settings of the "start and repeat time" switches cyclically actuates the associated valves in accordance with the program set with the switches.

This invention relates to automatic valve controls, and has particular reference to control apparatus for programming the cyclic actuation of a plurality of valves. This application is a continuation of applicants' copending application Ser. No. 460,007, filed June 1, 1965, now abandoned.

While the control apparatus of the invention has general utility in programming the actuation of valves or analogous devices, it is especially suited for use in conjunction with a water sprinkling system on a golf course and the apparatus will be described with the sprinkler control operation in mind.

It can be appreciated that on a golf course watering is required for different periods of time, at different times of the day, often on different days of the week, and in a different number of applications per day all depending on the particular area of the golf course, its flora and growth condition, the season of the year, etc. These conditions are so subject to change that a fixed program for watering becomes impractical. For newly planted areas even daily changes in the watering schedule may be required depending on changing weather conditions and other factors.

So far as is known, automatic sprinkler controls prior to this invention have not solved the problems presented because they do not provide a sufficient permutation of programmable variables for each watering station and because changing the program is an intricate and tedious task.

These problems are solved by the control apparatus of the present invention, which programs the cyclic actuation of a plurality of valves through a control station for each valve. Each control station includes a manually operable "time interval" switching means for selecting any of a plurality of time intervals for which the valve is to remain actuated. A plurality of manually operable "day" switches corresponding to the days of the week can be

included in the system for selecting the days of the week on which the associated valve is to be actuated, and a manually operable "repeat" switching means can be included for selecting whether or not the same valve is to be actuated during repeat cycles on the same day. Associated with the control stations as a group is a set of manually operable switches corresponding to the hours of the day for selecting the cycle times for each day. Finally the apparatus includes automatic control means responsive to the manual settings of the switches for cyclically actuating the associated valves in accordance with the settings.

With the manually operable switches referred to above, it is seen that a large permutation of important variables is provided in a manner whereby an elaborate program can be easily set up and changed.

In one embodiment of the invention, an inventive automatic control means responsive to the manual switches comprises a station switch, an hour clock switch, a day clock switch, a cycle control, interval timing means, valve actuating means, and a repeat cycle control means.

The hour clock switch and the day clock switch respectively have cycles which include switch positions in accordance with the hours of the day and the days of the week, and means are included for driving these clock switches so that they accurately reflect this information.

The station switch lies at the heart of the system. It has a cycle which includes a position for each control station. Means are included for driving the station switch through its positions.

The operation of the station switch driving means is subject to the cycle control which includes first and second control means. The first control means is responsive to the hour clock switch and to the manual settings of the "start and repeat time" switches for initiating the action of the station switch driving means for a cycle of the station switch at each selected hour. The second control means is responsive to the day clock switch and to the manual settings of the plurality of "day" switches of each control station for interrupting the station switch driving means at each position where the current day is selected at the corresponding control station.

The interval timing means is responsive to the cycle control and to the manual settings of the "time interval" switching means of each control station for reinitiating the interrupted cycle of the station switch after the elapse of the time interval selected at the corresponding control station.

The valve actuating means responds to the cycle control and to the position of the station switch for actuating the corresponding valve during the time interval of each interruption.

The repeat cycle control means is responsive to a subsequent initiation during the same day of the cycle of the station switch for further limiting the actuation of valves to those among the group whose control stations have the "repeat" switches appropriately set. In one embodiment of the invention, the repeat cycle control means includes a primary switch, means responsive to the completion of a preset number of cycles of the station switch during the same day for actuating the primary switch, and means responsive to the subsequent initiation during the same day of a cycle of the station switch by the cycle control for further limiting the interruptions of the station switch driving means to positions among the group of whose associated control stations have their "repeat" switches appropriately set.

The foregoing and additional inventive features of the automatic valve control apparatus are explained in the following detailed description taken in conjunction with

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the accompanying drawings which illustrate a preferred embodiment of the invention, and in which:

FIG. 1 is a fragmentary elevation of the face of the control panel, and illustrates primarily the control stations and their manually operable switches, the set of "start and repeat time" switches, and the indicator knobs and legends associated with the day clock switch, the hour clock switch and the station switch;

FIG. 2 is a top view taken along line 2—2 of FIG. 1 and illustrates primarily the physical construction of and the driving means for the day clock switch, the hour clock switch, and the station switch;

FIG. 3 is a fragmentary perspective view taken along line 3—3 of FIG. 2 to more clearly illustrate certain cam actuated microswitches;

FIG. 4 is an elevation of one side of a wafer switch associated with the hour clock switch taken along line 4—4 of FIG. 2;

FIG. 5 is an elevation of the opposite side of the same wafer switch taken along line 5—5 of FIG. 2;

FIG. 6 is a schematic block diagram of the overall electrical circuit of the preferred embodiment of the invention;

FIG. 7 is a detailed schematic drawing of the starting and repeat time selector of FIG. 6;

FIG. 8 is a detailed schematic drawing of the cycle control indexing circuit of FIG. 6;

FIG. 9 is a detailed schematic drawing of the cycle control switching circuit of FIG. 6;

FIG. 10 is a detailed schematic drawing of the day change circuit of FIG. 6;

FIG. 11 is a detailed schematic drawing of the day-station selector of FIG. 6;

FIG. 12 is a detailed schematic drawing of the time interval selector of FIG. 6;

FIG. 13 is a detailed schematic drawing of the interval timing circuit of FIG. 6;

FIG. 14 is a detailed schematic drawing of the valve output circuit of FIG. 6; and

FIG. 15 is a detailed schematic drawing of the repeat circuit of FIG. 6.

Referring to FIG. 1, it will be noted that a plurality of control stations designated as station 1, station 2, etc., are mounted below and in line with the control panel 10 of the apparatus. In order to simplify the presentation, only four such stations will be shown as hooked up to the automatic control circuit. As will be seen the automatic control circuit is designed to handle twenty-four or any lesser number of control stations each for programming the actuation of an associated valve. Thus, a less elaborate system may grow to meet the requirements of a more elaborate sprinkling system merely by adding control stations as needed, up to twenty-four stations for the embodiment illustrated.

Each control station includes a plurality of manually operable switches corresponding to the days of the week and referred to herein as "day" switches. The "day" switches are conventional single pole slide switches. Each control station has seven of them respectively labelled with the abbreviation for Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday. Manually setting these "day" switches to their "on" and "off" positions will program the days of the week on which the associated valve will be operated.

