United States Patent

Gnägi et al.

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[54] APPARATUS FOR MONITORING THE CONDUCTORS OR LINES OF FIRE ALARM INSTALLATIONS

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[52] **U.S. Cl.** **340/409**, 340/256

[51] **Int. Cl.** **G08b 29/00**

[58] **Field of Search** 340/409

[56] **References Cited**

UNITED STATES PATENTS

3,072,827	6/1963	Benish	340/409
3,192,506	6/1965	Henn-Collins	340/409

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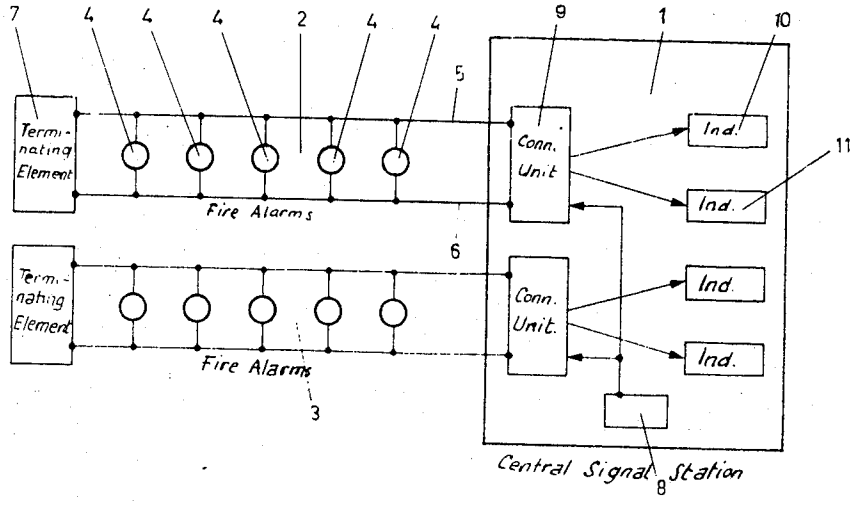
[57] **ABSTRACT**

An apparatus for supervising the continuity of the conductors of an alarm installation, especially a fire alarm installation, comprising a central signal station and a plurality of fire alarms each of which draws a quiescent current during normal operation and an alarm current when in an actuated condition. At least one pair of conductors electrically couples the fire alarms in parallel with one another and with such central signal station. A direct-current voltage supply is provided for the parallely connected fire alarms. Terminating element means serves to monitor the continuity of the conductors, such terminating element means being connected across the ends of the conductors located remote from the central signal station and generates and applies to such conductors a signal containing at least an alternating-current component, said signal being distinguishable from the signal delivered by said direct-current voltage supply to said fire alarms and further being distinguishable from the quiescent and alarm current signals drawn by said fire alarms. Also, the central signal station is provided with means responding to the presence of the signal applied to the conductors by the terminating element means.

15 Claims, 6 Drawing Figures



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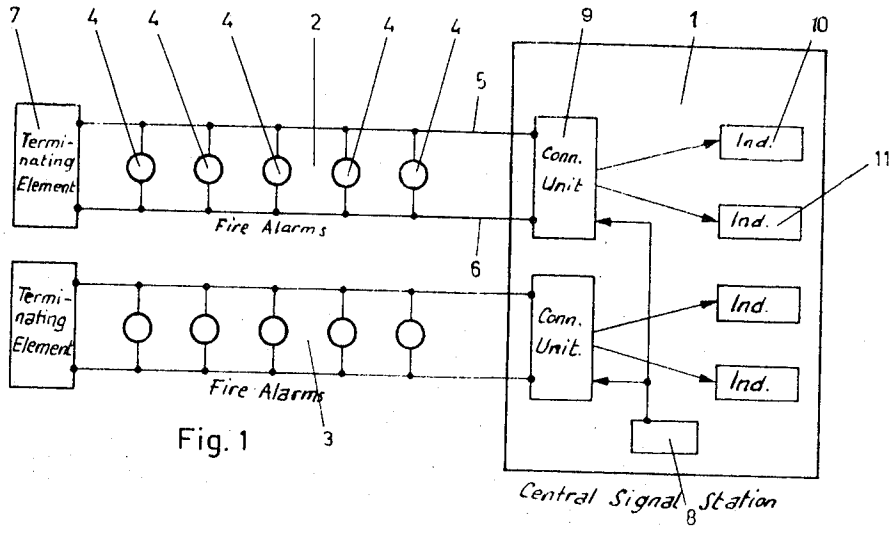

