Dec. 20, 1949 W. S. BACHMAN 2,491,794

VARIABLE RESISTANCE PHONOGRAPH PICKUP

Filed Nov. 28, 1944 3 Sheets-Sheet 1

Fig. 1.

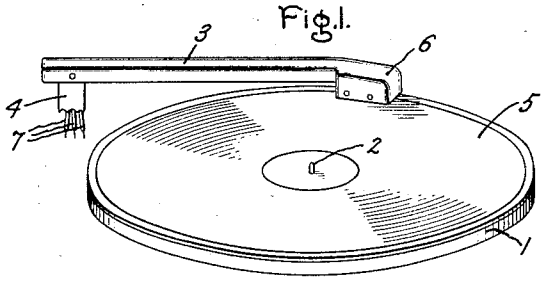


Fig. 2.

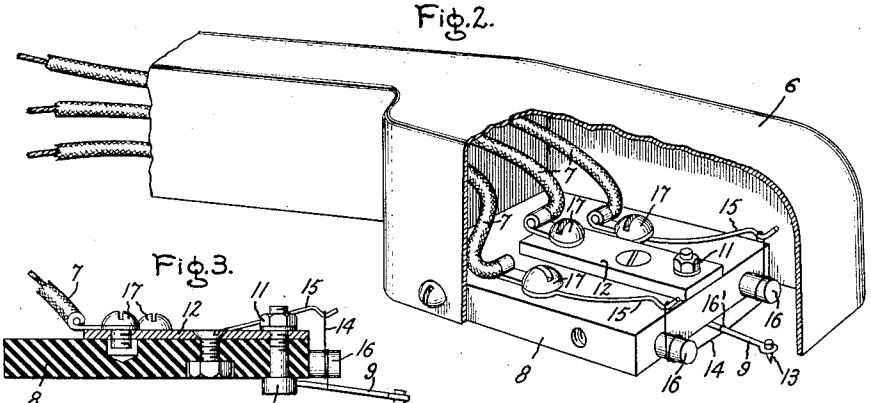


Fig. 3.




Fig. 4.

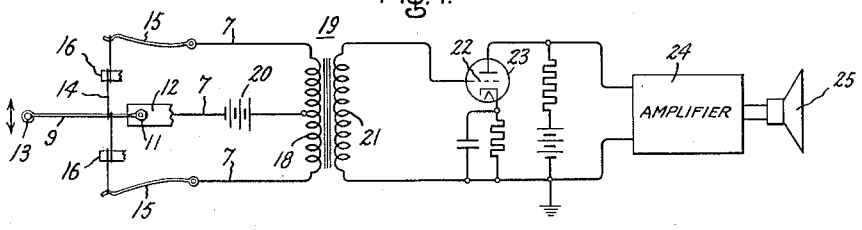


Fig. 5.

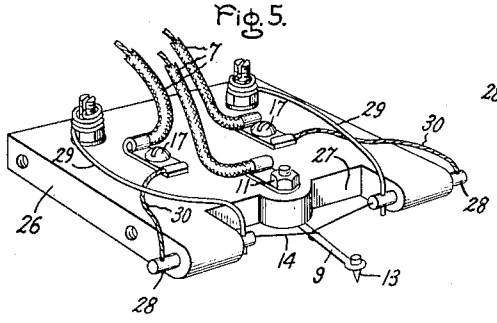


Fig. 6.

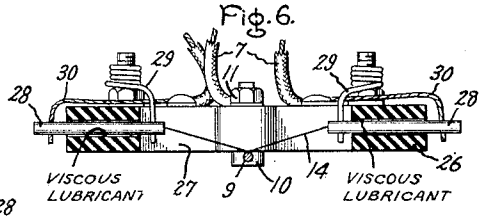


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Fig. 7.

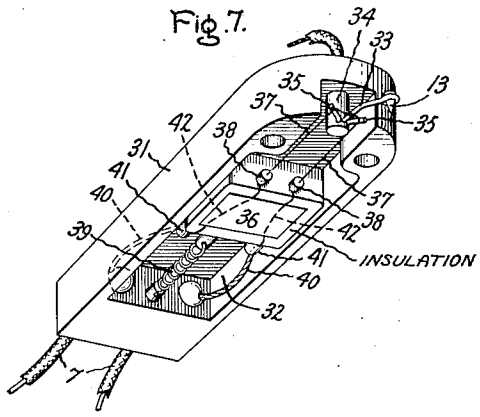


Fig. 8.

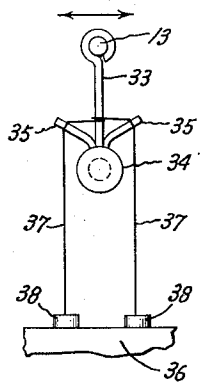


Fig. 9.

