

[54] **SYSTEM FOR SELECTION AND REMOTE CONTROL WITH SEQUENTIAL DECODING HAVING PLURAL DECODING STAGES**

[72] Inventors: **Donald E. Mereen; Jack E. J. Barrett,** both of Appleton, Wis.

[73] Assignee: **Midwest Communications & Audio, Incorporated,** Appleton, Wis.

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Primary Examiner—Harold I. Pitts
Attorney—Dawson, Tilton, Fallon & Lungmus

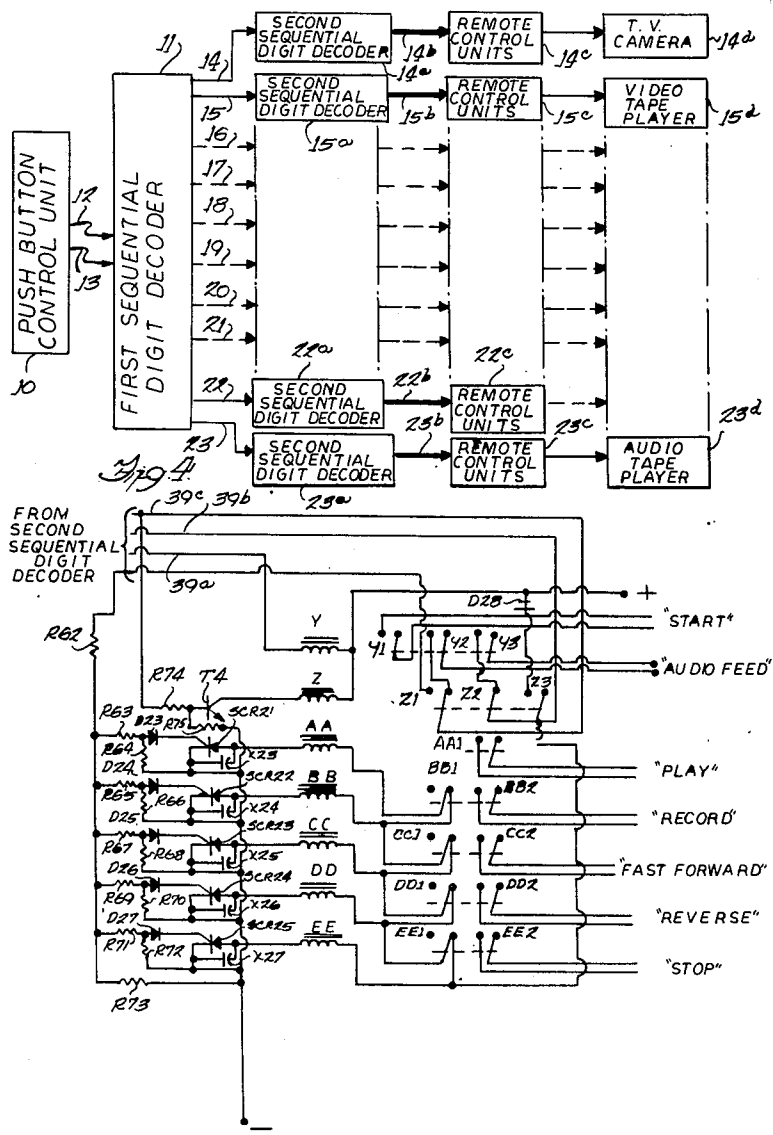
[57] **ABSTRACT**

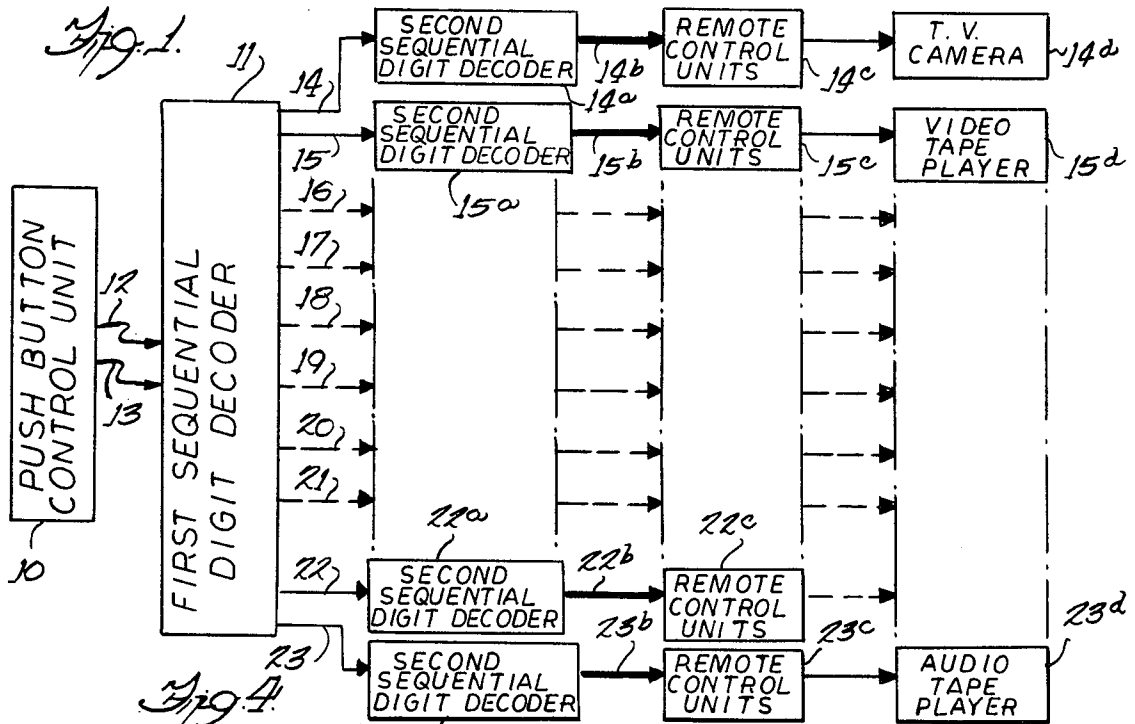
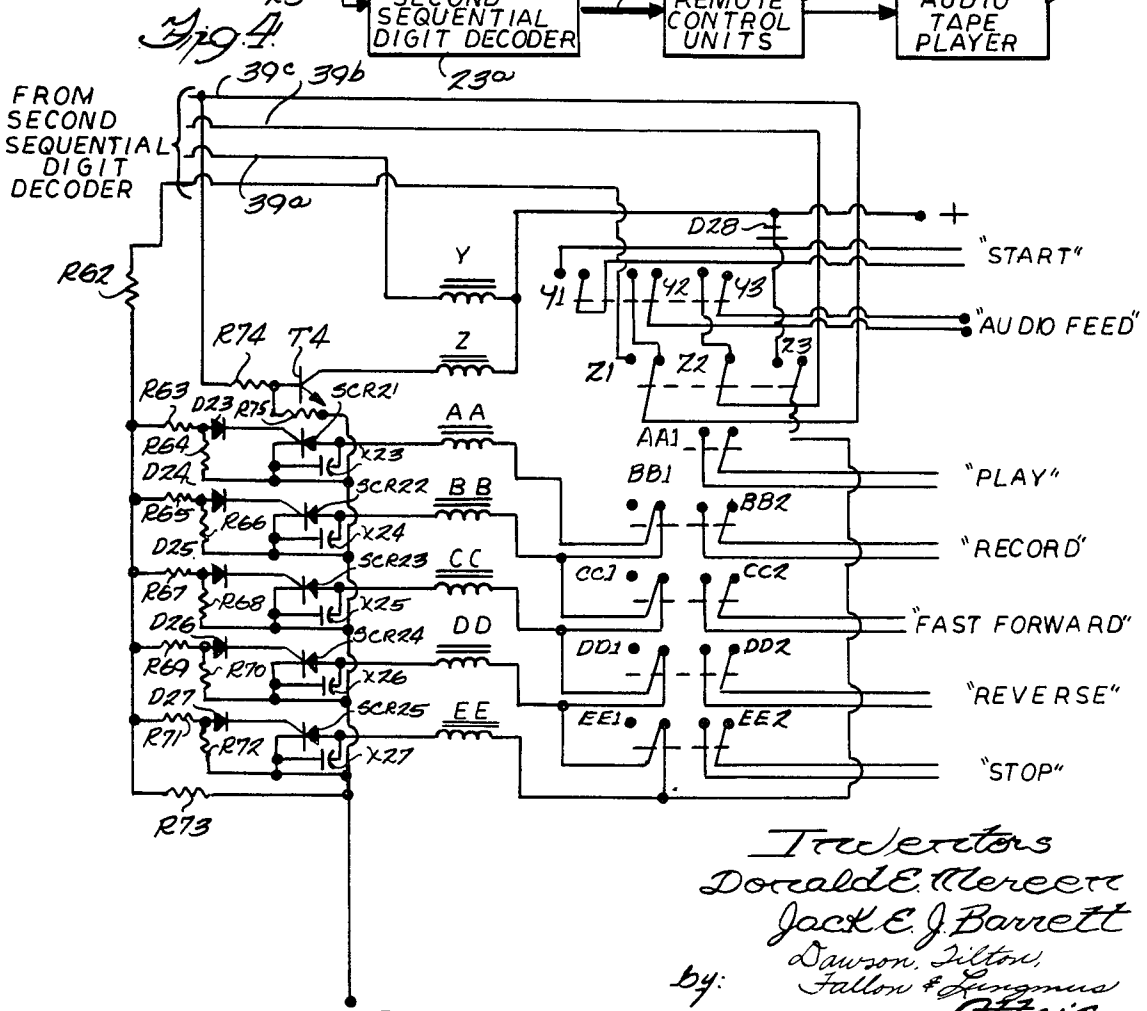
A system is disclosed for selecting and controlling any one of a number of remotely-located, controllable subsystems. A decoding network establishes a direct link from the user to control circuitry for the intended subsystem by sequentially decoding call or address signals initiated by the user and transmitted over a single pair of wires. Once the link from the user to a particular control unit selected has been established, the connection remains secure until broken by the user; and subsequent control signals actuated by the user select and control the desired function of the remote subsystem.

