

D. J. MUNROE
TRANSDUCER

Filed July 29, 1950

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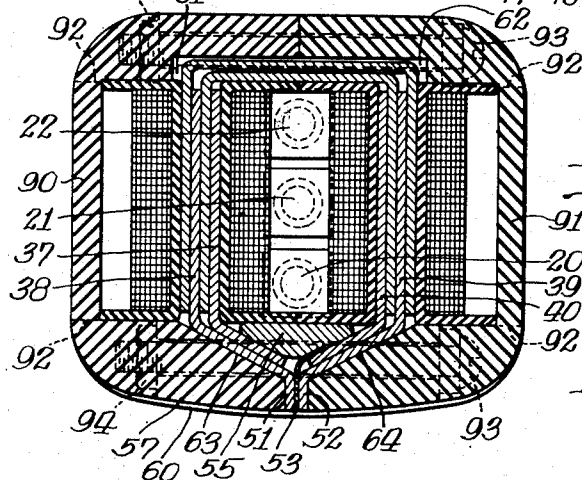
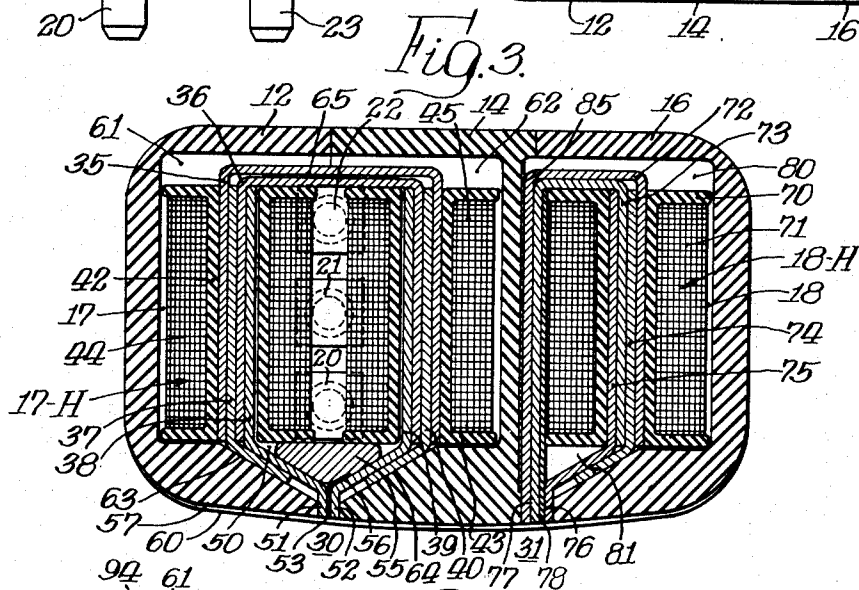


Fig. 4.

