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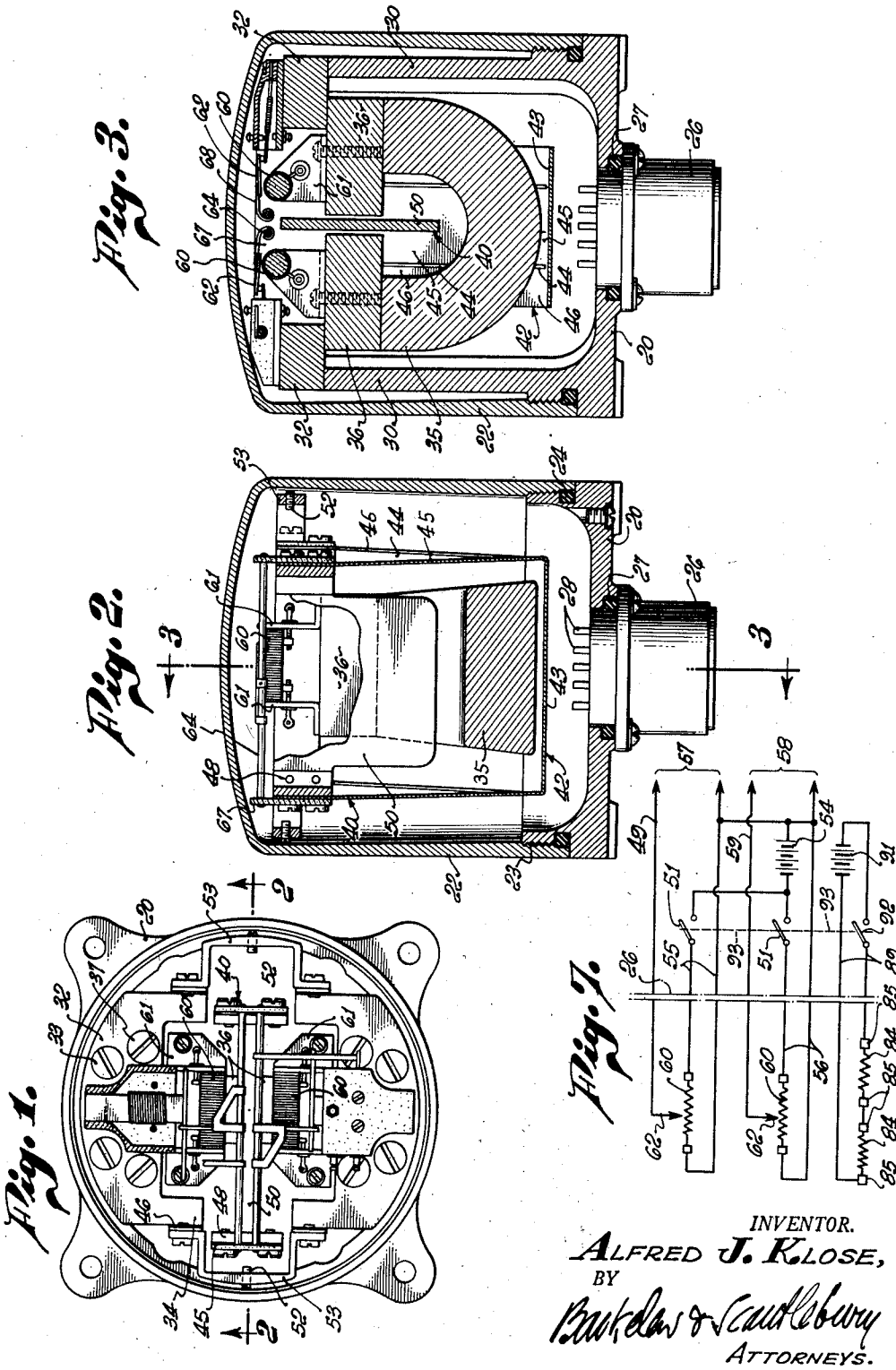
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BRUSH LIFTING DEVICE FOR VARIABLE RESISTANCES

