A radio transmitter transmits coded radio signals at frequencies within the citizen’s band. Each of a plurality of radio receivers comprises a decoder for decoding the coded radio signals which responds to a frequency specified for the particular radio receiver and a timer connected to the decoder for providing timing for a timing period initiated by the decoded radio signals. A motor actuator electrically connected to the timer of each radio receiver is coupled to the corresponding hydraulic valve actuator of one of a group of sprinkler heads comprising a plurality of sprinkler heads and controls the valve actuator to control the supply of water to the sprinkler heads of the group during the timing period.
FIG. 2

- TRANSMITTER 18
- CODER 17
- TIMER 16
- CLOCK 15

FIG. 3

- RECEIVER 19
- DECODER 21
- TIMER 22
- MOTOR DRIVER 28
- ROTARY ACTUATOR 31
- VALVES AND SPRINKLER HEADS
- VALVE CONTROL TUBE 30a
- PROTECTIVE SHEATH
- ACTUATOR MOTOR 32
- MOTOR DRIVER 29
- ROTARY ACTUATOR 34
- VALVES AND SPRINKLER HEADS
- VALVE CONTROL TUBE 30b
FIG. 6

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AUTOMATED IRRIGATION SYSTEM

DESCRIPTION OF THE INVENTION

The present invention relates to an automated irrigation system. More particularly, the invention relates to an automated irrigation system utilizing radio controlled electrically connected units.

The principal object of the present invention is to provide a new and improved automated irrigation system which is simple in structure and efficient, effective and reliable in operation.

An object of the invention is to provide an automated irrigation system which may be installed with facility and rapidity, and by non-professionals.

An object of the invention is to provide an automated irrigation system which is inexpensive in installation and operation.

An object of the invention is to provide an automated irrigation system which may operate on batteries instead of field power.

An object of the invention is to provide an automated irrigation system which utilizes fully transistorized circuitry.

An object of the invention is to provide an automated irrigation system which is fail safe.

Another object of the invention is to provide an automated irrigation system which has long life and requires little or no maintenance.

Another object of the invention is to provide an automated irrigation system which operates at frequencies in the citizen's band.

Another object of the invention is to provide an automated irrigation system which utilizes a field effect transistor as a timer.

Another object of the invention is to provide an automated irrigation system which utilizes semiconductor controlled rectifiers.

Another object of the invention is to provide a device to protect fragile hydraulic conductors.

Still another object of the invention is to provide a device for simple and facile installation of hydraulic conductors, and the facile and simple replacement thereof.

In accordance with the invention, an automated irrigation system comprises radio transmitting means for transmitting coded radio signals at frequencies within the citizen's band. A plurality of radio receiving means receives the coded radio signals from the radio transmitting means. Each of the radio receiving means comprises decoding means for decoding the coded radio signals. The decoding means of each of the radio receiving means responds to a frequency and tone specified for the radio receiving means. Timing means connected to the decoding means provides timing control signals in accordance with the decoded radio signals. A plurality of groups of valve means each comprises a plurality of valve means. Each of a plurality of sprinkler heads is connected to a corresponding one of the valve means. The valve means supply water to the corresponding sprinkler heads. Actuating means electrically connected to the timing means of each of the radio receiving means and coupled to the valve means of each group operates the valve means to control the supply of water to the sprinkler heads of the group in accordance with timing control signals.

The radio transmitting means comprises clock means for providing clock signals, timer means electrically connected to the clock means for determining irrigation time periods from the clock means, coding means electrically connected to the timer means for coding the time signals and transmitter means electrically connected to the coding means for transmitting coded radio time signals corresponding to the time periods.

Each of the radio receiving means comprises receiving means for receiving the coded radio signals from the radio transmitting means, decoding means electrically connected to the receiving means for decoding the coded radio signals, timing means having an input electrically connected to the decoding means, a first output electrically connected to the receiver for providing automatic gain control disabling signals to the receiver and a second output for providing timing control signals in accordance with the decoded radio signals, and motor driving means electrically connected to the second output of the timing means for providing motor control signals in accordance with the timing control means.

The decoding means includes a tuning fork activated by a received coded radio signal to produce a signal having a frequency corresponding to that of the signal, rectifier means coupled to the tuning fork for rectifying the signal produced by said tuning fork, and filter means connected to the rectifier means having a pass-band for passing the rectified signal if it is in the pass-band of the filter.

The timing means comprises a potentiometer and a field effect transistor timer having a drain electrode connectable to ground through said potentiometer in a manner whereby when the drain electrode is grounded the field effect transistor commences timing in accordance with the adjustment position of the potentiometer.

Motor-operated switch means are provided and the actuating means includes motor means for controlling the valve means and the switch means.

The drain electrode of the field effect transistor is connectable to ground through the potentiometer and the switch means in a manner whereby when the drain electrode is grounded via the switch means the field effect transistor commences timing in accordance with the adjustment position of the potentiometer.

The actuating means further includes a semiconductor controlled rectifier for controlling the operation of the motor.

The motor-operated switch means comprises a detent switch controlled by the rotation of the motor.

