Aug. 4, 1970 E. W. STREIT 3,523,162

REMOTE SIGNAL SYSTEM

Filed Nov. 13, 1967 2 Sheets-Sheet 1

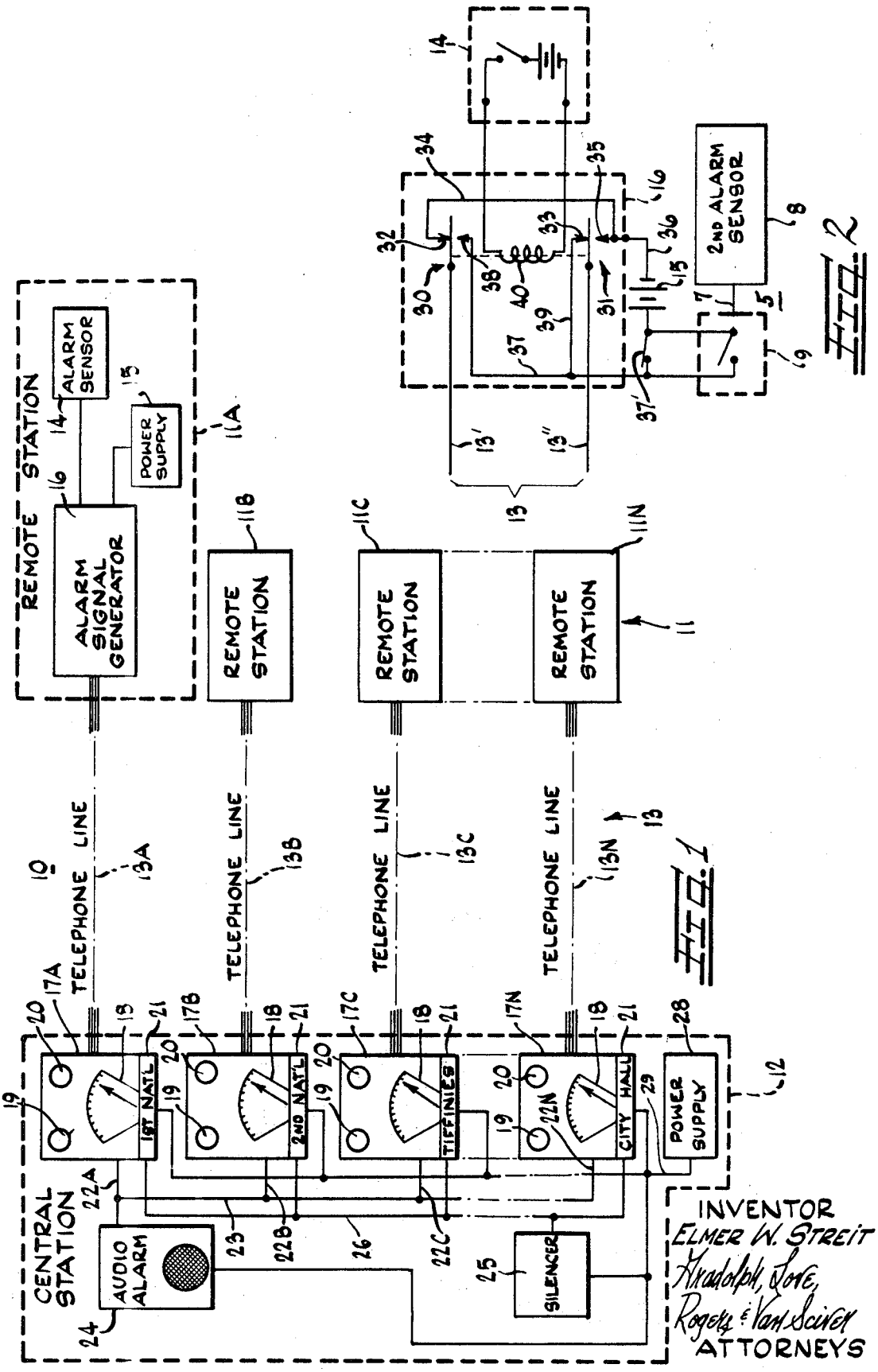

FIG. 2

FIG. 1

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REMOTE SIGNAL SYSTEM

Filed Nov. 13, 1967 2 Sheets-Sheet 2

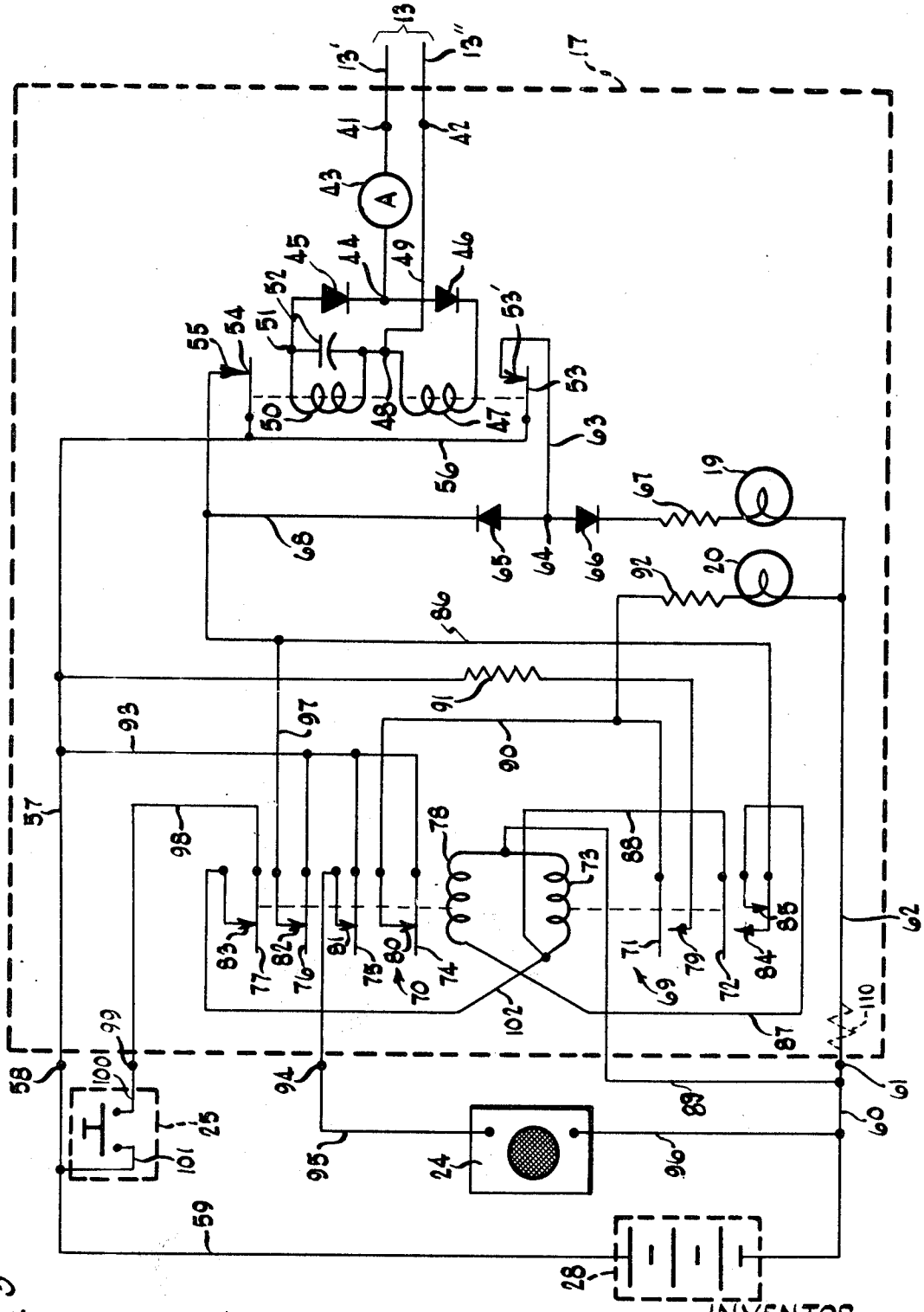

FIG. 3

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3,523,162

REMOTE SIGNAL SYSTEM

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ABSTRACT OF THE DISCLOSURE

A remote alarm system employing telephone lines to interconnect a central station, such as a police station, with a number of remote stations, such as stores, banks, etc., and a central station alarm detecting and signaling circuit are disclosed. The alarm system has special provisions against false actuation of alarm signals by temporary short or open circuiting of the phone lines and yet provides for identification of and distinction between a long term short or open circuit and a true alarm signal. The circuit also provides means for identifying a new alarm situation from existing but uncorrected alarm situations.

BACKGROUND OF THE INVENTION

The present invention is directed toward a new and improved remote alarm system and circuit of the type used to notify a central station of an alarm condition at one or more of a plurality of remote stations. A particular preferred application of the present invention is found in notifying a police station of an alarm condition, such as the breaking of a burglar alarm circuit, at a distant bank or store. While this application is the currently envisioned best mode of practicing the invention, it will be readily appreciated by those skilled in the art of remote alarm systems that many other applications of the principles taught herein can be made.

Many systems and circuits have been proposed in the past for accomplishing the task of alerting a central station of conditions at one or more remote stations. One such suggestion is shown in the U.S. Pat. No. 3,254,334 entitled "Electrical Protection System Utilizing Reverse Polarity Line Testing With Unidirectional Current Devices Having Reverse Breakdown Characteristic," which issued on May 31, 1966, in the name of L. H. Mitchell.

Similar systems are taught in the U.S. Pat. No. 2,944,252 entitled "Intruder Alarm System," which issued on July 5, 1960 in the name of M. W. Muehter, and in the U.S. Pat. No. 3,069,673, entitled "Remotely Controlled Alarm System," which issued on Dec. 18, 1962 in the names of E. J. Ward et al.

While these and other prior art systems and circuits may function adequately for some purposes and in some environments of use, they generally have one or more disadvantages such as requiring excessive installation time, requiring specially trained attendants, being unduly complex and therefore subject to frequent breakdown, providing an alarm indication at the central station only in response to a special signal, thus allowing the system to be defeated by cutting the communication line between the remote and central stations, making no distinction between an alarm signal and communication line trouble, or responding too readily to temporary breaks or shorts in the communication line.