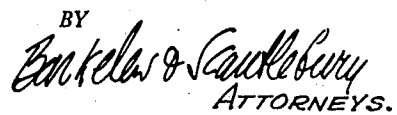
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BRUSH LIFTING DEVICE FOR VARIABLE RESISTANCES

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5 Claims. (Cl. 201—48)

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This invention has to do with means for extending the life and improving the performance of instruments of the type employing a variable resistance comprising an elongated resistive element, whether substantially straight, circularly curved, or of other forms, over which a contact brush is longitudinally movable. In such instruments, particularly when the resistive element comprises a coil of very fine resistance wire, any abnormal movement of the brush tends to produce excessive wear, leading to erratic behavior or actual breakdown of the instrument. Such abnormal movement of the brush may cause serious difficulty in instruments that are particularly sensitive to vibration, such as accelerometers.

The present invention completely eliminates the surface wear of resistive elements by vibratory or other movement of the contact brush when the instrument is out of use. That is accomplished by providing novel means for lifting the brush clear of the resistive element when the instrument is idle, and for returning the brush gently and smoothly to the resistive surface during periods when the instrument is in service.

In preferred form, the present invention has the particular advantage that the operation of lifting the brush free of the resistive surface does not interfere with its normal movement longitudinally of that surface. Furthermore, when the brush is returned to the resistive surface, as for normal operation of the instrument, the contact pressure is determined in the normal manner, and is not disturbed in any way by the presence of the brush lifting device.

In its preferred embodiment, the brush lifting means of the present invention is controlled electrically, and may conveniently be embodied in an instrument that is enclosed in a hermetically sealed container. Furthermore, the electrical power requirements of the device are extremely low, while its action is remarkably positive and reliable.

Whereas the invention, in its broader aspects, is not limited to any particular means for transforming electrical power into mechanical movement, it is preferred to produce the mechanical movement required for actuation of the brush lifting device by the application of electrically generated heat to a heat responsive element, such, for instance, as a bi-metallic thermal element employing two substances having different thermal coefficients of expansion. That particular manner of generating mechanical movement from electrical current has the great advantage of producing relatively slow and gentle move-

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ment, thus avoiding any possibility of causing jarring or chattering of the brush against the sensitive resistive element of the instrument.

The invention further permits, in combination with the brush lifting device, that the electric circuit through the brush be opened prior to the separation of the brush from the resistive surface, and be restored only after the brush has been returned to its normal operating condition.

A full understanding of the invention, and of its further objects and advantages, will be had from the following description of two illustrative embodiments of the invention in an accelerometer of a type that is responsive to rapid changes in acceleration and that translates the instant value of the acceleration into a corresponding electrical potential. Neither the selection of that type of instrument for the present illustration, however, nor the particular structure of the illustrated embodiments, is intended to imply any limitation upon the scope of the invention, which is defined in the appended claims.

In the accompanying drawings, which form a part of the present description:

Fig. 1 is a plan, showing a preferred embodiment of the invention in an accelerometer of illustrative type, with protective cover removed;

Fig. 2 is a vertical section on line 2—2 of Fig. 1;

Fig. 3 is a vertical section on line 3—3 of Fig. 2, showing the instrument in idle condition;

Figs. 4 and 5 are fragmentary views, corresponding to portions of Fig. 1 and Fig. 3, respectively, but at enlarged scale and showing the instrument in operative condition;

Fig. 6 is a fragmentary section on line 6—6 of Fig. 5, at further enlarged scale;

Fig. 7 is a schematic circuit diagram, showing illustrative control means;

Fig. 8 is a plan, showing a modification;

Fig. 9 is a fragmentary section taken on line 9—9 of Fig. 8 with the instrument in operative condition;

Fig. 10 is a fragmentary section taken on line 10—10 of Fig. 9, with the instrument in idle condition; and

Fig. 11 is a fragmentary perspective, showing a detail of the mechanism of Figs. 8 to 10 at enlarged scale.

