United States Patent

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[54] **MOVING MAGNET TYPE STEREO PICKUP**
11 Claims, 18 Drawing Figs.

[52] **U.S. Cl.** .... **179/100.41K,** 179/100.41 M
[51] **Int. Cl.** **H04r 11/12**
[50] **Field of Search** .... 179/100.41 D, 100.41 K, 100.41 Z, 100.41 M, 100.41 S

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ABSTRACT: A stereo pickup having an arm for carrying a stylus at one end and an armature comprising a flat magnet magnetized in the direction of its thickness attached to the other end of the arm and the pickup supported so that the armature has its center of gravity at substantially the center of vibration of the vibration system and a magnetic pickup coil supported relative to the armature so as to pick up the vibratory signals from the pickup.

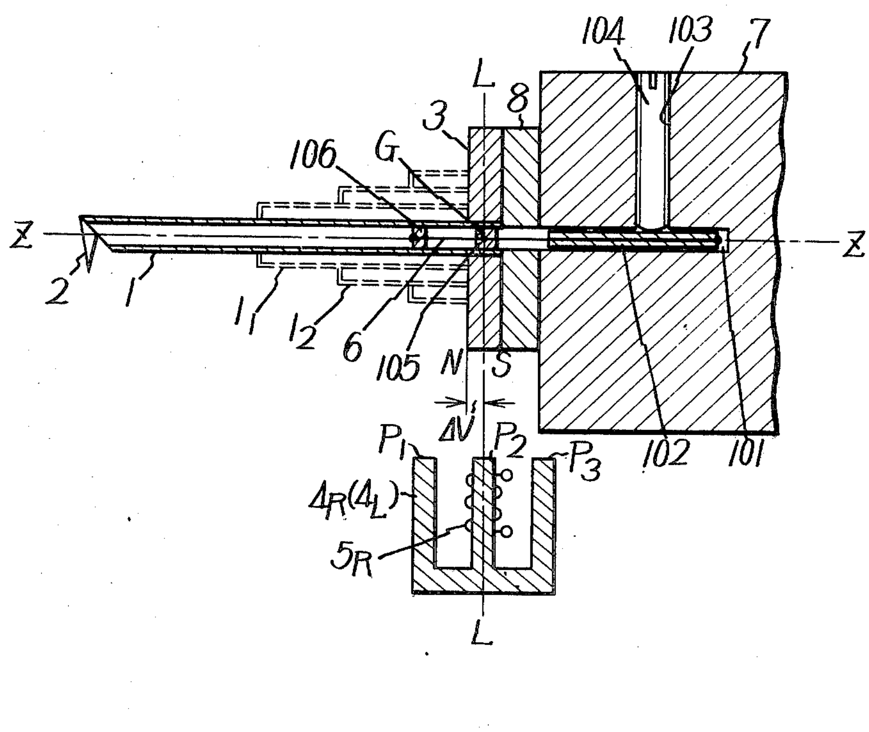

Fig. 1

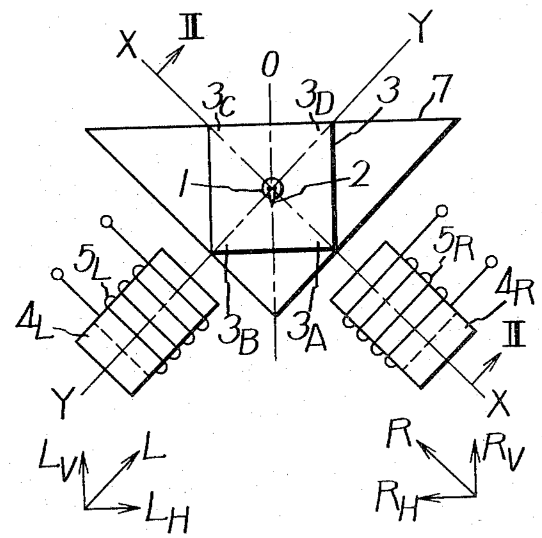

Fig. 2

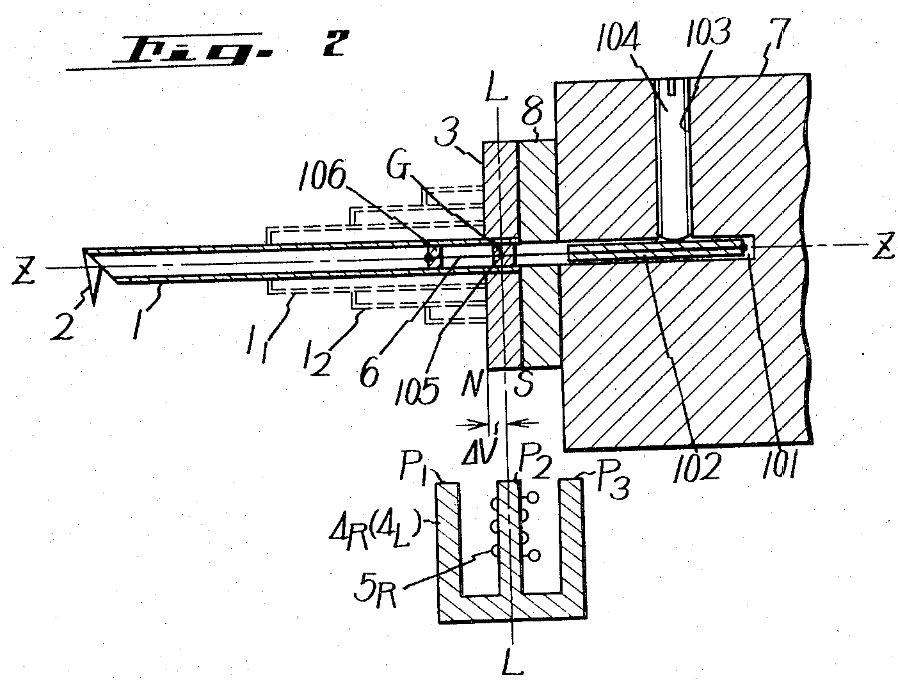

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FIG. 3A

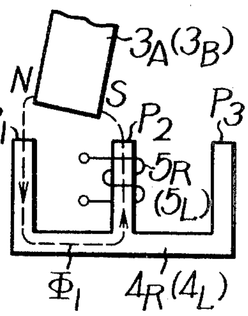


FIG. 3B

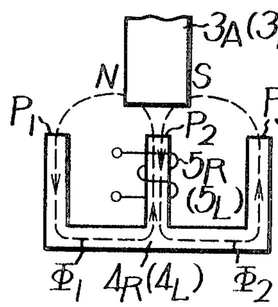


FIG. 3C

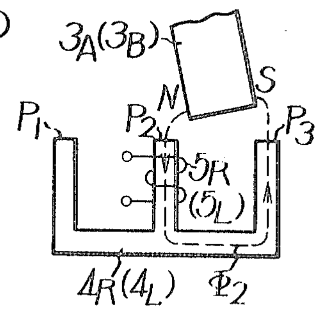
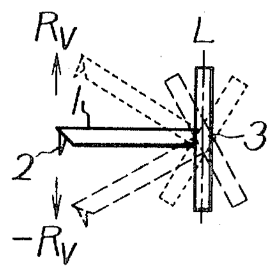


FIG. 4A



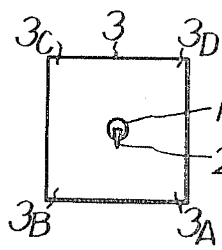


FIG. 4B

FIG. 5A

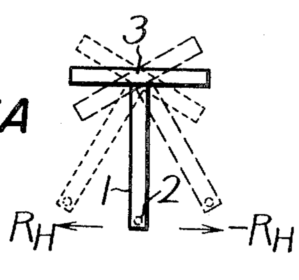
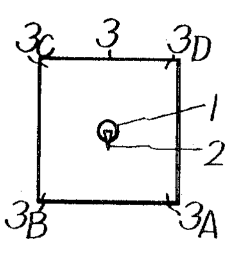


