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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 December 2001 (27.12.2001)

PCT

(10) International Publication Number
WO 01/99465 A2

(51) International Patent Classification[7]: H04Q 9/00

(21) International Application Number: PCT/US01/41045

(22) International Filing Date: 19 June 2001 (19.06.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/596,501 19 June 2000 (19.06.2000) US

(71) Applicant: INTRINZIX TECHNOLOGIES, INC. [US/US]; c/o Sheldon Jacobs, Snyder, Weiner, Weltchek et al, 1829 Reisterstown Road, Suite 100, Woodholme Center, Baltimore, MD 21208 (US).

(72) Inventors: AGUAYO, Erwin; 6483 Summer Cloud Way, Columbia, MD 20145 (US). CROWLEY, Steven, J.; 614 Lexington Place, N.E., Washington, DC 20002 (US).

(74) Agent: ZOLTICK, Martin; Zoltick Technology Law Group, PLLC, 21515 Ridgetop Circle, Suite 200, Loudoun Tech Center, Sterling, VA 20166 (US).

(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, 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, TR), 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*

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.

WO 01/99465 A2

(54) Title: HYBRID BI-DIRECTIONAL COMMUNICATION SYSTEM FOR MONITORING A POWER DELIVERY SYSTEM

(57) Abstract: The present invention is directed to a communication system that can be utilized in the reading and reporting of data from utility meters such as power usage monitoring meters in which a control station transmits signals to a utility meter. The communication system features a central transmitting/receiving station (CTS) for relaying a first signal generated by the control station to a utility meter and for relaying a second signal to the control station, a first response unit for processing and transmitting the first and second signals and a second response unit associated with the utility meter for wirelessly transmitting the second signal to the first response unit in response to the first signal. The first signal comprises command signals to provide a reading to the utility meter and the second signal includes data representing the meter reading, wherein the first response unit has at least one utility meter associated therewith.

Hybrid Bi-directional Communication System For Monitoring A Power Delivery System

Related Applications

This application is a continuation-in-part of currently pending Application Serial Number 09/248,270 filed on February 11, 1999 and entitled "Two-Way Communication System" which is a continuation of currently pending Application Serial Number 08/883,035 filed on June 26, 1997 and entitled "Wireless Two-Way Communication System Between Center and User Stations" which is a continuation of Application Serial Number 08/665,473 filed on June 18, 1996 and entitled "Wireless Two-Way Communication System Between Center and User Stations" now U.S. Patent Number 5,675,372 issued on October 7, 1997, which is a continuation of Application Serial Number 08/406,529 filed March 20, 1995 and entitled "Wireless Two-Way Transmission Between Center and User Stations Via a Relay" now U.S. Patent Number 5,555,015 issued on September 10, 1996.

Background of the Invention

1. Field of the Invention

The present invention is directed to a two-way communication system and more particularly to a communication system that may be utilized in the reading and reporting of data from utility meters such as power usage monitoring meters.

2. Discussion of the Background

In reading and reporting utility usage such as electricity for example, the most common method of performing these functions is sending one or more individual "meter readers" in a fleet of trucks to read the utility meters. By comparing the present reading with a previous reading, a determination is made as to how much power was consumed between the readings in the case of electricity usage for example.

A utility meter is shown in Fig. 7. The meter 700 includes an incrementally rotating dial 710 which displays a value indicating the amount of watts or kilowatts that have been consumed by a power consuming entity 720 to which the meter is attached. The power consuming entity 720 may be, among other things, a home, an office, a building or an apartment. The value in display 710 increases continuously and resets itself when its upper numerical limit is reached. That is, for a meter with a five digit capability, the value increases to 99999 and then rolls over to 0. More recently, electronic (or, digital) meters such as the EPRI SE-240 digital meter have been utilized which display the power usage in a digital form. The digital meters also reach a reading of zero once the upper limit of the meter is reached (e.g., after 99999 with a five digit meter). The SE-240 has the ability to disconnect power as well as a built-in time capability in the form of a clock.

Due to the recent deregulation of the utility industry, traditional utility companies no longer have geographical monopolies for providing electricity. As a result, these companies are forced to become more efficient in order to remain competitive with an expected host of providers. Utility providers need to monitor power usage on a more continuous and current basis than before. This type of monitoring enables the utility providers to make critical decisions pertaining to where the power will come from as the price of power varies greatly based on several factors. These factors may include weather patterns, economic conditions, etc. Such traditional activities as meter reading, connecting and disconnecting of service, payment collections and other related services are being outsourced. Technology is expected to play a large role in the industry's drive toward the above stated efficiency and competitiveness.

Meter reading is one of the above mentioned activities that is already automated to some degree. Technology providers such as CellNet, Whisper, Schlumberger and Itron all currently have some form of technology solutions directed to automated meter reading (AMR). These solutions include hand-held data devices, wireless drive-by systems, hardwire and fixed wireless networks and satellite networks. Although these technology solutions are offered, currently less than 2% of the meters are being read using these AMR solutions. The reasons for this low utility rate is that these technology solutions suffer from a variety of deficiencies.

Hand-held and wireless drive-by systems require extensive manpower which leads to an inefficiency and higher cost of operations for the utility companies. These systems limit the frequency with which the meter can be read and a physical number of lines that can be connected or disconnected over a period of time such as a day. Hardwire systems are fairly expensive to implement and maintain. In addition, hardwire systems have limitations and service priorities associated with the other communications services that may also be using the hardwire network. Fixed wireless networks have proven costly to deploy; they are also limited in terms of coverage. Satellite networks are also expensive to implement due to the costs of the uplink hardware that has to be attached to each meter from which a reading is performed. Data transmission costs are also high in this case.

SUMMARY OF THE INVENTION

The system of the present invention overcomes the limitations described above by providing an efficient and cost effective solution for monitoring and controlling utility meters in power delivery systems. The present invention obviates the need for mobile units or meter readers having to roam throughout a geographical area for recording utility meter readings. The need for hardwired communication is also eliminated with the present invention which facilitates wireless communication of data.

Accordingly, an object of the present invention is to provide a novel communication system for reporting power usage data to a central location.

Another object of the present invention is to provide a novel communication system for communicating control information from a central location to a utility meter.

A further object of the present invention is to provide a novel communication system which includes a satellite component and a terrestrial component.

An additional object of the present invention is to provide a novel communication system for use with a utility meter which allows more efficient monitoring of power loss.

Another additional object of the present invention is to provide a novel communication system for use with a utility meter which allows more efficient monitoring of power outages.

A further additional object of the present invention is to provide a novel communication system for use with a utility meter which facilitates the efficient testing for power leakage.

A yet additional object of the present invention is to provide a utility meter control system which can selectively control delivery of power to users.

A yet another object of the present invention is to provide remote connection and disconnection of utility service.

A yet further object of the present invention is to provide for detection of defective utility meters.

The objectives of the present invention are achieved by a novel communication system for use with a utility meter in which a power control station transmits and receives signals to and from utility meters using a hybrid satellite and terrestrial communication network. According to exemplary embodiments of the present invention, a central transmitting/receiving station (CTS) transmits first signals generated at a power control station to a first response unit and receives second signals from the first response unit. The first response unit receives the first signals and in response thereto, transmits second signals to be received by the CTS. The first response unit may be connected to the utility meter through which power usage is recorded. The second signals include information pertaining to power usage as recorded by a utility meter. In preferred embodiments, the CTS is located aboard a geosynchronous satellite.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 illustrates a conventional cable system;

FIG. 2 illustrates an overview of the communication system of the present invention;

FIG. 3 illustrates the details of a central transmitter/receiver shown in FIGs. 2 and 8;

FIG. 4 illustrates the details of a cell relay shown in FIGs. 2 and 8;

FIG. 5 illustrates the details of a micro-response transmitting unit (M-RTU) shown in FIGs. 2 and 8;

FIG. 6 illustrates the details of a response transmitting unit (RTU) shown in FIGs. 2 and 8;

FIG. 7 illustrates a conventional power usage monitoring meter;

FIG. 8 illustrates the communication system of FIG. 2 as modified for application in the monitoring and reporting of power usage according to exemplary embodiments of the present invention;

FIG. 9 illustrates a variation of the communication system of FIG. 8;

FIG . 10 illustrates a modified micro response transmitting unit (mM-RTU) as shown in FIG. 8 according to exemplary embodiments of the present invention; and

FIG. 11 illustrates an overall view of the communication system of the present invention.

DETAILED DESCRIPTION

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIG. 2 thereof, there is shown an overview of the communication system of the present invention.

The present invention is essentially directed to a wireless control system which can be retrofitted onto existing systems and provide a control or a monitoring of the existing systems. One preferred embodiment of the system of the present invention is as a complement to an existing cable television system, and this preferred embodiment is discussed in detail below. However, it is to be understood that the system of the present invention can find application in other types of systems which would benefit from a wireless monitoring or control.

As is shown in FIG. 2, the communication system of the present invention may operate in conjunction with the conventional cable transmission system. According to the present invention, a central transmitter/receiver unit 85 is connected to the cable control station 5. Furthermore, connected to most of the amplifiers 10, standby batteries 70, cell relay 80 and taps

15 is a respective micro-response transmitting unit (M-RTU) 95(n). Connected to each of the user units 20 is a response transmitting unit (RTU) 90(n).

According to the present invention, the cable control station 5 can generate various signals which can be wirelessly transmitted by the central transmitter/receiver 85. The signals transmitted by the central transmitter/receiver 85 are then received by the micro-response transmitting units 95. As the micro-response transmitting units 95 are connected to the amplifiers 10, standby batteries 70, cell relay 80 and taps 15, these micro-response transmitting units can generate information as to the operation of the amplifiers 10, standby batteries 70, cell relay 80 and taps 15, and can also control the amplifiers 10, standby batteries 70, cell relay 80 and taps 15.

FIG. 3 shows a specific configuration of the central transmitter/receiver unit 85. As is shown in FIG. 3, the central transmitter/receiver unit 85 features a digital data computing device 340. This digital data computing device 340 may be formed by a higher-power computing device such as a Sun Microsystems workstation or a high-end personal computer such as a Pentium or 486 machine. This digital data computing device 340 is connected to the cable control station 5 and receives signals from the cable control station 5 and provides signals to the cable control station 5.

The signals to be transmitted by the central transmitter/receiver unit 85 are output from the digital data computing device 340 to a transmitter 330. The transmitter 330 includes a channel encoder 332 and a digital modulator 334. According to the present invention, different signals can be sent to different receiving units by an appropriate encoding. In the present invention each M-RTU 95(n) can have an individual address. In the digital data computing device 340, a specific address of selected M-RTUs 95 can be designated if only a selected number of the M-RTUs 95 are to be addressed. The channel encoder 332 is provided to insert error detection and correction information into the transmission data stream, for example by a known 1/2 rate convolution encoding algorithm such as implemented in circuits by Qualcomm or Stanford Telecom.

As an example of the operation of the present invention, one signal which may be generated by the cable control station 5 is a polling signal which polls whether the amplifier units 10, standby batteries 70, taps 15 or cell relay 80 are operating properly. In this situation only the M-RTUs 95(1) and 95(3) which are connected to the amplifiers 10 need to be addressed if the operability of amplifiers 10 is being polled, or M-RTU 95(5) if the cell relay is being polled, or M-RTU 95(6) if the standby batteries 70 are being polled. In the digital data computing device 340, a code signal can be provided which is unique to only the M-RTUs 95(1) and 95(3) connected to the amplifiers 10(1) and 10(3), so that only these designated M-RTUs 95(1) and 95(3) act on the amplifier polling signals generated by the cable station 5.

