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(54) Vibration sensor unit for alarm system

(57) A vibration sensor unit for an alarm system has a vibration transducer, such as a piezo-electric crystal (4), connected to a circuit 5 which includes a sensitivity control (21) and to a switching circuit 8 having an indicator LED (9). The unit can be used in a set-up mode in which the indicator LED (9) is switched on when the transducer (4) is vibrated and is switched off after the vibrations terminate (rather than latching, as in the case in a normal operational mode of the unit).

A delay is introduced before the lamp switches off so that it is readily noticeable. The delay is produced with a capacitor circuit (22). The vibration sensor may be replaced by an acoustic sensor and the arrangement may include an IR detector. An anti-tamper switch 16 is also included.

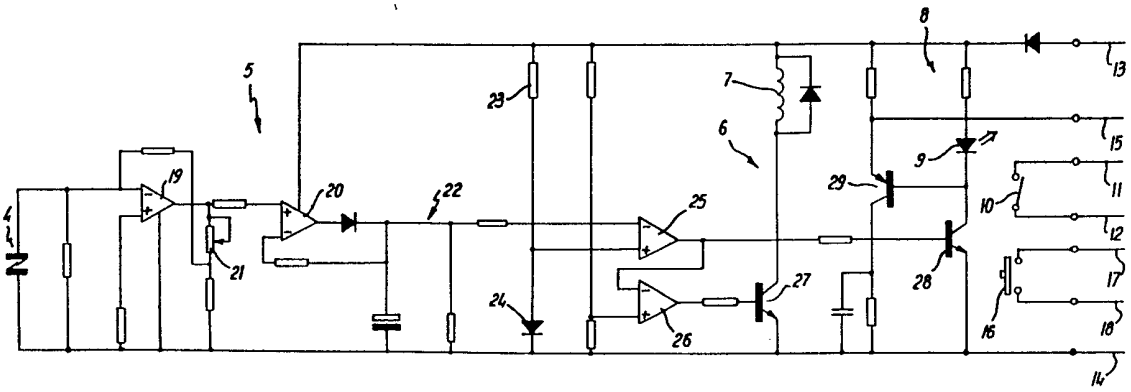

FIG.2

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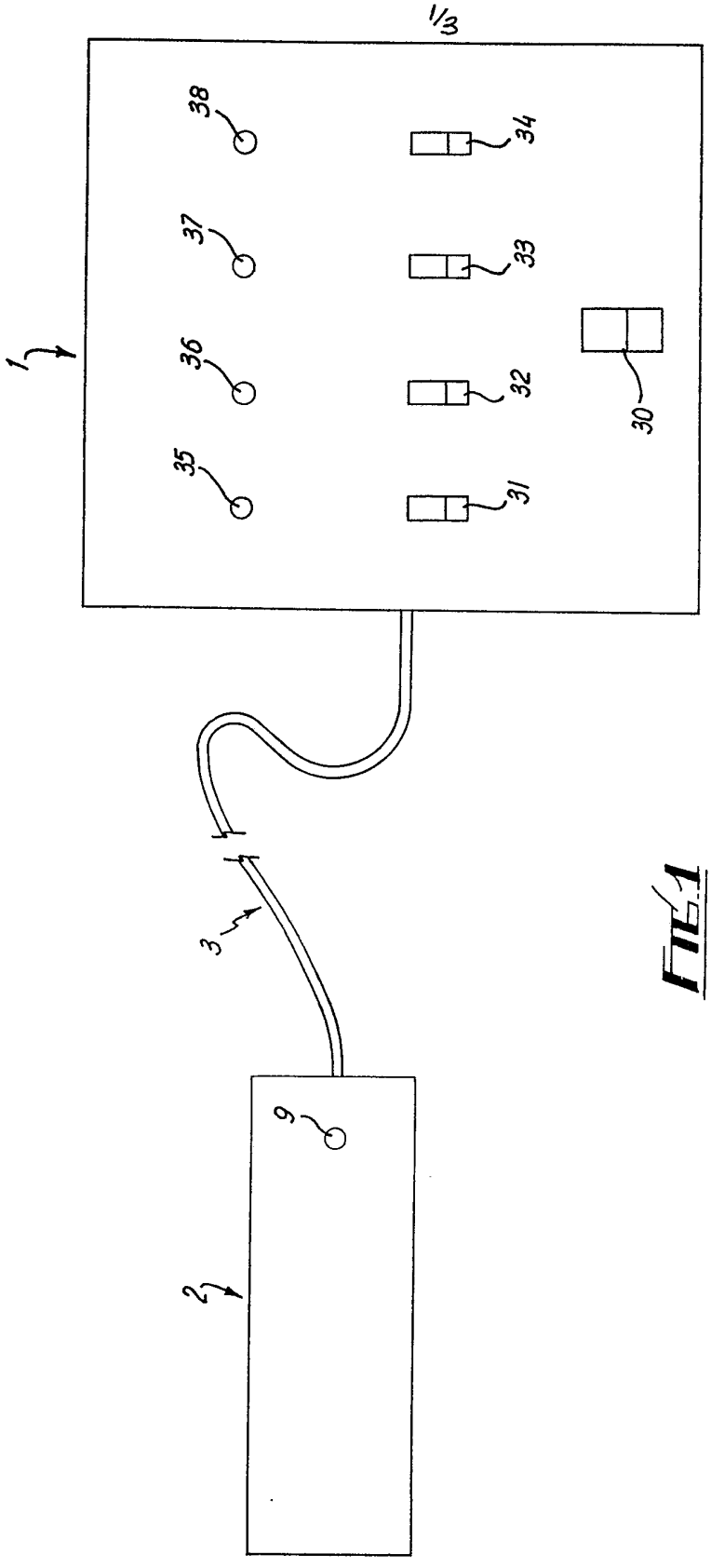
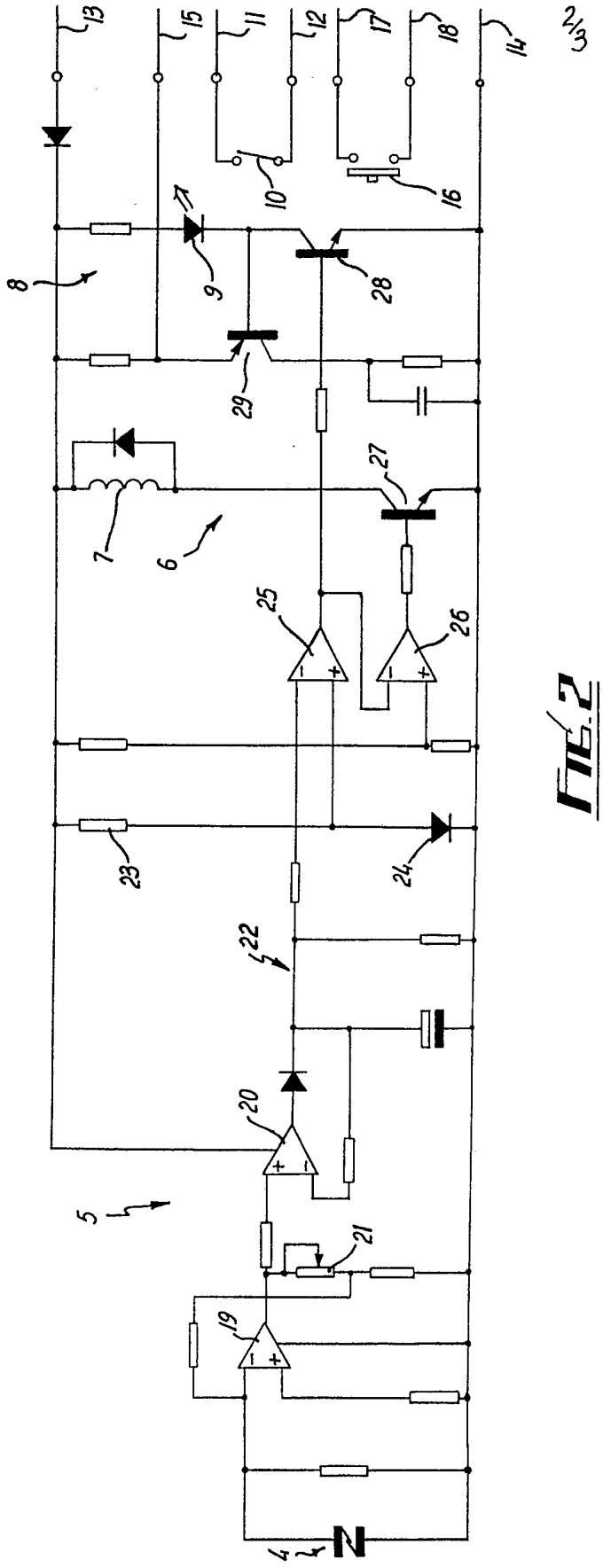