The present invention has as its object the overcoming of the aforesaid disadvantages, in a novel system that is both economic and easy to install and operate.

In accordance with the present invention direct current power and alarm activating mechanism for operating a remote station unit's trouble and alarm signal generation is located at the "local" station. Interconnecting of the units

with the central station is preferably via rented or leased public service company private telephone line facilities.

The use of public service company facilities presents a greater possibility of a false "trouble" alarm, due to the fact that the facilities are exposed to the elements. More often than not, these conditions are of a momentary nature, but nevertheless when they do activate they may actuate a signal at the central station so that a disposition must be made. It is desirable to reduce the number of these false signals as long as security is not jeopardized. It is one of the features and advantages of this invention that this is accomplished in an efficient and effective manner.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIG. 1 is partly schematic and partially block diagram of the overall remote signal system of the present invention;

FIG. 2 is a schematic circuit diagram illustrating one possible embodiment for the remote signal unit of the remote stations of FIG. 1; and

FIG. 3 is a schematic circuit diagram of the alarm unit of the central station of the system of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 the depicted system is generally designated by the number **10** and includes a plurality of remote or "local" stations **11**, individually designated **11A**, **11B**, **11C** . . . and **11N**, each connected to a single central station **12** via a communications telephone line **13A**, **13B**, **13C** . . . and **13N**. As indicated, there may be an indefinite number of remote stations **11** each interconnected by its own line **13** to the central station **12**. While in theory the central station **12** may accommodate an unlimited number of remote stations **11**, experience has found that the dictates of practical considerations limit the number of remote stations **11** that a single central station unit may accommodate to a number of the order of one hundred.

As preferably practiced the invention system **10** employs remote or local units at stores, banks, or other establishments whose management desires protection, with the central unit at a regional police station. Thus, the remote units are responsive to the actuation of a burglar or robbery alarm sensor or other device.

