

[54] **REPLACEABLE STYLUS FOR STEREOPHONIC PHONOGRAPH PICKUP**

3,538,266	11/1970	Cho.....	179/100.41 K
3,694,586	9/1972	Grado .....	179/100.41 Z
3,700,829	10/1972	Anneberg.....	179/100.41 Z
3,763,335	10/1973	Morita.....	179/100.41 M

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[57] **ABSTRACT**

A magnetic stereophonic phono cartridge having a replaceable stylus unit. The stylus unit comprises a support body including an armature of permeance material provided with a stylus arm with a stylus at the free end thereof, the armature being supported on the support body by means of a ring of elastic material; and further including an annular magnet being magnetized in an axial direction and coaxially surrounding the armature between the two ends thereof and being positioned close to the ring of elastic material.

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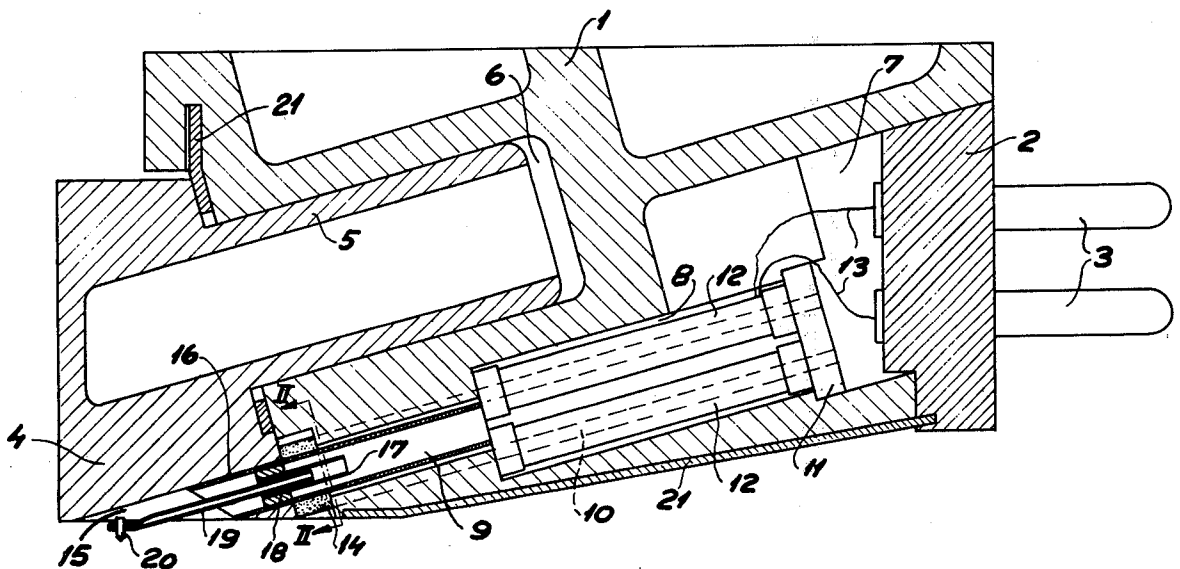
[51] Int. Cl..... **H04r 11/00**

