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Shapiro

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[54] **AUTOMATED IRRIGATION SYSTEM**

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[52] **U.S. Cl.** 239/70
[51] **Int. Cl.** A01g 27/00
[58] **Field of Search** 239/70

[56] **References Cited**

UNITED STATES PATENTS

3,440,434	4/1969	Yates et al.	239/70 X
3,599,867	8/1971	Griswold et al.	239/70
3,140,720	7/1964	Griswold	239/70
3,524,471	8/1970	Bresser	239/70

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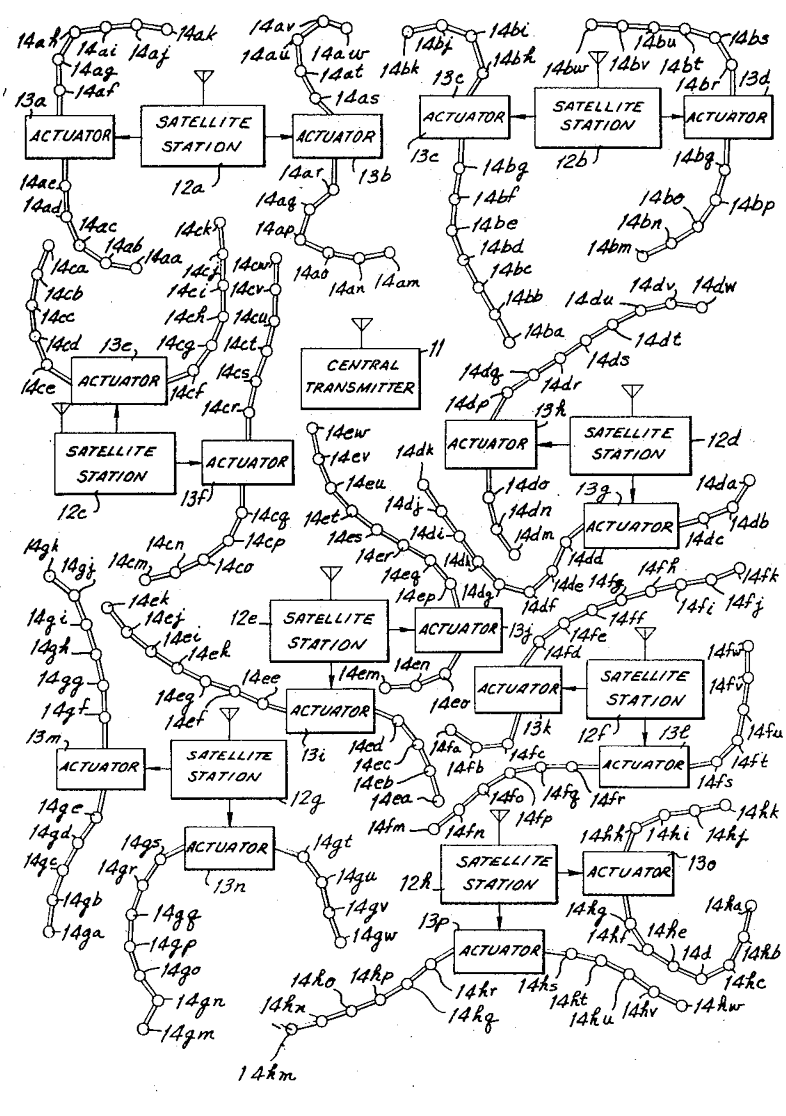
[57] **ABSTRACT**

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.

