April 1, 1958 D. J. BAKER 2,829,210

MAGNETIC PICKUP

Filed Aug. 15, 1951 2 Sheets-Sheet 1

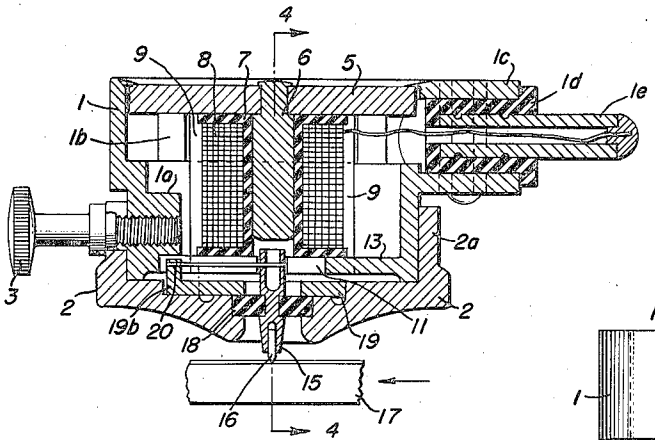

Fig. 1.

Fig. 2.

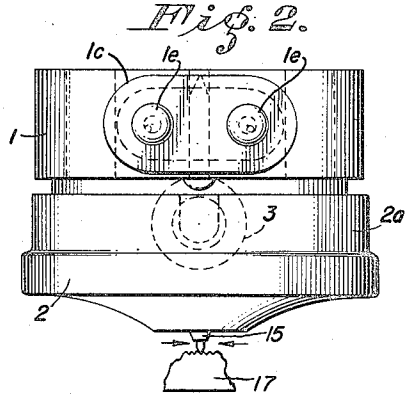

Fig. 3.

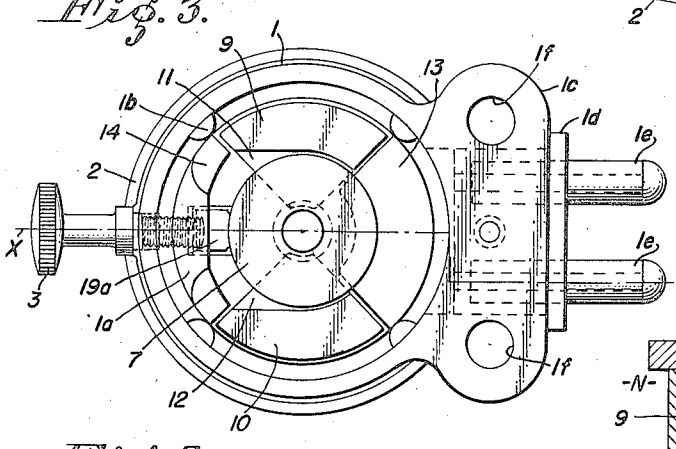

Fig. 4.

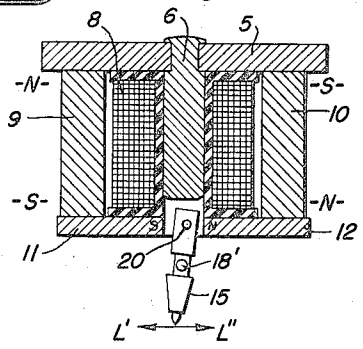

Fig. 5.

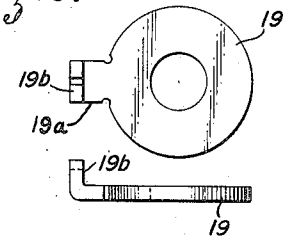

Fig. 6.

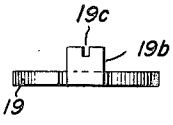

Fig. 7.

