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[54] TRANSMITTER CONTROL CIRCUIT FOR ALARM SYSTEM

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[52] U.S. Cl. .... 340/147 LP, 340/147 R
[51] Int. Cl. H04g 3/00
[58] Field of Search .... 340/147 LP, 147 R

[56] References Cited
UNITED STATES PATENTS
3,484,771 12/1969 Falck .... 340/147 UX

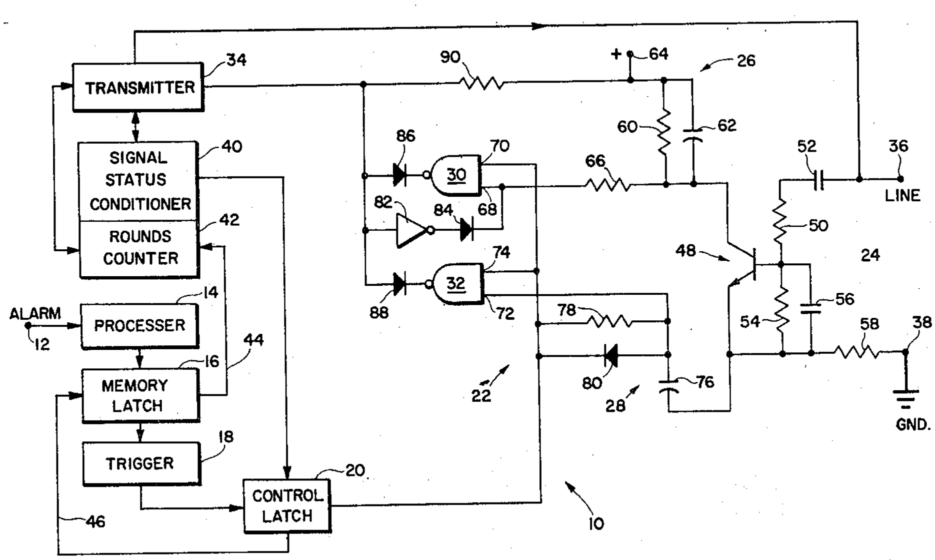
Primary Examiner—Harold I. Pitts

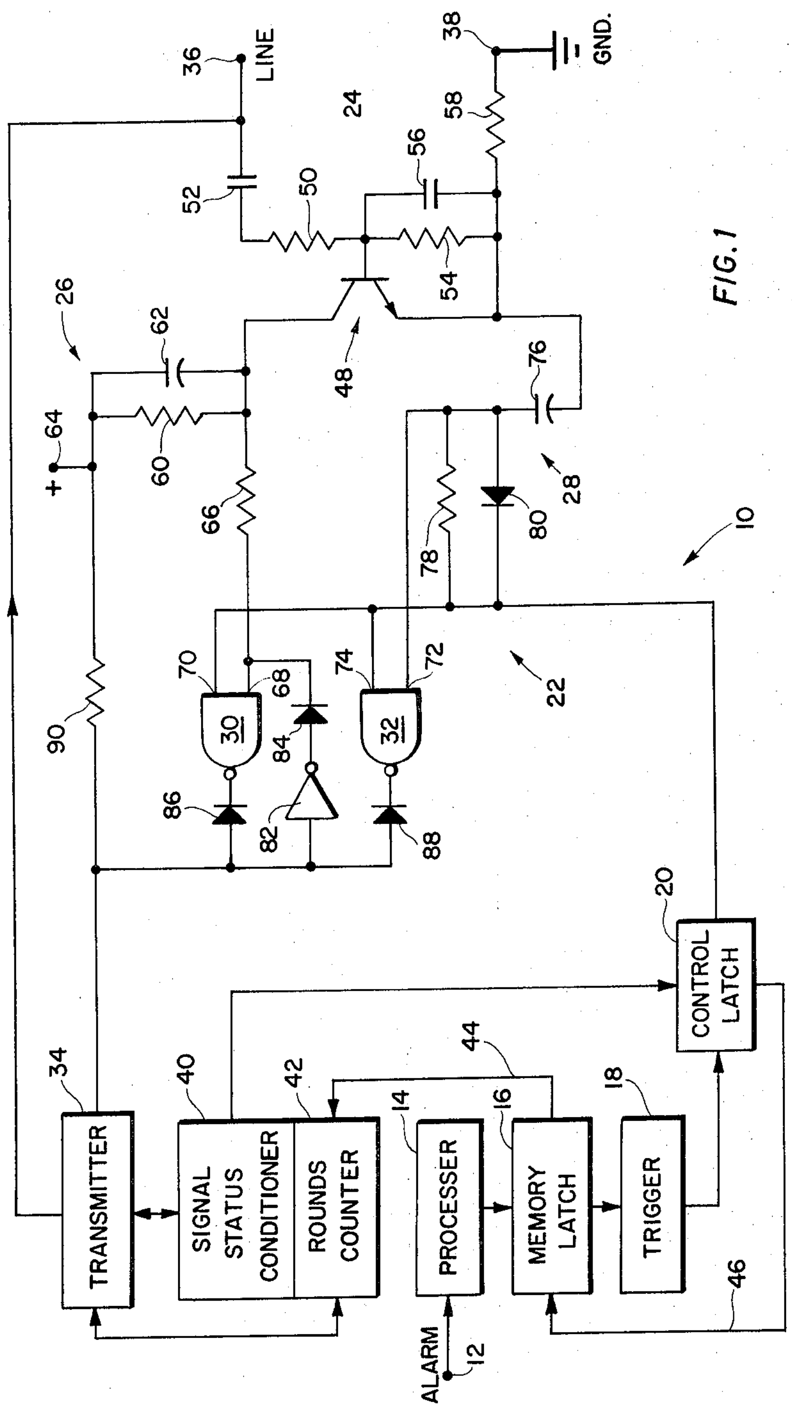
[57] ABSTRACT

In an alarm system having a plurality of stations connected to a single line, where each station has a transmitter which can transmit a pulsed signal to the line which is indicative of an alarm event at that station, it is important that "collisions" between signals from different stations on the same line be avoided. Line lock-out means are provided at each station to preclude transmission of a pulsed signal from that station when a pulsed signal from another station connected to the line is sensed; and the line lock-out means is provided with a timing circuit which operates to permit transmission from that station after a predetermined period of time following the last sensed pulse from another station on the line. Thus, the station may immediately transmit on the event of an alarm if sufficient time has passed since the last time a pulse from another station was sensed on the line; or the transmission is held off until that predetermined period of time follows the last sensed pulse on the line from another station.