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Feb. 9, 1954

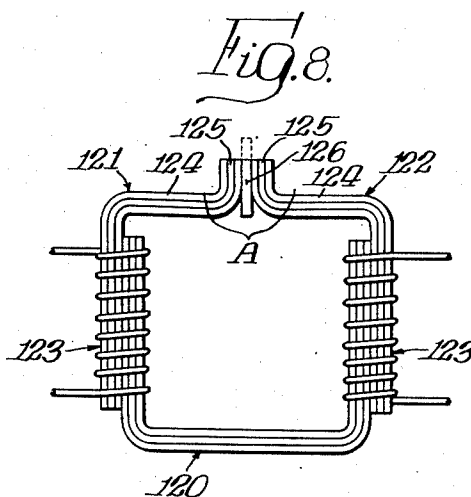
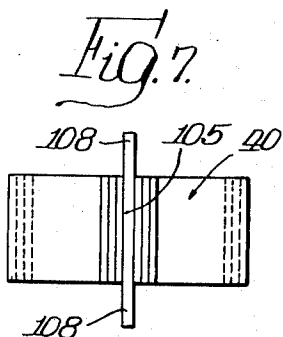
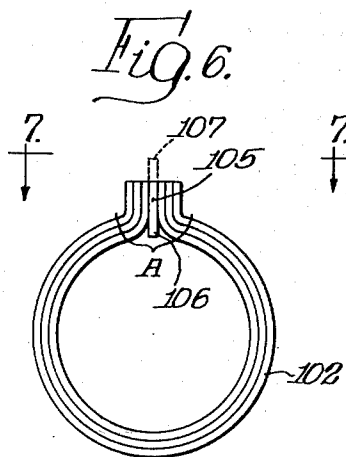
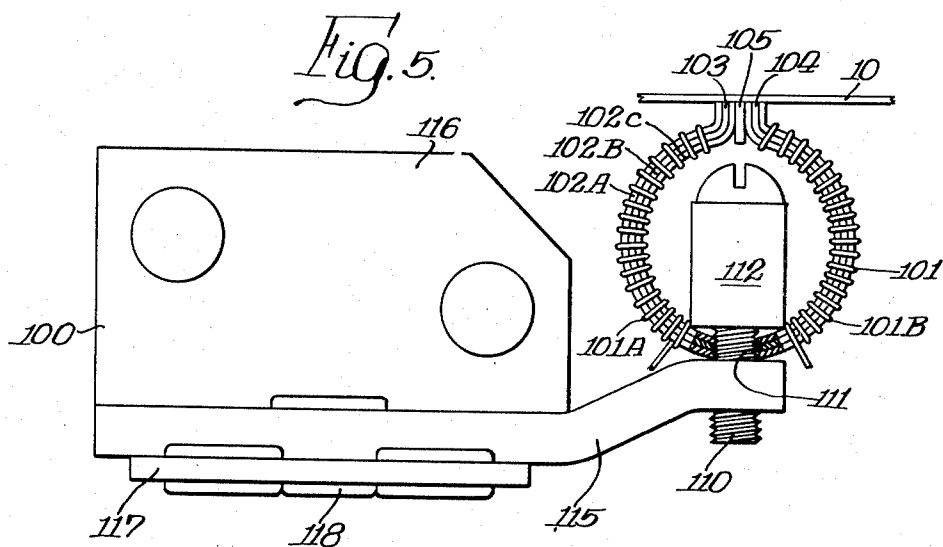
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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TRANSDUCER

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5 Claims. (Cl. 179—100.2)

1

2

The present invention relates to transducers, and, more particularly, to transducers of the magnetic type which are adapted for use with a longitudinally movable record medium and which may be used for recording, reproducing and erasing functions. The invention has for an object the provision of a transducer of this character which is economical to manufacture, efficient in operation, compact, simple and rugged in arrangement and construction. Specifically, the present application is a continuation-in-part of my copending application, Serial No. 162,697, which was filed May 18, 1950.

One of the problems involved in transducers of this type, and particularly in such transducers of relatively small dimensions, is the provision of a suitable core structure which has sufficient mechanical strength so that it can be better handled in assembly and to resist vibration and maintain the proper spacing between the pole pieces thereof to minimize distortion in the intelligence stored upon and reproduced from the longitudinally movable record medium. This problem is particularly important in connection with the use of laminated core structures for the magnetic circuits of transducers of this type due to the fact that the pole piece laminations are quite thin and difficulty is experienced in supporting the pole piece laminations in assembly and, in use, without the production of mechanical vibrations and the resultant noise in the output circuit of the transducer.

It is a further object of the present invention to provide a new and improved transducer for use with a longitudinally movable magnetic record medium in which a simplified and efficient magnetic circuit of interfitting laminations is employed which may be readily assembled on a mass production basis.

It is a still further object of the present invention to provide a new and improved transducer of the magnetic type in which a simplified and efficient magnetic circuit of interfitting laminations is employed and wherein mechanical support is provided for the free ends of opposed pole piece laminations while minimizing flux leakage therebetween.

It is a further object of the present invention to provide a new and improved plug-in type transducer for use with magnetic longitudinally movable record medium in which a record-reproduce head is spaced from and magnetically shielded from an erase head and both heads are completely enclosed in a unitary housing structure.

Briefly, in accordance with one aspect of the

present invention, the transducer includes a magnetic circuit consisting of interfitting laminations which may be readily assembled to form a generally rectangular core and pole piece defining structure, the latter including but short juxtaposed portions. A suitable coil structure is adapted to be placed on the core. A shim of nonmagnetic material is positioned between and in engagement with the pole piece laminations to provide accurate spacing of the pole pieces and to minimize flux leakage therebetween. Also, a spacer of nonmagnetic material is positioned in engagement with the free ends of the pole piece laminations to provide mechanical support therefor, this support being especially desirable during manufacture, and to provide further shielding against flux leakage. In accordance with a further aspect of the invention, the assembled core and coil structure is completely enclosed in complementary half shells of insulating material, between which half shells are provided pin type terminals. A further aspect of the invention resides in the provision of a unitary plug-in type transducer assembled in which a record-reproduce head and an erase head, the core structures of each of which consist of interfitting laminations, are positioned within an insulating housing and are magnetically shielded from each other.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