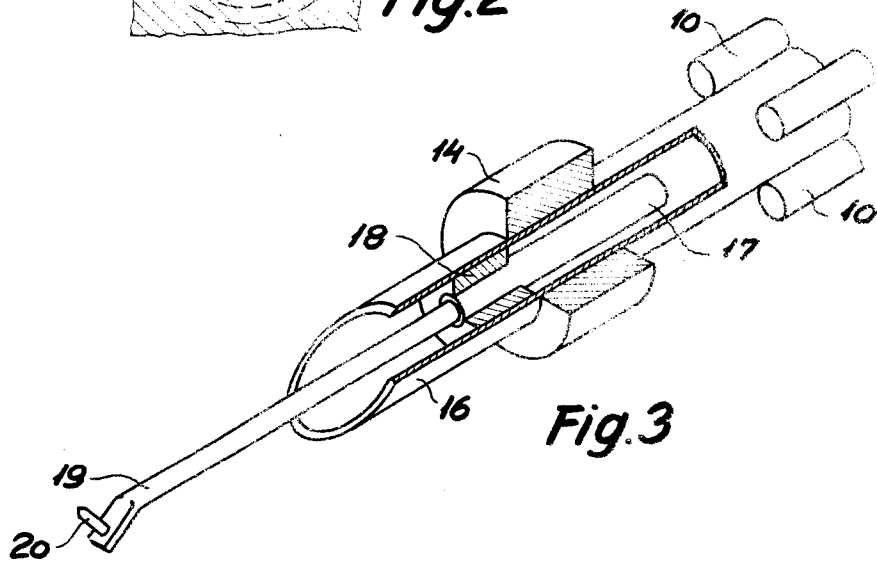
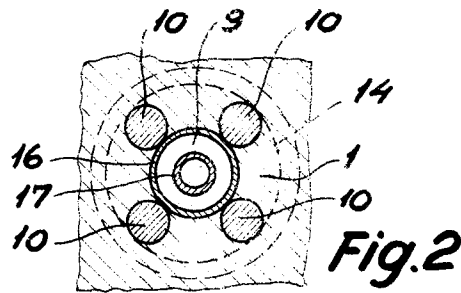
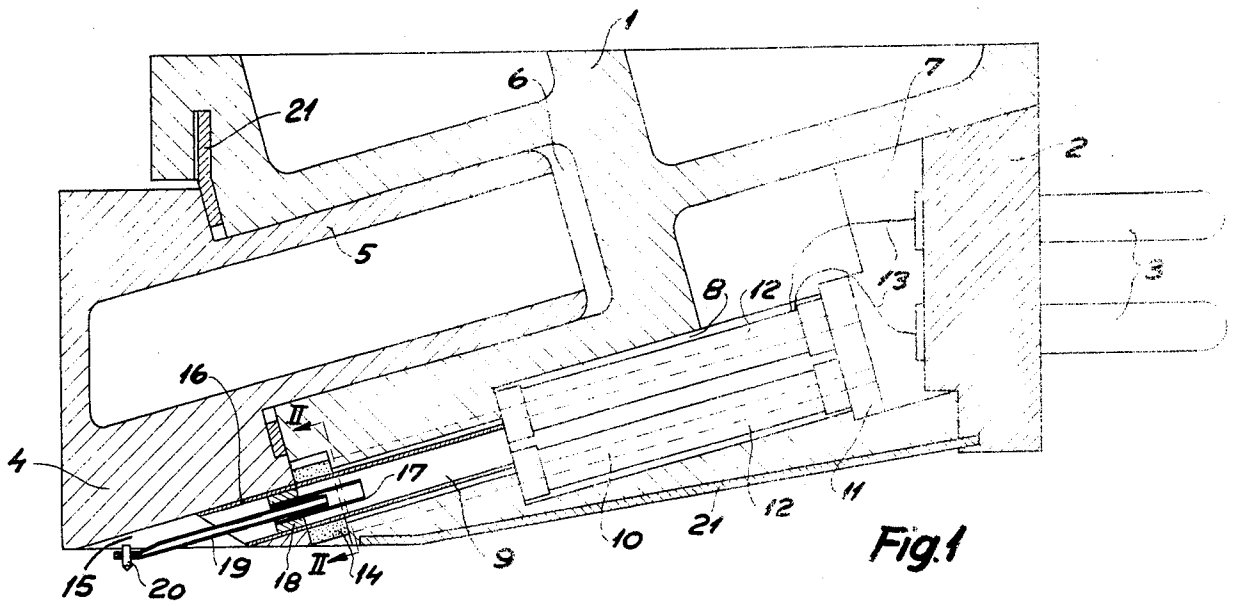
[58] Field of Search ..... **179/100.41 K, 100.41 Z, 179/100.41 S, 100.41 M, 100.41 D; 274/37**

[56] **References Cited**  
**UNITED STATES PATENTS**

3,294,405 12/1966 Pritchard ..... 179/100.41 K

**26 Claims, 3 Drawing Figures**





# REPLACEABLE STYLUS FOR STEREOPHONIC PHONOGRAPH PICKUP

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention, like that of U.S. Pat. application Ser. No. 885,220, filed Dec. 15, 1969, now U.S. Pat. No. 3,700,829 relates to electromagnetic transducers for reproduction of stereophonic phonograph records and particularly to replaceable stylus assemblies in which a portion of the magnetic circuit is incorporated into the replaceable assembly.