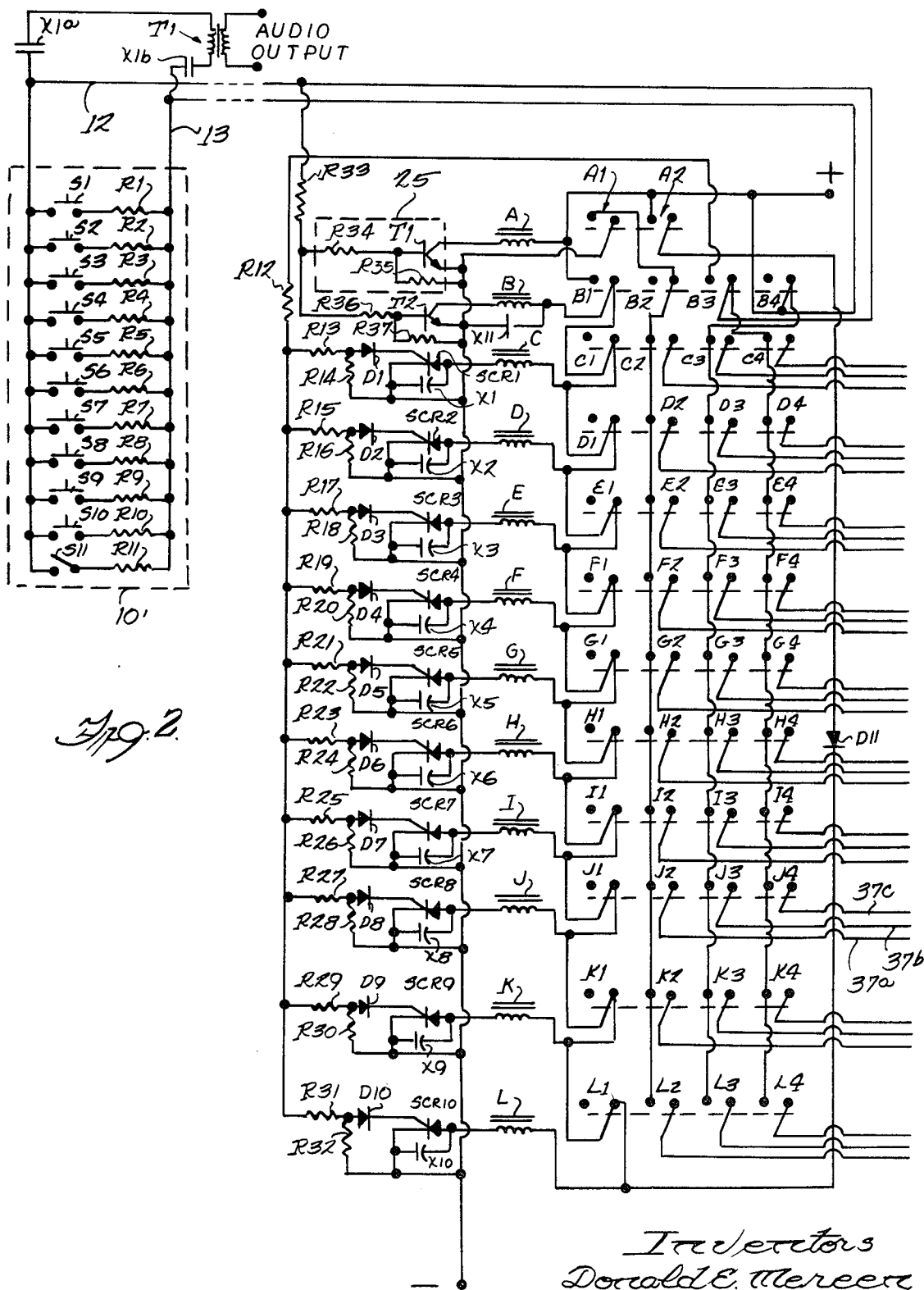
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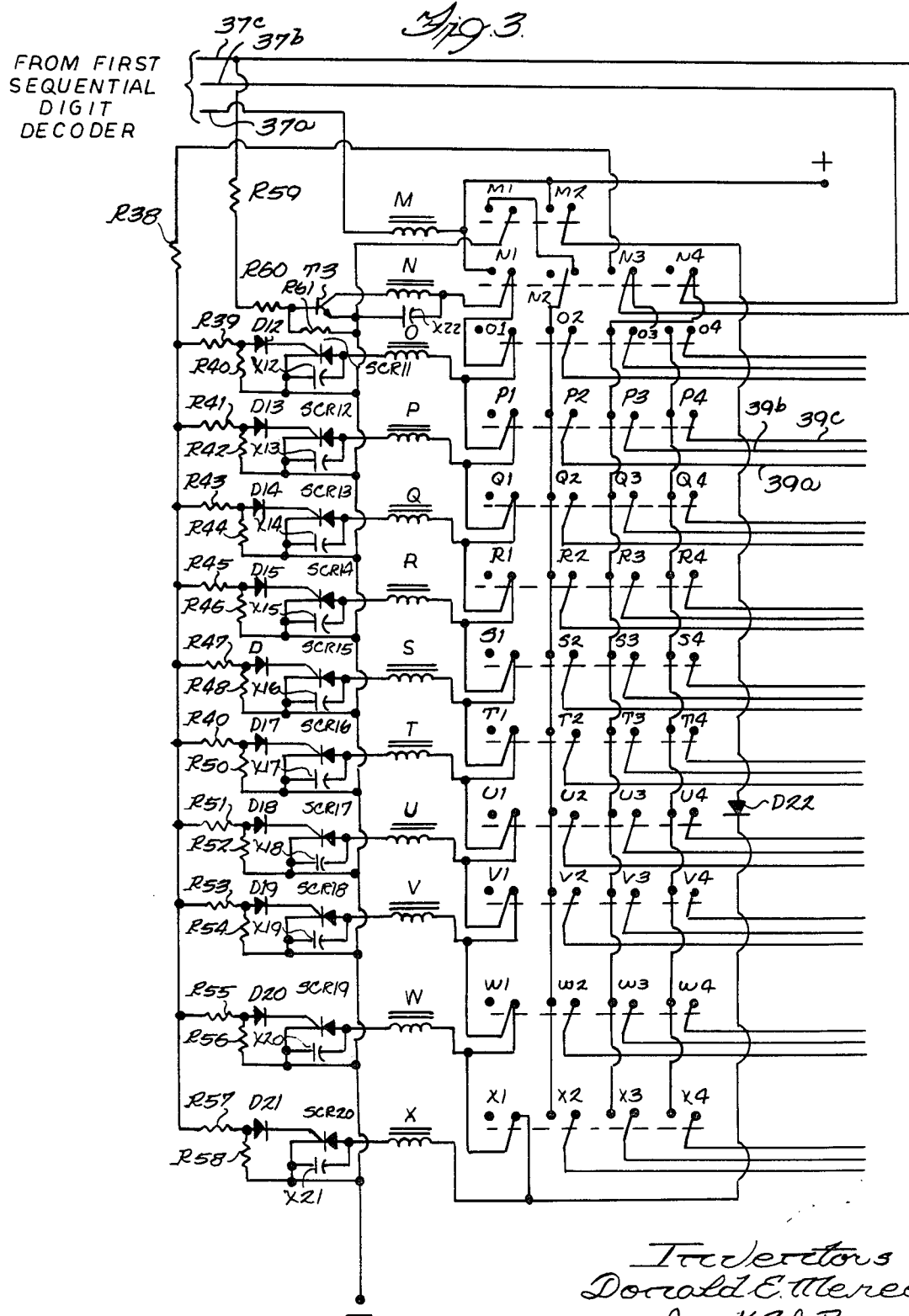
12 Claims, 4 Drawing Figures