Of course, the invention may be adapted to other functions, such as fire alarm or security within a large plant. However for definitiveness of disclosure it will be here described in conjunction with its presently contemplated best mode of operating, as a burglar or robbery alarm system for alerting a police station located at a distance from the protected establishments.

The remote stations **11** are thus each located in a different establishment which is remotely located from the police station **12**. Each remote station **11** comprises, as in station **11A** depicted in FIG. 1, an alarm sensor **14** and a power supply **15** coupled to an alarm signal generator **16**. The alarm sensor **14** may be any connectional device such as the conventional foil circuits used on many store windows, a manually operated foot button alarm such as often used in bank cages or any other device that senses or is actuated in response to an alarm situation.

The lines 13 interconnecting the remote stations 11 and the central or police station 12 are preferably telephone lines leased from the local telephone utility company. While other lines may be employed, the leasing of private lines from the telephone company has the twin advantages of being economical and easy to accomplish. Thus, a new store may be readily added to those subscribing to the service of the system 10 with a minimum of bother and effort on the part of the subscriber or the central station operator. Beside the convenience and economy of the leased telephone lines they are often the only practical method of obtaining intercommunication between a large number of widely separated, often by many miles, establishments and a central station.

However, the use of leased telephone lines while very advantageous for most purposes does result in magnification of the problems found with any remote alarm system. The problem of protection against false actuation that can result from temporary shorts or groundings or opens on the communication lines is thus accentuated. One of the major advantages of the present invention is the minimization of this problem.

At the central station 12 each line 13 is connected to an individual module 17. That is line 13A is connected to module 17A, line 13B to module 17B, line 13C to module 17C . . . and line 13N to module 17N. Each of these modules 17 has visual alarm indicators comprising an indicating meter dial 18 and a pair of lights 19 and 20. While the light 19 is preferably red and the light 20 is preferably yellow, any convenient differentiating coloration could, of course, be used. In addition, a subscribed indicia such as the name plates 21 are also mounted on each module 17 to aid the attendant (normally the police desk sergeant in a police station installation) in identifying the source of the alarm. Each of the modules 17 are preferably mounted in a panel display positioned facing the attendant.

The modules 17 are each coupled via one of the lines 22A–22N, to a common bus bar or line 23 which is connected to an audio alarm unit 24. The unit 24 preferably sounds an audio alarm of a dissonant type, such as a buzzer, to call the attendant.

A remotely located silencer 25 for silencing the audio alarm 24 is provided connected via a bus bar 26 to individual ones of the modules 17A–17N. The silencer 25 is preferably a simple push button switch and is preferably located nearby the attendant to minimize any annoyance to him that may result from the continued sounding of the audio alarm after it has complied its notifying task. The unit 12 also includes a conventional power supply 28 connected via a bus bar 29 to each of the modules 17 and also connected to the silencer 25 and the audio alarm 24.

One operable design for the alarm signal generator 16 of the remote stations 11 is depicted in detail in FIG. 2. Referring to that figure, the two conventional conductors of the telephone line 13 are there designated 13′ and 13″ and are connected to switch means of the relay type. The lines 13′ and 13″ are respectively connected to the switch blades of a pair of ganged relay switches 30 and 31. The switches 30 and 31 are each of the two contact type and are mechanically biased so as to normally make contact between their blades and a first contact 32 or 33. The contact 32 is connected via line 34 to the second or normally open contact 35 of the other switch 31. This contact 35, and thus contact 32 via line 34, are connected via a conductor 36 to the negative terminal of the voltage supply 15. The positive terminal of the supply 15 is connected via a closed switch 37′ and a line 37 to the second or normally open contact 38 of switch 30 and also, via line 39, to contact 33 of switch 31. The switch 37′ may be eliminated without effecting the operation of the basic circuit, as it functions to allow employment of an optional alarm subsystem 5 that will be discussed below.

Thus the line 13′ is normally connected via the switch blade of switch 30, the contact 32, the lines 34 and 36 to the negative side of supply 15 while the line 13″ is connected to its positive side via the blade of switch 31, contact 33 and lines 39 and 37. When the ganged switch blades of switches 30 and 31 are thrown the polarity is reversed. That is, the line 13′ is connected to the positive terminal of supply 15 via the blade of switch 30, contact point 38 and line 37, while the line 13″ is connected to the negative terminal of source 15 via contact 35 and line 36.

This reversal of polarity constitutes the alarm signal and is achieved by the actuation of the relay coil 40 which is connected across the sensor 14. The sensor 14 supplies a current through the coil 40 in response to its sensing of an alarm condition. This results in a switching of the blades of the switches 30 and 31 and causes the polarity of the voltage across lines 13′ and 13″ of the telephone line 13 to be reversed.

Referring to FIG. 3, the circuitry of the modules 17 and its interrelation with the audio alarm unit 24, the silencer 25 and the power supply 28 will now be described. The inputs from the phone line are designated 13′ and 13″ in conformity with FIG. 2. Thus, the line 13′ is normally negative and line 13″ is normally positive with the polarity of the lines being reversed whenever a true alarm condition exists. The line 13′ is connected to an input terminal 41 while line 13″ is connected to an input terminal 42.

An ammeter 43, whose meter dial 18 is depicted in FIG. 1, is connected between the terminal 41 and the junction 44 of a pair of series connected diodes 45 and 46. The diode 45 is connected so as to allow conventional current flow essentially only into the junction 44 while diode 46 is connected so as to allow conventional current flow essentially only out of the junction 44. The other side of the diode 46 away from the junction 44 is connected to one end of a relay coil 47. The other end of the coil 47 is connected to a junction 48 with a line 49 connected thereto and to the terminal 42.

Also connected to the junction 48 is one end of a second relay coil 50, the other end of which is connected to the diode 45. Connected across the coil 50 between the junction 48 and the junction 51 between the coil 50 and the diode 45 is a capacitor 52.

The relay coil 47 functions to move a switch blade 53. The blade 53 has a single contact point 54 associated with it and is mechanically biased as to have the switch formed thereby normally open in the absence of energization of the coil 47.

