This invention relates to remote alarm or indicator systems, and more particularly is concerned with a system for sending an alarm or other warning indication from any one station to another in a group of stations connected by electric wires over which other information may be transmitted. The invention is particularly useful as a burglar alarm, fire alarm, or the like.

Warning systems have heretofore been proposed by which a number of remote stations can communicate with a central station to provide an emergency warning and to indicate at the central station the source of the warning indication. One of the problems of warning systems of this general type is that of false alarms, which can be costly and time consuming to the agencies required to act on the alarm. This has been particularly true in the case of law enforcement in connection with burglar alarm systems, and for this reason law enforcement officials have generally been reluctant to install them. Thus in prior art warning systems for burglar alarms, for example, private guards have been used as part of the service to subscribers, greatly increasing the cost of such systems to the subscribers.

Furthermore such prior known warning systems have not provided two-way signaling between each remote station and the central station. This is of particularly great advantage in apprehending burglars and arsonists. For instance, the premises can be illuminated by remote control from the central station, fire apparatus can be similarly remotely controlled, and two-way communication can be established according to the features of the present invention.

The present invention provides an improved automatic alarm system which not only provides maximum protection to the user of such equipment but provides maximum service to the police, fire, or other public agencies in the conduct of law enforcement and protection of the community. The equipment, which provides suitable detecting apparatus at each subscriber station and uses conventional two-wire transmission lines, as provided by the American Telephone Co. or Western Union, communicating with a central control panel such as in a police or fire station, will not produce false alarms at the central station as a result of shorting of the transmission pair, grounding of either of the transmission wires, an open circuit on either of the wires of the transmission pair, or induced alternating currents in the transmission line. Because the equipment is relatively inexpensive and because public police protection is generally available in operating the system, the service cost to subscribers is substantially less than many presently employed burglar alarm systems.

The alarm equipment of the present invention provides at the subscriber station, either manual detection or automatic detection respectively for daytime or nighttime operation of the system. In either event, operation of the burglar or other emergency detector, in whatever form it takes, produces an audio alarm signal at the central station. At the same time a visual indication identifying the point of origin is activated at the central station. Operation of a selector switch at the central station puts the police or other operators in direct audio communication with the subscriber station, permitting them to receive audio information from the subscriber.

By means of a switch at the central station where the system is used as a burglar alarm, the police can turn on lights at the subscriber station after dispatching patrol cars to the area with the effect that the burglar's activities in the inside of the premises are revealed while the patrol officers are hidden by the dark from the burglar, greatly increasing the opportunity for apprehension. Where used as fire alarm or other warning devices, the operator can initiate any desired operation at the subscriber station, such as turning on selected equipment.

A periodic automatic check may be made at the central station of all incoming transmission lines, indicating any tampering with the equipment at the subscriber stations or with the transmission lines. At the same time, provision is made for automatically turning on the lights or actuating other equipment at the subscriber station where the transmission line has been cut or grounded.

In brief, the burglar system of the present invention provides an audio pickup arrangement at each of a number of subscriber stations and reproducing equipment at a central station and a two wire transmission line between a central station and each of the subscriber stations. The transmission line not only transmits audio frequency electrical signals but also acts as a D.C. conductor connection between a pair of balanced or differential relay circuits, with one relay located at the subscriber station and the other relay located at the central station. Actuation of the switch at a subscriber station unbalances the relay circuit in the central station without affecting the relay at the subscriber station. This produces, for example, an audio and/or visual alarm indication at the central station. At the same time, audio transmission at the central station may be completed over the transmission line.

At any desired time, such as after patrol cars have been dispatched to the subscriber station, an operator at the central station can actuate a switch which produces, through the common transmission line, unbalance of the differential relay circuit at the particular subscriber station. In the case of a burglar alarm system, this may be used to actuate the lighting circuits, illuminating the burglar's activities. A periodic test signal at the central station applied to all the transmission lines results in unbalance of particular differential relay circuits at the central station if the associated transmission lines have been cut, grounded, shored, or otherwise tampered with.