An illustrative embodiment of the invention in an accelerometer is shown in Figs. 1 to 7. The instrument there represented is enclosed in a case comprising a generally flat base member 20, to which a cover 22 (omitted in Fig. 1) may be threaded at 23, with sealing means shown as

an O-ring at 24. All electrical connections to the interior of the case are preferably made through a single electrical connector, which may be of standard type. Such a connector is represented at 25, set in a circular aperture in the center of base 20, in which it is sealed by the O-ring 27. For clarity of illustration, the individual wires connecting the several contacts 23 of connector 26 to the corresponding electrical contacts of the instrument are omitted in the drawings.

The instrument proper is mounted on base 20 by means of two upstanding frame posts 30, shown integral with the base, and two elongated frame shelf members 32, secured to the tops of the respective frame posts, as by the screws 33, in transversely spaced parallel relation. A permanent magnet 35 of horseshoe form, with spaced pole pieces 36, is rigidly suspended from the under faces of the two frame shelf members 32, as by the screws 37, with the air gap of the magnet parallel to end between the spaced shelf members. The suspension 40 of the instrument is mounted on shelf members 32, by means of inwardly extending arms 34 at their ends, for yielding translational movement with respect to the frame parallel to the gap between magnet pole pieces 36. As illustrated, the suspension mounting comprises a unitary spring member 42, formed from flat spring material. Spring member 42 is of generally U-form, with a flat web portion 43 and parallel leg portions each of which is divided by the longitudinal slots 44 into three adjacent legs, a relatively wide inner leg 45 and two relatively narrow outer legs 46. The ends of the two outer legs of one leg portion of the spring are rigidly secured to the respective opposing arms 34 of shelf members 32 at one end of the latter; and the two outer legs of the other leg portion of the spring are similarly secured to the arms 34 at the opposite ends of the two shelf members, the body of the spring hanging from its supports and spacedly enclosing magnet 35. The two inner legs 45 of spring 42 carry at their respective ends the two brackets 48, preferably of insulating material, which support, and are rigidly spaced apart by, the accelerometer weight 50 of electrically conductive material.

The weight 50 extends in closely spaced relation between the magnet pole pieces 36, so that eddy currents in the interior of the weight tend to damp the movement of the entire suspension. The weight 50 is movable by distortion of spring 42 in substantially rectilinear translation horizontally as seen in Figs. 1 and 2. That suspension movement is preferably limited, as by the adjustable stops 52, mounted in brackets 53, to a range corresponding to the effective length of the potentiometer coils, to be described. As illustrated, brackets 53 are secured with spring arms 46 to shelf arms 34, acting as washers in clamping the spring ends.

When the instrument, as typically illustrated, is in a horizontal position, but is not subject to acceleration, the resilience of spring 42 maintains suspension 40 in an equilibrium position which is ordinarily symmetrical with respect to the fixed frame of the instrument. If the instrument with its case is subject to acceleration, for example to the right in Figs. 1 and 2, the force of acceleration acting on weight 50 and on other parts of the suspension deflects the legs of spring 42 into such a position as that illustrated, in which the suspension is deflected in translation to the left with respect to the

frame. In the particular instrument illustrated, the instant condition of deflection of accelerometer weight 50 is indicated by variation of a voltage tapped off from either one of two potentiometers that may be related electrically in any desired manner.

