(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 January 2001 (11.01.2001)

PCT

(10) International Publication Number
WO 01/01752 A2

(51) International Patent Classification[7]: A01C

(21) International Application Number: PCT/IL00/00388

(22) International Filing Date: 4 July 2000 (04.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
130791 4 July 1999 (04.07.1999) IL

(71) Applicant *(for all designated States except US)*: **ARAD-COM, INC.** [US/US]; 9 East Lockerman Street, Dover, DE 19901 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **AMIT, Uri** [IL/IL]; Hashalom Street 44, 43561 Ra'anana (IL).

(74) Agent: **EITAN, PEARL, LATZER & COHEN-ZEDEK**; Gav Yam Center 2, Shenkar Street 7, 46725 Herzlia (IL).

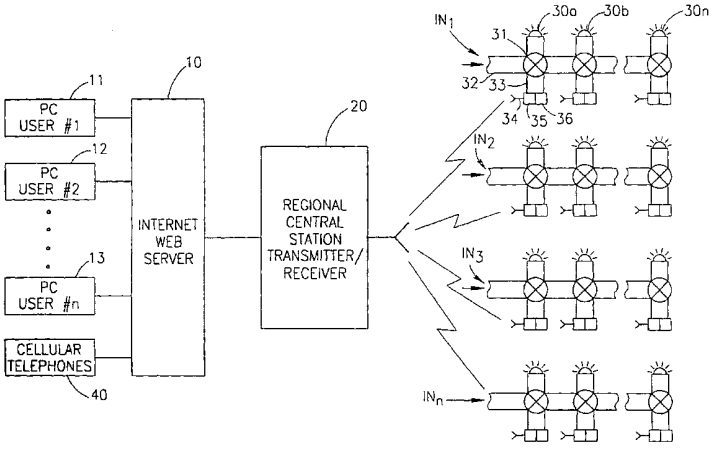
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *Without international search report and to be republished upon receipt of that report.*

*[Continued on next page]*

(54) Title: IRRIGATION METHOD AND SYSTEM




(57) Abstract: A method of controlling a plurality of irrigation networks, each including one or more water irrigation devices, by a plurality of irrigation network operators in accordance with irrigation programs individual to each network, is provided. The method includes the steps of equipping each water irrigation device with an individually-identifiable electrically-controlled valve, and with a wireless receiver for controlling its respective valve; allocating a web site in the Internet communication system for use by the operators to enter their respective irrigation programs, each program specifying "open" and "close" commands, the time each command is to be executed, and the identity of the water irrigation device of a network to receive the command; providing a regional control station having a wireless transmitter communicating with the wireless receivers of all the water irrigation devices; and controlling the regional control station transmitter to transmit the "open" and "close" commands at the proper times, and encoded with the identity of the water irrigation device to receive the command, according to the respective program entered in the Internet web site.

WO 01/01752 A2

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# IRRIGATION METHOD AND SYSTEM

## FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a method and system for irrigating plants and particularly for controlling irrigating networks each including one or more water irrigating devices.

Many irrigation control systems have been developed and are in use, both manual control systems and automatic control systems. Manual control systems include valves which are manually controlled so as to supply the irrigating water to the water irrigation devices as and where desired; whereas automatic control systems generally include a computer which is programmed according to a desired irrigation schedule, and which controls the water irrigation devices by electrical signals transmitted to such devices. The water irrigation devices include control valves, generally solenoid-actuated valves, which are actuated in accordance with the respective command signals. The automatic control systems may be wired systems in which the commands are transmitted via wires to the respective water irrigation devices, or wireless systems, in which the commands are transmitted in a wireless manner, e.g., via RF, to the water irrigation devices.

The automatic control systems now in use generally include a dedicated computer for each network of water irrigation devices to be controlled. The irrigation program may vary from day-to-day, week-to-week or month-to-month, with respect to the irrigation periods, the intervals between irrigation periods, and the times of the day in which the irrigation is to be

effected. The use of a separate dedicated computer for each irrigation network is costly. The Programming of each such computer may be very inconvenient, particularly if the computer is located remotely from the operator. Moreover, if it becomes necessary or desirable to make a change in the irrigation program because of special circumstances (e.g., temperature or humidity conditions, plant stress, etc.), making such changes generally requires the user to access the computer, which is not always convenient particularly if the computer is located at a distance from the operator.

