

United States Patent

Oda et al.

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[54] SEMICONDUCTOR STRESS TRANSDUCER

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179/100.41 K, 179/110 B, 179/110 D, 338/2

[51] Int. Cl. H04r 1/16, H04r 9/12, H04r 11/08

[58] Field of Search. 179/100.41 K, 100.41 V, 110 B,
179/110 D, 100.41 T; 338/2, 5

[56]

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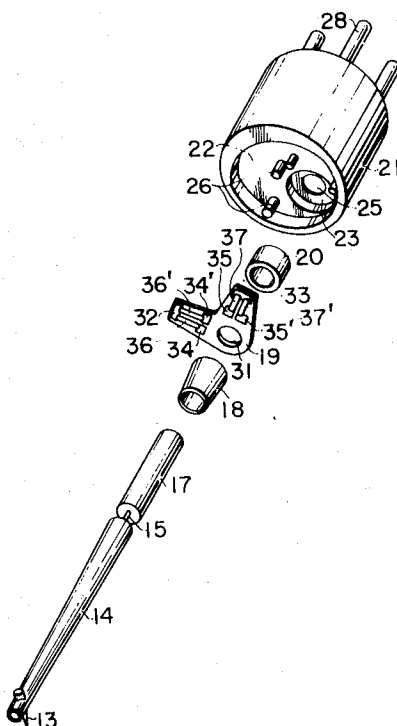
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[57]

ABSTRACT

A semiconductor stress transducing apparatus in which a semiconductor layer having a large piezo-resistance effect is deposited by vacuum evaporation on a highly flexible thin-film substrate of an insulating material and a bending stress is imparted to the deposited semiconductor layer through a flowable viscous material, whereby a change in the internal resistance of the semiconductor layer is detected.

4 Claims, 22 Drawing Figures



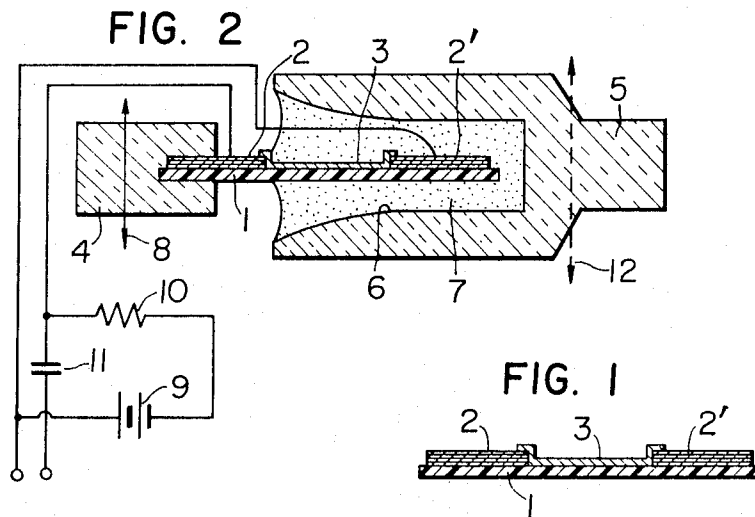


FIG. 3a

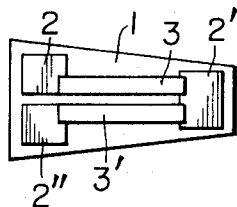


FIG. 3b

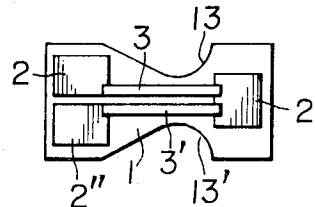


FIG. 3c

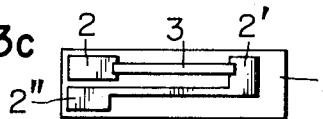
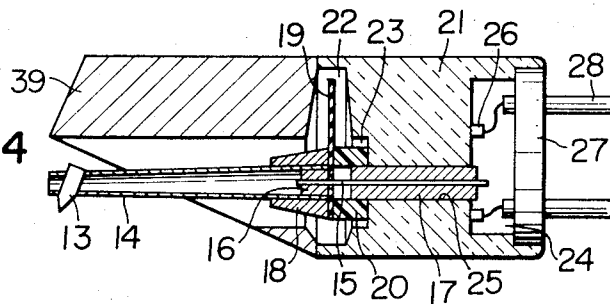