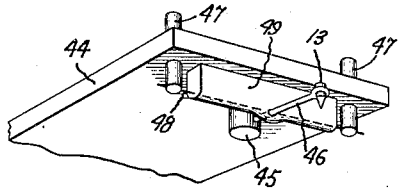


Fig. 10.

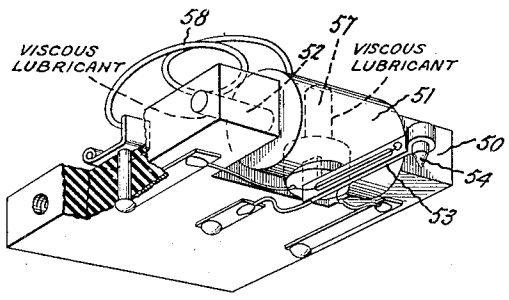


Fig. 11.

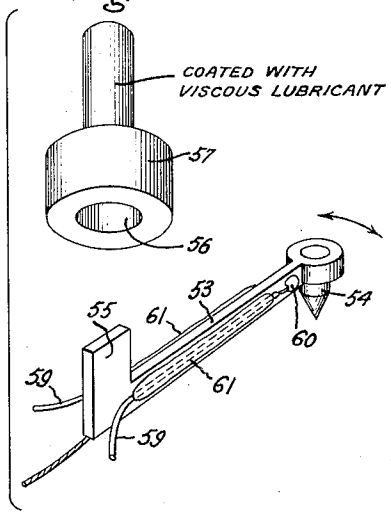


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Fig. 12.

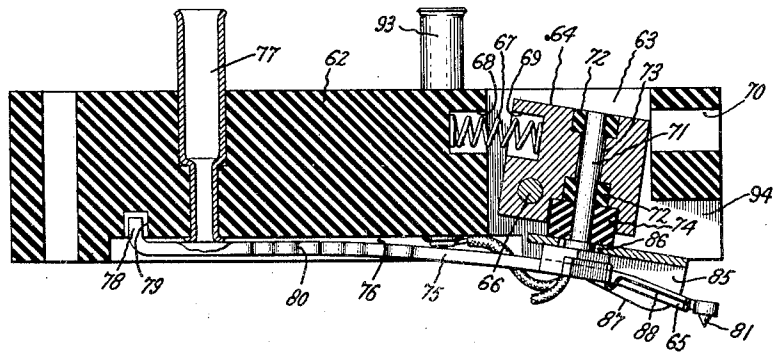



Fig. 14.

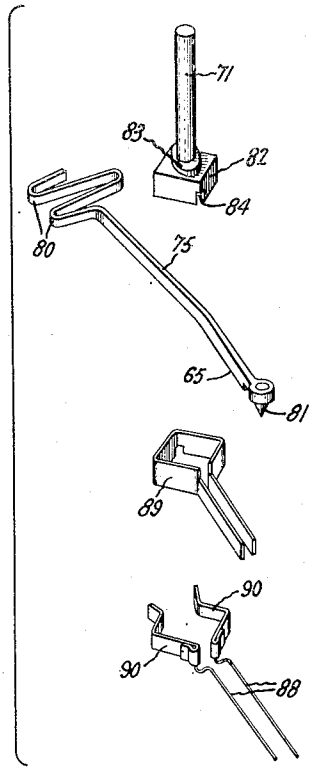
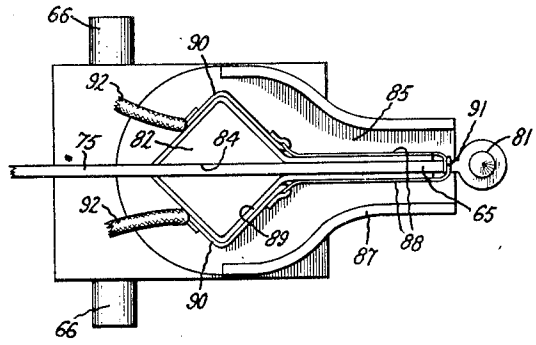



Fig. 13.

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Patented Dec. 20, 1949 2,491,794

# UNITED STATES PATENT OFFICE

2,491,794

## VARIABLE RESISTANCE PHONOGRAPH PICKUP

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Application November 28, 1944, Serial No. 565,537

15 Claims. (Cl. 179—100.41)

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My invention relates to vibration translating devices such as phonograph pickups and more particularly to such devices for translating mechanical vibrations into electrical variations.

In the construction of phonograph pickups it is desirable that the moving parts be made as light and as free moving as practicable to minimize damage to the record grooves and to enable the stylus to follow the grooves accurately over the desired range of frequencies of the recorded sounds. It is desirable also to minimize all extraneous sounds or noises and for this purpose the pickup should be designed to have minimum response to mechanical resonance effects. Furthermore, if true reproduction of the sound record is to be accomplished, the pickup response curve should be as nearly linear as possible within the desired range of frequencies.