The potentiometer coils are shown at 60 and are mounted rigidly with respect to the instrument frame by means of brackets 51, which are secured to the upper faces of the respective pole pieces 36. Electrical connections to the respective potentiometer coils may be made through the terminals 65, mounted in brackets 61, from which they are suitably insulated, or which are themselves made of insulating material. The two potentiometer brushes 62 are independently mounted on suspension 40 by means of the longitudinal rods 64, mounted on suspension brackets 48 by the plate-like supports 67 of insulating material. Those supports, as illustrated, serve also as washers in securing inner spring legs 45 to brackets 48. Each brush 62 is mounted on its support rod 64 by means of a resilient bracket 68. Brush brackets 68 are frictionally mounted on the rods 64. They are movable for adjustment longitudinally of the rods and also in rotation about the rod axes, but grip the rods sufficiently firmly to be effectively rigidly related to them during operation of the instrument. Brush brackets 68 are so constructed as to define positively the position of each brush 62 longitudinally of its support rod 64, except for the described adjustment, but to permit yielding movement of the brushes vertically (as shown) into and out of contact with the respective potentiometer coils 60. The force with which brushes 62 are urged by the resilient brackets 68 into contact with potentiometer coils 60 is adjustable by rotation of the rod gripping portion of each bracket about its rod 64.

Direct or alternating current power may be supplied to potentiometer coils 60 in any desired manner. For purposes of illustration, the potentiometer coils may be connected in parallel by the lines 55 and 56, respectively, as shown in Fig. 7, across a suitable source of voltage, shown schematically as the battery 54. In Fig. 7, electrical connector 26 is indicated conventionally by a pair of dashed lines. The voltage tapped from the potentiometers by the brushes 62 may then be taken, as indicated at 57 and 58, between the respective brush connections 49 and 59 and one side of battery 54, which may be grounded. Means for controlling power supply to the respective potentiometer coils are shown illustratively in Fig. 7 as the two switches 51, introduced between the other side of battery 54 and the potentiometer windings. Those switches, which may be operated independently, are shown linked mechanically for synchronized operation by a linkage indicated schematically at 93.

In accordance with the present invention, means are provided, indicated generally by the numeral 70, for lifting the brushes 62 against the light pressure of bracket springs 68 out of engagement with potentiometer coils 60 when the instrument is not in actual service. As shown best in Figs. 4 and 5, a thermal element 72, substantially enclosed within a housing 74, is mounted on the upper face of frame shelf member 32 in association with each potentiometer. Housing 74, as illustrated, is of heat insulating material and comprises a base member 76 and a cover member 77 that includes a

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cover portion 78, side walls 79, and a back wall 80, the front of the housing being open and extending substantially parallel to the length of the potentiometer coil, and spaced therefrom. Thermal element 72 is a generally flat bi-metallic strip, mounted in a plane generally parallel with the axis of potentiometer coil 60. As illustrated, the rear end of the strip is rigidly mounted in back wall 80 of housing cover 77 in a suitable slot, in which it is clamped by the screws 82. The body of strip 72 extends forwardly in housing 74 in spaced relation to the walls and base of the housing, and projects freely from its open mouth. A light rail 73 is mounted transversely on the free end of element 72 outside of housing 74, and extends substantially parallel to potentiometer coil 60 over a distance somewhat greater than the effective length of the coil.

As illustrated, means are provided for selectively applying heat to each bi-metallic thermal element 72, comprising a coil 84 of insulated resistance wire, coiled directly about the central portion of the bi-metallic strip. The wire ends of heating coil 84 may be connected to terminals 85 in a side wall of housing 74, as shown typically in Fig. 4, connections from those terminals to suitable tabs 28 of plug connector 26 being omitted in the drawings for clarity of illustration. When a voltage is applied across heating coil 84, the resulting current in the coil warms the central portion of thermal element 72, causing the strip to bend longitudinally in a vertical plane, in response to the different coefficients of thermal expansion of the two metals from which it is made. Since the rear end of the strip is rigidly anchored in rear wall 80 of the housing, the result of bending of the central portion of the strip is to vary the vertical level of its free forward end, which carries rail 73. Bi-metallic element 72 is preferably so arranged that the rail 73 is lowered in response to warming of the strip. Upper and lower limit stops are preferably provided, and are shown in Fig. 5 as the screws 87 and 88, adjustably threaded in the cover and base, respectively, of housing 74.

