June 30, 1970 B. B. SAUL 3,518,655

SECURITY DEVICES

Filed July 20, 1966 2 Sheets-Sheet 1

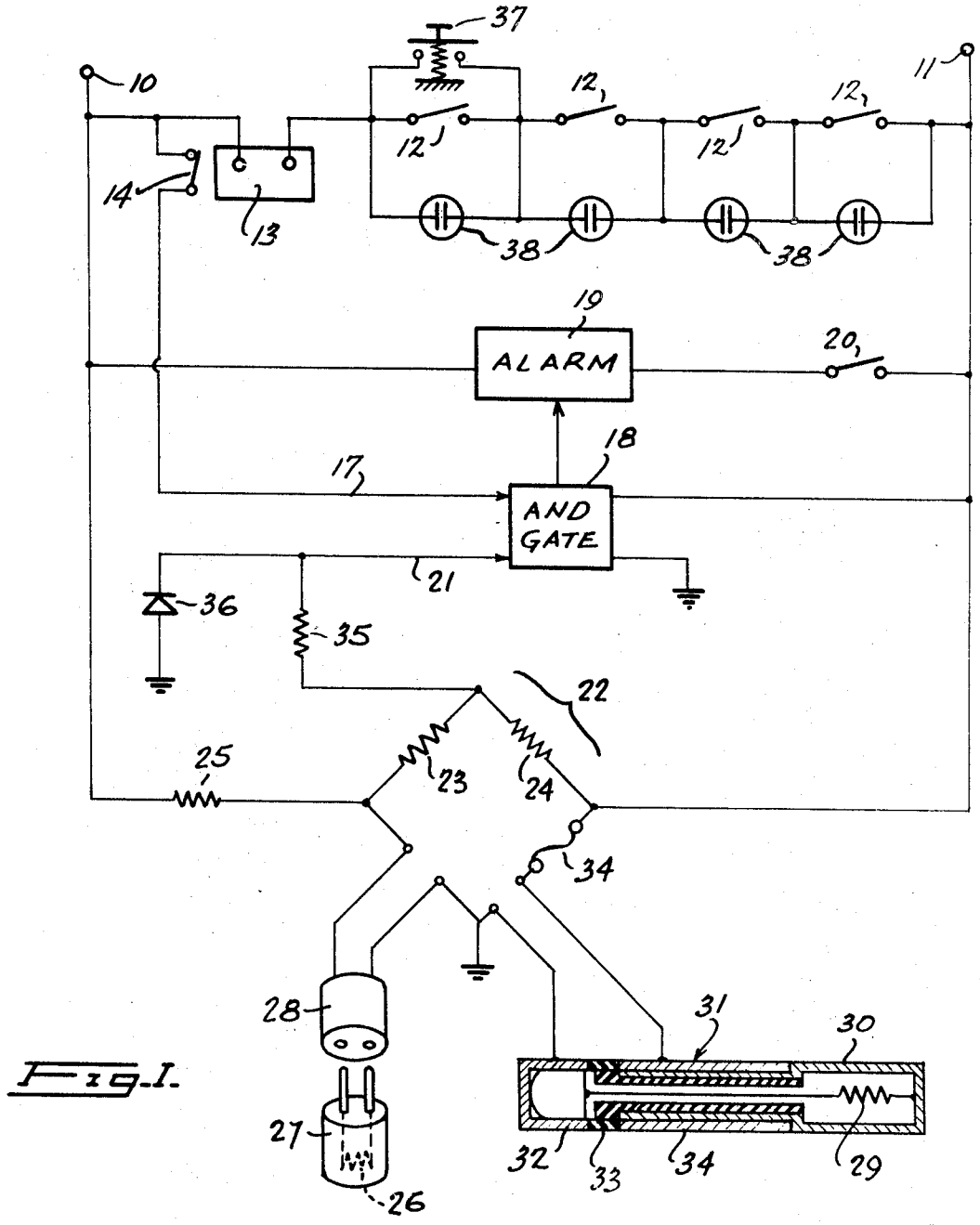

Fig. 1.

