United States Patent

Brailsford

[15] **3,665,259**

[45] **May 23, 1972**

[54] VIBRATION TRANSDUCER FOR BURGLAR ALARMS AND THE LIKE

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[22] Filed: **Aug. 19, 1970**

[21] Appl. No.: **64,968**

[52] **U.S. Cl.** .....**317/144,** 310/8.1, 310/8.4, 317/123, 317/148.5 R, 330/26, 330/29, 330/40, 340/261

[51] **Int. Cl.** **H01v 7/00**

[58] **Field of Search** 310/8.4, 8.1; 340/261, 262, 340/276; 317/DIG. 1, 157, 123, 148.5, 149; 330/26, 29, 40, 100; 307/117

[56] **References Cited**

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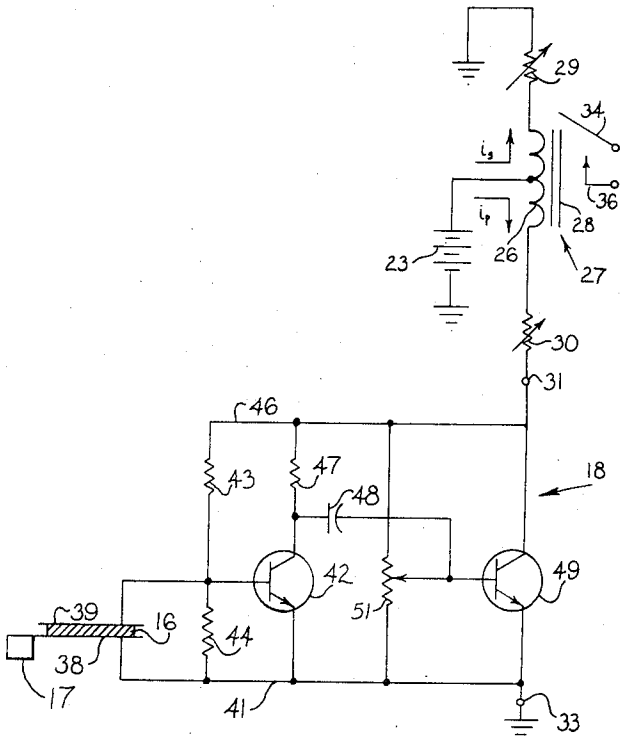
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[57] **ABSTRACT**

A sensing device constructed on a support to be attached to a safe or the like and having an electrical signal generator, such as a piezoelectric crystal, rigidly attached to the support at one end and freely movable at the other end to generate a voltage in response to vibrations of the safe. A feedback amplifier amplifies this voltage to produce a resultant output signal for connection to an alarm. The amplifier includes input and output stages and a controllable positive feedback loop to provide a two-terminal replacement for a carbon granule transducer.