A brush actuating arm 90, shown integral with brush 62, extends from the brush transversely of resistance coil 60, with its end overlying rail 73 in all longitudinal positions of the brush that are permitted by suspension limit stops 52. The relative levels of actuating arm 90 and rail 73 are so determined, for example, that when bi-metallic strip 72 is at or near normal temperature, with the free end of the strip in relatively elevated position, brush 62 is supported in spaced relation to the surface of potentiometer coil 60. That relation is typically indicated in Fig. 3. On the other hand, when a suitable voltage is applied across heating coil 84, bi-metallic strip 72 is warmed and its free end is deflected downward. Rail 73 is thereby lowered into spaced relation with brush actuating arm 90, as illustrated in Fig. 5, leaving brush 62 resting on the surface of potentiometer coil 60 with a yielding pressure that is determined entirely by the tension of spring bracket 68.

In operation of the invention, when the instrument is idle with bi-metallic strips 72 at normal temperature, each potentiometer brush is lifted free of the resistive surface of its associated coil 60, regardless of the longitudinal position of the brush with respect to the coil. In fact, longitudinal movement of the brush, such as results in the particular instrument of the present embodiment from imposed acceleration, is not at all

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interfered with by such lifting of the brush, since brush actuating arm 90 is able to slide freely along rail 73 over the entire range of movement permitted to the suspension by the limit stop 52. Accordingly, any change in the acceleration imposed upon the instrument as a whole, particularly such rapid and continuous changes as may result from vibration, cause no wear upon the delicate resistance wire of coil 60, but merely result in sliding movement of actuating arm 90 along rail 73. On the other hand, when it is desired to put the instrument into service, it is only necessary to apply a suitable voltage to heating coils 84, or, if the output of only one potentiometer is required, to the associated heating coil. In a few seconds bi-metallic strip 72 is smoothly deflected downward, gently restoring normal contact of brush 62 with the resistance coil. When the instrument is no longer required, the circuit through heating coil 84 is opened, permitting the bi-metallic strip to cool, returning the brush to idle condition, as already described.

Typical circuits for control of current to heating coils 84 are shown in Fig. 7. The heater coils 84 of the two brush lifting devices are shown illustratively connected in series by the lines 89 with each other and with a suitable source of voltage, indicated typically as the battery 91, and with circuit control means, shown illustratively as the switch 92. It will be understood that the two heating coils may alternatively be provided with independent control circuits, each of which may, for example, be constructed substantially like the single circuit shown in Fig. 7. Control switch 92 may be operated, if desired, independently of other parts of the electrical system, but it is preferred to provide means for operating heater control 92 in definite timed relation to the operation of the circuit or circuits by which power is supplied to the potentiometer coils 60. As an illustration of the type of timed relation that may be provided, the mechanical linkage, represented at 93 in Fig. 7, may include not only the two switches 51 but also heater control 92. That arrangement has the advantage of great simplicity, and yet insures that whenever power is supplied to potentiometer coils 60, the brush lifting device will also be actuated to restore the potentiometer brushes to operating condition. And when the potentiometers are no longer required, and switches 51 are opened, linkage 93, as illustrated, insures that switch 92 is also opened, actuating the brushing lifting mechanism to restore the potentiometers to idle condition with the brushes out of contact with the respective coils.

The described housing 74, in addition to protecting the bi-metallic element and its delicate heating coil 84 from mechanical damage when case cover 22 is removed, performs the additional valuable function of greatly reducing the loss of heat both by radiation and by air convection from heating coil 84 and thermal element 72 while the instrument is in service. By absorbing heat and radiating it back to the thermal element, housing 74 greatly reduces the power required by heating coil 84. In actual practice that power is found to be virtually negligible, and to cause no appreciable heating of the instrument as a whole.