The relay coil 50 functions to move a switch blade 54 which is mechanically biased so as to normally make contact with a contact point 55 in the absence of energization of the coil 50. The switch blade 54 is electrically connected to the switch blade 53 by a conductor 56 which is also connected to a line 57.

The line 57 is connected to the positive terminal of the power supply or direct current voltage source 28 through a terminal 58. The terminal 58 is connected to a common bus bar 59 which may have many of the modules 17 connected thereto. The negative terminal of the voltage source 28 is connected to a similar bus bar 60 to which the terminals 61 of the modules 17 are connected in common. For purposes of analysis the potential of bus bar 60, terminal 61 and a conductor 62 connected thereto shall be taken as a reference of termed "ground" potential, it being understood however that this potential level may not be connected to ground and may be at a different relative level from the reference potentials of other parts of the system.

The relay contact point 53′ of the relay formed by that contact point, the coil 47, and the blade 53 is connected via a conductor 63 to the junction 64 between two series connected diodes 65 and 66. The diodes 65 and

66 are each connected so as to allow conventional current flow essentially only away from the junction 64.

The other side of diode 66 away from the junction 64 is connected through a resistance 67 to one side of the lamp 19, the other side of which is connected to the line 62. The other side of diode 65 away from the junction 64 is connected via a line 68 to the contact point 55.

The module 17 also includes two relays generally indicated by 69 and 70 each of which has a plurality of ganged switch blades operated by the relay coil. The relay 69 comprises a ganged first and second switch blade 71 and 72 moved by a relay coil 73. The relay 70 comprises a first, a second, a third and a fourth ganged switch blades, respectively designated 74, 75, 76 and 77 and all controlled by a relay coil 78. The blades 71, 74, 75, 76 and 77 each have only a single contact point designated, respectively, 79, 80, 81, 82 and 83 associated with them, while the blade 72 is part of a "make before break" switch which includes a first contact point 84 which is itself a switch blade for a second contact point 85. The blade 72 is mechanically biased to be open, absent energization of the coil 73, with respect to point 84 while the contact point 84 is mechanically biased to be closed against the point 85 so that the contact between points 85 and 84 is normally closed.

The point 84 of relay 69 is connected via a line 86 to line 68. The contact point 85 is connected via a line 87 to one side of the relay coil 78. The blade 72 is connected via line 88 to one side of the relay coil 73. The other sides of both these coils 73 and 78 are joined together and connected via a bus bar 89 to reference potential source, line 60.

The other switch blade 71 of relay 69 is connected via a line 90 to the contact 80 of blade 70 while its contact point 79 is coupled through a resistor 91 to the positive potential line 57. The conductor 90 is connected through a resistance 92 to one side of the lamp 20, the other side of which is connected to reference potential line 62.

The first, second, and third switch blades 74, 75 and 76 of relay 70 are all connected in common via a conductor 93 to the positive potential line 57. The contact point 81 of blade 75 is connected to an output terminal 94 which is, in turn, connected to a bus bar 95. The bus bar 95 is further connected to one side of the audio alarm unit 24 which is also connected via a conductor 96 to the negative bus bar 60. Each of the modules 17 have an output terminal 94 which are connected in common to bus bar 95. The contact point of blade 76 is connected via line 97 to line 86.

The blade 77 is connected via a line 98 to module output terminal 99 which is connected in common with the similar outputs of module 17 to a bus bar 100. The bus bar 100 is connected to one terminal of a push button switch of the silencer 25. The other terminal of the push button switch of silencer 25 is connected via a line 101 to positive bus bar 59. The point 83 associated with blade 77 is connected via a line 102 to the junction of line 88 and coil 73.

Having described the overall circuit of FIG. 3, its operation will now be considered. When there is no alarm condition present at the remote station connected by the leased telephone line 13 to the module input terminals 41 and 42, and when there is no abnormal interference with the service of the line 13, the conductor 13'' will be positive with respect to conductor 13' and a small current will flow between the lines 13' and 13'' through the terminal 42, the line 49, the relay coil 50, the diode 45 and the ammeter 43 to the terminal 41. Furthermore, a charge will have been built up across capacitor 52 and current flow through the coil 47 is prevented by the diode 46. The current flow through the coil 50 maintains the normally closed relay switch of blade 54 and blade contact 55 open and the lack of current through coil 47 keeps the normally open relay switch of point 53' and blade 53 open. As such, the module 17 draws no power from the supply 28 and the visual indicators, save for meter dial 18, are not actuated.

When an alarm signal is sent by the remote station the polarities of conductors 13' and 13'' are reversed. The reversal of polarities cause a current to flow from terminal 41 through the meter 43, in the opposite direction, through the diode 46, the coil 47, the line 49 and the terminal 42. This current operates the relay switch blade 53 to cause direct current to flow from the source 28 through the bus bar 59, the input terminal 58, the line 57, the line 56, the blade 53, the contact point 53', the line 63, the junction 64, the diode 66, the resistance 67, the lamp 19, the line 62, the terminal 61 and the bus bar 60. This current lights the red alarm lamp 19.

A current is also caused to immediately flow through a closed current path from the positive line 57 to the negative line 62 through the junction point 64, the diode 65, the line 68, the line 86, the movable contact point 84, the fixed contact point 85, the line 87, the coil 78 and the bus 89. This current causes, after a momentary delay, the ganged first, second, third and fourth relay switches of blades 74–77 to close. This in turn causes current to flow from positive line 57 through line 93, the first closed switch of blade 74 and contact 80, line 90, resistance 92 and the trouble lamp 20, to the line 62, thereby lighting the lamp 20.

At the same time, current is caused to flow from line 93 through the second relay switch of blade 75 and blade contact 81, output terminal 94, bus bar 95, through audio alarm unit 24, the line 96 to the negative bus bar 60 thereby sounding the audio alarm.

The direct current potential present on line 93 is also simultaneously applied through the third relay switch made up of blade 76 and blade contact 82, to the line 97 and from thence to line 86. This serves as a second current path to the switch of blade 53 and contact 54.