For a more complete understanding of the invention, reference should be made to the accompanying drawings, wherein:

FIG. 1 is a schematic wiring diagram of the basic alarm circuit; and

FIG. 2 shows a schematic wiring diagram of a complete burglar alarm system embodying the features of the present invention.

Referring to the circuit as shown in FIG. 1, the numerical 1 indicates generally a conventional two-wire transmission line having signal producing apparatus 2 and signal receiving apparatus 3 connected to the ends of the line. The signal producing and receiving apparatus may be various types of devices such as audio apparatus for conveying voice frequency signals or telescribing apparatus operating on alternating current signals. Isolation transformers 4 and 5 are provided at each end of the transmission line.

The alarm system employs a pair of balanced or differential relays 6 and 7, each of which has its two windings connected in series between the transmission line side of the transformers 4 and 5 and a common ground. The series junction point between the two coils of the respective relays 6 and 7 may be selectively connected to ground or to potential sources, such as the batteries indicated at 8 and 9 respectively. Switches 10.
and 11 provide means for making the selective connections. These switches may be operated manually or automatically as desired at a given installation. In normal standby operation the switches 10 and 11 are set to provide a ground connection to the series junction point of the coils of the relays 6 and 7 respectively.

The circuits associated with the relays 6 and 7 are arranged so that the resistance of the current path through the grounded coil of the relay is twice the resistance of the path through the coil of the relay connected directly to the transmission line 1. This may be accomplished either by design of the coil itself to achieve the desired resistance or by connecting a suitable resistance in series with the coil.

In operation, actuating the switch 10 to connect the potential source 8 to the two coils of the relay 6 does not actuate the relay 6 but does actuate the relay 7. The reason is that the current divides equally between the two coils of the relay 6 in a manner such as to produce opposing magnetic flux within the relay core. However, in the relay 7, the current passes through only one coil and through the switch 11 to ground, causing the relay 7 to operate.

Similarly if the switch 11 is actuated to apply a potential from the source 9 to the relay 7, it does not actuate the relay 7 but does actuate the relay 6. In this way, a switch at either station can be made to operate a relay at the other station using a common transmission line and without interfering with normal communication over the transmission line.

After either switch 10 or 11 has been operated to connect to the source of potential to actuate the balanced relay at the other end of the transmission line, the other switch may be operated to connect its source of potential to the transmission line and thereby actuate the other balanced relay if the sources of potentials 8 and 9 provide the same voltages. For example, when the switch 10 is operated to connect to the source of potential 8, the relay 7 is activated. If the switch 11 is then operated to connect the source of potential 9 to the transmission line, the potentials of the sources 8 and 9 back one another and cancel out so that no current flows through the transmission line or through to coils of the relays 6 and 7 which are directly connected to the transmission line. However, current will flow from each source of potential through the other coil of each of the relays to ground, thereby actuating both relays.

In a burglar alarm system, for example, the relay 7 may be located at a central station and be made to operate a suitable alarm 12 by closing a relay operated switch 13. The relay 6 may be used to turn on a lighting circuit or control other apparatus, as indicated at 14, at the subscriber station by means of a relay-operated switch 15.

The basic circuit shown in FIG. 1 is used with slight modification in the burglar alarm system shown in detail in FIG. 2.

With particular reference to the form of the invention as shown in FIG. 2, the numeral 16 indicates generally the circuitry associated with a subscriber station in a burglar alarm system, and the numeral 17 indicates generally the circuitry associated with the central station. The latter circuitry is in the form of a panel installation at the police station or other appropriate law enforcement agency. Each of a number of subscriber stations, such as indicated at 16, are coupled to the central station by a two-wire telephone transmission line 18. It is also assumed in the installation of the system that a common ground is provided between the subscriber station and the central station as is in accordance with present standards for telephone wiring.