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MAGNETIC PICKUP

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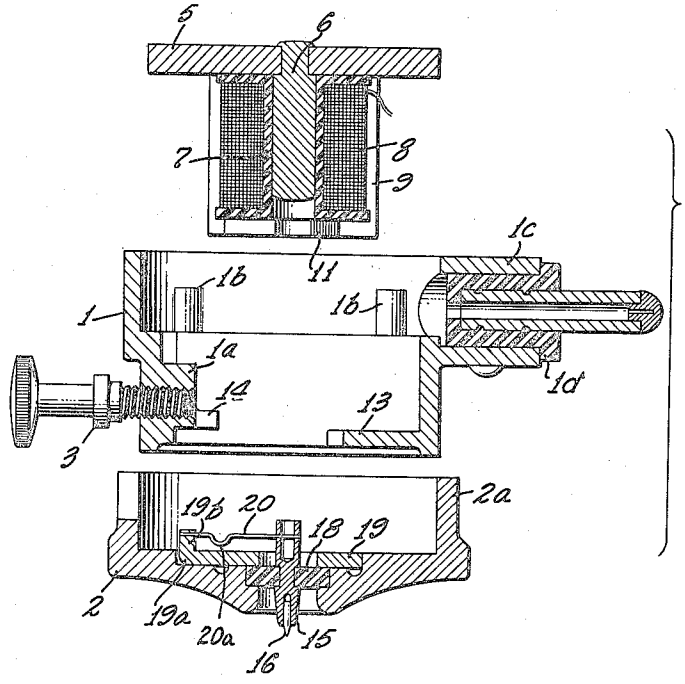

Fig. 8.

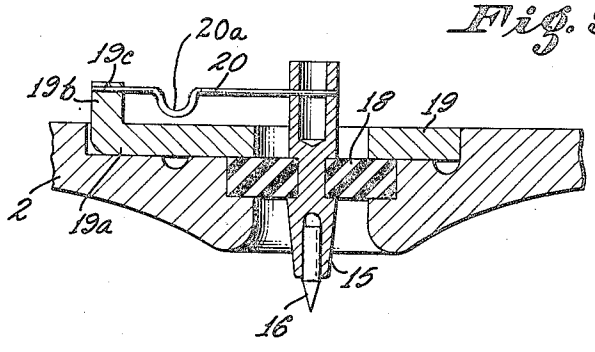

Fig. 9.

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United States Patent Office

2,829,210

Patented Apr. 1, 1958

2,829,210

MAGNETIC PICKUP

Donald J. Baker, Los Angeles, Calif.

Application August 15, 1951, Serial No. 242,047

13 Claims. (Cl. 179—100.41)

This invention relates to a pickup device of the magnetic type designed for use on sound records of the lateral cut type.

One object of the invention is to design a pickup which is small in size and therefore light in weight.

Another object of the invention is to devise an improved magnetic circuit and armature arrangement to produce high efficiency in the modulation of the magnetic flux by movement of the armature.

Still another object of the invention is to devise an improved mounting for the armature of the pickup to eliminate interference commonly due to extraneous vibrations or movements originating in the mounting or suspension.

Other features of my improved armature mounting or suspension are: it is of small size; it cushions the stylus against shock effects; it provides a certain amount of vertical compliance for the stylus; and it provides the necessary damping of the armature without the use of separate damping blocks or elements. All of these features are secured by mounting the armature substantially at its mid-point in a block of yieldable, rubber-like material which supports the armature for vibration about an axis lying within the plane of the block. The mounting block not only serves to maintain the armature in its normal position, but it also provides an inherent damping effect to damp out resonance of the armature and other disturbing effects.

Still another feature of the invention is the provision of a stylus supporting armature of very small mass.

Yet another object is to devise an armature mounting arrangement permitting the removal of the armature and stylus and the replacement of the armature and stylus by a new unit when it is necessary to replace the stylus, for use on different records and for replacing worn and damaged stylii.

In my co-pending application Serial No. 73,084, filed January 27, 1949, for "Pickup Head With Removable Armature and Stylus Assembly," I have disclosed and claimed a pickup wherein the stylus suspension may be quickly removed from the magnetic pickup head. That case also discloses and claims an improved armature suspension wherein the armature is carried by a resilient disc, with compensation for record drag.

Other objects of the present invention are to improve the construction of the pickup which is the subject of the above mentioned patent application, and more particularly (1) to increase the accessibility of the screw or fastening device which removably holds the stylus suspension cover in place, (2) conceal the tension wire which opposes record drag, so that such wire is not exposed to view or in a position subject to accidental damage, (3) to provide improved means for more firmly holding the stylus suspension rubber disc in position, (4) improve the magnetic circuit of the pickup head so as to make it possible to use a shorter armature than heretofore, and, (5) provide an improved manufacture for the magnetic circuit whereby permanent poles and end

pieces therefor may be soldered together when the pickup coil is absent to avoid possible damage to the coil, for later assembly of the coil with such unit fitting in a casing in such manner that the removable stylus assembly is held in coaxial relation to the magnetic structure.