Fig. 1

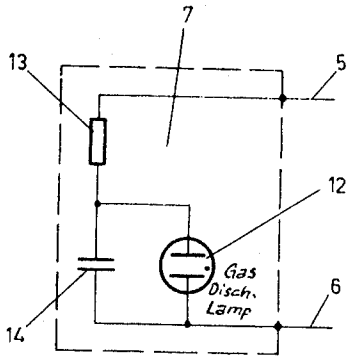

Fig. 2

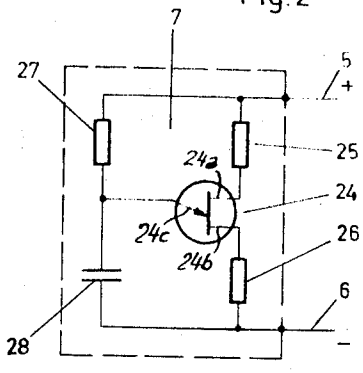

Fig. 4

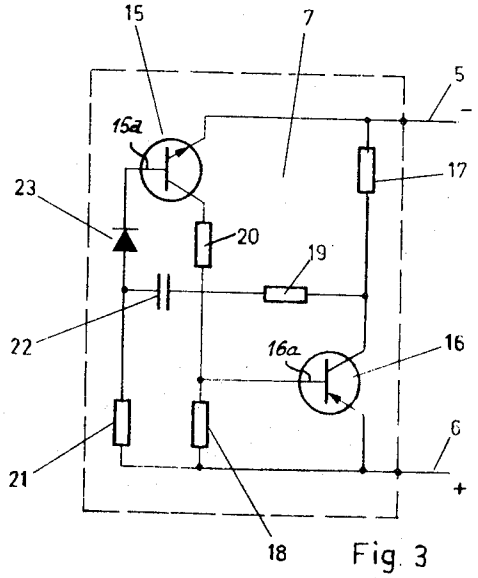

Fig. 3

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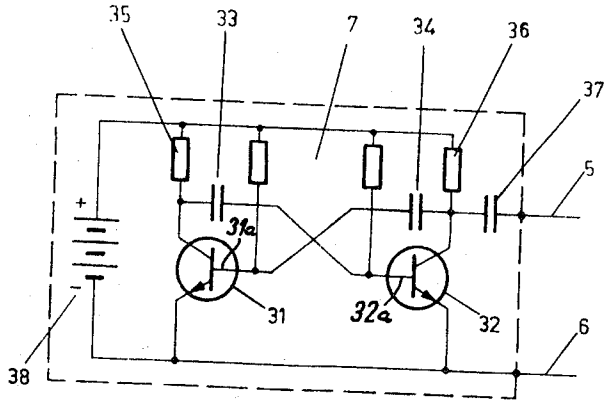