FIG. 5B



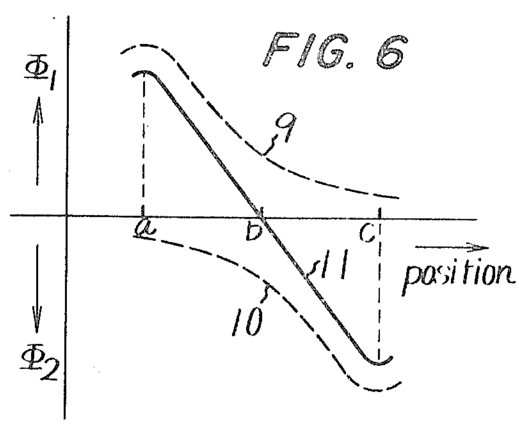


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Fig. 7

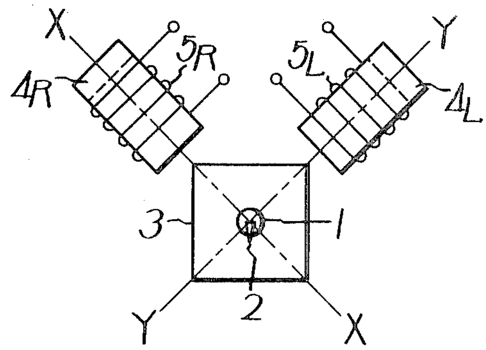


Fig. 8

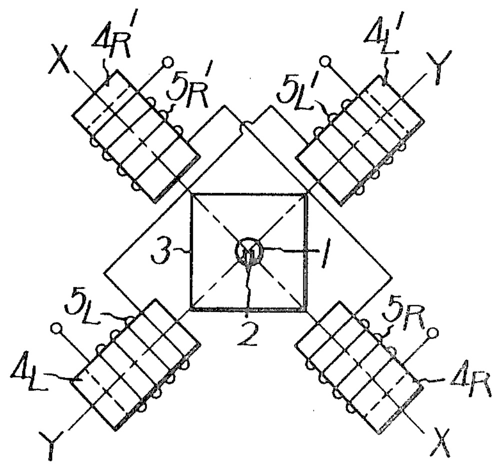
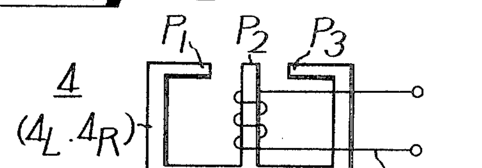


Fig. 9



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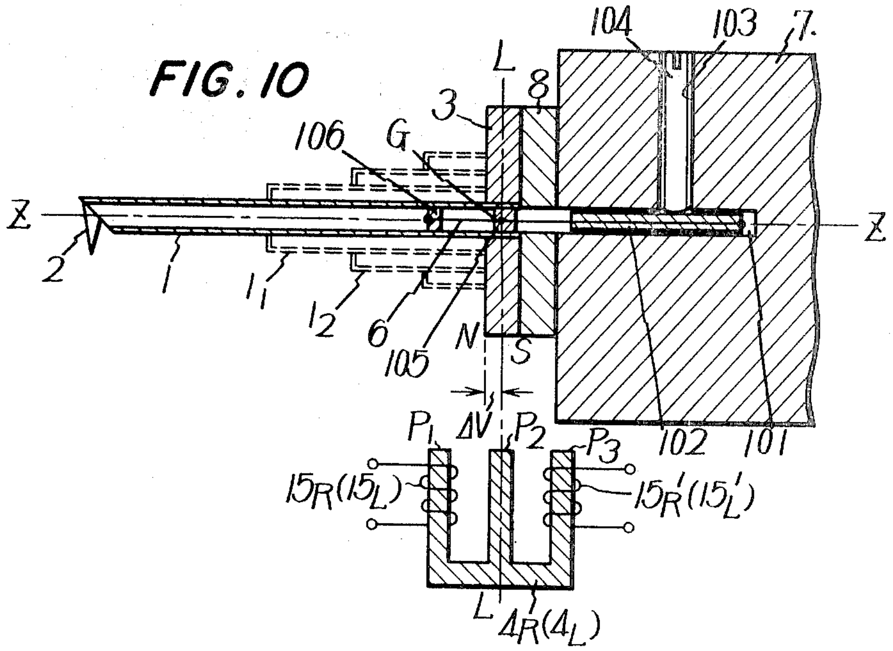

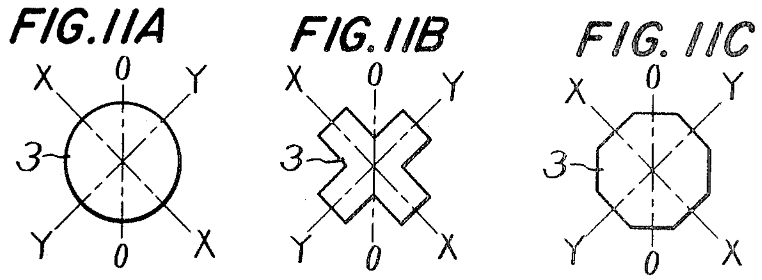

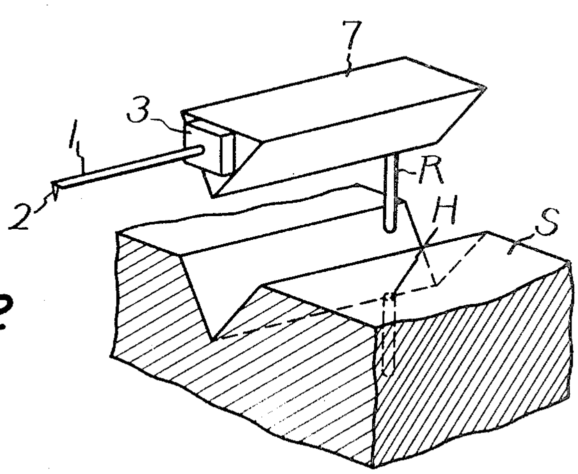

FIG. 12

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MOVING MAGNET TYPE STEREO PICKUP

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a novel stereo pickup for use with 45°—45° stereo records and more particularly refers to a moving msving-magnet-type stereo pickup.