The preferred form of the invention is illustrated in the accompanying drawing in which Figure 1 is a sectional view of the pickup taken along a vertical plane passing through the fore and aft axis of the pickup. Figure 2 is an elevational view of the pickup as seen from the right of Figure 1. Figure 3 is a plan view of the pickup as shown in Figure 1 except that the magnetic disc at the top of the pickup has been omitted. Figure 4 is a sectional view of Figure 1 taken along the line 4—4 but omitting the casing of the pickup and showing the armature in elevation. Figure 5 is a plan view of a ring forming part of the armature mounting. Figure 6 is a side elevational view of Figure 5 and Figure 7 is a side view of Figure 6 as seen from the left of Figure 6. Figure 8 is an exploded view of the parts shown in Figure 1, showing a modification in part 20, and Figure 9 is an enlarged view of that part of Figure 9 which shows the armature and its suspension.

Referring to the drawing, the cylindrical casing of the pickup is shown at 1, the lower end of the casing being closed by a removable cap or cover 2 provided with a cylindrical flange 2*a* which surrounds the lower end portion of the casing in close fitting relation. Cap 2 is removably secured to the casing by means of a clamping screw 3 which passes through a vertical slot formed in the flange 2*a* and clamping screw 3 has threaded engagement with a tapped hole formed in boss 1*a* of the casing 1. The casing 1 is formed of non-magnetic material, such as aluminum or molded plastic. Cap 2 also is non-magnetic and may be formed of molded plastic material.

The magnetic structure of the pickup is formed as a unit of E shape, with the back of the structure arranged horizontally and the 2 end magnets or legs arranged vertically on opposite sides of the fore and aft axis of the pickup, which axis is indicated by the line X in Figure 3. The back of the magnetic structure is formed of a magnetic iron disc 5 which is positioned within the upper end of casing 1 and substantially closes the end of the casing as shown in Figure 1. The disc 5 is supported upon an integral part of the casing 1, for example, it may be supported upon the upper ends of a number of vertical ribs 1*b* spaced about the inner wall of the casing and formed integrally therewith. If desired, the disc 5 may be supported upon a continuous shoulder formed on the inner cylindrical wall of the casing 1. The central leg of the magnetic structure is formed of a round magnetic iron rod 6 mounted at the center of the disc 5 and extending vertically downward and terminating at a point above the lower end of casing 1. The rod 6 may be secured to the disc 5 in any suitable manner, as by riveted connection between the reduced upper end portion of the rod and the disc 5 as shown in Figure 1. The center leg 6 is surrounded by a spool 7 which carries a pickup winding 8. The spool 7 is not essential if the winding 8 is wound in self-sustaining form. In any case, the winding extends somewhat below the lower end of center leg 6 as shown in Figure 1, thus providing a cavity in the lower end of winding 8, that is, the space within the lower end of winding 8 is left open.

The outer legs of the magnetic structure are formed of two vertical magnets or bar members 9 and 10 positioned on opposite sides of the pickup winding 8 with respect to the axis X. The upper ends of these bars are secured to the lower face of disc 5 in any suitable manner as by soldering. The lower ends of the bar members extend down to the plane of the lower end of the spool 7 or to the plane of the lower end of the winding 8 in case the

spool is not employed. As shown in Figure 3 of the drawing, the bars 9 and 10 are formed with curved outer surfaces which are concentric with the axis of the center leg 6, and the inner surfaces of these bars located to the rear of the transverse plane passing through the axis of arm 6 also are curved and are concentric with the axis of the leg 6 but the inner surfaces of these bars on the forward side of the transverse plane are arranged parallel with each other for the purpose of facilitating the assembly of the pickup as will be explained hereinafter.

A pair of pole pieces 11 and 12 are secured in any suitable manner to the lower ends of the magnets or members 9 and 10. These pole pieces are of sector shape having curved outer edges conforming with the outer surface of bars 9 and 10 and having wedge shaped portions extending inwardly beneath the lower end of spool 7, the pointed ends of the pole pieces terminating at equal distances on opposite sides of the axis of the central arm 6 to form an air gap between the pole pieces for receiving the armature of the pickup. The axis of central arm 6 is located in the vertical plane containing the fore-and-aft axis of the pickup device, and pole tips of pieces 11 and 12 are located on opposite sides of this reference plane. As shown in Figures 1 and 3 of the drawing, the casing 1 is provided with an inwardly extending flange 13 which substantially fills the space between the pole pieces 11 and 12 on the rear side of these pole pieces and a similar flange 14 is provided in the space between the pole pieces at the front of the pole pieces. These flanges serve as aligning elements to properly position the pole pieces within the casing, but these flanges are not essential if the magnetic core is properly positioned by means of the disc 5. The magnetic structure including the disc 5 and the members 9 and 10 may be cast in one piece if desired. The central arm 6 is located in the neutral plane of magnets 9 and 10 and the lower end of this arm constitutes a neutral pole.