More particularly, the invention relates to such transducers having a magnetic structure defining an airgap and comprising four magnetic legs each surrounded by its respective coil and forming an airgap in which a stylus carrying armature is pivotally mounted; the armature also carries permanent magnetic means for producing a magnetic field which cooperates with the magnetic legs to form a magnetic circuit loop. By arranging the magnetic legs in two pairs perpendicular to each other the signals produced by movements of the stylus can be decomposed into two components each corresponding to its respective recording track of a stereophonic record.

### 2. Description of the Prior Art

In the early pickup assemblies of this type, the armature itself is constituted by a permanent magnet. However, the still increasing requirements as to reproduction of signals at the upper end of the tone frequency spectrum has led to the development of pickups in which the effective stylus mass has been reduced by using a permanent magnet placed outside the oscillating stylus system for producing the magnetizing force, so that the armature may be constituted by a light tube of magnetically conducting material such as soft iron.

The known pickups of this kind have the feature in common with other magnetic pickup assemblies that the armature is coupled magnetically in series with the coil carrying legs, so that the signal-producing flux changes are produced by alterations of the overall reluctance of the magnetic circuit caused by movement of the armature.

## SUMMARY OF THE INVENTION

According to the present invention, a novel structure is provided in which the armature is so placed that it forms a magnetic load coupled in parallel with the permanent magnet or magnets, the four coil carrying legs forming two magnetic conductors each having both ends engaging the same pole face of the permanent magnet or pole faces of the same polarity of the permanent magnet. In the rest position of the armature, in which the structure is perfectly symmetrical, both ends of each magnetic conductor are at the same magnetic potential and hence no flux is flowing through the coil carrying legs. When the armature is deflected, however, the magnetic load on the permanent magnet portion opposite one end of a magnetic conductor is increased while the load on the magnet portion opposite the other end of said conductor is decreased resulting in the occurrence of a magnetic potential difference between the ends of the magnetic conductor whereby a flux is produced in the coil carrying legs.

An object of the invention is to provide an improved electromagnetic transducer in which the effective mass

of the oscillating stylus system is reduced by placing the permanent magnet or magnets outside said system.

It is a further object of the invention to provide a transducer in which the magnetic structure including the armature is perfectly symmetrical.

A still further object of the invention is to provide a magnetic structure for use in a transducer in which the coil carrying legs can be made very thin thus allowing the use of signal coils having low resistance and capacity.

Another object is to provide a replaceable stylus assembly in which the permanent magnet portion is incorporated into the replaceable assembly.

Another object of the invention is to provide an electromagnetic transducer which is easy and cheap to produce.

Still another object of the invention is to provide a magnetic stereo pickup having improved sound reproduction characteristics, particularly at the upper end of the tone frequency range.

## BRIEF DESCRIPTION OF THE DRAWING

Other objects and advantages will appear from the following description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a longitudinal section of an embodiment of the pickup according to the invention;

FIG. 2 is a section along the line II—II in FIG. 1; and

FIG. 3 is a perspective view of the front end of the magnetic system with the stylus assembly partially removed.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The pickup shown in FIGS. 1-3 comprises a housing 1 cast in a suitable plastics material. At one end the housing has a recess 7 in which is mounted a contact member 2 with four legs 3, of which only two are shown in FIG. 1. At the other end of the housing is provided a replaceable stylus assembly comprising a cast plastics support body 4 which, by means of a projecting hollow guide pin 5 of non-circular cross-section, engages a recess 6 formed in the housing 1 and having the same cross-section.

Between the bottom of the recess 7 and the front face of the housing 1 is provided a through-going recess with a rear portion 8 of substantially square cross-section and a front portion 9 the cross-section of which, as indicated in FIG. 2, is formed as a middle circle and four peripheral circles tangential to the middle circle and equally spaced along the periphery thereof.

The said through-going recess 8, 9 serves as accommodation for the magnetic system which comprises four cylindrical legs 10 of permalloy, the front portions of which are disposed in their respective cylindrical edge portions of the recess 9 and extend rearwardly through the recess 8. The rear ends of the legs 10 are attached to and interconnected magnetically by a cross member 11, which is likewise made of permalloy. About each leg 10 is disposed a coil 12 which is mounted in the recess 8, and each pair of diametrically opposed coils are connected to one another and to two of the legs 3 by leads 13.

