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W. P. WEST

2,459,299

MAGNETIC TRANSDUCER WITH SEPARABLE POLE FACES

Filed July 20, 1946

2 Sheets-Sheet 1

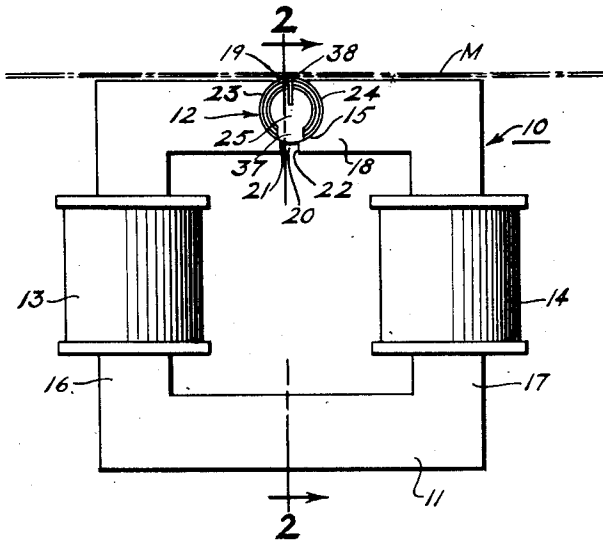


FIG. 1.

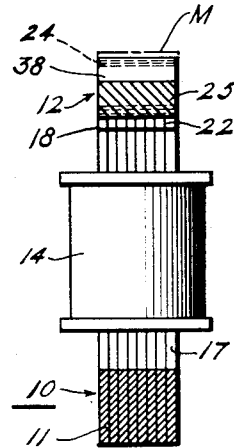


FIG. 2.

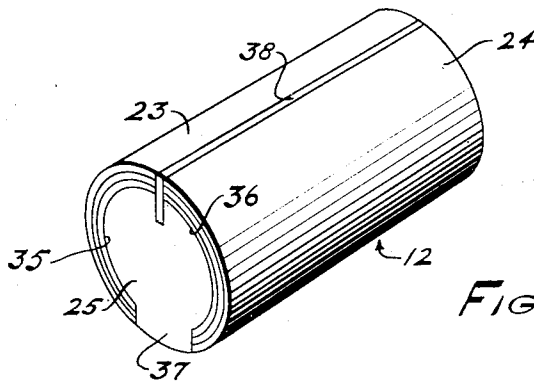
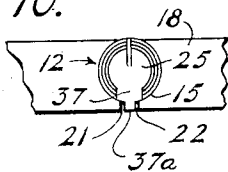


FIG. 3.

FIG. 10.



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2 Sheets-Sheet 2

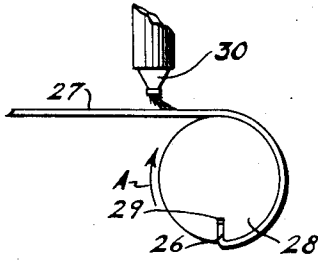


FIG. 5.

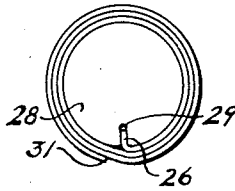


FIG. 6.

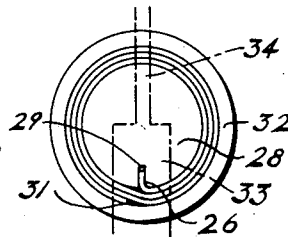


FIG. 7.

FIG. 8.

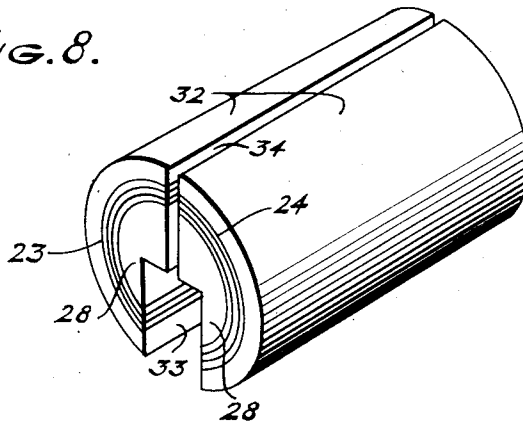


FIG. 9.

