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Getchell
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[54] ALARM SIGNALLING NETWORK

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[73] Assignee: **Signatron, Inc.**, Lexington, Mass.

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[21] Appl. No.: **170,558**

[52] **U.S. Cl.** **340/413**, 340/409
[51] **Int. Cl.** **G08b 29/00**
[58] **Field of Search** 340/408, 409, 213, 340/413, 163

[56] **References Cited**

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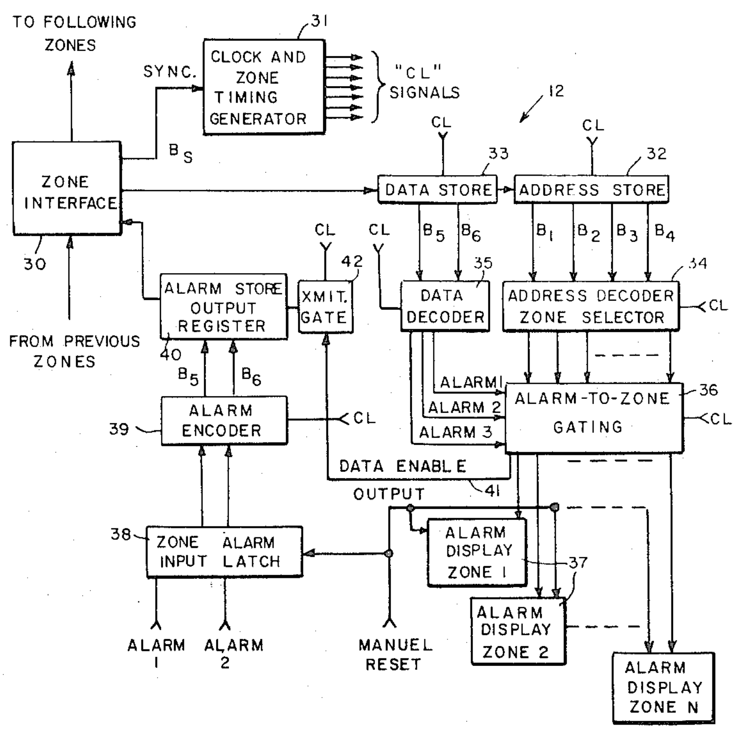
Primary Examiner—Donald J. Yusko
Attorney—Sewall P. Bronstein, John D. Woodberry and Robert T. Gammons et al.

[57] **ABSTRACT**

An alarm signalling network which monitors the alarm status of a plurality of separate zones under surveillance. A control station supplies a composite signal for transmission to a receptor station at each of the zones, which signal includes interrogation portions to which the receptor stations respond. Each receptor station thereupon produces an alarm status signal, which are included as alarm status signal portions of the composite signal. The composite signal is transmitted via a common transmission link between the control station and receptor stations, at least one of the receptor stations having means for displaying the alarm status from one or more of the other receptor stations, and the operations of the control and receptor stations are appropriately synchronized.