FIG. 4



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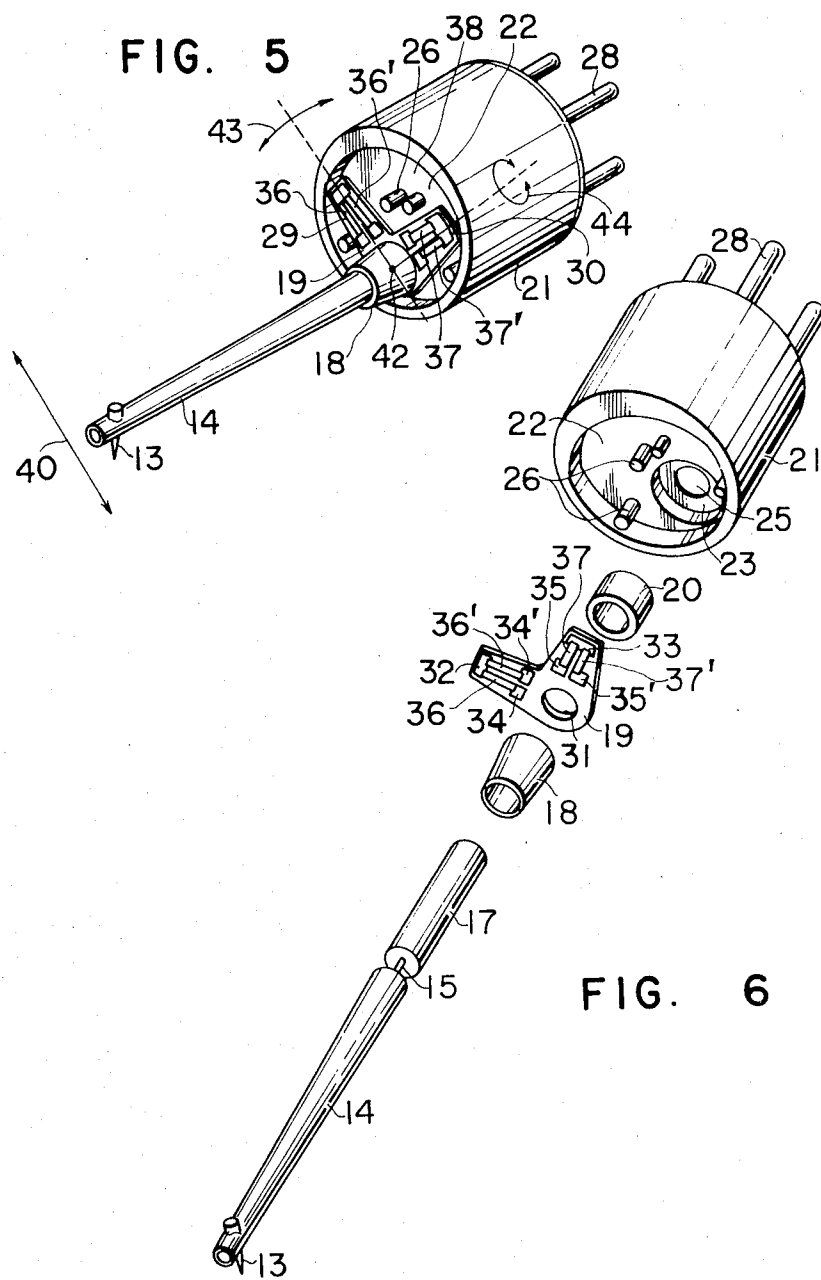