The channel encoded signals are then modulated in digital modulator 334 and are then provided to transmit/receive switch 310, which may be an electronic switch or coaxial relay. Transmit/receive switch 310 controls whether the central transmitter/receiver unit 85 is operating in a transmission mode or a reception mode. The signals are then radiated by antenna 300, which may be a conventional antenna such as manufactured by Decibel Products or Scala Electronics.

Antenna 300 also receives signals generated from the M-RTUs 95 and the RTUs 90. These signals are received in receiver 320 and are demodulated in digital demodulator 324 and decoded in digital data computing device 340. Channel decoder 332 is provided to use the error detection and correction information in the decoding to increase data integrity. The received signals after error detection and correction are then supplied to the digital data computing device 340, and are then provided to the cable control station 5.

As noted above, typical types of signals generated by the central transmitter/receiver unit 85 are polling signals. A polling signal is a signal which can poll a particular unit to determine its operational status. As discussed above, each M-RTU 95 and RTU 90 may have a unique address. As a result, in the present invention each polling signal may be specifically encoded in digital data computing device 340 to be directed to particular M-RTUs 95 or RTUs 90. As each of the polling signals is transmitted, each respective M-RTU 95 and RTU 90 will recognize its unique address identification signal in the polling signal, and process only the polling signals intended for the particular respective M-RTUs 95 and RTUs 90.

After each particular M-RTU 95 and RTU 90 receives its respective polling signal, each M-RTU 95 and RTU 90 can respond to the polling signal by generating response signals. These response signals are received by antenna 300 of the central transmitter/receiver 85 and are provided to the cable control station 5 through receiver 320 and digital data computing device 340. These response polling signals may indicate whether the devices to which the M-RTUs 95 or RTUs 90 are connected are functioning.

As discussed above as a specific example, the system of the present invention may periodically generate polling signals to determine whether the amplifiers 10, standby batteries 70 or cell relays 80 are operating properly. In this situation, the system of the present invention generates specific polling signals for each specific M-RTU 95(1) and 95(3) connected to an amplifier 10. When each of the M-RTUs 95(1) and 95(3) connected to the amplifier 10 receives such polling signals, each of the M-RTUs 95(1) and 95(3) determines whether the amplifier 10(1) and 10(3) connected thereto is properly functioning. Each M-RTU 95(1) and 95(3) then provides a unique response signal based on whether the specific amplifier 10(1) and 10(3) connected thereto is properly functioning. This response signal is then received by the central transmitter receiver unit 85 to provide the information as to the operation of the amplifier units 10 to the cable control station 5.

Another type of signal which can be transmitted by the central transmitter/receiver unit 85 is an actual control signal which can control an action of the taps connected to the M-RTUs 95 and RTUs 90.

For example, if a user 20 changes his/her level of cable service, e.g. to receive an extra premium or pay channel, the system of the present invention allows this change in service to be implemented remotely, i.e. without requiring a cable technician to physically change a cable connection at the appropriate tap 15. This operation of the present invention works as follows. Assume that the user 20(1) has changed his/her cable subscription package to receive an extra pay channel. The cable control station 5 of the present invention then generates a signal which is provided to central transmitter/receiver unit 85. This signal will specifically address the M-RTU 95(4) which is connected to the tap 15(2), which in turn controls the signals provided to user 20(1). This specific signal generated by the central transmitter/receiver unit 85 controls the tap 15(2) to allow the extra pay channel to be transmitted to the user 20(1). In this operation of the present invention, the tap 15(2) can be controlled, to operate as essentially a smart tap device, and this allows the cable system to remotely control the contents of the cable signal supplied to the user 20(1).

In this way, in the present invention the central transmitter/receiver 85 can generate control signals which can open or close a signal path or channel that a user 20 ultimately receives. Other types of signals which can be transmitted by central transmitter/receiver unit 85 are other polling signals, a signal which authorizes the M-RTUs 95 to conduct a signal strength test and report the results thereof, authorizing the M-RTUs 95 to automatically broadcast a signal indicating that a cable signal has dropped to levels below a predetermined threshold, or any other actions which may be required by the cable operation.

FIG. 4 shows the details of a cell relay 80, which is an optional element in the present invention. The function of the cell relay 80 is to receive signals from the individual M-RTUs 95 and RTUs 90, and to relay such signals to the central transmitter/receiver unit 85. The cell relay 80 can be connected to the central transmitter/receiver 85 either by wire or by a wireless communication. The use of cell relay 80 allows the M-RTUs 95 and RTUs 90 to be of a lower power than would otherwise be necessary if the M-RTUs 95 or RTUs 90 directly communicated with the central transmitter/receiver 85. The distance between the M-RTUs 95 and RTU units 90 to the cell relay 80 is generally much less than the distance from the M-RTUs 95 and RTUs 90 to the cell transmitter/receiver 85.

As is shown in FIG. 4, the cell relay 80 has a similar construction to the cell transmitter/receiver 85 in that the cell relay 80 features a transmitter 430 which includes a channel encoder 432 and digital modulator 434, a transmit/receive switch 410 and an antenna 400. On the reception side a receiver 420 includes a channel decoder 422 and a digital demodulator 424. The data transmitted and received also passes through a digital data computing device 440. This cell relay 80 operates essentially as a conduit for information on and its main objective is to ensure that the signals received are equivalent to the signals transmitted in content. In the present invention several cell relay units 80 may be dispersed throughout the cable franchise area.

The specifics of the M-RTUs 95 are shown in FIG. 5 of the present specification. Each of these M-RTU 95 features a transmitter 530 which includes a channel encoder 532 and a digital modulator 534, a receiver 520 which includes a channel decoder 522 and a digital demodulator 524, a transmitter/receive switch 510 and an antenna 500, similarly as discussed above with respect to the central transmitter/receiver 85 and cell relay 80. Furthermore, a digital data computing device 540 provides the transmission signals and receives the reception signals, which device may be a lower-power computing device such as a 4 bit or 8 bit microprocessor controller circuit card. These noted elements in the M-RTU unit 95 having similar operations as discussed above in that these elements transmit and receive data and can encode the data to be received by only specific M-RTUs 95.

As shown in FIG. 5, also connected to the digital data computing devices is an expansion port 595, a cable service on/off switch 560, a channel-specific interference generator or channel-specific trap 570, a cable signal presence/strength sensor 580 and a cable leakage receiver 590.

The expansion port 595 is essentially a port which can allow future expansion of the M-RTU 95. The cable service on/off switch 560 is a control device which can completely deactivate cable service. This switch 560 can be used, for example, if a user 20 cancels a cable subscription, then switch 560 can completely shut off cable service to the designated user 20.

Channel-specific interference generator or channel-specific trap 570 is used to control the level of service to the user 20. Cable systems will have different levels of service, for example, basic service, premium service and various premium channels. The channel-specific interference generator or channel-specific trap 570 controls which channels are actually fed to a user 20 based on the level of service which the user 20 has paid for. In this way, the M-RTU 95 can control the signals provided to the user 20.

Cable signal presence/strength sensor 580 monitors the amplitude of the cable signal provided to the user 20. The cable signal presence/strength sensor 580 can be activated either by a polling signal transmitted by the central transmitter/receiver unit 85 or can continuously monitor the cable signal presence/strength, and automatically activate the M-RTU 95 to output an indication signal if the cable signal amplitude falls below a predetermined level. It is also possible in the present invention to not attach M-RTUs 95 to the amplifiers 10. In this situation, the output of the cable signal presence/strength sensor 580 will provide an insight as to whether an amplifier 10 is malfunctioning.

The cable leakage receiver 590 can be used to continuously, or by a polling signal generated by central transmitter/receiver 85, monitor signal leakage or radiation, such as required by the FCC. As the M-RTUs 95 may typically be mounted on an auxiliary pole on which the tap 15 is mounted, and as these M-RTUs 95 may be provided throughout the cable service area, the cable leakage receiver 590 will provide a good indication of signal leakage or radiation.

The M-RTU device as shown in FIG. 5 is the device which will be typically connected to the taps 15. If a M-RTU device as is connected to an amplifier 10, standby batteries 70 or cell relay 80, such a device would not require the cable service on/off switch 560 or the channel-specific interference generator or channel-specific trap 570. In this situation, the M-RTUs 95 connected to the amplifiers 10, standby batteries 70 or cell relay 80 may only feature the expansion ports 595, the cable signal presence/strength sensor 580 and the cable leakage receiver 590 and other specific circuitry to test amplifiers 10, standby batteries 70 or cell relay 80.

FIG. 6 shows the details of the response transmitting units RTU 90. The response transmitting units 90 feature transmitter 630 which includes a channel decoder 632 and a digital modulator 634, a transmitter/receive switch 610, an antenna 600, and receiver 620 which includes a channel decoder 622 and a digital demodulator 624, similarly as discussed above with respect to the central transmitter/receiver unit 85, cell relay 80 and M-RTUs 95. Further, the signals transmitted and received by the RTUs 90 are input into a digital data computing device 640, which in turn is connected to a user input device 650. This user input device 650 may be any type of input device such as a remote control keypad.

The use of the RTUs 90 provides each individual cable user 20 with a form of direct control over the cable service for each individual user 20. The RTUs 90 allow information input from the user 20 via the user input device 650 to be transmitted to the M-RTUs 95, to the central cell relay 80 or to the central transmitter/receiver 85.

As one example of the operation of the RTUs 90, these RTUs 90 can be used by each individual user 20 to select a pay-per-view program in the following manner. If a pay-per-view program is available, and if a user 20 specifically desires to purchase such a pay-per-view program, the user 20 will activate the user input device 650 in the RTU 90, which typically will be connected, either by wire or wirelessly, to the cable box inside the user's home. The digital data computing device 640 will then interpret this input as an indication that the user 20 wishes to purchase a specific pay-per-view program, and digital data computing device 640 generates a control signal based on this input.

This control signal is then encoded in channel encoder 632, and the signal is then modulated in digital modulator 634 and then radiated by antenna 600. As this signal is a request for the user 20 to receive a pay-per-view program, the signal radiated by antenna 600 will be received by the M-RTU 95 which is connected to the tap 15 which supplies the cable signal to the individual user 20.

With reference to FIG. 2 of the present specification as an example, if user 20(1) selects a particular pay-per-view program, user 20(1) provides such an input on a user input pad 650 in the RTU 90(1). The RTU 90(1) then transmits a signal to the M-RTU 95(4), which in turn controls the tap 15(2) which supplies the cable signal to the user 20(1). When the M-RTU 95(4) receives this request from the user 20(1), the channel-specific interference generator or channel-specific trap 570 formed in the M-RTU 95(4) controls the tap 15(2) to allow the specifically selected pay-per-view program to be supplied to the user 20(1).

Further, the M-RTU 95(4) also transmits a confirmation signal to the cell relay 80 which indicates that the user 20(1) has a selected the particular pay-per-view program. This signal is then relayed to the central transmitter/receiver 85 and is then provided to the cable control station 5. This confirmation signal which confirms the operation of the M-RTU 95(4) is supplied to the cable control station 5 so that the cable control station 5 can have an accurate and automatic accounting of the pay-per-view selection of the user 20(1). In this operation of the present invention, the user 20(1) can individually control the pay-per-view selection, and the cable control station 5 will have an accurate accounting thereof so that the user 20(1) can be appropriately billed.

The RTUs 90 can also receive signals from the central transmitter/receiver 85 or M-RTU 95(4), which signals may, as an example, poll whether the RTUs 90 are operating properly. Further, responses to these polling signals in the RTUs 90 can then be directly transmitted to the cell relay 80 or central transmitter/receiver 85, i.e., responses to such polling signals need not be transmitted to the M-RTUs 95.