## OBJECT AND BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide a method and system for irrigation having advantages in one or more of the above respects.

According to one aspect of the present invention, there is provided a method of controlling a plurality of irrigation networks, each including one or more water irrigation devices, by a plurality of irrigation network operators in accordance with irrigation programs individual to each network, comprising: equipping each water irrigation device with an individually-identifiable electrically-controlled valve, and with a wireless receiver for controlling its respective valve; allocating a web site in the Internet communication system for use by the operators to enter their respective irrigation programs, each program specifying "open" and "close" commands, the time each command is to be executed, and the identity of the water irrigation device of a network to receive the command; providing a regional control station having a wireless transmitter communicating with the wireless receivers of all the water irrigation devices; and controlling the regional control station transmitter to transmit the "open" and "close" commands at the proper times, and encoded with the identity of the water irrigation device to receive the command, according to the respective program entered in the Internet web site.

According to further features in the preferred embodiment of the invention described below, each water irrigation device is also equipped with a wireless transmitter for transmitting the current status of the respective water irrigation device; and the regional control station is also equipped with a wireless receiver for receiving the current status of the water irrigation devices and for

communicating the status, via the Internet web site, to the operator of the respective irrigation network.

Each operator or user may enter the individual irrigation programs of the respective irrigation network via a personal computer communicating with the Internet web site. Each operator may also modify the irrigation program, whenever necessary or desirable, via a cellular telephone or other equipment communicating with the Internet web site.

According to another aspect of the present invention, there is provided an irrigation system, comprising: a plurality of water irrigation networks each including one or more water irrigation devices, each device having its own identity, its own electrically-controlled valve, and its own wireless receiver; an Internet web site allocated for use by operators of the irrigation networks to enter individual irrigation programs for controlling the water irrigation devices of the networks; input devices for the operators enabling each operator to input its respective irrigation program, specifying "open" and "close" commands, the time each command is to be executed, and the identity of the water irrigation device of a network to receive the command; and a regional control station having a wireless transmitter communicating with the receivers of all the water irrigation devices of all the networks, the transmitter of the regional control station being controlled by the Internet web site to transmit the "open" and "close" commands, at the proper times, including the identity of the water irrigation device of a network to receive the command, according to the respective program entered into the Internet web site.

It will thus be seen that the method and system of irrigation according to the present invention provides a number of important advantages over the conventional methods and systems. Thus, the method enables the existing, and rapidly-growing, Internet communication system to be used also for controlling a plurality of irrigation networks in an automatic and pre-programmed manner, without the need for installing a separate dedicated computer for each network. Since most households today are already equipped with personal computers communicating with the Internet, the irrigation network can generally be installed without the expense of an additional computer. Moreover, the irrigation network can be changed as desired by merely adding, removing or changing the arrangement of the water irrigation devices in the field. Further, the irrigation program can also be conveniently introduced or changed via the Internet web site. In addition, the method enables a single regional control station, which may be an existing pager or cellular telephone station, to individually control many water irrigation devices of many irrigation networks according to individual programs for each network. Further, besides enabling each individual irrigation program to be entered in a very convenient manner, it also enables each program to be modified or overridden whenever necessary according to changing conditions.

Further features and advantages of the invention will be apparent from the description below.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a block diagram illustrating one form of irrigation system constructed in accordance with the present invention;

FIG. 2 is a block diagram illustrating one form of regional control station which may be included in the system of FIG. 1;

FIG. 3 is a block diagram illustrating one form of water irrigation device control circuit that may be included in the system in FIG. 1; and

FIG. 4 is a block diagram illustrating a cellular telephone which may be used for changing or overriding an irrigation program if and when needed according to changing conditions.

## DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1, illustrates one form of water irrigation system constructed in accordance with the present invention for controlling a plurality of water irrigation networks $IN_1$ --$IN_n$, each including one or more water irrigation devices, such as sprinklers, drippers, sprayers, or the like, as may be located in different locations, such as in parks, gardens, fields, households, etc., all within a clearly defined region. The water irrigation devices in the different networks would normally be controlled by different users or operators according to different programs each individual to a respective network.

According to the present invention, the Internet communication system is used for controlling the water irrigation devices. A web site in the Internet is allocated for this purpose by providing a server, as schematically shown by block 10 in FIG. 1, for use by a plurality of users or irrigation operators to enter their individual irrigation programs via their respective personal computers, or other means for communicating with the Internet, as schematically shown at 11, 12 and 13.

The system illustrated in FIG. 1 further includes a regional control station, generally designated 20, having a wireless transmitter / receiver for establishing two-way communication with all the water irrigation devices in the respective region to be controlled by the Internet web site.

Each irrigation network operator may use its personal computer 11 – 13 for communicating with the Internet web server 10 such as to control, via the regional control station 20, all the water irrigation devices within the respective region in accordance with an irrigation program specific to the

respective network; and such an irrigation program will be automatically executed by the Internet web server 10 via the regional control station 20. Thus, each program entered by a user will specify the "open" and "close" command, the time each command is to be executed, and the identity of the water irrigation device in a particular network to be controlled by the respective command; and this information is used by the Internet web server 10, via the regional control station 20, to control the various water irrigation devices within that region according to the respective program.

FIG. 2 more particularly illustrates the construction of the regional control station 20. As shown in FIG. 2, it includes: an input interface 21 interfacing with the Internet web server 10; an encoder 22 for encoding the command and identification data inputted from the Internet web server; a modulator 23 for modulating the command and identification data onto a carrier wave; and a transmitter 24 for transmitting the modulated carrier wave via an antenna 25. Each command is transmitted to all the water irrigation devices of all the irrigation networks within the region, but is effective to control only the water irrigation device identified in the respective command in accordance with the respective command.

The communication between the regional control station 20 and the water irrigation devices is bi-directional, to enable each water irrigation device not only to receive the transmitted commands, but also to inform the regional control station 20 as to the status of the respective water irrigation device, i.e., whether it is in an open condition or a closed condition. This may be done for purposes of confirming to the Internet web server that the transmitted

command has been properly executed, and / or, to advise the irrigation network operator as to the current status of the water irrigation devices in the respective network, if and when polled by the operator via the Internet web server.

For purposes of enabling each water irrigation device to advise the Internet web server of the status of the respective device, the regional control station 20 further includes: a receiver 26 connected to the antenna 25 for receiving the status report from the water irrigation device; a demodulator 27 for demodulating the received signal; a decoder 28 for decoding the identification and status data received by the receiver; and an output interface 29 for interfacing with the Internet web server 10.

As shown in FIG. 1, each irrigation network $IN_1 - IN_n$ includes one or more water irrigation devices, shown as 30a – 30n for network $IN_1$. Each water irrigation device includes a hydraulic valve 31 connected to a water supply line 32 and controlled by a solenoid 33 in accordance with the signal received on its antenna 34 from the regional control station 20. The signal received by the antenna 34 of the respective control valve 31 is processed by a control circuit, schematically shown at 35 in FIG. 1, and more particularly illustrated in the block diagram of FIG. 3. Each control circuit 35 includes its own power supply, in the form of a battery 36 for supplying power to the control circuit 35 and to the respective solenoid 33.

As more particularly shown in FIG. 3, the control circuit 35 for each of the water irrigation device valves 31 includes a receiver 35a for receiving the signal from the respective antenna 34; a demodulator 35b for demodulating

the received signal; and a decoder 35c for decoding the command and identification information of the respective signal. Thus, if the received signal identifies the valve 31 for the respective water irrigation device 30a of the irrigation network $IN_1$, the command signal from decoder 35c is applied to the valve solenoid 33 to actuate the valve 31 of water irrigation device 30a in accordance with the command signal. Thus, if the received signal for the respective water irrigation device is an "open" command, the valve solenoid 33 is activated to open the respective valve 31', and if the signal is a "close" command, the solenoid is activated to close the valve.