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SECURITY DEVICES

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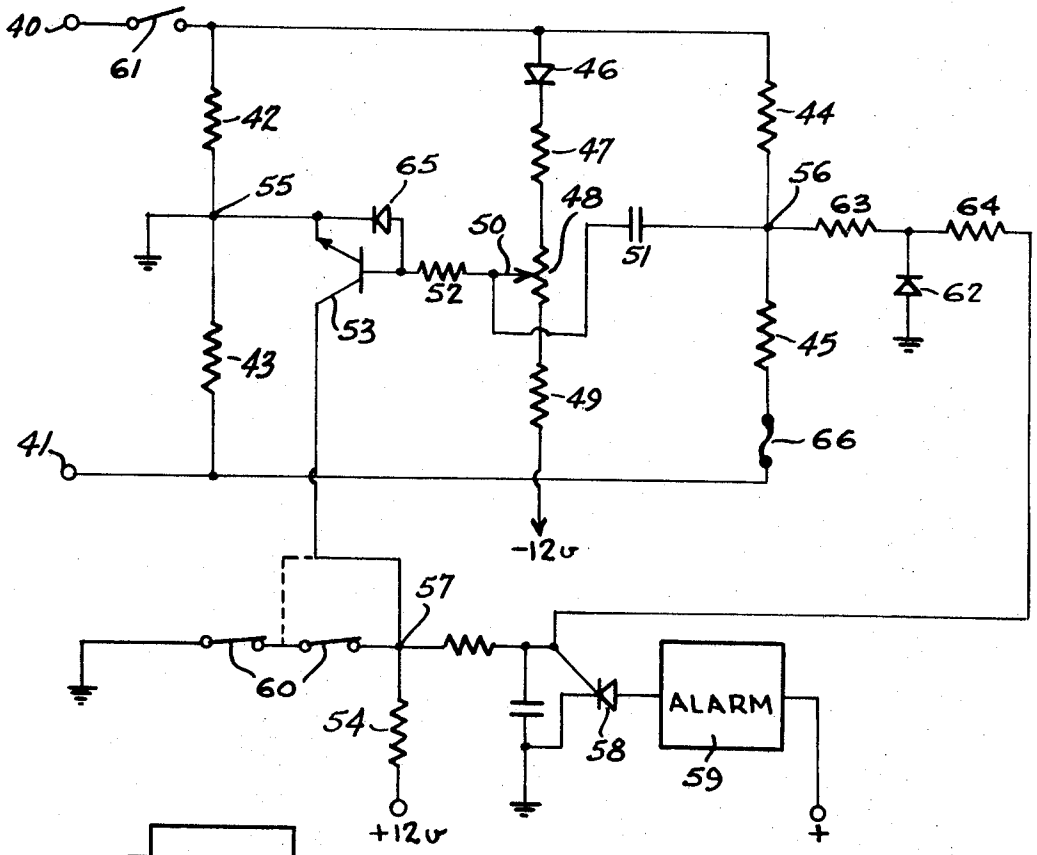

Fig. 2.

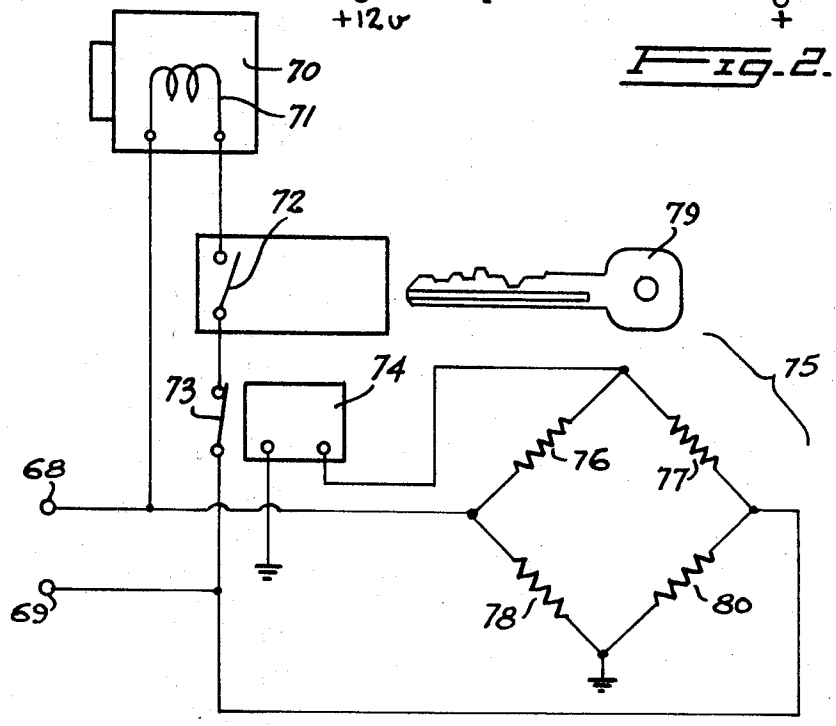

Fig. 3.