Each control station has a twelve position rotary selector switch which is referred to herein as the "time interval" switch. The respective positions of the time interval switch are designated as "off", 2, 4, 6, 8, 10, 12, 14, 20, 30, 40, 60" with the numerical designations referring to time intervals in minutes. Thus, any of eleven different time intervals may be selected by manually setting the rotary "time interval" switch. This determines the time interval for which the valve corresponding to the control station will remain actuated each time it is actuated on the days selected.

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Finally, each control station includes a "repeat" switch. The "repeat" switch is a single pole slide switch having an "off" and an "on" position. When the switch is moved to its "on" position, the valve associated with the control station may be repeatedly actuated for the selected time interval on the selected days.

A plurality of twenty-four "start and repeat time" switches are mounted on the control panel 10. These switches are labelled by the hour of the day and by the a.m. and p.m. Each switch is a single pole slide switch manually moveable between an "on" and an "off" position. The hour of the day at which the cycle of valve actuation is started is determined by the earliest switch set to its "on" position, and the time of initiation of repeat cycles is determined by subsequent switches set in the "on" position. As can be seen, the day is chosen to begin between six and seven a.m., which is found to be optimum for sprinkling system.

Referring now to FIGS. 1 and 2, the control or front panel 10 is mounted in spaced relation to a rear panel 12 by means of a pair of side panels 14, 16. Mounted between the front and rear panels 10, 12 are three switches, a day clock switch assembly 18, an hour clock switch assembly 20, and a station switch assembly 22.

The day clock switch assembly 18 includes two phenolic wafer switches 24, 26 rigidly mounted in spaced relation to a supporting plate 28 which is in turn secured rigidly to the control panel 10. A flattened shaft 30 is rotatably journaled through the front and back panels 10, 12. At the back panel 12, the flattened shaft 30 is engaged by an electric motor 32 which is referred to as the "day motor." An indicator knob 34 is connected to the forward end of the shaft 30, for setting and indicating the day of the week. The day motor 32 is a 120 volt, alternating current, synchronous motor. It turns at one revolution per minute and is periodically energized to turn the shaft 30 through one-seventh revolution so as to change the day setting from one day to the next, and to accordingly change the settings of the wafer switches 24, 26. The wafer switches 24, 26 are referred to as "day wafer 1" and "day wafer 2." Day wafer 1 serves the same function as a single pole, double throw micro-switch. Its normally closed position corresponds to the indicator knob resting on a day of the week as opposed to being in transit and in between days of the week. Day wafer 2 serves to provide contact closures in accordance with the days of the week in correspondence to the indicator knob and its surrounding legend.

The clock wafer switch assembly 20 includes two wafer switches 36, 38 rigidly mounted in spaced relation to a mounting base 40 which is in turn rigidly mounted to the control panel 10. A flattened shaft 42 is rotatably journaled between the control and rear panels 10, 12. The rear end of the shaft 42 is engaged by a 120 volt AC. synchronous motor 44 called the "clock motor." An indicator knob 46 is connected to the front end of the shaft and serves to set and indicate the time of day in accordance with its surrounding legend. The clock motor 44 is energized at all times to continuously drive the shaft 42 hence the wafer switches 36, 38 and the indicator 46 to accurately accord with the time of day. The wafer switches 36, 38 are known as "clock wafer 1" and "clock wafer 2." Clock wafer 2 makes contact closures in accordance with the twenty-four hours of the day indicated on the legend of the indicator knob 46. Clock wafer 1 serves to determine the time of day at which the day motor 32 may be energized to change the day setting of the day clock switch assembly 18 to the next day.

Clock wafer 1 is best illustrated in FIGS. 4 and 5. In common with all conventional wafer switches, it has an outer phenolic section 48 having mounting holes 51, 53 for mounting the section 48 in fixed position, and an inner circular phenolic section 50 rotatably journaled with a circular opening 52 in the outer section. The inner section or rotor 50 has a central opening 54 which matches

the cross-sectional configuration of the flattened shaft 42, so that the flattened shaft rotates the inner section 50 relative to the outer section 48 to activate switching components carried between the sections. In the case of clock wafer 1, these switching components include a common conductive ring 56 mounted on the inner section 50 and engaged by a common wiper 58 mounted on the outer section 48. The common conductive ring has a protruding tab 60 which engages a second wiper 62 fixed on the outer section 48 when the inner section 50 is turned to the corresponding position. On the opposite side of the wafer, a conductive ring 64, which is electrically connected to the conductive ring 56, is carried by the inner section 50. The conductive ring 64 has a notch 66 therein such that a wiper 68 fixed to the outer section 48 is normally engaged with the conductive ring 64 except when its position corresponds to the notch 66 therein.

Referring again to FIGS. 1 and 2, the station switch assembly 32 includes ten wafer switches 70, 72, 74, 76, 78, 80, 82, 84, 86 and 88. These wafer switches are rigidly mounted in spaced relation to a bracket 90 which is in turn rigidly mounted to the control panel 10. A flattened shaft 92 is rotatably journaled through the control and back panels 10, 12. The rear end of the flattened shaft 92 is engaged by a 120 volt AC. synchronous motor 94 called the "station motor." An indicator knob 96 is connected to the forward end of the flattened shaft 92 for indicating an "off" position and twenty-four control station positions as shown on its surrounding legend in FIG. 1. One revolution of the station indicator knob 96 corresponds to one complete cycle through all of the control stations, hence through all of the associated valves.

In the station switch assembly 22, seven of the wafer switches 70-82 inclusive are twenty-four position rotary switches each including in addition an "off" position and one of them including as well a "0" position for a purpose which will be explained. These seven wafer switches are respectively known as the "Sunday wafer," the "Monday wafer," the "Tuesday wafer," the "Wednesday wafer," the "Thursday wafer," the "Friday wafer" and the "Saturday wafer." The three additional wafer switches 84, 86, 88 also are twenty-four position rotary switches with an additional "off" position and are respectively known as the "interval wafer" 84, the "repeat wafer" 86, and the "valve wafer" 88.