Inventors
 Donald E. Mearns
 Jack E. J. Barnett
 by: Dawson, Jilton, Fallon
 & Longmire
 Attys



Inventors
Donald E. McCreary
Jack E. J. Barrett
by: Dawson, Sutton
Fallon & Lungmus
Attys

SYSTEM FOR SELECTION AND REMOTE CONTROL WITH SEQUENTIAL DECODING HAVING PLURAL DECODING STAGES

BACKGROUND AND SUMMARY

The present invention relates in general to electronic selection systems; and more particularly, it relates to a system for remotely selecting a subsystem and controlling the operation of the same over a single pair of wires.

The type of system with which the present invention is concerned has very broad application in the selection and control of remote subsystems. In this system, a number of remotely-located users (or "subscribers") have access to any number of controllable subsystems by signaling in a predetermined code a central location which will then establish a communication link between the subscriber and the control unit for the selected subsystem.

A typical use for this type of selection and control system might be the consolidation of all of the separate communications, signaling and control systems in a school. For example, schools may make provision for many different and separate subsystems or devices which may include a centralized public address system, a programmed clock system for generating class dismissal signals, a fire alarm system, an rf distribution system, a video distribution system (TV transmission, etc.), a central language laboratory or other information stored on magnetic tape, an information retrieval system, audio-visual aids, temperature and humidity control systems, computer-assisted instruction, etc.

The present invention contemplates integrating all such subsystems into a single or master system wherein a number of remotely-located subscribers may selectively address a predetermined one of these subsystems and, once access has been established, may control it in any desired manner.

By way of example, and without intending to limit the scope of the inventive principle in any manner whatsoever, with the present system, a classroom teacher could have the capability of performing any of the following functions:

1. selecting any other desired classroom and conducting a two-way conversation with an occupant of the selected location;
2. selecting a central sound console for receiving a desired program being transmitted — or originating an entirely new program;
3. addressing or calling a film library and selecting a desired film program, starting the motion picture projector as well as assuming complete control over the operation of the projector — starting, stopping, reversing, etc. — receiving the film over a TV link to the desired classroom; or
4. addressing or calling the film library and selecting a slide program and assuming control over the slide projector — again, receiving the information over a TV link to the classroom.

Other environments in which the instant type of selection and control system is useful are a factory wherein machines may be remotely located, paging systems remotely addressed, and surveillance equipment such as hidden TV cameras, etc., remotely controlled. Still another environment in which the present invention is well suited for use is that of a completely automated shopping center wherein a customer would enter a sales area, determine his requirements, and, through the use of the instant system, select his purchases from a remote storage area. Once selected, the purchased products might be brought forward by means of conveyor systems.

In one suggested selecting system of the type with which the present invention is concerned, a number of differential relays are arranged at a central location. Each relay has a first and a second winding, and the relay is actuated only when the current in each winding is the same. At the central location, the relays are arranged so that the current flowing in the first winding of a number of these differential relays is progressively increased in a steplike manner so that the same current flows in no two of the first coils of the differential relays. At

the remote location, there are arranged a plurality of push buttons, each adapted to cause a different incremental current to appear on the line connecting the remote location to the central location; and this current is sent through the secondary winding of each of the differential relays. Thus, for the selected line current which is present on the line, one and only one of the differential relays will have a current corresponding in its first winding; and only that relay will activate an associated mechanism. There is, of course, in this type of system no provision for thereafter controlling the operation of the selected subsystem along the same two wires, as with the present invention.

The present invention includes a control unit, a number of which may be located at the various user or subscriber locations; and in a preferred embodiment, the control unit includes a plurality of push buttons connected in circuit with as many resistors for generating voltage signals. Each signal is representative of a different digit of the call number or address.

As used herein, in term "call word" refers to the sequential set of digits or signals generated by a subscriber in order to communicate with and control a remotely-located subsystem. The initial portion of a call word, that is, a predetermined number of signals or digits occurring first in order, will sometimes be referred to as the address portion of the call word since it is these signals that establish a communication between the subscriber and the control unit for the remote subsystem. Subsequent signals occurring after the address portion will sometimes be referred to as the control portion of the word.