However, in the event of continual sensing of a line busy condition because of an intermittent fault on the line or a "runaway" transmitter at another station, each station will seize the line after a predetermined length of time has passed since the event of an alarm at that station, regardless of the condition of the line. Thus, the line lock-out circuitry will preclude transmission of a signal from a station for about 5 seconds after sensing any pulse from another station, but the line may be seized after 5 seconds from the last sensing of a pulse from another station. A 2 minute "override" timer operates to seize the line regardless of its condition, two minutes after an alarm event at that station, if the alarm signal has not already been transmitted.

6 Claims, 2 Drawing Figures




LINE
GND.
TRANSMITTER
SIGNAL STATUS CONDITIONER
ROUNDS COUNTER
PROCESSER
MEMORY LATCH
TRIGGER
CONTROL LATCH
ALARM
+
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
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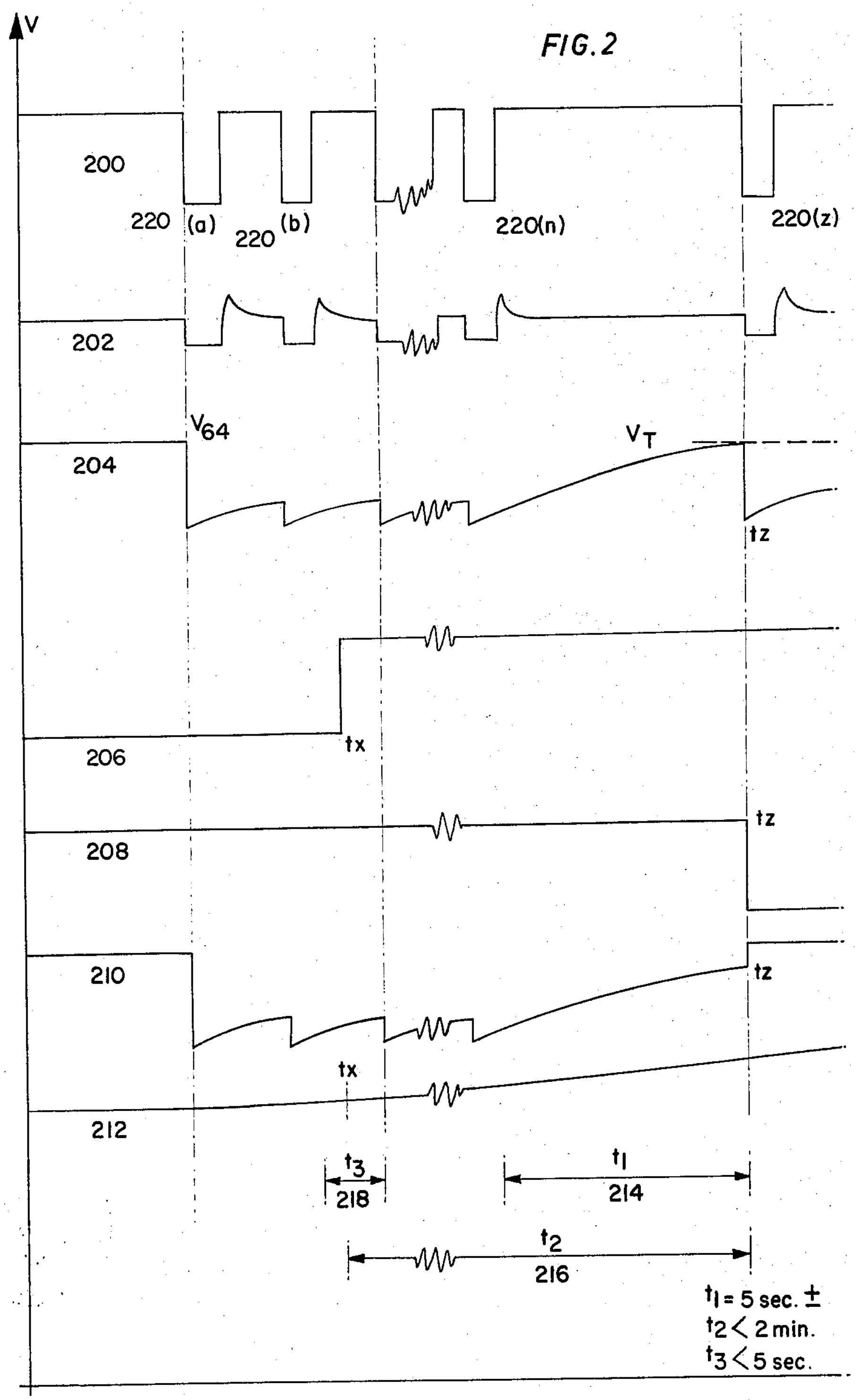
66
68
70
72
74
76
78
80
82
84
86
88
90

FIG. 1

FIG. 2


V
200
220 (a)
220 (b)
220(n)
220(z)
202
V64
VT
204
tz
206
tx
208
tz
210
tz
tx
212
t3
218
t1
214
t2
216
t1 = 5 sec. ±
t2 < 2 min.
t3 < 5 sec.