For purposes of informing the Internet web server 10, via the regional control station transmitter 20, as to the current status of the respective valve 31, the circuit 35 for each water irrigation device (e.g., 30a – 30n in network $IN_1$) further includes an encoder 35d for encoding the status and identification of the respective valve; a modulator 35e for modulating this information onto a carrier wave; and a transmitter 35f for transmitting this information via the antenna 34 to the regional control station 20, which station, in turn, transmits this information to the Internet web server 10. Thus, the Internet web server is automatically informed of the status of each valve immediately upon executing an "open" or "close" command thereby confirming to the Internet web server that the command was properly received and executed by the identified water irrigation device. This status information is also available to the user (i.e., the operator of the respective irrigation network), via the user's personal computer 11 – 13, whenever desired, e.g., by

merely having the Internet web server poll the status of the water irrigation devices of the respective irrigation networks.

Each user may use its respective personal computer 11 – 13 for this purpose, or any other means for communicating with the Internet web server, such as by the use of a cellular telephone as shown schematically at 40 in FIG. 1. The user may also use the personal computer 11 – 13, or a cellular telephone 40, for modifying an inputted program, or for overriding a particular command, according to circumstances that may change during the programming period. For example, on exceptionally hot or dry days, the user may wish to increase or change the irrigation period. The cellular telephone 40 may be conveniently used for this purpose. FIG. 4 is a block diagram illustrating the basic construction of such a cellular telephone programmed to enable it to be used for this purpose.

Thus, the cellular telephone 40 illustrated in FIG. 4 includes a receiver / transmitter for communicating with the Internet web server; a micro-controller 42; a keyboard input 43 to the micro-controller; a memory 44 for storing addresses and other information, as well as the controller program; and a display 45 for displaying a particular address or other data inputted by means of the keyboard 43. Thus, to address a particular water irrigation device for purposes of polling its status, or for purposes of overriding a command in the respective irrigation program, the micro-control 42 would be programmed to enable the user to input the command and to identify the respective water irrigation device by means of the keyboard 43, and then to display the identity of the water irrigation device, as well as the command, in

the display 45, before the command is transmitted to the Internet web server 10 by depressing the "enter" key on the keyboard.

The regional control station 20 merely serves as a transmitter and receiver, for transmitting commands received from the Internet web server 10 to the water irrigation devices in its region, and for receiving status reports from the water irrigation devices for forwarding to the Internet web server. Accordingly, the regional control station 20 may be a relative simply system such as a pager regional control station. Since the Internet system is global, it will be appreciated that the irrigation system could include a plurality of such regional control stations, each allocated to and communicating with a plurality of the water irrigation devices via the Internet web server, and each accessible for programming, over-riding, or polling from virtually any location throughout the World.

While the invention has been described with respect to one preferred embodiment, it will be appreciated that this is set forth merely for purposes of example, and that many other variations, modifications and applications of the invention may be made. Rather the scope of the present invention is defined only by the claims which follow:

## CLAIMS

1. A method of controlling a plurality of irrigation networks, each including one or more water irrigation devices, by a plurality of irrigation network operators in accordance with irrigation programs individual to each network, comprising:

equipping each water irrigation device with an individually-identifiable electrically-controlled valve, and with a wireless receiver for controlling its respective valve;

allocating a web site in the Internet communication system for use by the operators to enter their respective irrigation programs, each program specifying "open" and "close" commands, the time each command is to be executed, and the identity of the water irrigation device of a network to receive the command;

providing a regional control station having a wireless transmitter communicating with the wireless receivers of all said water irrigation devices; and

controlling said regional control station transmitter to transmit said "open" and "close" commands at the proper times, and encoded with the identity of the water irrigation device to receive the command, according to the respective program entered in said Internet web site.

2. The method according to claim 1, wherein: each water irrigation device is also equipped with a wireless transmitter for transmitting the current status of the respective water irrigation device; and

wherein said regional control station is also equipped with a wireless receiver for receiving the current status of the water irrigation devices and for communicating the status, via said Internet web site, to the operator of the respective irrigation network.