A separate switch at the push button control unit unlocks the decoding circuitry when operated by a user so that subsequent address signals and control signals may be decoded and transmitted. A First Sequential Digit Decoder establishes a predetermined addressing link between the push button unit and a Second Sequential Digit Decoder responsive to the first address signal generated by pressing one of the push buttons at the push button unit.

Any number of sequential address signals may be provided for, for example, the address portion of a call word may be two, three, or more sequential digits. After the proper sequential address signal has been generated at the push button unit, a direct link is established through the decoding matrix from the subscriber to a remote control unit which the subscriber desires to use. Subsequent signals thereafter generated by the user will no longer serve to address a subsystem sought to be used, but rather, these subsequent signals will be used as control signals to operate the various functions of the selected subsystem.

For example, the sequential digits 3-8-3 may be the address portion of a call word which establishes a communication link between a subscriber and an audio taper player. Subsequent signals generated by the user may then turn the tape on, adjust the volume, etc.

With the present system, then, a number of users placed at different locations have the capability of addressing any number of remotely-located subsystems and controlling the same over a single pair of wires extending between the subscriber and the control unit.

Other features and advantages will be compared to persons skilled in the art from the following detailed description of a preferred embodiment together with the attached drawing.

THE DRAWING

FIG. 1 is a block schematic diagram of a system according to the present invention;

FIG. 2 is a detailed circuit schematic diagram of a push button control unit and a First Sequential Digit Decoder;

FIG. 3 is a detailed circuit schematic of a Second Sequential Digit Decoder; and

FIG. 4 is a detailed circuit schematic diagram of a Remote Control Unit.

DETAILED DESCRIPTION

In the explanation of the disclosed embodiment, it will be assumed that each bit (i.e. signal) in a call word is comprised of a digit, one through zero (ten), so that any possible combination of numbers is realizable; however, it will be appreciated that letters, as well as numbers, may be employed and that additional bit values could be used.

Referring now to FIG. 1, a Push Button Control Unit schematically represented by the block 10 is actuated by a remote subscriber or user; and it feeds a First Sequential Digit Decoder 11 over a pair of wires 12 and 13 respectively. As will be described in greater detail within, after a user has actuated the energizing switch, he depresses a push button on the Push Button Control Unit corresponding to one of the 10 digits available to generate a discrete voltage level between the lines 12 and 13 for establishing a direct connection between the Push Button Control Unit 10 and a selected one of 10 output lines, identified by reference numerals 14-23 respectively, of the First Sequential Digit Decoder 11. As will be seen later, each of the output lines 14-23 is in reality three separate wires. Each of the output lines 14-23 is coupled to an associated Second Sequential Digit Decoder, four of which are indicated reference numerals 14a, 15a, 22a, and 23a and fed respectively by the lines 14, 15, 22 and 23.

With only a minor variation, each of the Second Sequential Digit Decoders is similar in operation and result to the First Sequential Digit Decoder 10; and each of the Second Sequential Digit Decoders therefore has itself ten separate output lines. In FIG. 1, these 10 output lines are schematically represented by the heavy black lines 14b, 15b, 22b and 23b. Each of the ten output lines 14b may be connected to a separate Remote Control Unit; but for simplicity, only one Remote Control Unit block is illustrated in FIG. 1. Each of these Remote Control Units may control a separate subsystem.

As illustrated in the drawing, the Remote Control Units fed by the lines 14b, 15b, 22b, and 23b are designated respectively 14c, 15c, 22c, and 23c. One of the Remote Control Units, 14c in the illustrated embodiment, controls a TV camera schematically shown in block 14d. The Remote Control Unit 23c controls an audio tape player 23d. It will be appreciated that a total of one hundred subsystems may be incorporated into the system of FIG. 1, each subsystem being selectively addressable by the sequential order of the first two digits and then controlled by subsequent signals generated by the user at the push button control unit 10. In other words, when a subscriber actuates the Push Button Control Unit and depresses a first preselected one of the push buttons, he will automatically select one of the output lines of the First Sequential Digit Decoder 11. For example, if he depresses the push button for the digit 9, the output line 22 will be actuated to establish a direct link to the Second Sequential Digit Decoder 22a. Other output lines will be locked out. The depression of a second digit in order will then establish a direct connection between the Push Button Control Unit 10 and one of the 10 output lines 22b to control one of the Remote Control Units 22c. When an individual Remote Control Unit is selected, subsequent signals are received by that control unit and serve to perform selected functions in the subsystem controlled by it.

DETAILED CIRCUITRY

Turning now to FIG. 2, the circuitry which comprises the Push Button Control Unit is enclosed within the dashed line 10'. Included in the circuitry for the Push Button Control Unit are ten push switches (i.e. actuated only when depressed) designated S1-S10 respectively, each having a first fixed contact directly connected to the output line 12 and a second fixed contact connected to an associated resistor. These resistors are designated R1-R10 respectively; and the other terminals of all of the resistors R1-R10 are connected in common and to the line 13. An ON/OFF switch S11 is connected in series with a resistor R11 between the lines 12 and 13. Switch S11 is actuated in order to energize the Push Button

Control Unit. Lines 12 and 13 are ac coupled to a transformer T1 via capacitors X1a and X1b to generate an audio output signal coupled from a remote location and transmitted across lines 12 and 13, as will be described.

As already mentioned, the wires 12 and 13 are preferably routed from the position of the subscriber having the control unit 10 to a central location housing the circuitry for the First Sequential Digit Decoder which comprises the remaining circuitry shown in FIG. 2. At the location which houses the First Sequential Digit Decoder there is located a source of dc power (not shown) which has a positive and a negative voltage terminal, marked respectively with a plus and a minus sign in the drawing.

Included in the First Sequential Digit Decoder are twelve relays which are designated respectively by the letters A through L. These relays each control a number of switches, identified in the drawing by a letter (corresponding to the relay which actuates it) and a number which identified its position or "station." Each of these relay switches includes a movable contact and a pair of fixed contacts with the movable contact and engaging the right-hand one of the fixed contact in the drawing when the relay coil is de-energized. Hence, the two contacts are distinguished herein as the normally-open contact and the normally-closed contact.

The relay A has two such switches, A1 and A2. Each of the relays B-L is provided with four switches, B1-B4, C1-C4, etc. All switches controlled by a common relay are linked together by means of a dashed line in the drawing.

The positive terminal of the voltage supply is directly connected to one terminal of the coil of relay A, to the normally-open contact of switch B1, to the normally-open contact of switch A2, to the movable contact of switch B4, and to the line 13 to supply a voltage to each of the resistors R1-R11 in the Push Button Control Unit 10. The movable contact of switch A1 is directly connected to the negative terminal of the power supply. The movable contact of switch B1 is directly connected to one terminal of the coil of relay B. The normally-closed contact of switch B1 is connected to the movable contact of switch C1. The normally-closed contact of switch C1 is directly connected to one terminal of the coil of relay C and to the movable contact of switch D1. Subsequent ones of the first-position switches of each of the relays D through L are connected in similar fashion to the connections described for the first-position switch of relay C — namely, the normally-closed contact is connected to one terminal of the relay coil associated with it and to the movable contact of the first-position switch of the next succeeding relay. Finally, the normally-closed contact of switch L1 is connected to one terminal of the coil of relay L and to the cathode of diode D11, the anode of which is connected to the movable contact of switch A2.

It will be observed that a connection is thereby established from the movable contact of switch A2 via the diode D11 to each of the coils of the relays B through L as long as none of these relays is energized; but that as soon as one of the relays becomes energized, relays of a preceding order are automatically disconnected by the opening of the first-switch position of the relay that is energized.