8 Claims, 10 Drawing Figures



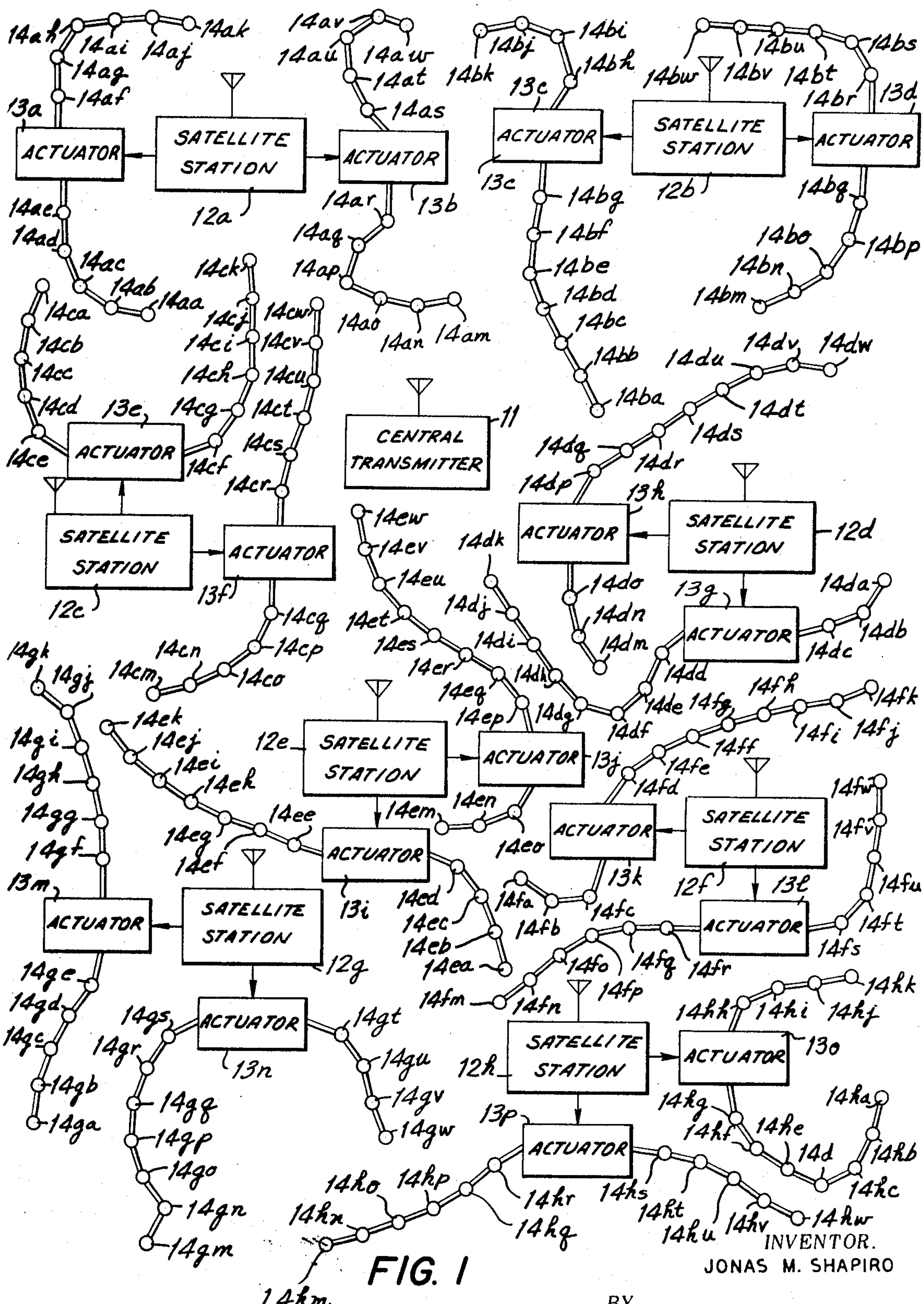


FIG. 1

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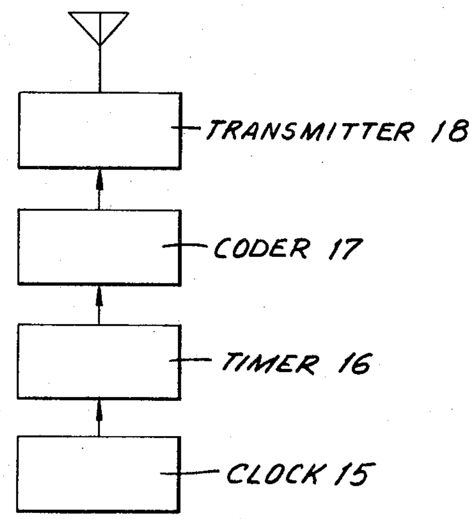