As a further possibility of the operation of the RTUs 90, these RTUs 90 can be used to poll a user. For example, the cable control station 5 may send a polling signal to each of the users 20. Each of the users 20 can then respond to this polling signal by inputting a specific data into user input device 650. This data will then be transmitted back to the cable control station 5 through the cell relay 80 and central transmitter/receiver 85. In this situation the RTUs 90 will directly communicate with the cell relay 80 or central transmitter/receiver 85 and again bypass the M-RTUs 95.

The system of the present invention can also be used to accurately monitor which programs a household is watching. It is a concern of television programmers to have an accurate indication of which programming a user is watching. This is conventionally done by polling services in which a user must keep a written log of the programming they watch. By the use of the present invention, the RTUs 90 through the digital data computing device 640 can keep an accounting of which channel a user is watching, and this information can then be automatically transmitted back to the cable control station 5. With such an operation, a very accurate record of a user's viewing habits can be obtained which does not rely on the user to make any efforts.

Clearly, other possibilities of the system of the present invention are also possible. The system of the present invention has been described at this time in a particular environment of a cable television system. However, the system of the present invention can find other applications in other environments.

As an example, the system of the present invention could also be used to monitor power use. At this time, power usage by homes and businesses is, to a significant degree, measured through meters which must be manually read by a technician from the power company. The system of the present invention could clearly find application in monitoring such power usage in that a modified micro-response transmitting unit of the present invention could be attached to such power meters. In this situation, in response to periodic polling signals, the micro-response transmitting units could provide a central control station with an indication of the power usage. In such a situation, the micro-response transmitter units could also alert a central control station as to a malfunction in a power meter or the leakage of power.

This particular application of the present invention in monitoring and reporting power usage may be realized by the use of combined satellite and terrestrial wireless technology.

As illustrated in FIG. 8, the communication system of the present invention may operate in conjunction with utility meters 20 using the structure described above with reference to a cable station. A power control station 5 (similar to cable station 5 of Fig. 2) transmits signals (polling or control signals for example) to the utility meters 20 (similar to users 20 of Fig. 2). These signals may be transmitted through a hybrid satellite and terrestrial network. The signals may request readings from one or more of the utility meters 20. The requested readings may be used to determine an amount of power consumed by an entity to which the meter is connected. This entity may be a home, a commercial building, a group of rental rooms, a single or a collection of appliances or other power consuming devices. Utility meters 20 are known and the EPRI Model SE-240 is one such meter for example.

In existing power delivery systems, as illustrated in FIG. 8, power is transmitted from a power control station 5 to substation 70 as well as to end users such as homes, offices and the like 20. In order to reduce the high voltage flowing from the control station to facilitate usage in homes for example, step-down transformers 10 are used. The power is transmitted from a control station 5 through at least one step-down transformer 10 (somewhat similar to amplifier 10 of Fig. 2) and taps 15 (similar to taps 15 of Fig. 2) to users having utility meters 20.

The system of the present invention may, in a preferred embodiment, be adapted to obtain power usage information from a plurality of utility meters 20. This objective of the present invention may be realized by a combined satellite and terrestrial communication network. With this approach, the previously described signals from the control station 5 are transmitted in a wireless manner to a central transmitter/receiver station (CTS) 85. The CTS 85 may be ground based or it may be located aboard a geo-synchronous satellite. If the CTS 85 is aboard a satellite, then the signals from the control station 5 may be transmitted via a satellite link. The signals are relayed by the CTS 85 through a terrestrial cell relay 80 to a plurality of modified micro response transmitting units mM-RTU 95 (similar to M-RTU 95 of Fig. 2). Depending on the signal received, the mM-RTU 95 then transmits the signals to either the tap 15 or the utility meter 20 which has a response transmitting unit (RTU) 90 associated therewith. The signal from the mM-RTU 95 to the RTU 90 may be transmitted in a wireless manner.

In order to realize the efficiency of the present invention, each mM-RTU 95 is preferably associated with one tap 15 and a plurality of utility meters 20. Each mM-RTU 95 may transmit signals to a plurality of RTUs 90 associated with utility meters 20 that are associated with the mM-RTU 95. The mM-RTU 95 is illustrated in FIG. 10 and the modifications from the previously described M-RTU are highlighted in greater detail below. Based on the topography, the CTS 85 may transmit directly to a mM-RTU 95 without utilizing the cell relay 80.

As stated, a response transmitting unit RTU 90 (similar to RTU 90 of Fig. 2) is associated with (or is integral to) each of the utility meters 20. The RTU 90 may operate on power supply from the user 20. The mM-RTUs 95, on the other hand, obtain the needed power for operation from the taps. The mM-RTUs may also have a battery backup. Upon receiving the signals from the control station via the mM-RTU 95, the reading from the utility meter 20 is transmitted by the RTU 90 to the mM-RTU 95 to which the RTU 90 corresponds. That is, the mM-RTU 95 transmits signals to the RTU 90 and waits for a reply signal. If no reply is received from a particular RTU 90 to repeated signals from the mM-RTU 95, then the corresponding non-responsive utility meter 20 is treated as being defective and is identified as requiring a service call. The first signal may be transmitted a predetermined number of times and at a predetermined interval. The signal may be transmitted three times and at an interval of fifteen minutes for example. The non-responsive utility meter 20 may also be diagnosed by diagnostic signals from the control station 5.

The mM-RTU 95 aggregates the information received from its associated utility meters 20 via the RTUs 90. That is, data is collected from the RTU 90 and converted to a data stream. The aggregated information is then transmitted from each of the mM-RTUs 95 to the CTS 85 as a data stream which is relayed to the control station 5. The transmission from the mM-RTU 95 may be made directly to the CTS 85 without using the cell relay. The cell relay 80 is utilized when line of sight concerns prevent a mM-RTU 95 from communicating directly with the CTS 85. In the alternative, the utility meter 20 may be programmed to provide the reading at predetermined times or upon the meter reading incrementing by a predetermined number. For example, the meter may be programmed to provide the reading on the first day of every month or upon the meter reaching a predetermined number like every thousand kilo watts of usage.

The transmitting power of the RTU 90 is less than that of the mM-RTU 95. Signals from the mM-RTU 95 are transmitted further (i.e., traveling a greater distance) than those of the RTU 95. The distance between the RTU 90 and a corresponding mM-RTU 95 is less than that of between a mM-RTU 95 and the CTS 85. As described above, a plurality of RTUs 90 may transmit signals to one mM-RTU 95 and one mM-RTU 95 may transmit signals to a plurality of RTUs 90.

According to the present invention, the control station 5 can generate various signals which can be wirelessly relayed by the CTS 85. The signals relayed by the CTS 85 are then received by the mM-RTUs 95. As the mM-RTUs 95 are connected to the cell relay 80 and taps 15, the mM-RTU 95 can generate information as to the operation of the cell relay 80 and taps 15, and can also control the cell relay 80 and taps 15.

Example of the various signals include, *inter alia*, instructions to measure signal strength at each of the taps 15 so that the quality of the power being distributed may be measured. This information can be compared with the output signal of the control station 5 to detect any power leakage that may have occurred in power transmission.

The functionality of each of the remaining parts of cable system may be modified slightly for adaptation to the power usage monitoring and reporting according to a preferred embodiment of the present invention. In FIG. 3, for example, the cable control station 5 could be replaced by a power control station 5 as illustrated in FIG. 8. The cell relay of FIG. 4 remains unchanged.

The M-RTU of FIG. 5 is modified as illustrated in FIG. 10. The cable service on/off switch 560 of the M-RTU of FIG. 5 is not needed as the mM-RTU 95 transmits a power on/off signal which may signal a RTU 90 to completely deactivate power to a user 20 upon a user request or if the user has not paid the utility bill for instance. The utility meter 20 has the capability to deactivate the power. The system of the present invention may also be used to control power delivery to designated locations (such as homes) by having a user pre pay for an amount of power. This situation is likely to arise where the user may be renting a vacation home for a period of time (such as a month for example). To achieve this functionality, the control station can transmit control signals which instruct a termination of power delivery to a designated user upon the utility meter having reached a predetermined reading representing the amount of power the user has prepaid for. A utility meter that may be reset to zero can be used for this exemplary purpose. This may also be achieved without having to reset the meter 20. If the user has prepaid for 1000 kilo watt hours of power for example, a control signal from the control station may request a reading of the meter corresponding to this user. Upon obtaining this reading (assume for example that the meter reads 50000 kWh), another signal from the control station may instruct the meter to disconnect power when the meter reading increments to 51000 kWh. The channel specific interference generator/channel-specific trap 570 is not needed here for power usage monitoring; therefore, the modified M-RTU does not include this element. Cable signal presence/strength sensor 580 may be modified to monitor the power signal strength through a tap 15. As described previously with respect to a cable service, the signal presence/strength sensor 580 may be activated either by a polling signal transmitted by the CTS 85 or may continuously monitor the signal presence/strength, and automatically activate the mM-RTU 95 to output an indication signal if the power signal strength falls below a predetermined value. The cable leakage receiver 590 of FIG. 5 may be modified to detect power leakage based on information collected at the tap 15.

The RTU 90 of FIG. 6 may remain unchanged for the power monitoring system application. FIG. 11 illustrates the communication system of the present invention in which the CTS 85 receives signals from both the control station 5 for relay to mM-RTU 95 and from mM-RTU 95 for relay to control station 5. The mM-RTU 95 transmits signals to utility meters 20 having RTUs 90 associated therewith. The RTU 90 transmits signals to mM-RTU 95.

The RTU and the mM-RTU may operate in the 216-220 MHz range for example. Waves in this frequency range follow the curvature of the earth in the form of a ground wave. Other frequencies that may be used include, but are not limited to, the 1400 MHz frequency range corresponding to the Itron spectrum. The communication with the CTS 85, if embodied as a satellite, is dependent upon the frequency at which the satellite hosting the CTS 85 operates. An exemplary frequency of operation for a satellite is the 1530 to 1559 MHz range for the downlink communication and 1631.5 to 1660.5 MHz for the uplink communication. The RTU 90 may weigh approximately 4 ounces and be of small dimension to fit within a space of approximately 0.5 X 3 X 4 inches. The system of the present invention may include thousands of RTUs 90 reporting to hundreds of mM-RTUs 95. A greater efficiency is realized when the number of RTUs 90 responding to one mM-RTU 95 is between 2000 and 4000. If the density of users (and hence the utility meters) is sparse such as in rural areas, each utility meter may have its own mM-RTU 95 as opposed to a RTU 90 due to the higher transmitting power of the mM-RTU 95 in being able to communicate with the CTS 85 aboard a satellite. This arrangement facilitates the reception of signals and transmission of information directly from the user (utility meter) to the CTS 85.

Upon receiving a reading from the utility meters, the control station may process the data to determine a bill reflecting an amount of power consumed by a particular customer. The billing records may be made available to the user (or, customer) via the Internet.

While a description of a preferred embodiment has been described with respect to a power usage monitoring, the present invention may be easily adapted for use in monitoring, controlling and reporting information pertaining to natural gas delivery, water delivery, and data delivery.

The present invention can also be used in a demand side management system for electrical and gas utility plants, as it would eliminate the use of a dedicated telephone line therefore.

The present invention can also find particular use in monitored home security systems, which presently are dependent on hard wire telephone systems.

Specifically, current electronic home security systems are commonly found to be of many and varied types. Such systems range from very simple devices attached to doors which sound an alarm when the door is moved or shaken, to elaborate self-contained video systems, inclusive of on-premise security guards. Of all these systems, the two most generally used are on-premise alarm only systems or central station monitoring systems.