The normally-open contact of switch A1 is directly connected to the normally-closed contact of switch B2; and the movable contact of switch B2 is directly connected to the normally-open contact of the second-position switch of each of the succeeding relays, namely, C2 through L2.

The normally-closed contact of switch B4 is directly connected to the normally-open contact of the third-position switches of each of the relays C through L — namely, the normally-open contacts of switch C3-L3. Similarly, the normally-closed contact of switch B3 is directly connected to the normally-open contact of each of the switches of relays C through L — namely, switches C4-L4. The normally-open contact of switch B3 is connected to a resistor R12. The movable contact of switch B3 is directly connected to the line 12.

The movable contacts of each of the second, third and fourth position switches of the relays C through L are con-

nected to separate wires; and these wires are brought and fed to the Second Sequential Digit Decoders, as explained more fully within.

Each of the relays C through L is selectively switched to an energized state by means of an associated silicon control rectifier (SCR) designated respectively SCR1 through SCR10. Each of the SCR's has an anode, a cathode, and a gate lead. The anodes of the silicon control rectifiers SCR1-SCR10 are connected respectively to the coils of the relays C through L; and the cathode of each of these SCR's is directly connected to the negative terminal of the voltage supply. Each of the SCR's has a capacitor connected between its anode and its cathode for limiting the rate of voltage rise across it; and these capacitors are designated respectively X1 through X10. Each of the SCR's is triggered by means of a voltage-divider network having one terminal connected to resistor 12 and the other terminal connected to the negative terminal of the voltage supply. The intermediate position of the voltage divider network is connected to the anode of a diode having its cathode connected directly to the gate lead of the SCR being triggered. The bias resistors for SCR1 are designated R13 and R14 respectively; and the triggering diode D1. The remaining bias resistors for silicon control rectifiers SCR2 through SCR10 are designated respectively R15 through R32; and their associated diodes are designated D2 through D10.

The relays A and B are energized respectively by transistors T1 and T2 which are NPN transistors and have their collector junctions connected to the coil of the relay which they energize. The emitter junction of each of the transistors T1 and T2 is connected directly to the negative terminal of the voltage supply. A resistor R33 connects the line 12 to bias networks for each of the transistors T1 and T2. Resistors R34 and R35 form the bias network for transistor T1; and resistors R36 and R37 form the bias network for transistor T2. The transistor T1 together with its associated bias resistors R34 and R35 are enclosed within a dashed line 25 as indicative of the circuitry which is included in the First Sequential Digit Decoder, but not in subsequent Sequential Digital Decoders for reasons explained within.

A capacitor X11 is connected between the negative terminal of the voltage supply and the terminal of the coil of relay B which is connected to the movable contact of switch B1.

Each of the bias networks for triggering the silicon control rectifiers SCR1 through SCR10 is designed to turn on its associated SCR at progressively higher voltage levels. That is, the lowest voltage which is necessary to trigger SCR1 is insufficient to trigger SCR2, and the lowest voltage which is necessary to trigger SCR2 is insufficient to trigger SCR3, and so on. It will be observed that a voltage which triggers one SCR will trigger all of the SCR's of lower order. The resistors R1-R10 in the Push Button Control Unit are selected in order to generate the progressively higher voltage levels between the lines 12 and 13 to trigger the SCR's. These levels are generated in the order of the push buttons S1-S10; and they are designed, in combination with R12 and the biasing networks for the SCR's, in incremental values to selectively trigger predetermined ones of the SCR's. For example, R1 is selected so that in combination with R12, R13, and R14, SCR1 will be triggered, but SCR2 will not, and so on. This example assumes that S11 is closed, for the system is turned "on" by closing the switch S11.

When the switch S11 is closed, a circuit is established between the positive terminal of the voltage supply at the central location to feed a current through R11 and S11 back through line 12 to resistor R33 to cause the transistor T1 to conduct in a saturated condition. This, in turn, will energize the coil of relay A and thus cause the movable contact of switches A1 and A2, to change positions and engage the normally-open contacts thereof.

The biasing networks for the transistors T1 and T2 are designed so that if S11 is closed and none of the switches S1-S10 are closed, only T1 will conduct. However, if any of the switches S1-S10 are also closed, a sufficient additional

voltage will cause the transistor T2 to conduct. Hence, when the switch S11 is closed, a sufficient voltage is generated across R35 to cause the transistor T1 to saturate (bias current being conducted through resistors R33 and R34) and thereby energize the coil of relay A. When the movable contact of switch A2 engages the normally-open contact, power is fed through diode D11 to the coil of relay B (as well as the coil of relays C through L); however, since transistor T2 is not in a state of conduction, this relay is not energized. At the same time, when the movable contact of switch A1 engages its normally-open contact, the normally-open contact of each of the second-position switches C2 through L2 are connected to the negative terminal of the power supply via the normally-closed contact of switch B2.

Depressing any one of the push buttons S1-S10 thereafter operates preselected ones of the relays C through L (up to the preselected order) together with relay B.

For example, depressing switch S8 will increase the voltage appearing across the lines 12 and 13 to a level which is sufficient, in combination with biasing resistors 27 and 28 to trigger the gate lead of SCR8 after relay B has been energized. It will be observed that the voltage triggering SCR8 will first cause transistor T2 to conduct thereby energizing relay B. Actuation of switch B1 causes a positive holding voltage to appear at one terminal of the coil of relay B. Actuation of switches B2, B3, and B4 remove all subsequent Sequential Digit Decoders from operation by opening the wires connected to them. Further, the line 12 is then established through the contacts of switch B3 and resistor R12 to the biasing network for each of the silicon control rectifiers SCR1 through SCR10. By depressing switch S8, relay B is energized and a sufficient voltage is thereafter generated across the biasing network R27 and R28 to trigger the gate lead of SCR8 which thereupon energizes relay J. The actuation of relay J will break the conduction of the positive power bus to the relays C through I via diode D11; but it will be remembered that as long as (and only for as long as) the push button S8 remains depressed, relay B is also energized.

Even though the voltage on line 12 will be sufficient to cause the silicon control rectifiers SCR1-SCR7 to conduct, relays C through I are not energized due to the open circuit of switch J1 and no signal is sent to subsequent Sequential Digit Decoders until push button S8 is released.

When push button S8 is released, transistor T2 returns to a non-conducting state thereby de-energizing relay B. It will be appreciated that silicon control rectifier SCR8 remains conducting once triggered, so only the relay controlled by that silicon control rectifier remains energized (along with relay A, of course).

The voltage signal generated by depression of S8 is insufficient to cause SCR9 and SCR10 to conduct. Therefore, only relay J of the decoding relays remains energized.

When relay J is thus energized, and the push button S8 released, relay B is de-energized, and the three output lines 37A, 37B, 37C, controlled by the relay J and associated respectively with contacts J2, J3, and J4, are fed to a Second Sequential Digit Decoder associated with this digit. That is to say, the line 12 is extended through the normally-closed contact of switch B3 and the normally-open contact of the fourth-position switches C4-J4 to line 37C. The line 13 is extended through the normally-closed contact of switch B4 and the normally-open contacts of each of the third-position switches C3-J3 to the line 37b. Further, the holding line is extended through the normally-open contact of switch A1 (which at this stage is closed), the normally-closed contact of switch B2, and the normally-open contacts of the second-position switches C2-J2 to the line 37a.

