

May 31, 1949.

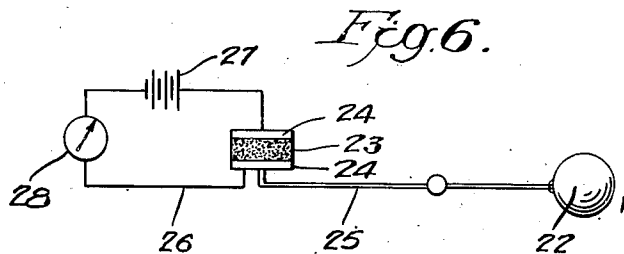
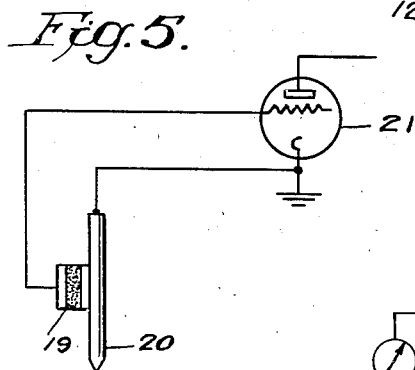
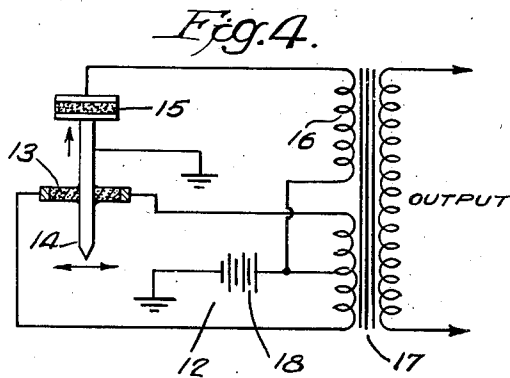
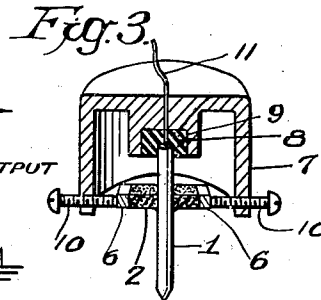
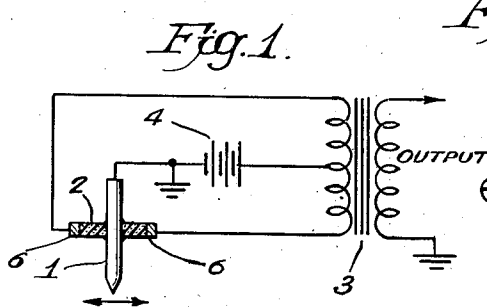
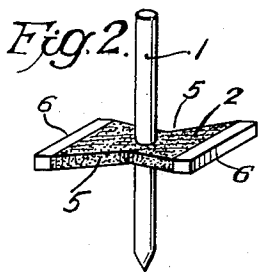
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2,471,601

VARIABLE RESISTANCE PHONOGRAPH PICKUP

Filed April 28, 1944

2 Sheets-Sheet 1



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Fig. 7.

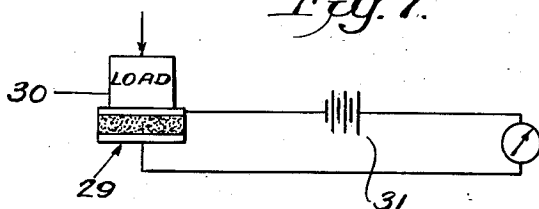


Fig. 8.

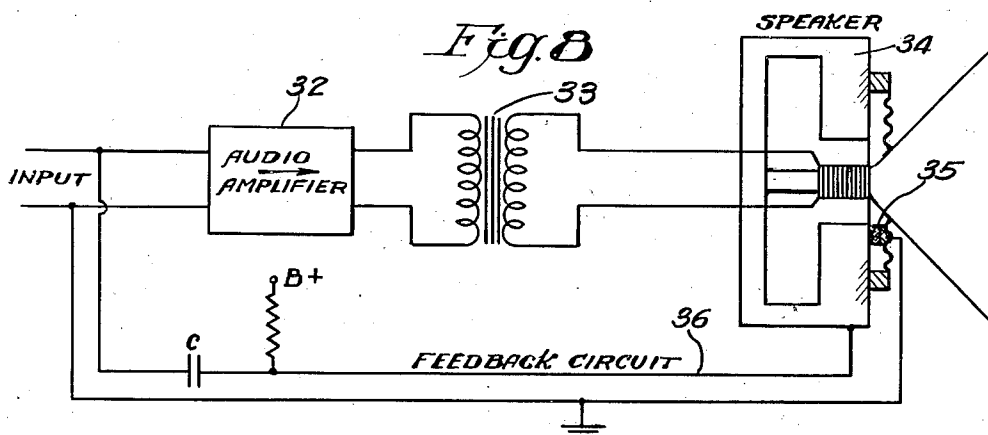
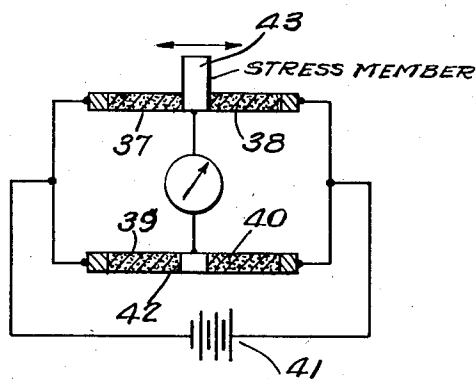