24 Claims, 12 Drawing Figures



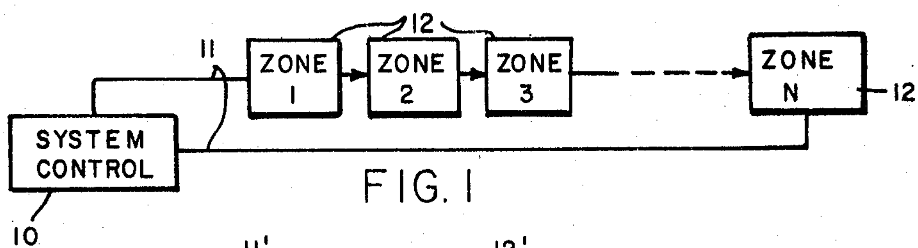


FIG. 1

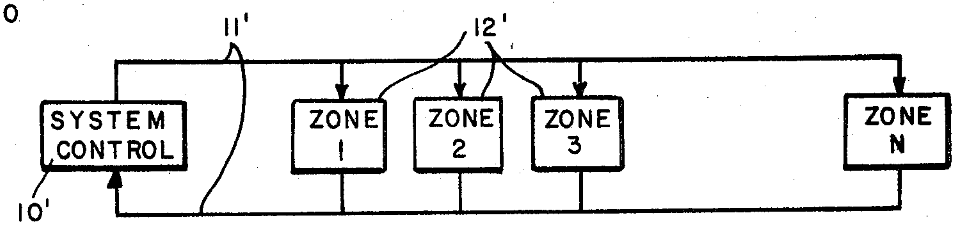


FIG. 1A

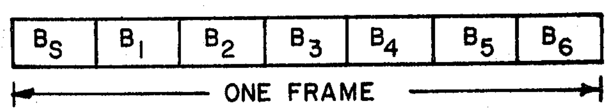


FIG. 2

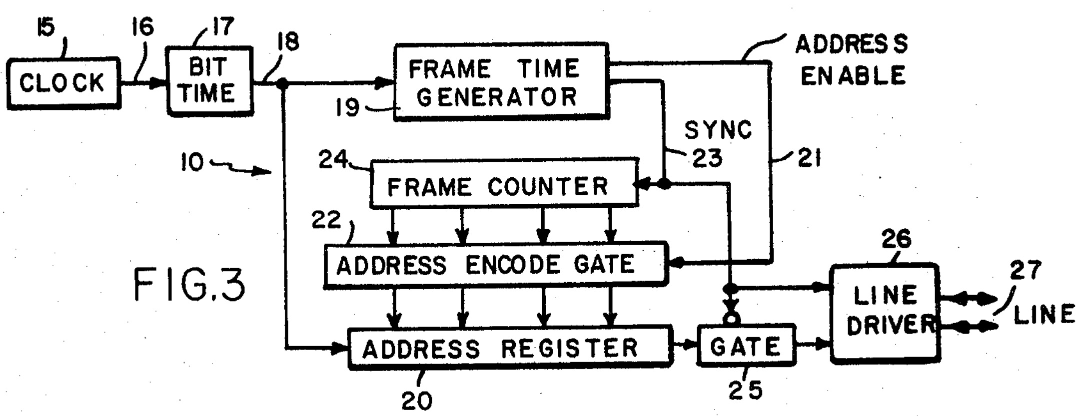


FIG. 3

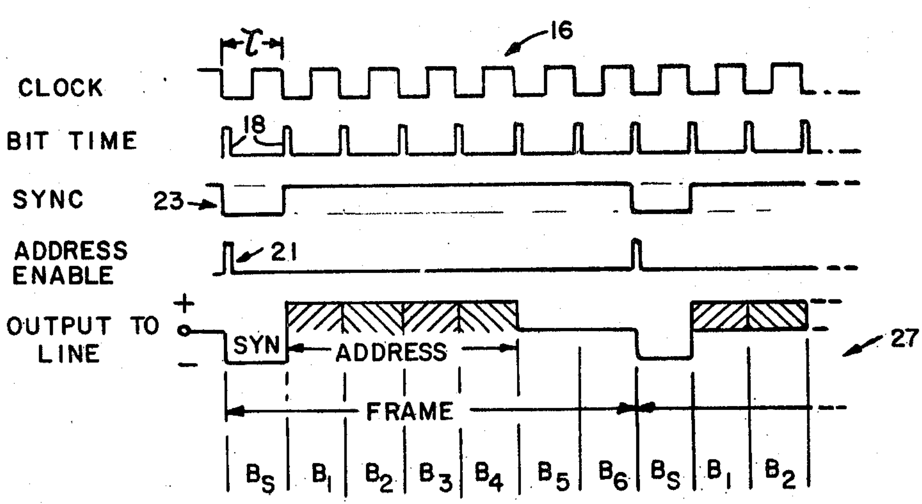


FIG. 3A

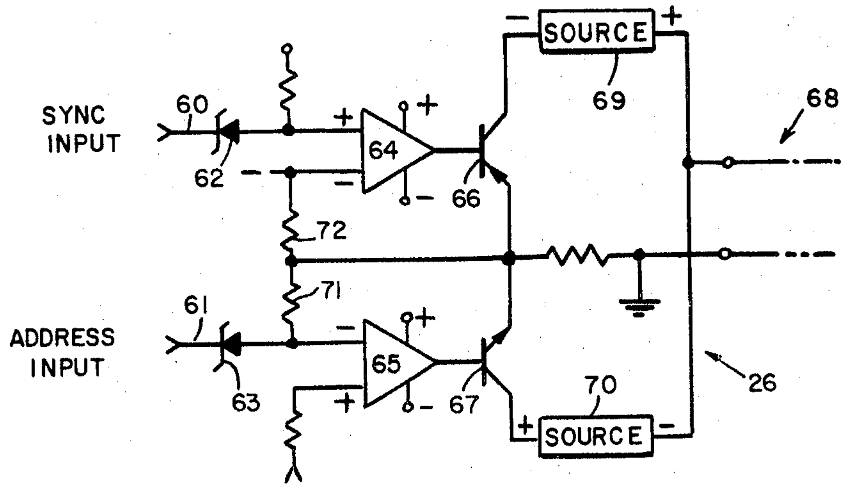

SOURCE
69
68
SYNC
INPUT
60
62
64
66
72
71
61
ADDRESS
INPUT
63
65
67
70
26
SOURCE

FIG.4

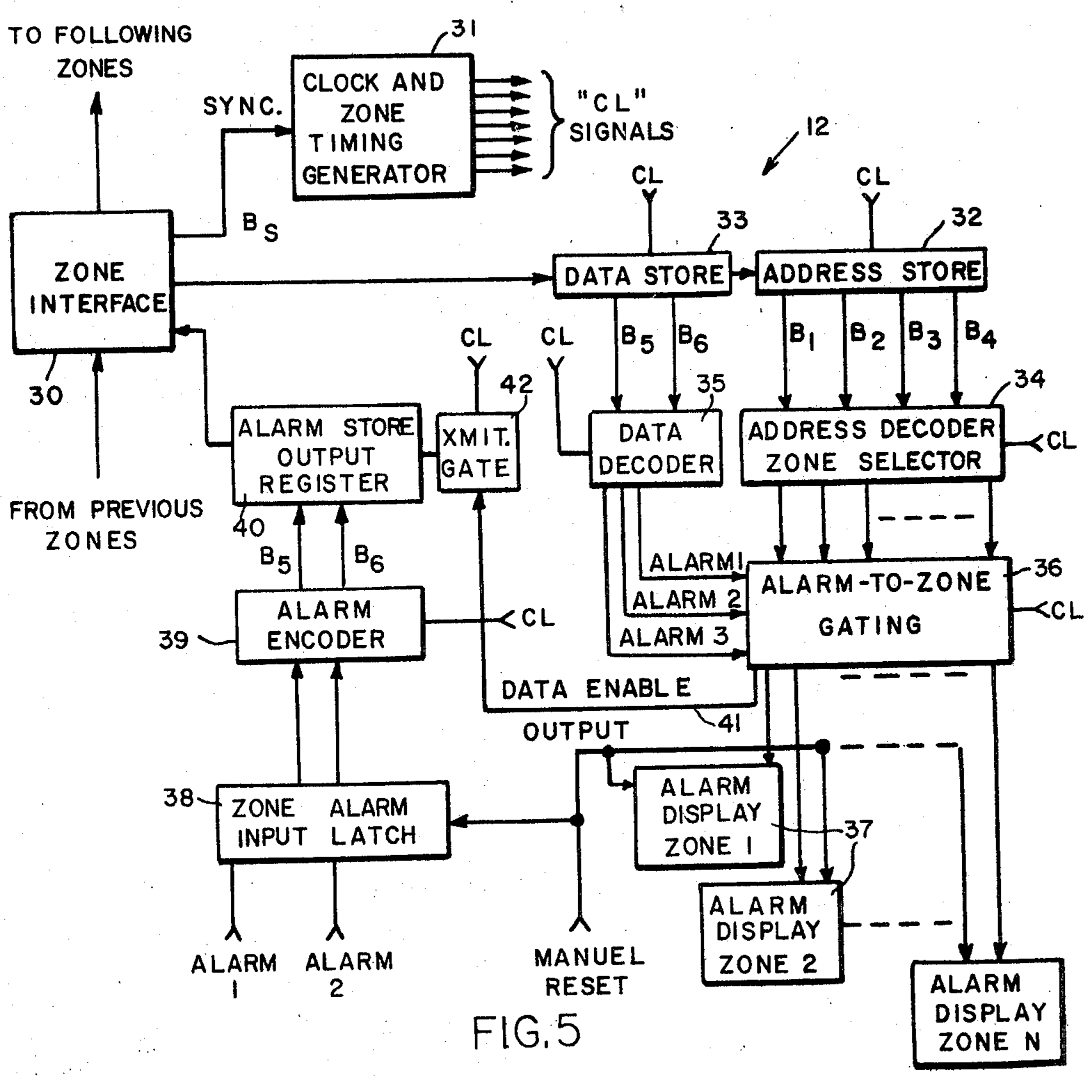

TO FOLLOWING
ZONES
31
SYNC.
CLOCK AND
ZONE
TIMING
GENERATOR
"CL"
SIGNALS
12
CL
CL
33
32
B_S
ZONE
INTERFACE
DATA STORE
ADDRESS STORE
CL
CL
B_5
B_6
B_1
B_2
B_3
B_4
30
42
35
34
ALARM STORE
OUTPUT
REGISTER
XMIT.
GATE
DATA
DECODER
ADDRESS DECODER
ZONE SELECTOR
CL
FROM PREVIOUS
ZONES
40
B_5
B_6
ALARM1
ALARM 2
ALARM 3
ALARM-TO-ZONE
GATING
36
CL
39
ALARM
ENCODER
CL
DATA ENABLE
OUTPUT
41
38
ZONE ALARM
INPUT LATCH
ALARM
DISPLAY
ZONE 1
37
ALARM
DISPLAY
ZONE 2
ALARM
1
ALARM
2
MANUEL
RESET
ALARM
DISPLAY
ZONE N