In the lower portion of the support body 4 of the stylus assembly is formed an inclined cylindrical, through-going channel 15 opening in the under face of the body and forming an elongation of the recess 9 in the hous-

ing 1. In this channel is secured a tube 16 of a non-magnetic material, for instance aluminum, which projects from the support body 4 and, when the stylus assembly is fitted, enters the cylindrical central portion of the recess 9. An annular permanent magnet 14, which is magnetized in the axial direction and which consists of a ceramic, magnetically anisotropic material is coaxially mounted about the exterior portion of tube 16 adjacent the face of body 4. When the support body 4 is mounted in the housing 1, the magnet 14 is disposed in an enlarged section of the recess 9 at the front of the housing 1.

A tubular soft iron armature 17 is mounted within the tube 16 by means of an annular, resilient pad 18, for instance of rubber or neoprene, to be freely pivotable in all directions about a point disposed in or adjacent to the center of the pad. The armature 17 is slightly longer than the annular magnet 14 and is disposed coaxially with and symmetrically with respect to the magnet. To the armature is attached one end of a tubular, thin-walled aluminum stylus 19 extending through the channel 15. The free end of the stylus arm 19 projecting outwardly of the support body 4 is flattened and supports a stylus 20.

On the under face of the housing 1 is mounted a magnetic screen 21 which extends upwardly along the front face of the housing between the housing and the support body 4 of the stylus assembly.

In accordance with the present invention, the annular magnet is firmly attached to the replaceable stylus unit. By means of this special arrangement a number of advantages are obtained. First of all, it is obvious that different types of annular magnets could be used in the replaceable stylus unit so that it will be possible to alter the pickup by replacing the stylus unit with another having a different type of magnet. This would not be possible by a construction where the magnet is fixed in the housing, such as in Ser. No. 885,220, of which this invention constitutes an improvement.

It should also be mentioned that the armature could consist not only of a permeance material but also of a magnet having its poles positioned opposite the poles of the annular magnet. If such an embodiment is used, it is, of course, of greatest importance that during the production of the stylus unit the two magnets be positioned correctly relatively to one another. Further, it would completely spoil the armature magnet if, by replacement of the stylus unit, this armature magnet were removed from its position within the annular magnet. It might also be mentioned that in the novel construction disclosed herein the annular magnet will have a tendency to support the forces holding the stylus unit firmly in its position with the annular magnet abutting the free ends of the four rods in the housing.

The operation of the magnetic pickup comprising the composite units of the support body and main housing is fully disclosed in the aforementioned U.S. Pat. application Ser. No. 885,220, the pertinent portions of which are incorporated herein by reference. Generally, the anisotropic ceramic annular magnet 14 shows great reluctance in all directions perpendicular to the axial direction and is therefore magnetically equivalent to two permanent rod magnets disposed at the end and in extension of their respective legs 10. Assuming the two magnets to be of equal strength, the magnetic conductor formed by the legs 10 and the cross member 11 will have the same magnetic potential at its two end faces

in the neutral position of the armature 17, and no flux will therefore flow through this conductor. But a relatively high flux will pass from the north pole of each magnet through the armature to the south pole of the magnet, and as the armature has a much lower reluctance than the ceramic magnet 14 and the airgaps in actual practice are very small, this flux may, with some justification, be described as a short circuit flux.

If the armature as a result of the stylus movement oscillates upwards in the plane of the paper it will approach the upper magnet and thereby reduce the reluctance in the short circuit flux path for said magnet and simultaneously move away from the lower magnet, with the result that the short circuit flux thereof meets increased reluctance. In other words, the upper short circuit flux will be increased and the lower short circuit flux will be reduced. On account of the relatively high inherent reluctance of the magnets this will cause the magnetic potential at the north pole of the upper magnet to be reduced, while the magnetic potential at the north pole of the lower magnet will be increased. Thus a magnetic potential difference is created between the two ends of the magnetic conductor 10, 11, 10 in response to the armature movement, which results in a flux in the conductor inducing in the coil windings 12 electrical voltages which added together represent the sensed sound signal.

Armature oscillations resulting from the other sound channel follow a direction perpendicular to the plane of the paper and are converted in the same manner to electrical voltages in the second half of the electromagnetic system disposed in this plane.

The magnetic conductor 10, 11, 10 leads only the effective signal flux which changes direction in response to the armature oscillations, and the legs 10 can therefore be designed very thin without risking that the magnetic point of operation deviates from the rectilinear part of the magnetization curve.