Any suitable well known burglar detecting devices may be employed at the subscriber station in connection with the present burglar alarm system. For example, a number of manually operated normally opened switches 19 may be connected in parallel and located at strategic positions throughout the premises, such as at teller or cashier windows or the like. For nighttime detection, conventional conductive window types, such as illustrated at 20, are connected; and the switches 21 and window operated switches 22, which latter switches are normally closed when the doors and windows are secured, may be provided in series circuit. Other types of detecting devices, such as photoelectric devices and the like may be readily incorporated in the system if desired.

Burglar detector devices are arranged to operate a normally closed or energized relay 24. The relay is initially energized by connecting its coil across a battery 26 or other suitable potential source by means of a reset push-button switch 28. When the relay is energized it closes a holding switch 36 which provides a return current path through a current limiting resistor 32 and a switch 34 which is normally closed for daytime operation. The switch 34 for example may be operated by a door lock such that when the door is locked at night, the switch 34 is automatically opened.

Assuming daytime operation, in which the switch 34 is closed, the relay is maintained energized as long as the holding switch 36 is closed. If either of the switches 19 is momentarily closed to initiate an alarm, they provide a momentary short-circuit bypass of the relay 24, momentarily de-energizing the relay coil and permitting the switch 36 to open. Opening of the relay 24 initiates an alarm at the central station hereinafter described in detail.

For nighttime operation, the switch 34 is open and the holding circuit through the switch 36 and the resistor 32 is completed through the window tape 20 and the door and window switches 21 and 22. If any of these devices are open-circuited, the relay 24 is de-energized, opening the holding circuit in series with door operated switch 26. A special test switch 36 is provided by means of which the proprietor can test whether the switch is in working order after all the doors and windows have been closed at night. Switch 36 is arranged when actuated to complete a circuit between the battery 26 and the normally closed burglar detector devices 20, 21, and 22 in series through a lamp 38. If the doors and windows are properly secured the lamp will light when the test switch 36 is actuated, indicating that the nighttime operation of the system is properly set.

An audio pickup device including one or more microphones 48 coupled to a pre-amplifier 42 is provided at the subscriber station. The output of the amplifier 42 is coupled to the transmission line 18 through an isolation transformer 44. Operation of the pickup system is turned off and on through the amplifier 42 by means of a switch 46 controlled by the relay 24. The pre-amplifier 42 is arranged with a power input lead 48 to the battery 26, rendering the pre-amplifier 42 operative to amplify and transmit audio signals from the microphone 48 through the transmission line 18 to the central station 17.

The switch 46 also operates to control a balanced or differential relay 50 having two separate control windings which are connected in series. The series connection point of the differential relay 50 is connected through the switch 46 either to ground when the relay 24 is energized, or to the battery 26 when the control relay is released. One coil of the differential relay 50 is connected to ground through a resistor 51 while the other coil of the differential relay 50 is connected to the central station 17 through the transmission line 18. To this end one coil of the relay 58 is connected to a center tap on the secondary of the isolating transformer 44 whereby the transmission line 18 provides two parallel D.C. current paths to the central station 17.

By virtue of a common ground between the subscriber station 16 and the central station 17 and circuitry de-
rectly connected to the transmission line at the central station 17 as hereinafter described, current from the battery 26 applied to the series connection point of the two coils of the differential relay 50 normally divides equally between the two coils, half the current passing through the resistor 51 and the other half of the current passing through the transmission line to the central station 17. The two coils of the differential relay 50 are energized equally but in a manner to buck each other magnetically. Thus the relay 50 is not actuated when the relay 24 is initially released. However, the portion of the current from the battery 26 passing through the transmission line 18 provides an indication at the central station 17.

A number of transmission lines come in from a plurality of subscriber stations to the central station 17, provision for three lines being indicated. Each of the transmission lines is connected to an associated isolation transformer, three of which are indicated at 52, 52', and 52" respectively. While three are shown by way of example, it will be understood that any number of input transmission lines may be provided according to the number of subscriber stations in the system.