Also in the station switch assembly 22 is a cam 98 called the "indexing cam." The indexing cam 98 is illustrated in FIGS. 2, 3 and 8. It is rigidly mounted on the flattened shaft 92 adjacent three microswitches 100, 102 and 104 respectively known as microswitch 1, microswitch 2, and microswitch 3 or MS1, MS2, and MS3. The indexing cam 98 includes a first smooth periphery or cam surface 106 which has a single notch 108. This notch 108 corresponds to the "off" position of the station switch assembly and to the "off" positions of all of the wafer switches included therein. The indexing cam 98 has a second ring or cam surface which is defined by a plurality of notches 110 and intervening lands 112, with the notches 110 being spaced around the periphery of the ring in accordance with the twenty-four station positions as indicated on the legend of the station indicator knob 96. This ring also includes an elongated land 114 (see FIG. 8) located to correspond with the "off" position and with the single notch 108 in the smooth cam ring 106. Microswitch 1 and microswitch 3 respectively have cam followers 116, 118 which cooperate with the single notch 108 in the cam ring 106. Microswitch 2 has a cam follower 120 which cooperates with the lands 112, 114 and grooves 110 formed in the other cam surface or ring of the indexing cam. As seen in FIGS. 1, 3 and 8, the station switch assembly is in the "off" position such that the cam followers 116, 118 for microswitches 1 and 3 are engaged in the notch 108, and the cam follower 120 of

microswitch 2 is engaged with the land 114. These are chosen as the normal positions for the switches for indicating the contact closures shown in FIG. 8.

The station motor 94 is periodically energized to turn the flattened shaft 92 at one revolution per minute. As the flattened shaft turns through a complete revolution, the following things will occur: Microswitch 2 will be actuated twenty-four times and returned to its normal position by virtue of its cam follower 120 engaging the twenty-four notches 110 disposed around the indexing cam 98; microswitches 1 and 3 will each be actuated one time as their respective cam followers 116, 118 ride out of the notch 108 and are returned to the notch 108 at the end of the revolution; the Sunday through Saturday wafers 70-82, and the interval wafer 84, the repeat wafer 86, and the valve wafer 88 will each go from their "off" positions through their twenty-four station positions and back to their "off" positions in accordance with the position of the station indicator knob 96.

Mounted alongside the switch assemblies 18, 20 and 22 is a timing mechanism which includes an electric motor 122 known as the "time generator motor." The time generator motor is a 120 volt A.C. synchronous motor with an output speed of thirty revolutions per hour, or one revolution each two minutes. The motor 122 is mounted on the rear plate 12, with the motor shaft extending through the plate. An impulse cam 124 having a single lobe 126 is turned by the time generator motor 122. A fourth microswitch 128 known as "microswitch 4" is mounted to the rear panel 12 proximate the impulse cam 124. Microswitch 4 has a cam follower 130 which is periodically actuated by the lobe 126 on the cam 124 as the cam is driven by the motor 122.

Referring now to FIGS. 6 through 15, the individual circuits and their cooperation will be explained.

Starting and repeat time selector

The starting and repeat time selector circuit is indicated generally in FIG. 6 and in more detail in FIG. 7. It includes the twenty-four start and repeat time switches labeled in accordance with the a.m. and p.m. hours of the day for the manual selection of a starting time and a repeat time or multiple repeat times. Power (meaning the hot or L₁ side of 120 volts alternating current) is supplied to one side of all of the switches. The opposite sides of the switches are respectively connected to the twenty-four corresponding positions of clock wafer 2 over the typical leads shown so that the hour of the day designating of each of the start and repeat time switches corresponds to the hour of the day designation indicated on clock wafer for its respective twenty-four positions. The inner section or rotor 132 of clock wafer 2 is constantly driven at a speed of one revolution per day of $\frac{1}{24}$ revolution per hour by the clock motor 44 through the flattened shaft 42. The rotor 132 of clock wafer 2 carries a conductive ring 134 having a protruding tab 136. A common wiper 138 engages the conductive ring. Each position on clock wafer 2 represents a wiper to engage the tab 136 as the rotor 132 moves the tab 136 into coincidence therewith, whereby an electrical circuit is completed from one side of the corresponding start and repeat time switches and over an output lead 140 which runs from the common wiper 138 to the first armature 142 of relay 2 in the cycle control switching circuit, and which continues over a lead 144 from the normally closed contact of the armature 142 to the station motor 94. Thus, each time the tab on the rotor of clock wafer 2 encounters a position supplied with power from the start and repeat time switches, current flows to the station motor 94 provided the first armature 142 of relay 2 is in its normally closed position. As will be seen, once relay 2 has been energized to switch its first armature 142 to the normally open position, current through clock wafer 2 continues over a lead 146 from the normally open contacts of the first armature of relay 2 to the coil of relay 2 so as to

hold relay 2 energized until the rotor of clock wafer 2 continues on and breaks the current contact. This is significant because the tab 136 of clock wafer 2 may remain in contact with a particular position or terminal for approximately 40 minutes.

Cycle control indexing circuit

The cycle control indexing circuit is indicated generally in FIG. 6 and in detail in FIG. 8. It comprises microswitch 1, microswitch 2 and microswitch 3 respectively labeled with the reference numerals 100, 102, and 104 and with the designations MS1, MS2, and MS3. Microswitch 1 is a double pole switch and has a first armature 148 and a second armature 150. Both microswitch 2 and microswitch 3 are single pole switches.

The power to operate most of the automatic control system is supplied over a lead 152 from the day change circuit and through the normally open contact of the first armature 148 of microswitch 1 to a lead 156 which runs from the cycle control indexing circuit to the day station selector, the cycle control switching circuit, and the interval timing circuit. As will be seen, power is always supplied over the lead 152 from the day change circuit during a cycle of the station switching assembly 22, and inasmuch as microswitch 1 is always actuated by the indexing cam 98 when out of the "off" position, power is supplied over the power lead 156 immediately after the start and up until the conclusion of the cycle of the station switch assembly.

When the indexing cam 98 is in the "off" position such that the first armature 148 of microswitch 1 is in its normally closed position, power received over lead 152 is supplied through the first armature 148 of microswitch 1 to a lead 149 connected to the normally closed contact and running to the repeat circuit for purposes later to be described.

The second armature 150 of microswitch 1 is connected to the day change circuit over a lead 158, and its normally closed contact is connected to a lead 160 which runs in common with another output lead 162 from the day change circuit to the day motor 32. As will be seen, the day change cannot occur during a cycle of the station switch assembly, because the second armature 150 of microswitch 1 is during that time actuated to its normally open position to break the circuit between the leads 158 and 160.