The stereo pickup described above and shown in FIGS. 1-3 of the drawings can be changed into a mono pickup, merely by removing one pair of legs 10 and rotating the remaining pair an angle of approximately 45° about the common axis of the magnetic structure with respect to the stylus assembly.

In the embodiment described, the armature 17 is constituted by a thin-walled tube of soft iron, by which the effective inertia of the oscillating stylus assembly is minimized. It is within the scope of the invention, however, to replace the soft iron armature by a permanent magnet which may be tubular or rod shaped and which is poled oppositely to the fixed, outer magnet, so that it increases the short circuit flux. In this way, the sensitivity of the pickup can be increased to some degree.

It will be understood that the invention is not limited to the embodiments shown and described and that it will be possible within the scope of the invention to modify the structure in various respects. Thus for example, the legs 10 may be square or rectangular in cross-section instead of circular as also the armature may have other cross-section shapes.

What is claimed is:

1. An electromechanical transducer comprising a housing having a bore extending at one end obliquely into one surface thereof and a replaceable stylus unit adapted to be removably inserted into said bore, said stylus unit comprising an annular permanent magnet, a stylus carrying armature resiliently pivotally supported

within said unit and disposed coaxially with said annular magnet, plural rods of a high permeance material disposed within said housing and spaced around the axis of said bore, means including magnetizable material magnetically interconnecting the inner ends of said rods, and coils mounted on said rods, the arrangement of said rods within said housing being such that their free end faces abut one pole face of the annular permanent magnet when said stylus unit is inserted into said housing.

2. The combination according to claim 1, wherein said armature is a hollow annular cylinder having an axial length greater than the axial length of said permanent magnet.

3. The combination according to claim 2, wherein is provided a stylus arm for said stylus, said stylus arm having one end mounted within said hollow annular cylinder and having a stylus at its other end.

4. The combination according to claim 3, wherein said armature is a permanent magnet.

5. The combination according to claim 3, wherein said armature is fabricated of magnetically permeant material.

6. In an electromechanical transducer comprising a housing having at one obliquely into one surface thereof, four rods of a high permeance material extending parallel to and equiangularly spaced around the axis of said bore and having outer and inner ends, means magnetically interconnecting the inner ends of said rods, and four coils mounted on said rods respectively between the other end of said bore and said inner ends, said coils being series connected in pairs each comprising oppositely disposed coils and connected to respective terminals, the provision of a replaceable stylus unit adapted to be inserted into the housing by sliding the unit in the direction of the axis of said bore in the housing, said stylus unit comprising a hollow tube of non-magnetic material, an armature of permeance material provided with a stylus arm with a stylus at the free end thereof, said armature being supported with respect to said hollow tube by means of a ring of elastic material, and an annular permanent magnet magnetized in the axial direction mounted on and externally of said hollow tube, said magnet being positioned for abutting said outer ends of said four rods when said hollow tube is located in said housing.

7. The combination according to claim 6, wherein said armature is a hollow cylinder, and wherein said stylus unit includes a stylus support rod having one end supported internally of said hollow cylinder and having another end supporting a stylus.

8. The combination according to claim 7, wherein said armature is a permanent magnet.

9. The combination according to claim 7, wherein said armature is a hollow cylinder of magnetically permeant material.

10. A transducer, comprising a plastic body having terminals extending therefrom, a stylus bearing replaceable cartridge, said body including a recess, said cartridge having an extension mating into said recess to provide a rigid mounting for said cartridge relative to said body, said body mounting four relatively spaced permanent rods having inner ends and outer ends, means magnetically shorting said outer ends, said cartridge including a stylus assembly which includes an annular permanent magnet having its ends of opposite polarities, a magnetic armature passing through said

annular permanent magnet, means mounting said armature for free pivoting with respect to said permanent magnet, a stylus arm secured to said armature at one end of said stylus arm, a stylus secured to the other end of said stylus arm, said permanent magnet being positioned to abut said inner ends when said cartridge is inserted into said body, and coils connected to said terminals and respectively wound about said rods.

11. The combination according to claim 10, wherein is provided a hollow non-magnetic tube, a resilient annulus securing said armature internally spaced with respect to said tube, said permanent magnet being mounted on said tube exteriorly of said tube, and said resilient annulus enabling free pivoting of said armature in any direction with respect to the axis of said armature and of said tube.