In accordance with the invention, a sheath for protecting fragile hydraulic conductors comprises material of hollow cylindrical configuration surrounding the conductors.

In accordance with the method of the invention for installing hydraulic conductors, a sheath of material of hollow cylindrical configuration is installed in the ground and hydraulic conductors are pulled through the sheath after the installation thereof.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a block diagram of an embodiment of the automated irrigation system of the present invention;
FIG. 2 is a block diagram of an embodiment of the central transmitter of the automated irrigation system of FIG. 1;

FIG. 3 is a block diagram of an embodiment of a satellite station of the automated irrigation system of FIG. 1;

FIG. 4 is a block diagram of an embodiment of part of the hydraulic system of the automated irrigation system of FIG. 1;

FIG. 5 is a schematic diagram of an embodiment of an actuator motor and a circuit diagram of an embodiment of a timer and motor driver of a satellite station of the automated irrigation system of FIG. 1;

FIG. 6 is a circuit arrangement of an embodiment of the decoder, a timer and a motor driver of a satellite station of the automated irrigation system of FIG. 1;

FIG. 7 is a block diagram of an embodiment of a satellite station of the automated irrigation system of FIG. 1, including a panel assembly;

FIG. 8 is a circuit diagram of an embodiment of the panel assembly of FIG. 7;

FIG. 9 is a block diagram of the part of the hydraulic system shown in FIG. 4; and

FIG. 10 is a block diagram of another embodiment of the automated irrigation system of the present invention.

In FIG. 1, in the central timing mode, a central transmitter 11 transmits 11 time spaced identical tone coded radio signals at frequencies within the citizen's band. The signals transmitted by the transmitter 11 are of the same radio frequency and tone and each frequency pulse drives or operates all the satellite stations 12a, 12b, 12c, 12d, 12e, 12f, 12g and 12h. Although eight satellite stations 12a to 12h are shown, any suitable number of said stations may be utilized in the system of the invention. The satellite stations 12a to 12h are strategically positioned to provide for the irrigation of a large area such as, for example, a golf course. The satellite stations 12a to 12h receive the radio signals transmitted by the central transmitter 11. Each satellite station 12a to 12h is tuned to the same frequency as the others.

A plurality of actuators 13a to 13p are provided. Although two actuators are shown electrically connected to each satellite station, any suitable number of actuators may be electrically connected to each satellite station. In the embodiment of FIG. 1, actuators 13a and 13b are electrically connected to the satellite station 12a. Actuators 13c and 13d are electrically connected to the satellite station 12b. Actuators 13e and 13f are electrically connected to the satellite station 12c. Actuators 13g and 13h are electrically connected to the satellite station 12d. Actuators 13i and 13j are electrically connected to the satellite station 12e. Actuators 13k and 13l are electrically connected to the satellite station 12f. Actuators 13m and 13n are electrically connected to the satellite station 12g. Actuators 13o and 13p are electrically connected to the satellite station 12h. Each satellite station moves its corresponding actuators one step per pulse until 11 steps have been completed.

In the centrally initiated field timing mode, the central transmitter 11 transmits a single clock initiated coded tone and radio frequency within the citizen’s band. This advances all the satellite stations 12a to 12h from their home position to the first of 11 steps. There are no other pulses transmitted by the central transmitter 11. Each satellite station 12a to 12h then operates and advances in accordance with its own timing period set in the field by a potentiometer, as described with reference to FIG. 5. A repeat code may be initiated by the central transmitter 11 clock after all the satellite stations 12a to 12h have completed their timing periods.

In certain instances, satellite stations may be designated to operate only on the greens and tees of a golf course. Other satellite stations may operate only on the fairways. This is accomplished by a variable address from the central transmitter 11. In this mode, a dual coded tone may be utilized as required, one tone each to address the greens and tees and another tone to address the fairways. The irrigation programs may be initiated manually by presetting of a clock and switch by an operator.

A plurality of sprinkler heads are controlled in operation by each actuator 13a to 13p via a corresponding valve. Each sprinkler head is controlled by a valve coupled thereto. Although eleven valves are shown hydraulically connected through hydraulic control tubes in a 1-inch sheath to each actuator 13a to 13p, any suitable number of valves may be connected to each actuator via control tubes in an appropriate sheath.

A sheath for protecting fragile hydraulic conductors may comprise any suitable material such as, for example, synthetic or plastic material of hollow cylindrical configuration surrounding the conductors. In the method of the invention for installing hydraulic conductors, a sheath of synthetic material of hollow cylindrical configuration is installed in the ground. Hydraulic conductors are pulled through the sheath after its installation in the ground. This provides a simple device for installing the hydraulic conductors in the sheath and also permits the simple and facile replacement, in the field, of the hydraulic conductors.

In the embodiment of FIG. 1, valves 14aa to 14ak are hydraulically connected to the actuator 13a and valves 14am to 14aw are hydraulically connected to the actuator 13b. Valves 14ha to 14hk are hydraulically connected to the actuator 13c and valves 14bm to 14bw are hydraulically connected to the actuator 13d. Valves 14ca to 14ck are hydraulically connected to the actuator 13e and valves 14cm to 14cw are hydraulically connected to the actuator 13f. Valves 14da to 14dk are hydraulically connected to the actuator 13g and valves 14dm to 14dw are hydraulically connected to the actuator 13h.