FIG. 7

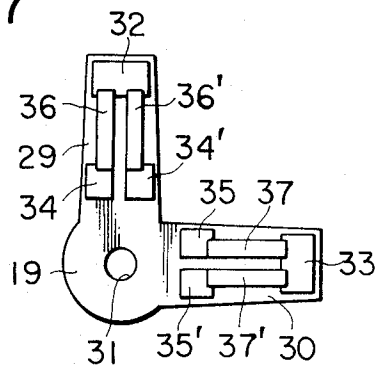


FIG. 8

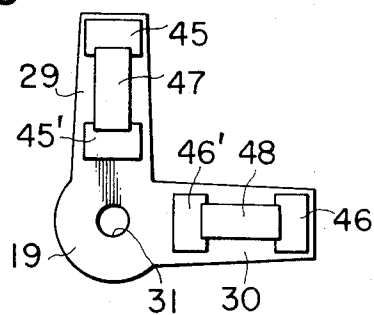


FIG. 9

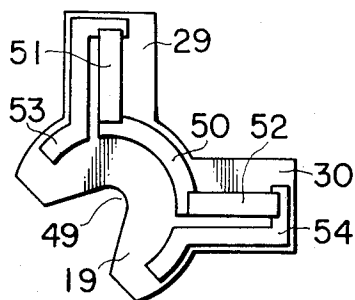


FIG. 10

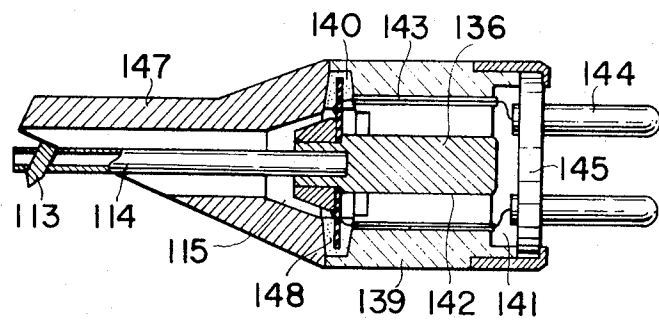


FIG. 11

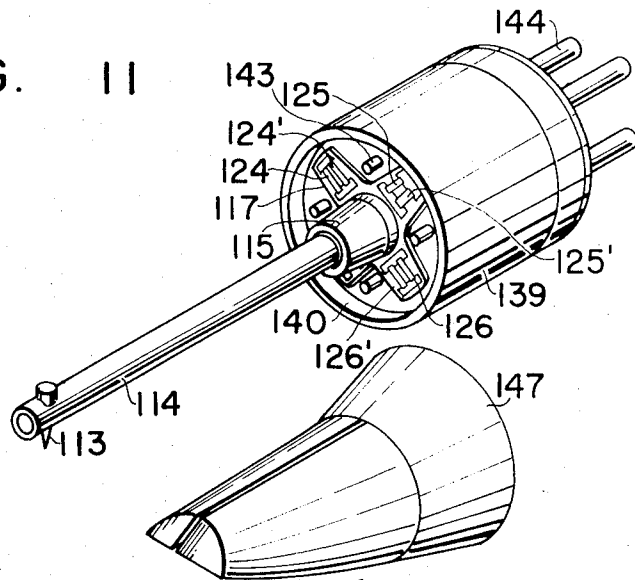


FIG. 12

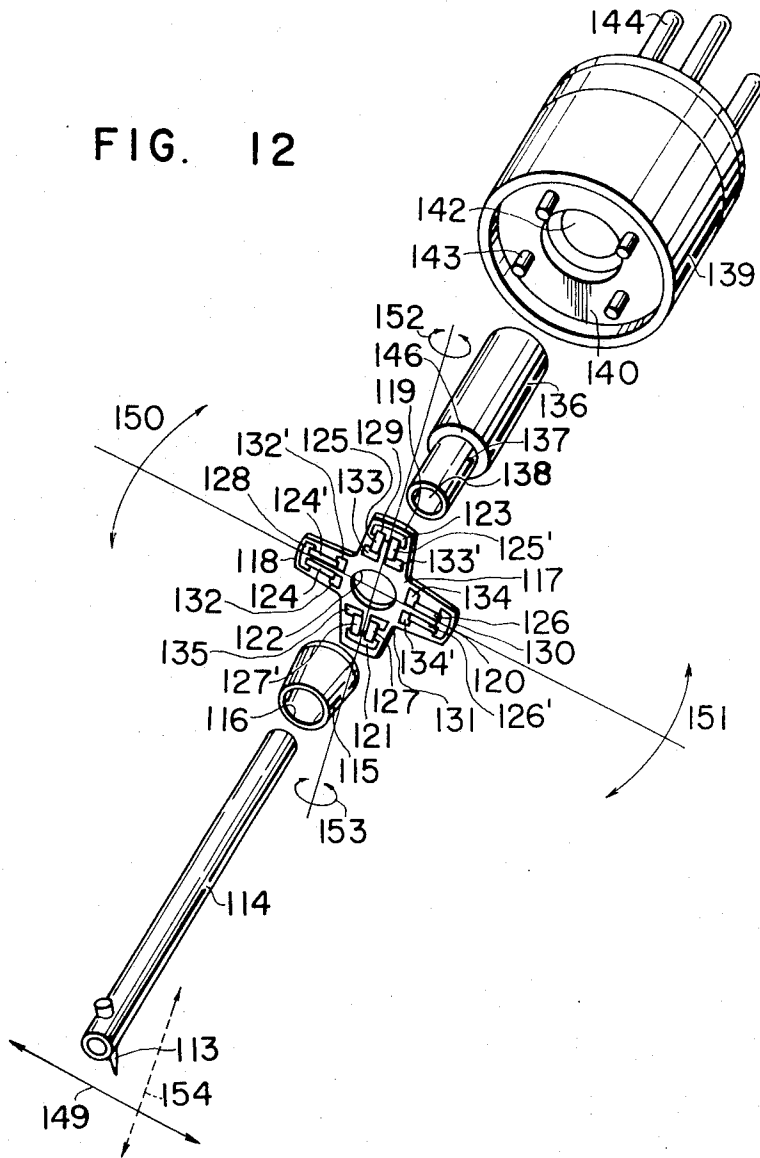


FIG. 13

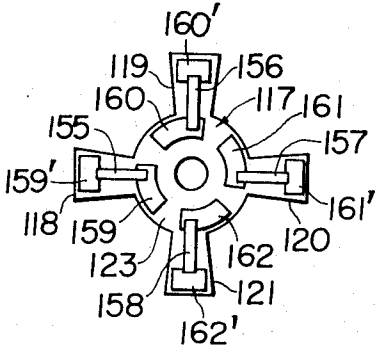


FIG. 14

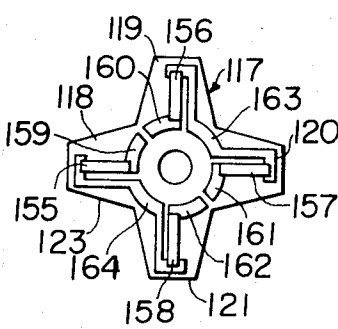


FIG. 15

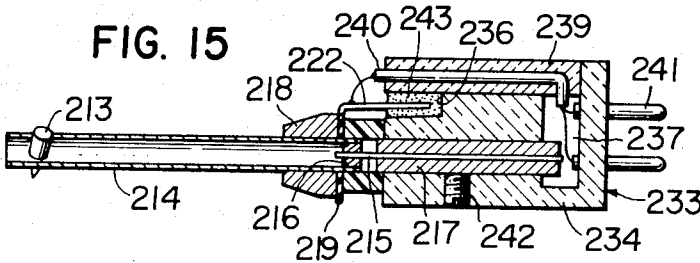


FIG. 16

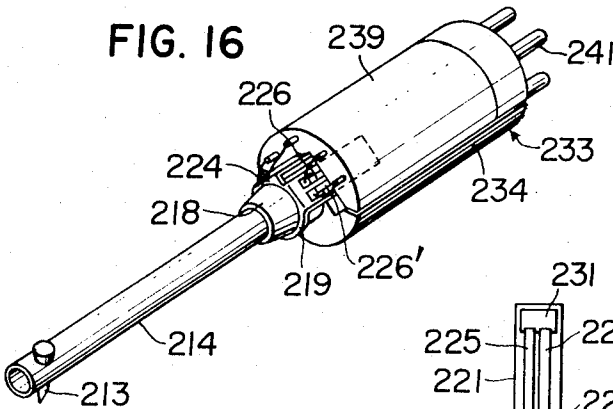
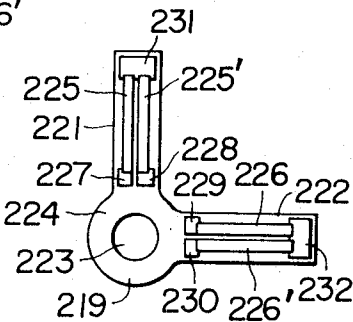
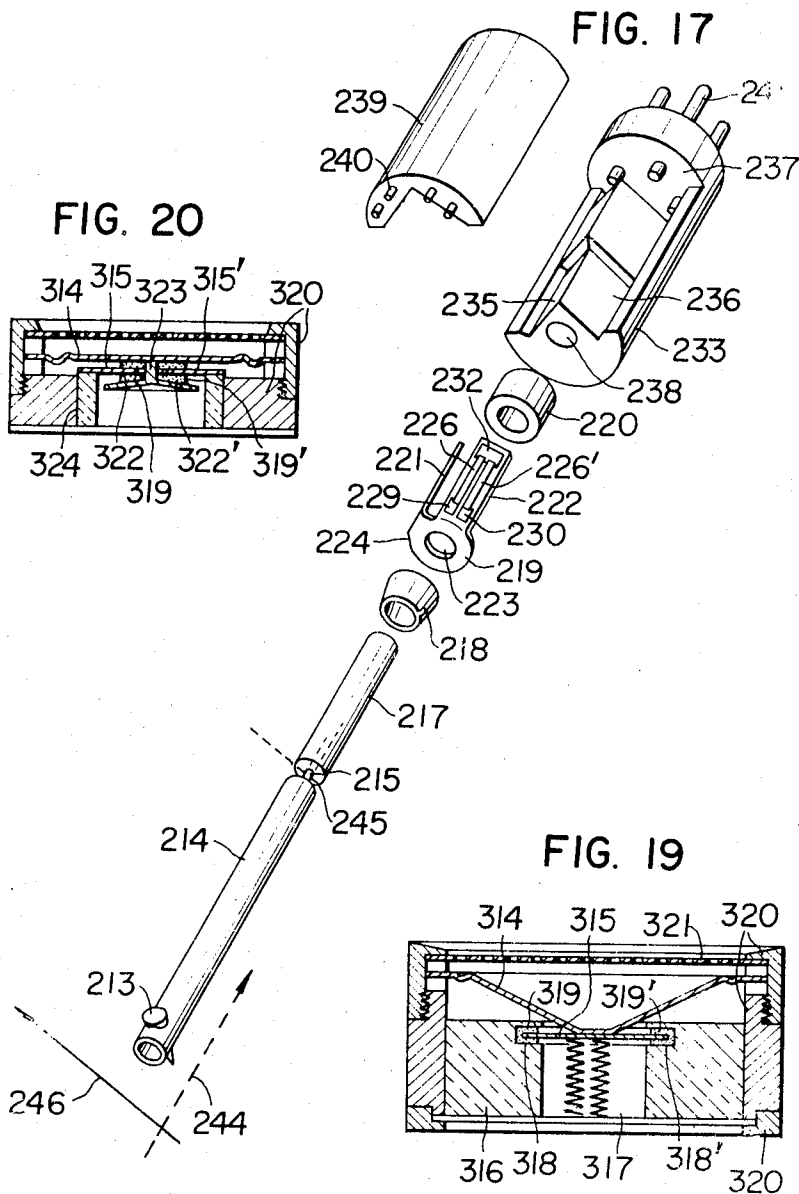


FIG. 18





SEMICONDUCTOR STRESS TRANSDUCER

The present invention relates to a semiconductor stress transducer which converts mechanical stress into electricity using a semiconductor film element.

Various type of sound converting element, utilizing the piezo-resistance effects of single crystals of silicon and germanium, have been proposed heretofore. However, in order to obtain a sufficient effect of conversion and output voltage, any one of these prior art elements must be fabricated into the shape of a rod or thin plate having an extremely small cross-sectional area, such as 0.1 mm² or smaller, and further it must be bonded to a mechanical vibration system so as to receive a uniaxial stress. Such a prior art element using a single crystal is so small in mechanical compliance that difficulties have frequently been encountered in the mechanical construction to obtain a converting apparatus of satisfactory sound characteristic. In addition, the fabrication of the semiconductor element, involving an extremely delicate work, has called for a high degree of skill and yet further, because of the insufficient mechanical strength, the element thus obtained has frequently become unserviceable during the process of assembly.

It is, therefore, the object of the present invention to provide a semiconductor stress transducer which utilizes the piezo-resistance effect of a semiconductor layer deposited on a flexible thin-film of an insulating material, and which, therefore, can be produced by a simple process.

According to the present invention, a bending stress is imposed on the semiconductor piezo-resistance element uniformly continuously through a flowable viscous material and local concentration of an excessively large stress can be avoided. Therefore, a breakage of the element can be avoided. Further, any desired damping effect can be obtained by suitable selecting the configuration of the insulating film base, the configuration of a supporting structure and the type