Electrical connection to the respective brushes 62 may be made conveniently via the support rods 64 and spring brackets 68. For example, if the electrical circuit of the instrument permits connection to both brushes by a single lead wire, both

support rods 64 may be connected electrically at one or both ends to inner spring leg 45, and thence via suspension spring 42 to the fixed end of one of outer spring legs 46, frame shelf members 32 being then preferably constructed of insulative material (see the alternative modification described below). On the other hand, if the two potentiometer brushes are to be electrically isolated, as in the illustrative circuit of Fig. 7, support plates 67 being of insulative material, connection to each of the support rods 64 is preferably made via a flexible arm 68, frictionally engaging the rod, rather than in the more conventional manner by means of a flexible lead wire soldered to one end of the rod. In the drawings, 15 contact arms 69 are illustratively shown with one end mounted rigidly, as by soldering or welding, on a mounting stud 75, secured in a sidewall 73 of housing 74. Arms 69 are of flexible, electrically conducting material, and are so formed and mounted as to lightly contact the respective rods 64. It is found in practice that satisfactory electrical connection can be provided with a contact pressure that is sufficiently light to cause no appreciable damping of the translational movement of suspension 40. A further advantage of the particular illustrated structure is attained by extending brush lifting rail 73, as indicated at 73a, to underlie contact arm 69. With the parts suitably proportioned and mounted, rail extension 73a 30 then engages arm 69 and deflects its free end resiliently upward out of engagement with rod 64 when thermal element 72 is in its upwardly deflected position (that is, at normal temperature in the present preferred embodiment). When thermal element 72 is heated and deflected downward, rail end 73a first lowers contact arm 69 gently into yielding engagement with rod 64, and then, with further downward movement, becomes spaced and electrically isolated from contact arm 69, as well as from brush actuating arm 90. Wear of arm 69 where it engages rod 64 is thereby avoided except when the instrument is actually in use.

In operating position, with contact arm 69 resting on rod 64 and with brush 62 resting on potentiometer coil 60, brush actuating arm 90 is preferably more widely spaced from rail 73 than is contact arm 69, as illustrated in Fig. 5. Upward movement of rail 73, due to impressed change of temperature of thermal element 72, then lifts contact arm 69 free of rail 64, breaking the electrical circuit through the potentiometer brush, before that brush is lifted from the potentiometer coil; and, conversely, when the instrument is restored to operation, the brush is necessarily caused to engage the potentiometer coils before the electrical circuit through it is closed by contact of arm 69 with rail 64. That preferred relation has the advantage of preventing any possibility of sparking between the brush and coil as contact is made or broken.

A second illustrative embodiment of the invention, illustrated in Figs. 8 to 11, is characterized by the fact that the entire brush lifting device of the invention is carried on the suspension of the instrument, and therefore moves with the brush in its movement longitudinally of the resistance coil. Furthermore, in the second embodiment only a partial enclosure is provided for the temperature responsive element, and a single such element is utilized to control the condition of two brushes on separate potentiometer coils. The basic structure of the instrument itself is similar to that of Figs. 1 to 6, except that no enclosing case is shown. Corresponding parts are identified

by the same numerals in both modifications, but with addition of the postscript *a* in the modification of Figs. 8 to 11 in those instances in which the part in question is of appreciably different form. The upper frame members 32a are supported by means of corner posts on a base, not shown, and correspond in function to the frame shelf members 32 of the previous embodiment. Two independent potentiometer coils 60 are mounted, as by brackets 61a, on magnet pole pieces 36a.

The potentiometer brushes 62a, as shown, are frictionally mounted at 100 for adjustable longitudinal movement on the horizontal posts 94. Those posts correspond in broad function to the rods 64 of the previous embodiment, but are mounted at one end only in upwardly projecting ears 96 of a plate-like bracket member 95, which is rigidly secured, together with inner spring leg 45, to one of the end suspension brackets 43a, by the screws 97. Bracket 95 may, for example, be of electrically conductive material, forming a connection between both brush supporting posts 94 and inner spring leg 45, so that connections to the brushes may be made, as indicated at 99, to the anchored end of one of the outer spring legs 46. Alternatively, bracket 95 may be of insulative material, electrically isolating the two brush supporting posts 94, which may then be connected by flexible means to independent lead wires in any suitable manner.