2. Description of the Prior Art

In a conventional moving-magnet-type stereo pickup a cantilever arm is mounted on one end of a bar magnet, a stylus is fixedly mounted on one end of the cantilever arm and the bar magnet is supported by a damper in a casing of a substantially square cross section. With such a construction, when the stylus vibrates in sound grooves during playing a record the fulcrum of the vibration is likely to shift to introduce distortion in the reproduced sound.

A moving-coil type, namely Ortofon-type stereo pickup has been proposed as an improvement of the aforementioned moving-magnet-type pickup. In this moving-coil-type pickup, its center of vibration is definitely settled in the vicinity of the center of gravity of the armature to thereby eliminate one of the problems encountered in the moving-magnet-type pickup. However, this moving-coil-type pickup has great mass which is a disadvantage.

SUMMARY OF THE INVENTION

This invention is to provide a novel stereo pickup which is free from the drawbacks experienced in the prior art, and in which a vibration system consists of a flat armature magnet magnetized in the direction of its thickness and a cantilever arm having a stylus and secured to the armature magnet, the center of vibration is settled in the vicinity of the center of gravity of the armature magnet and specific signal-generating means are provided in relation to the armature magnet, thereby reducing mechanical impedance relative to the stylus, minimizing crosstalk and distortion and facilitating the manufacture and replacement of the stylus.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an enlarged front view schematically illustrating one example of the stereo pickup produced according to this invention;

FIG. 2 is an enlarged cross-sectional view taken along the line II—II in FIG. 1;

FIGS. 3A to 3C are schematic diagrams for explaining the principle of this invention;

FIGS. 4A and 4B are schematic diagrams for explaining the principle of generation of the stereo pickup of this invention;

FIGS. 5A and 5B are similar schematic diagrams for explaining the principle of generation of the stereo pickup of this invention;

FIG. 6 is a graph showing the relationship between the position of an armature and magnetic flux;

FIGS. 7 and 8 are enlarged front views illustrating other examples of the stereo pickup of this invention;

FIG. 9 is an enlarged side view illustrating one example of a magnetic core usable in the stereo pickup of this invention;

FIG. 10 is a side view showing another example of the stereo pickup of this invention;

FIGS. 11A to 11C are enlarged front views illustrating other examples of the armature usable in the pickup of this invention; and

FIG. 12 is a perspective view schematically illustrating the pickup of this invention and one part of its attachment portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1 and 2 reference numeral 1 indicates a cantilever arm carrying at one end a stylus 2 and fixed at the other end to a flat armature 3 magnetized with north and south magnetic poles in the direction of its thickness. The armature 3 is designed so that its center of gravity lies centrally of its center axis Z—Z, and is shaped in such a configuration as to be symmetrical relative to two assumed straight lines X—X and Y—Y intersecting with the center axis Z—Z and each other at right angles and relative to an assumed line O—O crossing the lines X—X and Y—Y at an angle of 45° thereto and intersecting with the center axis Z—Z. As illustrated in FIGS. 1 and 2, the armature 3 may be made in the form of a plate having a thickness of, for example, approximately 0.5 mm. and a square cross section measuring 2 mm. by 2 mm.

The cantilever arm 1 is mounted on the armature 3 at such a location that the center axis Z—Z of the armature 3 in the direction of its thickness is substantially in agreement with the axis of the cantilever arm 1 in its lengthwise direction, that the center G of gravity of the armature 3 lies at or near the center of vibration of a vibration system and that the line O—O runs in substantially the same direction as that of the stylus 2.

A pair of magnetic cores 4R and 4L are disposed on the extensions of the lines X—X and Y—Y symmetrically relative to the line O—O in opposing relation to the peripheral surface of the armature 3. In the illustrated example the magnetic cores 4R and 4L are positioned under the armature 3.