It is an object of my invention to provide a vibration translating device including an improved arrangement for minimizing the vibrating mass of the device.

It is another object of my invention to provide a phonograph pickup including an improved arrangement for insuring linear response within a desired range of frequencies.

It is another object of my invention to provide a phonograph pickup including an improved vibration translating element of light and simple construction.

It is a further object of my invention to provide a phonograph pickup including an improved arrangement for damping low frequency vibrations to prevent excessive vibration of the stylus at the resonant frequency of the mechanical parts of the pickup.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view of a portion of a sound reproducer including a turntable and tone arm provided with a pickup embodying my invention;

Fig. 2 is an enlarged view of the pickup shown in Fig. 1, with a portion of the casing broken away to show the details of construction of the head;

Fig. 3 is a sectional side elevation of the head shown in Fig. 2;

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Fig. 4 is a diagram of the electric circuit connections employed with the pickup;

Fig. 5 is a perspective view of a pickup head embodying a modification of my invention;

Fig. 6 is a sectional front elevation view of the head shown in Fig. 5;

Fig. 7 is a perspective view of a pickup head embodying a further modification of my invention;

Fig. 8 is an enlarged detail view of a portion of Fig. 7;

Fig. 9 is a perspective view of a pickup head embodying another modification of my invention;

Fig. 10 is a perspective view, partly in section, of a further embodiment of my invention;

Fig. 11 is an enlarged exploded view of the stylus and support shown in Fig. 10;

Fig. 12 is a sectional side elevation of a pickup head illustrating a still further modification of my invention;

Fig. 13 is an enlarged bottom plan view of the stylus support of the head in Fig. 12; and

Fig. 14 is an exploded perspective view of the stylus arm and associated parts shown in Fig. 13.

Briefly, each of the pickups illustrated in the drawings is provided with a fine electrical resistance wire and an arrangement for straining the wire in proportion to the vibrations of the stylus as it moves over a record sound track. The resistance wires are arranged so that they are never strained to their elastic limits and the variation in electrical resistance is directly proportional to the vibrations of the stylus. The stylus arm is a small lightweight resilient cantilever beam and the resistance wire in some of the pickups is secured transversely of the beam and in others it is secured directly to the beam longitudinally thereof. Distortion of the reproduced sounds because of tone arm resonance and other disturbances is minimized by damping arrangements particularly suited to the lightweight cantilever beam construction of the stylus arm.

Referring now to the drawings, the sound reproducer illustrated in Fig. 1 comprises a turntable 1 mounted on a drive shaft 2 which is supported and driven by a mechanism mounted in a suitable cabinet or other structure (not illustrated). A tone arm 3 is pivotally mounted on a post 4 only a portion of which is shown, the base of the post being mounted on the supporting cabinet. A pickup for translating into electrical vibrations the sound vibrations re-

corded on a disk record 5 is provided within a casing 6 at the end of the tone arm 3 and electrical connections are made to the amplifying apparatus (not shown) through wires 7. The pickup arranged in the casing 6, which is shown in detail in Figs. 2 and 3, comprises a supporting head 8 which is a block of suitable insulating material. A stylus arm 9 is rigidly secured to the head of a bolt 10 which in turn is securely clamped to the block 8 by a nut 11 tightened against a conducting plate 12. A suitable stylus or stylus point 13, which may be a sapphire or other jewel, is mounted or otherwise provided at the outer end of the arm 9 so that when the stylus moves over the sound track of a record it is displaced laterally and bends the arm 9 as a cantilever beam. In order to translate the vibrations of the arm 9 into electrical vibrations, a fine resistance wire 14 is secured to the arm 9 and is held under tension by a pair of conducting springs 15. The arrangement is such that the wire is strained by the vibrations of the arm 9 and its resistance varies in proportion to the strain. The wire is wound one and one-quarter times about two insulating posts 16 which act as snubbers. The wire is secured at its midpoint to the arm 9, as indicated at 16', and the two straight portions on either side between the posts 16 and the arm are the portions of the wire which are strained by the vibration of the arm, the snubbers 16 preventing straining of the upright portions of the wire by the high velocity vibrations of the stylus produced by the record sound track.