TRANSMITTER CONTROL CIRCUIT FOR ALARM SYSTEM

FIELD OF THE INVENTION

This invention relates to an alarm system, and particularly a control circuit for an alarm system which is used in multistation systems where a plurality of stations is connected to a single line. The invention is particularly adapted to alarm and supervisory scanning transmitters of the sort which are installed in buildings such as offices, warehouses and factories and which may supervise or scan one of a plurality of conditions within that building and be such as to generate an alarm condition in the event of an abnormality of any condition being supervised or scanned. The invention provides means for precluding collision of signals from one station with signals from another station connected to the same line; and the invention further provides override means by which the line may be seized by a station having an alarm status after a predetermined passage of time.

BACKGROUND OF THE INVENTION

There are many systems of supervising and scanning alarm systems which may have a number of stations or subscribers all connected to a single line. For example, a number of subscribers in a particular geographic area of a city may be connected to a single telephone line which is terminated at a central office. The central office may have a considerable number of lines under its supervision, and would be of the sort operated by businesses which operate supervisory or surveillance of other businesses, private homes etc. In any one of the subscriber stations which is connected to a line, there may be supervisory and scanning apparatus which maintains an electrical or electronic surveillance of conditions with respect to many possible sets of alarm circumstances — such as pressure drop in a sprinkler system, burglar intrusion, water temperature drop in a sprinkler system or temperature drop within a building such that the sprinkler system might freeze, unauthorized entry into security areas of a building, etc. Generally speaking, each of these sets of circumstances may be electronically or electrically supervised by a master board which scans the steady state condition of electrical signals from a plurality of sensors which would be installed and connected for that purpose. In the event of an interruption of the steady state condition of any one of those signals, an alarm event would be assumed, the master board would initiate an alarm status signal and an alarm and supervisory scanning transmitter would generate the signal and transmit it to the line. It should be remarked, of course, that the above description and sequence may vary from one type of installation of an alarm system to another, but in any event a transmitter which is installed at the premises of the subscriber acts to transmit a signal to the line which is shared with a number of other subscribers so that the supervising central office can be made aware as promptly as possible of the alarm event.

It may happen, however, that at the time that an alarm event — or an assumed alarm event which may be predicated by such as a temporary drop of water pressure in a sprinkler system — occurs, another station or suscriber may be in the process of transmitting a signal on the line indicative of an alarm event at that other station. Such signals are pulsed, generally square wave, and may be at a rate of approximately 5 to 10 pulses per second where each pulse width is characteristic of a running pulse train of square waves at, say, 40 cycles per second. In all such alarm systems as the sort described above, each subscriber or station transmits various numbers of pulses and blank spaces between pulses so as to code the identification of the station, and in some cases so as to code the type of alarm event that may have been noted at that station. In any event the coded, pulsed signal from any station is transmitted to the line by intermittently causing a short circuit of the line to ground, each of the intermittent short circuits to ground being distinguished as a pulse at the central station because of the temporary collapse of the line voltage for each pulse. On any one line, a maximum blank period between two pulses in the same code train is set, and that maximum period of time is the determinate factor which is sensed at each station and which controls the access of a station to the line when an alarm event happens at a station.

Thus, means are provided in accordance with this invention to sense and continuously monitor the line to which the station is connected so as to determine at any time whether the line is busy because it has been seized by a station for the purpose of transmitting a pulsed signal indicative of an alarm event at that station, or if the line is free so that it might be instantaneously seized by any station in the event of an alarm at that station. The maximum blank time between pulses in a single pulse train is normally set so as to be a fairly short period of time — say in the order of 5 seconds.

It should also be noted that there is a maximum period of time over which any station would normally transmit a coded, pulses signal indicative of an alarm event at that station; and such pulsed signal would normally be repeated three or four times in a single transmission. Still further, when an alarm condition is removed or restores to normal at a station, a reset signal would be sent to the central office by a coded, pulsed signal, usually once or twice in a single transmission after the station has identified itself, so that the central office can determine the present status of the station and any alarm condition that may have existed thereat. A "rounds counter" is usually to be found in the alarm and supervisory scanning transmitter at any subscriber station, which controls the number of times that a coded, pulsed signal train is transmitted to the line, so that the determination of alarm or reset condition can be made. There is a maximum amount of time that would normally be taken for transmission of any given number of rounds of a pulsed signal in a signal alarm transmission, and that would be the maximum amount of time that the line would normally be busy by having been seized by a station connected thereto. Such a period of time would not normally exceed two minutes and is usually much shorter.