The magnetic cores 4R and 4L are, for example, the so-called E-shaped cores, as exemplified in FIG. 3, which have three platelike magnetic poles P_1, P_2 and P_3 equally spaced from adjacent ones and interconnected at one end with one another. The relative position of each of the magnetic cores 4R and 4L to the armature 3 is such that where the stylus 2 is not subjected to vibration, namely in its stationary condition, the central magnetic pole P_2 lies on a line L—L passing the center of gravity of the armature 3, namely the center G of vibration of the vibration system and intersecting with the center axis Z—Z of the cantilever arm 1 at right angles thereto. The central magnetic poles P_2 have wound thereon windings 5R and 5L respectively.

Reference numeral 6 designates a fine core wire formed of, for example, a flexible metal material, which is positioned to pass through a cylindrical caulking member 102 inserted into an aperture 101 formed through the support 7 and is secured at one end to one end of the caulking member 102 by means of, for example, an adhesive binder or the like. The caulking member 102 is fixed by a setscrew 104 threadably engaged with a female screw 103 formed in the support 7. While, the other end of the core wire 6 is secured, by means of, for example, an adhesive binder or the like, to a ring 106 fixed in the cantilever arm 1, passing through a central aperture of a damper 8 disposed between the armature 3 and the support 7 and through an O-ring 105.

In the absence of the core wire 6 in the vibration system of the above construction, when recorded signals on the record become large the damper 8 is shifted in the axial direction of the cantilever arm 1, namely in the direction of the line Z—Z. As a result of this, the center of vibration of the vibration system is also caused to shift in the direction of the line Z—Z.

In the present invention, however, since the core wire 6 is secured at both ends to the cantilever arm 1 and the support 7 respectively, as previously described, shifting of the vibration system in the direction of the line Z—Z such as mentioned above is prevented. However, the core wire 6 is flexible and fine, and hence it does not obstruct vibrations of all directions about the center of vibration of the vibration system except that of the direction of the line Z—Z.

The principle of generation of the present invention pickup of the above construction will hereinafter be described in detail. Let it be assumed that the stylus 2 is subjected to vibrating forces proportional to right and left signals from directions at an angle of 45° to the vertical axis O—O passing the center axis of the armature 3, namely on the lines X—X and Y—Y. The vector R of the right signal applied to the stylus 2 on the line X—X is decomposed into a horizontal component R_H and a vertical component R_V. The vector −R is likewise decomposed into $-R_H$ and $-R_V$.

Referring now to FIGS. 4 and 5, a description will be given in connection with the manner in which the armature 3 is displaced by the vectors R and −R. With the vertical component R_V of the vector R, the armature 3 and the cantilever arm 1 are displaced as shown by dotted lines in FIG. 4A. If the displacement of the armature 3 from its full-line position to the cantilever side is defined to be minus (−) displacement, upper corners 3C and 3D of the square-shaped armature 3 are displaced by +Δ and the lower corners 3A and 3B are displaced by −Δ. With the horizontal component R_H of the vector R, the armature 3 and the cantilever arm 1 are respectively displaced as indicated by dotted lines in FIG. 5A. In this case the displacements of the corners 3B and 3C of the armature 3 are +Δ, while the displacements of the corners 3A and 3D are −Δ.

Accordingly, the vector R causes the corner 3A of the armature 3 to be displaced by −2Δ from its neutral position and the corner 3C to be displaced by +2Δ from its neutral position. While, the displacements of the corners 3B and 3D by the vertical and horizontal components R_V and R_H are opposite in direction, so that the displacements are cancelled and the corners 3B and 3D are not displaced.

With the vertical component $-R_V$ of the vector −R, the armature 3 is displaced as indicated by broken lines in FIG. 4A, namely the corners 3A and 3B of the armature 3 are displaced by +Δ and the corners 3C and 3D are displaced by −Δ. With the horizontal component $-R_H$ of the vector −R, the armature 3 is, in turn, displaced as shown by broken lines in FIG. 5A. Namely, the displacements of the corners 3B and 3C are −Δ, while those of the corners 3A and 3D are +Δ. Thus, the vector −R provides displacement of the corners 3A and 3C by +2Δ and −2Δ from their neutral positions respectively.

Briefly stated, when a force vibrating in the direction of the line X—X is applied to the armature 3, its corners lying on the line X—X are vibrated but the corners on the line Y—Y are not vibrated. In other words, the force vibrating in the direction of the line X—X causes the armature 3 to vibrate about the line Y—Y.

It will readily be understood that when a force vibrating in the direction of the line Y—Y, namely a vector L of the left signal is applied to the pickup, the corners of the armature 3 lying on the line Y—Y are vibrated about the line X—X.

When a force is exerted to the armature 3 in the direction of the line X—X, the corners 3A and 3C vibrate as described above. The corners 3A and 3B are respectively disposed opposite to the magnetic cores 4R and 4L, as illustrated in FIGS. 1 and 3.