In the case of an on-premise alarm only system, the doors, windows and other means of ingress and egress of the house are wired with electrical contacts. When the circuit of one or all of these contacts is broken an on-premise alarm sounds. This alarm will alert neighbors in the immediate area of a break-in. A central station monitoring system is similarly wired. However, in addition to the on-premise alarm, a central station is linked by hardware telephone lines and a digital dialer. This central station receives a signal that an electrical circuit in a contact at a particular house has been broken. With the use of this central station monitoring system, central station personnel can take immediate procedural action to alert proper authorities of a break-in.

The drawbacks with such conventional systems is that if the systems themselves have any malfunctioning elements, the malfunction of these elements is not brought to anyone's attention. The present invention can overcome such drawbacks by setting forth a two-way wireless link between a home and a central station. The wireless nature of the system of the present invention provides additional security in that there is no wire that can be cut by a perpetrator. The present invention may specifically utilize a modified form of an M-RTU as discussed above in the environment of the cable television system. The M-RTU used in the home security device will be connected to the home security device to determine its operation and functionality. Further, in the present invention the M-RTU will be continuously or systematically polled for diagnostic testing to determine whether any element in the home security system is not operating properly. This provides a significant advantage over existing systems which have no way of automatically detecting a malfunction.

In addition to normal security, the use of a M-RTU as in the present invention provides an ability to wirelessly link a home to a central station for emergencies such as regarding air quality, i.e. carbon monoxide or other household contaminants, to link the system to a wireless hand-held ingress and egress control and to link the home security system to the local cable CATV system for on-screen reporting of an internal home status and external neighborhood watch and alert programs. Further, the system of the present invention can also be used for fire and medical alert situations.

The system of the present invention may have a configuration in which a M-RTU is installed in the eaves of a house or in another secure location. This M-RTU is connected to the home security system to monitor and control all contacts on the windows, doors and other ingress and egress portals of the house. The control link can be deployed wirelessly or by an internal home hardwired network. Communication signals are received at the M-RTU from a central transmitter/receiver unit such as disclosed in FIG. 2 with respect to the cable television environment of the present invention. The M-RTU may transmit, in response to polling signals or periodically self-generated signals, signals from the home to the central transmitter/receiver. These signals contain specific messages, such as a diagnostic of the operation of the home security system, which are then transmitted to a central control station, and thus has a similar operation as discussed above with respect to the system disclosed in FIG. 2 of the present invention.

The present invention can also find particular use in inventory control systems such as for a vending machine industry as it can provide a low cost method of reporting inventory levels of vending machines without the need for an expensive hardwired link or without the need for visual inspection.

The present invention can also find particular application in environmental protection monitoring systems because the M-RTUs of the present invention can be economically placed within an extensive geographical grid and can be attached to existing sensors which report levels of pollution via radio frequency.

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

WHAT IS CLAIMED IS:

1. A communication system for monitoring a power delivery system in which a control station transmits signals to a utility meter, comprising:

a central transmitting/receiving station (CTS) for relaying a first signal generated at said control station to a utility meter and for relaying a second signal to the control station;

a first response unit for processing and transmitting the first and second signals; and

a second response unit associated with the utility meter for wirelessly transmitting the second signal to the first response unit in response to the first signal, wherein the first signal comprises command signals to provide a reading of the utility meter, and the second signal includes data representing said reading, wherein said first response unit has at least one utility meter associated therewith.

2. The system of claim 1, wherein the CTS is a terrestrial station.

3. The system of claim 1, wherein the CTS is aboard a satellite.

4. The system of claim 3, wherein said reading from the utility meter reflects an amount of power consumed by a user.

5. The system of claim 4, wherein said second signal is transmitted at a predetermined interval specified by said first signal.

6. The system of claim 5, wherein said interval is a period of time.

7. The system of claim 5, wherein said interval is determined by an amount of consumed power.

8. The system of claim 1, further comprising a tap connected to the first response unit.

9. The system of claim 8, wherein the tap provides operating power to the first response unit.

10. The system of claim 8, wherein said first signal further comprises signals to the tap.

11. The system of claim 10, wherein said signals instruct the tap to provide information pertaining to a quality of power signals measured at the tap.

12. The system of claim 1, wherein said first signals include a signal to terminate power supply to a designated user.

13. The system of claim 12, wherein power is terminated by a utility meter associated with the designated user.

14. The system of claim 12, wherein the power supply to the designated user is terminated based on a plurality of predetermined conditions.

15. The system of claim 14, wherein said predetermined conditions include a user being delinquent on charges associated with power consumption.

16. The system of claim 14, wherein said predetermined conditions include a user prepaying for an amount of power.

17. The system of claim 1, wherein a transmitting power of the first response unit is greater than a transmitting power of the second response unit.

18. The system of claim 1, wherein the first response unit has a plurality of second response units associated therewith.

19. The system of claim 18, wherein the data within the second signal from the plurality of second response units is aggregated into a data stream by the first response unit.

20. The system of claim 19, wherein said data stream is transmitted to the CTS by the first response unit.

21. The system of claim 1 further comprising a cell relay intermediate the CTS and the first response unit.

22. A communication system for monitoring a power delivery system in which a control station transmits signals to a utility meter, comprising:

a central transmitting/receiving station (CTS) for relaying a first signal generated at said control station to a utility meter and for relaying a second signal to the control station;

at least one first response unit for processing and transmitting the first and second signals;

a tap connected to the first response unit; and

at least one second response unit associated with the utility meter for transmitting the second signal to the first response unit in response to the first signal, wherein the first signal comprises command signals to provide a reading of the utility meter, and the second signal includes data representing said reading, wherein said fist response unit has at least one utility meter associated therewith.

23. The system of claim 22, wherein power is delivered through power lines from said control station to a plurality of users via at least one step-down transformer and the tap.

24. The system of claim 22, wherein said first signal further comprises signals to the tap.

25. The system of claim 24, wherein the first signal comprises control signals to measure power signal strength at the tap.

26. The system of claim 25, wherein the power signal strength is used to determine power leakage between the control station and the tap.

27. The system of claim 22, wherein the CTS is a terrestrial station.

28. The system of claim 22, wherein the CTS is aboard a satellite.

29. The system of claim 28, wherein said reading from the utility meter reflects an amount of power consumed by a user.

30. The system of claim 29, wherein said second signal is transmitted at a pre-determined interval specified by said first signal.

31. The system of claim 30, wherein said interval is a period of time.

32. The system of claim 31, wherein said interval is determined by an amount of consumed power.

33. The system of claim 22, wherein said first signals include a signal to terminate power supply to a designated user.

34. The system of claim 33, wherein the power is terminated by a utility meter associated with the designated user.

35. The system of claim 33, wherein the power supply to a user is terminated based on a plurality of predetermined conditions.

36. The system of claim 35, wherein said predetermined conditions include a user being delinquent on charges associated with power consumption.

37. The system of claim 35, wherein said predetermined conditions include a user prepaying for an amount of power.

38. The system of claim 22, wherein a transmitting power of the first response unit is greater than a transmitting power of the second response unit.

39. The system of claim 22, wherein the first response unit is wirelessly connected to the second response unit.

40. The system of claim 22, wherein a first response unit has a plurality of second response units associated therewith.

41. The system of claim 40, wherein the data within the second signal from the plurality of second response units is aggregated into a data stream by the first response unit.

42. The system of claim 41, wherein said data stream is transmitted to the CTS.

43. The system of claim 22 further comprising a cell relay intermediate the CTS and the first response unit.

44. The system of claim 43, wherein said relay is used when line of sight concerns prevent the CTS from communicating directly with the first response unit.

45. The system of claim 22, wherein said first signal is transmitted from the first response unit at predetermined intervals.

46. The system of claim 45, wherein said interval is fifteen minutes.

47. The system of claim 22, wherein said first signal is transmitted a predetermined number of times.

48. The system of claim 47, wherein said predetermined number of times is three.

49. The system of claim 47, wherein a lack of the second signal in response to the first signal having been transmitted said predetermined number of times indicates a defective utility meter.

50. The system of claim 49, wherein a defective utility meter is reported to the control station.

51. A method of communicating monitoring information in a power delivery system in which a control station transmits signals to a utility meter, said method comprising the steps of:

relaying a first signal from the control station by a central transmitting/receiving station (CTS) to a first response unit;

processing the first signal by the first response unit;

transmitting the processed first signal by the first response unit to a second response unit;

generating a second signal by the second response unit in response to the first signal;

transmitting the second signal by the second response unit to the first response unit;

processing the second signal by the first response unit;

transmitting the processed second signal by the first response unit to the CTS; and

relaying the second signal by the CTS to the control station, the second response unit wirelessly transmitting the second signal to the first response unit, wherein the first signal comprises command signals to provide a reading of the utility meter and the second signal includes data representing said reading, and the first response unit having at least one utility meter associated therewith.

52. The method of claim 1, wherein the CTS is a terrestrial station.

53. The method of claim 1, wherein the CTS is aboard a satellite.

54. The method of claim 53, wherein said reading from the utility meter reflects an amount of power consumed by a user.

55. The method of claim 54, further comprising the step of:

transmitting said second signal by the second response unit at a predetermined interval specified by the first signal.

56. The method of claim 55, wherein said interval is a period of time.

57. The method of claim 55, wherein said interval is determined by an amount of consumed power.

58. The method of claim 51, wherein a tap is connected to the first response unit.

59. The method of claim 58, wherein the tap provides operating power to the first response unit.

60. The method of claim 58, further comprising the step of:

transmitting of signals by the first response unit to the tap.

61. The method of claim 60, wherein the signals to the tap instruct the tap to provide information pertaining to a quality of power signals measured at the tap.

62. The method of claim 51, wherein said first signals include a signal to terminate power supply to a designated user.

63. The method of claim 51, wherein power is terminated by a utility meter associated with the designated user.

64. The method of claim 51, wherein the power supply to the designated user is terminated based on a plurality of predetermined conditions.

65. The method of claim 64, wherein said predetermined conditions include a user being delinquent on charges associated with power consumption.

66. The method of claim 64, wherein said predetermined conditions include a user prepaying for an amount of power.

67. The method of claim 51, wherein the first response unit has a higher transmitting power than the second response unit.

68. The method of claim 51, wherein the first response unit has a plurality of second response units associated therewith.

69. The method of claim 68, further comprising the step of:

aggregating the data within the second signal from the plurality of second response units into a data stream by the first response unit.

70. The method of claim 69, further comprising the step of:

transmitting the data stream by the first response unit to the CTS.

71. The method of claim 51 further comprising the steps of:

relaying the first signal by a cell relay from the CTS to the first response unit; and

relaying the processed second signal by the cell relay from the first response unit to the CTS.

72. A method of communicating monitoring information in a power delivery system in which a control station transmits signals to a utility meter, said method comprising the steps of:

relaying a first signal from the control station by a central transmitting/receiving station (CTS) to a cell relay;

relaying the first signal by the cell relay to the first response unit;

processing the first signal by the first response unit;

transmitting the first signal by the first response unit to one of a second response unit and a tap, the tap being connected to the first response unit;

generating a second signal by one of the second response unit and the tap in response to the first signal;

transmitting the second signal by one of the second response unit and the tap to the first response unit;

processing the second signal by the first response unit;

transmitting the processed second signal by the first response unit to the cell relay;

relaying the processed second signal by the cell relay to the CTS; and

relaying the processed second signal by the CTS to the control station, the second response unit wirelessly transmitting the second signal to the first response unit, wherein the first signal comprises command signals to provide one of a reading of the utility meter and a status of the tap, the second signal includes data representing one of said reading and said status, the first response unit having at least one utility meter associated therewith.