Microswitch 3, which like microswitch 1 is actuated during a cycle of the station switching assembly, supplies power from its armature over a lead 164 which runs to the valve output circuit as well as to the armature of microswitch 2. As on the power lead 156, power is constantly supplied on lead 164 immediately after the initiation and continuing until the conclusion of a cycle of the station switch assembly.

The armature of microswitch 2 assumes its normally closed position each time its cam follower 120 rides up on one of the leads 112, 114 residing between the notches 110 on the indexing cam 98. Thus, microswitch 2 is in its normally closed position when the station switching assembly is at its "off" position, and when it is moving between station positions. Utilizing the power supplied to its armature over lead 164 from microswitch 3, which is only during a cycle of the station switch assembly, microswitch 2 supplies this power through its normally closed contact over an output lead 166 which runs to the interval timing circuit. As will be seen, the power supplied by microswitch 2 over output lead 166 serves both to reset the interval timing mechanism as well as to continue the power to the station motor 94 until the station switching assembly resides exactly on the succeeding station as reflected by the fact that the cam follower over microswitch 2 has dropped again into one of the notches 110 on the indexing cam 98.

Cycle control switching circuit

The cycle control switching circuit is shown schematically in FIG. 6 and in detail in FIG. 9. It and the cycle control indexing circuit together comprise the cycle control for the system.

The cycle control switching circuit comprises relay 2, relay 3, and relay 4, their coils, armatures, and connections. Relay 2 has first and second armatures 142 and 168; relay 3 has first and second armatures 170 and 172; and, relay 4 has first and second armatures 174 and 176. As was previously explained, when a starting or repeat time impulse is received over the output 140 from the starting and repeat time selector, this power is transferred through the normally closed contact of the first armature 142 of relay 2 over an output lead 144 running to the station motor 94, whereby the station motor turns the station switch assembly and thus the indexing cam 98 which results in power on the leads 156 and 164 from microswitch 1 and microswitch 3 respectively in the cycle control indexing circuit. As the station motor moves the station switch assembly from its "off" position, one of the wafer switches (the Saturday wafer) will go through a "0" position and momentarily supply power over an output lead 178 from the day station selector to the coil of relay 3. As will be seen, power supplied over output lead 166 from microswitch 2 in the cycle control indexing circuit through the interval timing circuit and to the station motor will keep the station motor operating until the station switch assembly arrives at its first position which occurs after the mentioned wafer switch has passed its "0" position so as to cut off the power to lead 178. Inasmuch as power is supplied over lead 156 at all times during a cycle to the first armature 170 of relay 3, the momentary actuation of relay 3 over the lead 178 supplies power from the lead 156 to a lead 180 which runs from the normally open contact to the coil of relay 2. Hence, momentarily after the initiation of a cycle, the coil of relay 2 will be energized through the normally open contact of the first armature 170 of relay 3, whereupon relay 2 will be held in the energized condition through the normally open contact of its first armature 142 over lead 146 as long as power is supplied to the first armature 142 of relay 2 over the lead 140 from clock wafer 2 in the starting and repeat time selector. When power from clock wafer 2 ceases, relay 2 will relax and again be prepared to initiate a cycle of the station switch assembly when clock wafer 2 supplies a new starting impulse over lead 140.

Each time the station switch assembly 22 arrives at a position where the day switches of the corresponding control station have selected the current day for actuation of the associated valve, power will be supplied from the day station selector over the output lead 178 to actuate relay 3 and hence to interrupt power over the output lead 144 to the station motor. The station switch assembly remains at this position until the interval timing circuit again actuates the station motor after the expiration of the selected time interval over an output lead 182. As will be seen, moving the station switch assembly off the position at which it was stopped will cause power to cease on lead 178 from the day station selector, hence will cause relay 3 to relax, thereby re-establishing power to the station motor over lead 144 through the first armature of relay 3. Of course, if the next succeeding position of the station switch assembly corresponds to a control station that has selected the current day, relay 3 will again be actuated to stop the station motor. So long as the current day is not selected by the control stations corresponding to succeeding positions of the station switch assembly, relay 3 will remain in the relaxed condition and continue to supply power through its first armature to the station motor.

It is possible that a day will occur when none of the "day" switches of the control stations are set in their

"on" position for the current day. Under these conditions, the station switch assembly would be turned continuously through one cycle and back to its "off" position, whereupon power on the lead 156 from microswitch 1 in the cycle control indexing circuit would be cut off, which would cut off power through the first armature of relay 3 to the station motor thereby causing the station motor to stop. A new cycle would not be immediately initiated through relay 2, because relay 2 would be held in the actuated condition through its own first armature 142 so long as power was supplied over lead 140 from clock wafer 2. As the rotor of clock wafer 2 was moved to succeeding positions, each time selected on the "start and repeat time" switches would cause, as each of these successive times came up, the reinitiation of a single cycle of the station switch assembly.

Relay 4 controls the actuation of valves and the initiation of the action of the interval timing circuit. Through its first armature 174 and the normally closed contact thereof, it connects the power lead 156 from microswitch 1 to an output lead 184 which runs to the interval timing circuit. It controls power to the valves by making and breaking contact between a pair of leads 186, 188 running to and from the valve output circuit.

So long as relay 4 remains actuated, no interval will be timed and no valve will be actuated. It will be noted that the coil of relay 4 is connected to the lead 144 running to the station motor; hence, relay 4 is actuated at all times the station motor is running. Thus, no valves are actuated or intervals timed when the station motor is running, and likewise when the station switch assembly is at rest in its "off" position due to the interruption of power on the lead 156 from microswitch 1.

When relay 3 is actuated during a cycle to stop the station motor at a particular station, relay 4 relaxes and, in resuming their normally closed position, the first and second armatures of relay 4 switch power on over the lead 184 to the interval timing circuit and complete the power circuit between the lead 186 and 188 respectively running to and from the valve output circuit.

Further, in the cycle control switching circuit, it will be noted that power is supplied to the second armature 168 of relay 2. When relay 2 is actuated, power through the normally open contact of the second armature 168 is supplied over a lead 190 running to the repeat circuit for purposes which will be described. Also, power is supplied through the normally open contact of the second armature 172 of relay 3 to an output lead 192 running to the repeat circuit and to the time interval selector, for purposes which will be described.