2 Claims, 3 Drawing Figures



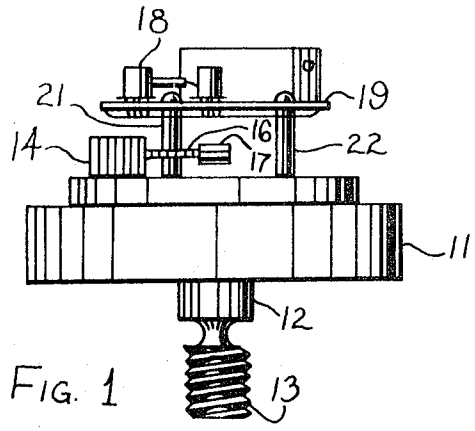


FIG. 1

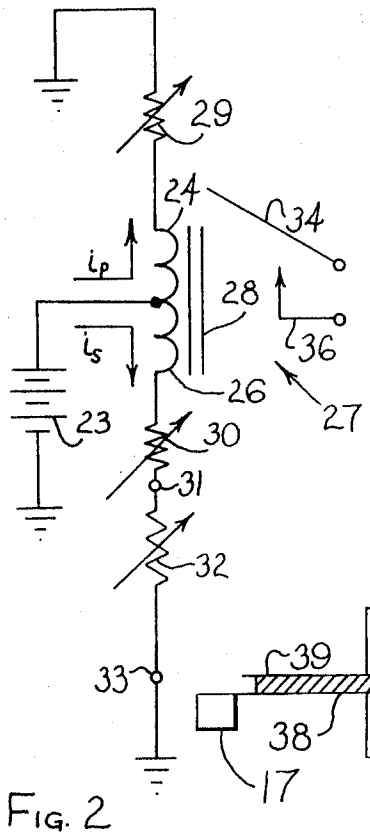


FIG. 2

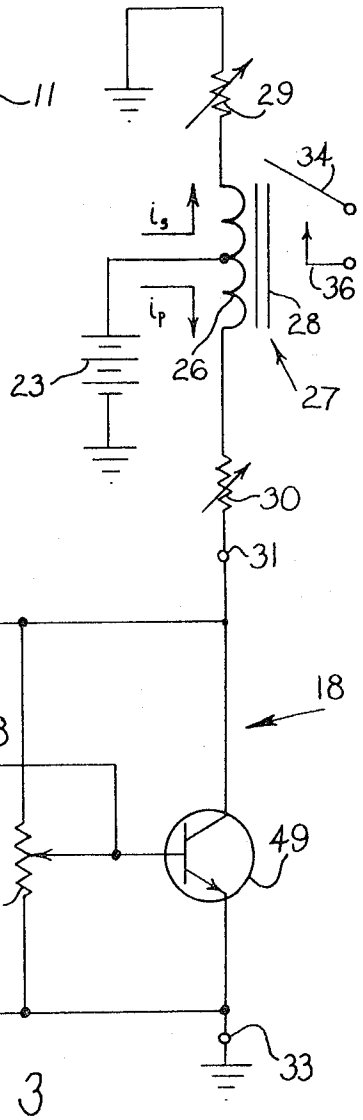


FIG. 3

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VIBRATION TRANSDUCER FOR BURGLAR ALARMS AND THE LIKE

FIELD OF THE INVENTION

This invention relates to devices for sensing vibrations and particularly to sensing devices for use in burglar alarm systems for safes and the like.

BACKGROUND OF THE INVENTION

For many years the sensing component in the surveillance system for bank vaults has been a vibration transducer in the form of a variable resistor using carbon particles, or granules, as the variable resistance element. This type of transducer was rigidly attached to the wall of the vault, for example, by means of a threaded stud, so that any vibration, such as would be produced by any attempt to break into the vault, caused a corresponding oscillatory change in the resistance, which produced a corresponding oscillation in current through the transducer. This current was then utilized to actuate further apparatus, such as a differential relay. The relay, in turn, was used to set off an alarm system to alert guards or the police or others concerned with the security of the vault.

The carbon granules used in these vibration transducers change with age, atmospheric conditions, and other environmental causes so that the transducers must be renewed or rebuilt periodically.

It is a principle object of the present invention to provide an improved sensing device having at least the same sensitivity as a new carbon granule transducer but having much greater immunity to the effects of aging and environmental conditions.

Since a great many carbon granulate transducers are already in operation in systems built to accomodate their characteristics, it is essential that any replacement sensing device have at least comparable sensitivity, impedance, and output amplitude.

It is a further object of the present invention to provide a sensing device suitable as a direct replacement for transducers used heretofore.

BRIEF DESCRIPTION OF THE INVENTION

The present invention includes a signal generating element, such as a piezoelectric device or the like having one end affixed to a rigid support and the other end free to vibrate so as to produce an oscillating signal. The support preferably has an external configuration virtually identical to previously existing carbon granule transducers and includes a cylindrical base having an axial, threaded stud extending from one end. The piezoelectric device is connected to an input circuit of a multistage transistor amplifier and the output of the first stage is connected to an output transistor. The output of the latter transistor is connected to a differential relay and the amplifier has positive feedback from the output stage to the input stage and to the input circuit of the output stage. The feedback connection to the input circuit of the output stage includes a potentiometer directly connected across the output stage and having an arm connected to the base of the output transistor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a sensing device constructed according to the invention;

FIG. 2 is a schematic diagram of the basic components of a circuit using a carbon granule transducer constructed according to the prior art; and

FIG. 3 is the complete schematic diagram of a sensing device according to the invention and incorporated in a circuit of the type shown in FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

The sensing device of FIG. 1 comprises a base 11 of solid material, preferably insulating material, with a central metal rod 12 extending from one side. The other end of the rod is threaded as shown as reference numeral 13 so that it can be

inserted into a receptical of the type heretofore provided in safes and other places where such sensing devices are used.

On the upper surface of the base 11 is a support member 14 from which an elongated piezoelectric device 16 extends. The free end of the device 16 has a weight 17 attached to it to improve the mechanical vibration characteristics of the device. An electrical circuit indicated by reference numeral 18 is supported on an insulating disk 19 attached to the base 11 by two spacer rods 21 and 22. In normal use the electronic components supported by the base 11 are all included within a cover (not shown).

The components of the transducer of the prior art are shown in FIG. 2 and include a battery 23 that has one terminal connected to ground and the other terminal connected to the two windings 24 and 26 of a differential relay 27. These windings are wound so that the currents i_p and i_s flowing through them cause opposite magnetic fluxes in the core 28. A resistor 29 is connected between the coil 24 and ground. The other winding 26 is connected through an adjustable resistor 30 to a terminal 31. A vibration sensitive carbon granule resistor 32 is connected from the terminal 31 to a terminal 33, which is also grounded.

The resistor 29 may be adjusted so that the currents i_p and i_s produce equal and opposite magnetic fluxes in the core 28. As a result there is no net magnetomotive force to attract the arm 34 into contact with the terminal 36. However, any variation in the resistance of the carbon granule resistor 32 either increases or decreases the current i_s and produces a net current that magnetizes the core 28 to close the arm 34 against the terminal 36. The arm 34 and the terminal 36 may be connected to an audible or visible alarm or a radio frequency generator or any other device located adjacent the safe or in some remote location, such as a police station, to alert those responsible for the security of the safe that some vibrations have been picked up by the carbon granule resistor 32.