FIG. 2

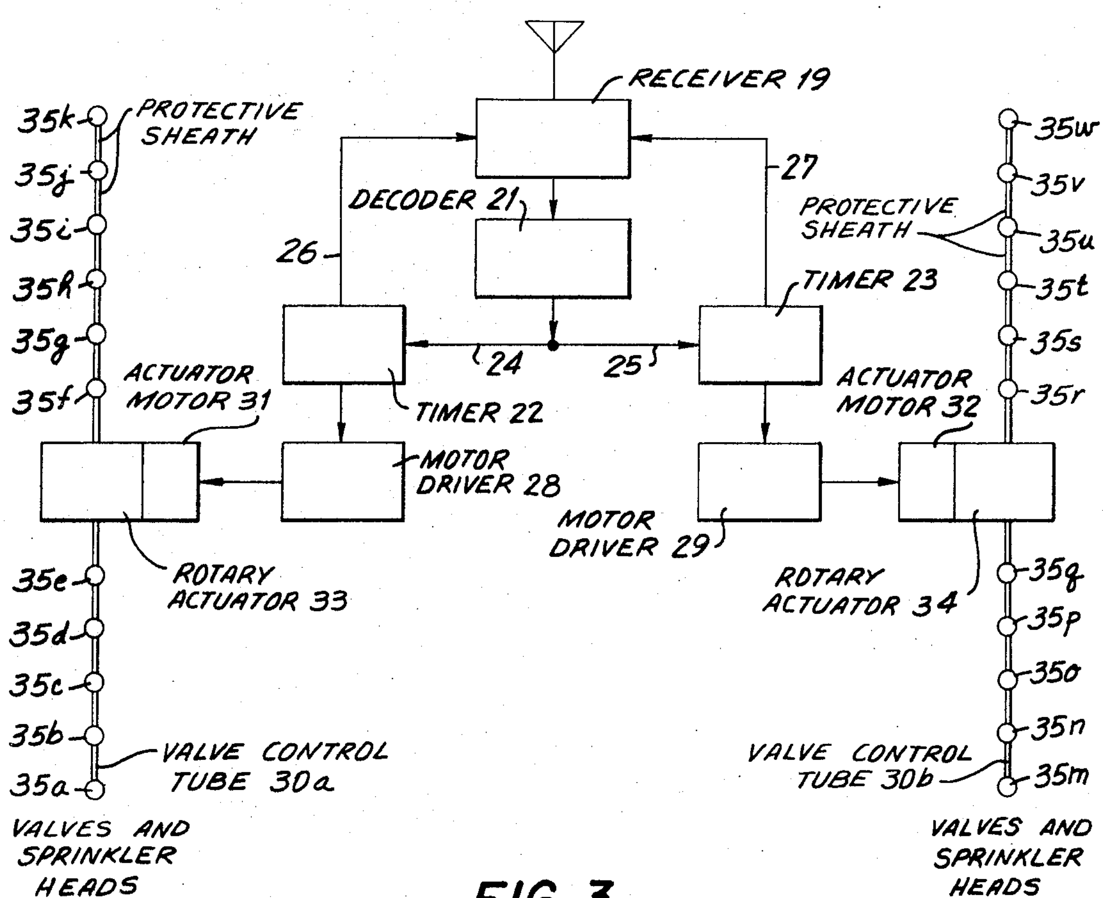

FIG. 3

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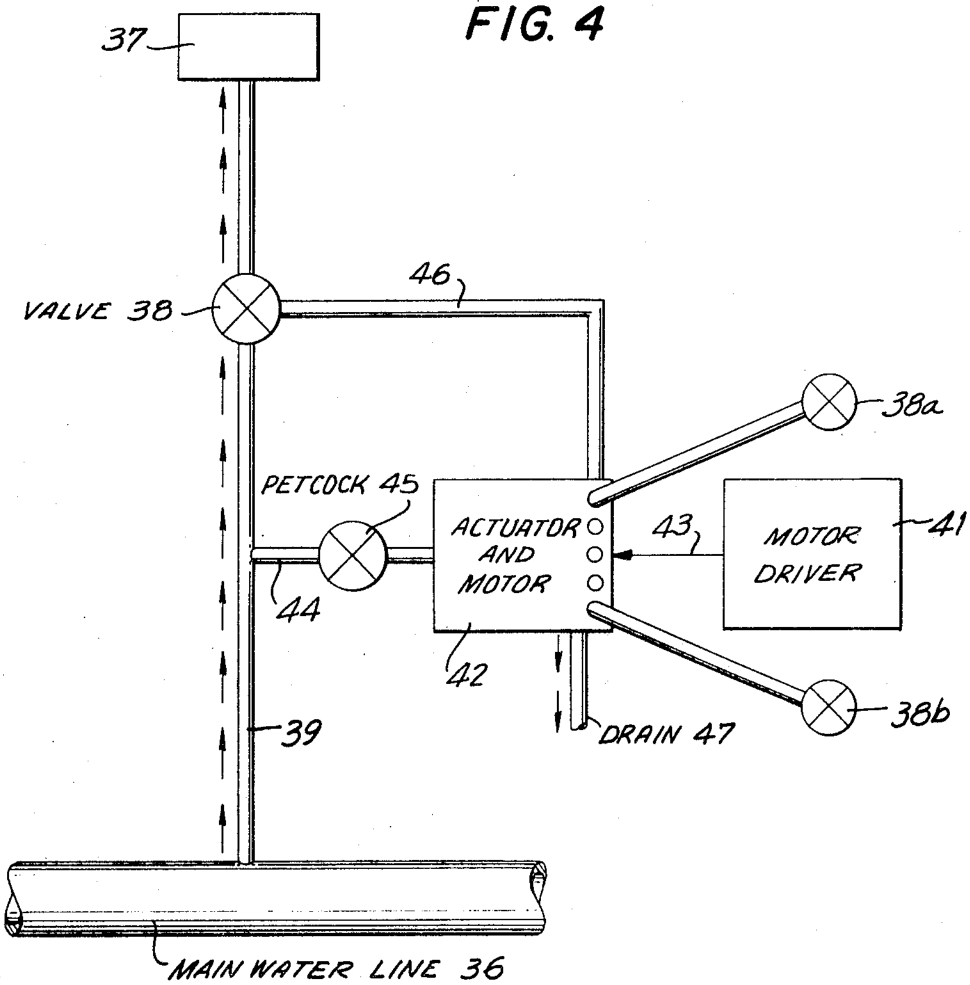
FIG. 4