It will be appreciated that there is associated with each of the relays C through L, if desired a Second Sequential Digit Decoder; and these may all be identical in structure, operation and result. Therefore, only one such Second Sequential Digit Decoder need be described in detail in order to fully understand the present invention.

Turning then to FIG. 3, the Second Sequential Digit Decoder receiving the lines 37a, 37b, and 37c is shown in circuit schematic form. As already mentioned, the Second Sequential Digit Decoder is similar to the First Sequential Digit Decoder except that it does not have the circuitry enclosed within the dashed line 25. Therefore, the conventions already explained for identifying the elements will be used. There are twelve relays identified respectively and in order by letters M through X; and each of the relays N through X have associated with it four switches. Each switch is identified by a capital letter together with a numeral, as before. The relay M has associated with it two such switches, M1 and M2. Again, the positive terminal of the power supply is connected to the relay M, the normally-open contact of switch N1 and the normally-open contact of switch M2. The other terminal of the coil of relay M is directly connected to a line 37a so that as soon as the push button which energizes relay J in the First Sequential Digit Decoder is released and relay B is de-energized, the relay M becomes energized actuating switches M1 and M2 which respectively supply a direct connection to the negative terminal of the power supply to each of the normally-closed contacts of switch O2-X2 and directly connecting the positive terminal of the power supply to the normally-closed contact of each of the switches N1-X1 through diode D22.

As with the First Sequential Digit Decoder, the Second Sequential Digit Decoder includes ten silicon control rectifiers for selectively energizing the relays O through X respectively; and these SCR's are designated SCR11 through SCR20. Each of the silicon control rectifiers SCR11-SCR20 has a capacitor connected across its power terminals, a bias resistor network and a diode coupling the bias resistor network to its gate lead — these are identified respectively as X12 through X21, R39 through R58, and D12 through D21.

Line 37c is also connected via a resistor R59 to a biasing network comprising resistors R60 and R61 connected to the base of a transistor T3. The collector of the transistor T3 is connected to the coil of relay N; and the emitter of transistor T3 is connected to the negative terminal of the power supply. A capacitor X22 is connected between one terminal of the coil of relay N and the negative terminal of the power supply. A resistor R38 is connected between the normally-open contact of switch N3 and the bias networks for the SCR's of the Second Sequential Digit Decoder.

As will be recalled from the previous example, the normally-closed contacts of switches B3 and B4 (FIG. 2) are open as long as the push button S8 (or any push button actuating the First Sequential Digit Decoder) is depressed, and lines to Second Sequential Digit Decoder are thereby open. Hence, no signals may be fed beyond the First Sequential Digit Decoder. Releasing push button S8 de-energizes relay B. However, silicon control rectifier SCR8 remains in a conducting state. Once the First Sequential Digit Decoder is actuated by depressing one of the push buttons S1-S10, it may not thereafter be actuated until switch S1 is opened because, in the example, the relay B can no longer be energized. The reason that it cannot be energized is that the conduction of the positive terminal of the power supply has been broken by switches J1 and B1. Therefore, when the next of the push buttons S1-S10 is depressed, for example S2, an increase in voltage appears on lines 37b and 37a which are extensions of the previously-identified lines 12 and 13 respectively.

Thus, when push button S2 is depressed, a voltage increase appears between lines 37c and 37b by conducting additional current through R2 and S2, through the normally-closed contact of switch B3 and the normally-open contact of J4, and the bias network R59, R60, and R61 to cause transistor T3 to conduct thereby energizing the coil of relay N. The positive terminal of the power supply is connected to the coil of relay N through the then-closed contacts N1. Relay P is then energized by triggering the gate lead of SCR12 via the depressed switch S2, resistor R2, the normally-closed contact of switch B3, the normally-open contact of switch J4, line 37c, the normally-open contact of switch N3, resistor R38, and the bias network R41 and R42.

Energy is supplied to relay P from the positive terminal of the power supply through the normally-open contact of switch M2, diode D22, and the contacts of the first position switches Q1-X1. As with the First Sequential Digit Decoder, the actuation of contact P1 prevents power from being fed to the coil of relay O and thereby prevents its actuation. Since, while the push button S2 is depressed, relay N is actuated, the normally-closed contacts of switches N3 and N4 are disconnected respectively from lines 37c and 37b. Therefore, operation beyond the Second Sequential Digit Decoder cannot occur at this time because there is no continuity. However, when the push button S2 is released, line 37c is continued through the normally-closed contact of switch N3, and the normally-open contact of switch P4 to the output line 39c. Similarly, the line 37b is continued through the normally-closed contact of switch N4 and the normally-open contact of switch P3 to the line 39b. The negative terminal of the power supply is coupled through the normally-open contact of switch M1, the normally-closed contact of switch N2, and the normally-open contact of switch P2 to an output line 39a.

The lines 39a-39c may be fed to a Third Sequential Digit Decoder, if desired, or in the alternative, to a Remote Control Unit such as the one illustrated in circuit schematic form in FIG. 4.

Turning then to FIG. 4, the Remote Control Unit seen is somewhat similar in its selection operation to the previously-described Sequential Digit Decoders. As seen therein, the Remote Control Unit includes a first relay Y having one coil connected to the positive terminal of the power supply and another terminal connected to line 39a. The relay Y has associated with it switches designated Y1, Y2, and Y3 respectively. Switches Y2 and Y3 couple an audio feed from the remote location back to the transformer T1 (see FIG. 2) via lines 12 and 13 when relay Y is energized. When the Second Sequential Digit Decoder is energized, and the push button energizing it is released, the line 39a will connect one terminal of the relay Y to the negative terminal of the power supply as already described, thereby energizing the coil of relay Y and actuating the switches Y1-Y3. In this example, the subsystem which is controlled by the Remote Control Unit of FIG. 4 is an audio tape recorder. Therefore, the contacts Y1 may be connected to a "Start" solenoid as shown.

The Remote Control Unit also includes a relay Z with a coil having one terminal connected to the positive terminal of the power supply and a second terminal connected to the collector of a transistor T4, the emitter of which is connected to the negative terminal of the power supply. The base of transistor T4 is connected to a biasing network including a resistor R74 and a resistor R75. One terminal of the resistor R74 is directly connected to the line 39c; and a terminal of resistor R75 is directly connected to the negative terminal of the power supply. The relay Z has associated with it three switches, Z1 through Z3 respectively. Switches Z1 and Z2 have movable contacts which are connected directly to lines 39c and 39b respectively. The normally-closed contacts of switches Z1 and Z2 are connected to the normally-open contacts of switches Y2 and Y3 respectively.

The Remote Control Unit also includes in the illustrated embodiment, five relays designated AA-EE respectively. The relay AA has associated with it one set of contacts of AA1; and the relays BB-EE have associated with them two switches BB1 and BB2, CC1 and CC2, DD1 and DD2, and EE1 and EE2 respectively. Each of the relays AA-EE is controlled by an SCR, respectively identified as SCR21-SCR25. Diodes D23-D27 are coupled respectively to the gate leads of the silicon control rectifiers SCR21-SCR25. Bias networks similar to the ones previously described are provided by means of the resistors R63-R72 respectively. Capacitors X23-X27 are connected across the power terminals of the silicon control rectifiers SCR21-SCR25 respectively for purposes previously described. An input resistor R62 is connected between the normally-open contact of switch Z1 and the biasing networks; and a resistor R73 is connected to the negative terminal of the power supply.