Because identical circuitry is provided in connection with each of the incoming transmission lines, similar reference characters are used where circuitry is duplicated for each of the incoming lines, prime and double-prime marks being used to distinguish core winding elements of the several identical circuits in the central station.

The center tap of the primary of the isolating transformer 52 is connected to ground through the series-connected windings of a differential relay 54 and a series resistor 56. It should be noted that with the relay 24 opened at the subscriber station, current from the battery 56 passes through the transmission line 18 and through the two windings of the differential relay 54 in an accumulative or non-buckling direction so as to actuate the relay 54. It also should be noted that to maintain a balanced condition of the differential relay 50 at the subscriber station, the value of the resistor 51 must be adjusted such that the impedance of the current path including the one coil of the relay 50 and the resistor 51 is equal to the impedance of the current path including the other coil of the relay 50, the transmission line 18, the two coils of the differential relay 54, and the resistor 56 in series. For example, the relay coils may all be 1000Ω, the resistor 56 may be 1000Ω; in which case, the series combination of the transmission line 18, which is usually relatively small. The resistor 51 is preferably made variable so that systems can be balanced after installation.

When the control relay 24 at the subscriber station is energized, initiating an alarm, associated differential relay 54 at the central station 17 is energized, closing a switch 58 which completes a circuit through a panel indicator light 60 across a battery 61 or other suitable potential source. The panel indicator light 60 provides a visual indication at the central station of activation of the alarm at the indicated subscriber station.

When a particular panel light is lit, indicating an alarm from the identified subscriber station, the operator at the central station sets a manually-operated securit switch, indicated generally at 62, to an appropriate position to select the indicated subscriber station. The switch 62 includes two banks 62A and 62B.

The bank 62A is arranged to selectively connect any of the isolation transformers 52 across a volume control potentiometer 64 associated with the input of an audio amplifier 66 to drive a speaker 68. In this manner the operator can listen to any sounds picked up at the selected subscriber station when the alarm has been initiated.

The bank 62B selectively connects the series junction points of the several differential relays 54 to a normally open switch 70 which in turn is connected to a battery 72 or other suitable potential source. When the switch 70 is closed, a potential is provided at the series junction of the two coils of the differential relay 54 which is balanced against the potential provided by the battery 26 on the series junction point of the two coils of the differential relay 50 at the subscriber station. Thus a bucking potential is provided in the transmission line 18 which opposes the normal flow of current from the battery 26, unbalancing the flow of current through the two coils of relay 50. This results in the closing of a relay-operated switch 73 associated with the differential relay 50. The switch 73 is connected in series with a switch 74 which is operated in the control relay 24. The relay switches 73 and 74, when closed, provide a shunting current path across a main light switch 75 on the premises of the subscriber station thereby turning on the lights, indicated at 76, on the premises of the subscriber. A relay-operated switch 77 shuts the resistor 51 to lock in the relay 50 until the reset switch 28 is operated.

In addition to the visual signal produced by the panel indicator lights 63, an audio warning sound is produced in response to an alarm initiated by any one of the subscriber stations. The audio signal is produced by providing positive feedback between the output and input of the amplifier 66, causing the amplifier to oscillate and generating a squeal over the speaker 68.

To actuate the audio warning signal, each of the differential relays 54 is provided with an additional relay-operated switch indicated at 78, the several switches being connected in parallel. The closing of any of the switches 78 completes a circuit between the coil of a relay 80 and a battery 82. The relay 80 is thus energized whenever an alarm is initiated from any one of the subscriber stations.

The relay 88 actuates a switch 84, the switch 84 completing a circuit through one coil of a double wound relay 86, a series resistor 88, and a series capacitor 88, across a battery 82. Charging of the capacitor 88 from the battery 82 provides a momentary current impulse through the one coil of the double wound relay 86 thereby closing a relay-operated switch 84 and completing a holding circuit through the other coil of the double wound relay 86 whereby the relay 86 is maintained in an energized condition.