of the flowable viscous material. In other words, the damping effect, compliance and output voltage can be designed very easily. Another advantage of the present invention is that, since the semiconductor piezo-resistance element is a pure resistor, it will not be subjected to a detrimental induction and furthermore, since it is formed by vacuum evaporation, it can be provided in an extremely small size and can be used with stability, even on excitation of high frequencies. A further excellent advantage of the present invention is that the element can be produced in a large quantity of a single process, so that the elements of uniform quality can be obtained at low costs, and moreover the construction thereof is simple.

Further features of the present invention will become apparent from the following description of the embodiments of the invention when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a cross-sectional view exemplifying the semiconductor-deposited film element to be used in the semiconductor stress transducer of the present invention;

FIG. 2 is a diagram for explaining the basic construction and operation of the apparatus according to the invention;

FIGS. 3a-3c are a set of views showing different forms of the semiconductor-deposited film element;

FIG. 4 is a cross-sectional view showing an embodiment of the pickup cartridge according to the invention;

FIG. 5 is a perspective view of the pickup cartridge showing the construction inside thereof;

FIG. 6 is an exploded perspective view of the pickup cartridge;

FIG. 7 is a front view of the semiconductor-deposited film element;

FIGS. 8 and 9 are front views of the other forms of the semiconductor-deposited film element respectively;

FIG. 10 is a cross-sectional view of another embodiment of the pickup cartridge according to the invention;

FIG. 11 is a perspective view of the pickup cartridge of FIG. 10, with the front cap thereof removed;

FIG. 12 is an exploded perspective view of the pickup cartridge of FIG. 10;

FIGS. 13 and 14 are front views of the other forms of the semiconductor deposited film element respectively;

FIG. 15 is a cross-section view of still another embodiment of the pickup cartridge according to the invention;

FIG. 16 is a perspective view of the pickup cartridge of FIG. 15;

FIG. 17 is an exploded perspective view of the pickup cartridge of FIG. 15;

FIG. 18 is a front view of the semiconductor-deposited film element of the embodiment of FIGS. 15-17; and

FIGS. 19 and 20 are cross-sectional views of a microphone in which the present invention is embodied.