When the armature 3 is in its stationary condition, the corner 3A (or 3B) of the armature 3 assumes a position opposite to the central magnetic pole P_2 of the magnetic core 4R (or 4L), as depicted in FIG. 3B. In this case, a magnetic flux Φ_1 starting from the armature 3, passing through the magnetic poles P_1 and P_2 and returning to the armature 3 and a magnetic flux Φ_2 starting from the armature 3, passing through the magnetic poles P_2 and P_3 and returning to the armature 3 are equal in magnitude in the central magnetic pole P_2 but is opposite in direction. Therefore, no electromotive force is generated in the winding 5R (or 5L) wound on the central magnetic pole P_2.

A discussion will be made in connection with the case where the armature 3 is subjected to the aforementioned forces R(−R) and L(−L), in particular only R and −R for the sake of simplicity. Applying the force R or −R to the armature 3, the corners 3A and 3C are displaced by |2Δ| about their neutral position. Accordingly, in this case the relation between the corner 3A of the armature 3 and the magnetic core 4R varies as shown in FIGS. 3A and 3C. That is, when the corner 3A of the armature 3 is displaced toward the left-hand magnetic pole P_1 of the magnetic core 4R as illustrated in FIG. 3A, if the armature 3 is magnetized in the direction of its thickness with polarities indicated, the magnetic flux Φ_1 increases and when the corner 3A lies midway between the magnetic pole P_1 and the central magnetic pole P_2 the magnetic flux Φ_1 reaches its greatest value. This introduces variations in the magnetic flux of the central magnetic pole P_2, providing an electromotive force in the winding 5R.

Having returned to its initial position such as depicted in FIG. 3B, the armature 3 stands opposite to the central magnetic pole P_2. Under such conditions, the magnetic fluxes Φ_1 and Φ_2 are equal in magnitude in the central magnetic pole P_2 and is opposite in direction, so that these magnetic fluxes are cancelled. As a result of this, no magnetic flux flows through the central magnetic pole P_2 and a magnetic flux flows from the magnetic pole P_1 to the magnetic pole P_3 as a whole. Therefore, no electromotive force is generated in the winding 5R.

Further, when the corner 3A of the armature 3 has shifted from its position in FIG. 3B to a position midway between the central magnetic pole P_2 and the right-hand magnetic pole P_3, as depicted in FIG. 3C, the magnetic flux Φ_2 flowing from the central magnetic pole P_2 to the magnetic pole P_3 reaches its maximum value. Electromotive forces is generated in the winding 5R in response to the variations in the magnetic flux passing through the central magnetic pole P_2.

The foregoing will be described in detail only in connection with the magnetic flux flowing from the magnetic pole P_1 to the central magnetic pole P_2. Let it be assumed that the magnetic core is not provided with the right-hand magnetic pole P_3 and hence is composed of the left-hand magnetic pole P_1 and the central magnetic pole P_2 in the form of a U. In this case, the magnetic flux Φ_1 is at its maximum value when the corner 3A of the armature 3 lies at the center between the magnetic poles P_1 and P_2, as depicted in FIG. 3A, and the magnetic flux Φ_1 gradually decreases as the corner 3A moves from the central position. FIG. 6 illustrates the relationship between the magnitude of the magnetic flux Φ_1 and the relative position of the corner 3A of the armature 3 to the magnetic core, in which the ordinate represents the magnitude of the magnetic flux Φ_1 and the abscissa the position of the armature 3 relative to the magnetic core. In this graph a curve 9 indicates the magnetic flux Φ_1, points *a*, *b* and *c* on the abscissa indicating the positions of the armature 3 depicted in FIGS. 3A, 3B and 3C.

Now, the magnetic flux Φ_2, flowing from the central magnetic pole P_2 to the right-hand magnetic pole P_3, will be discussed similarly in connection with a U-shaped magnetic core consisting of the magnetic poles P_2 and P_3. The magnetic flux Φ_2 reaches its maximum value when the armature 3 lies at the center between the magnetic poles P_2 and P_3, and the magnetic flux Φ_2 gradually decreases as the armature 3 leaves the central position. The characteristics of the magnetic flux Φ_2 is as indicated by a curve 10 in FIG. 6.