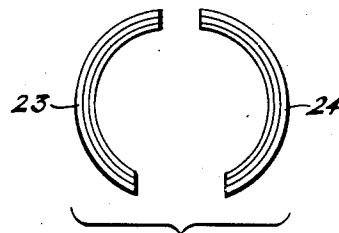
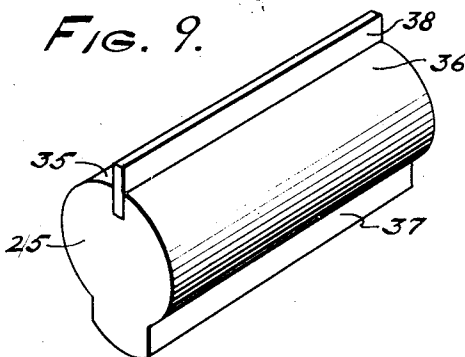


FIG. 4.

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11 Claims. (Cl. 179—100.2)

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The present invention relates to magnetic recording and reproduction of sound. Particularly, the invention is concerned with sound recording and reproducing systems in which a record medium such as a magnetic tape or wire is passed in contact with a magnetic sound recording, reproducing or obliterating head. More specifically, the invention has to do with improvements in the construction of such magnetic heads.

It is a well recognized fact that when the magnetic head is used for recording sound in systems of the type above mentioned, a certain amount of demagnetization of the record tape or wire takes place as it leaves the head. This demagnetization may result in serious sound distortions, especially noticeable at the higher-frequency signals. Likewise, it is a well recognized fact that when the magnetic head is used for reproducing sound recorded on the tape or wire, a certain amount of secondary or stray flux occurs which may deleteriously effect the reproduction by producing spurious variations in the frequency response curve. However, as is generally known in the art, the results of demagnetization and the effects of secondary or stray flux are negligible when the gap over which the magnetic medium travels, is sufficiently short in comparison with the shortest recorded wavelength.

With magnetic heads of the kind above referred to, it has been found desirable to construct the pole pieces of thin laminations in order to avoid the effects of eddy currents. Also, with such magnetic heads, it has been found that best results are obtained if the gap which is provided between the adjacent ends of the pole pieces at the effective portion of the head, is located exactly at the point where the tape or wire is tangent to the gap. Moreover, the length of the gap, that is, the distance between the adjacent ends of the pole pieces at the effective portion of the head, must be small and carefully controlled in order to obtain the best response at the higher-audio frequencies. These requirements, together with the fact that the component parts of the magnetic head are of small dimensions, create serious manufacturing problems which have heretofore complicated assembly and made production difficult.

It is therefore the primary object of this invention to improve the construction of magnetic heads of the general type mentioned so that they can be readily manufactured and easily assembled in mass production.

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Another object of the invention is to provide a magnetic head so constructed that it can be made in two major parts. Such a construction has the advantage that the part which requires the greatest accuracy can be made as a unit for ready association with the other part to complete the device. This construction further has the advantage that the part which is most susceptible to wear can be readily removed as a unit for repair or replacement.

Still another and more specific object of the invention resides in the provision of an improved pole-piece unit for a magnetic head. The provision of such a unit facilitates assembly and makes possible the rapid mass production of inexpensive but good magnetic heads.

These and other objects, and the manner in which they are attained, will appear from the following description based on the accompanying drawings which illustrate a preferred embodiment of the invention.

In these drawings:

Figure 1 is a front elevational view of a magnetic head constructed in accordance with the invention, the device as shown being approximately three times the actual size;

Figure 2 is a vertical sectional view taken substantially on line 2—2 of Figure 1;

Figure 3 is a perspective view on a greatly enlarged scale illustrating the construction of the pole-piece unit;

Figure 4 is an end elevation of the companion pole pieces employed in the unit shown in Figure 3;

Figures 5, 6, 7 and 8 are explanatory views illustrating a series of successive steps which are preferably followed to produce the laminated companion pole pieces;

Figure 9 is a perspective of the support for the pole pieces;

Figure 10 is a fragmentary view illustrating a portion of the structure shown in Figure 1, but showing an element added to the pole piece support for the purpose of insuring proper mounting of the pole piece unit.