3. The method according to either of claims 1 or 2, wherein each operator enters the respective irrigation program via a personal computer communicating with said Internet web site.

4. The method according to any one of claims 1 - 3, wherein each operator may also modify an entered irrigation program via a cellular telephone communicating with the Internet web site.

5. The method according to any one of claims 1 - 4, wherein there are a plurality of said regional control stations, each allocated to, and communicating with, a plurality of said water irrigation devices via said Internet web site.

6. An irrigation system comprising:

a plurality of water irrigation networks each including one or more water irrigation devices, each device having its own identity, its own electrically-controlled valve, and its own wireless receiver;

an Internet web site allocated for use by operators of said irrigation networks to enter individual irrigation programs for controlling the water irrigation devices of the networks;

input devices for said operators enabling each operator to input its respective irrigation program, specifying "open" and "close" commands, the time each command is to be executed, and the identity of the water irrigation device of a network to receive the command; and

a regional control station having a wireless transmitter communicating with the receivers of all said water irrigation devices of all said networks, said transmitter of the regional control station being controlled by said Internet web site to transmit said "open" and "close" commands, at the proper times, including the identity of the water irrigation device of a network to receive the command, according to the respective program entered into said Internet web site.

7. The irrigation system according to claim 6, wherein each of said water irrigation devices also has its own battery power supply.

8. The irrigation system according to either of claims 6 or 7, wherein said electrically-controlled valve in each of said water irrigation devices is a solenoid-controlled valve.

9. The irrigation system according to any of claims 6 – 8, wherein: each water irrigation device is also equipped with a wireless transmitter for transmitting the current status of the respective water irrigation device; and wherein said regional control station is also equipped with a wireless receiver for receiving the current status of the water irrigation devices and for communicating said

status, via said Internet web site, to the operator of the respective irrigation network.

10. The irrigation system according to any one of claims 7 – 9, wherein said input devices include a personal computer for at least some of said users communicating with said Internet web site.

11. The irrigation system according to any one of claims 7 – 10, wherein said input devices include a cellular telephone for at least some of said users communicating with said Internet web site.

12. The irrigation system according to any one of claims 7 – 11, wherein said regional control station includes an input interface with said Internet web site, an encoder for encoding the commands to be executed and the identity of the water irrigation device of a network to receive the command, a modulator for modulating said encoded commands and said identity of the water irrigation device, and a transmitter for transmitting said modulated, encoded commands and said identities; and

wherein each of said water irrigation devices includes a receiver, a demodulator, and a decoder for receiving, demodulating and decoding said received commands and for controlling the valve of the respective water irrigation device in accordance with said command.

13. The irrigation system according to claim 12, wherein each of said water irrigation devices further includes an encoder, a modulator, and a wireless transmitter for encoding, modulating and transmitting the current status of the valve of the respective water irrigation device; and

wherein said regional control station includes a wireless receiver, a demodulator, a decoder and a web site interface for receiving, demodulating, decoding and recording the current status of the respective water irrigation devices.

14. The irrigation system according to any one of claims 6 – 13, wherein there are a plurality of said regional control stations, each allocated to, and communicating with, a plurality of said water irrigation devices via said Internet web site.

15. A method of controlling networks of water irrigation devices according to any one of claims 1 – 5, substantially as described with reference to and as illustrated in the accompanying drawings.

16. The water irrigation system according to any one of claims 6 – 14, substantially as described with reference to and as illustrated in the accompanying drawings.