Fig. 5

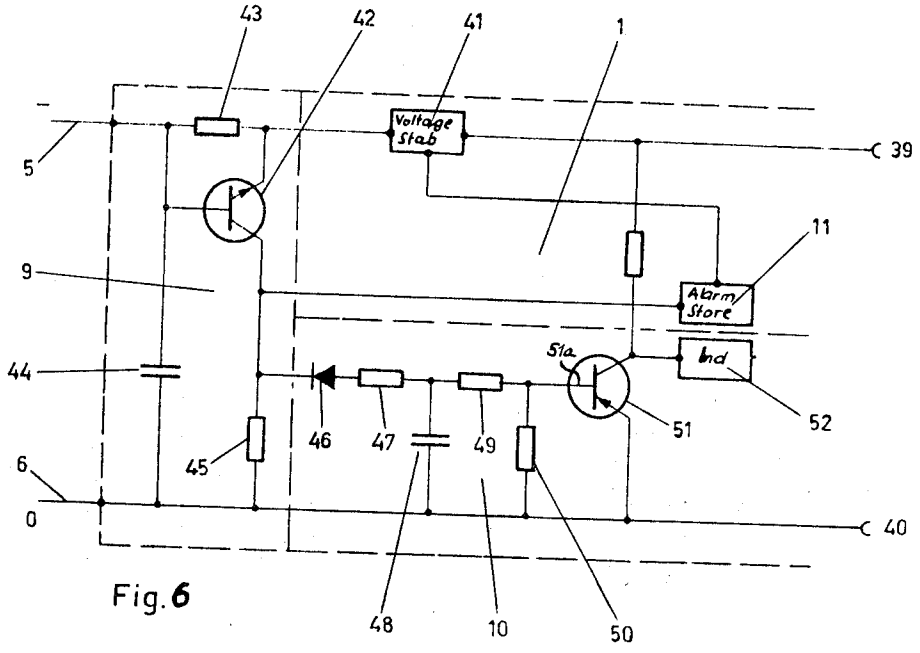

Fig. 6

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APPARATUS FOR MONITORING THE CONDUCTORS OR LINES OF FIRE ALARM INSTALLATIONS

BACKGROUND OF THE INVENTION

The present invention relates to an improved circuit arrangement or apparatus for monitoring the continuity of connecting conductors or leads in alarm installations of the kind in which a central signal station or panel including a supply source of direct-current voltage is connected to one or more groups of alarm devices, typically fire alarms, of the type which during normal operation draw a quiescent current and in an actuated condition draw an alarm current, the alarm devices of each group being connected to the central signal station in parallel over common conductors or leads, and the conductors of at least one group of alarm devices are connected by a terminating element.

In fire alarm installations a large number of fire alarm devices are often connected to one central signal station or panel. Under the expression "alarm devices," or more briefly "alarms," as used in the context of the present specification and in the appended claims, there is to be understood an automatically operating condition sensitive device which, in the presence of a phenomenon which is to be detected, for example a pheonomenon consequent upon combustion, changes its condition, for example its electrical resistance, or produces a short-circuit between the leads to which it is connected, that is, together with a corresponding electrical circuit it produces a change from a quiescent current to a usually relatively larger alarm current. In particular types of alarm devices this quiescent current may be, in fact, vanishingly small, or even may be zero. Such types of alarm devices are, for example, ionization fire alarm devices, optical smoke detectors, flame-responsive alarm devices, and maximum-temperature or temperature-differential alarms or devices, which react to one or other of the changes produced by combustion or fire. As the actual detector or sensor elements there may be used ionization chambers, photo-sensitive elements, light- or temperature-sensitive resistors, bi-metal contact devices, or other known sensors of pheonomena consequent upon combustion, or other pheonomena to be detected.

To reduce the expense of the electrical installation, in such arrangements several alarm devices are often connected in parallel to one input of the central signal station, usually in fact by way of two, three or four common leads. Several of such groups of alarm devices, or sets of leads, are often electrically coupled with the same central signal station or panel.

Since the individual alarm devices are often widely distributed about the object or area to be protected, and are disposed remote from the central signal station or panel, it is important to be able at any time to check the operational readiness of the system. In order for the system or installation to be operational the conductors or leads must be continuous up to the most remote alarm device. Hence, there have been provided alarm installations in which the ends of the leads beyond the last-connected alarm device are bridged by a terminating element which, in the simplest case, consists of a resistance. From the value of the voltage applied to the leads and from the magnitude of this terminating resistance there may be determined a definite quiescent current for the group of alarm devices, which may be monitored at the central signal station. If the current alters, as a result of a broken conductor or a short-circuit, a fault indication is initiated.