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SECURITY DEVICES

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ABSTRACT OF THE DISCLOSURE

An alarm operated by the opening of a door or window contact simultaneously with unbalance in a bridge that can be balanced by use of the correct "key" in the form of a predetermined resistor. The combination can be changed by plugging in a different resistance in another arm of the bridge. The bridge circuit can also be used as part of an electrical lock without the alarm.

This invention relates to electrically operated security devices of the type that require a special "key" having a predetermined electrical value to operate them, and the invention has for its primary object an improvement in such devices that permits quick and convenient changing of the "combination," that is to say a ready changing of the circuit in a manner that will immediately result in the need for a different key to operate the device, with former keys no longer being effective for this purpose.

One application of the invention is to the improvement of burglar alarm systems. Another application is to the enhancement of the security of any device that is normally closed by an electrically operated lock, for example, the access door of a typical vending machine. It is believed that the numerous possible uses to which the invention may be applied will become apparent from the examples that follow.

In its application to an alarm system, the invention may be directed towards a burglar or similar type of alarm system. However, as will appear from the description that follows, the system can also incorporate additional features that are typical of other types of alarm systems.

The object of this aspect of the invention is to provide an alarm system having improved facilities, and more particularly an especially convenient method by which the security of the system can be maintained in the event of loss of a "key" that affords access to the installed premises without triggering the alarm.

Various methods of carrying the inventoion into practice are illustrated diagrammatically and by way of example in the accompanying drawing. It is to be understood that the specific systems described are illustrated merely by way of example and not by way of limitation of the inventoion, the broad scope of which is defined in the appended claims.

In the drawings:

FIG. 1 shows a schematic circuit diagram of an alarm system, with certain parts also shown in physical form;

FIG. 2 is a circuit diagram of an alternative alarm system; and

FIG. 3 demonstrates the application of the invention to the control of an electrically operated lock.

The circuit of FIG. 1 includes a source of power represented by lines **10** and **11**, which may be connected to a battery or any other convenient source of power, either alternating or direct current as required. In practice, the various parts of the system may operate at different voltages and have individual power supplies, D.C. for the loop circuit and A.C. for the bridge. However, for the purposes of schematic illustration of the principles of the invention, a single power supply has been shown for simplicity.

The system includes means sensitive to an alarm condition, in the form of a conventional series circuit of door and window contacts **12**, these being connected across the power supply and in series with a relay **13**. When all the contacts **12** are closed, the relay **13** is energized and its contacts **14** are held open. When any one of the contacts **12** is opened, the relay **13** is released to close its contacts **14**. This arrangement is entirely conventional.

When the contacts **14** are closed they complete a first circuit **17** to an AND gate **18**, the output of which triggers an alarm **19** which is connected across the power supply through a main ON-OFF switch **20**. The exact nature of the alarm **19** may vary widely. It may include both visual and audible alarm devices, as well as such additional features as direct communication with a central station or a police switchboard. The alarm **19** will be such that it will continue to operate once triggered, whether or not a signal continues to be received by it from the gate **18**. Such features of alarm devices are known and the present invention is not concerned with these details. In addition, the alarm **19** may include another triggering circuit (not shown) for actuation by sensors designed for detecting smoke or fire.

A second circuit **21** leads to the AND gate **18**, and the latter is only actuated to trigger the alrm **19** when inputs are received by the gate simultaneously from both input circuits **17** and **21**. The circuit **21** is essentially the output from a balanced detector circuit which is shown generally at **22** and which, in the specific example, consists of a bridge, two arms of which comprise resistors **23** and **24** connected through a series resistor **25** across the power supply. The third arm of the bridge is constituted by a resistor **26** mounted in a plug **27** which can be inserted into a socket **28** to connect the resistor **26** in circuit. The fourth arm of the bridge comprises a resistor **29** that is mounted in a plug or "key" **30** which fits into a socket **31** to connect this resistor in the bridge circuit through contacts **32** and **34** that are insulated from each other by material **33**. The resistors **26** and **29** form a matched pair of bridge elements that serve to bring the bridge to a balanced condition, when they are both in circuit. When the bridge is balanced there is no output in line **21**. Also in the same arm of the bridge as resistor **29** there is located a fuse **34**.

The system also inludes a series resistor **35** in the circuit **21** connecting the detector circuit **22** to the gate **18** and a Zener diode **36** is connected across the circuit **21** and ground.