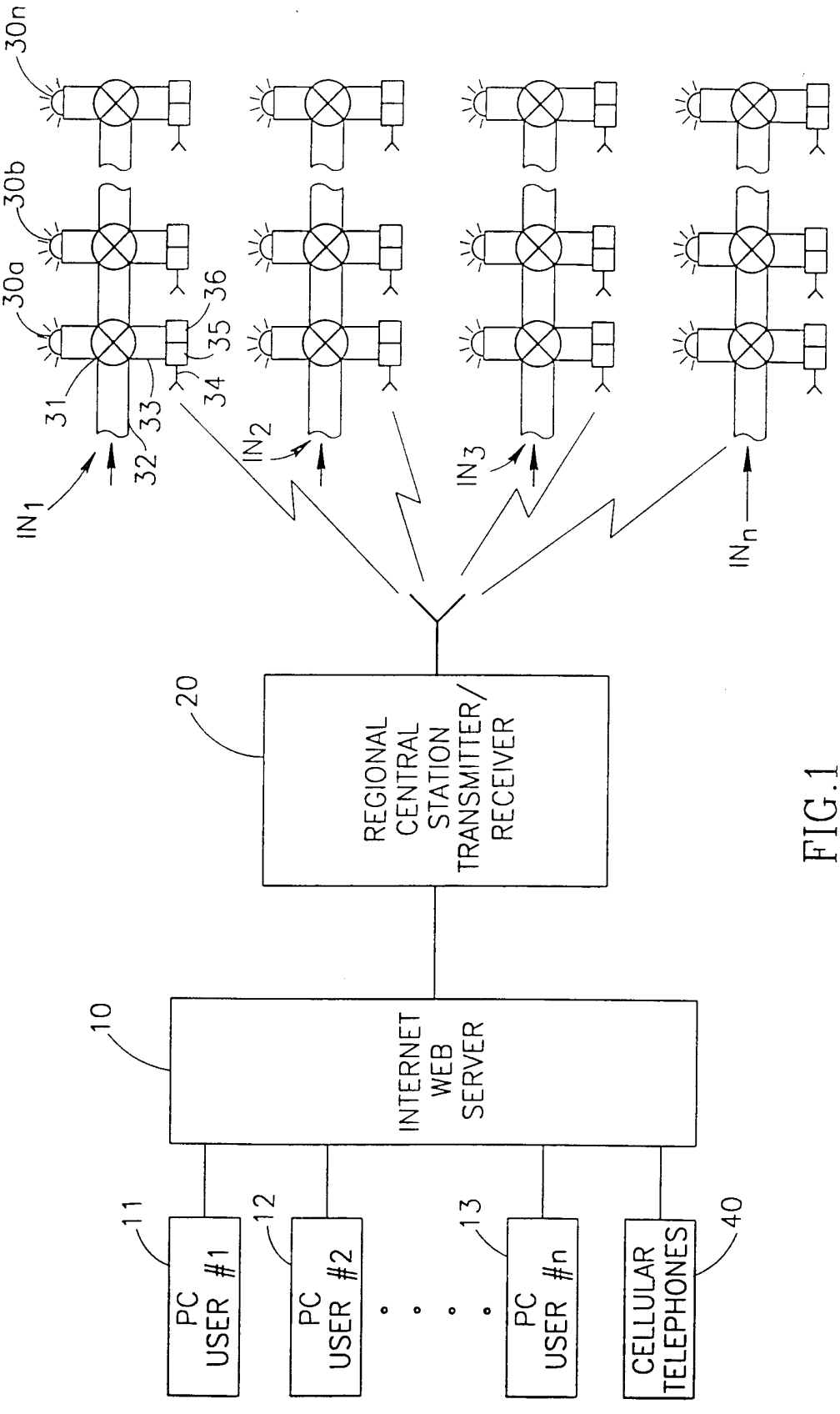

30n
30b
30a
36
35
34
33
32
31
IN1
IN2
IN3
INn
20
REGIONAL CENTRAL STATION TRANSMITTER/ RECEIVER
10
INTERNET WEB SERVER
11
12
13
40
PC USER #1
PC USER #2
PC USER #n
CELLULAR TELEPHONES