However, many types of alarm devices possess a certain, even though very high, input resistance, so that any individual alarm device itself draws a certain quiescent current. In order to be able to distinguish between the total quiescent current of the group and the quiescent current of the alarm devices when a large number of alarm devices are connected in parallel with one another to common leads, the terminating resistance must be chosen with a relatively low value, and this results in a high continuous current consumption. This leads either to the number of alarm devices per group being limited in quiescent current monitored systems, or dispensing with the monitoring feature.

To avoid a high current consumption it is known to employ a terminating element with a variable resistance which possesses a high resistance at normal supply voltages but which has a relatively small resistance in a lower voltage range. By lowering the supply voltage it may then be determined at any time whether the leads are continuous. It is also possible to construct the last alarm device of a group so that it possesses a voltage-dependent resistance.

It has also been proposed to employ as the terminating element passive components which select a particular voltage component from the supply voltage. For example, when the supply voltage is an alternating voltage a voltage component of one polarity may be selected by means of a diode. When a direct voltage is superimposed upon an alternating voltage, the terminating element may be a capacitor which passes only the alternating voltage component, which is separately observed at the central signal station or control panel. Terminating elements with such wholly passively operating components cannot be used, however, for those types of fire-alarm system which are commonly driven by direct-current.

SUMMARY OF THE INVENTION

In consequence of what has been explained heretofore, it should be apparent that a real need exists in the art for a monitoring device for alarm installations which is not associated with the aforementioned drawbacks of the prior art constructions. Hence, a primary objective of the present invention is to provide just such monitoring device which effectively and capably fulfills this need.

Another, more specific objective of the present invention relates to an alarm installation, especially a fire alarm installation, possessing a novel and improved type of monitoring apparatus for the conductors or lines of the fire alarm installation, this monitoring apparatus distinguishing itself through the features that it has very low power consumption, can be operated from a direct-current power supply, is relatively inexpensive in construction, particularly requiring a minimum of components, and can be easily and inexpensively installed at the actual fire alarm installation.

A further significant object of the present invention relates to an improved monitoring apparatus for checking the continuity of the conductors or lines of a fire alarm installation having a number of detector or fire alarms connected in parallel to a central signal station, wherein the monitoring device can be operated from the same power supply as used for the group of parallely connected fire alarms, and wherein the monitoring device generates a signal during its conductor checking operation, this signal being clearly distinguishable from the power supply signal and the signals drawn by the fire alarms, either during normal operation or when assuming an alarm state.

Now, in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the inventive apparatus for supervising the continuity of the conductors or leads of an alarm installation will be seen to comprise a plurality of alarms connected by a respective pair or pairs of conductors in parallel with one another into a group or groups, respectively, and with a central signal station having a direct-current voltage supply for such group or groups of parallely connected alarms. Each alarm device draws a quiescent current during normal operation and an alarm current when in an actuated condition or state. A terminating element is connected to the ends of the conductors remote from the central signal station in parallel with the last alarm of each group of alarms. This terminating element monitors possible interruptions at the conductors of each group of parallely connected alarms, specifically serves to generate and apply to such conductors a signal distinguishable from the direct-current supply signal fed over the conductors from the central signal station to the alarm devices and further distinguishable from the quiescent and alarm currents drawn by such parallely connected alarm devices. Furthermore, a device for evaluating or responding to the presence of

such signal appearing on the conductors is provided at the central signal station.

The various embodiments of the invention enable conductor-continuity monitoring to be effected with low power consumption, require a minimum of additional expense in installation and component costs, and are driven by a direct-current supply voltage.