The relay 86 operates a second switch 96 which normally grounds one end of the volume control 64. However, when the relay 86 is energized, the switch 96 connects the volume control to the output of the amplifier 66, thereby providing a positive feedback loop which causes the amplifier 66 to oscillate. This generates an audio signal from the speaker 68, warning the operator that an alarm has been initiated from one of the subscriber stations. An audio squeal button switch 96 in series with the switch 94 can be pressed by the operator to release the relay 86 and restore the amplifier 66 to its normal operation, enabling the operator to listen to the audio signals produced at the selected subscriber station.

One of the features of the transmission circuitry of the present invention is that it enables an operator at the central station to test for certain malfunctions at the subscriber station. Under normal operation, assuming, or grounding either of the leads of the transmission line 18 does not result in an alarm being produced at the central station. The reason is that the differential relays 54 are not energized as a result of any of these conditions. This feature eliminates false alarms due to malfunction of the transmission line 18 and the subscriber station relay circuitry. A test is made periodically by applying a potential to the series junction point of the two coils of the several differential relays 54. This may be accomplished, for example, by means of a motor-actuated switch indicated generally at 108, which includes a geared timing motor 102 operating a cam 104 arranged to periodically close a switch 106. When the switch 106 is closed, it connects the battery 82 to each of the series junction points.
between the two coils of each of the differential relays 54. The connections are made through isolation diodes 108. If each of the subscriber stations is functioning properly with the switch 46 grounding the two coils of the differential relay 50, an equal current flows in both of the coils of differential relay 54 in bucking fashion so that the relay is not actuated. One current path includes one of the differential relay 54 and the resistor 56 while the other current path includes the other coil of the differential relay 54, the transmission line, and one coil of the differential relay 50.

However, if the transmission line 10 is open or grounded, the current flowing in the two coils of the differential relay 54 is not balanced and the relay is therefore actuated. This causes the appropriate panel light to light and the audio alarm to be sounded.

To provide an indication of malfunction that differs from an indication of an alarm, and also to stop automatic line testing during an alarm condition, a relay 110 is provided whose coil is connected across the battery 62 through a switch 112 operated by the relay 89. Since the relay 50 is always energized when an alarm is initiated at a subscriber station, it automatically energizes the relay 110 by closing the switch 112. The relay 110 opens a normally closed switch 114 in series with the test circuit provided by the switch 106 thus automatically interrupting the test routine during an alarm condition.

The relay 89 is also energized when any of the differential relays 54 is actuated during a test due to malfunction as discussed above. In closing the switch 112, the relay 89 thus energizes the relay 110 and interrupts the test circuit through the switches 114 and 106. This causes the particular relay 54 associated with the malfunctioning subscriber station to drop out, thereby causing the relays 89 and 110 to drop out, thus restoring the test circuit. The occurrence of events is repeated throughout the test periods when the test switch 106 is closed. As a result, during the test routine, an open or grounded transmission line causes the associated differential relay 54 to continuously open and close. This causes a low frequency interruption of the audio signal and a flashing of the indicator light 60. In this manner, the malfunction indication is easily distinguished from an alarm indication, since the latter is a continuous indication whereas the former is a flashing or interrupted type of indication.

It should be noted that severing or grounding the transmission line produces an unbalance of current in the two coils of the differential relay 50 at the subscriber station if the alarm has been actuated. This results in the lighting circuit being turned on, even though communication with the central station has been interrupted. This provides an added safety feature in that it may scare away the burglar and also acts to alert police in the vicinity of the subscriber station.

While the audio communication is shown as being only from the subscriber station to the central station, it will be apparent that two-way communication can be provided if desired. It will also be apparent that the basic system, as illustrated in Fig. 1, may be employed in many different systems and is not limited to the alarm system shown in Fig. 2.