An additional current path to line 86 results from the de-energization of coil 50. Upon the reversal of polarity current can no longer flow through the diode 45. However, the capacitor 52, in accordance with an important feature of the present invention, provides a transcendent current path through the coil 50 for a short period after the potential reversal. Eventually, the current through the coil 50 drops below the level necessary for maintaining the switch of blade 54 and contact 55 open and that switch is closed. This provides an additional current path through the blade 54 and the contact point 55 to the line 68.

The first relay switch, made up of switch blade 74 and blade contact 80, also serves to connect the positive potential of line 93 therethrough to line 90 and switch blade 71 of the first relay switch of relay 69.

The fourth switch of relay 70 electrically connects the push button silencer 25, via the line 100, the terminal 99, the line 98, the closed fourth relay switch, and the line 102 to one end of coil 73. No current flows through this path as the push button switch 25 open-circuits the current path between the positive bus bar 59 and the negative bus bar 89 and line 62.

Thus, when an alarm signal reversal of polarities occurs on conductors 13' and 13'' the module 17 causes the lights 19 and 20 to light, and the audio alarm unit 24 to sound. The ammeter 43 also indicates a current flow in the opposite direction than before and thus provides another visual indicator of the alarm situation existing at the remote station.

The audio alarm will continue to sound until the push button silencer 101 is depressed by the attendant. Therefore, if the alarm signal is received during the temporary absence of the attendant, the alarm will continue to sound until his return.

The audio signal is silenced by the making or closing the circuit path from the positive bus bar, through the line 101, the push button switch silencer 25, the line 100, the module terminal 99, the line 98, the blade 77, the blade contact 83, the coil 73 and the line 89 to negative

line 62. This results in a flow of current through relay coil 73 and the consequential movement of the ganged switch blades 71 and 72.

The movement of blade 72 into contact with blade contact 84 closes a second current path for coil 73. This path, from positively connected line 86 (through relay switch blades 53 and 54) the blade contact 84, the blade 72, the line 88, through the coil 73, to negatively connected bus bar 89, maintains relay coil 73 energized even though the push button switch of silencer 25 is returned to its open circuit condition. As the blade 72 is further advanced, it moves the movable contact 84 out of contact with the contact point 85. This causes the open circuiting of the current path through relay coil 78 which results in the opening of the four switches of relay 70. The opening of the fourth switch made up of blade 77 and blade contact 83 open circuits the current path from the silencer 25 and assures that further depressions of the push button will have no effect on the circuitry of the module 17.

The opening of the third switch of relay 70 prevents current flow through line 97 to the line 86. The opening of the second relay switch open circuits the current path to the audio alarm unit 24 and silences the audio alarm.

The opening of the first switch of relay 70 prevents current flow through the line 90 and would result in the extinguishing of the lamp 20 save for the alternate current path formed by the closing of the first switch of relay 69. This path, from positive line 57 through resistor 91, the blade contact 79, the blade 71 to the line 90, is closed momentarily before the opening of circuit through the first switch of relay 70, causing no extinguishing of the lamp 20. However, because of the resistor 91 the lamp 20 is caused to glow with reduced brightness. This allows for easy differentiation by an attendant between modules 17. If this light were not dimmed it would be difficult for an attendant to distinguish between it and a subsequent alarm indicating module 17.

Should the alarm signal from the remote station now be replaced by the normal signal, that is the polarities of conductor 13′ and 13″ would respectively be returned to positive and negative again, the relay switches formed of blades 53 and 54 and their associated contacts 53′ and 55 would be opened. This would cause lamp 19 to be extinguished, the relay switches of relay 69 to open (reclosing the contact between make before break contact 84 and contact 85) and extinguishing the lamp 20. This would restore the module to its normal condition, in which it is ready to receive another alarm signal and to repeat the above described operation.

Should the alarm signal have been received at the terminals 41 and 42 but normal condition restored before the pushing of the push button silencer 25 by the attendant, the module 17 would not be restored to normal. This is an advantage of the inventive circuit, in that it prevents restoration to normal by, for example, a burglar's resetting the signal generator 16 at the remote station 11.

Other conditions that the module 17 may indicate are a short or open circuit on the telephone line 13. In either of these cases no current will flow between the terminals 41 and 42. Should the condition be a temporary one, such as occasioned by a telephone repairman temporarily cutting into the line 13 in a search for another line, no signal will result. This desirable feature of the present invention is provided by the capacitor 52 which stores a sufficient charge to maintain a current through the coil 50 for a short period after the cessation of the current between the terminals 41 and 42. In practice, approximately two seconds is considered to be the proper period of delay and the capacitance of the capacitor 52 is chosen accordingly.

If the short or open circuit between the conductors 13′, 13″ continues beyond the delay period, the current in coil 50 will fall below the level necessary to keep open the normally closed relay switch formed by blade 54 and blade contact 55 and that switch will close. This closure actuates, in the aforesaid manner, the audio alarm 24 and the trouble lamp 20. The alarm lamp 19 is not actuated by the short or open circuit. The audio alarm may be silenced only by operation of silencer 25 by the central station attendant. The trouble lamp will remain lighted at a reduced level of illumination thereafter while the short or open circuit continues. Should conditions be restored to normal the light 20 will be extinguished.

As mentioned before the use of telephone lines presents a greater possibility of a false "trouble" alarm, due to the fact that the facilities are more exposed to the elements. More often than not, these conditions are of a momentary nature, but nevertheless when they do activate the module 17, a disposition must be made by the attendant. It is desirable to reduce the number of these false signals as long as security is not jeopardized. The capacitor 52 provides a momentary delay of, e.g., one to two seconds before the operation of the trouble relay switch 54–55. Security is not jeopardized for an "alarm" type signal, since the action of the alarm relay 54, 54′, and rectifier 65 instantaneously initiates an "alarm" signal.

If a signal is once initiated, it is "locked-in" to permit definite identification and disposition of it. Uncertainty would result with a non-locking unit if normal conditions were restored between perception of the audible signal and attempted identification of the visual signal. Uncertainty would lead to laxity on the part of the central station attendants and jeopardy of security.