Valves 14ea to 14ek are hydraulically connected to the actuator 13i and valves 14em to 14ew are hydraulically connected to the actuator 13j. Valves 14fa to 14fk are hydraulically connected to the actuator 13k and valves 14fm to 14fw are hydraulically connected to the actuator 13l. Valves 14ga to 14gk are hydraulically connected to the actuator 13m and valves 14gm to 14gw are hydraulically connected to the actuator 13n. Valves 14ha to 14hk are hydraulically connected to the actuator 13o and valves 14hm to 14hw are hydraulically connected to the actuator 13p.

The central transmitter 11 transmits tone coded initiating signals to the satellite stations 12a to 12h to...
start the field timing operation of the corresponding sprinkler heads for preset periods of time, as described with reference to FIG. 5. The time periods may be determined by a clock at the central transmitter 11 in the central timing mode or by a field satellite station program in the field timing mode via a potentiometer, as described with reference to FIG. 5. When a satellite station 12a to 12h receives a radio signal of a frequency to which it is tuned from the central transmitter 11, the satellite station is actuated. When a satellite station 12a to 12h is actuated, it actuates the motors electrically connected thereto and drives or operates the actuators which operate the associated hydraulic valves through control tubes. The valves supply water to the associated sprinkler heads to irrigate the area of the sprinkler heads for the predetermined period of time set in a potentiometer, as described with reference to FIG. 5.

FIG. 2 illustrates an embodiment of the central transmitter 11 of the automated irrigation system of the invention. In the central transmitter, a clock 15, which may comprise any suitable source of time or clock signals, provides time signals. The clock 15 provides preset signals on a daily and weekly basis. A timer 16 has an input connected to the output of the clock 15 and provides the timing signals for the operation of the sprinkler heads. The timer 16 may comprise a manually controlled timing mechanism or a recorded program indicating periods of time for the operation of the various sprinkler heads. After the clock signals initiate the operation, the timer 16 controls how long after such initiation the time period extends. A taped program may be utilized as a 24-hour clock.

A tone coder 17 has an input connected to the output of the timer 16. The tone coder 17 may comprise any suitable coder means for tone coding the signals of the timer 16 for the sprinkler heads. A transmitter 18 of any suitable type has an input connected to the output of the coder 17. The transmitter 18 transmits tone coded radio signals corresponding to the satellite stations 12a to 12h. The signals transmitted by the transmitter 18 are in the citizen's band. One, two or more tones may be utilized if it is desired to address a separate satellite station, for the greens, tees and fairways of a golf course, for example.

FIG. 3 shows an embodiment of a satellite station of the irrigation system of the invention. In FIG. 3, a receiver 19 may comprise any suitable receiver for radio signals transmitted by the transmitter 18 of the central transmitter 11. A decoder 21 has an input connected to the output of the receiver 19. The decoder 21 decodes the tone coded radio signals received from the transmitter 18 and actuates a timer 22 and a timer 23 if the coded signals are of the tone and frequency corresponding to the particular satellite station. The timer 22 has an input connected to the output of the decoder 21 via a lead 24 and the timer 23 has an input connected to the output of said decoder via a lead 25.

An output of the timer 22 is connected to an input of the receiver 19 via a lead 26 and an output of the timer 23 is connected to another input of said receiver via a lead 27. When the timers 22 and 23 are actuated, they produce continuous timing control signals that AGC disable the receiver 19 for approximately one minute, that is, one shot. The AGC feedback makes the receiver 19 a one shot operation. Any accumulated 12 seconds despite interference through 40 seconds of transmission time turns the receiver 19 off. Without the AGC circuit, the receiver 19 might operate as much as three times. Another output of the timer 22 is connected to the input of a motor driver 28 and another output of the timer 23 is connected to the input of a motor driver 29. Each of the motor drivers 28 and 29, when energized or actuated by the corresponding timer 22 or 23, amplifies the timing control signal provided by the timer to a magnitude sufficient to energize or drive an actuator or stepping motor.

The output of the motor driver 28 is connected to an actuator or stepping motor 31 and energizes or drives said actuator motor one step. The output of the motor driver 29 is connected to an actuator or stepping motor 32 and energizes or drives said actuator motor one step. The actuator motor 32 is mechanically coupled to a rotary actuator 33. The actuator motor 32 is mechanically coupled to a rotary actuator 34.

The actuator 33 is hydraulically coupled to a plurality of valves 35a to 35k via a ⅛ inch polyethylene control tube 30a in a 1-inch plastic sheath and controls said valves and the supply of water to corresponding sprinkler heads. The actuator 34 is hydraulically coupled to a plurality of valves 35w to 35w via a ¼ inch polyethylene control tube 30b and controls said valves and the supply of water to corresponding sprinkler heads. A sprinkler head is hydraulically coupled to each of the valves 35a to 35l and 35m to 35w. Each of the valves 35a to 35k and 35m to 35w is in a water line, as described with reference to FIG. 4.