Referring first to FIG. 1, there is shown an embodiment of the semiconductor-deposited film element used in the apparatus of this invention. In the Figure, reference numeral 1 designates a substrate which consists of a heat-resistant, insulating and highly flexible film made of such material as polyimide, polyamide or mica, and having a thickness of about several tens microns. Reference numerals 2, 2' designate electrodes which are provided on the base plate 1 by depositing a metal, such as nickel, chromium or gold, by vacuum evaporation. Reference numeral 3 designates a semiconductor piezo-resistance element which is formed by depositing a semiconductor material of large piezo-resistance effect, e.g., silicon, germanium, indium, antimony or the like with a suitable quantity of a selected impurity blended therein, by vacuum evaporation in the shape of a band bridging the electrodes 2, 2', using a suitable mask. Therefore, when the semiconductor piezo-resistance element 3 undergoes a tension change in the direction to connect the electrodes 2, 2' or a deformation under a bending stress exerted on the entire body thereof, a change occurs in the resistance across the electrode terminals due to a mechanical deflection. FIG. 2 is a view to explain the principle of a stress converting apparatus incorporating the semiconductor-deposited film element constructed as described above. Reference numeral 4 designates an insulating holder supporting one end, i.e. the electrode 2, of the semiconductor-deposited film element and 5 designates another holder supporting the other end of the same. The holder 5 is provided with a cavity 6 in which are received the other electrode 2' and the

semiconductor piezo-resistance element 3 of the semiconductor-deposited film element. The cavity 6 is filled with a viscous material 7 consisting of a silicon-base grease or the like, and the other end portion of the semiconductor-deposited film element is supported by the holder 5 through said flowable viscous material 7.

In the construction described above, when the holder 4 or 5 is displaced in the direction of the arrow 8, a bending stress occurs in the semiconductor piezo-resistance element 3 due to the braking effect of the member 7. As a result, the semiconductor piezo-resistance element 3 is pulled or compressed and the internal resistance thereof varies according to the displacement of the holder 4. It will, therefore, be understood that, when a direct-current source 9, such as a battery, and a load resistance 10 are connected in series with the semiconductor piezo-resistance element 3 to form a closed circuit, the resistance change of said semiconductor piezo-resistance element 3 is detected as a voltage change at the terminal end of the load resistance 10 and the resultant alternating-current component is taken out through a capacitor 11. The resistance of the semiconductor piezo-resistance element 3 can be changed similarly by displacing the holder 5 in the direction of the arrow 12, while holding the holder 4 stationary.

The construction of the semiconductor-deposited film element 3 can vary widely as exemplified in FIG. 3. For instance, the semiconductor-deposited film element 3 may be constructed as shown in FIG. 3a wherein two semiconductor piezo-resistance elements 3, 3' are formed on an insulating film base plate 1, with one ends thereof connected to electrodes 2, 2'' respectively and with the other ends connected to a common electrode 2', so as to be used in series, or as shown in FIG. 3b wherein the insulating film substrate 1 is provided with recesses 13, 13' on both side edges thereof so as to make large the resistance change of the semiconductor piezo-resistance elements 3, 3' caused by a bending stress imposed on said insulating film substrate 1, or further as shown in FIG. 3c wherein an electrode 2'', connected to an electrode 2' is provided in side-by-side relation with an electrode 2 so as to facilitate the connection of the electrodes with the external elements. Besides those described above, many other constructions can of course be employed.

Now, the practical construction of the pickup cartridge according to the present invention will be described hereunder:

With reference to FIGS. 4, 5 and 6, reference numeral 13 designates a needle point which traces the sound track of a phonograph record to detect the vibration; 14 a cantilever to transmit the vibration of the needle point 13 to a mechano-electrical transducing unit, said cantilever being made of a light alloy material; and 15 an ultrafine wire constituting a fulcrum of vibration when said needle point 13 and said cantilever 14 vibrate according to the sound track. The ultrafine wire 15 is securely supported at one end by a spacer 16 which is fitted into the inner end of the cantilever 14.

Reference numeral 17 designates a supporting member to secure the ultrafine wire 15 to the main body, i.e. the mounting block, of the cartridge. The supporting member 17 is fixed on the ultrafine wire 15, with a slight gap of 1 mm or smaller between it and the

inner end of the cantilever 14, so as to provide for free vibration of the needle point 13 and the cantilever 14 about the ultrafine wire 15.

Reference numeral 18 designates a supporting member which clamps between it and a damping support material 20, consisting of an elastic material or the like, an insulating film substrate 19 having a semiconductor film deposited thereon.

Reference numeral 21 designates a cylindrical mounting block made of an insulating material and having a recess 22 formed in one end face thereof. The bottom of the recess 22 is formed with a recess 23 at a portion thereof for receiving one end of the damping support material 20. An elongate hole 25 is bored from the center of the recess 23, communicating said recess 23 with a recess 24 provided in the other end face of the mounting block 21.

On the other hand, terminal rods 26 are embedded in the mounting block 21, with the opposite ends thereof projecting into the recess 22 in one end face and the recess 24 in the other end face of said mounting block respectively, and the ends projecting into the recess 24 are connected with lead terminals 28 respectively which are provided on a terminal plate 27 securely fitted in said recess 24.