The exact variation with time of the signal or signals provided by the terminating element may be selected in any suitable manner. Since the supply is a direct-current voltage supply the terminating element generates a signal having an alternating-current component, for instance such terminating element signal can be an alternating voltage or alternating current clearly distinguishable from the direct-current component without difficulty at the central signal station. Furthermore, in many cases the use of a square-wave signal or brief pulses, which either follow one another in regular sequence or are generated in accordance with a predetermined code, may be found advantageous. The receiving device in the central signal station or control panel is arranged to respond appropriately to the receipt of these correctly spaced or coded pulses. Other arbitrary forms of signal may also be employed, for example, the particularly simply generated saw-tooth signal voltage, etc. The variation with time of the quiescent current need not correspond with the alarm current, for example, with the direct-current voltage supply the alarm signal may be an alternating voltage. In any event, the monitoring signal supplied by the terminating element must be clearly distinguishably different from both the quiescent current and the alarm current.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. 1 is a schematic block diagram illustrating an alarm installation equipped with two groups of fire alarm devices;

FIG. 2 is a circuit diagram of one embodiment of terminating element suitable for use in systems according to the invention using a sawtooth generator;

FIG. 3 is a circuit diagram of another embodiment of terminating element using a current-pulse generator;

FIG. 4 is a circuit diagram of another embodiment of terminating element making use of a unijunction transistor;

FIG. 5 is a circuit diagram of an embodiment of terminating element using an alternating-current generator; and

FIG. 6 is a circuit diagram of a central signal station including a current-pulse discriminator.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, FIG. 1 schematically shows the construction of inventive alarm installation. Two groups of alarms 2 and 3 are connected to a central signal station or panel 1. The individual alarms 4 of a group are connected in parallel with one another to common conductors or leads 5 and 6, which proceed from the central signal station or panel 1 and are terminated by a terminating element 7 after the last alarm of each group, as shown. The central signal station 1 contains a direct-current voltage source 8, for example a battery or a mains-fed direct-current power supply unit. This provides the direct-current supply voltage for the conductors or leads 5 and 6 and the individual units for the central signal station 1.

The conductors 5 and 6 are electrically coupled, first of all, to a respective connection unit 9, which evaluates the incoming signals on the lines or conductors 5 and 6, which may be currents or voltages, and transmits them to suitable indicator units 10 and 11 as will be further explained shortly. The terminating element 7 is designed and constructed that it generates a voltage or current supervisory signal which is distinguishable from the direct-current supply voltage as well as from the quiescent or alarm current of the alarm devices 4, and applies this signal to the conductors or lines 5 and 6. The connection unit 9 is designed and constructed such that it is capable of separating this supervisory signal originating in the terminating element from the supply voltage and from the signals coming from the individual alarms 4. This supervisory signal is conducted to a fault indicator unit 10, which indicates whether the supervisory signal emitted by the associated termination element 7 appears with its correct value on the lines 5 and 6 at the central signal station or control panel 1. If an alarm signal is produced by the alarms 4, then this is transmitted by the connection unit 9 to another indicator unit 11, which indicates whether or not an alarm condition is present.

The construction of the other groups of alarms is similar to that explained above, and, therefore, need not be further discussed. Either one group of alarms or a number of groups of alarms may be connected to one central signal station or panel.

It has been stated that the supply voltage applied to the conductors or leads 5 and 6 is a direct-current voltage. What is of significance to the concepts of the inventive conductor-monitoring system is that the terminating element 7 must produce a signal, either a voltage or a current, which at the central signal station or panel, is distinguishable from the supply voltage or the alarm signal discussed above. As the voltage source for the terminating element 7, there may be used either the supply voltage applied to the conductors or lines 5 and 6 or a separate voltage source, for example a battery at the terminating element itself. This would be necessary, for example, when the supply voltage necessary for the alarms is zero, as such would be the case, for instance, when using thermoelements or active photo-elements. The terminating element 7 may be so designed that it yields a signal only when the necessary supply voltage is present and reaches the input of the terminating element. The supervisory signal provided by the terminating element 7 is very advantageously fed back to the central signal station or panel 1 over the conductors or lines 5 and 6, but it is alternatively possible to contemplate signal transmission over a separate supervisory line or by wireless means not using conductors: this would however necessitate increased cost.