The system may typically be used in the following manner by a householder, in whose house the system is installed. Assume that the householder is outside his house and that all the door and window contacts **12** are closed. The relay **13** will thus be energized to open contacts **14** so that the gate **18** receives no energization through circuit **17**. The householder is then free to remove the key **30** from its socket **31** and leave the house unattended. The detector circuit **22** is now unbalanced, so that a signal appears on line **21** at the input to the gate **18**. Thus, whenever any one of the door or window contacts **12** is opened by an intruder to release the relay **13** and close the contacts **14**, the gate **18** will be operated to trigger the alarm **19**.

When the householder returns, assuming that the alarm has not been triggered in his absence by an intruder, he inserts his key **30** into its socket **31** to balance the detector circuit **22**. He is then free to open any of the doors and windows, because the gate **18** is no longer receiving a signal on the line **21** and an input from the line **17** alone is insufficient to operate the gate. Once inside the house, the owner will normally switch off the system at the main switch **20**, although, if it is desired to leave the alarm in operation while the owner is inside the house,

for example during the night, this is possible by simply removing the key **30**, closing all the contacts **12** and turning on the alarm at the switch **20**. Indeed, when the owner is inside the house, he will not normally leave the key **30** in place, since the socket **31** will be located at a convenient outside position, e.g. beside the front door on the outside of the house.

To enable a housewife to answer a call at the front door, while having the alarm system operative, a pushbutton switch **37** is provided in parallel with the contacts **12** of the front door. She sets the alarm by the switch **20** (assuming the key **30** not to be in place) and holds the pushbutton **37** depressed as she opens the front door. The switch **37** will be located at a convenient position somewhere on or near the rear surface of the front door. The relay **13** will remain unreleased while the front door is open, provided the switch **37** remains depressed. Should the caller attempt to force his way into the house, release of the switch **37** will set off the alarm.

A further feature of the system is the provision of neon lamps **38** connected across each of the door and window contacts **12**. These lamps are particularly useful in locating a pair of open contacts when the alarm is being set. When setting the alarm it is sometimes found that the alarm is triggered, although it was thought that all the contacts were closed. One of the pairs of contacts **12** must be improperly closed, but without the lamps **38** it can be quite a time consuming job to find out which are the faulty contacts. The lamp **38** corresponding to the improperly closed pair of contacts will glow, because substantially the full supply voltage will be across it, and this will provide an immediate indication of which door or window requires to be more firmly secured. The lamps **38** may be arranged on a control panel with other parts of the alarm and the main switch **20**, or they may be individually mounted adjacent the respective doors and windows themselves.

In the event that a key **30** is lost, with the possibility that it might have fallen into the hands of an unauthorized person, security can be immediately restored by merely replacing the plug **27** with a different plug **27** containing a resistor **26** of a different resistance value. A new key **30** to match must of course also be provided. In other words, the key **30** and the plug **27** represent a matched pair of elements, for which any other similarly matched pairs of elements may be substituted. In this connection, the term "matched" is not intended to suggest that the resistors are equal in resistance value, but rather that the ratio of their resistance values is predetermined. Such ratio will, of course, be equal to the ratio of the resistance values of the resistors **23** and **24** in the first two arms of the bridge. Thus, not only is a very large number of "combinations" possible for each installation, but the particular combinations of plug and key that provide balance in one installation will not normally do so in another. The ratio of the values of resistors **23** and **24** can be varied from installation to installation, so that each installation is virtually unique in this respect.

The fuse **34** is provided to prevent the system being rendered inoperative by an unauthorized person who might attempt to introduce a destructively high voltage into the system through the socket **31**. If a high voltage were applied at the socket **31**, the fuse **34** would rupture and prevent damage to the gate **18** or alarm **19**. Once the fuse **34** has been ruptured, the circuit **22** will remain permanently out of balance and hence the alarm will always be operative, until the fuse **34** has been replaced. If desired, the fuse **34** can also be formed as a separate plug-in element, and indeed may be incorporated physically in the same plug **27** as the resistor **26**, if this is convenient. The Zener diode **36** similarly provides a shunt path for protection against excess currents or voltages.

In the event that an alternating supply to the bridge circuit is employed, the electrically matched elements may be capacitors and/or inductors, instead of the resistors **26** and **29**, although normally resistors would be used, because of their simplicity. By the same token, the circuit **22** need not necessarily be a bridge. Any other known circuit may be used as the detector circuit, that contains a pair of elements that are matched to each other so as to "balance" the circuit, i.e., yield a substantially zero output, and in which such elements may be replaced with equal effect by other similar but different pairs of matched elements.