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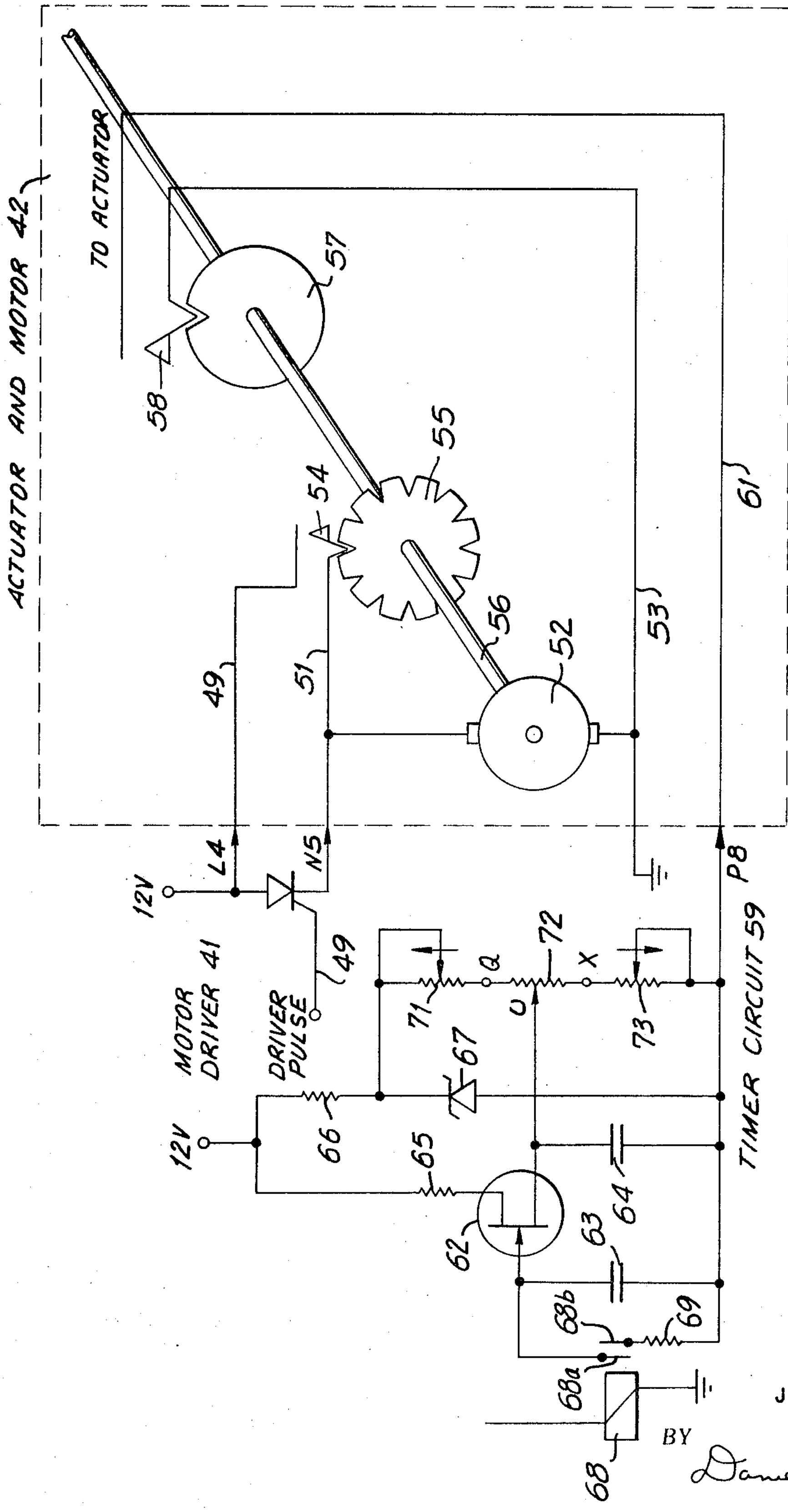