Fig. 9.



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UNITED STATES PATENT OFFICE

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VARIABLE RESISTANCE PHONOGRAPH PICKUP

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8 Claims. (Cl. 179—100.41)

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This invention relates to electrical resistance devices, and more particularly to a variable resistance device of novel character.

The principal object of the invention is to provide a low cost, highly efficient, variable resistance device which is capable of a wide variety of applications or uses.

In its broadest aspect, my invention contemplates the provision of a variable resistance device comprising a deformable body composed of a resilient non-conductive material and a conductive material, and means for deforming the said body to vary its electrical resistance. While any suitable materials may be employed in accordance with the broad concept of the invention, I prefer to use a composition of rubber and a conducting material such as graphite. One such available composition, which is preferred, comprises a layer of conducting material vulcanized or otherwise secured to the rubber. Alternatively, a homogeneous mixture of the materials could be used.

The invention may be more fully understood by reference to the accompanying drawings, which show certain preferred forms and applications of the novel variable resistance device.

In the drawings:

Fig. 1 is a diagrammatic illustration of a phonograph pick-up device employing the novel resistance device of the invention;

Fig. 2 is a perspective view showing the arrangement of the pick-up stylus in association with the variable resistance element;

Fig. 3 is a cross-sectional view of a specific mounting for the combined stylus and variable resistance element;

Fig. 4 is a schematic illustration of another phonograph pick-up arrangement embodying the invention;

Fig. 5 is a schematic illustration of still another pick-up arrangement;

Fig. 6 is a schematic illustration of the invention applied to a gauge or indicator;

Fig. 7 is a similar illustration of the invention as applied to a weight or load indicator;

Fig. 8 is a schematic illustration of the invention applied to a feed-back circuit in an audio amplifier and loud speaker system; and

Fig. 9 is a schematic illustration of the invention as applied to a bridge circuit.

Referring first to Fig. 1, there is illustrated a phonograph pick-up arrangement in which a stylus 1 is associated with a resistance element 2 of the character contemplated by the present invention, and in which the vibratory movement of the stylus caused by the undulations of a record

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groove deforms the resistance element and thereby varies its resistance. The electrical output circuit of the device as shown comprises an output transformer 3, the primary winding of which has its extremities connected to electrodes associated with the resistance device 2. The midpoint of the primary winding is connected through a source of unidirectional voltage 4 to the stylus 1. The secondary winding of the transformer 3 may be connected to the grid of an amplifier tube, as well known.

Fig. 2 shows the resistance element 2 in association with the stylus 1. As shown in this figure, the resistance element 2 may take the form of a block of material of the type above mentioned. For example, this element may comprise a block of such material which is available in blocks $\frac{1}{16}$ " thick and $\frac{3}{16}$ " square, such block having a resistance of approximately 377 ohms. A single block of this character is suitable for use in the pick-up device illustrated. The block 2, however, is preferably recessed or cut away at its sides 5 to diminish the width of the central area where the stylus 1 is located. The stylus extends through the central part of the resistance block which may be molded thereto. The reason for diminishing the width at the central part of the block 2, as shown, is to subject the entire resistance element to distortion by the stylus 1 when the latter vibrates laterally in response to lateral cut undulations of a record groove. If the block 2 were not cut away, and if it were of simple rectangular form, the side portions thereof would present resistance paths which would be substantially unaffected by vibrations of the stylus. A pair of metallic electrodes 6 are arranged to engage opposite edges of the block 2, which preferably is molded directly to the electrodes.

In Fig. 3 there is shown a form of support for the stylus and the associated resistance element, which may comprise an inverted cup-shaped insulating support 7, shaped in cross section, as shown. The upper end of the stylus 1 may be embedded in a resilient anchorage member 8 within a recess 9 of the support member. A pair of screws 10 extend through the lower part of the wall of the support 7 at diametrically opposite points, and the inner ends of these screws engage the electrodes 6 associated with the resistance element 2. The screws 10, in addition to serving as supports for the resistance element, also serve as electrical terminals by means of which connection is made to the electrodes. Connection to the stylus, as indicated in Fig. 1, may be ef-

fectured by means of a conductor 11 extending upward through the support member 7. It will be understood, of course, that the assembled unit shown in Fig. 3 may be mounted on a tone arm in any suitable manner.