FIG.1



ФИГ.2

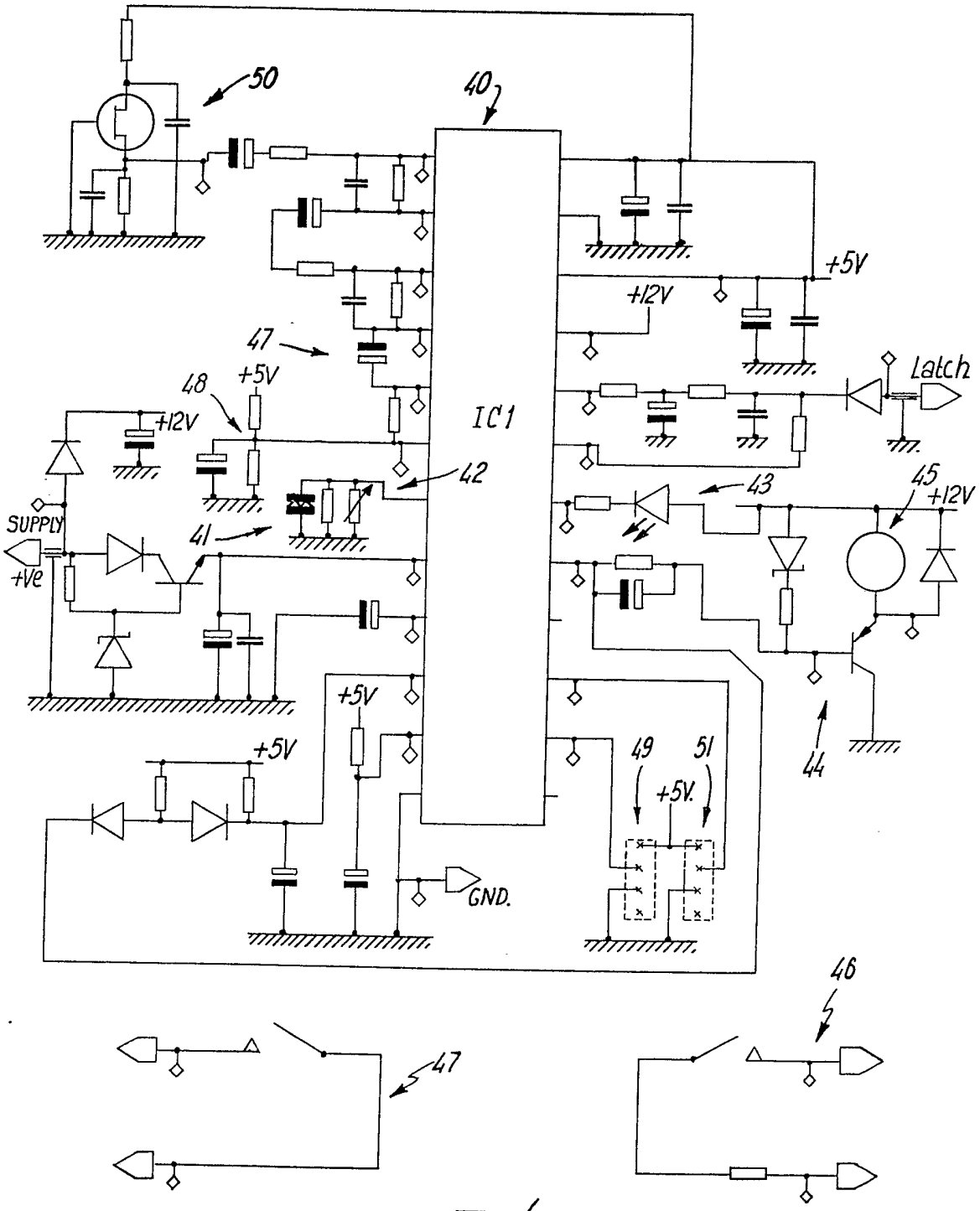

50
40
+5V
+12V
47
48
+5V
+12V
IC1
Latch
42
43
45
+12V
SUPPLY
+Ve
41
+5V
+5V
49
51
+5V.
GND.
44
46
47

FIG.3

SPECIFICATION

Vibration sensor unit for alarm system

This invention relates to a vibration sensor unit for an alarm system.

For the protection of premises against unauthorised entry it is known to use an alarm system incorporating a sensor unit which contains a vibration-sensitive piezo-electric crystal and which may be mounted on a window or door. If an attempt is made to force open or break the window or door the resulting vibrations give rise to the production of an electrical output which is used to trigger an alarm circuit at a control module to which the sensor unit is remotely connected via a cable. In order to avoid unwanted triggering of the alarm circuit it is usual to adjust the sensitivity of the sensor unit so that the alarm-triggering output is only produced if the vibrations exceed a predetermined limit. There is however the problem of adjusting the sensitivity in a simple and convenient manner bearing in mind that it is desirable to do this with the sensor unit installed.

With one known arrangement, as described in European Patent 44725, the sensor unit incorporates an indicator light-emitting diode (LED) which is illuminated whenever the alarm-triggering output is produced. The sensitivity can therefore be adjusted by applying test vibrations whilst monitoring the illumination of the LED. In order that the illumination of the LED can be seen even with short-lived vibrations a latching circuit is provided in the sensor unit, and to enable successive sensitivity adjustments to be made, the latching circuit is automatically re-set seven seconds after it is actuated. This timed re-setting of the latching circuit is effected with appropriate circuitry in the control module which comes into operation when the module is switched to a set-up mode, the alarm circuitry being de-activated in such mode. With this arrangement, however, there is the problem that a specially adapted control module containing the requisite timing circuitry is required.

An object of the present invention is to provide a vibration sensor unit for an alarm system with which the sensitivity can be adjusted in a convenient and simple manner without requiring a specially adapted control module for connection thereto.

According to the invention therefore there is provided a vibration sensor unit, for an alarm system, which is arranged to produce an electrical output when activated by vibrations exceeding a predetermined limit, said unit having a sensitivity adjusting device for preselecting said limit and an indicator arranged to be actuated on production of said output, characterised in that said unit has a set-up mode in which the indicator after actuation by vibrations as aforesaid is deactuated following cessation of said vibrations, and the unit includes a prolonging circuit which is operable to extend the duration of said actuation for a period beyond said cessation.

With this arrangement in the set-up mode, due to the provision of the prolonging circuit, it is not necessary to use a latching circuit to sustain the actuation of the indicator long enough to be readily noticeable, whereby sensitivity adjustment can be effected in a simple and convenient manner without requiring a specially adapted control module connected to the unit.

If desired, a latching circuit may be included to sustain actuation of the indicator in a normal operational mode of the sensor unit, such unit being switchable between such operational mode and the set-up mode in which the latching circuit is not effective. There may also be the facility to select operation or non-operation of the latching circuit in the operational mode.