FIG. 5

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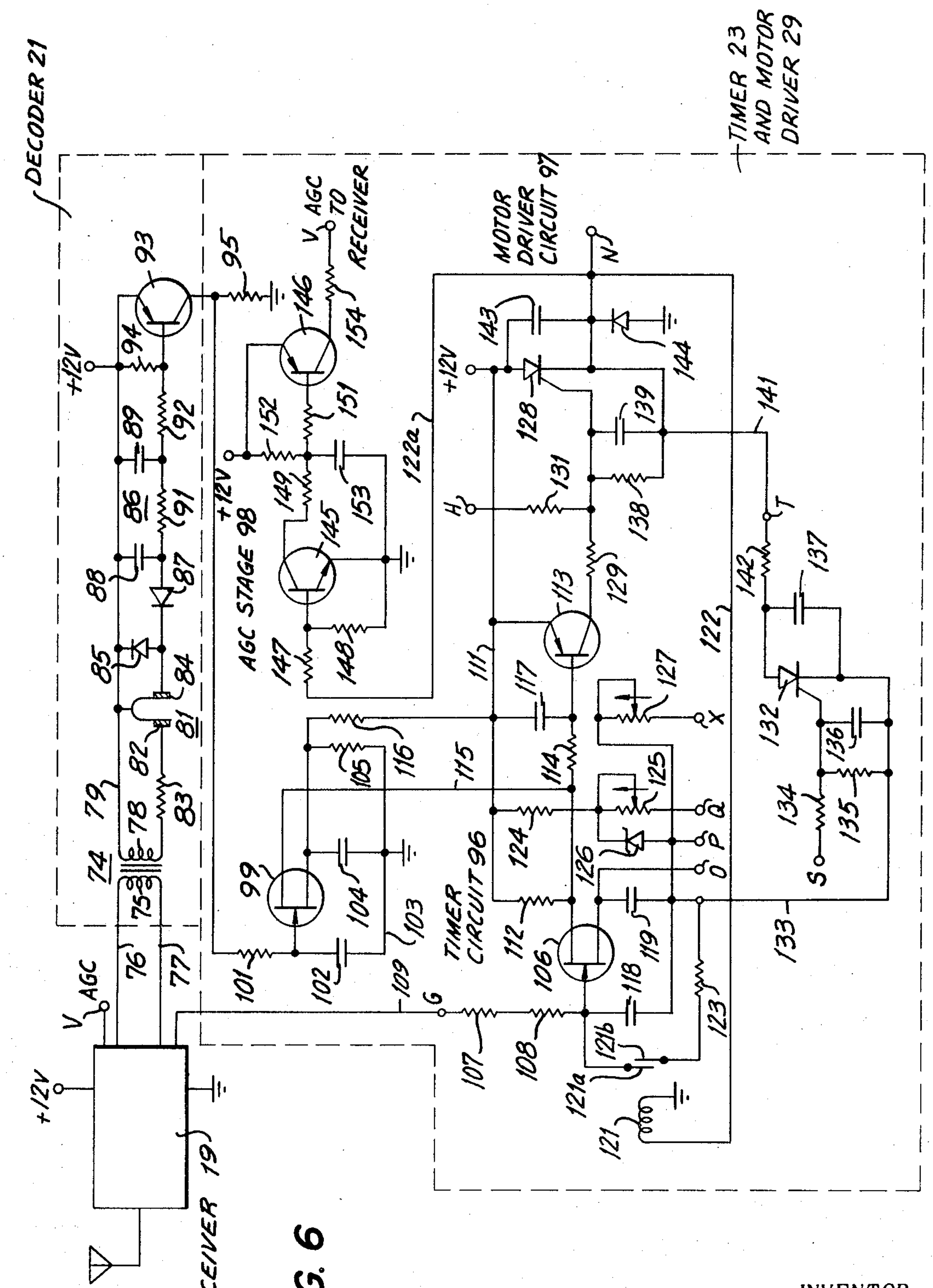

FIG. 6

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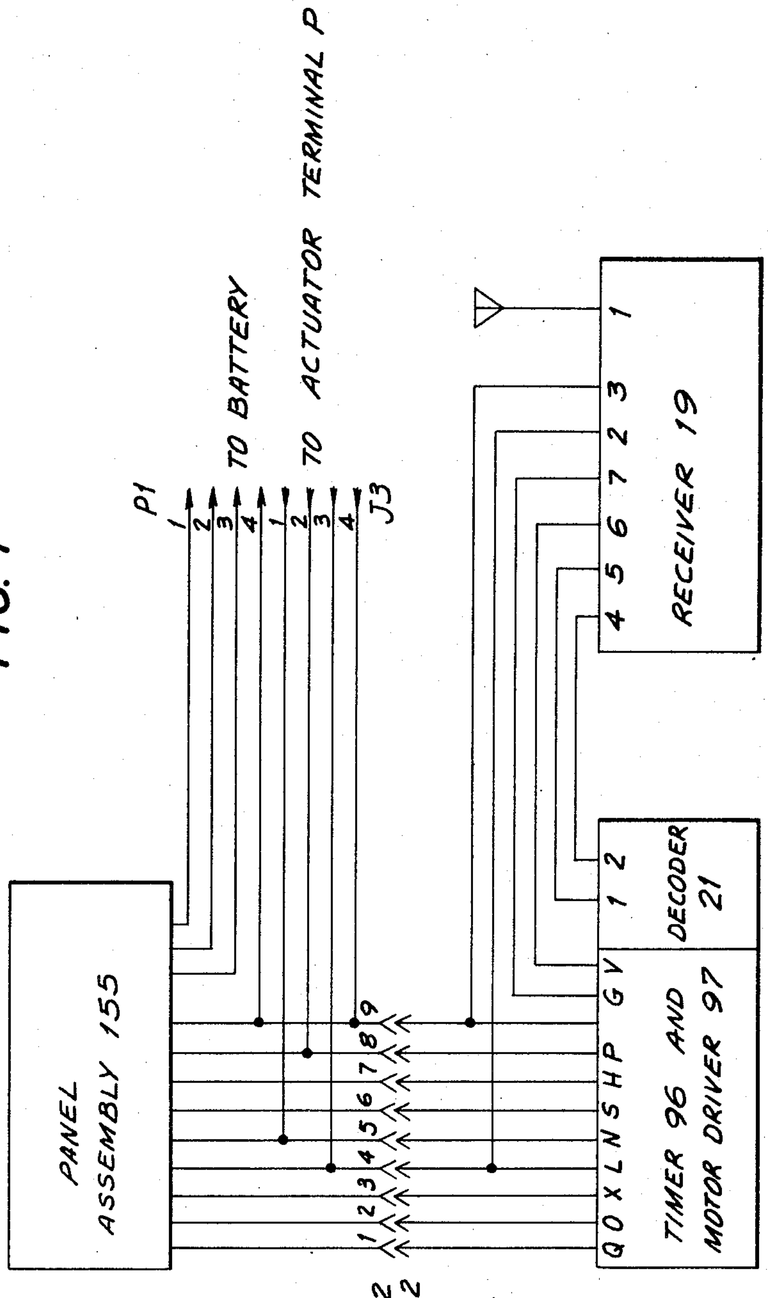
FIG. 7