FIG.5

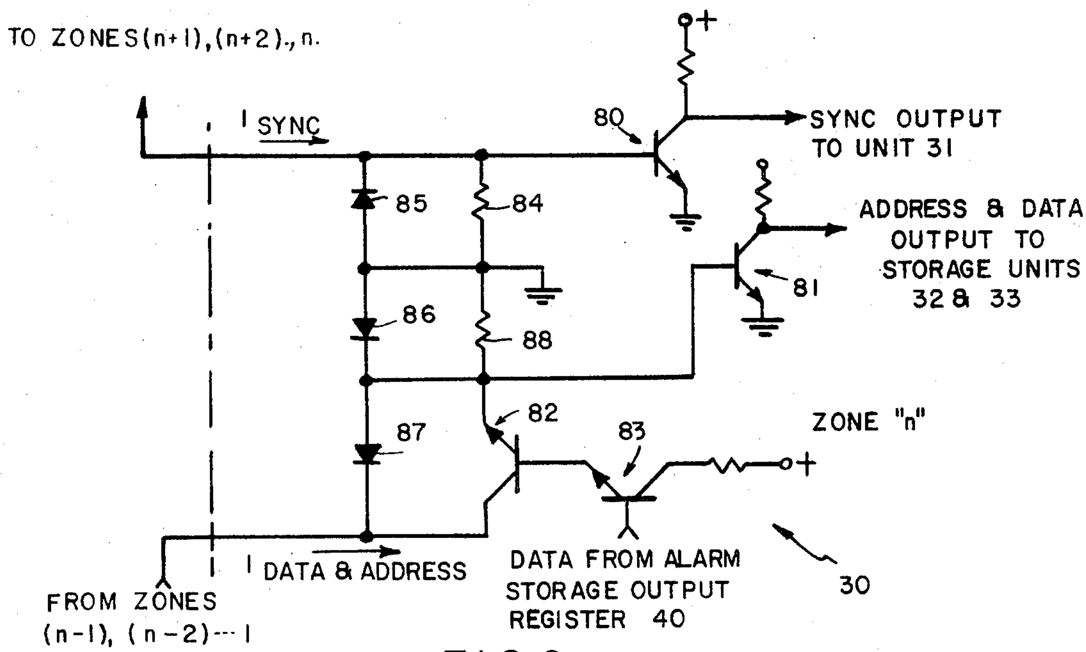

TO ZONES(n+1),(n+2).,n.
SYNC
80
SYNC OUTPUT TO UNIT 31
85
84
ADDRESS & DATA OUTPUT TO STORAGE UNITS 32 & 33
81
86
88
82
87
83
ZONE "n"
DATA & ADDRESS
DATA FROM ALARM STORAGE OUTPUT REGISTER 40
30
FROM ZONES (n-1), (n-2)--- 1

FIG.6

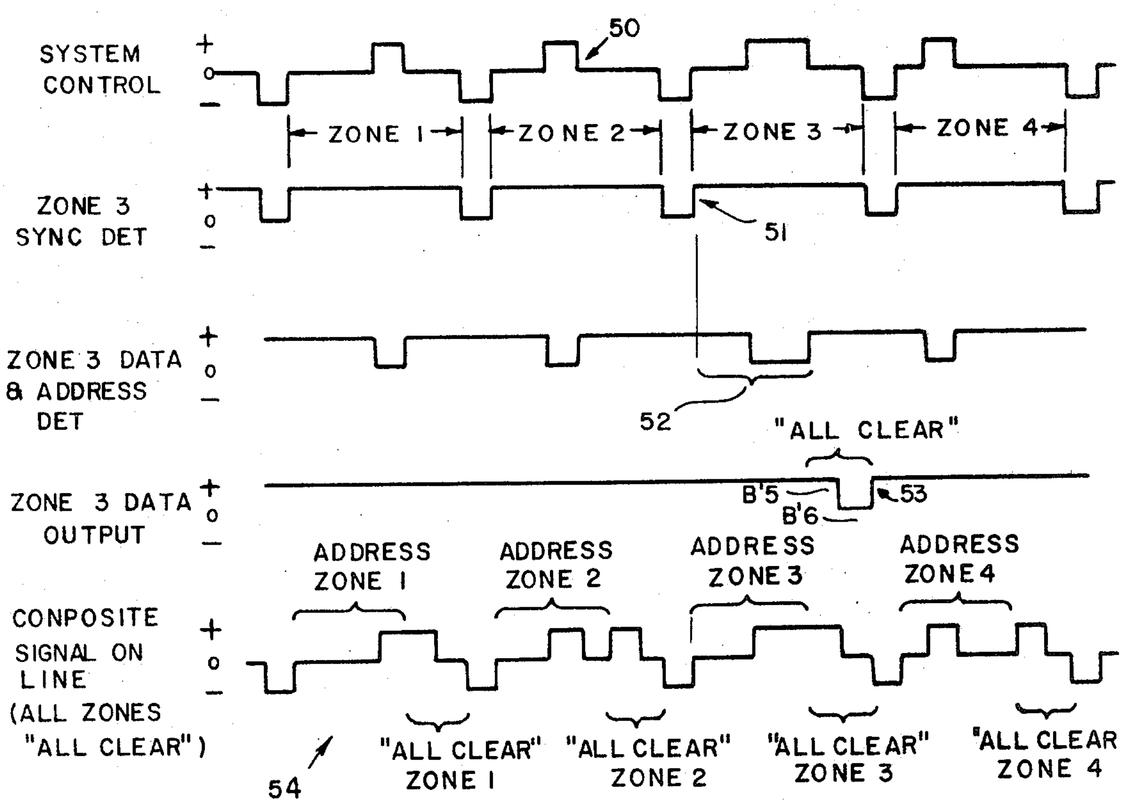

SYSTEM CONTROL
50
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 3 SYNC DET
51
ZONE 3 DATA & ADDRESS DET
52
"ALL CLEAR"
ZONE 3 DATA OUTPUT
B'5
B'6
53
ADDRESS ZONE 1
ADDRESS ZONE 2
ADDRESS ZONE 3
ADDRESS ZONE 4
CONPOSITE SIGNAL ON LINE (ALL ZONES "ALL CLEAR")
54
"ALL CLEAR" ZONE 1
"ALL CLEAR" ZONE 2
"ALL CLEAR" ZONE 3
"ALL CLEAR' ZONE 4