In operation of the above described phonograph pick-up, the lateral movement of the stylus 1 causes a distortion or deformation of the electrically conductive element 2, which effects substantial variations in the resistance of this element, thereby producing electrical current undulations of substantial magnitude. While it is not desired that the invention shall be limited to any particular theory of operation of the variable resistance device, it is believed that the substantial resistance variations are due to changes in volume of the element. The operation, according to this theory, may be best explained by supposing a simple rectangular block (which in practice might be exceedingly small in cross-section) of the material of which the resistance element is composed, and by supposing that electrodes are engaged with the end portions of the block and that a force is applied lengthwise of the block or in the direction of current flow between the electrodes. Now, in the absence of the force, the block will have a certain volume, and it will have a certain resistance which is proportional to the length of the block and inversely proportional to its cross-sectional area. Now, when a force is applied as mentioned above, the length of the resistance block is decreased and its cross-sectional area is increased. The effect of this is to produce a relatively large decrease of the resistance of the block. Conversely, a force in the opposite direction, tending to elongate the resistance block, will produce a large increase of its resistance. Thus, a relatively small deformation of the resistance element will produce a relatively large variation of its resistance.

In the device of Figs. 1 to 3, the stylus effects differential deformation of different parts of the resistance element. That is, when moving in one direction, the stylus effects compression of one portion and elongation of the other portion. The resultant voltage variation produced by this differential action is derived through the electrical circuit arrangement of Fig. 1, as will be well understood.

In Fig. 4, there is illustrated a phonograph pick-up arrangement which is adapted for use with both lateral and vertical cut records. The lower portion of the circuit, designated generally by reference character 12, is similar to the arrangement of Fig. 1 and includes a resistance element 13 associated with a stylus 14 in the manner above described. This portion of the device operates in conjunction with a lateral cut record in the manner of the above described device. Additionally, however, there is provided a second resistance element 15 of the character above described associated with the stylus 14 so as to be affected by vertical vibrations of the stylus when a vertical cut record is employed. An additional primary winding 16 is provided on the output transformer 17 and is connected to the resistance element 15 and to the voltage source 18 as illustrated. It will be apparent from inspection that vertical vibrations of the stylus will produce an undulatory electrical output. Of course it will be understood that only one portion of this circuit arrangement operates at a time, depending upon the type of record being employed.

In Fig. 5 there is shown schematically the use of a variable resistance element 19 and an associated stylus 20 in direct association with a vacuum tube 21. In this instance the stylus vibrates laterally, as described in connection with Fig. 1, and distorts the associated resistance element 19. This pick-up unit is connected directly to the grid and cathode of the vacuum tube and employs no polarizing voltage source. This arrangement may be used where the resistance of the element 19 is very large, e. g. 4-15 megohms.

In Fig. 6 there is illustrated the application of the invention to a gauge or indicator arrangement responding to some mechanical movement such as that of a float 22. Thus, the arrangement shown may be utilized to indicate the level of a body of liquid. The resistance element in the form of a block is shown at 23 and has associated electrodes 24. Through the action of a lever 25 carrying the float member 22, a force is applied to the lower side of the resistance element, which deforms the said element to a degree depending upon the position of the float. A circuit 26 is connected to the electrodes and includes a source of unidirectional voltage 27 and a suitable indicator 28 adapted to be actuated by direct current. The operation of the device will be obvious from the foregoing description.

In Fig. 7, the invention is applied to a simple mechanical load or weight indicating apparatus. In this instance the resistance element 29 is distorted or deformed by the pressure of a weight or load 30, and a simple indicator circuit 31 is connected to the resistance element, as in the device of Fig. 6.

In Fig. 8, the invention is shown applied to an audio amplifier and loudspeaker system to remove distortion due to harmonics produced by the loudspeaker cone and driving system. The audio amplifier 32, the output transformer 33, and the electro-dynamic loudspeaker 34 are of conventional form. A resistance element 35, of the type herein contemplated, is associated with the loudspeaker in a manner to respond to the objectionable harmonic vibrations of the loudspeaker. As shown, the resistance element may be interposed between the field magnet of the speaker and the cone support, although any other suitable arrangement may be employed. The resistance element is connected in a feed-back circuit 36 which extends to the input of the audio amplifier 32. One side of the feed-back circuit may be connected to B+ through a suitable resistance while the other side of the feed-back circuit may be grounded. A blocking condenser C may be connected as shown, so that the audio component only is fed back to the input of the amplifier.