73. The method of claim 72, further comprising the step of:

delivering power by the control station through power lines to a plurality of users via at least one step-down transformer and the tap.

74. The method of claim 73, wherein the first signal to the tap comprises control signals to measure power signal strength at the tap.

75. The method of claim 74, further comprising the steps of:

providing the power signal strength by the tap to the first response unit;

determining power leakage between the control station and the tap based on the power signal strength.

76. The method of claim 72, wherein the CTS is a terrestrial station.

77. The method of claim 72, wherein the CTS is aboard a satellite.

78. The method of claim 77, wherein said reading from the utility meter reflects an amount of power consumed by a user.

79. The method of claim 78, further comprising the step of:

transmitting said second signal at a pre-determined interval specified by said first signal.

80. The method of claim 79, wherein the interval is a period of time.

81. The method of claim 80, wherein the interval is determined by an amount of consumed power.

82. The method of claim 72, further comprising the steps of:

instructing the second response unit to terminate power supply to a designated user.

83. The method of claim 82, wherein the power is terminated to the designated user by a utility meter associated with the designated user.

84. The method of claim 82, further comprising the step of:

determining the designated user.

85. The method of claim 84, wherein the determination is based on a plurality of predetermined conditions.

86. The method of claim 85, wherein the predetermined conditions include a user being delinquent on charges associated with power consumption.

87. The method of claim 85, wherein the predetermined conditions include a user prepaying for an amount of power.

88. The method of claim 72, wherein the first response unit has a higher transmitting power than the second response unit.

89. The method of claim 72, wherein the second response unit derives operating power from the user.

90. The method of claim 72, wherein the first response unit has a plurality of second response units associated therewith.

91. The method of claim 90, further comprising the step of:

aggregating the data within the second signal from the plurality of second response units into a data stream by the first response unit.

92. The method of claim 91, further comprising the step of:

transmitting said data stream by the first response unit to the CTS.

93. The method of claim 72, wherein said relay is used when line of sight concerns prevent the CTS from communicating directly with the first response unit.

94. The method of claim 72, further comprising the steps of:

transmitting the first signal at predetermined intervals.

95. The method of claim 94, wherein the predetermined interval is fifteen minutes.

96. The method of claim 72, further comprising the steps of:

transmitting the first signal by the first response unit a predetermined number of times.

97. The method of claim 96, wherein the predetermined number of times is three.

98. The method of claim 96, wherein a lack of the second signal in response to the first signal having been transmitted said determined number of times indicates a defective utility meter.

99. The method of claim 98, further comprising the step of:

transmitting a defective utility meter indication in the second signal by the first response unit to the control station.

100. The method of claim 99, further comprising the step of:

transmitting a diagnostic signal by the control station to a defective utility meter.

101. A micro-response unit connected to a tap in a power delivery system providing power to a plurality of users from a control station, said unit comprising:

a receiver for receiving a first signal from a central transmitter/receiver station and for receiving a second signal from at least one of the tap and a utility meter, the second signal being responsive to the first signal; and

a transmitter for transmitting the first signal to at least one of the tap and the utility meter and for transmitting the second signal to the central transmitter/receiver station, wherein the first signal is generated at the control station.

102. The micro-response unit of claim 101, wherein the first signal requests a reading from the utility meter.

103. The micro-response unit of claim 102, wherein the reading is used to determine an amount of power consumed.

104. The micro-response unit of claim 101, wherein the first signal is repeatedly transmitted to the utility meter at a predetermined interval.

105. The micro-response unit of claim 101, wherein the first signal is transmitted a predetermined number of times.

106. The micro-response unit of claim 105, wherein a non response from the utility meter indicates a malfunctioning of the meter.

107. The micro-response unit of claim 101, wherein the first signal requests a signal strength measurement from the tap.

108. The micro-response unit of claim 107, wherein the signal strength at the tap is used to determine power loss in transmission.

109. The micro-response unit of claim 101, wherein the power is delivered from a control station to users via at least one step-down transformer and the tap.

110. The micro-response unit of claim 101, wherein power from the tap is used for operation of the micro-response unit.

FIG. 1 PRIOR ART

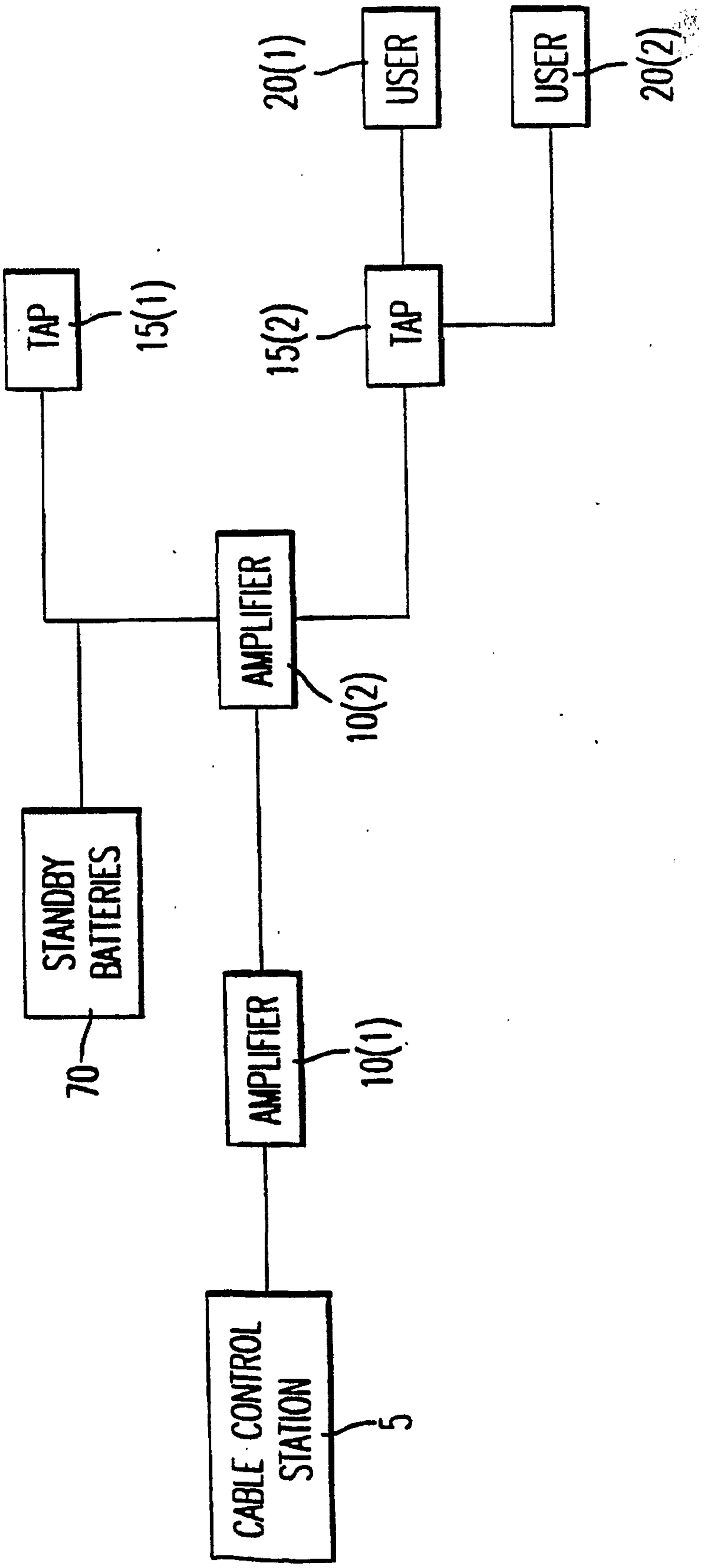
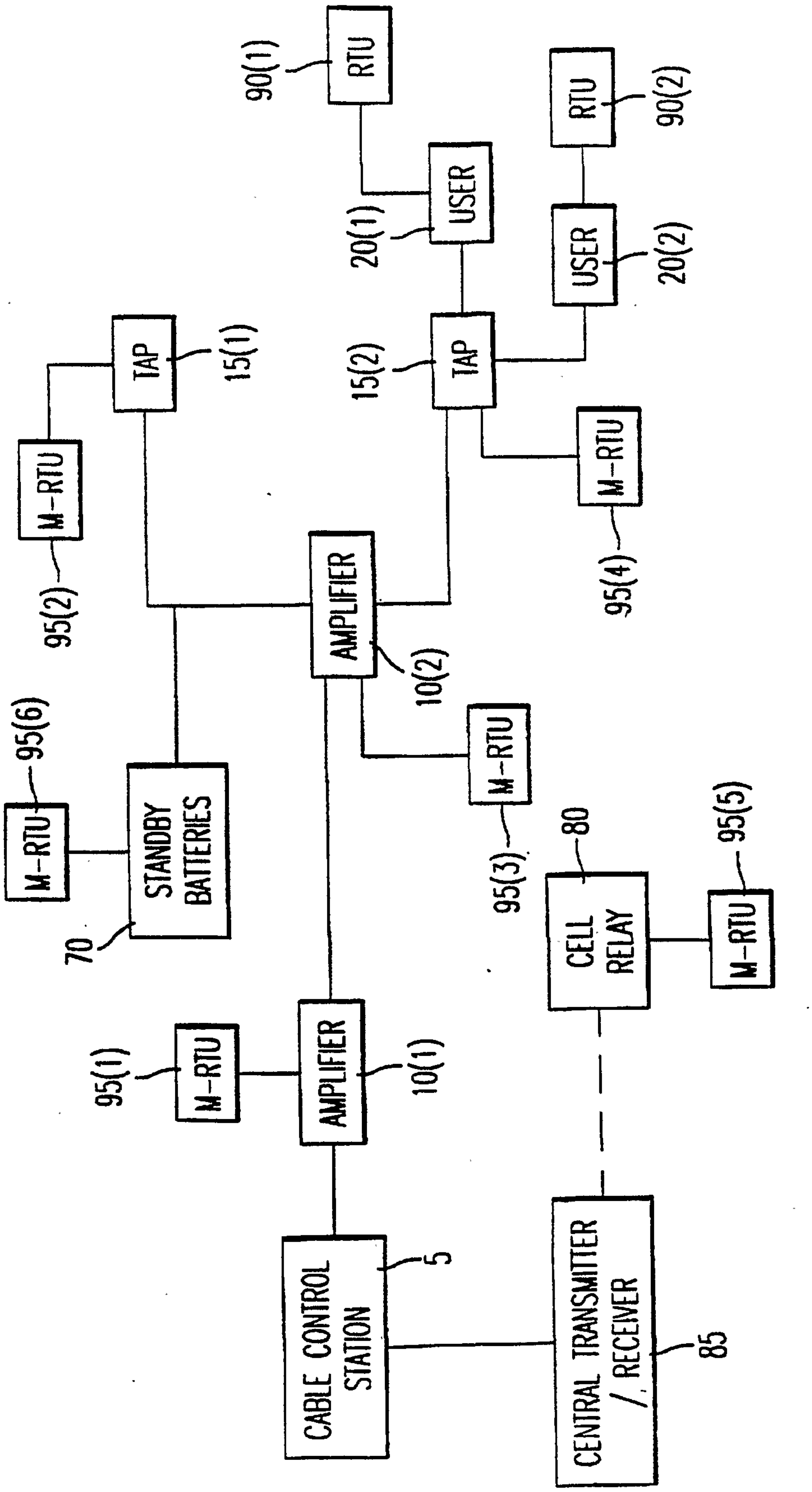