The circuit of FIG. 3 accomplishes this "locking-in" by means of the relay 70. The "lock-in" feature is cut out only after the silencer push button switch 25 is manually operated. In the interim, definite identification may be made. If normal conditions were restored in the interim, the unit would automatically restore itself upon the pressing of the push button 25.

The above described circuit is also designed so that only a single push button switch 25 is required to silence the audible signal originating from any unit. This feature is important in communication centers such as a metropolitan police district headquarters. It is accomplished by means of the "make before break" contacts 72, 84 and 85 of relay 69 and the "make" contacts 77 and 83 of relay 70. It permits locating of the larger space requiring module cabinets away from the attendant so that more frequently used telephone switchboard and radio transmitting equipment may be conveniently placed for attendants. The single push button also provides for more efficient operation by handicapped personnel.

The circuit also provides for differentiating between a previously received and a newly received signal. A previously received signal "trouble" lamp 20 will have been dimmed due to the fixed resistor 91 while a newly received signal "trouble" lamp will be bright.

An "alarm" type signal is initiated by reversing the direct current polarity to the transmission conductors at the "local" or remote station. Since the rectifiers 65 and 66 are associated primarily with this "alarm" type signal, a discussion of their importance follows.

If the alarm relay and associated alarm lamp circuit were eliminated, and the winding of the relay were replaced by an equivalent value resistor, an "alarm" type signal could still be received by observing the "zero center reading" meter. Two objections to this type of indication would be that the more discernible alarm lamp signal and the instantaneous alarm signal feature would be eliminated. The instantaneous alarm feature could be incorporated in this type circuit by removing the capacitor, but this would revert the system to increased false alarm possibilities previously mentioned.

If the alarm relay circuitry would be as shown, but with rectifier 66 shorted and rectifier 65 removed, an

"alarm" type signal would be received much in the same manner as mentioned above. This type circuit would, however, have the advantage of the more discernible lighting of the lamp **19**, but the problem of the delayed audible signal or increased false alarms would still exist.

If the alarm relay circuitry would be as shown, but with both rectifiers **65** and **66** shorted, "trouble" type signals would be delayed and alarm type signals would not be delayed. The objection to this type circuitry is that the purpose of the discernible "alarm" lamp **19** would be defeated by the fact that it would also be energized when a delayed "trouble" type signal appears.

If the alarm relay circuitry would be as shown, but with rectifier **66** shorted, the system would operate as intended with the delayed trouble type signal and the instantaneous alarm type signal. This circuitry however has a hidden trouble possibility.

As is well known, all circuit connecting elements such as the ordinary wires used to interconnect most elements in the module **17** and to interconnect the modules **17** and the various external elements of the system, such as the power source **28**, have some measurable resistance. In most cases this resistance is so small as to be unimportant and is justifiably ignored in diagrams such as FIG. 3.

One such normally negligible distributed resistance **110** is depicted in dashed lines superimposed on line **62** adjacent to terminal **61**.

In a normal installation, the numerical value of resistance **110** is quite low, and the effect that it would have on other units would be negligible even if rectifier **66** were shorted. There is, however, a possibility of the numerical value of resistance **110** becoming quite high under a "loose connection" condition. It is under these conditions that an appreciable voltage would develop across this resistance as soon as a signal, either "trouble" or "alarm," is initiated.

Under these conditions the voltage level at the line **62** side of alarm lamp **19** may be significantly different from that at bus bar **89**. As, with diode **66** shorted a current path exists through alarm lamp **19**, resistance **67**, junction **64**, diode **65**, line **68**, contacts **84** and **85**, the line **87** and coil **78** to bus bar **89** such a current can develop.

It is possible that the developed current could be of sufficient amplitude to make the brilliance of the associated alarm lamp **19** enough to be noticeable and thereby confuse the attendant, and/or reach the pick-up point of the relay **70** and thereby cause a chain reaction by an increase in the developed voltage across the resistance **110**. The increase would be due to the closed relay contacts of relay **70** and its associated "trouble" lamp **20**.

In other words, under a "trouble" alarm condition, the voltage level at the line **62** side of the trouble lamp **20** may be significantly different from that at bus bar **89**. As with diode **66** shorted, an initial current path exists from positive lines **57** and **93**, through contacts **74** and **80** of energized relay **70**, line **90**, resistor **92**, trouble lamp **20**, line **62**, resistor **110**, to negative bus bar **89** such a voltage can develop at resistor **110**.

Under a "true alarm" condition, the voltage level at the line **62** side of trouble lamp **20** and alarm lamp **19** may be significantly different from that at bus bar **89** and to a greater degree than indicated for a "trouble" alarm condition. As with diode **66** shorted, an initial current path exists as described for a "trouble" alarm condition, and an additional initial current path exists from positive lines **57** and **56**, through closed contacts **53** and **53'** of energized relay **47**, junction **64**, resistor **67**, alarm lamp **19**, line **62**, resistor **110** to negative bus bar **89** such an increased voltage can develop at resistor **110**.

It is possible that the developed voltage at resistor **110** could be of sufficient amplitude to make the brilliance of an adjacent alarm lamp **19** enough to be noticeable and thereby confuse the attendant, and possibly reach the pick-up point of an adjacent relay **70** and thereby cause a chain reaction by an additional increase of the developed voltage across resistor **110**. This additional increase would be due to the closed relay contacts **74** and **80** of the additionally picked up relay **70** and its associated trouble lamp **20**.

As, with diode **66** shorted, a dissipating current path, which causes a brilliance of an adjacent alarm lamp **19** and a possible pickup of its associated relay **70**, exists from line **62** (positive side of developed voltage) through adjacent alarm lamp **19**, resistor **67**, junction **64**, diode **65**, line **68**, line **86**, closed contacts **84** and **85** of adjacent relay **69**, line **87**, adjacent relay coil **78** to bus bar **89** (negative side of developed voltage).

Although the possibility of this condition is remote, the blocking rectifier **66** is included to prevent this possibility and assure the reliability of the circuit and system.