If a fault has occurred in the transmitter at one subscriber station which is connected to a line such that the transmitter seizes the line and continues to repeat its coded, pulsed signal train without stopping after the appointed number or rounds — in other words, a "runaway" transmitter — or because of other, intermittent line problems, the line monitor or line sensing circuits at each other station connected to that line would all continue to sense a "line busy" condition. In the known alarm systems of the type described herein, when the line is busy, each of the other stations is held off or locked out by the station line lock-out circuits, and no other station has access to the line. However, because it is known that any normal transmission of an alarm event at a station connected to a line would take a maximum period of time, this invention provides that an override timer will act to seize a line and cause alarm status transmission to be made to the line even if it is continuously sensed to be busy for a predetermined period of time after an alarm event at that station. The override transmission control is predicated on the fact that, even with a runaway transmitter at a first station, with several rounds of a pulsed signal train from another station which is indicative of an alarm event at that other station, there is not likely to continually be collisions between the pulses from the two stations transmitting to the line at the same time, and because of the repetitive nature of the signal train from the runaway transmitter, the real alarm pulses from the second or subsequent station can be recognized and read. Also, in the event of a number of stations all transmitting bona fide alarm signals to a single line, at the same time, it is evident that there is very serious trouble with respect to a number of subscribers on that line. Therefore, the override transmission control provides a high degree of certainty that an alarm signal from a station can be recognized and determined at the central supervisory office even though the line may have been seized by a faulty transmitter or be continuously sensed to be busy because of other intermittent line faults.

It is important to note that previous alarm systems have been unable to override a busy line, and therefore a real alarm situation at a subscriber station may be unable to be transmitted to the supervisory central office under certain circumstances. Still further, the previously known alarm systems have been such that access to the line by a station at which an alarm has occurred is not permitted until after a certain predetermined period of time has elapsed from the time that the transmission control at the station wishing to transmit an alarm signal determines two conditions, namely that the line is truely clear of all transmission from other stations and that an alarm condition has existed at the station since the time when the transmission control at that station has initiated its scan of a line to determine that it is truely clear. Thus, with prior alarm systems — particularly such as those taught in Falck U.S. Pat. No. 3,484,771, dated Dec. 16, 1969 — when an alarm condition occurs and the line is busy such that immediate access to the line cannot be obtained for transmission of an alarm event signal from that station, access to the line is delayed for a period of time so that the line can be tested to be truely clear of transmission following the last pulse of the transmission from another station, and only when an alarm event has happened and the fact of that alarm event is stored in a memory element at the subscriber station wishing to transmit.

Falck teaches that if the line is occupied upon the occurrence of an event at a given station, a circuit operates to delay access to the station for a minimum period of Y seconds by inhibiting the start-up of a transmission control access for a period of Y -X seconds and then when the line is clear, initiating the line access which takes a period of X seconds, thereby resulting in a minimum time delay of access to the line of Y seconds.

This invention, on the other hand, provides a transmission control circuit and line lock-out circuit including means for continuously monitoring the line and for enabling transmission to the line from any station after the passage of a predetermined period of time from the last sensing of a pulse from any station on the line, regardless of whether or not the sensing station has an alarm event noted or in its memory at the beginning of the timing cycle from the last sensing of the line busy condition. That is to say, the invention provides a timer which is independent of the fact that an alarm event may or may not have occurred at that station, but which precludes transmission of a pulsed signal indicative of an alarm event in the event that the alarm has happened at that station in a predetermined period of time since the last sensed line busy condition; thereby precluding any possibility of collision in the normal circumstances while assuring the soonest possible access to the line from a station which requires to transmit an alarm event. The invention further provides that, in the event of a runaway transmitter at another station or other intermittent line faults such that the line is continuously sensed as being busy, after a predetermined period of time from the occurrence of an alarm event at a station, that station will transmit to the line its coded, pulsed signal indicative of that alarm, irregardless of the fact that the line is continuously sensed as being busy.

In contradistinction to most of the known alarm systems, particularly including the Falck alarm system referred to above, the present invention provides a line lock-out and transmission control circuitry, including timers aand transmitters means, that may be entirely solid state, thereby providing relatively maintenance and service free operation over a long period of time and without high costs. In addition, the present invention provides line lock-out and transmission control circuitry which utilizes simple logic elements, particularly NAND gates, and simple RC timer and integrator networks.

BRIEF SUMMARY OF THE INVENTION

It is a major feature of this invention that a line lock-out circuit is provided which permits access to an alarm transmitting line by a transmitter at a subscriber station in the event of an alarm event at that subscriber station, at the soonest possible moment after that alarm event if the line was sensed to be busy at the time of the alarm event.

A further object of this invention is to provide a transmission control circuit for multi-subscriber alarm systems where a plurality of subscriber stations are connected to a single line, having override means in each station to provide that a coded, pulsed signal indicative of an alarm at any station may be transmitted to the line after a predetermined period of time following the occurrence of that alarm event, regardless of whether or not the line has continuously been sensed to have been busy since the time of happening of the alarm event.

A further object of this invention is to provide circuits of the sort discussed above which can be relatively easily and inexpensively produced and which are substantially free of maintenance and repair requirements.

DESCRIPTION OF THE DRAWINGS

These and other features and objects of this invention are discussed hereafter in association with the accompanying drawings in which:

FIG. 1 is a circuit diagram of an alarm system including the line lock-out and override circuits in accordance with this invention; and