FIG. 2


CABLE CONTROL STATION
5
AMPLIFIER
10(1)
M-RTU
95(1)
STANDBY BATTERIES
70
M-RTU
95(6)
AMPLIFIER
10(2)
M-RTU
95(3)
M-RTU
95(2)
TAP
15(1)
TAP
15(2)
M-RTU
95(4)
USER
20(1)
USER
20(2)
RTU
90(1)
RTU
90(2)
CELL RELAY
80
M-RTU
95(5)
CENTRAL TRANSMITTER / RECEIVER
85

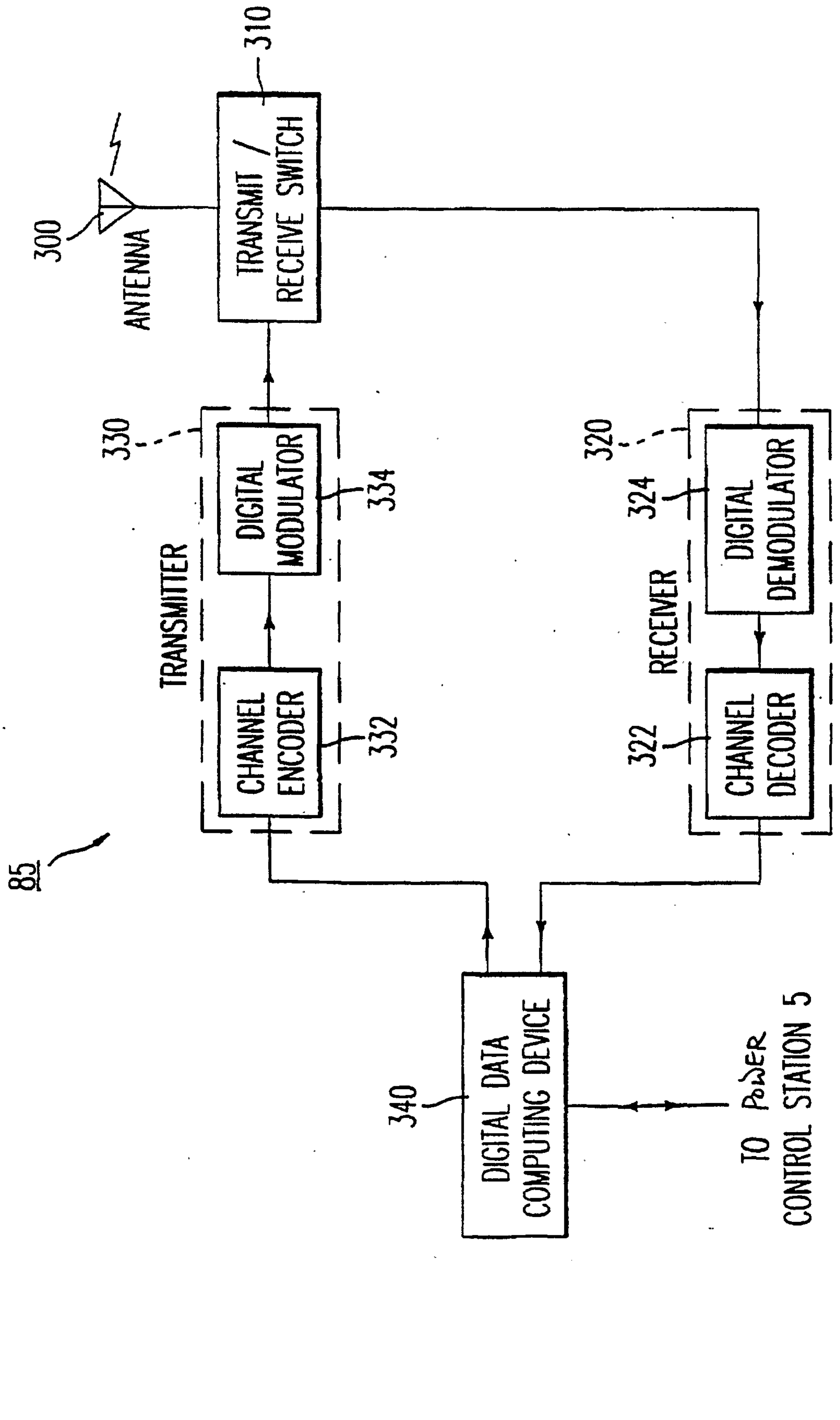

85
300
ANTENNA
TRANSMIT / RECEIVE SWITCH
310
330
TRANSMITTER
CHANNEL ENCODER
332
DIGITAL MODULATOR
334
320
RECEIVER
CHANNEL DECODER
322
DIGITAL DEMODULATOR
324
340
DIGITAL DATA COMPUTING DEVICE
TO POWER CONTROL STATION 5

FIG. 3

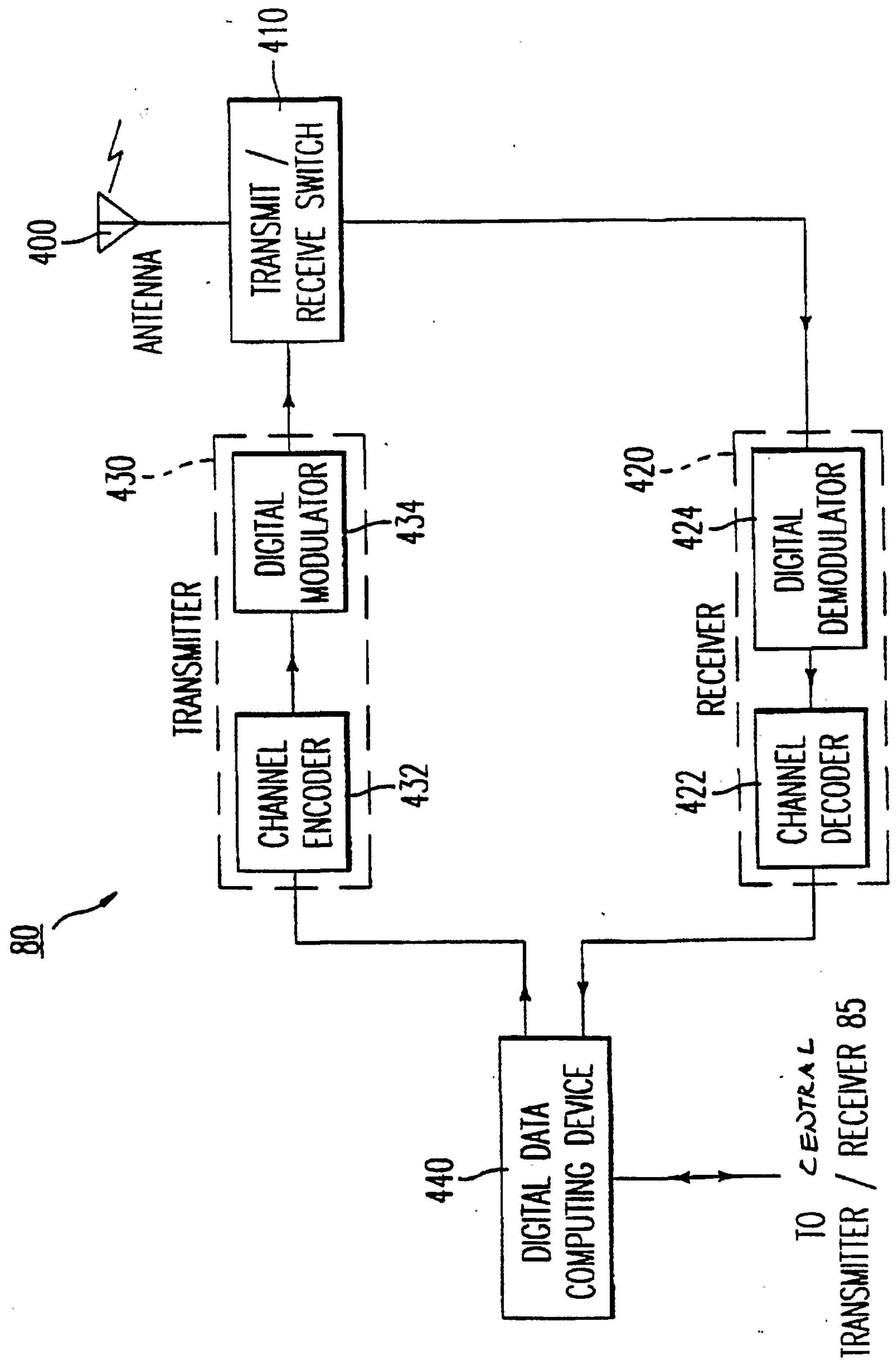

80
400
ANTENNA
TRANSMIT / RECEIVE SWITCH
410
430
TRANSMITTER
DIGITAL MODULATOR
434
CHANNEL ENCODER
432
420
RECEIVER
DIGITAL DEMODULATOR
424
CHANNEL DECODER
422
DIGITAL DATA COMPUTING DEVICE
440
TO CENTRAL TRANSMITTER / RECEIVER 85