The tension maintained by the springs 15 is such that the wire 14 is strained to about one-half its elastic limit so that variations in strain both above and below the initial strain take place, it being obvious that when the arm 9 moves to one side the tension on one portion of the wire increases while that on the other portion decreases. In order to utilize the opposite changes in electrical resistance of the wire 14 on the two sides of the arm 9, the conducting springs 15 are connected to two of the wires 7 through suitable clips secured to the head 8 by screws 17 which also hold the springs 15 in position, and the third conductor 7 is connected to the conducting strip 12 by a third screw 17 and is thereby electrically connected directly to the arm 9 through the bolt 10. The wire 14 is connected in a balanced electrical circuit as shown in Fig. 4, the outer two conductors 7 connecting the springs 15 to the terminals of the primary winding 18 of a transformer 19. The midpoint of the wire 14 is connected through the arm 9 and the middle conductor 7 to one terminal of a battery 20 the other terminal of which is connected to a midpoint tap on the primary winding 18. When the arm 9 is in repose, the tension on the two sides of the wire 14 is equal and the electrical circuit is balanced so that the same amount of current flows in the two halves of the primary winding 18. However, as soon as the arm 9 is displaced by vibrations of the stylus 13, the resistances of the two sides of the wire 14 vary oppositely and the current flow through the winding 18 increases in one direction or the other depending upon the direction of unbalance of the resistances of the two portions of the wire 14. Any variations in current in the primary winding 18 produce corresponding voltage changes in a secondary winding 21 of the transformer. The voltage changes in the secondary 21 are impressed on a control electrode 22 of an electron discharge device 23 which supplies the amplified voltages to a power amplifier 24 to drive a loudspeaker 25. The circuit arrangement of Fig. 4 is conventional and has been employed heretofore to amplify oppositely varying electrical quantities.



The wire 14 may be made of Nichrome or other suitable material and should be selected to have uniform elasticity and electrical resistance throughout its length. The diameter of the wire may be of the order of one one-thousandth of an inch. The dynamic mass of the cantilever beam or arm 9 may be made very small. The small dynamic mass enables the stylus 13 to follow the sound track readily with minimum possibility of damage and the tone arm may be counterbalanced so that a very small unbalanced weight, say one-half ounce or less, may be provided to hold the stylus in the record groove.

The construction of the pickup head illustrated in Figs. 5 and 6 is similar to that of Figs. 2 and 3 and corresponding parts have been designated by the same numerals. The construction differs from that of the first modification in that the insulating head indicated at 26 is provided with a recess 27 at its forward end and horizontally mounted damping rods 28 are employed instead of the snubbers 16. The rods 28 are slidably mounted in openings in the head 26 on either side of the recess 27 and the resistance wire 14 is secured directly to the inner ends of the rods. The rods are maintained under tension by springs 29 which urge them outwardly away from the arm 9, and the electrical connections to the ends of the wire 14 are made through flexible wires 30 connected between the outer ends of the rods 28 and the outer two leads 7. The tension of the springs 29 is adjusted to maintain the wire 14 under tension with a strain about half way to the elastic limit in the same manner as the wire 14 in Fig. 2. In order to provide a damping action and prevent distortion due to low velocity displacements of the arm 9, a viscous liquid is provided to lubricate the engaging surfaces of the rods 28 and the walls of the openings in the head 26. The fluid is selected so that at the velocities of the displacements produced by the vibration of the stylus 13 in a sound track the rods 28 will remain substantially stationary. However, when displacements at lower velocities occur, the rods will move and minimize strain in the wire 14. One suitable liquid for lubricating these bearings is a solution of polymerized isobutylene in mineral oil.

The precise values of friction and damping effect necessary to provide the required frequency characteristics may be determined in accordance with the well-known principles of mechanics applicable to vibrating systems including elastic elements.

In the pickup of Figs. 7 and 8 an arrangement is provided for locating the portions of the resistance wire which are to be strained in positions longitudinally of the pickup head. As shown in Fig. 7, an insulating head 31 is provided with a downwardly opening recess 32. A stylus arm 33 similar to the arm 9 of Figs. 2 and 5 is mounted in the forward end of the head 31 on an upright conducting member or post 34. Rigidly secured to the base of the arm 33 are two small rods 35 which constitute bell cranks moving with the vibrations of the arm 33. The details of construction of the arm 33 and the bell cranks 35 are clearly shown in Fig. 8. The bell cranks are tied to the arm by a resistance wire 37 and flex with the arm in accordance with its vibrations.

A block 36 of insulating material is mounted in the recess 32 so that it may slide longitudinally of the head, and the two ends of resistance wire 37 are connected to posts 38 on the block 36, the wire being looped around the ends of the bell cranks 35 and around the arm 33. A spring 39 is secured between the back end wall of recess 32 and the block 36 to maintain the desired tension on the resistance wire 37. Electrical connections to the resistance wire are made through flexible wires 40 connected to posts 41 at the rear of the block 36 and connected to the posts 38 by suitable wires 42; the wires 42 preferably pass under a protective sheet 43 of insulating material cemented to the block 36. The wires 40 and the post 34 constitute the three terminals of the pickup and are connected to the three conductors 7. The two portions of the wire 37 between the stylus arm and the posts 38, therefore, may be connected in the electrical circuit of Fig. 4 in the same manner as the two portions of the wire 14 in the embodiments of Figs. 1 to 6. The head 31 may be made small and compact and may be adapted readily to accommodation in a slender tone arm and cover such as illustrated in Fig. 1.