FIG. 2 is a series of curves of voltages occurring at various places in the circuit of FIG. 1 during the passage of a period of time.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, there is shown a subscriber station 10 in an alarm system, and it is assumed that the alarm system has a plurality of stations similar to that illustrated in FIG. 1, or in any event of the known type which transmits a pulsed signal to a line where the characteristics of the pulse are known. The station 10 has an alarm terminal input 12, or a plurality of such terminals each connected to different sensors to indicate an alarm status at any one of those sensors. The alarm input or inputs 12 are, in any event, connected to an alarm signal processor 14. The signal processor 14 is such as to have an output which can be positively changed in the event of an alarm input, and at a voltage and having other signal characteristics compatible with the circuitry of the station. The output of the signal processor 14 goes to a latch 16 which serves as a memory latch, as discussed in greater detail hereafter. The output from the memory latch 16 goes to a trigger circuit 18, and thence to a master control latch 20, as discussed in greater detail hereafter. The output of the control latch 20 goes to a line lock-out circuit indicated generally at 22, which includes line monitor circuitry indicated generally at 24, a line access timer indicated generally at 26, an override time indicated generally at 28, and parallel gates 30 and 32. The outputs of the gates 30 and 32 are tied together, and go to a transmitter 34 which is adapted for transmitting a pulsed signal to a line, via line terminal 36. A ground terminal 38 is also provided in the subscriber station 10 of FIG. 1, and it should be noted that in the normal, quiescent circumstances, a DC voltage exists between ground and line. Thus, the station 10 and any station like it which is connected to the line has means which are responsive to an alarm event connected to the alarm input 12; transmitter means 34 for transmitting a pulsed signal train to the line via line terminal 36 where the pulsed signal train is indicative of an alarm event at the station; means 24 which sense the presence on the line of a pulsed signal from any station which is connected thereto, including itself; and line lock-out means 22 adapted to preclude operation of the transmitter 34 when a pulsed signal from another station connected to the line is sensed. The line lock-out means 22 is adapted to permit operation of the transmitter 34 after a predetermined period of time following the last sensed pulse from another station connected to the line, as discussed in greater detail hereafter; and the line lock-out means 22 further includes the override timer 28 which is operative only for a predetermined period of time from the occurrence of an alarm event at the station and the insertion of an alarm input at terminal 12, so that operation of the transmitter 34 is precluded in the event that the line monitor circuit 34 continuously senses a line busy condition at terminal 36 for the period of operation of the override timer, and so that upon expiration of that period when the line monitor circuitry 24 has continuously held off or precluded operation of the transmitter 34, the transmitter operates anyway, irregardless of the presence of other signals which may be on the line and are being sensed at terminal 36.

There are four sets of conditions which may happen with respect to an alarm event at a station and the condition of the alarm line at the moment that the alarm event occurs. Those conditions are as follows:

i. an alarm event occurs, and the line is free.

ii. no alarm event has occurred, and the line is busy.

iii. an alarm event occurs, the line is busy and the line lock-out circuitry becomes operative.

iv. an alarm event has occurred, the line has been continuously sensed as being busy, and the override timer operates to permit transmission of signals from the transmitter to the line.

Each of the circumstances set out above is discussed in greater detail hereafter, with reference to the figures and a full explanation of the operation of the circuits according to this invention.

CONDITION I

When an alarm event occurs, an alarm signal appears at input 12 and is passed to the signal processor 14. The alarm signal then goes to the memory latch 16, which may be a bi-stable device having two specific outputs at different levels for purposes of controlling the transmitter 34 in manner discussed hereafter so that the signal transmitter to the line is indicative of the alarm input or a reset of the alarm condition to its quiescent state. Assuming for the moment that an alarm input has occurred, the output of the memory latch 16 goes to trigger 18, which has a single pulse output to set the master control latch 20 — which is a bi-stable latch — in its state which is indicative of an alarm event having occurred.

Assuming, for the moment, that the line is free and has been free for more than a predetermined period of time so that immediate acquisition of the line can be obtained by transmitter 34, the operation of the transmitter 34 is initiated by an appropriate output from gate 30 in a manner discussed hereafter. When the transmitter 34 begins its operation to transmit a pulsed signal indicative of an alarm event at the station to the line via line terminal 36, a signal status conditioner 40 and a rounds counter 42, each of which is associated with the transmitter 34, become operative. Thus, when an alarm event is being signalled by transmitter 34, the rounds counter determines the condition of the memory latch 16 by a memory status connection 44; and permits a specific number of rounds of coded, pulsed signals to be transmitted from transmitter 34, which are indicative of the alarm event. Usually the coded the pulse train is transmitted to the line 3 or 4 times, under the control of the rounds counter which has determined from the memory latch that an alarm event has occurred and the memory status of the memory latch is such as to indicate that fact.

[Because the memory latch is bi-stable, and the control latch is also bi-stable, when an alarm event occurs and the control latch 20 switches to its alarm status, an inhibit signal is sent by an inhibit connection 46 to the memory latch 16 to preclude it from switching away from its alarm status. When the alarm condition has been removed, an alarm reset signal — or in any event, a difference in the state of the signal which otherwise indicates an alarm event — appears at alarm input 12.

In that event, the processor **14** passes another signal to memory latch **16** — which may be way of a pulse going in the opposite direction than a pulse which set the memory latch to its alarm status, so that the memory latch **16** is then reset to its reset status or non-alarm status. Once again, the transmitter is caused to operate, sending a different signal or in the more usual case a single pulse train under the control of the round counter which determines the reset memory status as opposed to an alarm memory status. Following the reset signal transmission from transmitter **34**, the signal status conditioner resets control latch **20** to its quiescent, non-alarm status.]

The above discussion has been to provide a description of the operation of the control circuit when conditions are such that an alarm event results in immediate acquisition of the line by the transmitter **34**; and also when the alarm condition is reset to its quiescent or normal operating status.

CONDITION II

The premise of condition II is that no alarm input occurs, but that the line is sensed as being busy because of the presence on the line of a pulsed signal from another station, which pulsed signal is sensed by the line monitor circuitry **24**. It should also be noted that the line monitor circuitry **24** will sense the presence of a pulsed signal on the line from transmitter **34** in the same station **10**, and that condition is discussed hereafter.