In practice, since the magnetic core 4 is not U- but E-shaped, a magnetic flux Φ flowing through the central magnetic pole P_2 having wound thereon the winding 5R(5L) is composed of the magnetic fluxes Φ_1 and Φ_2, which is indicated by a full-line curve 11 in FIG. 6. That is, the magnetic flux Φ flowing through the central magnetic pole P_2 is zero when the armature 3 assumes a position opposite to the central magnetic pole P_2, as shown in FIG. 3B. When the armature 3 is displaced from the above position toward the left-hand magnetic pole P_1 the magnetic flux Φ flows through the central magnetic pole P_2 from the bottom to the top, and when the armature 3 is displaced from the central magnetic pole P_2 toward the right-hand magnetic pole P_3 the magnetic flux Φ flows through the magnetic pole P_2 from the top to the bottom.

As indicated by the curve 11 in FIG. 6, the magnetic flux Φ flowing through the central magnetic pole P_2 varies linearly about the point b close the points a and c where the magnetic fluxes Φ_1 and Φ_2 reach their maximum values. Consequently, the magnetic flux Φ is in direct proportion to the displacement of the armature 3 to ensure that a distortionless output voltage is obtained from the winding wound on the central magnetic pole P_2 through which the magnetic flux Φ flows.

Further, when the stylus is subjected to a vibration of only one direction, the relative position between the magnetic core and the armature disposed vertically to the direction of the vibration is not altered, as described above. Accordingly, in this case no voltage is produced in the winding wound on the magnetic core, thus preventing crosstalk which is harmful to stereo sound. Therefore, the pickup of this invention exhibits excellent performance as a pickup for use with stereo records.

In accordance with this invention the use of flat armature 3 and positioning the vibration center of the vibration system on or above the center G of gravity of the armature 3 reduces the mechanical impedance from the stylus 2 and eliminate distortion and crosstalk in the reproduced sound.

In addition, since the flat armature is magnetized in the direction of its thickness, the magnetization can readily be effected to enhance efficiency of manufacturing operations.

Although the magnetic cores 4R and 4L are disposed opposite to the underside of the armature 3 in the foregoing example, it is also possible to arrange the magnetic cores 4R and 4L above the armature 3 on the lines X—X and Y—Y in the same relation as that described above, as shown in FIG. 7, or to dispose four magnetic cores 4R, 4R' and 4L, 4L' opposite to all the corners of the armature 3 respectively in the same relation as the above-described one. In the latter case, windings 5R and 5R' wound on central magnetic poles P_2 of the magnetic cores 4R and 4R'are connected in series to each other, and windings 5L and 5L' wound on the magnetic cores 4L and 4L' are similarly connected in series to each other. Further, these windings are connected together in such a manner that their outputs are added together to provide a large output.

The foregoing example employs the platelike E-shaped magnetic core 4 having the magnetic poles P_1, P_2 and P_3, but it will be apparent that the top end portions of the magnetic poles P_1 and P_3 can be bent inwardly as shown in FIG. 9. The E-shaped magnetic core may also be formed in the shape of a cylinder with the poles P_1 and P_3 forming the outer walls of a cylinder and with a center pole P_2 extending upwardly at the center of the cylinder.

Further, in the above example the winding is wound on the central magnetic pole P_2 of the magnetic core 4 for leading out an electrical signal. In some cases, however, windings 15R and 15L and 15R', 15L' are wound on the magnetic poles P_1 and P_3 of the magnetic core 4 as illustrated in FIG. 10 and in this case the windings 15R and 15R' are connected in series to each other and the windings 15L and 15L' are similarly connected in series to each other. In this case the turning directions of the windings and their connections are selected so that when the armature 3 stands opposite to the central magnetic pole P_2 outputs induced in the windings 15R and 15R', 15L and 15L' by the magnetic fluxes Φ_1 and Φ_2 produced in the magnetic poles P_1 and P_3 may be cancelled by each other. With such an arrangement, it is also possible to provide an output which is distortionless and free from crosstalk, as in the foregoing.

Although the foregoing examples employ the armature 3 of a square configuration, it is also possible to use circular, cross-shaped, octagonal or like armatures so long as they are flat and magnetizable with north and south magnetic poles in the direction of its thickness, as depicted in FIGS. 11A, 11B and 11C. That is, the requirements imposed upon any of the armatures are such that its center of gravity lies on the central axis and that its shape is symmetrical relative to the two straight lines X—X and Y—Y running in the direction of its plane and intersecting with each other at right angles. Further, in this case the armature 3 is mounted on the cantilever arm 1 in such a manner that the lines X—X and Y—Y respectively form an angle of approximately 45° with the plane including the extension of the stylus 2 and the axial direction of the cantilever arm 1. It is preferred in practice to position the armature 3 as close to the magnetic cores 4R and 4L as possible.