FIG.1

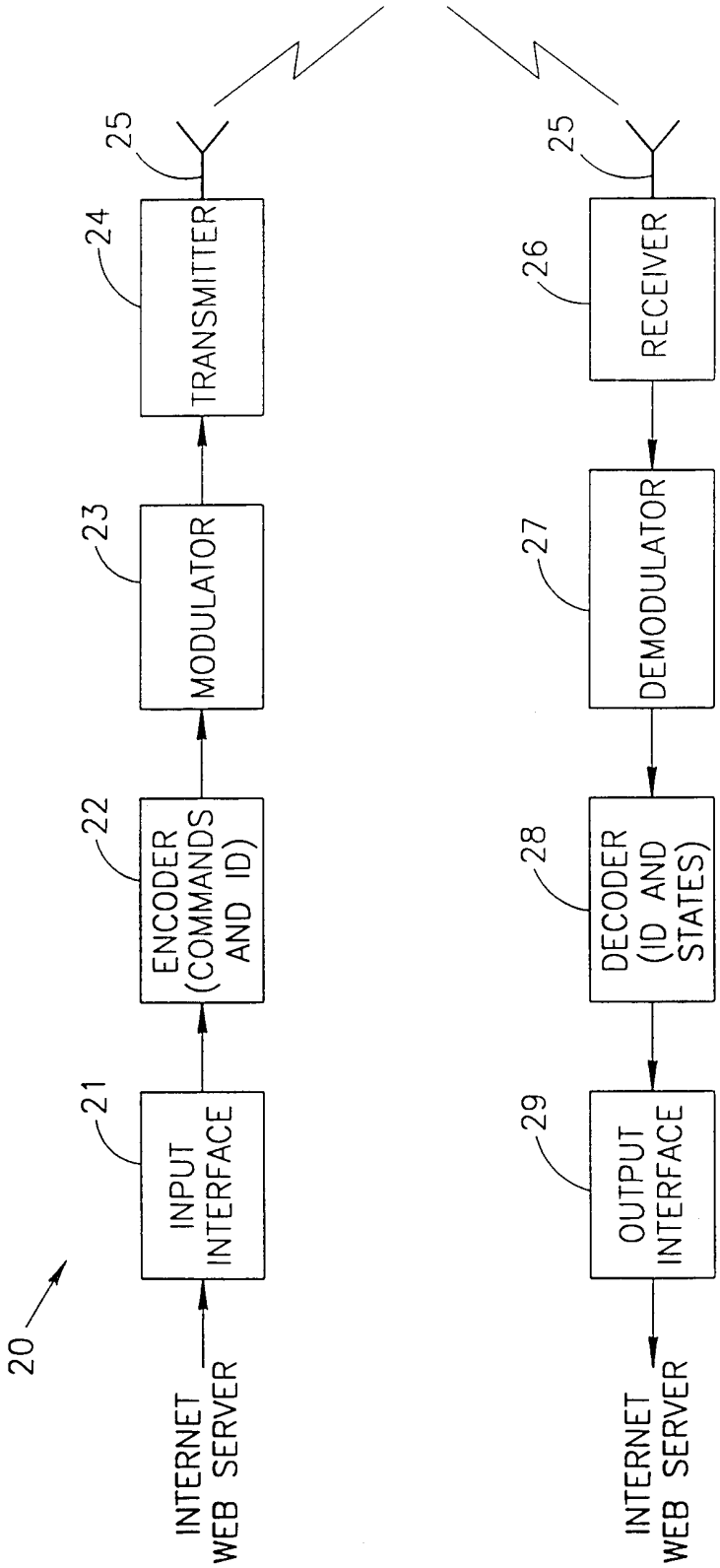

20
INTERNET WEB SERVER
21
INPUT INTERFACE
22
ENCODER (COMMANDS AND ID)
23
MODULATOR
24
TRANSMITTER
25
25
RECEIVER
26
DEMODULATOR
27
DECODER (ID AND STATES)
28
OUTPUT INTERFACE
29
INTERNET WEB SERVER