In assembling the pickup cartridge, the supporting member 18 is fitted on the terminal end of the cantilever 14 at first and then the insulating film base plate 19 and the damping support material 20 are fitted in such a manner as to clamp the insulating film substrate 19 between said supporting member 18 and said damping support 20. Thereafter, the supporting member 17 is inserted into the hole 25 in the mounting block 21, while holding the damping support 20 in pressure contact with the bottom of the recess 23, and is secured to said mounting block 21 by means of an adhesive or the like. Here, the insulating film substrate 19 corresponds to the substrate 1 shown in FIGS. 1 and 2, and has integral arms 29, 30 lying in the same plane in substantially perpendicular relation to each other to form a V-shape as shown in FIG. 6. The insulating film substrate 19 is provided with a hole 31 at the flexed portion thereof, through which the supporting member 17 is inserted, and is clamped between the supporting member 18 and the damping support 20.

As shown in FIG. 7, on each of the arms 29, 30 are formed by vacuum evaporation semiconductor piezo-resistance elements 36, 36' or 37, 37' of the same conditions as that shown in FIG. 1, with one ends thereof connected with electrodes 34, 34' or 35, 35' and the other ends connected with a common electrode 32 or 33. The arms 29, 30, provided with the semiconductor piezo-resistance elements 36, 36' and 37, 37' respectively, are positioned within the recess 22 of the mounting block 21 with an air space between them and the bottom wall of said recess, and said recess 22 is filled with a flowable viscous material 38. Thus, it will be seen that the arms 29, 30 are held by the mounting block 21 through the flowable viscous material 38. The electrodes 34, 34' and 35, 35' are connected with the terminal rods 26 respectively and the two semiconductor piezo-resistance element 36, 36' or 37, 37' are connected in series with each other. Reference numeral 39 designates a front cap of the pickup cartridge.

The operation of the pickup cartridge of the invention having the construction as described above will be briefly explained hereunder with reference to FIG. 5.

When a vibration is imparted to the needle point 13 as indicated by the arrows 40, said needle point 13 and the cantilever 14 are moved in the same directions. Therefore, the semiconductor piezo-resistance elements 36, 36', parallel to the arrows 40 undergo a vibration as indicated by the arrows 43, so that a bending stress is created in said semiconductor piezo-resistance element 36, 36' by the flowable viscous material 38. As a result, the internal resistance of the semiconductor piezo-resistance elements 36, 36' across the electrodes thereof varies according to the stress change, and the mechanical vibration of the needle point 13 is detected as an electric signal.

On the other hand, the other semiconductor piezo-resistance elements 37, 37' undergo a rotational force about the dotted line axis as indicated by the arrows 44. Therefore, a bending stress is not substantially imposed on the semiconductor piezo-resistance elements 37, 37' and hence a change in internal resistance is very minor.

It will be obvious that the above-described condition will be reversed when the needle point 13 vibrates in a direction at right angles to the arrows 40.

Besides the construction shown in FIG. 7, the semiconductor-deposited film element may be of the construction as shown in FIG. 8 wherein each of the arms 29, 30 of the insulating film base plate 19 is provided with a pair of electrodes 45, 45' or 46, 46' and a semiconductor piezo-resistance element 47 or 48; or of the construction as shown in FIG. 9 wherein a notch 49 is formed in the insulating film base plate 19 extending to the central portion of the latter and semiconductor piezo-resistance element 51, 52 are formed on the arms 29, 30 respectively, with one ends connected to a common electrode 50 and the other ends connected to electrodes 53, 54 respectively, said electrodes 53, 54 being extended so as to facilitate connection with the terminal rods; or of any other construction.

Another embodiment of the pickup cartridge according to the invention will be described with reference to FIGS. 10, 11 and 12. In these Figures, reference numeral 113 designates a needle point which traces the sound track of a photograph record to detect a vibration and 114 designates a cantilever to transmit the vibration of the needle point 113 to the mechano-electrical transducing unit, said cantilever being made of a light alloy material. Reference numeral 115 designates a holder made of an elastic material and adapted to hold a semiconductor-deposited film element between it and a supporting member to be described later. The holder 115 is provided with an axial hole 116 through the center thereof.

Reference numeral 117 designates the semiconductor-deposited film element comprising a cross-shaped insulating film substrate 123 having four arms 118, 119, 120 and 121 lying in the same plane at substantially right angles to each other, and provided with a through-hole 122 at the center thereof; and two semiconductor piezo-resistance elements 124 and 124', 125 and 125', 126 and 126' or 127 and 127' provided side by side on each of said arms, with one ends thereof connected to a common electrode 128, 129,

130 or 131 and the other ends connected to electrodes 132 and 132', 133 and 133', 134 and 134' or 135 and 135' respectively.

Reference numeral 136 designates a cylindrical support member having a stepped, reduced diameter portion 137 at one end thereof. The reduced diameter portion 137 is provided therein with a hole 138 for receiving the inner end of the cantilever 114 therein.

Reference numeral 139 designates an insulating mounting block serving simultaneously as a cartridge housing. The insulating mounting block 139 has recesses 140, 141 in the opposite end faces thereof, and an axial hole 143 extending between the centers of said recesses 140, 141 for receiving the supporting member 136 therein. Terminal rods 143 are embedded in the mounting block 139 with the opposite ends thereof projecting into the recesses 140, 141 respectively and a terminal plate 145 having terminal rods 144 extending therethrough is securely fitted in the recess 141, said terminal rods 144 being connected to the ends of the terminal rods 143 projecting into said recess 141 respectively.

The pickup cartridge of the construction described above is assembled in the following manner:

First of all, the reduced diameter portion 137 of the supporting member 136 is inserted into the through-hole 122 formed in the insulating film substrate 119 of the semiconductor-deposited film element 117 and the holder 115 is fitted on said reduced diameter portion 137, with the latter received in the axial hole 116 of the former, thereby to clamp the semiconductor-deposited film element 117 between said holder 115 and the shoulder 146 connecting the reduced diameter portion with the larger diameter portion of the supporting member 136.

Then, the cantilever 114 is inserted into the axial hole 138 of the supporting member 136 with pressure and the supporting member 136 carrying the cantilever 114 is inserted into the hole 142 of the insulating mounting block 139 and secured therein as by an adhesive or the like.