In Fig. 9 there is illustrated a pickup which makes it possible to employ a normally unstressed resistance wire which, when stressed by vibration of the stylus, is strained alternately in tension and in compression. A pickup head 44 of suitable insulating material is provided with a central conducting post 45 on which is mounted a stylus arm 46 of the cantilever beam type employed in the pickups described above. Two conducting posts 47 are provided, one on either side of the arm 46, and a resistance wire 48 is secured at its ends in good electrical contact with the posts. The wire 48 is also secured to the arm 46 in the same manner as the wire 14 is secured to the arm 9 in Fig. 2. The wire 48 and the portion of the arm 46 to which it is secured are embedded in a body of resilient insulating material 49 which has been illustrated as cemented or otherwise secured to the underside of the head 44. Any suitable flexible insulating material which may be made to closely embed the wire 48 and restrict its lateral movement may be employed. One material suitable for this purpose is that sold under the trade name of "Pyralin." When the stylus arm 46 is vibrated by displacement of the stylus 13 as it moves along the sound track of a record, the resistances of the portions of the wire 48 embedded in the material 49 on either side of the arm 46 are varied in proportion to the intensity of the vibrations. The material 49 restricts lateral movement of the embedded wire and although the wire constitutes a long slender column which would readily bend upon application of a compressive force, the insulating material restricts this bending under high velocity stresses, and, as a result, the wire is strained both in compression and in tension. Thus, for any one displacement of the stylus arm, the portion of wire on one side of the arm 46 is strained in compression while that on the other side is strained in tension, and as the arm 46 vibrates, this alternate and opposite straining of the portions of the wire produces proportional alternate and opposite variations of the electrical resistance of the wire. The pickup of Fig. 9 may be connected in the electrical circuit of Fig. 4 in the manner already described in order to reproduce the recorded sound. Strain of the resistance wire is produced only at the high velocities produced as the stylus follows a sound track. It is only at relatively high velocities that sufficient force can be developed to produce the required strain of the fine resistance wire 48, and low velocity disturbances do not produce corresponding resistance changes. The resistance wire employed in the pickup of Fig. 9 may be of the same material and diameter as that employed with the pickups of Figs. 2 to 8 inclusive, a resistance wire having a diameter of one one-thousandth of an inch and having uniform elasticity throughout its length being suitable for this purpose.

Because the resistance wire 48 in the pickup of Fig. 9 is strained only when the pickup arm is vibrated at a sufficiently high frequency, it is possible to mount the wire 48 so that it is normally in repose without any initial tension. This makes it unnecessary to provide the somewhat complicated arrangements for maintaining the tension on the wire at a sufficiently high point in the elasticity curve. Furthermore, this construction makes it possible to employ the entire elasticity curve of the wire instead of merely the tension portion of that curve. The resistance characteristic of the wire is linear over a wide range of sound frequencies.

In Figs. 10 and 11 I have illustrated a pickup construction employing a variable resistance, vibration sensitive wire and which makes it possible to provide very effective damping to prevent distortions due to vibrations other than those produced by the sound track. This pickup, as illustrated in Fig. 10, comprises a head 50 of insulating material provided with a recess at its forward end in which a supporting block 51 is mounted on trunnions 52, only one of which is illustrated. The block 51 supports a resilient cantilever beam type stylus arm 53 having a jewel or other suitable stylus point 54 mounted or otherwise provided at its other end. As shown in Fig. 11, the arm 53 has an upwardly projecting lug 55 formed at its rear end which is fitted into a circular recess 56 in an upright metal pivot member or post 57. The lug 55 fits snugly in the recess 56 and is secured therein by a suitable cement, and the pivot member 57 is pivotally mounted in the block 51 so that the arm 53 is mounted for rotation on either of two axes at right angles to one another. The trunnions 52 of the block 51 and the pivot member 57 are all lubricated with a damping liquid of the same type as that employed in the pickup of Fig. 5. The viscous liquid on the bearing surfaces of the post 57 restrains rotation of the post when the arm 53 is vibrated at the high velocities of the sound vibrations on a record track, and, consequently, the arm 53 bends laterally in proportion to the intensities of the sounds. In order to limit rotation about the trunnions 52 when the stylus 54 is bearing on a record, a spring 58 is provided between the head 50 and the block 51. This spring is selected to have sufficient force to counterbalance the unbalanced weight of the tone arm and maintain the stylus 53 in its desired position.