In the central timing mode, the central transmitter 11 turns the receivers of the satellite stations 12a to 12h on (FIG. 1). The receivers 19 turn on the field timers 22 and 23 (FIG. 3). The timers 22 and 23 (FIG. 3) turn themselves off after going through eleven steps.

FIG. 4 illustrates the hydraulic system of the automated irrigation system of the invention. In FIG. 4, water flows at sufficient pressure through a main water line 36. Each group of sprinkler heads comprising a plurality of sprinkler heads is hydraulically connected to the main water line 36 via a corresponding valve. A sprinkler head 37 is thus hydraulically connected to the main water line 36 via a valve 38. The valve 38 is connected in a branch line, conduit, duct or pipe 39, called a swing joint, extending from the main water line 36. The sprinkler heads, of which only the sprinkler head 37 is shown, are hydraulically connected to the branch line 39 through corresponding ones of the valve 38 and 39a, 39b, and so on. Each sprinkler head may comprise any suitable sprinkler device such as, for example, that described in my copending patent application Ser. No. 133,028, filed Apr. 12, 1971, for Remote Controlled Valve for Irrigation Systems, now U.S. Pat. No. 3,707,991.

A motor driver 41 is electrically connected to an actuator and motor 42 via a lead 43 and energizes or drives said actuator and motor, as described with reference to FIG. 4. The actuator and motor 42 may comprise any suitable electrohydraulic motor combinations such as, for example, that described in my aforesaid copending patent application. The electrohydraulic motor 42 is hydraulically and mechanically connected to the branch line 39 via a hydraulic or
water line, conduit, duct or pipe 44 and a petcock 45 through the actuator and then through the valve 38 via a hydraulic or water line, conduit, duct or pipe 46. The actuator and motor 42 have a drain 47 for excess water.

The valve 38 comprises any suitable valve for controlling the flow of water through the branch line 39 and is opened by the actuator and motor 42 when said actuator and motor are energized to the position which drives the actuator to feed water via the appropriate control tube and is closed by said actuator and motor when said actuator and motor are again energized and the motor steps to the next position to turn on the next valve. When the valve 38 is open, the sprinkler head 37 operates to spray water over its allotted area. When the valve 38 is closed, the sprinkler head 37 is not supplied with water and does not operate. When any of the valves 38a, 38b, and so on, are open, the corresponding sprinkler heads 37a, 37b, and so on (not shown in the FIGS.) operate to spray water over their allotted areas.

FIG. 9 illustrates the same hydraulic system as FIG. 4, except that it shows the locations of the components relative to each other. In FIG. 9, a swing joint 47a couples the sprinkler 37 to the branch line 39.

FIG. 5 shows an embodiment of the actuator and motor 42 and an embodiment of a timer and motor driver 41 of the irrigation system of the invention. The motor driver 41 comprises a semiconductor or silicon controlled rectifier or SCR 48. A drive pulse is supplied to the firing or control electrode of the silicon controlled rectifier or SCR 48 via a lead 49 from a timer of the satellite station (FIG. 3). A 12.0 volt source of DC voltage is connected to the anode of the SCR 48. The lead 49 is connected to the firing electrode or trigger of the SCR 48 and a lead 51 is connected to the cathode of said SCR.

The actuator motor 42 comprises an electric motor 52 connected between the lead 51 and a ground lead 53. When the circuit 49,51 is open, as shown in FIG. 5, the SCR 48 energizes the motor 52 via the lead 51 and said motor moves one step and closes said circuit via a detent switch 54. When the circuit 49,51 is closed, it short-circuits and resets the SCR 48 which supplies power to the motor 52 and carries said motor to the next detent of a detent wheel 55, mounted on the motor shaft 56, which operates the detent switch 54. The detent wheel 55 has 12 detents or notches, equidistantly provided around its periphery. The switch 54 also resets the SCR 48 by short-circuiting its anode to its cathode.

A detent wheel 57, having one detent or notch in its periphery, is also mounted on the motor shaft 56. The detent wheel 57 operates a detent switch 58 which opens and closes a timer circuit 59 via the ground lead 53 and a circuit ground lead 61. When the detent switch 58 is open, as shown in FIG. 5, the ground leads 53 and 61 are disconnected and the timer circuit 59 does not produce a timing control signal. When the detent switch 58 is closed, during the remainder of the cycle of rotation of the detent wheel 57, the ground leads 53 and 61 are connected and the timer circuit 59 is energized and produces a timing control signal for the motor driver 41.

The timer circuit 59 comprises a field effect transistor or FET 62. The field effect transistor or FET is described, for example, in the McGraw-Hill En-
cyclopedia of Science and Technology, Volume 14, McGraw-Hill Book Company, Inc., 1960, page 38. A capacitor 63 is connected between the gate electrode of the FET 62 and the ground lead 61 and a capacitor 64 is connected between the source electrode of said FET and said ground lead. A resistor 65, a resistor 66 and a Zener diode 67, for source biasing the FET 62, are connected in series circuit arrangement between the drain electrode of the FET 62 and the ground lead 61. A 12.0 volt source of DC voltage is connected to a common point in the connection between the resistors 65 and 66.