It should first be noted that each of gates **30** and **32** is a NAND gate, having two inputs and a single output. The conditions of operation of a NAND gate are such that two high inputs to the NAND make a low output; and any low input to the NAND gate makes a high output. It should also be noted that operation of the transmitter **34** is initiated only when the output from either gate **30** or **32** goes low; i.e. when both inputs to either gate are high.

A transistor **48** — preferably an NPN transistor — is connected from its base to the line terminal **36** through the series connection of resistor **50** and capacitor **52**. Between the base and emitter of transistor **48** is a parallel RC network comprising resistor **54** and capacitor **56**; and the ends of that parallel RC network which are remote from the base of transistor **48** are connected through series resistor **58** to the ground terminal **38**. The series resistor **58** is provided as an isolation resistor so that the station **10** does not have a hard connection to ground; and its value is orders of magnitude less than the value of resistor **50**. Capacitor **52** is a DC blocking capacitor so that the line monitor circuitry **24** is AC coupled to the line terminal **36**. The values of the series RC network **50, 52** and the parallel RC network **54, 56** are chosen so that the base of transistor **48** of the line monitor circuit **24** is connected by a band-pass filter to the line terminal **36** and ground terminal **38**, and so that the line coupling to the line terminal **36** is frequency and amplitude dependent. The networks pass only signals to the base of transistor **48** to turn transistor **48** on when signals are detected at line terminal **36** which have the characteristic of pulses which are of a predetermined length and magnitude, thereby having a predetermined energy storage differential from quiescent state. The only signals which appear at line terminal **36** and which act to turn the transistor **48** on are those having the characteristic of an alarm transmission on the line **36**. Thus, square-wave pulses having the wrong magnitude or duration, and therefore the wrong energy storage characteristic, would not pass to the base of transistor **48**; and superimposed AC signal such as **60** cycle hum could not pass to the AC coupled line monitor circuit, and in any event would be integrated to zero energy storage by the RC network **54, 56.**

The collector of transistor **48** is connected to the bottom end of a resistor **60** and a capacitor **62** which are in parallel, and the top end of each of resistor **60** and capacitor **62** is connected to an internal positive voltage terminal **64**. The values of resistor **48** turns on for a sufficient length of time, the RC network **60, 62** has a time constant which is set at a predetermined period of time. In other words, a known period of time is required for capacitor **62** to charge to a specific voltage, which may be the voltage at positive terminal **64** or very slightly below that voltage with reference to ground. In any event, the RC network **60, 62** functions as a timer, referred to hereafter as the acquisition timer, and in the usual case the acquisition timer has a time constant of approximately five seconds. The acquisition timer is connected through series resistor **66** to a trigger input **68** of gate **30.**

It is important to note the operation of the acquisition timer and its relationship to gate **30** and the line monitor circuit **24**. Reference is made to FIG. **2**, and particularly curves **200, 202** and **204**. Those curves are plots of voltage versus time, taken at line terminal **36**, the base of transistor **48** and the collector of transistor **48**, respectively. It will be noted that at the beginning of each pulse **220**, the base voltage of transistor **48** reduces and may become slightly negative; and that at the termination of each pulse **220**, the base voltage increases and then decays in accordance with the time constant characteristic of the RC networks connected to it. At the beginning of the first pulse **220**(a), at which time transistor **48** turns on, the collector voltage reduces from approximately that of positive terminal **64** to substantially zero, and then begins to rise with a rising characteristic determined by the acquisition timer RC circuit **60, 62**. The interval between pulses **220** is less than the predetermined time constant of the acquisition timer as mentioned above. At the beginning of each new pulse, the collector voltage again collapses and begins to rise in accordance with the characteristic of the RC circuit of the acquisition timer, since the capacitor **62** is discharged every time the transistor **48** turns on. After a number of pulses, the last pulse of a pulsed signal train of another station connected to the line occurs, and that is indicated on curve **200** as pulse **220**(n). Once again, at the beginning of pulse **220**(n), the base voltage of transistor **48** behaves as before, and the collector voltage of the transistor **48** collapses. However, it will be noted that a period of time t_1 as indicated at **214** then begins. The significance of period t_1 is discussed hereafter, but for purposes of the present discussion, it will be noted that the length of period t_1 is at least 5 seconds. During that interval, which is the predetermined period of time which is set as the time constant for the acquisition timer RC network **60, 62**, the collector voltage continues to rise in accordance with the time constant until it reaches a voltage indicated in curve **204** as voltage v_t. That voltage may be equal to or slightly less than the voltage of positive terminal **64** v_{64}. No further discussion with respect to curve **204** follows at this time, because the next circumstance shown in that curve after the collector voltage reaches v_t is relevant with respect to Condition III discussed hereafter. In any event voltage v_t is the threshold or trigger voltage for gate **30** at which one of the two inputs to the gate can be considered to be high. Thus, it will be seen that after a predetermined period of time which is equal to the time constant of the acquisition timer RC circuit **60, 62,** the trigger input to gate **30** goes high and gate **30** is thus preconditioned with one high input. That predetermined period of time follows the last sensed pulse at line terminal **36,** irrespective of the alarm status of the station. Therefore, in order for the operation of the transmitter to begin, it is merely necessary for a high input to be imposed on trigger **30** at its enable input **70** — it being remembered that operation of the transmitter **34** will be initiated immediately upon gate **30** having two high inputs so that its output can go low and the transmitter **34** may begin to operate.