FIG. 4

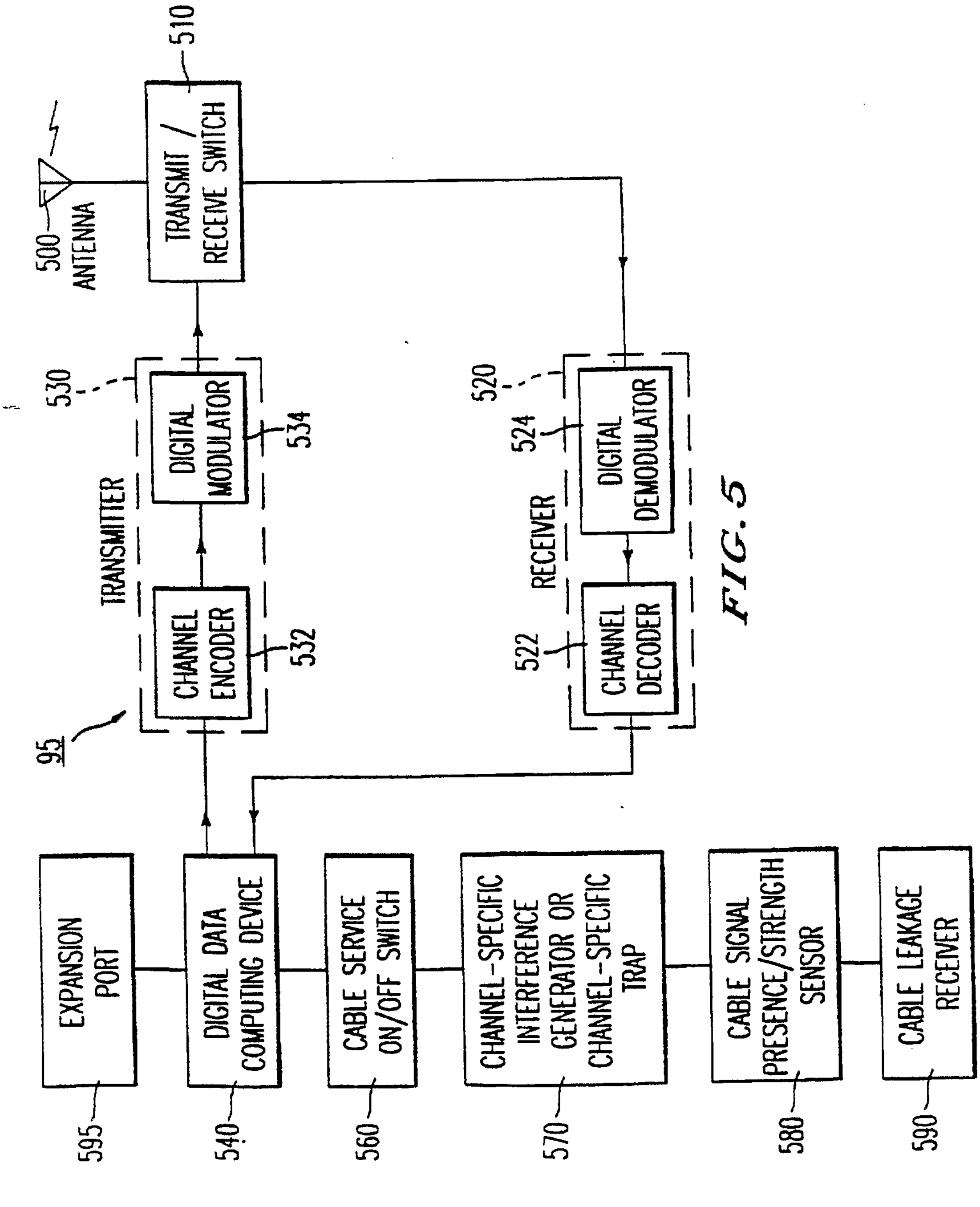

500
ANTENNA
TRANSMIT / RECEIVE SWITCH
510
530
TRANSMITTER
DIGITAL MODULATOR
534
CHANNEL ENCODER
532
95
520
RECEIVER
DIGITAL DEMODULATOR
524
CHANNEL DECODER
522
EXPANSION PORT
595
DIGITAL DATA COMPUTING DEVICE
540
CABLE SERVICE ON/OFF SWITCH
560
CHANNEL-SPECIFIC INTERFERENCE GENERATOR OR CHANNEL-SPECIFIC TRAP
570
CABLE SIGNAL PRESENCE/STRENGTH SENSOR
580
CABLE LEAKAGE RECEIVER
590

FIG. 5

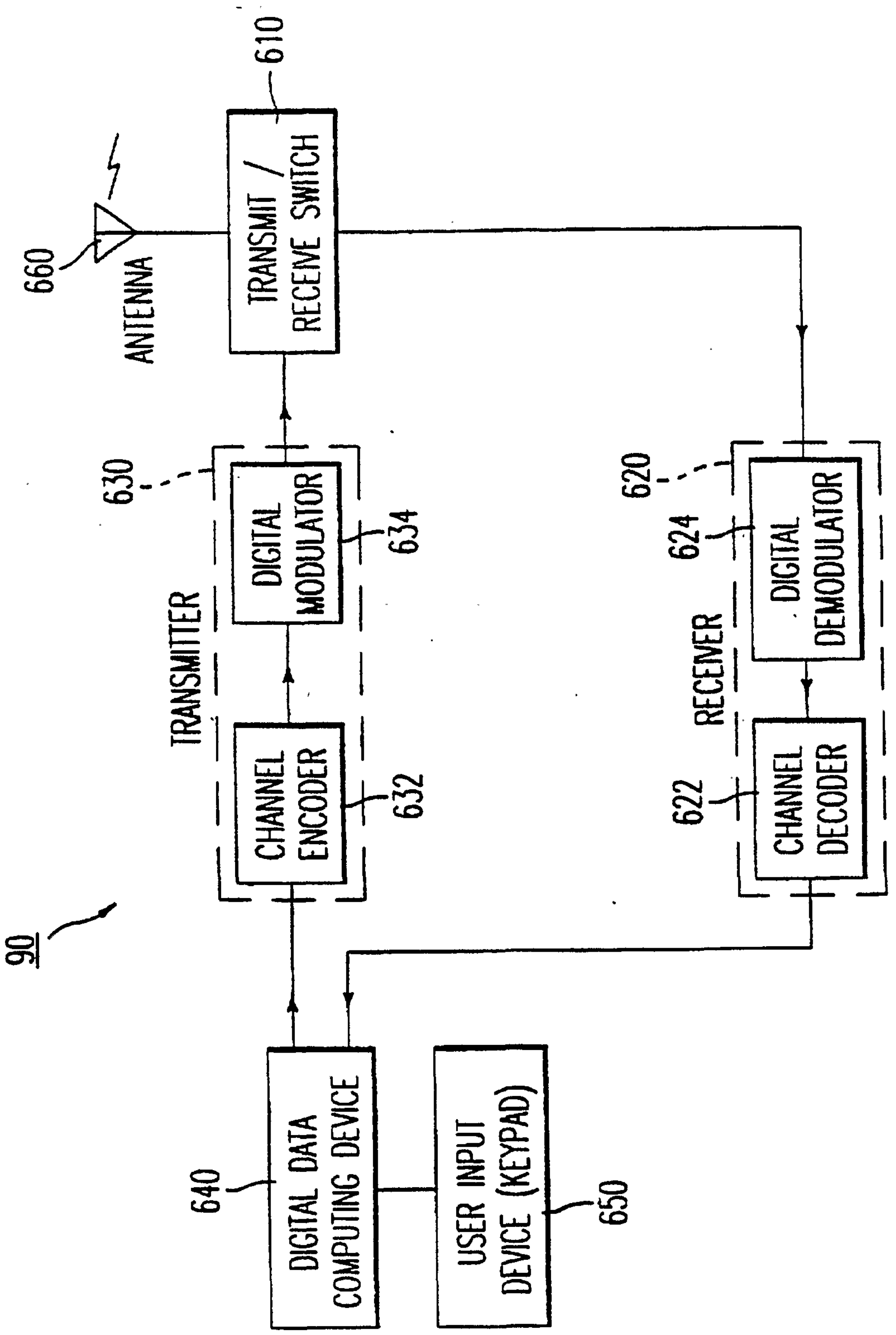

90
660
ANTENNA
TRANSMIT / RECEIVE SWITCH
610
630
TRANSMITTER
CHANNEL ENCODER
632
DIGITAL MODULATOR
634
620
RECEIVER
CHANNEL DECODER
622
DIGITAL DEMODULATOR
624
DIGITAL DATA COMPUTING DEVICE
640
USER INPUT DEVICE (KEYPAD)
650

FIG. 6

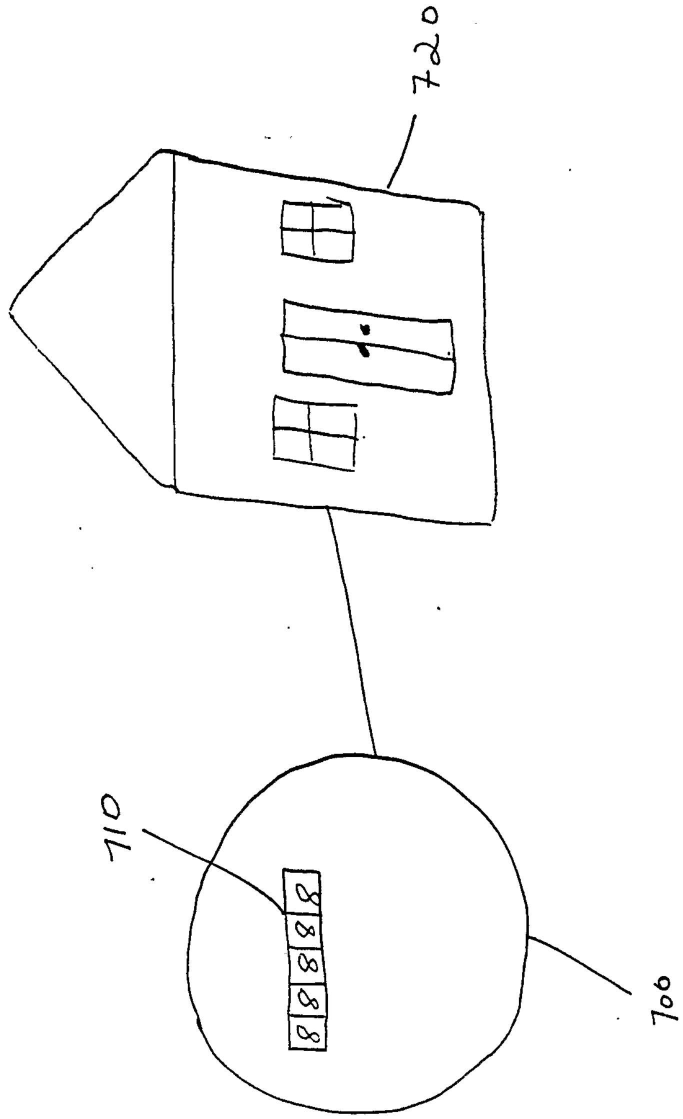


FIG. 7 (PRIOR ART)