In order to reproduce electrically the vibrations of the stylus arm, resistance wires 59 are secured to the sides of the stylus arm 53 and the ends of the wires adjacent the stylus 54 are soldered or otherwise suitably secured in good electrical contact with the arm 53 as indicated at 60. Each of the wires 59 has a straight portion extending along the arm 53 and securely bonded to the arm by resilient insulating cement indicated at 61. These straight portions are secured on opposite sides of the stylus arm 53 and, therefore, only one of the straight portions is visible in the drawings. When the stylus 54 is vibrated, the

arm 53 bends and the straight portions of the wires 59, which are bonded to the arm, are strained in proportion to the bending of the arm. One portion of the wire is strained in tension and the other in compression during the bending of the arm and the electrical resistances of the wires are varied accordingly. The resistance portions therefore can be connected in the electrical circuit of Fig. 4 in the same manner as the variable resistance portions of the resistance wires of the other pickups described. The stylus arm 53 has been illustrated as having greater depth than width so that there will be little bending of this arm in the vertical plane. However, should the arm 53 bend in the vertical plane both straight portions of the wire 59 will be strained equally and any variations in resistance will be equal and opposite; therefore, changes in current flowing in the two portions will balance out in the primary of the transformer 18. In some applications, however, it may be desirable to employ only one of the wires 59, the electrical circuit in this case being the same as that in Fig. 4 with one of the outer conductors 7 disconnected or removed. When only one resistance wire is employed in this manner, bending of the arm 53 in the vertical plane tends to produce a strain in the wire and a corresponding change in current through the wire which cannot be balanced out in the electrical circuit. For this reason, when a single straight portion of the wire 59 is employed, it is located as nearly as possible along the neutral axis of the arm 53 when considered as a cantilever beam. The neutral axis is a line along which there is no strain in the material of the beam, the material on one side being strained in compression and on the other side in tension. By locating the resistance wire along the neutral axis, straining of the wire due to bending of the beam in the vertical plane is minimized.

The damping arrangement including the pivotal support of the stylus arm on horizontal and upright axes makes it possible to minimize distortions due to vibrations such as mechanical vibrations of the pickup and associated parts at the resonant frequency of the assembly. Other low frequency vibrations such as those due to unevenness in the surface of the record disk are also damped out. Since the dynamic mass of the stylus is very small, the pickup arm may be mounted with a very small unbalanced weight and the stylus 54 may therefore be made to follow the record groove and trace the record vibrations with accuracy over a wide band of frequencies.

In the pickup illustrated in Figs. 12, 13 and 14, there is provided a compact arrangement for mounting a stylus arm of the type employed in the pickup of Fig. 10 and including a similar damping arrangement of the pivotal supports for the stylus arm. As illustrated in Fig. 12, the pickup comprises a head 62 constructed of rigid insulating material and provided with a rectangular opening 63 extending from the top to the bottom thereof near the forward end of the head. A rocker block 64 for supporting a stylus arm 65 is pivotally mounted within the recess 63 on a shaft 66. The block 64 may be constructed of light metal such as aluminum and the size of the block is such that its pivotal movement within the recess 63 is limited by the walls of the recess. A spring 67 is mounted in recesses 68 and 69 in the head 62 and block 64, respectively, and biases the block 64 forwardly in a clockwise direction, as viewed in Fig. 12, so that the front end of the block 64 rests against the front wall of the recess 63. A drill hole 70 in the forward wall of the recess 63 is present merely because it is formed during the drilling of the recess 68 in the head at the rear wall of the recess. The arm 65 is mounted on an upright post 71 on washers 72 of resilient insulating material such as Pyralin which hold the post in spaced relation to the sides of an upright bore 73 in the rocker block 64. A third washer 74 of Pyralin or other suitable insulating material is provided at the lower end of the post 71 in an enlarged portion of the upright bore 73. The two washers 72 and the washer 74 provide the desired damping action to suppress undesired vibrations of the stylus arm. The stylus arm 65 is a forwardly extending portion of a resilient bar 75 which extends rearwardly from the post 71 in a downwardly opening recess 76 in the head 62 and is soldered to the lower end of a conducting metal sleeve 77. The rear end of the bar 75 is upturned at 78 and fits within a recess 79 in the head which serves to locate the bar during assembly of the pickup. The portion of the bar 75 between the sleeve 77 and the post 71 is bent sinuously in a horizontal plane, as indicated at 80, to provide a spring which cooperates with the spring 67 to determine the position of the block 64 when the stylus is resting on a record. The stylus or point is indicated at 81 and may be a sapphire or other suitable jewel secured at the end of the arm 65.