Fig. 1 is a front elevational view of a unitary record-reproduce-erase head constructed in accordance with the present invention, the container portion of which is shown only in part;

Fig. 2 is a bottom plan view of the transducer of Fig. 1, the container being omitted;

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 1, the container being omitted;

Fig. 4 is a view similar to Fig. 3 of a modified form of the transducer;

Fig. 5 is a plan view of a modified form of transducer, together with its supporting means;

Fig. 6 is a plan view of the magnetic core utilized in the transducer of Fig. 5;

Fig. 7 is a side elevational view of the core of Fig. 6 taken along the lines 7—7 thereof; and

Fig. 8 is a plan view of a further modified form of transducer.

While the transducer assembly of the present invention may be utilized with various types of

record media, it is particularly designed for use with an elongated magnetizable record medium which may be a tape coated or impregnated with magnetic material, such as the tape 10, of which a very short length is illustrated in Fig. 5. Furthermore, the transducer of the present invention is particularly adapted for use in magnetic recorder-reproducer apparatus of the type shown in my copending application referred to heretofore, and in my prior copending application, Serial No. 79,663, filed March 4, 1949.

Referring now particularly to the embodiment of the present invention shown in Figs. 1 to 3, inclusive, the transducer of the present invention is constructed as a structural unit and includes a metallic container 11 and a multi-section housing which is preferably made of insulating plastic material or the like, and comprises a left-hand section 12, a middle section 14, and a right-hand section 16. The sections 12, 14 and 16 are adapted to interfit so as to provide a completely enclosed structure for both a record-reproduce head and an erase head. Thus, the adjacent sections 12 and 14 are provided with complementary recesses which define a chamber 17 within which the core and coil structure of the record-reproduce head 17-H is contained. Likewise, the section 16 is provided with the recess 18 which cooperates with the wall of the section 14 to provide a chamber within which the core and coil assembly of the erase head 18-H is contained.

The necessary electrical connections are provided through a series of terminal pins which extend through and are secured in place by the wall portions of adjacent housing sections. Thus, the terminals 20, 21 and 22 are spaced along the adjoining edges of the sections 12 and 14 and the terminals 23, 24 and 25 are spaced along the meeting boundaries of the sections 14 and 16. The terminals have square heads received in square openings at the interior of the housing and reduced diameter neck portions whereby they are securely held in place.

The housing sections 12, 14 and 16 are further provided with openings in the front surface thereof through which project the pole piece structures of each transducer head. Thus, the pole piece structure 30 of the record-reproduce head 17-H projects through an opening formed by notches in adjacent housing sections 12 and 14 and the pole piece structure 31 of the erase head 18-H is positioned within an opening formed by cooperating notches in the adjacent edges of the housing sections 14 and 16.

In order to provide a core and coil structure for each transducer head which may be readily assembled, is of low cost, and is particularly suitable for transducers of relatively small dimensions, the core of each comprises a plurality of thin laminations of magnetic material that are interfitted to form the desired core shape. Thus, the core structure of the record-reproduce head comprises a plurality of inverted U-shaped base laminations 35 and 36 interfitted with a plurality of laminations 37, 38, 39 and 40. The interfitting laminations form a generally rectangular core structure, the opposed legs of which receive the coil forms 42 and 43 upon which are prewound the record-reproduce coils 44 and 45. The coils 44 and 45 have an equal number of turns and are connected in series in "humbucking" manner to the terminals 20 and 21 internally of the transducer housing. The front portions of the laminations 37 to 40 extend for-

wardly and inwardly to define a pocket 50 between the laminations and the front ends of the coil forms 42 and 43. The end portions of the inner laminations 38 and 39 further extend forward in parallel relation to define a pair of relatively short, juxtaposed and closely spaced flux concentrating pole pieces 51 and 52 between which there is positioned a shim or spacer 53 of electrically conducting nonmagnetic material. The spacer 53, which has a width approximately twice that of the pole pieces (see Fig. 1), acts as a shield between the spaced pole pieces 51 and 52 to minimize flux leakage between these pole pieces, thereby increasing the coupling between the magnetic record medium and the pole pieces to provide increased efficiency. Furthermore, the shim 53 accurately fixes the desirable close spacing between the pole pieces and imparts additional mechanical rigidity to the pole piece structure.