FIG. 2 shows an alternative circuit that is especially designed for alternating current operation, to avoid the need for batteries for supplying the main operating power, and which circuit has additional fail safe characteristics, as will be described.

In FIG. 2, the alternating voltage input is applied across terminals **40**, **41**. The detector circuit is again in the form of a bridge, comprising resistors **42**, **43**, **44** and **45**. Resistors **42** and **43** are fixed (corresponding to resistors **23**, **24**); resistor **44** will be mounted in a plug (as resistor **26**) and resistor **45** represents the "key" (i.e., corresponds to the resistor **29**). For simplicity the resistors **44** and **45** have not been shown in their physical forms, since this would merely be a repetition of FIG. 1, but, as before, they form a matched pair, so that the combination can readily be changed by fitting a new resistor **44** and providing a corresponding new key **45**.

Also connected to input terminal **40** is a series circuit of a diode **46** and resistors **47**, **48** and **49** extending to a minus 12 volt potential. A tap **50** on the resistor **48** provides a controllable positive bias voltage which is smoothed by the decoupling condenser **51** and fed through a resistor **52** to the base of an NPN transistor **53** thus normally keeping the same forward biased and switched on, the collector of the transistor being connected through resistor **54** to a positive 12 volt potential. The output of the bridge circuit appears across terminals **55** and **56**, the former of which is grounded and connected to the emitter of the transistor **53**, and the latter of which is connected to the other side of the condenser **51**.

With the bridge balanced, i.e., the correct "key" resistor **45** in place, the transistor **53** will remain conducting. When the bridge becomes unbalanced the terminal **56** will carry an alternating voltage, the negative portion of which will reduce the positive bias on the transistor base to shut the same down. It will be noted that the collector circuit of the transistor includes some door and window contacts **60**. Thus, if any one of these is now opened, i.e., with the transistor **53** shut down, the terminal **57** goes more positive and this positive potential triggers a gating diode **58** which in turn energises a relay in an alarm **59**.

It will be appreciated that the operation of the circuit of FIG. 2 will be generally similar to that of FIG. 1, in that in FIG. 2 the alarm will be energised by the simultaneous opening of a pair of contacts **60** and unbalance in the detecting circuit.

As an alternative, the collector of the transistor **53** may be connected to the terminal **57** through some of the contacts **60**. For example, in FIG. 2, if the transistor collector were connected to the point between the two contacts **60** illustrated, as shown in broken lines, and the contact **60** to the left of such connection were assumed to represent the front door while the other contact **60** shown represents all the other door and window contacts, the situation would exist that the alarm would be triggered either

(a) when both the bridge is unbalanced and the front door is open (thus permitting the front door to be opened without triggering the alarm, when the key **45** is in place); or

(b) when any one of the other door and window contacts

is open (regardless of balance or unbalance in the bridge).

When operating in this latter manner the other door and window contacts will always be effective to trigger the alarm, whenever they are opened, and can only be rendered inopertaive by switching off the entire device at the main switch **61**.

The circuit is fail safe, because any failure in the circuit supplying the positive bias voltage to the transistor **53** will have the effect of cutting off or reducing such bias voltage sufficiently to shut down the transistor and trigger the alarm. If any person attempts to harm the circuit by applying a high external voltage across the socket where the resistor **45** is mounted, this voltage, if negative, will be shorted out by diode **62**, and, if positive or containing a positive portion (i.e. an alternating voltage) will trigger the diode **58** and hence the alarm **59** through resistors **63** and **64**. Zener diode **65** is provided for protection of the transistor **53** from an externally applied excessive voltage. A fuse **66** is also provided for protection against excessive currents.

FIG. 3 shows another way in which the invention can be carried into practice to protect a security device, in this case an electrically operated lock **70**, which could, as above mentioned be the lock on a vending machine. To open the lock **70** its solenoid coil **71** must be energised, and this may, for example, be achieved from power supply terminals **68**, **69** by a pair of contacts **72** operated by a conventional mechanical key **79**, in series with a pair of normally closed contacts **73** operated by a relay **74** which is only deenergised when a detector circuit **75** is balanced. The circuit **75** comprises a pair of fixed resistors **76** and **77**, a plug-in resistor **78** (corresponding in function to the resistor **26**), and a "key" resistor **80**, which corresponds in function to the resistor **29**. It is believed that the operation of this circuit will be clearly evident, both keys, i.e., the mechanical and the electrical being necessary to operate the lock. The important practical advantage of this arrangement is the ease with which the "combination" can be changed, should the mechanical key be lost or stolen. It is then unnecessary to change the mechanical parts of construction which is a relatively complicated undertaking. It is merely necessary to substitute a new resistor **78** of different resistance value, and in practice this can be done merely by substituting a fresh plug containing the new resistor. This can be done in a matter of seconds by an unskilled operator.