In Fig. 9, the invention is shown applied to a Wheatstone bridge in which the resistance arms are constituted by resistance elements of the type here contemplated. Thus, there are four resistance arms of this character designated by the numerals 37 to 40. Across one pair of diagonals of the bridge there is provided a unidirectional voltage source 41, while across the other pair of diagonals there is connected a D. C. meter or indicator 42. This device may be employed to indicate the amplitude of a mechanical stress or movement, and to this end there may be provided a member 43 which is actuated to vary the relative values of the resistance elements and thereby unbalance the bridge.

From the foregoing it will be seen that the variable resistance device provided by the pres-

ent invention is capable of wide application. It will also be seen that the invention provides a device of very simple form which, however, is highly efficient in effecting a substantial resistance variation in response to a relatively small movement or force.

I claim:

1. A phonograph pick-up device, comprising a deformable body composed of rubber and graphite, a stylus arranged to differentially deform different parts of said body when actuated by lateral cut undulations of a record groove, an output transformer including a primary winding, means connecting the extremities of said winding to the said parts of said body respectively, means connecting the midpoint of said winding to said stylus, a source of unidirectional voltage included in said last-mentioned connecting means, a second body similar to said first body and arranged to be deformed by said stylus when the latter is actuated by vertical cut undulations of a record groove, a second primary winding on said transformer, and means connecting said second body and said second winding in circuit with said voltage source.

2. A phonograph pick-up device, comprising a deformable resilient electrically-conductive body, the electrical resistance of said body being varied by deformation thereof, a stylus extending through the central part of said body intermediate outer parts thereof so as to effect differential deformation of the outer parts of said body when the stylus is actuated by undulations of a record groove, an output transformer including a primary winding, means connecting the extremities of said winding to the outer parts of said body respectively, means connecting an intermediate point of said winding to said stylus, and a source of unidirectional voltage included in said last-mentioned connecting means.

3. A phonograph pick-up device, comprising a deformable resilient electrically-conductive body, the electrical resistance of said body being varied by deformation thereof, a stylus extending through the central part of said body so as to effect differential deformation of the outer parts of said body when the stylus is actuated by undulations of a record groove, the central part of said body being of diminished dimension laterally of the direction of deformation of the body, an output transformer including a primary winding, means connecting the extremities of said winding to the outer parts of said body respectively, means connecting an intermediate point of said winding to said stylus, and a source of unidirectional voltage included in said last-mentioned connecting means.

4. A phonograph pick-up device, comprising an insulating support, a pair of opposed terminal members carried by said support, a deformable resilient electrically-conductive body supported by said terminal members, the electrical resistance of said body being varied by deformation thereof, a stylus extending through the central part of said body so as to effect differential deformation of the outer parts of said body laterally of the stylus axis when the stylus is actuated by lateral cut undulations of a record groove, means

for securing the upper end of said stylus to said support while permitting lateral movement of the stylus, and means for effecting electrical connection to said stylus.

5. A device for translating mechanical vibrations into an undulatory electrical current, comprising a deformable resilient electrically-conductive body, the electrical resistance of said body being varied by deformation thereof, said body being of relatively small lateral dimension at its central part and increasing in lateral dimension on opposite sides of said part, vibratile means engaging the central part of said body and adapted to effect differential deformation of the outer parts of said body, and circuit means including connections to said body for producing a resultant undulatory electrical current in response to the differential deformation of said body.

6. A phonograph pick-up device, comprising a deformable resilient electrically-conductive body, the electrical resistance of said body being varied by deformation thereof, said body being of relatively small lateral dimension at its central part and increasing in lateral dimension on opposite sides of said part, a stylus operatively connected to the central part of said body and adapted to effect differential deformation of the outer parts of said body, and circuit means including connections to said body for producing an undulatory electrical current in response to the differential deformation of said body.

7. A phonograph pick-up device for use with records having lateral undulations, comprising an elastic electrically-conductive element arranged to be generally parallel to a record during use therewith, the electrical resistance of said element being variable by compressive or tensional deformation of the element generally parallel to the record, a stylus operatively connected to an intermediate part of said element and adapted when actuated by the lateral undulations of the record to effect differential deformation of the outer parts of said element, and circuit means including connections to said element for producing undulatory electrical current in response to the deformation of said element by said stylus.

8. A phonograph pick-up device according to claim 7, wherein said element is composed of an elastic non-conductive material and a conductive material which renders the element conductive.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,577,981	Otto -----	Mar. 23, 1926
1,689,844	Slepian -----	Oct. 30, 1928
1,819,083	Edwards -----	Aug. 18, 1931
2,042,606	Kotowski -----	June 2, 1936
2,194,175	Wilhelm -----	Mar. 19, 1940
2,305,717	La Bell -----	Dec. 22, 1942
2,373,676	Germeshausen -----	Apr. 17, 1945
2,380,514	Germeshausen -----	July 31, 1945
2,429,137	Root -----	Oct. 14, 1947