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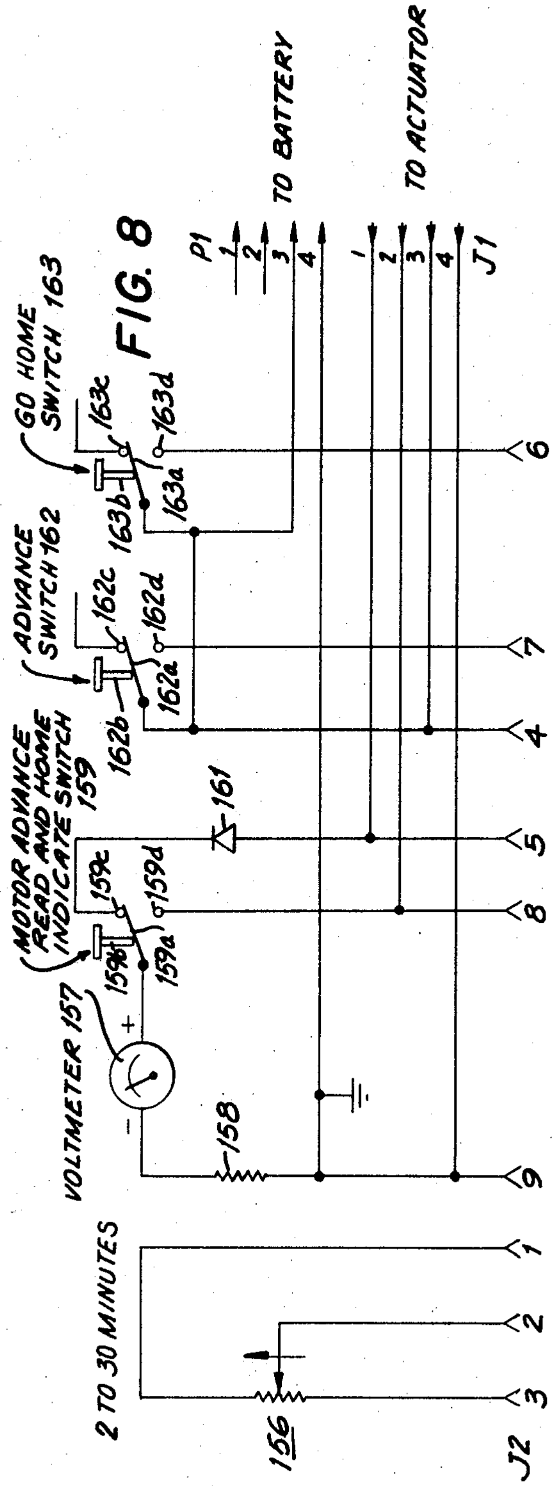