FIG.2

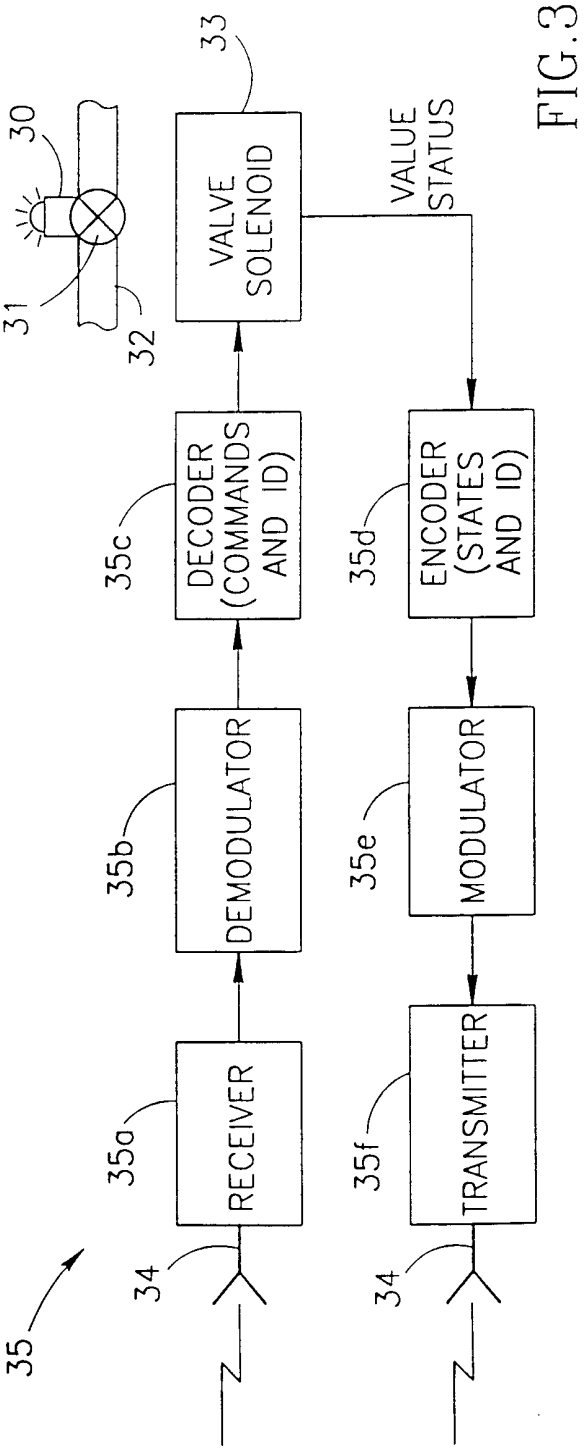

35
34
35a
RECEIVER
35b
DEMODULATOR
35c
DECODER (COMMANDS AND ID)
31
30
32
33
VALVE SOLENOID
VALUE STATUS
35d
ENCODER (STATES AND ID)
35e
MODULATOR
35f
TRANSMITTER
34

FIG.3

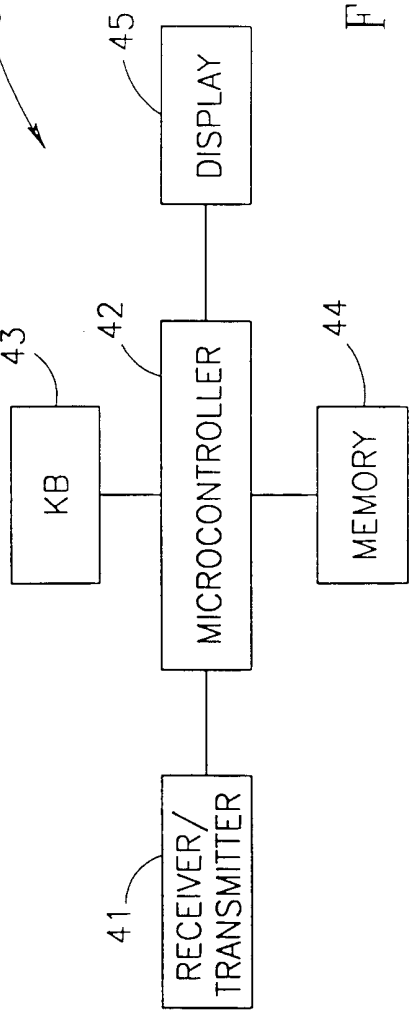

40
41
RECEIVER/ TRANSMITTER
42
MICROCONTROLLER
43
KB
44
MEMORY
45
DISPLAY

FIG.4