The magnetic armature of the pickup is formed of a rod-like member 15 arranged vertically within a central opening in the cover 2 and having the upper end thereof extending into the cavity within the lower end of the winding 8 and immediately below center leg 6. A suitable stylus 16 is mounted at the lower end of the armature 15 and engages the sound groove on the record 17.

The armature 15 is resiliently mounted upon the cap 2 for vibration about an axis coincident with the fore and aft axis of the pickup, and the preferred arrangement for mounting the armature comprises a disc 18 formed of resilient yieldable material, the outer edge of the disc 18 being supported by a pressed fit within a circular recess formed in the walls of the central opening of cap 2 and the armature 15 being secured within a central opening formed in the disc 18. As will be noted from Figure 1, the disc 18 is located about midway of the length of the armature and the disc provides a resilient mounting by which the armature may be vibrated about an axis lying substantially within the plane of the disc 18.

Mounting disc or block 18 is formed of a yieldable, rubber-like material having sufficient resilient stiffness to hold the armature to its normal or central position while allowing it to be vibrated by the record groove; the block must also have sufficient internal resistance to damp out any resonance effect of the armature mounting. Materials suitable for this purpose are known in the art, and I have found that a rubber-like material sold under the name "Hicar" gives excellent results. By forming mounting block 18 of this type of material the necessary damping is secured without the use of additional damping blocks commonly used heretofore.

It is desirable to provide means to prevent tilting of the armature by the frictional drag of the record against the stylus 16, and one suitable arrangement comprises a ring 19 formed of non-magnetic material such as brass, and seated within a recess formed in the upper face of cap 2 concentric with the armature 15. The ring is provided with a radially extending ear 19*a* which terminates in an upwardly extending portion 19*b* having a slot 19*c* formed in the upper end thereof.

A resilient wire 20 has one end thereof secured to the upper end of armature 15 and the other end is positioned within the slot 19*c* and is secured to the part 19*b* in any suitable manner as by soldering. As shown in Figures 1 and 3 of the drawing, the wire 20 is arranged parallel with the fore and aft axis of the pickup, and this wire, together with the resilient disc 18 serves to maintain the armature 15 in a vertical position against frictional drag of the record on the stylus. The spring 20 also serves as a resilient centering element tending to maintain the upper end of the armature 15 in its normal or central position with respect to pole pieces 11 and 12. As shown in Figure 1, it is preferred that the wire 20 be located as near the upper or top end of the armature as possible.

As shown in Figure 1, the upper end of the armature 15 is provided with a central bore to reduce the weight of the armature, and the torsional compliance wire 20 is secured to the armature by having the end thereof extending through a transverse bore formed in the upper end of the armature, the end of the wire being soldered to the armature.

The magnetic structure includes one or more permanent magnets which polarize the two pole pieces 11 and 12 at opposite polarity with respect to the neutral pole 6. As shown in Figure 4, the preferred arrangement is to form the vertical magnetic bars 9 and 10 as permanent magnets, but these bars may be formed of soft iron or other suitable magnetic material while the magnetic plate 5 may be formed as a permanent magnet with opposite poles arranged in contact with the bars 9 and 10.

As explained above, it is preferred to form the magnetic structure and the pickup winding as a unitary structure which may be inserted and removed through the upper end of the casing 1. Where the magnets 9 and 10 are soldered to the plate 5 and to the magnetic pole pieces 11 and 12, it is preferred to first assemble these parts by the necessary soldering operations before core 6 and the coil 8 are placed in position. After the soldering operations have been completed, the spool 7 carrying the winding 8 is inserted between the magnets 9 and 10 from the front of the magnetic assembly, and this is made possible by the parallel inner faces of the magnets 9 and 10 as explained above. When the spool is in its proper position, the core rod 6 is inserted into spool 7 from the bottom of the structure, the spacing between the pole tips of the pole pieces 11 and 12 being sufficient to pass the rod 6. The reduced upper end of the rod 6 is passed through the central opening in the disc 5 and is riveted to the disc as shown in Figure 4.