Fig. 11 illustrates clearly a preferred brush assembly structure. A spring clamp 100 frictionally engages supporting post 94, and supports brush 62a by means of an arm 101, which is preferably resiliently flexible in an axial plane of post 94 (that plane being vertical in the present embodiment) and relatively rigid in a direction normal to that plane. As illustrated, arm 101 comprises a strip of spring stock, which may be integral with spring clamp 100 or soldered to a separately formed bracket of similar material. The free end of arm 101 is transversely ridged to form the downwardly facing contact surface of brush 62a; and, beyond that ridge, is bent upwardly at 102, and then back upon itself to form a shelf 103, which forms the upper wall of a relatively open partial box formation 104. The main body of arm 101 may readily be adjusted by longitudinal bending in a vertical plane to provide the desired contact pressure under normal operating conditions between brush surface 62a and potentiometer coil 60.

The brush lifting device of the present embodiment includes a temperature responsive element, shown as the relatively flat bi-metallic strip 106, which may be mounted as illustrated upon the horizontally extending central ear 98 of bracket 95. Element 106 carries heating means, shown as a coil of insulated resistive wire 109, surrounding the central portion of that element, by which its temperature may readily be varied to cause deflection of its free end in a vertical plane.

The wire ends of heating coil 109 may be connected, as shown best in Fig. 8, to terminals 109, shown mounted in a supporting strip 116 of insulative material, secured, with posts 94, to bracket 95. Connections to terminals 109 may be made by light and highly flexible leads, indicated at 107. Two brush actuating arms 110 extend transversely in opposite directions from the free end of bi-metallic strip 106, their ends being received within the boxes 104 at the ends of brush supporting arms 100. As illustrated, both brush actuating arms 110 are formed from a single piece

of wire, secured to strip 106 by the screw 111, the wire being formed with a central hairpin bend 112, shown best in Fig. 8, which provides convenient adjustability of the arms longitudinally of strip 106. Brush actuating arms 110, as so constructed, are appreciably resilient transversely of their length, that resilience being readily controllable, as by selection of the diameter and composition of the wire of which they are formed. Limit stops are preferably provided which define extreme upward and downward deflected positions of bi-metallic strip 106. As illustrated, upward movement of strip 106 is limited by the screw 114, adjustably mounted in a rigid bracket 115 which also forms a partial heat shield for heating element 108; while downward deflection of the strip is limited by contact of screw 118, adjustably mounted in the free strip end, with the upper edge of accelerometer weight 50.

With bi-metallic strip 106 deflected upwardly, corresponding preferably, but not necessarily, to normal temperature, the ends of brush actuating arms 110 engage the lower faces of back-turned portions 103 of brush carrying arms 100, applying to the brush supports an upwardly directed resilient force. The resilience of arms 110 and the position of limit stop 114 are so adjusted that that force is sufficient to overcome the resilient force of brush supporting arm 101, and thereby to lift the brushes clear of their respective potentiometer coils 60 (Fig. 10). With strip 106 deflected downwardly, corresponding in the preferred embodiment to energized condition of heating coil 108, the ends of brush actuating arms 110 are lowered sufficiently as determined by adjustment of limit stop 118, not only to produce contact between the brushes and coil 60, but also, preferably, to break contact of the arms with bracket portions 103. With limit stop 118 so adjusted, spaced relationship of arms 110 within the box formations 104 is maintained during operation of the instrument, as illustrated particularly in Figs. 9 and 11. Accordingly, in operating condition of the instrument, the brush lifting device does not in the least disturb the action of resilient brush supporting springs 101 in determining suitable contact pressure of the brushes.

I claim:

1. In combination with an elongated electrical resistive element, brush means including a brush engageable, in response to a yielding force, with the resistive element to form therewith a path for electric current, brush actuating means acting to move the brush longitudinally with respect to the resistive element to vary the electrical properties of the said current path, brush lifting means comprising a bi-metallic heat responsive element shiftable by temperature change between two conditions, structure interposed between the brush means and the heat responsive element and movable in response to changes of its temperature, the said structure including a control member positioned adjacent the brush means in all longitudinal positions of the brush, the control member being movable in response to one condition of the heat responsive element to an idle position spaced from the brush means, and being movable in response to the other condition of the heat responsive element to an operating position engaging the brush means in all longitudinal positions of the brush, the control member in operating position applying to the brush means a force acting to oppose the said yielding force and to shift the brush into spaced relation

with the resistive element, and control means for selectively supplying heat to the heat responsive element.