In the described alarm installation, in the event of an interruption in one of the supply lines 5, 6 or a short-circuit between the two lines the supply voltage will no longer reach the terminating element 7 and, on the other hand, the supervisory signal produced by the terminating unit 7 will not be received at the central signal panel 1. In each case, therefore, a fault will be signalled at the central signal panel or station 1 by means of the fault indicator unit 10.

Now it may be here generally remarked that known voltage and current converter circuits may be employed as terminating elements.

For example, FIG. 2 shows a sawtooth generator which is suitable for detecting systems incorporating a direct-current voltage of some 200 V. A gas-discharge lamp 12 is connected in series with a resistor 13 across the supply conductors or lines 5 and 6. Connected in parallel with the gas-discharge lamp 12 is a capacitor 14. Since the ignition voltage of the gas-discharge lamp 12 is always higher than its extinction voltage, the capacitor 14 first charges to the ignition voltage of the gas-discharge lamp 12, whereafter the capacitor 14 discharges to the extinction voltage of such gas-discharge lamp and the process is periodically repeated. There appears on the lines or conductors 5 and 6 an additional sawtooth-like voltage which can readily be separated from the direct-current voltage at the central signal station 1.

In FIG. 3 there is shown a rigidly asymmetrically constructed pulse generator consisting of two transistors 15 and 16, the bases 15*a* and 16*a* of which are respectively controlled by the voltage drop at the collector resistances 17, 18 of the other transistor. By appropriate choice of the values of the resistors 17, 18, 19, 20 and 21 and the capacitor 22 it is achieved that the resistance of the current path provided by the

transistor 16 and the resistor 17 falls briefly at predetermined time intervals. Brief current pulses of one polarity are thus periodically generated in the lines 5 and 6. The continuous current drain can therefore be kept extraordinarily low. The maximum pulse current is advantageously chosen to correspond approximately to the alarm current of one alarm 4. As a result, the alarm signals provided by the alarm devices and the supervisory signal supplied by the terminating element can be commonly processed, e.g., amplified, in the input stage or stages of the connection unit 9 of the central station or control panel 1. In this case the discrimination between the two signals may be only effected in a later stage. The diode 23 serves to protect the transistor 15 from voltage peaks of the opposite polarity applied to its base 15 *a*.

FIG. 4 illustrates a circuit diagram of a termination element 7 which, when a direct-current voltage is applied to the conductors or lines 5 and 6, likewise yields periodic current pulses of one polarity. The base electrodes 24*a* and 24*b* of a unijunction transistor 24 are connected by way of respective resistors 25 and 26 to the conductors or lines 5 and 6, while the emitter electrode 25*c* of this unijunction transistor 24 is connected by a resistor 27 to supply lead 5 and by a capacitor 28 to supply lead 6. These circuits require a particularly low current to operate with a ratio of pulse separation to pulse duration of more than 10:1.

FIG. 5 illustrates a circuit diagram of a symmetrically constructed astable trigger circuit with two transistors 31 and 32, the bases 31*a* and 32*a* of which are cross-coupled by means of capacitors 33 and 34 respectively, with the respective collector resistors 35 and 36 of the other transistor. In this manner each transistor is alternately turned-on while the other is cut-off. From the collector of one of the transistors an alternating voltage may then be transmitted by means of a capacitor 37 to the lines 5 and 6. The frequency of this alternating voltage depends upon the values of the resistors and capacitors of the multi-vibrator. In this embodiment the supply voltage is obtained from an internal battery 38. In this manner the termination element 7 is made independent of the supply voltage and may be also used with alarm systems with active alarms, which in the case of an alarm themselves yield an alarm voltage, but do not require any supply voltage.