The day change circuit

The day change circuit is shown in detail in FIG. 10. It includes clock wafer 1, and relay 1, and their switches and interconnection. Primarily, the purpose of the day change circuit is to determine the time of day on which the day change will be made, and to ensure that no day change is made at that time of day until the completion of any cycle of the station switch assembly which may be in progress at that time.

The rotor of day wafer 1 carries a ring with seven evenly-spaced tabs respectively corresponding to the days of the week. A common brush 196 rides on the ring, and two tab brushes 198, 200 are alternately in engagement and out of engagement with the tabs such that day wafer 1 acts as a single pole double throw switch as it is rotated by the day motor. When the day clock switch assembly 18 is exactly on a day, the normally closed brush 198 of day wafer 1 will be in engagement with one of the tabs, and the normally open brush 200 will be out of engagement with the tabs. As can be seen, the normally open brush 200 is a dual brush, and includes a leading brush 202 and a lagging brush 204. As the rotor of day wafer 1 turns counterclockwise, the leading brush 202 will have con-

tacted the approaching tab prior to the time that the normally closed brush 198 will have lost contact with its tab. As the rotor continues to turn, the normally closed brush 198 will go out of contact and the normally open brush 200 will remain in contact until by the time its lagging brush 204 has passed out of contact with the tab, the normally closed brush 198 will then be in contact with a succeeding tab. Hence, power is normally supplied through the common brush 196 to the normally closed brush 198 and in turn to the output lead 152 which runs to the first armature 148 of microswitch 1 in the cycle control indexing circuit. The output lead 152 also runs to the first armature 206 of relay 1.

The day change circuit is designed to change days at 6:30 a.m. The first stage in operating the day change circuit occurs when clock wafer 1, being driven by the clock motor, rotates to the 5:00 a.m. position where the brush 62 comes into contact with the tab 60 carried by the rotor. At this position, power is supplied through the common brush 58, the tab 60 and brush 62, over a lead 209 running from the brush 62 to the coil of relay 1. This moves the first armature 206 of relay 1 to its normally open position to close a holding circuit for relay 1 through lead 152 from the normally closed brush 198 of day wafer 1. This also moves a second armature 208 of relay 1 to its normally open position. The other brush 68 of clock wafer 1 is connected to the second armature 208 by lead 210. When the armature 208 moves to its normally open position, it completes a connection from the brush 68 to the output lead 158 which runs from the normally open contact of this armature to the second armature 150 of microswitch 1.

At the moment when relay 1 was first energized by contact between the brush 62 and tab 60 of clock wafer 1, the other brush 68 of clock wafer 1 was disposed within the notch 66, hence in an open circuit condition. As the clock motor continues to drive clock wafer 1 to the 6:30 a.m. position, the brush 68 contacts the conductive ring 64 to which electrical power is supplied by the common brush 58. This supplies power through the second armature 208 of relay 1 to the second armature of microswitch 1 over the output lead 158. If at this moment a cycle of the station switch assembly is in progress, the second armature 150 of microswitch 1 will be in its normally open condition, and nothing will happen until the cycle is over permitting the second armature 150 of microswitch 1 to return to its normally closed position. The extent of the conductive ring 64 on clock wafer 1 provides for a very considerable waiting period, if necessary.

If the second armature 150 of microswitch 1 is in its normally closed position, or otherwise when it is returned to that position, power will be supplied over the output lead 160 and to the day motor 32, thus initiating a day change. As day wafer 1 is rotated, its normally closed brush 198 loses contact with the tabs which cuts off the power of the output lead 152 and releases relay 1. This cuts off the power to the day motor 32 through lead 158, microswitch 1, and lead 160; however, power to the day motor 32 is now supplied over the lead 162 which is connected to the normally open brush 200 of day wafer 1, this brush now being in contact with a tab. The day motor continues to run until power on lead 162 is cut off by driving the engaged tab out of contact with the lagging brush 204 of the normally open brush 200 in day wafer 1. This will not happen until the day motor has driven the day clock switch assembly 18 exactly to the next succeeding day position, with brush 198 of the day wafer also returned to its normally closed position with a succeeding tab.

The day station selector

The day station selector is shown in detail in FIG. 11 which as can be seen it comprises day wafer 2, the seven "day" switches from each control station and the Sunday

wafer, Monday wafer, Tuesday wafer, Wednesday wafer, Thursday wafer, Friday wafer, and Saturday wafer. The day station selector receives power over the lead 156 from microswitch 1, which power is supplied at all times during a cycle of the station switch assembly. The day station selector functions to supply this power over output lead 178 to energize relay 3 in the cycle control switching circuit. As has been previously explained, relay 3 is energized to stop the station motor.

Clock wafer 2 has seven fixed wipers respectively designated with the abbreviations of the days of the week which cooperate with a tab 214 on a conductive ring 216 carried by the rotor of clock wafer 2. Except when a day change is in progress, the tab 214 of clock wafer 2 will be closed with one of the wipers corresponding to the current day.

The seven wipers of day wafer 2 are respectively connected with the corresponding "day" switches of the control stations. Thus, typically, the Sunday wiper of day wafer 2 is connected by a lead 218 to the Sunday "day" switch of all stations. The other sides of the "day" switches are respectively connected to the sequential positions of the corresponding designated wafer. Thus, typically, the Sunday day switch of station 1 is connected to the first position of the Sunday wafer 70 over a lead 220, and the Sunday "day" switch of station 2 is connected to the second position of the Sunday wafer over a lead 222, and so on until all of the Sunday "day" switches are connected to the respective terminals of the Sunday wafer, all the Monday "day" switches are connected to the respective terminals of the Monday wafer, etc.

The Sunday wafer is typical of the others in the station switch assembly. Each position corresponds to a wiper adapted to successively engage a tab 224 on a ring 226 carried by the rotor of the Sunday wafer. The Sunday wafer, like the others, is turned through its successive positions as part of the station switch assembly. Also similar to the other wafers, the Sunday wafer has a common brush 228 connected to the output lead 178 that runs to relay 3 in the cycle control switching circuit.

Power is supplied to the common brush 230 of day wafer 2 over the lead 156, and thence by day wafer 2 to one side of all of the switches which bear the designation of the current day. This power proceeds through the actuated "day" switches bearing the current day designation to the corresponding terminals of the wafer switch bearing that day designation. Thus, if the current day is Sunday, power from that wafer 2 is supplied to all of the Sunday "day" switches over lead 218, and to the corresponding positions of the Sunday wafer through such Sunday "day" switches as are actuated at the several control stations.