The casing 1 is provided with rearwardly extending boss 1*c* of hollow construction for receiving an insulated insert 1*d* which carries two contact prongs 1*e* by which the pickup winding 8 may be connected to an external circuit. The boss 1*c* is provided with a pair of vertically extending holes 1*f* for receiving mounting screws by which the pickup may be mounted upon any suitable support.

The magnet and coil assembly may be secured in casing 1 in any suitable manner, as by cementing, or by spinning over the upper edge of casing 1 as shown in Figure 1.

The operation of the pickup may be explained by reference to Figure 4.

Normally the spring 20 and the resilient disc 18 will maintain the armature 15 in a vertical position so that the upper end of the armature will be substantially centered in the air gap between the tips of pole pieces 11 and 12. When the armature is vibrated by the groove on a record, the stylus end of the armature will move either in the direction L′ or L″, and the axis about which the armature vibrates is represented at 18′. When the stylus end of the armature moves in the direction L′, the

upper end of the armature moves toward the pole piece 12 and away from pole piece 11 thereby reducing the reluctance of the magnetic path for flux from magnet 10 through center leg 6, and correspondingly increasing the reluctance of the magnetic path for flux supplied from magnet 9 through center arm 6. This causes the flux to pass upwardly through the arm 6 in proportion to the amount of deflection of the armature. When the armature moves in the direction L'' the reverse action takes place and flux from magnet 9 flows downwardly through center leg 6. The final result is the generation of an alternating current voltage in the winding 8 which faithfully follows the vibration of the armature. Vibration of the armature effects opposite variations in the effective lengths of the air-gaps between the neutral pole 6 and the two poles 11 and 12.

When it becomes necessary to replace the stylus this may be done very quickly by loosening the screw 3 and removing the cap 2 and replacing it with a new cap carrying a new armature and stylus. This arrangement also permits the pickup to be used on both long playing records and ordinary records which require stylus points of different sizes. Each individual stylus is provided with its own mounting cap which may be mounted on the pickup casing without the exercise of any special skill.

The clamping screw 3, in cooperation with the slot in the cylindrical flange 2*a* of the cap 2 serves to index or properly position the stylus mounting with respect to the magnetic circuit so that the compliance wire 20 is always parallel with the fore and aft axis of the pickup. It will also be understood that the cavity provided in the upper face of cap 2 is provided with an indexing portion which receives the ear 19*a* of the ring 19 and maintains the wire 20 in proper relation with respect to the slot in the flange 2*a*.

In Figures 8 and 9 of the drawing I have shown a modified form of resilient wire 20 in which a small loop 20*a* is provided to permit a slight amount of compliance axially of the spring, and this seems to give sharper reproduction. This feature is disclosed in my earlier filed application Ser. No. 73,084.

My improved pickup is a highly efficient device and in actual construction it is of considerably smaller size than represented in the drawings. For example, a pickup constructed according to my invention and producing highly satisfactory results has an outside diameter of less than three-quarters of an inch and a height of less than five-eighths of an inch. This small size is made possible by the improved magnetic circuit in which the central arm of the E-shaped magnetic core is made shorter than the two outer arms, and the pickup coil substantially fills the entire space between the central arm and the two outer arms and extends beyond the free end of the central arm to provide a cavity for receiving the end of the armature. This arrangement reduces to the minimum the amount of iron required in the magnetic circuit, and it also provides for very effective modulation of the flux by the armature which may be of very small size. For example, in the model referred to above the armature has a length of only 0.245'', including the stylus tip, and a diameter of only 0.055''.

The disc of rubber 18 which supports the armature within the cap 2 also is of very small size in the model referred to and has a diameter of only 0.185'' and a thickness of 0.045''. The suspension disc 18 not only serves to support the armature but it has an inherent damping effect on the armature. The disk 18 also functions somewhat as a shock absorber with respect to the forward thrust of the record groove against the stylus. Since the lower end of the armature can yield minutely in a forward direction under the forward drag of the record on the stylus, the stylus will have much smoother tracking in the groove than in case the armature should be held rigid. Of course, the wire 20 prevents the upper end of the armature from tilting under the action of the record drag, while permitting free vibration of the armature at right angles to the wire.