In FIG. 12 there is illustrated one example of a support S for supporting the pickup of this invention. As depicted in the figure, a support rod R is fixed on the support 7 and a hole H for supporting the rod R fitted therein is formed in the support S. Insertion of the rod R into the hole H leads to supporting of the support 7 and consequently the stereo pickup on the support S. A groove conforming to the configuration of the support 7 is provided in the support S.

This facilitates attachment and detachment of the pickup of this invention and hence replacement of a damaged stylus with a new one is extremely simple.

It will be seen that reference to the exemplified shapes of the armature should not be construed as limiting this invention specifically thereto.

Further, a plurality of cylindrical members 1_1, 1_2, ... can be mounted about the cantilever arm 1, as shown in FIG. 2 by dotted line in a manner to gradually increase its diameter as the fixed portion of the cantilever arm 1 to the armature 3 is approached. This prevents vibration of the cantilever arm 1 itself due to its slenderness and hence prevents generation of noise.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention.

I claim as my invention:

1. A moving-magnet-type stereo pickup comprising a cantilever arm carrying at one end a stylus, an armature attached to the other end of said cantilever arm, said armature comprising a flat permanent magnet which is magnetized in the direction of its thickness and longitudinally of the arm, said cantilever arm fixed to said armature so that the longitudinal direction of said cantilever arm crosses the plane of said armature at right angles, means for supporting the armature in such a manner that the center of vibration of the vibration system including said stylus, cantilever arm and armature lie substantially at the center of gravity of said armature, E-shaped magnetic path-forming means comprising core means for forming a plurality of magnetic paths in cooperation with said armature, said E-shaped magnetic core means mounted adjacent said armature and disposed relative to said armature so that the legs of said E-shaped magnetic core means are arranged one after another along an axis parallel to the north and south poles of said armature, and the center leg of said E-shaped magnetic core means is adjacent said armature, and windings wound on said E-shaped magnetic core means for detecting movement of said stylus in two direction normal to each other and the response of said windings being linear as a function of movement of said armature so that distortionless response is obtained.

2. A moving-magnet-type stereo pickup comprising a cantilever arm carrying at one end a stylus, an armature attached to the other end of said cantilever arm; said armature comprising a flat permanent magnet which is magnetized in the direction of its thickness and longitudinally of the arm, said cantilever arm fixed to said armature so that the longitudinal direction of said cantilever arm crosses the plane of said armature at right angles, means for supporting the armature in such a manner that the center of vibration of the vibration system including said stylus, cantilever arm and armature lie substantially at the center of gravity of said armature, E-shaped magnetic path-forming means comprising core means for forming a plurality of magnetic paths in cooperation with said armature, said E-shaped magnetic core means mounted adjacent said armature and disposed relative to said armature so that the legs of said E-shaped magnetic core means are arranged one after another along an axis parallel to the north and south poles of said armature, and the center leg of said E-shaped magnetic core means is adjacent said armature, and windings wound on said E-shaped magnetic core means for detecting movement of said stylus in two directions normal to each other and the response of said windings being linear as a function of movement of said armature so that distortionless response is obtained, wherein the cantilever arm is composed of a plurality of nested cylindrical members each having different lengths, the plurality of cylindrical members disposed around the outside of the cantilever arm along its base portion, and the smaller cylindrical members having lengths which are greater than the larger cylindrical members and said stylus mounted at the end of the arm at its smallest diameter.

3. A moving-magnet-type stereo pickup as claimed in claim 2 in which said windings are wound on the center leg of said E-shaped magnetic core means.

4. A moving-magnet-type stereo pickup as claimed in claim 2 in which said windings are wound on both outside legs of said E-shaped magnetic core means.

5. A moving-magnet-type stereo pickup as claimed in claim 2 wherein the armature is square.

6. A moving-magnet-type stereo pickup as claimed in claim 2 wherein the armature is circular.

7. A moving-magnet-type stereo pickup as claimed in claim 2 wherein the armature is cross-shaped.

8. A moving-magnet-type stereo pickup as claimed in claim 2 wherein the armature is polygonal-shaped.

9. A moving-magnet-type stereo pickup as claimed in claim 2 wherein said magnetic path forming means comprise a pair of magnetic detectors, each disposed adjacent the armature.

10. A moving-magnet-type stereo pickup as claimed in claim 2 wherein said magnetic path forming means consist of two pairs of magnetic detecting means mounted adjacent the armature and windings on each pair of the detecting means connected together so that their outputs add together.

11. A moving-magnet-type stereo pickup as claimed in claim 2 comprising a first support means for supporting said vibration system, a pin attached to said first support means, and a second support means formed with a hole into which said pin is inserted to support said stereo pickup.

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