The sensor unit may incorporate a vibration transducer connected to an amplifier circuit incorporating the said adjustment device. The vibration transducer may be a piezo-electric crystal; the amplifier circuit may comprise one or more operational amplifiers, and the adjusting device may comprise an adjustable resistor in a feed back link of the amplifier circuit.

The said limit may be determined by a comparator which compares a signal derived from the abovementioned amplifier circuit with a reference value, the said sensor unit output only being produced when the signal exceeds said reference value.

The prolonging circuit may comprise a capacitive circuit connected across the output of said amplifier circuit. The duration of prolongation may be fixed or may be variable. In a preferred embodiment the period of prolongation is determined by the magnitude of the vibrations.

The sensor unit output may be utilised to operate a relay within the unit and this may be effected via a switching circuit, such as a transistor switching circuit.

The sensor unit output may be utilised to operate the indicator and this may be effected via a switching circuit, such as a transistor switching circuit. This transistor switching circuit may form part of the abovementioned latching circuit where this is provided.

The indicator may comprise a lamp such as an LED, or any other suitable device.

The sensor unit may be connected in use to a remote control module via a multi-lead cable. Switching between operational and set-up modes as aforesaid may be effected at the control module and this may involve removal or application of a supply potential for the latching circuit on one lead. The control module may be arranged, when the unit is not in the set-up mode, to monitor and respond to production of the sensor unit output either di-

rectly or indirectly e.g. via contacts of the aforementioned relay. The sensor unit may also include an anti-tamper switch which may also be monitored by the control module.

The invention will now be described further by way of example only and with reference to the accompanying drawings in which:-

Figure 1 is a diagrammatic representation of an alarm system incorporating one form of a sensor unit according to the invention; and

Figures 2 and 3 are alternative circuit diagrams of the sensor unit.

As shown in the drawings, an alarm system for protecting industrial or commerical or domestic premises against unauthorised entry comprises a central control module 1 connected to an alarm decice (not shown) such as an alarm bell, and a sensor unit 2 which is mounted in contact with a door or window of the premises and is connected remotely to the module 1 via a seven-lead cable 3.

The sensor unit 2 comprises circuitry housed within a plastics box having a flat bottom surface which may be bonded or otherwise fixed securely in contact with a surface of the door or window. The circuitry of the sensor unit 2 includes a piezo-electric crystal 4 of known kind which produces an electrical signal when physically distorted by mechanical vibrations. The crystal 4 is connected to signal processing circuitry 5 which is connected to a first switching circuit 6 including a winding 7 of a relay, and a second switching circuit 8 including a light-emitting diode (LED) 9. The relay has normally closed contacts 10 which bridge two of the leads 11, 12 of the cable 3. The LED 9 is visible through a hole in a top surface of the housing of the sensor unit 2. Two of the leads 13, 14 carry supply voltage from the control module 1 and a further lead 15 carries an intermediate supply potential. A normally closed anti-tamper switch 16 is mounted inside the housing of the unit 2 and bridges two further leads 17, 18. The switch 16 is arranged to open if any attempt is made to gain unauthorised entry to the interior of the housing of the unit 2. Thus, for example, the switch 16 may comprise a reed switch fixed beneath a cover of the housing and normally held closed by a magnet on a base part of the housing.

With regard to the signal processing circuitry 5 this has a number of stages. The piezo-electric crystal 4 is connected to the input of an integrated circuit operational amplifier 19 and the output of this is connected to a second operational amplifier 20. A feed back link connects input and output sides of the first amplifier via a resistor network including a variable resistor 21. The sensitivity of the operational amplifiers 19, 20 (i.e. their amplification factor) is determined by the setting of the resistor 21.

The output of the operational amplifier 20 is fed to a resistor/capacitor circuit 22 and a voltage is developed across this which is a function of the magnitude and duration of the output of the amplifier 20. Thus, if a series of vibrations or mechanical impacts is applied to the housing of the sensor unit 2 so as to be transmitted to the crystal 4, a corresponding series of amplified peaks will be produced at the output of the amplifier 20 and the voltage developed across the RC circuit 22 will be a function of the magnitude and width of each peak and the time separation of successive peaks. If the peaks are closely spaced they are in effect summed, whereas in the case of a single peak or widely spaced peaks, the voltage across the RC circuit 22 will be a function essentially one of the magnitude and width of the or each peak.