FIG. 7

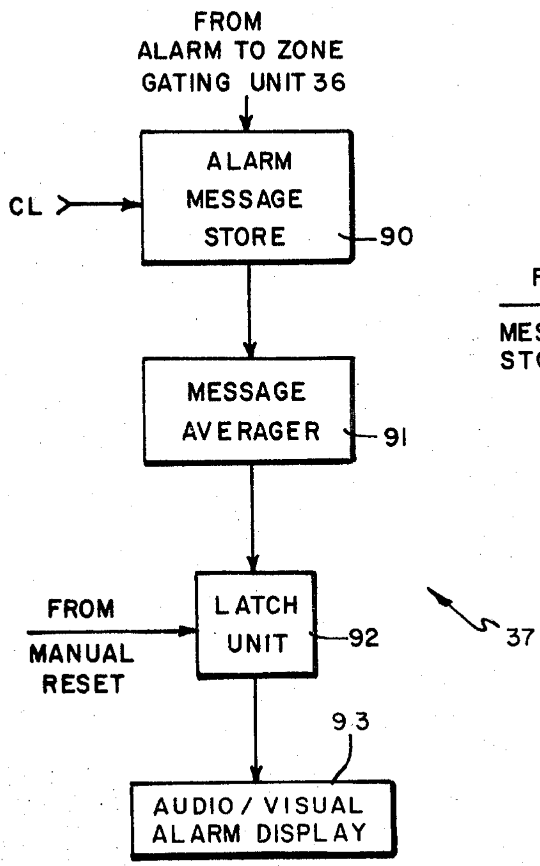


FIG.8

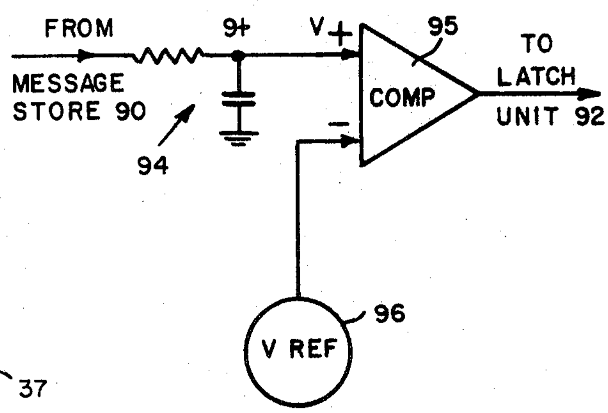


FIG.9

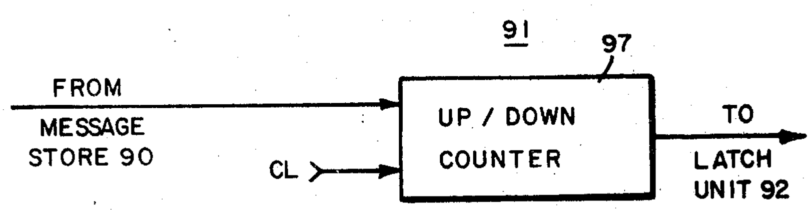


FIG.9A

ALARM SIGNALLING NETWORK

This invention relates generally to alarm systems for indicating the presence of trouble, or other alarm conditions, at a plurality of different locations and, more particularly, to an alarm system adaptable for use in residential neighborhoods for detecting the presence of intruders or fire at different subscriber locations within the same general vicinity.

It is desirable, in the protection of residences from fire or burglary, to provide an inexpensive and relatively unsophisticated alarm system that is readily usable by a system subscriber, such as a homeowner. At the present time most commercially available alarm systems effective for reporting the presence of an intruder and/or for reporting the presence of fire in a subscriber location comprise separate alarm detection equipment set up in each location and a separate central station for receiving the alarm information from each subscriber location, such central station being at an appropriate community location, such as a police station and/or a fire station. The central station may be connected by separate lines connected from each of the individual subscriber stations to the central station or the individual subscriber stations may be connected to the central station via a common line.

In either case the central station is usually passive in its operation, that is, it is arranged to receive the alarm signals but does not itself generate any operating signals. Moreover, such systems are relatively expensive to install since they require at least one or more separate lines which must be installed over relatively long distances from the subscribers to the central location being used. If individual lines are used the cost to each subscriber is high, and even where a common line is used, a large number of subscribers are required to support the installation and maintenance costs of the system. Additional charges for the operation of the community monitoring and detecting equipment located at one or more central stations are required, so that not only are initial installation charges high but continuing maintenance and service charges add to the overall cost.

This invention, however, provides a less expensive alarm system which eliminates the initial costs required in the installation of long separate lines or a long common line, from the subscribers to one or more central community stations and additionally reduces the continuous monitoring, maintenance, and other service charges associated therewith.

In accordance with the invention, the overall cost of the equipment is effectively shared by a limited but sufficient, number of subscribers, all of whom are usually located in the same general neighborhood within the community. The invention utilizes an alarm signalling network which is confined to the limited group of subscribers involved and comprises a central station, which usually can be located at one of the subscriber locations that is being serviced by the network, and a plurality of receptor stations, one located in each of the different subscriber locations thereof. The central station and the individual receptor stations utilize a common transmission line for interconnecting all of the stations. The network provides for a display, at each of the subscriber receptor stations, of the alarm status of at least some, or in some cases all, of the receptor stations in the network.

Thus, if a sufficient number of receptor stations is included in the network, the chances that one or more of the subscribers will be present to detect the presence of an alarm signifying trouble at one of the other stations is considerably enhanced and in some cases becomes virtually certain. Accordingly the detection of a "trouble" alarm condition at any one of the subscriber locations in the network can then be readily conveyed by telephone to the appropriate police, fire or other community station in order to obtain the necessary help. Such a system eliminates the need for separate lines to be run from each subscriber location directly to such a community central station or the need to rent lines from the telephone company specifically for such service, since the communication to the source of help depends on the use of already existing telephone lines. Moreover, the common transmission line interconnecting the central and localized individual receptor stations within the network is much shorter and, accordingly, is easier and less expensive to install. Moreover, the use of shorter lines interconnecting the network makes it less likely that noise picked up thereby will tend to generate false alarms, since the longer the line the more exposed the line becomes to external noise perturbations. In addition, shorter lines mean lower power requirements and, accordingly, cheaper standby battery equipment, as well as generally better reliability. Further, the encoding and decoding equipment can be less sophisticated in nature since in any one particular network the number of homes needed to be serviced is limited, and the identification of the locations and alarm status of each station within the network is thereby made much simpler.

Although the invention is described with reference to its application to a plurality of subscriber locations, such as residential homes located within the same general neighborhood, it is clear that the invention need not be limited to such use but the system may be adapted to other situations which may occur to those in the art.

The invention can be described as comprising a network having a system control station for producing an interrogation signal which is transmitted simultaneously, and is addressed in turn to each of the several separate locations, or zones, within the network. In the description of the invention, the word "zones" generally refers to a receptor station location at which an alarm signal may be generated for transmission to one or more other receptor stations within the network. Receptor stations located at each of the zones of the network each receive the interrogation signal from the control station and produce a signal signifying the alarm status of the zone at which the receptor station is located. A common transmission line interconnects the control station with each of the receptor stations and each of the latter stations to each other so that the interrogation signal can be transmitted from the control station to each of the receptor stations in turn and so that the alarm signals from each of the receptor stations can be transmitted to one or more of the other receptor stations. The receptor stations in each zone include means for detecting the alarm signals from one or more of the other receptor stations and for displaying the alarm status of some, or in some cases, all of the stations in the network. Appropriate means for synchronizing the operations of the control station and the receptor stations with respect to the appropriate encoding and decoding of the interrogation and alarm signals involved are provided at the control station and at each of the receptor stations of the network.

The invention can be described in more detail with the help of the accompanying drawings wherein:

FIGS. **1** and **1A** show simplified block diagrams of two appropriate embodiments of the alarm system network of the invention;

FIG. **2** shows the signal format which is used to transmit the synchronization, interrogation and alarm signal information in a specific embodiment of the invention;

FIG. **3** shows a block diagram of an exemplary control station for use in the network of the invention;

FIG. **3A** shows a timing diagram of the various signals in the control station shown in FIG. **3**;

FIG. **4** shows a schematic circuit diagram of the line driver unit of the control station shown in FIG. **3**;

FIG. **5** shows a block diagram of an exemplary receptor station for use in the network of the invention;

FIG. **6** shows a schematic circuit diagram of the zone interface unit between an individual receptor station and the common transmission line of the network of the invention;

FIG. **7** shows a timing diagram of the signals at various points in the network of the invention;

FIG. **8** shows a more detailed block diagram of an alarm display zone unit depicted in FIG. **5**; and

FIGS. **9** and **9A** show two alternative embodiments of the message averager unit depicted in FIG. **8**.