I claim:

1. An alarm system comprising

(a) a series circuit of pairs of door and/or window contacts and relay means for emitting a signal upon opening of a pair of said contacts,

(b) a bridge circuit including in two of the arms thereof a pair of balancing resistors for balancing said bridge circuit,

(c) alarm means for generating an audible and/or visual alarm,

(d) and AND gate means having an output connected to said alarm means for triggering of the same and inputs connected respectively to said series circuit (a) for receiving said signal therefrom and to said bridge circuit (b) for receiving a signal therefrom upon the occurrence of an unbalance therein,

(e) said balancing resistors each being mounted on a plug or like removable member adapted for cooperation with a socket having contacts connected in one of said bridge arms, whereby said removable members are replaceable by a similar pair of such members carrying a further pair of resistors having different resistance values but the same ratio of resistance values as said balancing resistors for maintaining balance of said bridge circuit.

2. An alarm system according to claim **1**, wherein said system is adapted for installation in a premise with one of said sockets mounted at a location accessible from the exterior of said premise, and wherein said bridge circuit includes a fuse located in series in the bridge arm in which the exteriorly located socket is connected.

3. An electrically operated security device comprising

(a) a balanced detector circuit including a pair of electrically matched elements for balancing said circuit,

(b) means sensitive to an alarm condition, including at least one pair of door and/or window contacts having a security condition and an alarm condition and means sensitive to movement of said contacts to their alarm condition,

(c) alarm means for generating an audible and/or visual alarm,

(d) and actuating means having inputs connected respectively to said means sensitive to an alarm condition for receiving a first signal therefrom upon occurrence of such an alarm condition, and to said detector circuit for receiving a second signal therefrom upon occurrence of an unbalance therein, and an output connected to said alarm means for triggering of the same upon simultaneous receipt of said first and second signals,

(e) said elements being readily removable from said detector circuit for replacement by a different but still matched pair of elements for balancing said circuit.

4. A device according to claim **3**, wherein said sensitive means (b) comprises a series circuit of pairs of door and/or window contacts and relay means for emitting a signal to said actuating means upon opening of a pair of said contacts.

5. A device according to claim **4**, including an indicating lamp connected across each said pair of contacts to provide an indication of an open condition of said contacts.

6. A device according to claim **3**, wherein said actuating means includes fail-safe means for actuating said alarm means on failure of a component of the device.

7. An electrically operated security system for securing a structure, said system comprising

(a) a bridge circuit including a pair of sockets having contacts connected in a respective one of a pair of arms of said bridge circuit for receiving a pair of matched resistors for balancing the bridge circuit,

(b) actuating means connected to said bridge circuit to react in a first manner to balance in said circuit and in a second manner to unbalance in said circuit,

(c) means mounting one of said sockets at a location accessible from the exterior of said structure,

(d) means mounting the remainder of said bridge circuit and said actuating means at a location in the interior of said structure inaccessible from the exterior thereof,

(e) a plurality of different pairs of removable members carrying matched resistors, said removable members being constructed for plug-in cooperation in pairs, each with a respective one of said sockets, whereby the removable members of a first pair are replaceable by the removable members of a further pair carrying a further pair of resistors having different resistance values but the same ratio of resistance values as the removable members of the first pair for re-establishing balance in said bridge circuit,

(f) means sensitive to an alarm condition, including at least one pair of door and/or window contacts having a security condition and an alarm condition and means sensitive to movement of said contacts to their alarm condition, and

(g) alarm means for generating an audible and/or visual alarm,

(h) said actuating means having a first input connected to said means sensitive to an alarm condition for receiving a first signal therefrom upon occurrence

of such an alarm condition, a second input connected to said bridge circuit for receiving a second signal therefrom upon occurrence of an unbalance therein, and an output connected to said alarm means to trigger the same upon simultaneous receipt of said first and second signals.

8. A system according to claim 7, including protective means located between the exteriorly accessible socket and the actuating means to protect said actuating means against damage from an excess voltage applied to the contacts of said exteriorly accessible socket.

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