What is claimed is:

1. A burglar alarm system comprising a transmission line between a subscriber station and a central station, audio pickup means coupled to one end of the transmission line at the subscriber station, and audio reproducing means at the central station, the system including a normally energized control relay at the subscriber station, manual and automatic alarm switch means in circuit with the control relay for releasing the relay to initiate an alarm, switch means actuated by the control relay when released for activating the audio picking means and differential relays located respectively at the subscriber station and the central station, each of the differential relays having a pair of windings connected in series, a potential source at the subscriber station, a resistor in series with the windings of the first differential relay and the series resistor when the control relay is released, a potential source at the central station, a resistor in series with the windings of the second differential relay having a resistance substantially equal to one of the differential relay windings, a switch actuated by the control relay for connecting the potential source across one winding of the first differential relay and the series resistor when the control relay is released, a potential source at the central station, and a lighting circuit at the subscriber station controlled by the differential relay at the subscriber station for turning on the lights at the subscriber station when the differential relay is closed.

2. A burglar alarm system comprising a transmission line between a subscriber station and a central station, audio pickup means coupled to one end of the transmission line at the subscriber station, audio reproducing means at the central station, each of the differential relays having a pair of windings connected in a closed direct current conductive loop, and a lighting circuit at the subscriber station controlled by the differential relay at the subscriber station for turning on the lights at the subscriber station when the differential relay is closed.

3. A burglar alarm system comprising a transmission line between a subscriber station and a central station, a normally energized control relay at the subscriber station, manual and automatic alarm switch means in circuit with the control relay for releasing the relay to initiate an alarm, first and second differential relays located respectively at the subscriber station and the central station, each of the differential relays having a pair of windings connected in series, a potential source at the subscriber station, a switch actuated by the control relay for connecting the potential source across one winding of the first differential relay when the control relay is released, a potential source at the central station, a switch for selectively connecting one winding of the second differential relay across the potential source, means including the transmission line for connecting the series windings and resistors of the two differential relays in a closed direct current conductive loop, and a lighting circuit at the subscriber station controlled by the differential relay at the subscriber station for turning on the lights at the subscriber station when the differential relay is closed.

4. A burglar alarm system comprising a transmission line between a subscriber station and a central station, a normally energized control relay at the subscriber station, and a differential relays located respectively at the subscriber station and the central station, each of the differential...
relays having a pair of windings connected in series, a potential source at the subscriber station, a switch actuated by the burglar detection means for connecting the potential source across one winding of the first differential relay when the control relay is released, a potential source at the central station, a switch for selectively connecting one winding of the second differential relay across the potential source, means including the transmission line for connecting the series windings of the two differential relays in a closed direct current conductive loop, and a signalling circuit at the subscriber station controlled by the differential relay at the subscriber station for turning on signals at the subscriber station when the differential relay is closed.

5. A remote control alarm system for signalling between a protected area and a control area, the system comprising means including a single transmission line interconnecting audio transducers at the two areas for transmitting sounds from the protected area and reproducing the sounds at the control area, alarm sensing means at the protected area for sensing an alarm condition, a warning device at the control area, means including the transmission line for actuating the warning device from the protected area for sensing faults in the transmission line without operating said relay means.

6. Apparatus as defined in claim 5 further including means responsive to a substantial change in the impedance of the transmission line for automatically operating the relay means.

7. A remote control alarm system for signalling between a protected area and a control area, the system comprising alarm sensing means at the protected area for sensing an alarm condition, a warning device at the control area, means including a transmission line for actuating the warning device from the protected area, means responsive to the alarm sensing means for activating the means for actuating the warning device, relay means at the protected area for aiding in control of the alarm condition, means including a switch at the control area for operating the relay means through the transmission line following operation of the alarm sensing means in response to an alarm condition, and periodically operated testing means at the control area for detecting faults in the transmission line without operating said relay means.

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