As the station switch assembly moves through its successive positions during a cycle, an electrical connection will be made through the day-station selector to the output lead 178 for each position of the switch assembly where the current day is selected by the appropriate "day" switch at the corresponding control station.

The Saturday wafer 82 is chosen arbitrarily as a wafer of the station switch assembly to include a "0" position. Power is supplied over lead 156 to this "0" position, so that at the beginning of a cycle when the tab of the Saturday rotor passes through the "0" position enroute to position 1, power will momentarily appear on output lead 178 to momentarily actuate relay 3. This momentary application of power occurs at the beginning of each cycle and is quite independent of the settings of the "day" switches and of day wafer 2.

The time interval selector

The time interval selector is shown in detail in FIG. 12. It includes the interval wafer 84, and the rotary time interval switch of each of the control stations. The basic operation of the time interval selector is to provide power

on the appropriate one of a plurality of eleven output leads 232 indicative of the setting of the time interval switch at the station to which the interval wafer's rotary position currently corresponds.

The common brush 234 of interval wafer received power over the lead 192 from the second armature of relay 3 during the time relay 3 is actuated to stop the station motor. The interval wafer is similar to the other station switch assembly wafers and includes a tab 236 on its rotor which contacts successively the twenty-four wiper positions around the switch. The respective wipers of the rotary "time interval" switches are connected respectively to the corresponding positions of the interval wafer. Thus, the rotor 238 of the time interval switch for station 1 is connected over a lead 240 to the first position or wiper of the interval wafer. Similarly, the rotor 242 of the time interval switch of station 2 is connected over a lead 244 to the second wiper or station position of the interval wafer.

The interval wafer turns through its positions as the station switch assembly goes through a cycle. When it arrives at a position where relay 3 is actuated, indicative of the fact that the day switch at that station for the current day is actuated, power is supplied through the interval wafer to the rotor of the time interval switch for that control station. This switch may be set in any one of twelve different positions, eleven of which correspond to different time intervals as previously described and one of which is an "off" or "0" position.

The respective terminals excepting the 60 minute terminals, of each of the "time interval" switches are wired to corresponding ones of the plurality of eleven output leads 232, each "time interval" switch being wired in parallel with the other switches to these output leads. Thus, when power is supplied through the interval wafer to the "time interval" switch of a control station, this power will be supplied to one of the eleven output leads 232 which corresponds to the setting of that switch. The only exception is where the selected "time interval" switch is turned to the "60 minute" position, in which case no power is supplied to any of the output leads 232, which is a matter that will be clarified in describing the interval timing circuit.

Interval timing circuit

The interval timing circuit is shown in detail in FIG. 13. It includes the time generator motor 122, the impulse cam 124 which is driven by the motor, microswitch 4 designated as MS4, and a stepping switch having a wiper 246, a stepping relay 248 and a reset relay 250.

Power supplied over the lead 156 during a cycle charges a condenser 252 through a diode 254 and resistor 256 and through the normally closed contact of microswitch 4. Each time the station motor stops during a cycle, power is supplied through the first armature 174 of relay 4 in the cycle control switching circuit to the time generator motor 122 in the interval timing circuit over the connecting lead 184. The time generator motor turns the impulse cam through one revolution in two minutes whereupon the lobe 126 on the cam engages the cam follower 130 of microswitch 4 which moves the armature to its normally open contact and discharges the condenser 255 through the stepping relay 248 of the stepping switch, causing the stepping switch wiper 246 to move from its rest position to its first position. As the time generator motor 122 continues to turn the impulse cam, succeeding impulses at two-minute intervals from the lobe 126 will discharge the condenser 252 through the stepping relay 248 and cause the wiper 246 of the stepping switch to move to successive positions. Thus, the stepping switch wiper moves from one position to the succeeding position each two minutes. Accordingly, the plurality of output leads 232 from the time interval selector are wired to stepping switch positions selected to correspond to the elapsed time that they represent per their connections to the "time interval" switches of the control stations. Hence, the 2-minute, 4-minute,

6-minute, etc. time intervals correspond to the first, second, and third positions of the wiper arm 246. The 20 minute, 30 minute, 40 minute and 60 minute intervals correspond to the 10th, 15th, 20th, and 30th positions of the stepping switch.

The time generator motor continues to cause the stepping relay 248 to fire each two minutes until the wiper arm 246 arrives at a position which is supplied with power, which corresponds to an elapsed time interval according to the setting of the time interval switch at the control station. Thus, the selected elapsed time has transpired and the arrival of the wiper arm 246 at this position connects power over the lead 182 which runs to the station motor, causing the station motor to resume and the station switch assembly to turn to the next station.

It will be noted that the "off" positions of the time interval switches are connected in parallel over one of the plurality of leads 232 to the rest position of the stepping switch. Thus, as a station is encountered that is set for a time interval of "0," power will merely be supplied through the stepping switch and over the lead 182 to the station motor causing the station motor to continue so that relay 4 never relaxes to energize the time generator motor. Also note that power is constantly supplied to the 30th or 60 minute time interval position of the stepping switch. This is a safety precaution which ensures that no valve will remain actuated for more than 60 minutes as might be the case if there were some failure in other parts of the circuit, especially the time interval selector.

At the same instant the wiper 246 arrives at a position which supplies power so as to initiate the action of the station motor by connecting this power over lead 182 to the station motor, the cam follower of microswitch 2 rises out of the notch 110 corresponding to the station for which the interval has just been timed, thus closing the armature of microswitch 2 and supplying power over lead 166 to the reset relay 250 of the stepping switch in the interval timing circuit. The reset relay closes its normally open armature 258 which supplies power from the lead 156 to the lead 182 running to the station motor, whereby the station motor continues to run until all station switches are centered on the next station, at which point the cam follower of microswitch 2 enters another notch 110 in the index cam 98, which shuts off the power over lead 166 energizing the reset relay 250 and in turn permits the armature 258 of the reset relay to assume its normally open condition thereby removing power to the lead 182.

Also, during the energization of the reset relay 250, the wiper arm 246 of the stepping switch will be returned to its rest position.