As shown in FIGS. **1** and **1A**, the alarm system of the invention may be as a network interconnected either in a series configuration to provide an effective current loop (FIG. **1**) or in a parallel configuration to provide a plurality of effective voltage loops (FIG. **1A**). In either case the network utilizes a system control station **10**, or **10'**, respectively, which station is interconnected by a common transmission link **11**, or **11'**, respectively, to a plurality of zones **12**, or **12'** respectively. The total number of "N" of zones is determined by the number of locations which are to be separately monitored and, in the case of the application of the invention to the protection of residential homes, for example, such zones represent individual homes usually located in the same general neighborhood within a community. Although the number of homes used in any particular network may vary it is believed that most networks operated in accordance with the invention will probably utilize from four to sixteen zones for most effective operation. In the example discussed below with reference to a particular embodiment of a network of the invention, it is assumed that the network comprises a single control station **10** and **16** receptor zones i.e., N=16).

The control station, which may be in a location separate from the receptor zones or may be located for convenience in one of the receptor zones itself provides a digital interrogation signal which includes a plurality of signal frames, each frame being utilized for interrogating a different one of the **16** receptor zones in question and including synchronizing, address, and alarm data information. The signal format for each frame is shown in FIG. **2** and, as seen therein, comprises seven data bits identified as B_s, B_1, B_2, B_3, B_4, B_5, and B_6. Data bit B_s includes the synchronization pulse, data bits B_1 through B_4 include the address pulses, and data bits B_5 and B_6 include alarm data pulses. In the particular example under discussion with respect to the **16** receptor zones which are used, the address bits can be arranged to identify each of the zones as shown below in Table I.

TABLE I

Zones	Data Bit Sequence B_1	B_2	B_3	B_4
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
16	0	0	0	0

The message content defining the alarm status of any particular zone can be used to indicate one of four conditions as shown below in Table II.

TABLE II

Message	Data Bit Sequence B_5	B_6
All Clear	1	0
Burglar	0	1
Fire	1	1
Malfunction	0	0

It is clear that if greater or less number of zones, or a greater or less number of alarm conditions are required, greater or lesser numbers of data bits may be used to convey the desired information and the number of bits in any one frame may be varied accordingly.

With respect to the transmission of the sequences of frames and the responses of the receptor stations thereto, the sequence of events of any particular receptor station can be described generally as follows.

The synchronization bit B_s in each frame as received from control station **10** starts the zone clock in each of the receptor stations upon receipt thereby. The address bits B_1 through B_4 in a first frame, for example, identify the first zone to be interrogated, and such interrogated zone in turn produces information at data bits B_5 and B_6 indicating its alarm status. All of the other zones, as they receive such information, decode the zone address (bits B_1, B_2, B 3 and B_4) and the message content of data bits B_5 and B_6 for that frame, as received from the zone under interrogation and display the results thereof. At the end of each frame received the zone clocks stops. The next frame received then again begins the synchronization and interrogation procedure and alarm data decoding process until all receptor stations have been interrogated, have transmitted their alarm data, and have displayed the alarm conditions of each of the other zones. The process continues indefinitely with the sequential interrogation and alarm and display information being continuously transmitted throughout the network.

The system is set up to require that all zones respond to indicate either an "All Clear," a "Burglar," or "Fire" alarm condition each time they are interrogated, as well as a fourth condition as shown in Table II to indicate if a "Malfunction" has occurred (i.e., the zone does not respond at all and $B_5 = B_6 = 0$). Such a lack of response indicates that the receptor station at the zone in question is not operating correctly and should be investigated.

FIG. 3 shows a block diagram of the control station 10 of the network which is utilized to produce the required multiframe data output signal for synchronizing the operations of the receptor stations at each zone with the control station and with each other and for interrogating each zone in sequence. As shown in FIG. 3 and the timing diagram of FIG. 3A, a suitable clock 15 generates a clock output signal 16 (see FIG. 3A) which is effectively a square ware signal having a periodicity with respect to the other signals in the station as shown in FIG. 3A. The clock signal is fed to a bit time generator 17 which effectively differentiates the clock signal at the beginning of each period to provide a plurality of pulses 18, each occurring at the beginning of each time period of the signal from clock 15. The time period τ is equal to the length of time for each bit in the frame format shown in FIG. 2, as further indicated at the bottom of FIG. 3A. The bit time generated signal 18 is fed to a frame time generator 19 and to an address register 20. The frame time generator provides two output signals, one an address enable signal 21 which is fed to an address encode gate 22 and the other a synchronizing pulse signal 23 which is fed to a frame counter unit 24 to a gate 24, and to a line driver unit 26.

As can be seen with reference to FIG. 3A synchronizing pulse signal 23 provides the synchronization pulse B_s at the beginning of each frame. In the particular example shown the synchronization pulse 23 reverses the current and voltage on the transmission line of the network to indicate the beginning of a particular frame. Many other techniques for synchronizing the operation of each receptor station with the others and with the control station may be used, such as those which utilize special code sequences or rest periods or combinations of pulses with particular polarity values, all of which are well known in the art.

The frame counter unit is advanced one count at the presence of each synchronization pulse 23 so that the frame counter cycles through a number of counts which is equal to the total number of zones to be interrogated in the network, in this case 16 zones, or receptor stations. The contents or "count" of the frame counter constitutes the address of the particular zone which is under interrogation. The address enable pulse 21, which is generated by frame time generator 19 and occurs at the input of each frame, enables the address encode gate 22 so as to cause a parallel transfer of the contents of frame counter 24 into the address register 20. The bit time generator then clocks the address that has been transferred into address register 20 out of the address register as a serial bit stream to the input to gate 25. After the fourth bit of the four bit address sequence, which is used in the particular example under discussion, is clocked out of address register 20, the latter is emptied and only zeros are shifted out as the bit clock continues to shift the address register serially.

During the shifting out process of the address content from address register 20, gate 25 is enabled by the absence of the synchronization pulse 23 so that the address is fed to the transmission line via line drive unit 26, the operation of which is described in more detail with reference to the circuit diagram of FIG. 4.

At the end of a particular frame, the synchronization pulse then cycles the frame counter to its next "count" wherein the address content relative to the next zone to be interrogated is transferred in parallel to address register 20 so that the address can be clocked out of the address register as a serial bit stream through gate 25 to line drive unit 26 for the next frame. Thus, the output to the line consists of a sequence of frame signals, each frame containing the synchronization pulse B_s and the particular address pulse sequence (bits B_1 through B_4) for each of the receptor stations being interrogated in turn and "zeros" in bit positions B_5 and B_6 as shown by the output signal 27 being fed to the line.

The operation of the receptor station is discussed with reference to FIG. 5 wherein the signal from the control station which, except for zone 1, has been transmitted through one or more of the other zones is received at a zone interface unit 30 and is fed into the receptor station 12. The synchronization pulse B_s at the first bit position of each frame is fed into a clock and zone timing generator 31 which produces a plurality of different clock signals, indicated as "CL" signals at the output thereof, which are fed to various units of the receptor station as shown. The address information and alarm data information in bit positions B_1 through B_6 of each frame are fed serially to address and data storage units 32 and 33, respectively, such data information being fed from such storage units in parallel to an address decoder zone selector unit 34 and to a data decoder unit 35, respectively. The address decoder unit 34 appropriately decodes the address signal in order to determine which zone is identified thereby in the particular frame which has been received and is being decoded. The data decoder unit 35 decodes the information at bits B_5 and B_6 to produce an alarm signal for the alarm condition present at the particular zone identified by the address decoder unit 34. The receptor station 12 is provided with a plurality of alarm displays, one corresponding to each of the zones in the network so that each receptor zone can provide a display of information concerning the alarm status of each of the zones in the network. The alarm to zone gating unit 36 feeds the alarm signal from data decoder 35 to an appropriate alarm display device identified with the particular zone associated with the address which has been decoded.