FIG. 8

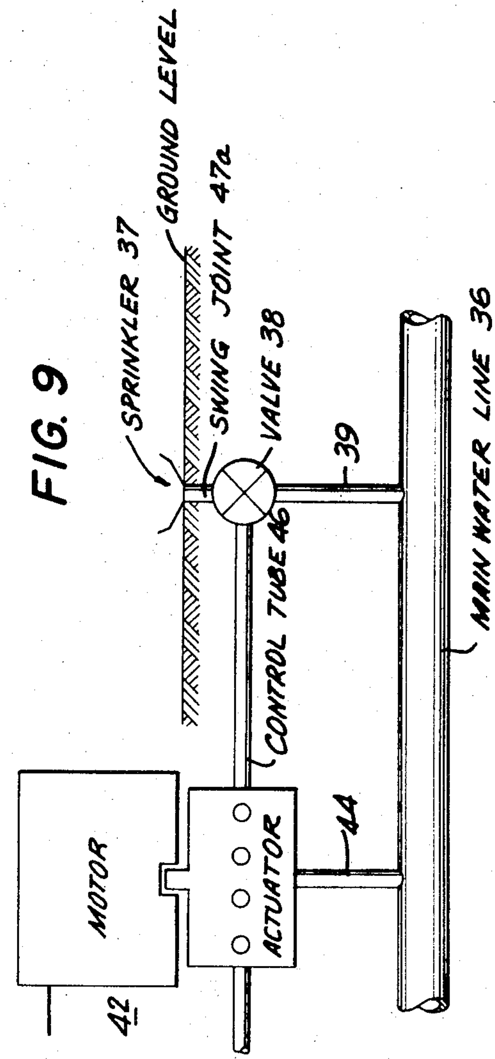

FIG. 9

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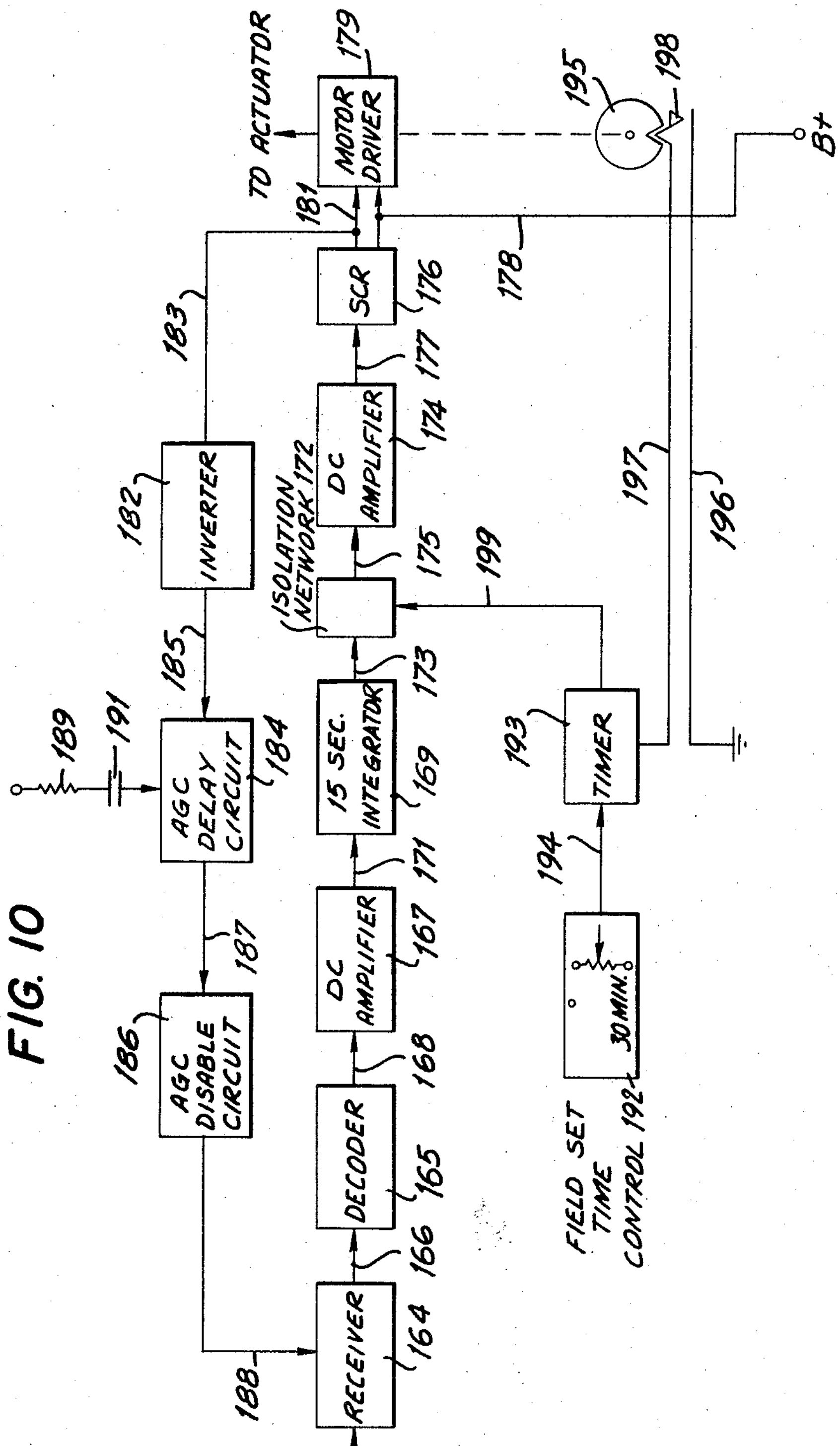

FIG. 10

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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 passband for passing the rectified signal if it is in the passband 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 **12*a***, **12*b***, **12*c***, **12*d***, **12*e***, **12*f***, **12*g*** and **12*h***. Although eight satellite stations **12*a*** to **12*h*** are shown, any suitable number of said stations may be utilized in the system of the invention. The satellite stations **12*a*** to **12*h*** are strategically positioned to provide for the irrigation of a large area such as, for example, a golf course. The satellite stations **12*a*** to **12*h*** receive the radio signals transmitted by the central transmitter **11**. Each satellite station **12*a*** to **12*h*** is tuned to the same frequency as the others.