12. The combination according to claim 11, wherein said resilient annulus extends axially beyond said permanent magnet, and wherein said armature extends through said resilient annulus in one direction and beyond said permanent magnet in a direction opposite to said one direction, whereby said permanent magnet is axially coextensive with only part of said armature.

13. The combination according to claim 10, wherein said recess extends on an acute angle to said terminals.

14. The combination according to claim 10, wherein said body includes a further recess for accepting said stylus mounting, said further recess and said first mentioned recess having parallel axes.

15. The combination according to claim 11, wherein said body includes a further recess for accepting said stylus mounting, said further recess and said first mentioned recess having parallel axes.

16. The combination according to claim 12, wherein said body includes a further recess for accepting said stylus mounting, said further recess and said first mentioned recess having parallel axes.

17. The combination according to claim 13, wherein said body includes a further recess for accepting said stylus mounting, said further recess and said first mentioned recess having parallel axes.

18. A replaceable stylus assembly for a phonograph record reproducer, comprising a non-magnetic hollow cylinder, a cylindrical axially hollow permanent magnet mounted externally on said hollow cylinder, said magnet having oppositely polarized ends, a flexible annulus mounted interiorly of said hollow cylinder, said flexible annulus being coaxial with said magnet and offset axially from said magnet, a hollow cylindrical permeance armature mounted interiorly of said annulus, said armature extending axially beyond said magnet in two directions, a stylus arm having one end secured within said hollow of said armature and having another end externally of said armature, and a stylus secured to said another end.

19. The combination according to claim 18, wherein said armature is a permanent magnet having its ends oppositely polarized.

20. The combination according to claim 18, wherein said armature is fabricated of magnetically permeant material.

21. An electromechanical transducer comprising a housing having a bore extending at one end obliquely from one surface thereof and a replaceable stylus unit adapted to be removably inserted into said bore, said stylus unit comprising an annular permanent magnet, a stylus carrying armature pivotally supported within said

unit and disposed coaxially with said annular magnet, four rods of a high permeance material disposed within said housing extending parallel to and equiangularly spaced around the axis of said bore and extending beyond the other end thereof, a cross piece of magnetizable material magnetically interconnecting the inner ends of said rods and fixably held in the said housing, and four coils mounted on said rods at the inner ends thereof adjacent said cross-piece, said coils being series connected in pairs each comprising oppositely disposed coils and connected to respective terminals, the arrangement of said rods within said housing being such that their free end faces will abut one pole face of the annular permanent magnet, when the said stylus unit is inserted into the housing with its axis coinciding with the axis of said bore.

22. An electromechanical transducer as claimed in claim 21 in which the stylus unit comprises a connecting member extending parallel to the axis of the armature, and wherein the housing comprises a recess adapted to receive the connecting member when mounting the stylus unit on the housing.

23. An electromechanical transducer as claimed in claim 21 wherein the replaceable stylus unit further comprises a tubular member of a non-magnetizable material, an annular member of an elastic material for pivotally supporting the stylus carrying armature with said tubular member coaxially therewith, said annular permanent magnet surrounding said tubular member coaxially therewith and adjacent said annular support-

ing member therein.

24. The combination according to claim 21, wherein said armature is a permanent magnet.

25. The combination according to claim 21, wherein said armature has magnetic permeance.

26. In an electromechanical transducer comprising a housing having a bore extending at one end obliquely from one surface thereof, four rods of a high permeance material extending parallel to and equiangularly spaced around the axis of said bore and extending beyond the other end of said bore, a cross-piece of magnetizable material magnetically interconnecting the inner ends of said rods and fixedly held in said housing, and four coils mounted on said rods respectively between the other end of said bore and said cross-piece, said coils being series connected in pairs each comprising oppositely disposed coils and connected to respective terminals, the provision of a replaceable stylus unit adapted to be inserted into the housing by sliding the unit in the direction of the axis of said bore in the housing, said stylus unit comprising an armature of permeance material and being provided with a stylus arm with a stylus at the free end thereof, said armature being supported in the unit by means of a ring of elastic material, and an annular permanent magnet being magnetized in the axial direction, said magnet being positioned for abutting the outer ends of said four rods when the stylus unit is attached to the housing.

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