Valve output circuit

The valve output circuit is illustrated in detail in FIG. 14. It includes the valve wafer 88 which has its twenty-four positions respectively wired to the solenoid valves corresponding to the control stations. Thus, a solenoid valve 260 associated with station 1 is wired to the first position of the valve wafer, a solenoid valve 262 corresponding to the second control station is wired to the second position of the valve wafer, and so forth. Similar to the other wafers in the station switch assembly, the valve wafer has a common brush 264 which rides on a ring 266 carried by the rotor of the wafer, the ring having a tab 268 which engages the successive positions of the wafer as the rotor turns.

The valve output circuit also includes a transformer having a primary 270 which is energized through power supplied over the lead 164 from microswitch 3, such power being supplied only during a cycle of the station switch assembly so that the transformer is not constantly powered when unnecessary. The 120 volts A.C. supplied across the primary 270 of the transformer is reduced to 12 volts A.C. in the secondary 272 of the transformer. One side of the secondary 272 of the transformer is connected by

a common lead 274 to all of the solenoid valves. The other side of the secondary 272 of the transformer is fused as at 276 and is connected through the second armature 176 of relay 4 by the leads 188 and 186 running respectively to and from the cycle control switching circuit. Lead 186 continues to the common wiper 264 of the valve wafer.

As the station switch assembly turns through its positions, the secondary of the transformer is connected across the coils of the respective corresponding solenoid valves in succession and, but for the second armature of relay 4 in the cycle control switching circuit, each valve would in turn be actuated. Notably, however, no power is supplied through the valve wafer when the station switch assembly is in its off position, and the second armature 176 of relay 4 is in its normally closed position only when the station motor is stopped as by the actuation of relay 3, at which station and at which moment it is intended that the valve be actuated. Obviously, the solenoid valves can control one or more sprinkler heads each.

Repeat circuit

The repeat circuit is shown in detail in FIGS. 15, and includes the repeat wafer 86, the individual "repeat" switches from all the stations, and relay 5 and relay 6. Relay 5 has first and second armatures 278 and 280, and relay 6 has first and second armatures 282 and 284. The repeat wafer is similar to the other wafers in the station switch assembly and includes a common wiper 286 which engages a conductive ring 288. The ring has a protruding tab 290 and is carried by the rotor of the repeat wafer.

The "repeat" switches for stations 1 through 24 as indicated are connected respectively to the corresponding twenty-four terminals or positions of the repeat wafer. Thus, as the station switch assembly goes through a cycle, the common of the repeat wafer is connected successively to the repeat switches of the successive stations. The repeat switches of all stations are connected in common to the first armature 284 relay 6. The lead 182 running to the station motor is connected to the normally open contact for this armature, and the basic operation of the repeat circuit is to prevent repetition of the actuation of all of the valves whose "day" switches are set for the current day and restrict the actuation in the repeat cycle only to those whose repeat switches have been moved to their "on" positions.

The first cycle of the station switch initiated during a given day will result in the energization of relay 2, which in turn causes power to be supplied over the lead 190 to energize relay 5 in the repeat circuit. Relay 5 completes a holding circuit through its first armature 278 so that it will remain actuated as long as power is supplied over lead 152 from the day change circuit which power is not interrupted so long as the current day remains unchanged. At the same time, relay 5 completes a circuit through its second armature 280 connecting lead 149 from microswitch 1 to the coil of relay 6. If a cycle is in progress, power will not be supplied over the lead 149 until that cycle is ended and the first armature of microswitch 1 is returned to its normally closed position, at which time relay 6 will be actuated. Actuation of relay 6 closes a holding circuit through its first armature 282 which connects lead 152 from the day change circuit through the coil of relay 6. Energization of relay 6 also closes its second armature 284 which connects one side of all the "repeat" switches to the lead 182 running to the station motor.

When relay 2 in the cycle control switching circuit is again relaxed, and a new cycle is initiated by the starting and repeat time selector over lead 140, the normal course of events previously described proceeds again with one very important exception. The exception is that each time the station switch assembly arrives at a station at which relay 3 is actuated to stop the station motor, power is supplied through the second armature 172 of relay 3 over the lead 192 and through the repeat wafer to the corre-

sponding "repeat" switch for the station at hand. If this repeat switch is in a closed condition as indicated in FIG. 15, power will continue through the second armature 284 of relay 6 and over the lead 182 to the station motor, whereby the station motor will continue to run and relay 4 will not relax despite the fact that relay 3 was actuated. On the other hand, if the repeat switch for the particular station at hand was moved to its "on" position, which opens the switch, the power would not be supplied over the lead 182 through the repeat circuit and the actuation of relay 3 would be effective to stop the station motor and cause this station to repeat its actuation in exact accordance with its previous actuation on the same day.

Relay 5 responds to the first initiation of a cycle during the day and locks itself in the energized condition so as to store the fact that a first cycle has been initiated. Relay 6, which is the prime relay for the repeat circuit cannot be actuated until the completion of this first cycle due to the operation of microswitch 1. Hence, relay 5 typifies a counter capable of counting to one, and provides an actuation of relay 6 after this predetermined number of cycles of the station switch have occurred during the same day, namely one cycle. Obviously counters capable of counting higher could be substituted for relay 5 so that the repeat circuit would not come into operation until after several unrestricted cycles of the station switch assembly.

The holding circuits to relay 5 and relay 6 are broken by the interruption of power on lead 152 from the day change circuit, which occurs when the normally closed brush 198 of day wafer 1 loses contact with the tabs during a day change. Thus, at the end of each day, relay 5 and relay 6 are reset to their relaxed condition.

We claim:

1. Apparatus for programming the cyclic actuation of a plurality of valves for selected time intervals on selected days of the week starting at selected hours of the day and for repeating the cycle for selected valves at subsequent selected hours of the same selected days, comprising:

(a) a control station for each valve, each control station having:

a first manually operable switching means which includes a plurality of switch elements corresponding to the days of the week for selecting the days of the week on which the valve is to be actuated;

a second manually operable switching means for selecting any of a plurality of time intervals for which the valve is to remain actuated; and,

a third manually operable switching means for selecting whether or not the valve is to be actuated during repeat cycles on the same day;

(b) a fourth manually operable switching means including a plurality of switch elements corresponding to the hours of the day for selecting the starting and repeat cycle times for each day; and

(c) an automatic control means responsive to the manual settings of the first, second and third manually operable switching means of the control stations and to the manual settings of the fourth manually operable switching means for cyclically actuating the associated valves in accordance therewith.