The separation of the supervisory signals supplied by the termination element from the supply voltage and from any alarm signals at the central signal station or control panel can be effected in known manner by means of capacitors or frequency filters. In cases where the termination element 7 is constructed as a pulse generator, as described in relation to FIGS. 3 and 4, so that the maximum current of the pulse is about of the same order of magnitude as the alarm current of one detector, differing therefrom by a factor of not more than two, a central signal station or control panel may be employed which is provided with the particularly simple and suitable circuit arrangement shown in FIG. 6.

Here, a supply voltage supplied by a mains-driven power unit is received at terminals 39 and 40, whence it is applied by way of a voltage stabilizer and current limiter device 41 to the lines 5 and 6. If a signal enters over these conductors or lines, for example a supervisory signal or an alarm signal, then this is processed by the connection unit 9, which is arranged as a threshold detector and amplifier. The connection unit consists of a transistor 42, a resistor 43 and a capacitor 44. If the current arriving on line 5 exceeds a predetermined threshold level, then a voltage drop is produced across the resistance 45 connected in the collector lead of transistor 42. If the current on lead 5 is a constant current, that is, an alarm signal, then the voltage drop on resistor 45 is applied to the alarm store 11. After a predetermined time interval, which may for example be 0.2 second, an alarm signal transmitter is set into operation which, by means of feedback applied through the voltage stabilizer 41 periodically reduces the supply voltage on the lead 5, so that an alarm indicator lamp situated on the alarm device itself begins to blink and thus indicates the alarm which has been actuated. The current pulses provided by the termination element described in relation to FIG. 3 or FIG. 4 give rise to brief alterations of voltage on the resistance 45. The duration of these voltage transients is less than the response time of the alarm store 11, so that an alarm is not given.

In the fault evaluator 10, however, the voltage pulses appearing on resistor 45 are applied by way of a diode 46 and a resistor 47 to charge a capacitor 48. Capacitor 48 is discharged by way of two resistors 49 and 50 connected in series and having their junction connected to the base of a transistor 51. If the supervisory impulses at the input of the central signal station or signal penal 1 persist for a longer period, for example, during one second, then the capacitor 48 is charged to such an extent that transistor 51, the base 51a of which is connected to resistors 49 and 50, is turned on. A fault indicator 52 is thus prevented from operating. If the supervisory pulses are absent for a predetermined time, the capacitor 48 discharges by way of resistors 49 and 50, transistor 51 is cut off and indicator 52 indicates a fault. The reason for the absence of the supervisory signal may be, for example, a break in a conductor. The condition of a short-circuit between the lines 5 and 6 at any place has the initial result of an increased current. The voltage stabilizer and current limited 41 is thus actuated to switch-off the supply voltage from the leads 5 and 6, so that the voltage at the resistor 45 falls to zero and the fault indicator 52 is set in action to indicate a fault. If, however, an alarm is given by one of the alarm devices 4, then in the manner described, the alarm indicator 11 is set in action, but the capacitor 48 remains charged and therefore a fault is not indicated.

The circuit shown in FIG. 6 is particularly suitable for alarm devices which require to be supplied with low direct-current voltages. For alarm devices which require a higher direct-current voltage, the components of the central signal panel or station which are illustrated in FIG. 1 must be correspondingly constructed, for example, by replacing the semiconductor elements by tubes, and so forth. It is merely necessary to ensure that in addition to arrangements for providing a supply voltage to the lines, for amplifying alarm signals which may arise and if necessary for other purposes, e.g., for monitoring the operational readiness of the alarms, the central signal station or signal panel contains a suitable discriminator for separating out the supervisory signals from the termination element which appear on the leads and also a device for evaluating these signals to control a fault indicator as necessary.

With reference to the arrangement of the terminating element in a group of alarm devices, a particularly favorable solution results when the terminating element is combined with the alarm device which on any set of leads is positioned most remotely from the central signal station.