A relay comprising a relay winding 68 is energized by an output stage of the timer circuit 59, not shown in FIG. 5, but shown in FIG. 6. The relay winding 68 controls the operations of relay contacts 68a and 68b which are opened, as shown in FIG. 5, when the relay winding 68 is deenergized and closed when said relay winding is energized. The relay contact 68a is directly connected to the gate electrode of the FET 62 and the relay contact 68b is connected to the ground lead 61 via a resistor 69. The circuit drops the charge in the capacitor 63 and prepares for a new timing cycle after the motor 52 moves to a new position. When the motor 52 moves, it one shots the relay winding 68 and drops the charge in the capacitor 63.

A potentiometer comprising three variable resistors 71, 72 and 73 connected in series circuit arrangement, is connected between the cathode of the Zener diode 67 and the ground lead 61. The potentiometer 72 is adjusted to determining the operation of the FET 62 and, therefore, the timing period of the system of the invention for irrigation. The movable tap of the variable resistor is directly connected to the drain electrode of the FET 62. The movable tap of the variable resistor 71 is directly connected to one end of said variable resistor and to the cathode of the Zener diode 67. The movable tap of the variable resistor 73 is directly connected to one end of said variable resistor and to the ground lead 61. The adjustment or variation of the potentiometer 72 provides variable set drain biasing of the FET 62, thereby providing a variable timing period for the system.

The timer circuit 59 is electrically connected to the motor driver 41 by suitable circuitry, not shown in FIG. 5, but shown in FIG. 6.

FIG. 6 is a circuit diagram of an embodiment of the decoder, timer and motor driver of a satellite station of the irrigation system of the invention. In FIG. 6, the receiver 19 (FIG. 3) receives the coded signals transmitted by the central transmitter. The output signal of the receiver 19 is supplied to the input of the decoder 21 (FIG. 3) via a transformer 74 having a primary winding 75 connected to the output of said receiver via leads 76 and 77, and a secondary winding 78. One end of the secondary winding 78 of the transformer 74 is connected to a 12.0 volt source of DC voltage via a lead 79.

A tuning fork 81 has a stem electrically connected to the lead 79. One of the lines of the circuit is ceramic piezoelectric coupled to the tuning fork 81 via material 82 connected to the other end of the secondary winding 78 of the transformer 74 via a resistor 83. Another of the lines of the circuit is ceramic piezoelectric coupled to the tuning fork 81 via material 84.
A diode 85 is connected between the lead 79 at the stem of the tuning fork 81 and the contact 84, with its cathode connected to the lead 79 and its anode connected to the contact 84. A filter 86 is coupled to the tuning fork 81 via the diode 85 and a diode 87. The filter 86 is connected to the stem of the tuning fork 81 via the lead 79 and to the contact 84 via the diode 87. The filter 86 is connected to the anode of the diode 87, and the cathode of said diode is connected to the contact 84. The diode 85 is interposed between the diode 87 and the tuning fork 81.

The filter 86 comprises a pair of parallel-connected capacitors 88 and 89 and a pair of series-connected resistors 91 and 92, connected in a known manner to function as a π and T type filter. The capacitor 88 is thus connected between the lead 79 and a common point in the connection between the diode 87 and the resistor 91. The capacitor 89 is connected between the lead 79 and a common point in the connection between the resistors 91 and 92. The resistor 92 is connected to the base electrode of a transistor 93. A 12.0 volt source of DC voltage is connected to the lead 79 and to the emitter electrode of the transistor 93 and to a common point in the connection between the resistor 92 and the transistor 93 via a resistor 94.

The signal received by the receiver 19 activates the tuning fork 81 to produce a signal having a frequency corresponding to that of the signal. The signal produced by the tuning fork 81 is rectified by the diode 85 and 87. The rectified DC signal is then filtered by the filter 86 which passes only DC. If the signal produced by the receiver is in the passband of the tuning fork 81, it is rectified and filtered and is supplied to the base electrode of the transistor 93 as a DC signal. The collector electrode of the transistor 93 is connected to a point at ground potential via a resistor 95. The signal at the collector electrode of the transistor 93 is fed to the gate electrode of an FET of a timer circuit.

The timer 23 and motor driver 29 comprise a timer circuit 96, a motor driver circuit 97 and an AGC state 98. The timer circuit 96 comprises a field effect transistor or FET 99. The signal at the collector electrode of the transistor 93 is fed to the gate electrode of the FET 99. The gate electrode of the FET 99 is connected to the collector electrode of the transistor 93 via a resistor 101. A capacitor 102 is connected between the gate electrode of the FET 99 and a ground lead 103. A capacitor 104 is connected between the drain electrode of the FET 99 and the ground lead 103. A resistor 105 is connected between the drain electrode of the FET 99 and the ground lead 103.