In the display operation the display may be arranged to provide an averaging process so as to minimize the effects of the occasional errors which may arise due to noise or interference either on the transmission line or within any of the receptor stations of the network. The alarm displays can be arranged so that an alarm condition is displayed only if the condition persists and, accordingly, occurs through a plurality of interrogation cycles with respect to any particular receptor station. Once a display has been locked into a condition where it appropriately annunciates an alarm (e.g., burglar or fire) either audibly or visually, the alarm remains locked in and the condition continues to be annunciated until the system is reset in a suitable manual fashion, for example, as shown.

At each zone the receptor station is provided with an input signal from appropriate alarm sensing devices (not shown) which provide output alarm signals when detecting an alarm condition. Any suitable fire or intrusion detection devices known to the art can be used for such purpose to provide alarm indications as shown by the "Alarm 1" or "Alarm 2" signals at the input of zone alarm input latch unit 38 to indicate the alarm status of the zone in which the particular receptor station in question is located. If an alarm signal should appear at either alarm input of the zone alarm input latch unit 38, the alarm condition is appropriately locked in so that, if the alarm input condition is removed for some reason, the latch unit "remembers" the alarm condition and continues to provide an alarm output signal therefrom to an alarm encoder unit **39** until the zone alarm input latch unit operation is reset manually.

The alarm encoder unit **39** produces a two-bit data output code which represents any one of four conditions at the input to the alarm store output register **40.** For example, if an output is received from the zone alarm input latch unit **38** the alarm encoder produces an output signal indicating either a "Burglar" alarm condition (e.g., a "01" code) or a "Fire" alarm condition (e.g., a "11" code), in accordance with Table II. If no input is provided to encoder unit **39** the encoder generates a two-bit code representing an "All Clear" condition (e.g., a "10" code), as defined in Table II. If, for some reason, the equipment at a particular receptor station in question is not operating properly, for example, due to power failure or the like, an appropriate two-bit code representing a "Malfunction" condition is indicated (e.g., a "00" code).

The alarm store output register **40** is a shift register into which the two data bits B_5 and B_6, representing the alarm status of the receptor station in question, are parallel loaded from alarm encoder **39.** If the address decoder **34** indicates that the particular receptor station in question has been addressed, the gating circuit **36** provides a data enable output signal **41** which enables transmit gate **42** so as to allow the contents of the alarm store output register **40** to be shifted serially into the zone interface unit **40** for transmission to the other zones.

FIG. **7** shows various pertinent signals within the network during operation, the particular operational signals with reference to receptor station for zone **3** being given as examples. As can be seen therein, the signal **50** from the system control station **10** provides a sequence of signal frames in which each frame contains an initial synchronization pulse and a four-bit sequence of address pulses which differ for each receptor station zone being interrogated. In FIG. **7**, the address signals for zones **1, 2, 3** and **4** are shown.

As can be seen, the address signal **52** for zone **3** is indicated as the **4**-bit data sequence "0011" in accordance with Table I above. The clock and zone timing generator of the receptor station at zone **3** appropriately receives the synchronization pulse and provides suitable clock signals for operating the various portions of the receptor station, as discussed above with reference to FIG. **5** and as shown by the zone **3** synchronization detection signal **51.** The zone **3** address and data detection systems decode the interrogation address signal **52** corresponding to that of zone **3** and, with respect to the frame associated with the address of zone **3,** produce an appropriate data enable output signal for causing a data output from the alarm store output register of the receptor station at zone **3** to be fed to the zone interface unit of such zone. Under "All Clear" conditions i.e., $B_5 = 1$ and $B_6 = 0$) an "All Clear" signal is obtained at the data output point of alarm store register **40** of the zone **3** as shown with reference to signal **53.**

The composite signal on the transmission line indicates the alarm status as well as the addresses of all of the zones involved and is partially shown by composite signal **54** in FIG. **7.** As can be seen, each of the addresses is present on the composite signal as well as the alarm status signal, which in this case shows "All Clear" for each of the four zones being depicted.

The operation of the line driver unit **26** of the control station **10** and the zone interface unit **30** of each of the receptor stations is discussed below with reference to the schematic diagrams of FIGS. **4** and **6.**

In FIG. **4** the line drive unit **26** of control station **10** provides the signal on transmission line **11** which is sent in sequence to each of the receptor stations at the zone under surveillance. The line driver unit in effect acts as a two-phase current source with one phase thereof driven by the synchronization pulses and the other phase driven by the address pulses. Only one current phase (or polarity) is excited at one time and the line driver operating modes are mutually exclusive as shown in the following table.

TABLE III

Sync. Input (volts)	Address Input (volts)	Output
0	+5	I (sync.)=one
+5	0	I (address)=one
0	0	Not Allowed
+5	+5	I (address)=zero

As can be seen in FIG. **4,** the line driver circuitry comprises two input lines **60** and **61** feeding the "Sync Input" signal to a first diode **62** and the "Address Input" signal to a second diode **63,** respectively. The signals are then appropriately fed to amplifiers **64** and **65,** respectively. The output from amplifier **64** is applied to the base of a PNP transistor **66** while the output of amplifier **65** is fed to the base of an NPN transistor **67.** The collector of transistor **66** is fed to the output line **68** via a voltage source **69** while the collector of transistor **67** is fed to transmission line output **68** via a voltage source **70.**

If the "Sync Input" signal is at a positive voltage (e.g., +5v.) and the address input is at zero voltage, such condition corresponds to the transmission of an address "one" output signal from the line driver unit, as shown in Table III. Diode **62** is conducting in its Zener mode and the output of amplifier **64** is positive so that transistor **66** is cut off. Diode **63** is in a non-conducting state and the output of amplifiers **65** is positive so that NPN transistor **67** is conducting. The resistor **71** to the negative input of amplifier **65** stabilizes the current.

If the "Sync Input" signal is at zero voltage and the "Address Input" signal equals a positive voltage (e.g., +5v.), such condition corresponds to a sync "one" output, in accordance with the Table III. Diode **63** conducts and the output of amplifier **65** is negative so that NPN transistor **67** is cut off. At the same time diode **62** is non-conductive and the output of amplifier **64** is negative so that PNP transistor **66** is conducting. The negative feedback path via resistor **72** to the negative input of amplifier **64** also stabilizes the current under such condition.

Thus, the signal output of the line drive unit is a sync "one," an address "one," or an address "zero" output in accordance with the input signals thereto, such output signal being transmitted along the common transmission line to the appropriate receptor station.

FIG. **6** shows a typical zone interface unit **30** used at each receptor station. If it is assumed that the circuit of FIG. **6** represents the zone interface unit for zone "*n*", then the transmission line input thereto feeds signals from previous zones, identified as zones (*n*-1), (*n*-2) .

. . . etc., and the output from the unit feeds signals to subsequent zones, identified as zones $(n+1)$, $(n+2)$. . . etc. The directions of the current signals containing the synchronization information and the data and address information are as shown. Transistor **80** detects the synchronization pulses, transistor **81** detects the address and data pulses and transistors **82** and **83** are used to transmit alarm data from zone "n" when appropriate. The latter two transistors are biased conducting, when receiving, and are biased either conducting or non-conducting in accordance with the alarm information, when transmitting.