2. The apparatus of claim 1 wherein the automatic control means includes a day clock rotary switch assembly, an hour clock rotary switch assembly and a station rotary switch assembly mounted on a panel; each switch assembly including an actuating shaft, means for driving the shaft, an indicator knob on the front end of the shaft and a legend on the panel associated with the indicator knob.

3. The apparatus of claim 2 wherein the station switch assembly includes a circular indexing cam, the indexing cam having a plurality of lands and notches spaced around it corresponding to the number of control stations, and wherein the automatic control means includes

at least one switch mounted on one of the panels, the switch having a cam follower engaging the index cam and responsive to the lands and notches for actuating the switch.

4. Apparatus for programming the cyclic actuation of a plurality of valves for selected time intervals on selected days of the week starting at selected hours of the day and for repeating the cycle for selected valves at subsequent selected hours of the same selected days, comprising:

(a) a control station for each valve, each control station having:

a first manually operable switching means which includes a plurality of "day" switch elements corresponding to the days of the week for selecting the days of the week on which the valve is to be actuated;

a second manually operable switching means for selecting any of a plurality of time intervals for which the valve is to remain actuated; and,

a third manually operable switching means for selecting whether or not the valve is to be actuated during repeat cycles on the same day;

(b) a fourth manually operable switch means including a plurality of switch elements corresponding to the hours of the day for selecting the starting and repeat cycle times for each day;

(c) a station switch having a cycle which includes a position for each control station; means for driving the station switch;

(d) an hour clock switch having a cycle which includes switch positions in accordance with the hours of the day; means for driving the hour clock switch;

(e) a day clock switch having a cycle which includes switch positions in accordance with the days of the week; means for driving the day clock switch;

(f) a cycle control which includes:

first control means responsive to the hour clock switch and to the hour settings of the fourth manually operable switching means for initiating the action of the station switch driving means for a cycle of the station switch at each selected hour; and

second control means responsive to the day clock switch and to the day settings of the first manually operable switching means of each control station for interrupting the station switch driving means at each position where the current day is selected at the corresponding control station;

(g) interval timing means responsive to the cycle control and to the time interval settings of the second manually operable switching means of each control station for reinitiating the interrupted cycle of the station switch after the elapse of the time interval selected at the corresponding control station;

(h) valve actuating means responsive to the cycle control and to the position of the station switch for actuating the corresponding valve during the time interval of each interruption; and

(i) repeat cycle control means responsive to a subsequent initiation during the same day of the cycle of the station switch for further limiting the actuation of valves to those among the group whose control stations have their third manually operable switching means appropriately set.

5. The apparatus of claim 4 wherein the repeat cycle control means comprises a primary switch, means responsive to the completion of a preset number of cycles of the station during the same day for actuating the primary switch, and a means responsive to the actuation of the primary switch and to the subsequent initiation during the same day of a cycle of the station switch by the cycle control for limiting the interruptions of the station switch driving means to positions in accordance with the repeat settings of the third manually operable switching means of the corresponding control stations.

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6. Apparatus for programming the cyclic actuation of a plurality of valves for independently selected time intervals on independently selected days of the week at selected hours of the day, comprising:

(a) a plurality of control stations each for programming the actuation of an associated valve, each control station having:

a first manually operable switching means for independently selecting a schedule of the days of the week on which the associated valve is to be actuated; and

a second manually operable switching means for independently selecting the time interval for which the associated valve is to remain actuated;

(b) a third manually operable switching means for selecting the starting cycle times for each day; and

(c) an automatic control means associated with said plural control stations responsive to the manual settings of the first and second manually operable switching means of the control stations and to the manual settings of the third manually operable switching means for cyclically actuating only the valves for which the current day has been selected, at the selected starting cycle times, and for the selected time intervals.

7. The apparatus of claim 6 wherein the first manually operable switching means of each control station includes a plurality of switch elements corresponding to the days of the week, and the third manually operable switching means includes a plurality of switch elements corresponding to the hours of the day.

8. The apparatus of claim 6 wherein the automatic control means includes a day clock rotary switch assembly, an hour clock rotary switch assembly, and a station rotary switch assembly having an index position for each control station; each switch assembly including a rotatable shaft for actuating the switch assembly, an indicator and legend associated with the shaft, and means for driving the shaft.

9. The apparatus of claim 6 wherein the automatic control means includes:

(a) a station switch having a cycle which includes a position for each control station; means for driving the station switch;

(b) an hour clock switch having a cycle which includes switch positions in accordance with the hours of the day; means for driving the hour clock switch;

(c) a day clock switch having a cycle which includes switch positions in accordance with the days of the week; means for driving the day clock switch;

(d) a cycle control means responsive to the hour clock switch and to the settings of the third manually operable switching means for initiating the action of the station switch driving means for a cycle of the station switch, and responsive to the day clock switch and to the day settings of the first manually operable switching means of each control station for interrupting the station switch driving means at each position where the current day is selected at the corresponding control station;

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(e) interval timing means responsive to the cycle control and to the time interval settings of the second manually operable switching means of each control station for reinitiating the interrupted cycle of the station switch after the elapse of the time interval selected at the corresponding control station; and,

(f) valve actuating means responsive to the cycle control and to the position of the station switch for actuating the corresponding valve during the time interval of each interruption.

10. Apparatus for programming the cyclic actuation of a plurality of valves for selected time intervals starting at selected times of the day and for repeating the cycle for selected valves at subsequent selected times of the same day, comprising:

(a) a control station for each valve, each control station having:

a first manually operable switching means for selecting the time interval for which the associated valve is to remain actuated; and

a second manually operable switching means for selecting whether or not the valve is to be actuated during repeat cycles on the same day;

(b) a third manually operable switching means for selecting the starting and repeat cycle times for each day; and

(c) an automatic control means responsive to the manual settings of the first and second manually operable switching means of the control stations and to the manual settings of the third manually operable switching means for cyclically actuating the associated valves in accordance therewith.

11. Apparatus for programming the cyclic actuation of a plurality of valves for independently selected time intervals on independently selected days of the week at selected hours of the day in accordance with claim 6 wherein the automatic control means includes:

station switch means having a position for each control station; and

means responsive to the manual setting of the third manually operable switching means for cycling said station switch means through all of its said positions at each selected starting cycle time and responsive to the manual settings of the first manually operable switching means of each control station for actuating only the valves for which the current day has been selected.

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