The details of construction of the post 71 and the method of supporting the stylus arm 65 are shown in Figs. 13 and 14. The post is provided with an enlarged lower end 82 of square cross section and having a shoulder 83 of oblong cross section at the top thereof. A diagonal slot 84 in the head portion 82 receives the rod 75 which is secured therein by soldering. A metal shield 85 is secured on top of the head 82 and has an opening 86 of the same oblong shape as the shoulder 83, the shoulder being of the same height as the thickness of the shield 85. The oblong shape of the shoulder holds the shield in the desired position with respect to the stylus arm. The shield 85 is provided with downwardly extending side members 87 which prevent injury to the arm 65 during the handling of the pickup head. Two lengths of fine resistance wire 88 are secured on either side of the stylus arm 65 over a paper insulator 89 shaped, as shown in Fig. 14, to cover the sides of the square head 82 and of the stylus arm 65. The paper insulator 89 is cemented to the block 82 and stylus arm 65 by a suitable resilient insulating cement such as that sold under the trade name "Glyptal." The two lengths of resistance wire 88 are secured to metal foil ribbons 90 and the wires, together with the ribbons, are cemented to the sides of the block 82 and arm 65 over the paper insulator 89 with "Glyptal" or other suitable resilient cement. These wires are similar in all respects to the wires described in connection with the other embodiments of the invention. The forward ends of the wires 88 are soldered or otherwise suitably secured to the stylus arm 65, as indicated at 91. The positions of the wires 88 along the stylus arm 65 are made alike on both sides and preferably the wires lie along the neutral axis of the arm with respect to bending in a vertical plane. This position of the wires minimizes or prevents distortion due to bending of the stylus arm 65 laterally in directions other than the normal direction of vibration of the stylus 81 when following the sound track of a record. The ribbons

90 are connected by wires 92 to two upright sleeves 93 of the same construction as the sleeve 77 and mounted in the head rearwardly of the recess 63. Only one of the sleeves 93 is shown in the drawings since the view of the head 62 in Fig. 12 is a section along the center line thereof. The sleeves 93 are riveted in position on the head 62 in the same manner as the sleeve 77 and the wires 92 are soldered to the lower ends of the respective sleeves. The three leads indicated at 7 in Fig. 4 may be connected to the sleeve 77 and the two sleeves 93 so that the pickup may be connected in the circuit of Fig. 4 in the same manner as the other pickups described above, the operation of the pickup of Fig. 12 being essentially the same as that of the pickup of Fig. 10.

The pressures exerted by the springs 67 and 80 are selected so that when the stylus 81 is engaging a record sound track the block 64 will be in a position out of contact with the front and back walls of the recess 63 and the springs will carry the unbalanced weight of the tone arm. Interference between the shield 85 and the block 62 is prevented by providing a downwardly opening recess 94 at the forward end of the head opening into the recess 63.

Damping to prevent interference due to mechanical resonance frequencies of the pickup and tone arm is provided by the resilient washers 72 and the washer 74. These washers perform the function of the viscous lubricant in the pickup of Fig. 10 and prevent rotation of the post 71 upon lateral displacement of the stylus arm 65 at the high velocities produced by the recorded sound track. The washers, together with the springs 67 and 80, also afford movement of the stylus arm 65 without bending when low velocity forces are applied in any direction.

It is readily apparent from the foregoing that I have provided a vibration translating device having vibrating parts of very small mass and a very simple and effective element for translating mechanical vibrations into corresponding electrical variations. Furthermore, simple and effective damping arrangements are provided for preventing distortion due to mechanical vibrations at undesired frequencies. It will readily be apparent to those skilled in the art that the pickups which I have illustrated and described may be rearranged in many ways to utilize the features of my invention.

Although I have described and illustrated my invention as applied to phonograph record disks provided with the so-called "laterally cut" sound tracks, it is obvious that the invention is equally applicable to other types of sound tracks. For example, it may be applied to the hill and dale type recording, it being necessary merely to dispose the elements of the pickup so that vibration laterally of the longitudinal axis of the stylus arm and in the direction determined by the type of sound track produces the required strain in the resistance wire.

Although I have illustrated and described particular embodiments of my invention in connection with a single type of sound track, other applications will readily occur to those skilled in the art. I do not, therefore, desire my invention to be limited to the particular arrangements illustrated and described and I intend by the appended claims to cover all modifications which fall within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A phonograph pickup comprising a supporting head, a stylus arm having a stylus point at one end and being supported on said head at its other end whereby said arm is vibrated by vibrations of said stylus point, an electrical resistance wire having one of its ends secured on said head and its other end attached to said arm to be strained by vibrations of said arm to vary the resistance of said wire in accordance with vibrations of said stylus point.