The receiver 19 has an output terminal connected to the gate electrode of a field effect transistor or FET 106 via a pair of series-connected resistors 107 and 108 in a lead 109 and supplies a DC regulated output to said FET. A 12.0 volt source of DC voltage is connected to the source electrode of the FET 106 via a voltage lead 111 and a resistor 112. The source electrode of the FET 106 is connected to the base electrode of a transistor 113 via a resistor 114. The source electrode of the FET 99 is connected to the source electrode of the FET 106 via a lead 115. The drain electrode of the FET 99 is connected to the base electrode of the transistor 113 via a resistor 116 and a capacitor 117 connected in series circuit arrangement, with a common point in the connection between said resistor and said capacitor being connected to the voltage lead 111.

A capacitor 118 is connected at one plate to the gate electrode of the FET 106 and at a capacitor 119 is connected at one plate to the drain electrode of the FET 106. The drain electrode of the FET 106 is connected to a terminal 0. The other plate of each of the capacitors 118 and 119 is connected in common with the other plate of the other. A relay has a relay winding 121 which is connected at one end to a point at ground potential and at the other end to the output of an SCR via a lead 122 and to the AGC stage 98 via the lead 122 and a lead 122a. The relay winding 121 controls the operation of relay contacts 121a and 121b. The relay contact 121a is connected to the gate electrode of the FET 106 and the relay contact 121b is connected to the common plate connection of the capacitors 118 and 119 via a resistor 123. When the relay winding 121 is energized, it closes the relay contacts 121a and 121b to close the circuit between them. This discharges the capacitor 118. When the relay winding 121 is deenergized, it opens the relay contacts 121a and 121b to open the circuit between them as shown in FIG. 6.

A potentiometer comprises a resistor 124 connected in series circuit arrangement with a variable resistor 125 between the lead 111 and a terminal Q. A Zener diode 126 is connected between a common point in the connection between the resistor 124 and the variable resistor 125 and a terminal P. The variable resistor 125 has a movable tap connected to the cathode of the Zener diode 126 and the common point between said variable resistor and the resistor 124. A variable resistor 127 is connected between the common plate connection of the capacitors 118 and 119 and the anode of the Zener diode 126 and a terminal X. The variable resistor 127 has a movable tap connected to the anode of the Zener diode 126 and the common plate connection of the capacitors 118 and 119. This circuit functions as a regulated drain variable time set biasing arrangement, as in FIG. 5.

The emitter electrode of the transistor 113 is directly connected to the lead 111. The collector electrode of the transistor 113 is connected to the control or firing electrode of a semiconductor controlled rectifier, silicon controlled rectifier SCR 128 of the motor driver circuit 97 via a resistor 129. The output of the SCR 128 is connected to the relay winding 121 via the lead 122. A terminal H is connected to a common point in the connection between the resistor 129 and the control electrode of the SCR 128 via a resistor 131. The FET 99 delays or integrates the radio signal for 12 seconds and then turns on the transistor 113, which fires the SCR 128. The radio signal moves out the actuator motor and the FET 106, which functions as the timer, has its drain electrode grounded and begins timing in accordance with the position of the potentiometer 125. The remainder of 28 seconds of the 40 second pulse is disabled in the receiver AGC by the AGC disable circuit state 98.

The common plate connection of the capacitors 118 and 119 is connected to the cathode of a semiconductor controlled rectifier, silicon controlled rectifier or SCR 132 via a lead 133. A terminal S is connected to the control or firing electrode of the SCR 132 via a resistor 134. A resistor 135 and a capacitor 136 are con-
connected in parallel between the control electrode and the cathode of the SCR 132. A capacitor 137 is connected between the anode and the cathode of the SCR 132. This circuit is operational when the lead 133 is grounded by the motor actuator (lead 61, FIG. 5). It then functions as a “Press to Home” device by firing the SCR 28 until it passes through all the detents (FIG. 5) and causes the timer to open along with the SCR 132.

A resistor 138 and a capacitor 139 are connected in parallel between the control electrode and the cathode of the SCR 128. The anode of the SCR 132 is connected to the cathode of the SCR 128 via a lead 141, a resistor 142 connected in the lead and a terminal T. This circuit operates by completing the path to ground via the resistor 131, the resistor 138, the resistor 142, the SCR 132 and the lead 133. In this way, positive bias is applied to the SCR 128 which fires said SCR and sends it home. That is, it breaks the ground return of the SCR 132 in the home position. A capacitor 143 is connected between the anode and the cathode of the SCR 128. A reverse voltage clipping diode 144 is connected between the cathode of the SCR 128 and a point at ground potential. An output terminal N of the motor driver circuit 97 is connected to the cathode of the SCR 128 and to a common point in the connection between the capacitor 143 and the diode 144.

The AGC stage 98 comprises a transistor 145 and a transistor 146. The lead 122a is connected to the base electrode of the transistor 145 via a resistor 147. The emitter electrode of the transistor 145 is connected to a point at ground potential. The base electrode and emitter electrode of the transistor 145 are connected to each other via a resistor 148. The collector electrode of the transistor 145 is connected to the base electrode of the transistor 146 via a pair of resistors 149 and 151 connected in series.