The circuit to which the vibration sensitive resistor 32 is attached is widely used and the circuit components are chosen according to the characteristics of the existing vibration sensitive resistors. This applies not only to the physical characteristics, such as size, but to the electrical characteristics. In order to replace the vibration sensitive resistor it is necessary that the transducer of the present invention be capable of matching these characteristics or exceeding them if desired, especially the sensitivity characteristics. It is essential, therefore, that the sensing device of the present invention be capable of being connected to the terminals 31 and 32 without any further modification.

The schematic diagram of the circuit components 18 is shown in FIG. 3. As may be seen, the circuit is connected by the terminals 31 and 33 to the same relay and current balancing components as shown in FIG. 2. The vibration sensitive element piezoelectric device may be a ceramic element mounted on a resilient support 38 and having a thin silver coating 39 on the exposed side. As shown in FIG. 1, one end of the element 16 is rigidly supported and the other end has a weight 17 attached to it. The weight 17 may simply be the weight of the resilient support 38 distributed along the length thereof rather than being concentrated as a separate mass attached to the free end of the support. The resilient support 38 is connected to a common line 41, and the silver coating 39 is connected to the base of the transistor 42. The bias level on the base is determined by the relative values of two resistors 43 and 44 connected as a voltage divider between a common load line 46 and the common line 41. The junction of the resistors 43 and 44 is connected to the base of the transistor 42. A resistor 47 is connected from the collector of the transistor 42 to the load line 46, and the output signal from the collector of the transistor is connected by way of a capacitor 48 to the base input circuit of an output transistor stage 49. The bias level on the base of the transistor 49 is set by a potentiometer 51, one end of which is connected to the line 46 and the other end to the line 41. The arm of the potentiometer is connected to the base of the transistor 49. The collector of the transistor

49 is connected to the line 46 and the emitter to the line 41 so that the output circuit of the transistor 49 is connected directly across the potentiometer 51.

Since the line 46 is not at a fixed potential but is connected to the battery 23 through the resistor 30 and the coil 26, voltage variations produced at the collector of the transistor 49 are fed back to the base input circuit of the transistors 43 and 44 and to the base of the transistor 49 by way of the potentiometer 51. The polarity of the feedback is positive and its effect is controlled by the setting of the potentiometer 51.

The sensing circuit operates as follows: the resistors 43 and 44 are selected to produce the desired bias on the base of the transistor 42. The arm of the potentiometer 51 also sets the bias for the base of the transistor 49 and serves as a sensitivity control. This permits the circuit to be set to the same sensing as the previously used carbon granule variable resistor 32 (FIG. 2). The potentiometer 51 may be adjusted to achieve a sensitivity compatible with any ambient condition likely to be encountered in the field.

Any impact or vibration within the acceptable frequency range will exert a transient force on the piezoelectric element 16 and will cause the weighted support 38 to vibrate. This produces a varying voltage difference between the support 38 and the coating 39, and this voltage is applied across the base-emitter input circuit of the transistor 42. This voltage is amplified by the transistor 42 and is coupled by the capacitor 48 to the base-emitter input circuit of the transistor 49, which causes a change in the current in the coil section 26. As a result, the current i_p and the current i_s are no longer equal, and a net magnetic flux is produced in the core 28. This causes the arm 34 to close against the contact 36 and thereby to actuate any circuit connected thereto.

It should be noted that the circuit 18 differs from conventional amplifiers in that there is no separate load resistor in the collector circuit of the transistors 42 and 49. The resistor 30 and the coil 26 are load elements common to both of these transistors. As a result, feedback to the base of the transistor 42 and to the emitter-collector output circuit is positive, which substantially increases the sensitivity of the circuit and makes it practical to operate with a minimum of components.

What is claimed is:

1. A sensing device for connection to a pair of terminals of an alarm system, said sensing device comprising:
   - A. A support;
   - B. An elongated vibratory member having one end attached to said support, the other end of said vibratory member being free to move with respect to said support;
   - C. Electrical signal generating means cooperating with said vibratory member to generate an electrical signal when said vibratory member moves relative to said support; and
   - D. A feedback amplifier comprising:
     1. A first transistor stage having an output circuit and an input circuit connected to said generating means,
     2. An output transistor stage having an input circuit connected to the output circuit of said first transistor stage and having an output circuit connected to said pair of terminals, and
     3. A feedback control connected between said input transistor stage and said output transistor stage to control the gain of said amplifier by controlling the feedback, said output stage and said input stage having their respective output circuits connected together to be connected to a common output impedance wherein said feedback control comprises a potentiometer having its ends connected directly in parallel with said output circuits of said output transistor stage, the arm of said potentiometer being connected to the base of said output transistor stage.

2. The sensing device of claim 1 in which one end of said potentiometer is connected to the collector of said output stage and said feedback amplifier comprises:
   - A. A load impedance connected in series between the collector of said input stage and the collector of said output stage; and
   - B. A common load impedance having a terminal connected to the collector of said output stage.

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