Among the advantages of my improved pickup construction are: extremely high compliance of the armature mounting; extremely low tracking pressure (only 2 grams being required); intermodulation is below one percent; the frequency response of the pickup is flat from 50 to over 20,000 cycles per second; smallness in size already mentioned; the case with which a new armature and stylus may be substituted in the pickup.

I claim:

1. A pickup device comprising a cylindrical casing, a disc of magnetic material mounted to close one end of said casing, a magnetic core rod secured to said disc at the center thereof and extending inwardly of said casing, a pickup coil surrounding said core rod and extending beyond the end of said core rod to provide a central cavity therein adjacent the end of said core rod, a pair of magnetic arms arranged parallel with said core rod and positioned on opposite sides of said coil, each arm being connected at one end with said magnetic disc, the other ends of said arms extending to the extended end of said coil, a pair of magnetic pole pieces mounted on the free ends of said magnetic arms and extending inwardly across the free end of said coil to provide an air gap between said pole pieces in front of said cavity and in alignment with said core rod, a removable cap closing the other end of said casing adjacent said pole pieces and having a central aperture formed therein in alignment with said core rod and said air gap, an elongated magnetic armature, and resilient means carried by said cap for mounting said armature within said aperture coaxially with said core rod and having the inner end thereof extending into said air gap and into the coil cavity adjacent the free end of said core rod.

2. A pickup device according to claim 1 wherein said resilient means comprises a disk of rubber closing the aperture in said cap and having a central aperture in which said armature is supported.

3. A pickup device according to claim 2 and including a resilient wire having one end thereof secured to the inner end of said armature and extending transversely of said armature at right angles to the common plane of said magnetic arms, and means rigidly securing the other end of said wire to said cap.

4. A pickup device comprising a cylindrical casing, a disc of magnetic material mounted to close one end of said casing, a magnetic core rod secured to said disc at the center thereof and extending inwardly of said casing, a pickup coil surrounding said core rod, a pair of magnetic arms arranged parallel with said core rod and positioned on opposite sides of said coil, each arm being connected at one end with said magnetic disc, the other ends of said arms extending beyond the free end of said core rod, a pair of magnetic pole pieces mounted on the free ends of said magnetic arms and extending inwardly towards the axis of said core rod, the inner ends of said pole pieces being spaced apart to provide an air gap between said pole pieces in front of the free end of said core rod, the removable cap closing the other end of said casing adjacent said pole pieces and having a central aperture formed therein in alignment with said core rod and said air gap, an elongated magnetic armature, and resilient means carried by said cap for mounting said armature within said aperture coaxially with said core rod and having the inner end thereof extending into said air gap and adjacent the free end of said core rod.

5. A pickup device comprising a tubular casing, a plate of magnetic material mounted to close one end of said casing, a magnetic core rod secured to said disc at the center thereof and extending inwardly of said casing, a pickup coil surrounding said core rod, a pair of magnetic arms arranged parallel with said core rod and positioned on opposite sides of said coil, each arm being connected at one end with said magnetic plate, the other ends of

said arms extending beyond the free end of said core rod, a pair of magnetic pole pieces mounted on the free ends of said magnetic arms and extending inwardly towards the axis of said core rod, the inner ends of said pole pieces being spaced apart to provide an air gap between said pole pieces in front of the free end of said core rod, a removable cap closing the other end of said casing adjacent said pole pieces and having a central aperture formed therein alignment with said core rod and said air gap, an elongated magnetic armature, and resilient means carried by said cap for mounting said armature within said aperture coaxially with said core rod and having the inner end thereof extending into said air gap and adjacent the free end of said core rod.

6. A pickup device according to claim 5 and including means carried by said cap for constraining said armature for vibration in the plane of said magnetic arms.

7. A pickup device comprising a tubular casing, a plate of magnetic material mounted to close one end of said casing, a pair of magnetic arms secured at their ends to the inner face of said plate and extending inwardly of said casing in parallel relation, a pair of magnetic pole pieces mounted on the free ends of said magnetic arms and extending inwardly towards the center of said casing, the inner ends of said pole pieces being spaced apart to provide an air gap between said pole pieces, a removable cap closing the other end of said casing adjacent said pole pieces and having a central aperture formed therein in alignment with said air gap, an elongated magnetic armature positioned within said aperture and having the inner unsupported end thereof extending into said air gap, resilient means carried by said cap for supporting said armature for vibration in the plane of said pole pieces and about an axis located in front of said pole pieces, a resilient wire having one end thereof secured to the inner end of said armature and extending transversely of said armature at right angles to the common plane of said magnetic arms, and means rigidly securing the other end of said wire to said cap.