Referring more particularly to the drawings, the magnetic head designated, generally, by the reference character 10 in Figures 1 and 2, includes a yoke structure 11 and a pole-piece unit 12. As shown, the yoke structure has the form of a core consisting of material of high permeability. Preferably, this core is of laminated construction to reduce eddy current losses, as is customary in cores used for transformers, chokes and the like. The core is provided with coils 13

and 14 and with a gap 15 (Figure 1). Preferably, the coils 13 and 14 are mounted on oppositely disposed branches 16 and 17 of the core, and the gap 15 is located in another branch 18 of said core. The gap 15 is of a size and shape to receive and to retain the pole-piece unit 12 in fixed position with respect to the yoke structure. Further, the gap 15 is so arranged that the effective portion of said unit, as indicated at 19 in Figure 1, protrudes slightly beyond the marginal edges of the yoke in order to provide good magnetic coupling between said effective portion and the travelling record medium shown diagrammatically at M and which may comprise a magnetic tape or wire. Also, the gap 15 is such that an air space, as represented at 20 in Figure 1, is maintained between the adjacent ends 21 and 22 of the yoke where these ends do not contact the pole-piece unit.

As is more clearly shown in Figure 3, the pole-piece unit 12 essentially comprises substantially C-shaped pole pieces 23 and 24 and a generally cylindrical support 25 therefor. The pole pieces consist of a plurality of laminations in order to avoid the effects of eddy currents, and each lamination is made of suitable material having the magnetic properties necessary to obtain the desired result. It has been found that materials such as high permeability silicon-iron alloys are most suitable if the head is to be used for sound recording or obliterating purposes, and that materials such as high permeability nickel-iron alloys may be used to advantage if the head is to be employed to reproduce recorded sounds. In practice, the laminations are coated with varnish or a like substance which not only contributes toward reduction of eddy current losses but also efficiently acts to bind the laminations together so that unitary and rigid C-shaped pole pieces as seen in Figure 4, are obtained.

A quick and efficient way of mass producing the companion pole pieces is illustrated in Figures 5 through 8. As shown in Figure 5, the end portion 26 of a long strip 27 of magnetic material suitable for the formation of the pole pieces, is engaged with a mandrel 28 which, for that purpose, is provided with a longitudinal narrow groove 29. By rotating the mandrel axially, as represented by arrow A, the strip is wound about the mandrel to form several complete turns. The number of turns determines the number of laminations required, and this number of laminations varies depending upon whether the pole pieces are to be used for recording, reproducing or obliterating sound. As the winding progresses, varnish or a like substance may advantageously be applied to the strip in the manner illustrated at 30 in Figure 5. The strip may be fed from a reel (not shown) and tensioning means (not shown) of any suitable known construction may be employed to maintain the strip under regulated tension in order to assure a compact spiral as shown in Figure 6. After the desired number of turns have been made, the strip is cut so that end portion 31 of the spiral terminates in the vicinity of groove 29 in the mandrel 28. With the spiral still retained on the mandrel, a sleeve 32 is slipped over the spiral for the purpose of facilitating subsequent handling, which involves a cutting operation longitudinally of the assembled sleeve, spiral and mandrel to split the mentioned assembled elements into a pair of sections, as is shown in Figure 8. The cutting operation is such as to provide comparatively wide and narrow radial cuts 33 and 34 in line with the groove in the mandrel

to eliminate the bent end portion 26 from the main convolutions of the spiral. The sleeve and mandrel sections are then removed, thus leaving the companion pole pieces shown in Figure 4, which pole pieces may then be readily associated with the support 25.