The bias networks for the silicon control rectifiers SCR21-SCR25 are designed in accordance with the described principles of individual selection. That is, as the voltage increments transmitted to the Remote Control Unit increase, an increasing number of the SCR's will be triggered; however, because the switches are connected to feed the positive power supply through the diode D28 and the first-positioned switches BB1-EE1, a predetermined number of said SCR's will be actuated, but only the last of the relay coils associated with these triggered SCR's will be energized because power will not be supplied to the relay coils of previous SCR's. For example, if the push button S3 is depressed, first transistor T4 will conduct to thereby energize relay Z. Voltage will then be fed to the bias networks of silicon control switches SCR21-SCR25 through switch Z1; and power will be fed to the coils of relays AA-EE through switch Z3. SCR23 will then be triggered and the coil of relay CC will be energized. However, this will cause switch CC1 to actuate thereby removing the positive supply from the coils of relays AA and BB inhibiting their operating despite that the silicon control rectifiers SCR21 and SCR22 have also been triggered. Switch CC2 is also closed and the tape recorder, having already been started, is controlled in its "fast forward" mode of operation. It will be observed that the operation of the Remote Control Units is unlike the Sequential Digit Decoders in the sense that the relay selected will be energized only so long as its associated push button is depressed, and the Remote Control Unit is not locked out of operation. That is to say, there is no mechanism for locking in the selected relay and thereby preventing the actuation of other functions. Depressing another push button will operate another relay of the Remote Control Unit in a similar fashion.

The system is de-activated by opening switch S11 at the Push Button Control Unit 10. This de-energizes all relays in the system by removing the bias from transistor T1 to de-energize relay A. Switch A1 then breaks the power line to relay M in the Second Sequential Digit Decoder. Switch A2 breaks the power line to all other relays in the First Sequential Digit Decoder. Switch M1 breaks power fed to relay Y in the Remote Control Unit; and switch M2 breaks the power line to all other relays in the Second Sequential Digit Decoder.

From the above description of the illustrated embodiment, it will be apparent to persons skilled in the art that the inventive principles described herein are very broad in their application. For example, any number of sequential digits may be used to form the address portion of a call word; and once a particular subsystem has been addressed, the Remote Control Unit associated with it may be actuated in any selected way to control that subsystem over a single pair of wires from the user or operator.

OPERATION

Persons skilled in the art will understand the operation of the inventive system from the foregoing detailed description of a preferred embodiment which incorporates information descriptive of the operation of individual system components as those components are disclosed. Nevertheless, it is deemed advisable for clarity to set forth a summarized description of the operation at this point.

Referring to FIG. 2, the closing of the ON/OFF switch S11 generates a voltage across lines 12 and 13 which causes transducer T1 to conduct and thereby energize the coil of relay A. The switches of relay A then close to supply positive voltage to the coils of relays B-L; and it connects the normally-open contacts of each of the second-position switches B2-L2 to the negative terminal of the power supply.

When push button S8 is closed, the voltage across the lines 12 and 13 increases by a predetermined increment which is sufficient to cause transistor T2 to conduct thereby energizing the coil of relay B. Switch B1 locks relay B in an energized state by connecting the coil thereof directly to the positive terminal of the power supply. Switch B2 interrupts the transfer of

the negative terminal of the power supply to the second-position switches. Switch B3 completes continuity between the line 12 and the bias networks for the SCR's in the First Sequential Digit Decoder which detect the various discrete voltage levels generated by the Push Button Control Unit. At the same time, switch B3 inhibits the establishing of continuity between line 12 and the fourth-position switches C4-L4.

Switch B4 opens to inhibit the establishment of continuity between the positive terminal of the power supply and the third-position switches C3-L3. There will be observed here that the relay B and its associated switches are actuated only as long as one of the push buttons S1-S10 is depressed and the switch S11 is closed. However, when the push button S8 is depressed and after the relay B is energized as just described, all of the silicon control rectifiers SCR1-SCR8 are also caused to conduct. The relays associated with these SCR's would also conduct except that when relay J is energized by SCR8, power is inhibited from flowing to the coils of relays C-I so that these relays cannot be energized. Relays K and L are not energized because the incremental voltage signal generated by depressing switch S8 is insufficient to cause SCR9 and SCR10 to conduct. Thus, relay B, when it is energized, operates to block out subsequent Sequential Digital Decoders and, at the same time, transmits the digital control voltage to the SCR detectors.

Upon release of push button S8, relay B is deenergized; and it performs two functions at this time. The first function is to block out the First Sequential Digit Decoder from further operation by opening switch B1 to inhibit the flow of power to the coil of relay B until relay J is de-energized. Secondly, when relay B is deenergized, switches B2-B3 cooperate with the switches of the selected relay (that is, switches J2-J4) to further the continuity of lines 12 and 13 and to feed the negative voltage of the power supply to a subsequent sequential digit decoder (or remote control unit) to energize the same.

Thus, line 37c becomes a continuation of line 12 via switch J4; and line 37b becomes a continuation of line 13 via switch J3; and line 37a is energized with the negative voltage of the power supply via switch J2.

The negative voltage transmitted through J2 to line 37a energizes relay M of the Second Sequential Digit Decoder (FIG. 3) thereby actuating switch M1 and M2. When push button S2 is depressed, transistor T3 is caused to conduct thereby energizing the coil of relay N, temporarily locking in that relay via switch N1 and interrupting transmission of the negative voltage of the power supply to the second-position switches (by means of switch N2). At the same time, the switch N3 closes to establish continuity between line 37c and the SCR detectors for the Second Sequential Digit Decoder. Thus, silicon control rectifiers SCR11 and SCR12 are switched to a conducting state but only relay P is energized because power is interrupted with respect to relay O. Again, the voltage generated across lines 12 and 13 by depressing the switch S2 is insufficient to trigger the higher-order SCR detectors of the Second Sequential Digit Decoder (Namely, SCR13-SCR20).

When push button S2 is released, relay N is deenergized because transistor T3 is cut off thereby opening switch N1 and removing the detection circuitry of the Second Sequential Digit Decoder from subsequent operation. Switches N3 and N4 complete continuity respectively between lines 37c and 39c, and lines 37b and 39b. Switch N2 then couples the negative voltage of the power supply to line 39a.

When the negative voltage appears on line 39a, relay Y (FIG. 4) of the remote control unit is energized to actuate switches Y1-Y3. Switch Y1 performs a control function; and switches Y2 and Y3 couple the audio feed to the lines 39c and 39d which, of course, are directly connected to the lines 12 and 13 so that the audio signal appears cross transformer T1 at the subscriber location as long as the relay Z is not energized. When one of the push buttons is then actuated, the voltage signal generated between lines 12 and 13 is directly transmitted to lines 39c and 39b to cause transistor T4 to conduct

and thereby energize the coil of relay Z. Switch Z1 couples line 39c directly to the SCR detectors of the remote control unit which operate in a manner similar to those already described for the sequential digit decoders. At the same time, switches Z1 and Z2 interrupt the coupling of the audio feed to the wires feeding back to the subscriber location; and switch Z3 couples the positive terminal of the power supply to feed the coils of relays AA-EE. It will be appreciated that when the push button is then released, transistor T4 is shut off thereby de-energizing the coil of relay Z and opening switch Z3 so that the actuated function relay is de-energized.