It should be noted that the invention is not limited in its application to fire alarm systems, but may be used in conjunction with all types of parallel-connected alarm devices which transmit either a relatively small quiescent current or a larger alarm current.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:

1. An apparatus for supervising the continuity of the conductors of an alarm installation, especially a fire alarm installation, comprising a central signal station, a plurality of fire alarms each of which draws a quiescent direct current during normal operation and an alarm direct current when in an actuated condition, at least one pair of conductors for electrically coupling said plurality of fire alarms in parallel with one another and with such central signal station, a direct-current voltage supply for said plurality of parallely connected fire alarms, terminating element means for monitoring the continuity of said pair of conductors, said terminating element means being connected across said pair of conductors at the ends thereof located remote from said central signal station

and generating and applying to said conductors a signal containing at least an alternating-current component, said signal being distinguishable from the signal delivered by said direct-current voltage supply to said fire alarms and further being distinguishable from the quiescent and alarm current signals drawn by said fire alarms, and means provided at said central signal station for responding to the presence of said signal applied to said conductors by said terminating element means.

2. The apparatus as defined in claim 1, wherein said central signal station contains said direct-current voltage supply.

3. The apparatus as defined in claim 2, wherein said signal produced by said terminating element means constitutes a train of pulses.

4. The apparatus as defined in claim 3, wherein the duration of said pulses is less by at least a factor of 10 than the separation between pulses.

5. The apparatus as defined in claim 3, wherein the maximum current of a pulse differs by not more than a factor of two from the alarm current of an individual fire alarm.

6. The apparatus as defined in claim 3, wherein said terminating element means includes a unijunction transistor generating said pulses.

7. The apparatus as defined in claim 3, wherein said terminating element means comprises a multivibrator incorporating at least two mutually cross-coupled transistors.

8. The apparatus as defined in claim 2, wherein said terminating element means comprises a sawtooth-wave generator incorporating at least a gas-discharge tube, capacitor means and resistor means.

9. The apparatus as defined in claim 1, wherein said terminating element means is equipped with an individual voltage source.

10. The apparatus as defined in claim 1, wherein said central signal station contains both means for providing an indication of an alarm current provided by at least one of said fire alarms and said means for indicating the presence or absence of signals provided by said terminating element means.

11. The apparatus as defined in claim 10, wherein said central signal station contains at least one common alarm amplifier stage for both the alarm signals and for the signals supplied by said terminating element means.

12. The apparatus as defined in claim 10, wherein said means for indicating an alarm current is operable only with a predetermined time-delay after the appearance of an alarm signal.

13. The apparatus as defined in claim 10, wherein said central signal station contains means for switching off said supply voltage in the event the current in said conductors exceeds a predetermined value.

14. The apparatus as defined in claim 10, wherein said central signal station includes means for fault indication for producing a fault indication only when the signals provided by said terminating element means have been absent for a period in excess of a predetermined minimum.

15. An apparatus for supervising the continuity of the conductors of a fire alarm installation, comprising a central signal station, a plurality of fire alarms each of which draws a quiescent current during normal operation and an alarm current when in an actuated condition, at least one pair of conductors for electrically coupling said plurality of fire alarms in parallel with one another and with such central signal station, a direct-current voltage supply for said plurality of parallely connected fire alarms, terminating element means for monitoring the continuity of said pair of conductors, said terminating element means being connected across said pair of conductors at the ends thereof located remote from said central signal station and generating and applying to said conductors a signal in the form of a train of pulses, the duration of said pulses being less by a factor of 10 than the separation between pulses, said pulse train signal being distinguishable from the signal delivered by said direct-current voltage supply to said fire alarms and further being distinguishable from the quiescent and alarm current signals drawn by said fire alarms, and means provided at said central signal station for responding to the presence of said signal applied to said conductors by said terminating element means.

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