In the assembled state, the arms 118, 119, 120 and 121 of the semiconductor-deposited film element 117 are positioned within the recess 140 of the insulating mounting block 139 and said recess 140 closed with a front cap 147 is filled with a flowable viscous material 148. Therefore, the arms 118, 119, 120 and 121 are supported by the cartridge housing, composed of the insulating mounting block 139 and the front cap 147, through the flowable viscous material 148.

On the other hand, the electrodes 132, 132'; 133, 133'; 134, 134' and 135, 135' on the semiconductor-deposited film element 117 are connected with the terminal rods 143 respectively in this state.

The operation of the pickup cartridge constructed as described above will be briefly explained hereunder with reference to FIG. 12. The semiconductor-deposited film element 117 is integral with the cantilever 114. Therefore, a vibration transmitted to the cantilever from the needle point 113 is propagated in four directions from the supporting member 136 in a cross shape.

When a vibration as indicated by the arrows 149 is given to the needle point 113, said needle point 113 and the cantilever 114 vibrate in the same direction as

that indicated by the arrows 149, with the center of vibration located at the supporting member 136.

As the cantilever 114 vibrates in the manner described, the arms 118 and 120 of the semiconductor-deposited film element 117, which are parallel to the arrows 149, undergo a vibration as indicated by the arrows 150, 151 respectively and hence the semiconductor piezo-resistance elements 124, 124' and 126, 126' formed on said respective arms 118, 120 are subjected to a bending stress caused by the braking force of the flowable viscous material 148. The resultant changes in the internal resistances of the semiconductor piezo-resistance elements 124, 124' and 126, 126' are detected through the terminal rods 144, which correspond to the vibration of the needle point 113.

On the other hand, the other arms of the semiconductor-deposited film element 117, i.e. the arms 119 and 121 extending perpendicular to the arrows 149, undergo a rotational force about the dotted line axis as indicated by the arrows 142, 153. Therefore, the semiconductor piezo-resistance elements 125, 125' and 127, 127' provided on these arms 119, 121 are subjected to substantially no bending stress and, therefore, a change in internal resistance thereof is very small.

Now, when the needle point 113 is caused to vibrate in the direction of the arrows 154 perpendicular to the direction of arrows 149, the internal resistances of the semiconductor piezo-resistance elements 125, 125' and 127, 127' are varied largely and those of the semiconductor piezo-resistance element 124, 124' and 126, 126' are not substantially varied, as will be readily understood.

FIGS. 13 and 14 show other forms of the semiconductor-deposited film element 117. In the form shown in FIG. 13, each of the four arms 118, 119, 120 and 121 of the cross-shaped insulating film base plate 123 is provided with one semiconductor piezo-resistance element 155, 156, 157 or 158 and its electrodes 159, 159'; 160, 160'; 161, 161' or 162, 162'. The form shown in FIG. 14 is similar to that of FIG. 13 in that each of the arms 118, 119, 120 and 121 is provided with one semiconductor piezo-resistance element 155, 156, 157 or 158, but is different from the latter in that one ends of the semiconductor piezo-resistance elements 156, 157 are connected to a common electrode 163 and one ends of the other semiconductor piezo-resistance elements 158, 155 are connected to another common electrode 164.

Still another embodiment of the pickup cartridge according to the invention will be described in detail with reference to FIGS. 15, 16 and 17. Referring to FIGS. 15, 16 and 17, reference numeral 213 designates a needle point to detect a vibration by tracing the sound track of a phonograph record and 214 designates a cantilever made of a light alloy material and adapted to transmit the vibration of the needle point 213 to a mechano-electrical transducer unit. Reference numeral 215 designates an ultrafine wire to constitute a center of vibration when the needle point 213 and the cantilever 214 vibrate according to the sound track. The ultrafine wire 215 is fixedly supported by a spacer 216 fitted into the inner end of the cantilever 214. Reference numeral 217 designates a supporting member to secure the ultrafine wire 215 to the main body of the cartridge, i.e. a mounting block. The sup-

porting member 217 is fixed to the ultrafine wire 215, with a slight gap of 1 mm or smaller being maintained between it and the inner end of the cantilever 214, so as to provide for free vibration of the needle point 213 and the cantilever 214 about said ultrafine wire 215.

Reference numeral 218 designates a supporting member to hold between it and a damping support 220 of an elastic material a semiconductor-deposited film element having layers of semiconductor deposited thereon.

As shown in the front view of FIG. 18, the semiconductor-deposited film element 219 comprises an insulating film substrate 224 having two integral arms 221, 222 arranged at substantially right angles to each other and having a through-hole 223 bored at the root portions of said arms, and on each arm 221 or 222 are formed two semiconductor piezo-resistance element 225, 225' or 226, 226' side by side by vacuum evaporation, with one ends thereof connected to electrodes 227, 228 or 229, 230 and the other ends connected to a common electrode 231 or 232. Namely, the semiconductor piezo-resistance elements 225, 225' or 226, 226' are connected with each other in series. The arms 221 and 222 are flexed at their roots in the same direction to extend parallel to each other as best shown in FIG. 17.

Reference numeral 233 designates an insulating mounting block which can be split into two pieces, i.e. a main body 234 and a fragment 239, and which is cylindrical in shape in the assembled state. The inside of the main body 234 of the mounting block is formed with two axially extending surfaces perpendicular to each other and one ends of said surfaces are recesses as at 235, 236. Slightly inwardly of the other end of the main body 234 is formed a cavity 237 and a through-hole 238 is bored axially centrally from one end face of the main body 234 to open in said cavity 237.

On the other hand, the fragment 239 is so shaped that when it is fitted on the main body 234, the recessed portions 235, 236 of the main body open only in one end face of the mounting block.