Reliability of operation of the system may be doubled by using two individual modules **17** at the central station for each "local" station. This type of operation still only requires one pair of private line conductors as ground is used as a third conductor but proper operation of the units is not dependent on ground conduction. For example, line **13'** may be normally maintained at a negative voltage below ground while line **13''** is maintained at a positive voltage above ground. In this case one input **42** of module **17** would be connected to line **13''** and the other input **41** connected to ground while the second module **17** of the pair would have its input **41** connected to line **13'** and its input **42** grounded.

For this double type of operation, the direct current voltage at the "local" station transmission conductors must of necessity be twice the value of a single unit type operation. The voltage must also be center tapped to ground. As with the single unit, the transmission conductor polarities must be reversed by mechanism at the "local" station to initiate an "alarm" type signal at the remote signal station.

Assuming that ground conduction and connections are normal, this type of operation would be able to transmit an "alarm" type signal on one of the units even if the other unit already indicated a "trouble" type signal. This type of operation is also an asset for servicing, in that it provides a better indication as to the nature and location of trouble.

Since this type of operation requires two individual component units per "local" location, the practical limit for a complete installation of this type would be 50 local stations.

The preceding double module type of operation greatly increase the security of a single module type, but for practical purposes, it would only be used where a very high type of security would be required.

Referring again to FIG. 2, the optional alarm sub-system **5** will now be discussed. The sub-system **5** including an additional alarm signal generator operated from a second alarm sensor **8** coupled as indicated by the line **7** to the sensor **14**. The second signal generator **9** is employed when a secondary indication of alarm condition is desired.

For example, it may be desirable in a bank to give a first alarm when an intruder enters the premises and a second alarm when the safe is tampered with. The secondary alarm sensor functions only after the initial alarm signal is sent. When this secondary system is employed the switch **37'** is opened. The generator **9** is normally closed circuited across the switch **37'** to allow unobstructed functioning of the generator **16**. However, once the generator **16** is functioning to send the main alarm signal the secondary alarm sensor **8** operates the secondary alarm generator **9** to cyclically open and reclose the circuit therethrough across the switch **37'**.

This alternating secondary alarm signal functions to flash the alarm lamp **19** of FIGS. 1 and 3 to give added attention to the particular remote station. It does this thing without affecting the other aspects of the circuit of the module **17**.

The circuit described above also provides reliability of operation. Conventional units pertaining to this type of remote signalling normally provide only a single relay with switch means for energizing audio and visual signal units. The circuit as shown on FIG. 3 would be of this conventional type if the following components were to be removed from the circuit: Relay coil **47** and its associated switch means, diodes **46**, **65**, and **66**, lines **56**, **63**, and **68**, and alarm lamp **19**, and resistor **67**.

It is readily noticeable that a malfunction of a conventional single relay means would result in a malfunction of the unit. The malfunction could be electrical due to a contamination of the switch means, or it could be mechanical which could prevent closure of the switch means.

The addition of diode **65**, in the manner indicated on FIG. 3, provides a second current path to the junction of lines **68** and **86** in the event of a true alarm, and in this manner provides a greater reliability of operation than is available with the single relay type conventional system.

In the event of a true alarm signal, a malfunction of the switch means associated with relay coil **47** of FIG. 3 would prevent energization of the alarm lamp **19**, but the proper operation of the switch means associated with relay coil **50** would nevertheless cause the energization of multiple contact relay **70**, with subsequent energization of the audio alarm **24** and the trouble lamp **20** to indicate the source of the alarm signal. A comparison of the lamp indication with the properly designated meter indication would nevertheless verify the alarm signal to be a true alarm signal.

In one practical embodiment of the invention a voltage source of twelve volts, direct current, is employed for the remote signal unit, to result in a small (two milliampere or less) current through the ammeter **43**. Because of the small power loss the remote unit may employ a battery as its power source, thus making it independent of the public power electric sources and consequently not affected by failures of such sources. Likewise, the central station may employ a similar twelve volt battery pack as its source of power for the same reasons. Of course, other power sources such as the more conventional direct current rectifiers may be employed, with or without a battery stand-by source.

As is now apparent the aforedescribed remote alarm system and circuit is both easy and economical to install and operate and may even be operated by a minimally trained or even an untrained attendant. The described system and circuit provides for a plurality of alarm distinctions, while at the same time providing protection against false actuation by a temporary short or open circuit.

Moreover, the system and circuit of the present invention are versatile and can be readily adapted and modified to different environments of use and differing alarm application.

For example, it will be readily apparent that other switch means such as transistors or electron tubes, may be employed in place of the relay switches without departing from the spirit of the teaching of the present invention.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A remote alarm system comprising

a plurality of remote stations each having an alarm sensor, and an alarm signal generator actively coupled to said sensor for activation thereby, said generator including a source of direct current;

a plurality of communication lines each of which is coupled, in a normally current carrying relationship, at one end to one of the alarm signal generators of said plurality of remote stations, said sensor, when activated, causing a variation in said normally carried current to constitute a signal; and

a central station coupled to the other end of each of said plurality of communication lines, said central station including:

a direct current power supply;

an audio alarm;

a silencer for said audio alarm; and

a plurality of modules coupled to said power supply, to said audio alarm, and to said silencer for separately and independently actuating said alarm and silencing said alarm, each of said modules being coupled to the other end of a different one of said plurality of communication lines and including:

at least one visual indicator; and

switching means responsive to a signal on said coupled communication line to actuate said visual indicator and said audio alarm;

whereby, in response to a signal on any one of said plurality of communication lines, said audio alarm is sounded and said visual indicator of the one of said plurality of said modules coupled to said any one of said remote stations is caused to indicate an alarm condition.

2. The remote alarm system as defined in claim **1** in which:

said alarm signal generator of said each remote station produces a direct current signal of one polarity during normal operation and a direct current signal of the opposite polarity in response to activation by said alarm sensor.

3. The remote system as defined in claim **2** in which:

said communication lines are of the two conductor telephone line type.

4. The remote alarm system as defined in claim **3** in which:

said each of said modules is responsive to said signal of opposite polarity on said two conductor communication lines to activate said visual indicator, and each of said modules includes a second visual indicator which is activated in response to absence of said signal of one polarity, and delay means for delaying the activation of said second visual indicator and for preventing the actuation of said second visual indicator should the absence of said signal of one polarity be only temporary.