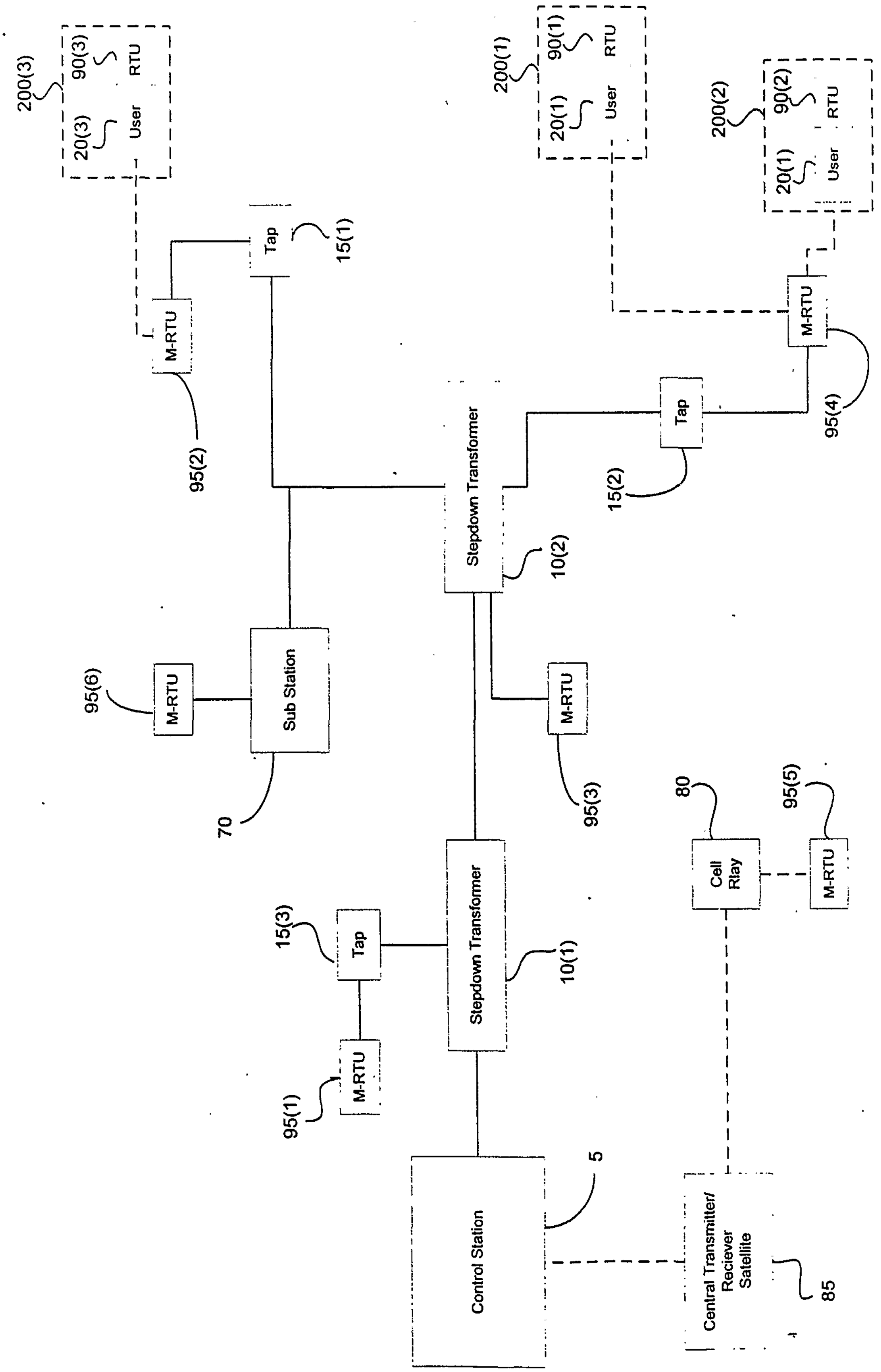


FIG. 8 - Utility AMR Architecture

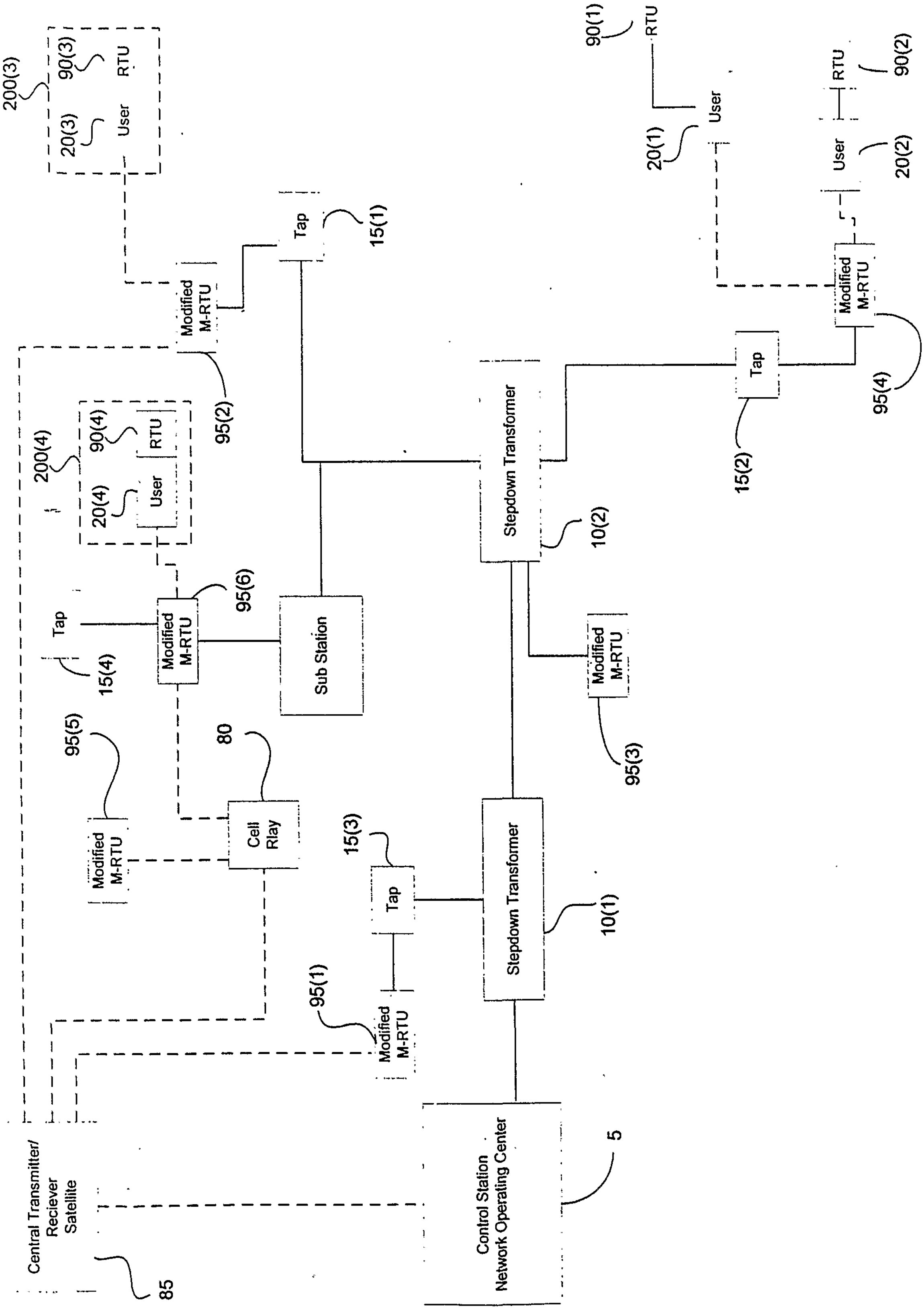


FIG. 9 – Utility AMR Architecture

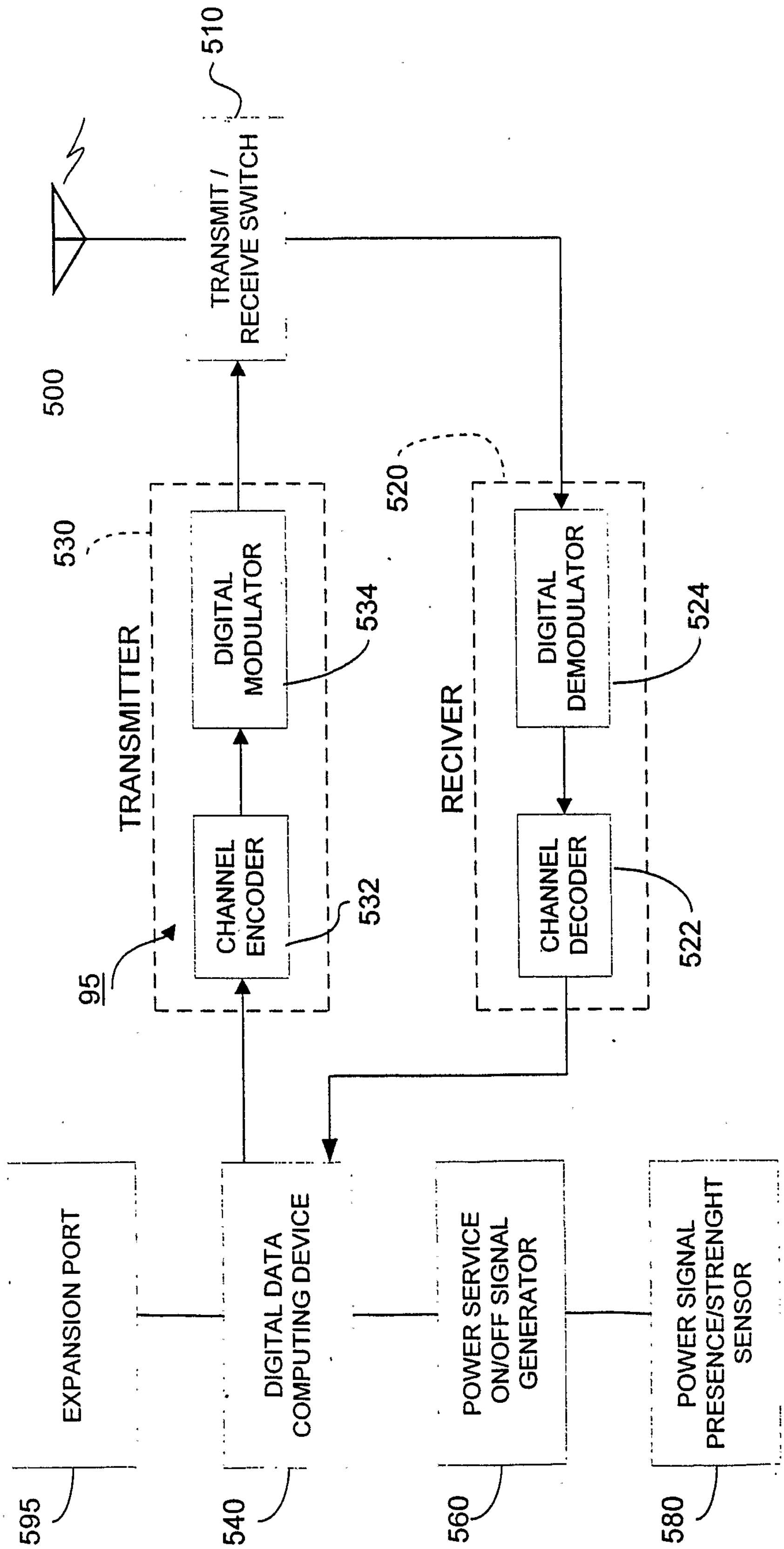


FIG. 10 - MODIFIED M-RTU

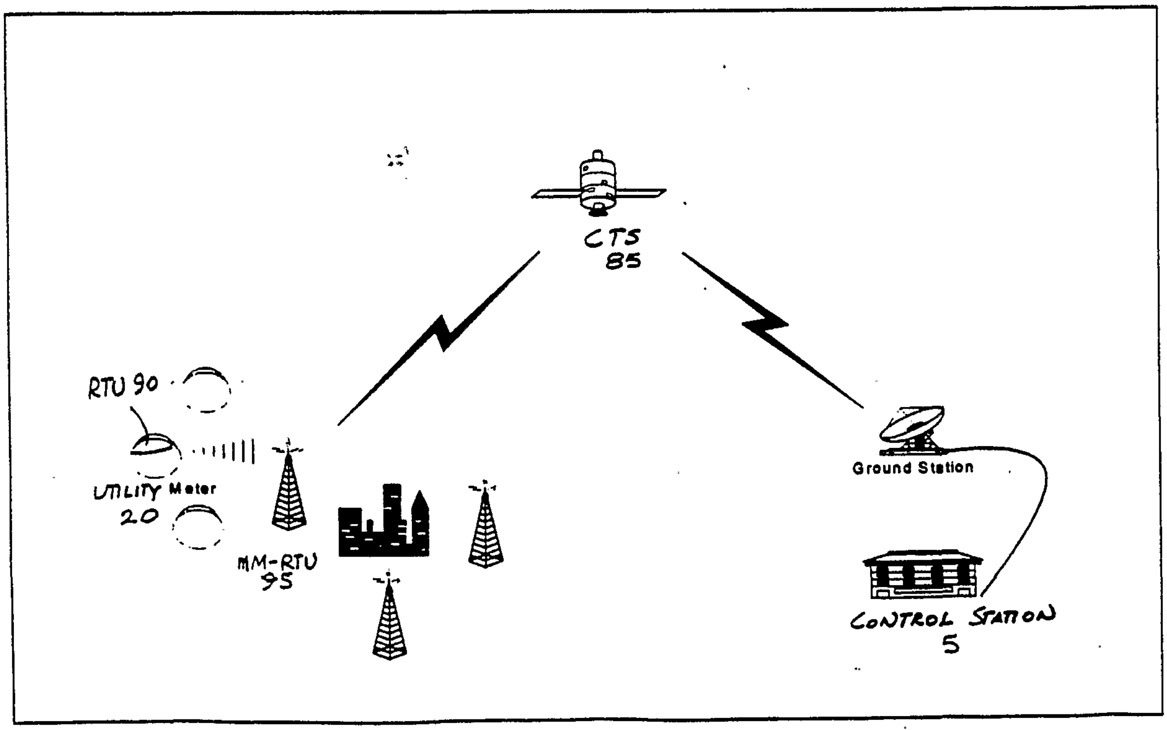


Figure 11- Hybrid Satellite/Terrestrial Network Architecture