Having thus described in detail a preferred embodiment of my invention, it will be apparent to persons skilled in the art that certain elements may be modified from those described and that circuitry capable of performing equivalent functions may be substituted for that which has been described with like results; and it is, therefore, intended that all such equivalents and modifications be covered as they are embraced within the spirit and scope of the invention.

We claim:

1. A system for addressing and controlling a remote subsystem comprising: control means controllable by a user for generating a digit signal preselected from a set of digit signals, each digit signal of said set differing from other digit signals of said set by a predetermined signal increment; a pair of wires; decoder means remote from said control means and connected thereto by said pair of wires for receiving digit signals generated at said control means, and including a plurality of first detector means, one associated with each digit signal of said set and responsive to a predetermined level of said digit signals whereby a received digit signal is capable of actuating all of said detector means responsive to signal levels up to the level of said received signal; a plurality of first switching means, one responsive to each of said first detector means for de-energizing all of said detector means of lower order when its associated detector means is energized by said received signal and for connecting said pair of wires to a preselected one of a plurality of output lines when its associated detector means is energized; remote control means associated with said subsystem and receiving said output line of said decoder means, said remote control means comprising a plurality of second detector means, each responsive to a different level of said signal levels whereby a received one of said signal levels actuates all of said second detector means up to the level of said received signal; and a plurality of second switching means, one responsive to each of said second detector means for de-energizing all of said second detector means of lower order when its associated second detector means is energized thereby leaving activated only that second detector means of highest order and responsive to said received signal level, said second switching means including signal transfer means for conveying a subsequent sign level to control a preselected function of an addressed subsystem by said user.

2. The system of claim 1 wherein said decoder means includes third switching means responsive to a received digit signal for interrupting the continuity of said pair of wires to said first switching means in response to the generation of one of said digit signals and for thereafter enabling the actuation of said first decoder means and for establishing continuity between said pair of wires and said plurality of first switching means only when said digit signal is not being generated, said third switching means thereupon rendering said decoder means unresponsive to subsequent digit signals.

3. The system of claim 2 further comprising an ON/OFF switch at said control means for energizing and de-energizing said decoder means, said ON/OFF switch releasing said third switching means of said decoder means to thereafter render said decoder means responsive to a subsequent digit signal.

4. The system of claim 1 wherein said control means is a push switch control unit comprising a plurality of push button switches, one for generating each discrete signal level transmitted to said decoder means; a resistor in series with each of said switches, each switch and resistor combination connected

between said pair of wires, said resistors having values of resistance such that when said wires are energized by a source of power, said discrete digit signals will be generated across said pair of wires in accordance with the actuation of one of said push switches.

5. The system of claim 4 further comprising in said control means a manually-controllable ON/OFF switch and a resistor connected in series therewith across said pair of wires, and fourth switch means in said sequential detector means responsive to the closing of said ON/OFF switch in said control means for coupling power to all of said first detector means in said decoder means whereby said sequential decoder means is rendered inactive until said ON/OFF switch in said push switch control unit is closed.

6. The system of claim 5 wherein each of said plurality of first switching means in said decoder means is further responsive to the closing of said ON/OFF switch and the actuation of any one of said push button switches for interrupting the continuity of said pair of wires to said output lines as long as a push button switch is actuated and for coupling power to energize said plurality of first detector means whereby said detector means are sequentially energized only after said third switching means and said fourth switchinG means are activated.

7. The system of claim 1 further including a plurality of second decoder means, one for each digit signal decodable by said first-named decoder means each selectable by an associated one of said first detector means only after the digit signal selecting the same is no longer being generated, said second decoder means receiving the continuation of said pair of wires along said output line transmittinG a second sequential signal, said second decoder means comprising a plurality of second detector means, one for each of said second digit signals and each responsive to a different predetermined increment level of said second digit signals and each responsive to a different predetermined increment level of said second digit signals whereby a second received digit signal actuates all of said detector means responsive to said digit signals up to the level of said received signal; and a plurality of fifth switching means, one responsive to each of said second detector means for de-energizing all of said second detector means of lower order, and for connecting said output line of said first decoder means to a second output line.

8. The system of claim 1 wherein each of said first detector means comprises a solid state switch; and a biasing network for triggering said solid state when energized with a digit signal of predetermined value.

9. The system of claim 8 wherein each of said first switching means comprises a relay having a coil energized by an associated one of said solid state switches and a plurality of relay switches controlled by said coil, one of said switches coupling power to detectors of lower order, others of said said switches coupling said pair of wires to a subsequent decoder when actuated.

10. The system of claim 9 further comprising sixth switching means interposed between said pair of wires and said biasing networks to energize the same only after said sixth switching means has been energized, said sixth switching means disconnecting said input lines from said output lines as long as said digit signal is generated and disconnecting said first detector means from said pair of wires after the first of said digit signals lapses.

11. A system for addressing and controlling a remote subsystem comprising: control means controllable by a user to generate one discrete signal level of a plurality of signal levels; first decoder means having a plurality of output lines and remote from said control means and responsive to a discrete signal therefrom to connect said control means to one of said output lines selected according to the level of said discrete signal and to thereafter remove said first decoder means from communication with said control means; a remote control unit for each of said output lines and receiving a discrete signal over a selected one of said lines subsequent to said first-named

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discrete signal to energize a function switch responsive to the level of said received subsequent discrete signal; and a plurality of second decoder means, one for each output line of said first decoder means and each having a plurality of second output lines and responsive to a second discrete signal to communicate said control means with one of said second output lines according to the level of said second discrete signal, said remote control units being connected to the second output lines of said second decoder means and responsive to the third-occurring of said discrete signals.

12. A system for addressing and controlling a remote subsystem comprising: control means controllable by a user for generating a digit signal preselected from a set of digit signals, each digit signal of said set differing from other digit signals of said set by a predetermined signal increment; a pair of wires; decoder means remote from said control means and connected thereto by said pair of wires for receiving digit signals generated at said control means, said decoder means including a plurality of first detector means, one associated with each digit signal of said set and responsive to a predetermined level of said digit signals whereby a digit signal is capable of actuating all of said detector means responsive to signal levels up to the level of said received signal; a plurality of relays, one associated with each of said detector means and having a first terminal of its coil connected to an associated detector means and a second power terminal, each relay further having a first set of normally closed contacts and second and third sets of normally open contacts; first conductive means connecting all of said first sets of normally closed

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contacts in series and for connecting the first contacts associated with the highest order detector means to a source of power; second conductive means for connecting each of said second and third sets of normally open contacts in circuit with said pair of wires such that when an associated relay coil is energized, continuity will be established between said pair of wires and a selected pair of output wires via the second and third sets of relay contacts of the energized relay; and a momentary relay means at said decoder means and energized only when any of said digital signals is received a first time, said momentary relay means having at least two sets of contacts for interrupting connection between said pair of wires and said second and third sets of normally open relay contacts, whereby a received digital signal from said control means will energize said momentary relay means and all of said detector means up to a preselected order, the opening of the first pair of contacts associated with the highest order one of the energized relays acting to interrupt power flow to relays of lower order detectors only, whereby the relay associated with the level of the received digital signal is energized and locked in, the second and third sets of contacts thereof being closed to thereby connect their associated pair of output wires to the said pair of wires when the received digit signal is removed and said momentary relay means is de-energized, said momentary relay means further being isolated by the energization of one of said relay means to become insensitive to a subsequent digit signal.

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