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BURGLAR ALARM SYSTEM

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1 Claim. (Cl. 177—316)

This invention relates to alarm systems and more particularly to an alarm system for use in connection with the protection of vaults and the like.

5 The object of this invention is to provide a system in which any change in the acoustical impedance in an enclosure will cause the operation of a signal device.

10 A feature of this invention resides in the provision in an enclosure of a continuously operated vibrating element, the amplitude or phase or both of which will change whenever a change occurs in the acoustical impedance of the enclosure.

15 Another feature of this invention resides in the means provided for preventing false operation of the signal device when any change in the amplitude or phase of the vibrating element is caused by a change in the operating current of the vibrating element.

20 A modification of this invention includes like protective means in a vault and an enclosure for the vault and a separate signal device for each enclosure.

In the drawing:

25 Fig. 1 shows a schematic diagram of a complete system for detecting entrance to a vault; and

Fig. 2 shows a schematic diagram of the modification in which a vault is protected by an enclosure and a separate detecting system is provided 30 for each enclosure.

At the present time in the protection of articles of considerable value stored in bank vaults and other enclosures, the practice is to equip doors and other means of access to the interior of a 35 vault with specially designed locks and to provide at such entrance points switches in control of some alarm device. To detect an attempt to break through the walls of a vault alarm system networks are embedded in the wall structure.

40 Sound pick-up devices are also located in vaults to pick up sound vibrations caused by anyone entering the vault or attempting to break through the wall. To fully protect the contents of a vault and make sure that any unlawful entry to the

45 interior of the vault will be detected, all of the above mentioned protective devices have to be included in the protective means employed. A protective system including all of the above mentioned protective means is quite expensive. If 50 the locks, door switches and the networks in the wall structures are eliminated and reliance is placed on the sound pick-up device there is always the possibility of some one gaining entrance

55 to the interior of the vault without producing

sound waves sufficient to cause operation of the sound pick-up device.

In the present invention a vibratory element is located within the vault or other enclosure of the contents to be protected. The vibratory element is continuously operated to produce a standing wave within the enclosure during the period for which protection is desired. Any opening made in the enclosure walls such, for instance, as opening of a door or boring through the walls of the enclosure will result in a change in the acoustic impedance of the interior of the enclosure. The amplitude or phase or both amplitude and phase of the standing wave producing element will change accordingly and result in the operation 15 of an alarm device.

For a complete description of this invention reference will now be had to the drawing in which like parts in the figures bear like numerals.

In Fig. 1, 1 is a vault comprising a front wall 2, a rear wall 3, the side walls 4—4, a floor and ceiling, not shown, and a door 5 located merely for the purpose of illustration in the front wall 2.

The rear wall 3 is apertured at 6 sufficient to receive a high efficiency loudspeaker 7 which in this instance is shown as a moving coil type loudspeaker. The loudspeaker has an electromagnet 8 including a coil 9 supplied with current from a battery 10, a vibrating element 11 and a moving coil 12 to operate the vibrating element 11. The vibrating element 11 is directed through the aperture 6 toward the interior of the vault 1. The moving coil 12 is included in a Wheatstone bridge circuit 13 and forms one arm of the bridge circuit, the remaining three arms comprising a 35 fixed resistance 14, a fixed resistance 15, a variable resistance R—16, in series with a variable inductance L—16, respectively. Bridge 13 is supplied with alternating current from an alternating current generator 17 at the input points 18 and 19. The circuit including the source of alternating current 17, the switch 37 and the conductors leading to the input points 18 and 19 of the bridge 13 forms the input circuit for the bridge 13. Connected to the neutral points 20 and 21 of the bridge 13 are conductors 22 and 23 respectively which lead to a detector 24 capable of detecting unbalancing effects in the bridge 13 and which may, for instance, be a detector of the vacuum tube type. The conductors 22 and 23 and the detector 24 form an output circuit for the bridge 13. The output of the detector 24 is led by means of conductors 25 and 26 to an amplifier 27, the output end of which is connected by conductors 28 and 29 to the operating coils of 55

a polarized relay 30. The polarized relay 30 is maintained polarized by current from a battery 31 supplied by way of the conductors 32 and 33, closed switch 34 and the variable resistance 35 and may be regulated as to its sensitiveness by adjustment of the variable resistance 35. The polarized relay 30 controls an alarm 36 which may be located at a central station.

To set the system in condition for operation the door 5 of the vault 1 is closed. The switches 34, 37 and 38 are closed and the generator 17 is set in operation to supply current through the bridge 13 to the coil 12. The variable resistance R—16 and the variable inductance L—16 in the bridge 13 and the variable resistance 35 in the circuit of the polarized relay 30 are then regulated until no signal is obtained from the alarm 36.

Assuming that the door 5 of the vault 1 is closed, the switch 37 of the circuit including the generator 17 is closed, the switch 38 in the magnetic circuit of the loudspeaker 7 is closed and that the variable resistance R—16 and variable inductance L—16 in the bridge 13 have been adjusted so that the bridge 13 is in a perfectly balanced condition, the generator 17 will operate the loudspeaker 7 to produce within the vault 1 a standing wave. The electrical impedance of the loudspeaker 7 will remain constant so long as the acoustical impedance of the interior of the vault 1 remains unchanged. Opening of the door 5 or creating any opening in the wall of the vault or even changing the position of an object within the vault 1 will change the acoustical impedance within the enclosure and cause variation in the electrical impedance of the loudspeaker 7. A variation in the electrical impedance of the loudspeaker 7 will result in an unbalance of the bridge 13 and cause a current to flow in the output circuit of the bridge 13. This current will pass through the conductors 22 and 23 and will be detected by the detector 24. The output of the detector 24 will be amplified by the amplifier 27 to cause operation of the polarized relay 30. The polarized relay 30 upon being operated will move its armature 39 against back contact 40 and close the circuit of the alarm 36.