A 12.0 volt source of DC voltage is directly connected to the emitter electrode of the transistor 146 and to a common point in the connection between the resistors 149 and 151 via a resistor 152. The common point in the connection between the resistors 149 and 151 is connected to a point at ground potential via a capacitor 153. The collector electrode of the transistor 146 is connected to an output terminal V via a resistor 154. AGC kill signals are provided at the output terminal V and supplied from said terminal to the receiver terminal V when the SCR 128 fires and are delayed 1 minute due to the time constant of the RC circuit 152, 153. When the SCR 128 fires, the receiver 19 is disabled or killed, so that the continuing transmitted signal will not cause double firing. This creates a one shot receiver output effect.

FIG. 7 illustrates the panel assembly of a satellite station of the irrigation system of the invention and FIG. 8 is a circuit diagram of an embodiment of the panel assembly of FIG. 7. In the satellite station of FIG. 7, the timer is manually controlled by a panel assembly 155.

In FIG. 7, the panel assembly 155 has a first plurality of jack connections J2 comprising nine jacks, a second plurality of jack connections J3 comprising four jacks, and a third plurality of four jack plugs P1. The jack plugs P1 may be connected to a battery (not shown in the FIG.) as a source of field power for the system of the invention. The timer 96 and motor driver 97 have a plurality of nine jack plugs P2, each of which is insertable into a corresponding one of the jacks of the jack connections J2.

Each of the terminals O, O, X, L, N, S, H and P of the timer 96 and motor driver 97 is electrically connected to a corresponding one of the jack plugs P2. These terminals are shown in FIGS. 5 and 6. Two points G and V (FIGS. 5 and 6) of the receiver 19 are electrically connected to the timer 96 and motor driver 97, two other points of said receiver are electrically connected to the decoder 21 and two other points of said receiver are electrically connected to corresponding leads from said timer and motor driver to corresponding ones of the jack plugs P2.

Each of the jack connections J3 is electrically connected to a corresponding lead from the panel assembly 155 to corresponding ones of the jack connections J2. One of the jack plugs P1 is electrically connected to a corresponding lead from the panel assembly 155 to a corresponding one of the jack connections J2. The jack connections J3 are connected to the actuator terminal 3.

FIG. 8 illustrates the panel wiring. In FIG. 8, a timing potentiometer 156 provides a variable timing adjustment for 2 to 30 minutes. The potentiometer 156 comprises a resistor having one end electrically connected to a jack connection 1 and another electrically connected to a jack connection 3 and a movable tap electrically connected to a jack connection 2. A voltmeter 157 has one terminal electrically connected to a jack connection 9 via a resistor 158 and another terminal electrically connected to a manually operable motor advance read and home indicate switch 159 which connects it to either a jack connection 8 or a jack connection 5 via a diode 161.

The motor advance read and home indicate switch 159 has a switch arm 159a operable by a pushbutton 159b. One end of the switch arm 159a is connected to the voltmeter 157 and the other end is movable between contacts 159c and 159d. The contact 159c is connected to the jack connection 5 via the diode 161 and the contact 159d is connected to the jack connection 8. A jack plug 4 of the group P1 and a jack connection 4 of the group J1 are electrically connected to the lead of the jack connection 9 of the group J2 and the electrical connection from the jack plug 4 of the group P1 is grounded. A jack connection 2 of the group J1 is electrically connected to the lead of the jack connection 8 of the group J2 and a jack connection 1 of the group J1 is electrically connected to the lead to the jack connection 5 of the group J2. The jack connections of the group J1 supply the actuator terminal.

An advance switch 162 has a switch arm 162a operable by a pushbutton 162b. One end of the switch arm 162a is electrically connected to the jack connection 4 and the other end is movable between contacts 162c and 162d. The contact 162c is open. The contact 162d of the switch 162 is electrically connected to a jack connection 7. A jack connection 3 of the group J1 is electrically connected to the lead to the jack connection 4, and then to the terminal 9 (FIGS. 6 and 7) where it functions to trigger the SCR 128 to advance the motor actuator.

A go home switch 163 has a switch arm 163a operable by a pushbutton 163b. One end of the switch arm
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163 is electrically connected to a jack connection 3 of the group P1 and to the corresponding end of the switch arm 162a of the switch 162. The other end of the switch arm 163a is movable between contacts 163c and 163d. The contact 163c is open. The contact 163d is electrically connected to a jack connection 6.

In the embodiment of FIG. 10, the output of a receiver 164 is connected to the input of a decoder 165 via a lead 166. The output of the decoder 165 is connected to the input of a DC amplifier 167 via a lead 168. The output of the DC amplifier 167 is connected to the input of a 15 second integrator 169 via a lead 171. The output of the integrator 169 is connected to an input of an isolation network 172 via a lead 173. The output of the isolation network 172 is connected to an input of a DC amplifier 174 via a lead 175. The output of the DC amplifier 174 is connected to the control electrode of an SCR 176 via a lead 177.