Thus, so long as any pulses are being sensed at line terminal **36** — except pulses from transmitter **34** at the same station, as discussed hereafter — and for a predetermined period of time after the last sensed pulse, operation of the transmitter **34** is precluded because gate **30** is not in a condition to pass an alarm signal. With respect to Condition I therefore, when the line is free and has been free for a length of time greater than the predetermined period which is the time constant of the acquisition timer RC circuit **60, 62,** the setting of the master control latch **20** to its alarm status immediately causes a high input at enable input **70** of gate **30,** and since the trigger input **68** is already high in that circumstance, the output of gate **30** immediately goes low and operation of transmitter **34** is initiated.

With reference to the circumstances of Condition II, so long as the line remains busy and no alarm event has occurred, the line lock-out circuitry **22** acts to preclude operation of the transmitter **34**; and the line lock-out also precludes the possible operation of transmitter **34** for a predetermined amount of time equal to the time constant of the acquisition timer RC network **60, 62.**

CONDITION III

Assume now that an alarm condition occurs so that an alarm input signal reaches input **12** and causes memory latch **16** to assume its alarm status signal level. Assume further that at the instant that the alarm condition occurs, the line monitor circuits **24** sense a line busy condition at line terminal **36** so that gate **30** has a low input at its trigger input **68.** These conditions are established in FIG. **2** where the occurrence of an alarm condition is assumed to occur after pulse **220**(b) at a time t_x as indicated in curve **206.** At that time, the control latch **20** switches to its alarm condition status, and puts a high input at enable input **70** of gate **30** and enable input **74** of gate **32,** which are tied together. At the same time, the override timer **28** is started by beginning a charging operation of capacitor **76** which, with resistor **78** forms an RC network having a time constant of approximately two minutes. At the end of the 2 minute period, the voltage of capacitor **76** will have reached the trigger level V_t for gate **32,** as discussed hereafter with respect to Condition IV. Diode **80** provides protection for the capacitor **76** when the control latch **20** goes to a high output, and provides means whereby the capacitor **76** immediately discharges when the control latch **20** assumes a non-alarm status and its output goes to its low level.

Thus, the slope of curve **212** after time t_x is characteristic of the time constant of the override timer **28.**

It will be noted that at time t_x the output of gate **30** remains high, indicative of the condition that there is at least one low input to that gate, because it will be noted that the trigger input **68** of gate **30** is low — that is, below the trigger voltage v_t. Indeed, it will be noted that the voltage at trigger input **68** of gate **30** follows the voltage at the collector of transistor **48,** because no current flows and there is no voltage drop across resistor **66.** Pulse **220**(n) finally occurs and is sensed at line terminal **36,** after which the collector voltage of the transistor **48** continues to rise until it reaches the trigger voltage v_t of gate **30.** It is assumed in curve **210** that the trigger voltage v_t is slightly below voltage v_{64}, and it will be noted that the voltage at the trigger input **68** incureases at time t_z which is the time at which the collector voltage of transistor **48** reaches trigger voltage v_t. At that precise instant the output of gate **30** goes low because it is at that instant that gate **30** has two high inputs. At that moment, operation of the transmitter **34** is initiated, and pulse **220**(z) is transmitted from the transmitter **34** and is sensed at the line terminal **36.** Thus, the alarm condition of the station begins to be transmitted to the line. As noted above, the control latch **20** remains high, and it is therefore necessary that the sensing of the pulse **220**(z) at line terminal **36** by the line monitor circuit **24** not be such as to turn transmitter **34** off. In other words, the line lock-out must be inhibited with respect to its operation because of sensing pulses from its own associated transmitter.

This latter condition is accomplished by inverter **82** and diode **84** which are in series from the outputs of gates **30** and **32,** and which are also in series with trigger input **68** of gate **30.** [It will also be noted that diodes **86** and **88** are in the output circuits from gates **30** and **32,** respectively, for protection of the gates when their output goes low; because it will be noted that the output terminals of the gates **30** and **32** are connected through resistor **90** to the internal positive voltage terminal **64.**] When the output from gate **30** goes low, the output from inverter **82** to diode **84** to the trigger input **68** goes high because of the connection through resistor **90** to the internal positive voltage terminal **64**; and the output of the inverter **82** to trigger input **68** of gate **30** remains high so long as the output from the gate **30** remains low. Thus, during the condition when output from gate **30** is low because the alarm condition still exists and transmission of that fact is being made by transmitter **34** to the line via line terminal **36,** the trigger input **68** remains high notwithstanding the operation of the line monitor circuit **24** and the manner in which the voltage of the collector of transistor **48** is operating. When the rounds counter **42** stops operation of the transmitter **34,** the other stations can seize the line and begin transmission of an alarm signal following operation of the acquisition timers of those stations to permit access to the line.

It should be noted that, in the event that two further stations have an alarm event while a first station is transmitting, and each of those other two stations is held off from the line by their own respective line lock-out circuitry, acquisition by one or the other of those two stations to the exclusion of the other is a function of the precise instant at which the acquisition timer in one of the stations reaches voltage v_t of the gate **30** of that station. There are certain component variations, even between identical components made seriatim on the same assembly line, so that the time constant characteristic of the acquisition timers of various stations are not precisely identical. It will also be noted that when the gate **30** of any station goes to a low input, operation of the transmitter **34** of that station is immediately initiated and the first pulse from that station is generated so as to establish acquisition of the line by that station.

CONDITION IV

Finally, a condition may exist on the line, as noted above, where an alarm event occurs at a station, and where the line monitor continuously senses a line busy condition for a predetermined period of time. In those circumstances, an override timer operates to initiate transmission of the alarm status at that station, regardless of the condition of the line.