The voltage across the RC circuit 22 is compared with a reference voltage provided by a potential divider formed by a resistor 23 and a diode 24. The comparison is effected by means of an operational amplifier 25. The output of the amplifier 25 is at a constant low level when the voltage across the RC circuit 22 is below the reference voltage. When the voltage exceeds the reference voltage the output of the amplifier 25 increases sharply to a higher level and is maintained relatively constant at such level until the voltage across the RC circuit 22 falls below the reference voltage whereupon the output of the amplifier 25 decreases sharply back to the abovementioned low level. In effect, the amplifier 25 produces a square wave output which has a duration dependent on the voltage developed across the RC circuit 22 and the time constant of such circuit. In practice, a sharp impact or vibration or series of vibrations, each of millisecond duration, will result in a square wave of around one second duration.

The output of the amplifier 25 is fed to an operational amplifier 26 which controls the first switching circuit 6 which has a switching transistor 27 in series with the relay winding 7. The transistor 27 is normally conductive so that the winding 7 is energised and the contacts 10 are held closed. However, the above described square wave output causes the transistor 27 to switch off thereby de-energising the winding 7 and opening the contacts 10 for the duration of the square wave.

The output of the amplifier 25 is also connected to the second switching circuit 8 which has a switching transistor 28 in series with the LED 9. The transistor 28 is normally non-conductive so the LED 9 is de-actuated. However, the above described square wave output causes the transistor 28 to switch on thereby illuminating the LED 9. The switching transistor 28 is interconnected with a second transistor 29 to define a latching circuit. When the transistor 28 is switched on the latching circuit is activated to hold the transistor 28 (and hence the LED 9) switched on, as long as the supply potential is applied to the lead

15. If supply potential is not applied to the lead 15, the circuit 8 does not latch.

The control module 1 includes switches whereby the module 1 can be set in an off mode, or a set-up mode, or an operational mode.

In the operational mode, supply voltage is applied to the leads 13, 14, 15 and the internal circuitry of the module 1 is actuated. This internal circuitry includes a monitor circuit which monitors the conductivity of the pairs of leads 11, 12, 17, 18. If either pair of these leads shows an open circuit due to opening of the relay contacts 10, due to opening of the anti-tamper switch 16 or due to cutting of the leads 11, 12, 17, 18, an alarm circuit is triggered and this causes the alarm device to be operated and/or other suitable action to be taken at the control module 1. Assuming that the leads 13–15 have not been cut the circuit 8 latches to hold the LED 9 on whereby the fact that the sensor unit 2 has been activated can be seen by inspection of the LED 9.

In the set-up mode, the monitor circuit and/or the alarm circuitry in the control module 1 is de-actuated, and supply is applied to the leads 13, 14 but not the lead 15. Vibrations applied to the sensor unit 2 can still cause the relay contacts 10 to open and the LED 9 to be actuated but the alarm circuitry in the module 1 is not triggered and the LED 9 is not latched on. The LED 9 switches off after termination of the square wave output. Thus, the setting of the resistor 21 and hence the sensitivity of the sensor unit 2 can be adjusted by applying test vibration to the unit 2 (e.g. by tapping the unit or the window or door to which it is fixed) whilst watching the LED 9 to see if it lights up. It will be appreciated that illumination of the LED 9 can be seen, despite the de-activation of the latching circuit 8 and despite the shortlived nature of the vibrations, because the signal processing circuitry 5 prolongs the signal output (i.e. such that the square wave output is of greater duration than the initiating vibrations).

If local identification of actuation of the sensor unit 2 is not required the latching circuit 8 may be rendered inoperative in the operational mode (by removal of supply potential from the lead 15).