When a synchronization pulse occurs the current flow through resistor **84** and diodes **85** and **86** causes an amplified "zero" pulse to occur at the "Sync Output" of transistor **80**. Since diodes **86** and **87** are conducting, transistor **81** remains cut off and the "Address and Data Output" signal at transistor **81** remains high and unchanging (i.e., a no data condition). Data current pulses flow through transistor **82**, resistor **88** and diode **85**. The "Address and Data Output" signal is an amplified and inverted replica of the pulsed current in resistor **88**, a data or address "zero" condition representing a current flow. Diode **85** is conducting so that transistor **80** remains cut off, preventing data from appearing at the "Sync Output" terminal.

It is desirable that the receptor station transmit alarm data to the network at a high signal to noise ratio with minimum power drain at the zone receptor station, even through the receptor station may have to signal over a relatively lossy transmission line, such as a telephone line. The power required to transmit at high signal-to-noise levels over such transmission lines can be many times more than that required to operate the zone electronics. However, the power required merely to interrupt an existing signal current on such a line is minimal. Accordingly, during that portion of the signal frame when the receptor station is transmitting the alarm data (i.e., at B_5 and B_6), the central station maintains a constant line current, as mentioned above, and alarm signals are transmitted to the network merely by opening or closing an effective receptor station line switch according to the alarm data to be transmitted. The receptor stations at all other zones detect the presence or absence of such current flow in the line. Thus, the only signalling power required at a given zone for transmitting alarm data is the power required to operate the switch. The power necessary to drive the line current is produced at the control station so that minimal power is required at each receptor station.

Thus, during bit times B_5 and B_6 of each frame the control station transmits a "zero" which provides a constant current on the transmission line. The data output signal which is fed to transistor **83** from alarm store register unit **40** is normally high (i.e., a "one" condition) keeping transistors **82** and **83** conducting during transmission periods from zones other than zone "n". Depending on the alarm condition to be identified during transmission periods from zone "n" the data output from alarm store register unit **40** will pulse high "one" or low "zero," accordingly switching transistors **82** and **83** on and off, which in turn appropriately pulses the current flow in the transmission line to all zones in the B_5 and B_6 alarm data positions in the signal frame representing zone "n."

As mentioned above, the display units at a receptor zone may be arranged to provide an averaging process which minimizes the chances for false alarms due to transient signals which may arise because of noise, or other interference, on the transmission line. For such a purpose, the alarm display units are as shown in FIG. 8 and in FIGS. 9 or 9A. In FIG. 8 the decoded alarm signal from alarm-to-zone gating unit **36** is fed to an alarm message store unit **90**. For any given zone display unit, the alarm-to-zone gating unit directs the decoded alarm message associated with that zone thereto once each N frames, where N equals the total number of zones in the system. The alarm data in alarm message store unit **90** is thereby updated once each N frames.

The stored alarm messages are then averaged over K periods, where $K>MN$ and M determines the total number of times an alarm message from a particular zone must be repeated for the averaging process. In general, $M \geq 2$ so that the alarm messages are averaged at least over two frames. The message averager unit **91** thereby produces an output signal only when an alarm input signal thereto has been repeated a selected number of times during the averaging process as discussed in more detail with reference to FIGS. 9 and 9A. If the alarm signal has so persisted, the latch unit **92** is actuated and in turn actuates an audio/visual alarm display device **93** which produces the appropriate audible, and/or visible alarm. Once the alarm display device **93** is actuated, it is locked into operation and will continue to annunciate an alarm until the latch unit has been reset, as by a manual reset signal as shown.

FIGS. 9 and 9A show alternative embodiments of appropriate averaging circuitry for producing the output from message averager unit **91** which actuates latch unit **92**. In FIG. 9, for example, the alarm signals which have been stored in message store unit **90** are applied to an appropriate low pass filter in the form of R-C filter **94** which in turn feeds one input of a voltage comparator **95**, the output of which is fed to latch unit **92**. The message store unit **90**, for example, can be an appropriate flip-flop circuit, a sample-and-hold circuit, or any similar device well known to those in the art. When an alarm has been transmitted by a zone in question, the storage element corresponding to the transmitted alarm is activated by the clock signal "CL" and the alarm message is stored. When an alarm has been stored the storage element output changes from a logic "0" (approximately 0 volts) to a logic "1" (approximately 5 volts). The voltage across the capacitor of the R-C network which is responsive thereto tends to slowly increase with time as alarm messages are received from message store unit **90** so that the V+ input voltage to locked unit **95** slowly begins to rise as determined by the R-C time constant of the network. When V+ equals V_{ref} the comparator output abruptly switches from a "0" volt output to a "+5" volts output, thereby tripping the alarm latch unit **92** and actuating the alarm display device for appropriate alarm annunciation.

Thus, if an alarm condition in a particular zone persists over the selected number of frames, or the alarm is intermittent but is present the majority of the time over such number of frames, the V+ voltage will gradually rise to equal the V_{ref} voltage and the alarm will be annunciated. The number of alarm messages which are thereby averaged is determined both by the R-C time constant and the values selected for the reference voltage.

FIG. 9A shows an alternative embodiment of an averaging circuit using digital techniques to provide an appropriate averaging process for actuating latch unit **92.** In such embodiment an "up/down" counter unit **97** is utilized to receive the alarm messages stored in alarm message store unit **90.** The alarm messages are sequentially stored and, when an alarm signal is applied to the counter unit **97,** the unit is advanced one count. Each subsequent message from store unit **90** causes the counter unit to advance an additional count until it reaches a selectable and preset count, whereupon the output signal therefrom trips latch unit **92** and the alarm is annunciated. If, in the sequence of alarm messages supplied to the counter unit, an alarm signal is omitted, the counter unit is retared by one count (0 being the lowest count in the unit). Thus, if the number of alarm occurrences exceeds by a predetermined count the number of times when no alarm is received, the up/down counter unit will gradually reach such predetermined count so that the counter unit provides an output signal which trips the latch. The number of messages to be averaged depends upon the predetermined preset count which is required to trip the latch. The circuit details and operation of such a digital up/down counter are well known to those skilled in the art.

As mentioned above, the control station may be located at one of the receptor zones or it may be at a separate location remote therefrom as, for example, at a centralized community police or fire station, if convenient, or at any other appropriate location, as desired.

Further, it is not necessary that the alarm status of all zones be displayed at each receptor station. For example, the network may be arranged so that the alarm status of each receptor zone may be displayed at only a few of the other receptor stations with a concomitant simplification of the display equipment required at each zone. The number of displays required will differ with the circumstances involved and the selection thereof should be sufficient to provide effective assurance that at least one of the number of receptor stations chosen will be attended and the alarm will be detected. In a relatively extreme situation, for example, it may even be found that one receptor station of the network will always be attended, in which case it may be necessary to provide for alarms to be displayed only at that one station and accordingly no alarm display equipment is needed at any of the other receptor stations.

Moreover, the line driver unit as shown in FIG. **4,** the zone interface unit shown in FIG. **6,** and the averaging circuitry shown in FIGS. **8** and **9** may be useful in other applications. For example, such units may be useful in a simple configuration wherein only a single control station and a single receptor station are formed in an alarm signalling network. The advantages of such units will be apparent even in such a less elaborate configuration.