A positive DC voltage is applied to the input electrode of the SCR 176 via a lead 178 from a source B+ of positive DC voltage such as, for example, a battery, and to a motor driver 179 of the system. The output of the SCR 176 is connected to the input of the motor driver 179 via a lead 181. The output of the SCR 176 is also connected to the input of an inverter 182 via a lead 183. The output of the inverter 182 is connected to the input of an AGC relay circuit 184 via a lead 185. The output of the AGC relay circuit 184 is connected to the input of an AGC disable circuit 186 via a lead 187. The output of the AGC disable circuit 186 is connected to an input of the receiver 164 via a lead 188. An RC circuit comprising a resistor 189 and a capacitor 191 is connected to, and controls the operation of, the AGC delay circuit 184.

A field set time control 192 comprises a potentiometer which is adjustable by an operator to set the timing period of a timer 193 having an input connected to the output of said field set time control via a lead 194. The potentiometer of the field set time control 192 determines the timing period in accordance with the position of its movable tap. Thus, when the movable tap of the potentiometer is at one end of the resistor, the timing period is 2 minutes. As the movable tap moves toward the other end of the resistor, the timing period merely increases, until, at the other end, the timing period is 30 minutes.

The operation of the timer 193 is controlled by a detent wheel 195. The detent wheel 195, in any position other than that shown in FIG. 10, closes the circuit of the timer 193 by closing a ground lead 196 to a timer lead 197 via a detent switch 198. When the detent wheel 195 is in the position shown in FIG. 10, the detent switch 198 fits into the single detent of said detent wheel and thus opens the circuit between the ground lead 196 and the timer lead 197. The detent wheel 195 is mechanically coupled to and driven by the motor driver 179. The output of the timer 193 is connected to another input of the isolation network 172 via a lead 199.

The embodiment of FIG. 10 operates in the manner disclosed with reference to FIGS. 5 and 6.

While the invention has been described by means of specific examples and in specific embodiments, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

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I claim:
1. An automated irrigation system comprising radio transmitting means for transmitting coded radio signals at frequencies within the citizen's band;
a plurality of radio receiving means for receiving the coded radio signals from the radio transmitting means, each of the radio receiving means comprising decoding means for decoding the coded radio signals, the decoding means of each of the radio receiving means responding to a frequency and tone specified for the radio receiving means, and timing means connected to the decoding means for providing timing control signals in accordance with the decoded radio signals;
a plurality of groups of valve means each comprising a plurality of valve means;
a plurality of sprinkler heads each connected to a corresponding one of the valve means, the valve means supplying water to the corresponding sprinkler heads; and
actuating means electrically connected to the timing means of each of the radio receiving means and coupled to the valve means of each group for operating the valve means to control the supply of water to the sprinkler heads of the group in accordance with the timing control signals.

2. An automated irrigation system as claimed in claim 1, wherein the radio transmitting means comprises clock means for providing clock signals, timer means electrically connected to the clock means for determining irrigation time periods from the clock means, coding means electrically connected to the timer means for coding the time signals and transmitter means electrically connected to the coding means for transmitting coded radio time signals corresponding to the time periods.

3. An automated irrigation system as claimed in claim 1, wherein each of the radio receiving means comprises receiving means for receiving the coded radio signals from the radio transmitting means, decoding means electrically connected to the receiving means for decoding the coded radio signals, timing means having an input electrically connected to the decoding means, a first output electrically connected to the receiver for providing automatic gain control disabling signals to the receiver and a second output for providing timing control signals in accordance with the decoded radio signals, and motor driving means electrically connected to the second output of the timing means for providing motor control signals in accordance with the timing control means.

4. An automated irrigation system as claimed in claim 3, wherein the decoding means includes a tuning fork activated by a received coded radio signal to produce a signal having a frequency corresponding to that of the signal, rectifier means coupled to the tuning fork for rectifying the signal produced by said tuning fork, and filter means connected to the rectifier means having a passband for passing the rectified signal if it is in the passband of the filter.

5. An automated irrigation system as claimed in claim 3, wherein the timing means comprises a potentiometer and a field effect transistor timer having a drain electrode connectable to ground through said potentiometer in a manner whereby when said drain
electrode is grounded said field effect transistor commences timing in accordance with the adjustment position of the potentiometer.

6. An automated irrigation system as claimed in claim 3, further comprising motor-operated switch means, and wherein the actuating means includes motor means for controlling the valve means and the switch means, and the timing means comprises a potentiometer and a field effect transistor timer having a drain electrode connectable to ground through said potentiometer and said switch means in a manner whereby when said drain electrode is grounded via said switch means said field effect transistor commences timing in accordance with the adjustment position of the potentiometer.

7. An automated irrigation system as claimed in claim 6, wherein the decoding means includes a tuning fork activated by a received coded radio signal to produce a signal having a frequency corresponding to that of the signal, rectifier means coupled to the tuning fork for rectifying the signal produced by said tuning fork, and filter means connected to the rectifier means having a passband for passing the rectified signal if it is in the passband of the filter, and wherein the actuating means further includes a semiconductor controlled rectifier for controlling the operation of the motor.

8. An automated irrigation system as claimed in claim 7, wherein the motor-operated switch means comprises a detent switch controlled by the rotation of the motor.

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