A plurality of actuators **13*a*** to **13*p*** 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 **13*a*** and **13*b*** are electrically connected to the satellite station **12*a***. Actuators **13*c*** and **13*d*** are electrically connected to the satellite station **12*b***. Actuators **13*e*** and **13*f*** are electrically connected to the satellite station **12*c***. Actuators **13*g*** and **13*h*** are electrically connected to the satellite station **12*d***. Actuators **13*i*** and **13*j*** are electrically connected to the satellite station **12*e***. Actuators **13*k*** and **13*l*** are electrically connected to the satellite station **12*f***. Actuators **13*m*** and **13*n*** are electrically connected to the satellite station **12*g***. Actuators **13*o*** and **13*p*** are electrically connected to the satellite station **12*h***. 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 **12*a*** to **12*h*** from their home position to the first of **11** steps. There are no other pulses transmitted by the central transmitter **11**. Each satellite station **12*a*** to **12*h*** 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 **12*a*** to **12*h*** 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 **13*a*** to **13*p*** 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 **13*a*** to **13*p***, 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 **14*aa*** to **14*ak*** are hydraulically connected to the actuator **13*a*** and valves **14*am*** to **14*aw*** are hydraulically connected to the actuator **13*b***. Valves **14*ba*** to **14*bk*** *are hydraulically connected to the actuator 13c* and valves **14*bm*** to **14*bw*** are hydraulically connected to the actuator **13*d***. Valves **14*ca*** to **14*ck*** are hydraulically connected to the actuator **13*e*** and valves **14*cm*** to **14*cw*** are hydraulically connected to the actuator **13*f***. Valves **14*da*** to **14*dk*** are hydraulically connected to the actuator **13*g*** and valves **14*dm*** to **14*dw*** are hydraulically connected to the actuator **13*h***.

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

The central transmitter **11** transmits tone coded initiating signals to the satellite stations **12*a*** to **12*h*** 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 manually or 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 **12***a* to **12***h* 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 **12***a* to **12***h* 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 **12***a* to **12***h*. 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 **35***a* to **35***k* via a ¼ inch polyethylene control tube **30***a* 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 **35***m* to **35***w* via a ¼ inch polyethylene control tube **30***b* and controls said valves and the supply of water to corresponding sprinkler heads. A sprinkler head is hydraulically coupled to each of the valves **35***a* to **35***k* and **35***m* to **35***w*. Each of the valves **35***a* to **35***k* and **35***m* to **35***w* 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 **12***a* to **12***h* 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 **38***a*, **38***b*, 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 aforedescribed 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 activator 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 **38***a*, **38***b*, and so on, are open, the corresponding sprinkler heads **37***a*, **37***b*, 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 **47***a* 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 Encyclopedia 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 **68***a* and **68** *b* 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 **68***a* is directly connected to the gate electrode of the FET **62** and the relay contact **68***b* 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 diodes **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 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 **122*a***. The relay winding **121** controls the operation of relay contacts **121*a*** and **121*b***. The relay contact **121*a*** is connected to the gate electrode of the FET **106** and the relay contact **121*b*** 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 **121*a*** and **121*b*** to close the circuit between them. This discharges the capacitor **118**. When the relay winding **121** is deenergized, it opens the relay contacts **121*a*** and **121*b*** 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 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 **122***a* 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 Q, 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 connection **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 **159***a* operable by a pushbutton **159***b*. One end of the switch arm **159***a* is connected to the voltmeter **157** and the other end is movable between contacts **159***c* and **159***d*. The contact **159***c* is connected to the jack connection **5** via the diode **161** and the contact **159***d* 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 to 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 **162***a* operable by a pushbutton **162***b*. One end of the switch arm **162***a* is electrically connected to the jack connection **4** and the other end is movable between contacts **162***c* and **162***d*. The contact **162***c* is open. The contact **162***d* 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 H (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 **163***a* operable by a pushbutton **163***b*. One end of the switch arm

163 is electrically connected to a jack connection 3 of the group P1 and to the corresponding end of the switch arm **162***a* of the switch **162**. The other end of the switch arm **163***a* is movable between contacts **163***c* and **163***d*. The contact **163***c* is open. The contact **163***d* 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 delay circuit **184** via a lead **185**. The output of the AGC delay 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.

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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