2. A phonograph pickup comprising a supporting head, a stylus arm having a stylus point at one end and being supported on said head at its other end, and a resistance wire having one of its ends secured to said head and its other end attached to said arm to be strained by vibrations of said arm to vary the electrical resistance of said wire in accordance with the vibrations of said arm.

3. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement along a record sound track, and an electrical resistance wire having its ends connected respectively to said arm and said head and arranged to be strained mechanically by the vibrations of said arm to vary the electrical resistance of said wire in accordance with the vibrations of said arm.

4. A phonograph pickup comprising a supporting head, a resilient stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement along a record sound track whereby said arm is stressed as a cantilever beam, and an electrical resistance wire having one of its ends secured to said head and its other end attached to said arm to be strained upon bending of said arm to vary the electrical resistance of said wire in accordance with the vibrations of said stylus point.

5. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement along a record sound track, and an electrical resistance wire having its ends connected respectively to said arm and to said head, said wire being strained by the vibrations of said arm to vary the electrical resistance of said wire in accordance with the vibrations of said arm.

6. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement along a record sound track, an electrical resistance wire having a point mechanically connected to said arm, and means including a resilient member mounted on said head and connected to another point of said wire for tensioning said wire between said head and said arm whereby said wire is strained in accordance with the vibrations of said arm and the electrical resistance of said wire is varied in proportion to such vibrations.

7. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement along a record sound track, and an electrical resistance wire having its ends mechanically connected to said head and its midportion mechanically connected to said arm to provide portions of said wire on either side of said arm, said portions being oppositely strained mechanically by vibrations

of said arm whereby the electrical resistances of said portions of said wire are varied oppositely in proportion to the vibrations of said arm.

8. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement along a record sound track, an electrical resistance wire mechanically connected to said arm, resilient means on said head for holding said wire under tension and for affording bodily movement of said wire with said arm, and means for damping high velocity movements of said resilient means whereby said wire is strained in accordance with vibrations of staid stylus point produced by a record sound track and the electrical resistance of said wire is varied in proportion to such vibrations.

9. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be displaced laterally upon movement along a record sound track, a member movably mounted on said head, an electrical resistance wire connected to said arm and to said member, resilient means connected between said member and said head for holding said wire under tension and for affording movement of said wire bodily with said arm, and a coating of viscous fluid between said member and said head for damping high velocity movements of said member whereby said wire is strained in accordance with vibrations of said stylus point produced by a record sound track and the electrical resistance of said wire is varied in proportion to such vibrations.

10. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement alond a record sound track, a pair of rods slidably mounted in said block one on either side of said arm, an electrical resistance wire having its midportion connected to said arm and its ends connected to said rods, resilient means arranged to urge said rods away from said arm for holding said wire under tension and for affording movement of said wire bodily with said arm, and coatings of viscous fluid between said rods and said head for lubricating said rods and for damping high velocity movements of said rods whereby said wire is strained in accordance with vibrations of said stylus point produced by a record sound track and the electrical resistance of said wire is varied in proportion to such vibrations.

11. A phonograph pickup comprising a supporting head, a stylus arm supported at one end on said head and having a stylus point at its other end adapted to be vibrated upon movement



along a record sound track, a crank rigidly s cured to said arm adjacent said head to form bell crank with said arm, an electrical resistan wire connected to said crank, and means inclu ing a resilient member on said head for tensio ing said wire between said head and said cra and in a direction longitudinally with respect said arm whereby said wire is strained upo vibration of said stylus point and the electric resistance of said wire is varied in accordan with such vibrations.

12. A phonograph pick-up comprising a strai responsive resistance wire mounted betwee spaced apart supports, and a phonograph styl connected to the midpoint of said wire for var ing the strain in the two halves of said wire i accordance with a phonograph record.

13. An apparatus for reproducing phonograp records comprising a tone arm having space apart supports, a strain responsive resistan wire connected between spaced apart supports c said tone arm, a stylus connected to the midpoi of said wire, a transformer having a center tappe primary winding, a source of potential connecte between the center tap of said winding and sai phonograph stylus, and means connecting th outer extremities of said transformer winding t the outer extremities of said wire.

14. A phonograph pick-up comprising a strai responsive resistance wire connected betwee spaced apart supports, a phonograph stylus con nected to the midpoint of said wire, and mean for balancing the tension in the two halves c said wire.

15. An apparatus for reproducing phonograp records comprising a tone arm having trans versely arranged spaced apart supports, a strai responsive resistance wire connected betwee said supports, a phonograph stylus connected t the midpoint of said wire, a bridge circuit in cluding an inductive impedance connected to th outer extremities of said wire and said phono graph stylus, said circuit including a source o direct current connected between said stylus an the midpoint of said impedance.

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