In order to provide mechanical support for the pole pieces 51 and 52 and the shim 53 and to provide additional shielding between the pole pieces, there is provided, in accordance with another feature of the present invention, a generally triangular prismatic brass block 55 which is positioned in the recess 50 and is seated upon the ends of the coil forms and engages the inner sides of the inwardly extending portions of front laminations 38 and 39. The outer sides front laminations 37 and 40 are engaged by the sloping inner walls 61 and 62 defining a trough for the reception of the front portion of the core structure. The nonmagnetic shim 53 is further held in place by tucking its inner end portion 56 between the block 55 and the sloping portion of the laminations 39. This construction definitely spaces the pole pieces 51 and 52 from the ends of the coil forms 42 and 43 and gives them mechanical support against any possible inward movement under the pressure of a magnetic type or other recording medium moving thereacross and, more importantly, during assembly and manufacture, especially when the front face of the structure is grooved to provide a tape receiving and guiding depression or pathway 57 inset some .025" below the front face 60 of the head.

In order additionally to prevent mechanical vibrations from being set up in the core and coil structure, the laminations are cemented together to provide a unitary core structure. Likewise, the housing sections 12, 14 and 16 of the transducer assembly are also secured together and to the core by cementing on the adjacent surfaces thereof. The core and coil structure is additionally secured within the chamber 17 by front and rear inner portions of sections 12 and 14 which engage the ends of the coil forms. Clearance for the tight portions of the laminations 35 and 36 is provided by recesses 61 and 62 at the rear ends of the housing sections.

In order electrically to connect the above-described laminated core structure to ground potential there is provided a thin conductive ground strip 65 which is positioned between the tight portions of the U-shaped laminations 35 and 36 and is connected to the ground terminal 22 internally of the chamber 17.

The erase head 18-H of the unitary transducer assembly of the present invention comprises a generally rectangular laminated core structure, one leg of which receives the coil form 70 and the prewound erase coil 71, the ends of which are connected to terminals 23 and 24. The core and coil structure of the erase head is

5

positioned within the cavity 18 and includes the pole piece structure generally illustrated at 31 which extends through the bottom surface 60 of the transducer assembly. The laminated core structure comprises a pair of U-shaped base laminations 72 and 73 which are interfitted with laminations 74 and 75. The front portions of the latter extend forwardly and inwardly. The short front end portion 76 of lamination 75 further extends in spaced parallel relationship to one end of the laminations 72 and 73 to form the opposed pole pieces 76 and 77. To provide a short gap between the pole pieces 76 and 77, there is provided the spacer 78 that is wider than the core structure, as shown in Fig. 1. It is of an electrically conducting nonmagnetic material, similar to the spacer 53 employed in the record-reproduce head. The strip 78 is in electrical contact with the entire length of one leg of the lamination 73 and is utilized as a ground strip to connect the core structure of the erase head to ground potential through the ground terminal 25. The strip is also somewhat heavier than shim 53 to give the core structure added strength and rigidity and to diminish further the flux leakage between the pole pieces.

The erase head core and coil assembly is supported within the chamber 18 like the record-reproduce head assembly. Thus, the chamber is provided at its ends with the recesses 80 and 81 to provide structure engaging the opposite ends of the coil form 70 and core structure.

In order magnetically to separate the erase coil 71 from the record-reproduce coils 44 and 45, there is provided a conductive shield 85 which is positioned between one side of the lamination 72 and the adjacent wall of the housing section 14. The shield 85 extends substantially the full length of the chamber 18 and effectively isolates the magnetic fields produced by the erase coil from the record-reproduce head.