8. A pickup device according to claim 7 wherein said resilient means comprises a disk of rubber forming a closure for the aperture of said cap and having a central aperture in which said armature is supported.

9. A pickup device comprising an E-shaped magnetic core having three parallel arms arranged in a common plane, a pickup coil surrounding the center arm of said core and extending beyond the free end of said center arm to provide a cavity in said coil adjacent the end of said center arm, the outer arms of said core extending substantially to the free end of said coil, a pair of magnetic pole pieces mounted on the free ends of said outer arms and extending across the free end of said coil to provide an air gap between said pole pieces in front of said cavity and in alignment with said center arm, an elongated magnetic armature positioned in said air gap in alignment with said center arm, with the inner end thereof extending into the cavity of said coil into closely spaced relation with the free end of said center arm, and resilient means engaging said armature at a point on the outside of said pole pieces for supporting said armature for vibration about an axis located in front of said pole pieces.

10. A vibration translating device comprising a magnetic unit having a T shaped core of magnetic material and a pair of permanent bar magnets extending parallel to the stem of said core, each of said bar magnets having an inwardly directed pole piece at the free end thereof, the inner ends of said pole pieces being spaced apart to define an air gap beyond the stem end of said T, a suspension unit comprising a support having a block of resilient material fixed thereto, an armature fixed in and carried by said block and having its free ends extending beyond the opposite sides of said block, one end of said armature comprising a stylus holder, means for removably securing said units together with the other free end of said armature in said air gap and in closely spaced relation with the end of the stem of said T, a strip of spring material having one end fixed to the said other end of said armature, said strip having another end secured in fixed relation to said support, said means for removably securing said magnetic unit and said suspension unit comprising means for orienting said units with said strip in line with the record drag on said stylus and with said strip serving as a tension member to resist such drag.

11. A pickup device according to claim 1 and including a resilient wire having one end thereof secured to the inner end of said armature and extending transversely of said armature at right angles to the common plane of said magnetic arms, and means rigidly securing the other end of said wire to said cap and a stylus secured to outer end of said armature.

12. A pickup device comprising a cylindrical casing mounted with its axis in a vertical direction and being open at its lower end, a magnetic structure mounted within said casing and comprising a fixed magnetic core mounted centrally of said casing with its axis in a vertical direction, a pickup coil surrounding said core, a pair of magnetic arms arranged parallel with said core and positioned on opposite sides of said coil, the lower ends of said arms extending below said coil and providing an air gap between said arms below the lower end of said core, a removable cap closing the lower end of said casing and having a central aperture formed therein in alignment with said core and said air gap, an elongated magnetic armature, and resilient means carried by said cap for mounting said armature within said aperture coaxially with said core and having the inner end thereof unsupported and extending into said air gap and being magnetically coupled with the lower end of said core, the outer end of said armature comprising a stylus support, said resilient means supporting said armature for vibratory movement about a horizontal axis lying substantially in the plane of said cap.

13. A pickup device comprising a main casing having an opening in a lower part thereof, a magnetic structure housed within said casing and including a pair of pole pieces having pole tips arranged adjacent said opening and being spaced apart horizontally on opposite sides of a vertical reference plane, a third pole member located in said reference plane and presenting a pole tip spaced vertically from said pair of pole tips, said magnetic structure also including magnetizing means for magnetizing said pair of pole tips at opposite polarities with respect to said third pole tip, a pickup coil housed within said casing and linking magnetic flux flowing through said third pole member, a casing part formed separately from said main casing and forming a cover for said opening, means for detachably securing said cover part to said main casing, said cover part having an aperture formed therein, on a vertical axis lying in said reference plane, an elongated magnetic armature mounted vertically within said aperture with a portion thereof magnetically coupled to said third pole tip and another portion magnetically coupled to said pair of pole tips, said armature extending downwardly out of said aperture and having a stylus support at the lower end thereof, and resilient means carried by said cover part and mounting said armature for vibratory movement about a horizontal axis lying substantially within the plane of said cover piece and located substantially in said reference plane, said horizontal axis being located at a point on the axis of said armature to effect variations in the air-gaps between said third pole tip and the poles of said pair of tips in opposite directions.

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