Since it is highly desirable in the protection of bank vaults to have an alarm system that is sufficiently sensitive to detect not only opening of the vault door but also the presence in a wall of the vault of a comparatively small opening made by a person attempting to break through the wall of the vault, I have devised the system described to meet such conditions. It is also desirable in my vault alarm system to produce within the vault a standing wave of only comparatively low intensity in order not to attract attention to the fact that the vault is equipped with an alarm system. In the system described, the standing wave produced within the vault may be of very low intensity. To produce the required standing wave of comparatively low intensity, the loud-speaking type receiver is operated on comparatively weak alternating current furnished by the alternating current generator 17. When the bridge 13 becomes unbalanced, the current produced in the output circuit of the bridge 13 will naturally be comparatively weak. To detect the comparatively weak current produced in the output circuit a vacuum tube detector element may be included in the output circuit of the bridge 13. The comparatively weak current detected by the detector element 24 may be sufficiently amplified by means of a suitable amplifier 27 to operate a relay. The relay controls an alarm device 36 in a local alarm

circuit. I have found that a polarized relay is particularly suitable for the purpose of controlling the local alarm circuit since a polarized relay may be adjusted to a very sensitive characteristic and the current detected by the detector element 24 need only be amplified by the amplifier 27 to a comparatively small extent to operate the polarized relay.

The generator 17 should be a reliable source of current supply and the loudspeaker be very efficient at the particular frequency employed. However, since the loudspeaker 7 is included in the bridge 13 and the bridge 13 is normally in a balanced condition any slight variation in the supply to the loudspeaker 7 from the generator 17 will not result in a false signal.

The loudspeaker should be very efficient at the particular frequency employed and should be operated to produce within the enclosure a standing wave of comparatively low frequency. The electrical impedance of the loudspeaker will depend to a considerable extent on the reaction of the air within the vault on the wave producing surface of the loudspeaker. The dimensions of the vault should also be considered in regard to the frequency employed. I have found that by using a high efficiency loudspeaker of the moving coil type and with a stretched diaphragm and by operating this loudspeaker at a frequency of about 200 cycles in a room about 20 by 30 feet with a 12 foot ceiling that an appreciable change in the electrical impedance of the loudspeaker occurs when a door of the room is opened. The change in the electrical impedance of the loudspeaker due to the change in the reaction of the air within the room caused by the opening of the door is sufficient to cause an unbalance in the bridge circuit. The electric current which flows in the conjugate arm of the bridge when this unbalance occurs may be amplified to control a signal. I have also found that signals are produced with the same apparatus when objects are moved about in the room.

In Fig. 2 the vault 1 is equipped with the same protective system shown in Fig. 1 and in addition is located in an enclosure 41 comprising a front wall 42, a rear wall 43, the side walls 44—44, a floor and ceiling not shown, and a door 45. A protective system similar to the system described for the vault 1 is provided to detect any opening of the door 45 or break in the walls of the enclosure 41. The high efficiency loudspeaker 7' is located in an aperture 46 of one of the side walls 44. The magnetizing coil 9' of the loudspeaker 7' is supplied with current from battery 10'. The vibratory element 11' is operated by the moving coil 12'. The moving coil 12' forms one arm of the Wheatstone bridge 13', the remaining arms comprising a fixed resistance 14', a fixed resistance 15', and a variable resistance R—16' in series with the variable inductance L—16', respectively. The bridge 13' is supplied with current from an alternating current generator 17' at the points 18' and 19'. Connected to the output points 20' and 21' of the bridge 13' are conductors 22' and 23', respectively, which lead to the detector 24'. Signals detected by the detector 24' are amplified by the amplifier 27' and pass to the polarized relay 30' which is supplied with polarizing current from the battery 31' by way of conductors 32' and 33' closed switch 34' and the variable resistance 35'. The polarized relay 30' controls an alarm 36' located at a central station.

When it is desired to detect any opening of the

door 45 or breaking through of any of the walls of the enclosure 41, the door 45 is closed and a standing wave is produced within the enclosure 41 by means of the loudspeaker 7'. If the door 45 is opened or any break is made in the walls of the enclosure 41 or an object is moved about within the enclosure 41 the acoustic impedance within the enclosure 41 changes and causes a change in the electrical impedance of the loudspeaker 7'. A change in the electrical impedance of the loudspeaker 7' causes an unbalance in the bridge 13' and the transmitting of a signal to the detector 24'. The signal transmitted is amplified and passed on to the polarized relay 30'. The polarized relay 30' operates and moves its armature 39' against back contact 40' and closes the circuit of the alarm 36'. The system shown in Fig. 2 provides not only for detecting a forced or unauthorized entrance to the vault 1 but also a forced or unauthorized entrance to the enclosure 41 in which the vault 1 is located.

It is obvious that certain changes may be made in the number and character or arrangement of the apparatus parts shown and described

and that the loudspeaker elements may be located entirely within the respective enclosures and only wires pass through the walls instead of having the loudspeaker project through the wall without departing from the spirit of this invention.

What is claimed is:

In a burglar alarm system for a vault, in combination, a loud-speaking type receiver having a diaphragm within the vault, a balanced electrical bridge system including in one of its arms said loud-speaking type receiver, a source of alternating current connected to input points of said balanced electrical bridge system to operate said loud-speaking type receiver to produce sustained air vibrations within the vault, a relay in circuit connection with output points of said balanced electrical bridge system, a local circuit controlled by said relay and an alarm device in said local circuit, said alarm device being operated when a change occurs in the acoustic impedance of the interior of the vault sufficient to cause unbalance of said balanced electrical bridge system.

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