Considering now the manner in which the above-described multiple head transducer unit may be assembled, it will be understood that the laminations of both the record-reproduce head and the erase head core structure are particularly designed for simplicity and ease in assembly. Thus, considering the record-reproduce head, the inverted U-shaped laminations 35 and 36 are inserted into the central opening of the spaced coil forms 42 and 43 and the laminations 37, 38, 39 and 40 interfitted with the arms of the U-shaped laminations and the laminations are cemented together to provide the unitary core and coil structure shown. The core and coil structure thus assembled is then positioned within the housing sections 12 and 14 by simply placing the housing sections around the core and coil structure with the pole pieces 51 and 52 fitting within the notches provided therefor in the edges of the sections 12 and 14. The terminals 20 and 22 are placed between the sections. The erase head core and coil structure and terminals are likewise assembled in the manner described above and the housing sections 12, 14 and 16 of the transducer assembly are then cemented together and to the terminals and cores to provide the unitary transducer assembly of the present invention. After assembly, the tape guiding recessed path 57 can be readily ground into the front face 60 of the head, the block 55 and shims 53 and 78 enabling this to be done without disturbing the position of the pole pieces.

A single unit structure is illustrated in Fig. 4. It comprises the opposed housing sections 90

6

and 91 provided with recesses 92 in the corners for the reception of the head portions of the securing bolts 93 and nuts 94. The bolts 93 extend through the housing sections 90 and 91 and thread into the nuts 94 so that the housing sections are securely clamped about the core and coil structure of the transducer head. In addition, the abutting surfaces of the sections 90 and 91 are cemented together.

The core and coil structure of the transducer head is substantially similar to the record-reproduce section of the transducer assembly of Fig. 3 with the exception that the laminations 37, 38, 39 and 40 are interchanged so that the laminations 38 and 39 are positioned outside the laminations 37 and 40 and engage the sloping bottom walls 63 and 64 of the housing sections. With this arrangement, the laminated pole piece construction is given additional strength and vibration of the pole pieces is further reduced. Also, the pole piece defining portions 51 and 52 may be made somewhat shorter, thereby to reduce the flux leakage.

The transducers of Figs. 1 to 4 are designed to record only upon one-half of a tape moved past them, so that a double record may be formed on the tape. That this is the case is made apparent in Fig. 1, wherein the tape guiding channel 57 is shown to have a width approximately twice the width of the pole pieces. It is thus simple to place the tape so as to bring the pole pieces into cooperative relationship with first one half and then the other half of the tape.

Referring now to Figs. 5 through 8, inclusive, these disclose embodiments forming a portion of the above identified copending application, Serial No. 162,697. Only an erase head has been illustrated, but record-reproduce heads may be constructed in like manner, differing therefrom only in the number of turns used in the coil.

The erase head shown in Fig. 5 is constructed in the form of an assembly including the head and the supporting structure indicated generally by the reference character 100, through which the erase head may be selectively operated, as disclosed in my copending application Serial No. 79,663, into and out of position to erase the previous magnetic record on the tape 10. In Fig. 5 the erase head is shown in position to be effective upon the tape 10. If desired, the effectiveness of the erase head may be controlled simply by controlling the supply of erase current to the erase head coil 101 comprising the two parts 101A and 101B, which are wound around the magnetic core 102. The core is preferably made of a number of thin laminations 102A, 102B and 102C, the major portions of which are curved to take a generally circular configuration but of which the outer ends 103 and 104 are bent outwardly beyond what might be considered to be the confines of the circle, to provide the generally parallel outwardly facing short pole pieces which bear against the tape 10. In accordance with the present invention, the core structure is constructed as a unitary structure with an electrically conductive, nonmagnetic shield or spacer 105 located between and secured to the poles 103 and 104.

Referring now more particularly to Fig. 6, it may be that the core laminations may be readily formed and assembled. The shield 105, which is preferably of copper, is located between the poles so that the lower end 106 thereof projects downwardly slightly below the adjacent portions of the magnetic core structures, thereby to provide

a more effective shield against leakage flux. To facilitate construction, the shield may initially have a projecting portion 107, indicated in phantom. The shield is assembled as shown relative to the core structure, and this assembly is soldered at its outer end portion, as from the region indicated by the bracket A in Fig. 6. After soldering, the projecting portion 107 of the shield is suitably removed as by grinding (this being comparable to the result of grinding the path 57 in the previous embodiments). It should be noted also that, as in the case of the previously described embodiments, the shield is of a width so that the sides 108 project laterally beyond the core a substantial distance.

The core is secured to the supporting structure by means and an arrangement that assist in holding the core so that it will not be easily broken or deformed. The securing means consists of a screw bolt 110 passing through or preferably threaded into a drilled and tapped opening 111 substantially centrally of the loop portion of the core. The core may be drilled and tapped after soldering of the magnetic pole structure and shield as earlier described. The screw is spaced from the interior of the core by an insulating sleeve 112.