5. The remote alarm system as defined in claim **4** in which:

each of said modules includes an ammeter actively coupled to the one of said communication lines coupled to that module for indicating the flow of current therein.

6. The remote alarm system as defined in claim **5** in which:

said central station includes a source of direct current potential which is coupled to each of said plurality of modules;

said direct current potential of said source is electrically isolated by said plurality of modules from the currents from said communication lines; and

each of said modules includes switching means responsive to a reversal of polarity of said communication coupled thereto to connect the potential from said source across said first lamp and to couple said potential to said audio alarm.

7. The remote alarm system as defined in claim **2** in which each of said plurality of modules includes:

a pair of power input terminals for connection across a source of direct current voltage;

a pair of input terminals for connection to one of said plurality of communication lines;

an audio output terminal for connection to said audio alarm;

a silencer input terminal for connection to said silencer;

a signal detection circuit coupled across said input terminals for closing a first switch means in the absence of a direct current of said one polarity between said input terminals and for closing a second switch means in response to a direct current of said opposite polarity between said input terminals;

said at least one visual indicator is a first lamp which is connected in series with said second switch means across said power input terminals;

a second lamp;

first means responsive optionally to said first switch means and to said second switch means for connecting one of said power input terminals to said audio output terminal, to said second lamp, and to holding means, and for connecting said silencer input terminal to silencer-signal-responsive second means, said second means responding to cause said connection of one of said power input terminals to said audio output terminal and to said holding means to be disconnected and to cause said connection between said second means and said silencer input terminal to be transferred to a connection between said second means and said first switch means while maintaining said second lamp connected between said power input terminals in such a manner as to diminish its brightness; and

said signal detection circuit includes delay means for delaying the activation of said first switch means.

8. The remote alarm system as defined in claim **7** in which:

said first switch means is a normally open relay switch whose relay coil (**50**) is connected in series with a first diode (**45**) across said pair of communication line input terminals, said first diode being connected so as to prevent current flow therebetween when said direct current therethrough is in said one polarity and to allow current to flow therethrough when said opposite polarity direct current is present;

said second switch means is a normally closed relay switch whose relay coil (**47**) is connected in series with a second diode (**46**) across said pair of communication line input terminals, said second diode being connected so as to allow current flow therethrough when said direct current between said signal input terminal is in said one polarity and for preventing current flow when said signal is of the opposite polarity;

said delay means is a capacitor (**52**) connected across said relay coil of said normally closed relay;

each of said modules further includes an ammeter (**43**) connected to one of said signal input terminals for determining the magnitude and direction of current flow between said signal input terminals;

one of the switch terminals of said relay switch of said first switch means and one of the switch terminals of said relay switch of said second switch means being coupled to one of said power input terminals (**58**) and the other of the switch terminals of the relay switch of said second switch means being connected to a third diode (**66**) which is connected in series in the said first lamp (**19**) in such a manner as to allow current to flow essentially only from the switch means to said first lamp, said lamp also being connected to the other of said power input terminals (**61**) so that said first lamp may light when the relay switch of said second switch means is closed;

said one power input terminal being for connecting to a positive input from said power source and said other power input terminal being for connecting to the negative input of said power source;

said means responsive to said first switch means includes a first multiple switch relay (**70**) having a first, second, third and fourth normally open relay switches controlled by a single relay coil (**78**) and a second multiple switch relay (**69**) said first relay switch being in series connection with said second lamp (**20**) and said series connection being connected between said power input terminals, said second relay switch having one switch terminal connected to the one power input terminal (**58**) and the other connected to said audio alarm output terminal (**94**), said fourth relay switch having one switch terminal connected to the one power input terminal (**58**) and the other to a control coil (**73**) of said second multiple switch relay (**69**)(said second multiple switch relay coil controlling two relay switch blades (**71** and **72**), one of which is part of a conventional normally open relay switch and the other of which is part of a make-before-break relay switch having two contact terminals (**84, 85**), one of the switch terminals of the conventional relay switch of said second multiple switch relay being connected to the junction of the series connection of said first relay switch and said second lamp and its other switch terminal being connected through a resistance (**91**) to said one power input terminal, the blade (**72**) of said make-before-break relay switch being connected to said other switch terminal of said fourth relay switch, said third relay switch has one switch terminal connected to the one power input terminal (**58**) and its other switch terminal connected to the other of the switch terminals of the relay switch of said first switch means, said make-before-break relay switch having two contact terminals which are normally connected but are open circuited when said switch blade (**72**) of said make-before-break switch is activated whereby one of those two contact terminals (**85**) is open circuited and the other (**84**) is connected to said make-before-break switch blade, said one terminal being connected to one side of the control coil (**78**) of said first multiple switch relay, the other side of that coil being connected to said other power input terminal (**61**) and said other switch terminal (**84**) of said make-before-break switch being connected to said other switch terminal of the relay switch of said first switch means; and

said modules further including a diode (**65**) connected between the other switch terminals of the relay switches of said first and second flow therethrough only from said second to said first switch means.

9. The remote alarm system as defined in claim **7** including additionally rectifier means in series with said second switch means and said first lamp to permit current flow only in the direction of said alarm polarity.

10. The remote alarm system as defined in claim **1** wherein

each of said modules includes at least one visual indicator;

first switching means responsive to the signal on said coupled communication line to actuate and hold said visual indicator and said audio alarm;

second switching means responsive to said silencer to silence said audio alarm; and

third switching means responsive to a restoration of said normal current carrying relationship on said coupled communication line to restore said module to signal detecting condition;

whereby, in response to an alarm signal from any one of said plurality of remote stations, said audio alarm and said visual indicator of the one of said remote stations is caused to indicate and hold an alarm condition,

whereby, in response to the operation of said silencer

for said audio alarm, said holding of an alarm condition is terminated, said audio alarm is silenced, and said visual indicator is retained, and

whereby, in response to a restoration of said normal current carrying relationship on said coupled communication line, said visual signal and said switching means are restored to normal signal detecting condition.

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