Reference numeral 240 designates terminal rods embedded in the fragment 239 of the mounting block 233, with one ends thereof projecting from one end face of said fragment and the other ends projecting inwardly at locations slightly inwardly of the other end face of the same. Reference numeral 241 designates terminal rods extending through the end wall of the main body 234 for connection with an external element.

The pickup cartridge of the construction described above is assembled in the following manner. First of all, the holder 218 is fitted on the inner end of the cantilever 214 and then the semiconductor-deposited film element 219 is mounted on the cantilever 214, with the latter extending through the through-hole 223 formed in the insulating film substrate 224 of the former. Thereafter, the damping support material 220 is mounted in such a manner as to bridge the inner end of the cantilever 214 and the supporting member 217, whereby the semiconductor-deposited film element 219 is clamped between the holder 218 and the damping support 220.

Upon completion of this, the supporting member 217 is inserted into the hole 238 of the main body 234 of the mounting block 233, while simultaneously inserting

the arms 221, 222 of the semiconductor-deposited film element 219 into the cavities 235, 236 respectively while keeping them out of contact with the inner walls of said cavities. The supporting member 214 thus inserted is secured in the hole 238 of the main body 234 as by means of a screw 242. In this case, the electrodes 227, 228, 229 and 230 of the semiconductor-deposited film element 219 are connected with the terminal rods 240 and said terminal rods 240 are in turn connected with the terminal rods 241 respectively.

After insertion of the arms 221, 222 of the semiconductor-deposited film element 219, the cavities 235, 236 are filled with a flowable viscous material 243 and said arms 221, 222 are supported by the mounting block 233 through said flowable viscous material 243.

The operation of the pickup cartridge thus assembled will be briefly explained hereunder. Since the semiconductor-deposited film element 219 is fixed at substantially the terminal end of the cantilever 214, a vibration transmitted from the needle point 213 is propagated in the directions of a V-shape. When a vibration is given to the needle point 213 as indicated by the arrow 244 in FIG. 17, said needle point 213 and the cantilever 214 vibrate in the same direction as that of the arrow 244 with respect to the center of vibration constituted by the ultrafine wire 215. Therefore, the arm 222 of the insulating film base plate 224 of the semiconductor-deposited film element 219, which lies in a plane crossing the arrow 244, is caused to vibrate and the semiconductor piezo-resistance elements 226, 226' on said arm 222 undergo a bending stress by being braked by the flowable viscous material 243. As a result, the internal resistances of the semiconductor piezo-resistance elements 226, 226' are varied according to the vibration of the needle point 213 and the variations in the internal resistances are detected through the terminal rods 241.

In this case, the other semiconductor piezo-resistance elements 225, 225' undergo the stress of vibration in the direction of the plane in which they lie and, therefore, no change occurs in the internal resistances thereof.

On the other hand, when the needle point 213 is vibrated in the direction of the arrow 246 which is perpendicular to the direction of the arrow 244, the semiconductor piezo-resistance elements 225, 225' undergo a bending stress and the semiconductor piezo-resistance element 226, 226' do not undergo a bending stress at all. Therefore, the internal resistance changes of the semiconductor piezo-resistance element 225, 225' are detected.

Although in the embodiment described above, the two sets of the mechano-electrical transducing means provided on the semiconductor-deposited film element are each composed of two semiconductor piezo-resistance elements, the same may be composed of only one semiconductor piezo-resistance element or may be of any other construction.

Now, a description will be given on a microphone to which the present invention is applied.

FIGS. 19 and 20 exemplify microphones incorporating the semiconductor stress converting apparatus

based upon the principle described hereinabove. Referring first to FIG. 19, the microphone shown is of the same construction as that of FIG. 2 wherein the holder 4 is to be displaced. Reference numeral 314 designates a diaphragm which is vibrated by a sound. The diaphragm 314 is connected to a semiconductor-deposited film element 315. The opposite edges of the semiconductor-deposited film element 315 are respectively supported in recesses 318, 318' through a flowable viscous material 319, 319', which recesses are formed opposite to each other in the inner peripheral wall of a central hole 317 formed in a mounting block 316. Reference numeral 320 designates a casing in which a protecting perforated plate 321 and the respective elements described above are mounted.

The microphone shown in FIG. 20 is of the same type as that of FIG. 2 wherein the holder 5 is to be displaced. In FIG. 20, similar parts are indicated by same numerals. A diaphragm 314 has fixed thereto a movable member 323 which defines recesses 322, 322' on both sides thereof, while a fixed member 324 has two semiconductor deposited film elements 315, 315' fixed thereto at one ends thereof, and the other ends of said semiconductor-deposited film elements are supported in said recesses 322, 322' respectively through a flowable viscous material 319, 319'.

What is claimed is:

1. A pick-up cartridge, comprising, in combination: a frame member having a cavity formed therein; a flowable viscous material contained in said cavity; a cantilever having a needle point at one end thereof; an insulating film substrate fixed at the other end of said cantilever and having a plurality of arms extending from the portion of said substrate fixed to said cantilever; band-shaped semiconductor elements formed on said plurality of arms by vacuum evaporation; and electrodes formed at opposite ends of said semiconductor elements; wherein said plurality of arms are disposed in said cavity and supported by said flowable viscous material, such that a vibrational stress transmitted from said needle point is imparted through said cantilever to said semiconductor elements as a bending stress to correspondingly change the resistance properties of said semiconductor elements.
2. The pick-up cartridge defined in claim 1, wherein said plurality of arms comprises two arms extending radially of the longitudinal axis of said cantilever and substantially perpendicular to each other in a common plane which is substantially perpendicular to said longitudinal axis.
3. The pick-up cartridge defined in claim 1, wherein said plurality of arms comprises four arms extending substantially perpendicular to each other in a cross shape in a common plane perpendicular to the longitudinal axis of said cantilever.
4. The pick-up cartridge defined in claim 1, wherein said plurality of arms extend from said portion fixed to said cantilever parallel to the longitudinal axis of said cantilever.

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