The erase head is supported upon an arm 115 secured in suitable manner to a bracket having a horizontal base portion 116 and an upstanding flange 117 to which the arm is secured as by a rivet 118.

In Fig. 8 there is illustrated a modified type of construction characterized by a multi-section core. One of the sections may well be termed a base section 120, it consisting of a number of generally U-shaped laminations of magnetic core material. The core is completed by generally right-angled core sections 121 and 122, which may be but are not necessarily identical in construction. They are also constructed of a number of laminations and include portions 123 generally parallel to and adapted to be secured in suitable manner to the upstanding legs of core section 120. If desired, the laminations may be interleaved in the manner of the previously described embodiments. The core sections 121 and 122 also include the right-angled intermediate portions 124 and the short generally parallel pole defining portions 125, which are separated from each other by the shield 126, corresponding to shield 105, to which they are secured as by cementing beyond the region A, as heretofore described.

From the foregoing, it is evident that the present invention provides a magnetic transducer of relatively small dimensions having a unitary construction which may be fabricated at low cost. The pole pieces of the laminated core structure are given good mechanical support, the magnetic coupling between the pole pieces is reduced and the elements of the transducer are completely enclosed and protected by a housing of insulating material. Also, the unitary transducer assembly thus provided is adapted for use as a plug-in unit to facilitate electrical connection thereto and replacement thereof.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention as defined in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A magnetic transducer for use with a longitudinally movable record medium, comprising a two-part housing of insulating material having a wall, said wall having an opening at the junction of the two parts of the housing, a laminated magnetic core structure positioned within said housing and including a plurality of generally U-shaped laminations of ribbon like material arranged with their sides facing each other, and a plurality of other ribbon like laminations similarly arranged and engaged with at least one set of said U-shaped laminations and extending therebeyond, certain of said laminations terminating in generally parallel, closely spaced pole piece defining portions which extend through the opening in and are secured to said wall.

2. A laminated magnetic core including a plurality of generally U-shaped laminations of ribbon like material arranged with their sides facing each other, and a plurality of other ribbon like laminations similarly arranged and engaged with at least one set of arms of said U-shaped laminations and extending therebeyond, certain of said laminations terminating in generally parallel, closely spaced pole piece defining portions, a coil structure mounted on said core structure behind the said extending portion, a nonmagnetic electrically conductive spacer between said pole piece defining portions and extending inwardly into the space between the coil structure and said extending portion of the core structure, a block of nonmagnetic electrically conductive material in the said space abutting against said spacer, and a housing surrounding the core, coil and block and holding them and the spacer in assembled relation.

3. In a transducer, a coil structure, a core structure supporting said coil structure, and including a portion extending from the coil structure to define at least a partially closed space and a pair of closely spaced pole pieces, a block of nonmagnetic electrically conductive material in said space abutting against the coil structure and the extending portion of the core structure, a nonmagnetic electrically conductive spacer located between said pole pieces and extending laterally beyond the sides thereof and inwardly into said space between said block and the core structure, and a two-part housing enclosing the core and coil structures and constructed to receive the pole defining portions of the core structure and said spacer.

4. A magnetic transducer for use with a longitudinally movable record medium, comprising first and second housing sections of insulated material and provided with inwardly opening recesses defining a first chamber therebetween, a first core and coil assembly positioned within said first chamber and including a pair of pole pieces extending through adjacent walls of said housing sections, a third housing section adapted to fit snugly against said second section and recessed to provide a second chamber therein, a second core and coil assembly positioned within said second chamber and including a pair of pole pieces extending through adjacent walls of said second and third housing sections, a plurality of terminals positioned partially in the adjacent side walls of each of said first and second housing sections and said second and third sections, means electrically connecting said first and second core and coil assemblies to said terminals, and a conductive member positioned between said first and second core and coil assemblies to shield each of said structures from the other.

5. In a transducer, a coil structure, a core structure extending forwardly from the coil structure to define at least a partially closed space, a block of nonmagnetic electrically conductive material in said space abutting against said coil structure and the forwardly extending portion of the core structure, said forwardly extending portion of the core structure defining spaced apart pole pieces, a non-magnetic electrically conductive shim located between said pole pieces and extending between said block and one of said pole pieces whereby it is held in contact against the pole piece by the block, and housing defining structure enclosing said coil and core structures, block and spacer and holding them in assembled relation.

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