2. An accelerometer comprising in combination a frame, an elongated electrical resistive element mounted in fixed relation to the frame, a massive element movably mounted on the frame for movement longitudinally of the resistive element in response to bodily accelerations of the frame, a heat responsive element capable of assuming distinct configurations in response to changes in temperature and having one portion mounted in fixed relation to the frame, a lift bar mounted on another portion of the heat responsive element and extending in parallel relation to the resistive element, the lift bar being movable transversely of the resistive element in response to changes of configuration of the heat responsive element, a brush mounted on the massive element for longitudinal movement therewith, the brush being yieldingly urged transversely into sliding engagement with the resistive element, the brush carrying a control surface that is transversely adjacent the bar in all longitudinal positions of the massive element, the bar being spaced from the control surface in one configuration of the heat responsive element, whereby the brush moves slidably over the resistive element in response to accelerations of the frame, and the bar engaging the control surface in another configuration of the heat responsive element, whereby the brush is spaced from the resistive element and the control surface moves slidably over the bar in response to accelerations of the frame, and control means for selectively supplying heat to the heat responsive element.

3. An accelerometer as defined in claim 2, and including also a protective housing enclosing the resistive element, the heat responsive element and the massive element, and an inner housing of heat insulative material within the protective housing and enclosing only the heat responsive element.

4. An accelerometer comprising in combination a frame, an elongated electrical resistive element mounted in fixed relation to the frame, a massive element movably mounted on the frame for movement longitudinally of the resistive element in response to bodily accelerations of the frame, brush means mounted on the massive element for longitudinal movement therewith and including a brush yieldingly urged transversely into sliding engagement with the resistive element, a heat responsive element capable of assuming distinct configurations in response to changes in temperature, means supporting the heat responsive element by one portion thereof, and brush lifting means mounted on another portion thereof, the brush lifting means including a brush actuating member that is adjacent a surface of the brush means in all longitudinal positions of the massive element, the member being spaced from that surface in one configuration of the heat responsive element, whereby the brush moves slidably over the resistive element in response to accelerations of the frame, and the member engaging that surface in another configuration of the heat responsive element and lifting the brush into spaced relation to the resistive element, whereby accelerations of the frame are prevented from causing sliding movement of the brush over the resistive element, and control means for selectively supplying heat to the heat responsive means.

5. An accelerometer comprising in combination a permanent magnet having spacedly op-

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posed pole faces, an electrically conductive massive element mounted in spaced relation between the pole faces of the magnet for substantially rectilinear movement parallel to their plane in response to bodily accelerations of the magnet, an elongated electrical resistive element mounted in fixed relation to the magnet and extending parallel to the said movement of the massive element, a brush mounted on the massive element for longitudinal movement therewith, the brush being yieldably urged transversely into sliding engagement with the resistive element, a housing of heat insulative material mounted in fixed relation to the magnet and extending transversely of the resistive element with an open end adjacent thereto, a bi-metallic strip having one end rigidly mounted within the housing and the other end extending freely from the open end thereof in a plane substantially parallel to the length of the resistive element, a lift bar carried by the free end of the bi-metallic element and extending parallel to the length of the re-

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sistive element, a control member on the brush transversely adjacent the lift bar in all longitudinal positions of the massive element, and electrical means for controllably generating heat within the housing to vary the temperature of the bi-metallic strip, the lift bar being spaced from the control member for one temperature range of the bi-metallic strip, whereby the brush moves slidingly over the resistive element in response to accelerations of the magnet, and the lift bar engaging the control member for another temperature range of the bi-metallic strip and thereby lifting the brush into spaced relation with the resistive element.

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