What is claimed is:

1. An alarm signalling network for monitoring the alarm status of a plurality of separate zones under surveillance, said network comprising

a control station for producing a composite signal which includes interrogation signals for transmission to each of said zones;

a receptor station at each of said zones for receiving said composite signal, each said receptor station including

means responsive to one of said interrogation signals for producing a signal signifying the alarm status of said zone for transmission in said composite signal;

common transmission link means interconnecting said control station and said receptor stations for transmitting said composite signal from said control station to each of said zone receptor stations;

at least one of said zone receptor stations further including

means responsive to said interrogation and alarm status signals from one or more of the others of said zone receptor stations for displaying the alarm status thereof; and

means at said control station and at each of said receptor stations for synchronizing the operations of said control station and said zone receptor stations.

2. An alarm signalling network in accordance with claim **1** wherein

each of said zone receptor stations includes means responsive to the alarm status signals from one or more of said other receptor stations for displaying the alarm status of said other receptor stations.

3. An alarm signalling network in accordance with claim **2** wherein each of said zone receptor stations includes means responsive to the alarm status signals from all of said other receptor stations for displaying the alarm status of all of said zones under surveillance.

4. An alarm signalling network in accordance with claim **1** wherein said control station and said receptor stations are connected in a series configuration in said network.

5. An alarm signalling network in accordance with claim **1** wherein said control station and said receptor stations are connected in a parallel configuration in said network.

6. An alarm signalling network in accordance with claim **1** wherein said control station is positioned at one of said zones under surveillance.

7. An alarm signalling network in accordance with claim **1** wherein

said control station produces a composite signal comprising a plurality of successive frames, each said frame including a synchronization signal and an interrogation address signal identified with a selected zone receptor station, and a signal portion reserved for transmitting an alarm information signal; and

each said selected zone receptor station in response to its selected interrogation address signal furnishes an alarm status signal for transmission in said reserved signal portion of the frame of said composite signal containing its selected interrogation address signal for transmission by said common transmission link means.

8. An alarm signalling network in accordance with claim **7** wherein said control station includes

means for producing a plurality of synchronization pulses and address enabling pulses;

means responsive to said address enable pulse for generating a sequence of pulses interrogation address signals each identified with a different receptor station; and

line driver means responsive to said synchronization pulse and to said pulsed interrogation address signals for feeding said signals to said common transmission link means to produce said composite signal.

9. An alarm signalling network in accordance with claim 8 wherein said interrogation address signal generating means includes

counter means for sequentially producing a plurality of address signals each in the form of a parallel generated pulse group, each said pulse group identified with one of said receptor zones;

address signal means responsive to the sequential feeding of said parallel generated pulse groups for sequentially providing a plurality of said pulse interrogation address signals each in the form of a series generated pulse group; and

means for feeding said synchronization pulses and said pulsed interrogation address signals to said line driver means in a prescribed sequence for the formation of said composite signal.

10. An alarm signalling network in accordance with claim 9 wherein said line driver means comprises

a two phase current source;

first means responsive to said synchronization pulses for driving one phase of said current source;

second means responsive to said pulse interrogation address signals for driving the other phase of said current source at a time different from the time at which said first means drives said one phase;

whereby said synchronization signals are fed to said common transmission link means when said one phase is driven and said pulsed interrogation address signals are fed to said common transmission link means when said other phase is driven.

11. An alarm signalling network in accordance with claim 1 wherein each said zone receptor station comprises

zone interface means for receiving said composite signal at said zone receptor station and for transmitting said composite signal from said zone receptor;

means for sequentially storing said interrogation signals and said alarm status signals received in said composite signal;

means for decoding said alarm status signals and said interrogation signals and for feeding said alarm status signals to one or more selected display means for displaying the alarm status of one or more of the zone receptor stations in said network.

12. An alarm signalling network in accordance with claim 11 wherein each said zone receptor station further includes

means for producing a signal representing the alarm status of said zone receptor station; and

means responsive thereto for supplying said alarm status signal to said zone interface means for providing an indication of said alarm status in said composite signal for transmission by said common transmission link means.

13. An alarm signalling network in accordance with claim 12 wherein each said zone receptor station further includes means for synchronizing the operation of said storing means, said decoding and feeding means, and said alarm status signal supplying means.

14. An alarm signalling network in accordance with claim 12 wherein each said zone receptor station further includes

means for averaging the alarm status signals fed to said display means over a plurality of interrogation cycles and for displaying the alarm status indicated by said alarm signals only if said alarm status is repeatedly fed to said display means over said plurality of said cycles.

15. An alarm signalling network in accordance with claim 14, and further including means for manually discontinuing the display of the alarm status indicated by said alarm status signals.

16. An alarm signalling network in accordance with claim 12 wherein

said control station produces said interrogation signals in said composite signal in the form of pulsed interrogation address signals and further produces synchronization pulse signals in said composite signal to provide for the synchronizing of the operation of said control station and said receptor stations.

17. An alarm signalling network in accordance with claim 16 and further wherein said zone interface means in each said zone receptor station includes

circuit means responsive to said composite signal on said common transmission link means for detecting said synchronization pulse signals and to feed signals representing said synchronization pulse signals to said zone receptor station;

circuit means responsive to said composite signal on said common transmission link means for detecting the alarm status signals and the pulsed interrogation address signals present in said composite signals and to feed signals representing said alarm status and said address signals to said zone receptor station for storage; and

means for detecting the presence of said alarm status signal indicating the alarm status of said receptor station and for inserting said alarm status signal into said composite signal for transmission by said common transmission link means.

18. An alarm signalling network in accordance with claim 14 wherein each said averaging means is responsive to the alarm status signal received with reference to a selected zone and includes

means for storing said alarm status signals over a selected number of interrogation cycles;

means for supplying a latch trip voltage when an alarm message is present for a preselected number of times within said selected number of interrogation cycles;

latching means responsive to said latch trip voltage for actuating an alarm display unit.

19. An alarm signalling network in accordance with claim 18 wherein said latch trip voltage supplying means includes

a low pass filter responsive to the stored alarm status signals for producing a gradually increasing voltage when an alarm message is present for a preselected number of times during said selected number of interrogation cycles;

means for supplying a reference voltage;

voltage comparator means responsive to said reference voltage and to said gradually increasing voltage supplied from said low pass filter means for producing an output voltage when said voltages are equal.

20. An alarm signalling network in accordance with claim 17 wherein said voltage supplying means includes

an up/down counter means responsive to the stored alarm status signals for producing an output voltage when the number of times an alarm status signal is received exceeds the number of times no alarm status signal is received by a preselected count.

21. An alarm signalling network in accordance with claim 7 wherein said control station includes

means for supplying a substantially constant current on said common transmission link means during said reserved signal portions of each said frame.

22. An alarm signalling network in accordance with claim 21 wherein each said receptor station includes

switch means for transmitting, or for interrupting the transmission of, said constant current on said transmission link means during the reserved portion of the frame associated with said receptor station;

whereby the alarm status of said receptor station is furnished to said common transmission link.

23. An alarm signalling network in accordance with claim 10 wherein said line driver means further includes means for stabilizing the current from said current source when said current source is driven in either said one phase or said other phase.

24. An alarm signalling network for monitoring the alarm status of a receptor station through a transmission link, said network comprising

a control station for providing a composite signal comprising a plurality of successive frames, each said frame including at least a synchronization signal and a signal portion reserved for transmitting an alarm information signal,

said control station including means for supplying a substantially constant current on said transmission link during said reserved signal portions of each said frame; and

said receptor station including switch means for transmitting, or for interrupting the transmission of, said constant current on said transmission in link in accordance with a predetermined code during the reserved signal portion of each said frame, whereby the alarm status of said receptor station is furnished to said transmission link.

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