With the above embodiment, it is possible to adjust the sensitivity of the sensor unit 2 in a particularly simple and convenient manner without requiring specially adapted circuitry in the control module 1.

It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiment which are described by way of example only. Thus, for example, although only one sensor unit 2 is shown connected to the control module 1, it is to be understood that any suitable number of sensor units may be used with the same control module as desired. Thus, as indicated, the control module 1 may have a main on/off switch 30, and a respective set-up/operational mode switch 31–34 for each sensor unit 2. An indicator lamp 35–38 may be provided for each sensor unit to indicate which sensor unit has triggered the alarm. Also, the sensor unit is not restricted in application to the detection of unauthorised entry into premises but may be used in any suitable context for any suitable purpose.

In addition to, or instead of, the vibration-sensitive piezo-electrical crystal 4, an accoustic sensor may be provided, such accoustic sensor being operable to detect the sound of breaking glass and to feed an electrical signal to the signal processing circuitry 5. The accoustic sensor may therefore be used in conjunction with or independently of the vibration sensor to activate the alarm system.

Fig. 3 shows a modified version of the circuit diagram of Fig. 2, using an integrated circuit 40 instead of the amplifiers 19, 20, 25, 26 of Fig. 2.

A piezo crystal 41 is connected via a sensitivity control (variable resistor 42) to the integrated circuit 40. The IC 40 is connected to an LED 43 and to a switching circuit containing an alarm relay 45 (connected in an alarm circuit 46). An anti-tamper circuit 47 is provided.

The output of the piezo-electric crystal 41 is used to develop a voltage across an RC circuit 47 and this is compared with a reference voltage from a potential divider 48.

If the developed voltage is higher, an actuating output is fed to the LED 43 and to the switching circuit 44 containing the relay 45 and such output can be latched. In a sensitivity-setting test mode, a switch 49 is opened and this inhibits latching.

In addition to the piezo-electric crystal 41 there is infra-red detector 50 connected to the integrated circuit 40. Other kinds of detectors may also be used if required.

The system may be arranged to avoid unwanted operation in noisy conditions by accumulation of inputs from the RC circuit 47 so that multiple successive separate inputs over a predetermined short period of time are required to produce an actuating output to the switching circuit 44. The facility is optional and can be doubled by opening switch 51.

CLAIMS

1. A vibration sensor unit, for an alarm system, which is arranged to produce an electrical output when activiated by vibrations exceeding a predetermined limit, said unit having a sensitivity adjusting device for preselecting said limit and an indicator arranged to be actuated on production of said output, characterised in that said unit has a set-up mode in which the indicator after actuation by vibrations as aforesaid is deactuated following cessation of said vibrations, and the unit includes

a prolonging circuit which is operable to extend the duration of said actuation for a period beyond said cessation.

2. A unit according to claim 1 characterised in that a latching circuit is provided to sustain actuation of the indicator in a normal operational mode of the unit, the unit being switchable between such operational mode and the set-up mode in which the latching circuit is not effective.

3. A unit according to claim 1 or 2 characterised in that the sensor unit incorporates a vibration transducer connected in an input circuit incorporating the said adjusting device.

4. A unit according to claim 3 characterised in that the adjusting device comprises an adjustable resistor.

5. A unit according to claim 3 or 4 characterised in that a comparator is provided which compares a signal derived from the said vibration transducer with a reference value, the sensor unit output only being produced when the signal exceeds said reference value.

6. A unit according to any one of claims 3 to 5 characterised in that the prolonging circuit comprises a capacitive circuit connected to the output of said input circuit.

7. A unit according to any one of claims 1 to 6 characterised in that the indicator comprises a lamp.

8. A unit according to any one of claims 1 to 7 characterised in that it is used in combination with a remote control module connected thereto via a multi-lead cable.

9. The combination according to claim 8 characterised in that switching means is provided on the control module for switching the unit between normal operational and set-up modes.

10. A unit according to claim 1 or a combination according to claim 8 substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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