This latter condition is achieved by operation of the timer network including resistor **78** and capacitor **76**, as mentioned above. It has been noted that at time t_x, being the time at which an alarm event occurs at the station presently being discussed, operation of the override timer begins as noted in curve **212** of FIG. **2**. As noted above, the enable input **74** of gate **32** is tied to the enable input **70** of gate **30**, and each of those enable inputs goes high at the same time when the control latch **20** assumes its alarm status level. If the line lock-out remains functional for the entire predetermined period which is the time constant of the override timer **28** so that operation of the transmitter **34** is precluded, then at the end of that predetermined period the trigger input **72** of gate **32** goes high and the output of gate **32** goes low so as to initiate operation of transmitter **34**. When that happens, the output of inverter **82** goes high, and once again the trigger input **68** of gate **30** is driven high so that its output goes low and so that sensing of signals at line terminal **36** does not operate to preclude further transmission of signals from transmitter **34**.

As noted, when the transmission of a coded, pulsed signal indicative of an alarm event is finished, the signal status conditioner **40** resets the control latch **20** to its low level, and the enable inputs **70** and **74** of gate **30** and **32** respectively go low so that the outputs of those gates go high and further operation of the transmitter **34** is precluded.

It should also be noted from FIG. **2** that the length of time period t_1 indicated at **214** is 5 seconds plus or minus, which is the time constant of the acquisition timer RC circuit **60, 62**, and which is the predetermined period of time after the sensing of a pulsed signal on the line from another station connected thereto that the transmitter of that station is permitted to operate to transmit a pulsed signal to the line indicative of an alarm condition at that station. The length of the time period t_2 indicated at **216**, which is the time passage from time t_x when an alarm condition occurs and an alarm input appears at terminal **12** until the time t_z when the first alarm pulse from that station is transmitted, is less than approximately 2 minutes. When the time period from t_x to t_z goes beyond 2 minutes, override timer **28** operates to make output of gate **32** low and thereby to initiate operation of the transmitter **34**. The length of time of time period t_3 indicated at **218** in FIG. **2**, which is the length of time between any two pulses in a coded, pulsed signal train from any station indicating an alarm condition at that station, is less than 5 seconds.

Other types of circuit components can be substituted for those which are shown in FIG. **1**, such as clock driven timers, other logic circuits than NAND gates, transistors and other integrated circuitry having the same or reverse operating polarities than those shown, etc. In any event, the operation of the acquisition timer and of the override timer, and their relationship to the line monitor and the gates of the line lock-out circuitry according to this invention have been clearly discussed with relationship to the circuits and curves which have been exemplary of the type of operation of such circuits; and any such alarm system or variation thereof as contemplated above would, in any event fall within the ambit of the accompanying claims.

What I claim is:

1. In an alarm system having a plurality of stations connected to a single line; each said station having alarm sensing means responsive to an alarm event, transmitter means for transmitting a pulsed signal to said line indicative of an alarm event at that station, means for sensing the presence on said line of a pulsed signal from any station connected thereto, and means to preclude transmission of a pulsed signal to said line when a pulsed signal from another station connected thereto is sensed; the improvement wherein:

said means to preclude transmission of a pulsed signal to said line when a pulsed signal from another station connected thereto is sensed, is adapted to permit operation of said transmitter means after a first predetermined period of time following the last sensed pulse from another station connected to said line;

and each said station further includes control and override means which is operative for a second predetermined period of time from the occurrence of an alarm event at a station to preclude operation of said transmitter means at that station in the event that said means for sensing continues to sense the presence of pulsed signals on said line throughout said second predetermined period of time, after which said override means is adapted to permit operation of said transmitter means at that station after said second predetermined period of time irregardless of the sensed presence of pulsed signals on said line.

2. The alarm system of claim **1** where said means to preclude transmission of a pulsed signal to said line when a pulsed signal from another station connected thereto is sensed, includes first gate means having a first alarm input and a second trigger input, at least said second input having a predetermined voltage level at which said first gate may become operative to initiate operation of said transmitter means;

said means for sensing the presence on said line of a pulsed signal from any station connected thereto, being connected to said second trigger input of said first gate and to an RC timer circuit to preclude acquisition of said predetermined voltage level by said second input for said first predetermined period of time following the last sensed pulse from another station connected to said line.

3. The alarm system of claim **2** where said control and override means includes second gate means having a first alarm input and a second trigger input, at least said second input having a predetermined voltage level at which said gate may become operative to initiate operation of said transmitter means; and an RC timer circuit connected to said second input and adapted to start timing said second predetermined period of time upon the occurrence of an alarm input signal at the first input of said second gate.

4. The alarm system of claim **3** where each first input of each of said first and second gates is connected to the other, and each is connected to a bistable latch adapted to switch to a first state and to pass an alarm input signal to said first inputs upon the occurrence of an alarm event at that station; and said bistable latch is connected to a circuit associated with said transmitter means to switch said latch to a second state and to remove said alarm input signal from said first inputs after said transmitter has transmitted a pulsed signal to said line indicative of said alarm event.

5. The alarm system of claim **1** where said means for sensing the presence on said line of a pulsed signal from any station connected thereto, includes RC filter networks to form a passband only for signals on said line of the pulse duration and frequency which are indicative of an alarm event at a station connected thereto.

6. The alarm system of claim **4** where said second input of said first gate is connected to the output of each said first and second gated through inverter means so that said first gate is operative to permit continued operation of said transmitter means when signals therefrom are sensed on said line, while an alarm signal continues to appear at the first input of said first and second gates.

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