As more clearly illustrated in Figure 9, the support 25 consists of a solid body of non-magnetic material having rounded surfaces 35 and 36 about which the C-shaped pole pieces 23 and 24 (Figure 4) may snugly fit (Figures 1 and 3), and further having gap-defining sections 37 and 38 against which the opposite extremities of said pole pieces may snugly abut (Figures 1 and 3). It is to be noted that the gap defined by one section 37 is much longer than the gap defined by the remaining section 38. Because of this construction it will be understood that concentration of a strong magnetic flux is insured at the narrower gap which constitutes the effective portion 18 hereinbefore referred to.

In practice, the gap-defining section 37 is obtained by providing a longitudinal boss integral with and projecting radially of the support body for a distance substantially equal to the thickness of the laminated pole pieces; and the gap-defining section 38 is provided by means of a shim (a strip of non-magnetic stock) embedded in the support to project radially therefrom also for a distance substantially equal to the thickness of the laminated pole pieces. Moreover, it is pointed out that the thickness of the boss substantially corresponds to the width of the wide cut 33, and the thickness of the shim substantially corresponds to the width of the narrow cut 34, which cuts are made during the formation of the pole pieces as above described. The use of a boss and of a shim in the manner stated makes it possible to determine accurately the length of the gap at the effective portion of the pole-piece unit.

Because the length of this gap controls the maximum frequency response for a given speed of the record tape or wire, accurate control of the gap length becomes an important factor. Moreover, the gap length is usually very small, in fact this length is generally of the order of one mil. Such a small gap is necessary to obtain maximum high frequency response. These requirements have heretofore made the attainment of the proper gap length tedious and difficult. Because, in accordance with the present invention, the C-shaped pole pieces 23 and 24 and support 25 therefor are so related that the pole pieces snugly embrace the support-surfaces 35 and 36, and the adjacent extremities of such pole pieces snugly abut the gap-defining sections 37 and 38 on said support, control of the gap length at the effective portion of the pole-piece unit becomes an easy matter. It merely involves use of a shim having a thickness equal to the desired gap length and the formation of a boss having a width sufficient to insure snug engagement between the faces of the shim and the extremities of the pole pieces adjoining said faces.

A suitable adhesive such as varnish or the like may be conveniently applied to the corresponding surfaces of the pole pieces and support when these elements are assembled. This insures retention of the pole pieces on said support and provides a rigid and compact pole-piece unit which can be readily inserted in the gap 15 of the core or yoke structure 11, to complete the magnetic head. Either before or after the pole-piece unit is mounted in the yoke structure, the

exposed surfaces of the pole pieces and of the shim are conveniently smoothed out to insure a clean even area for good contact with the magnetic tape or wire.

In manufacturing the pole pieces, an extended strip of magnetic material may advantageously be wound on a long mandrel, and an equally long sleeve may be slipped over the wound strip so that by cutting the assembled sleeve, spiral and mandrel transversely along the length thereof, several pair of companion pole pieces of desired length may be obtained from one winding operation. Likewise, the support may be made in long lengths which may then be cut into sections of required size to accommodate the pole pieces.

As shown in Figure 10, the boss 37 on support 25 may be provided with an extension 37a adapted to be introduced in the gap between the adjacent end portions 21 and 22 of branch 18 of the yoke. This extension serves to guide the mounting of the pole-piece unit 12 in the gap 15 of the yoke and to prevent the mounted pole-piece unit from rotating within said gap 15 beyond desired limits.

In view of the foregoing it will be appreciated that the component parts of a magnetic head constructed in accordance with the present invention can be readily manufactured and assembled into compact units and that such units, in turn, can be easily assembled without requiring particular skill. Moreover, because the invention makes it possible to manufacture the pole-piece unit separately, the accurate and precise relationship which must exist between the two pole pieces can be readily attained. Particularly, the invention so facilitates the control of the air gap length at the effective portion of the magnetic head that the provision of a good magnetic head becomes a matter of mere mechanical procedure rather than skillful achievement of scientific calculations.

Although a particular embodiment of the invention has been described with great particularity, it is to be understood that this has been done by way of example only. Various changes in the details of construction and in the combination and arrangement of parts may be resorted to without departing from the spirit of the invention which is subject only to such limitations as are imposed by the prior art or are specifically called for in the appended claims.

I claim:

1. In a magnetic head, companion pole pieces constructed to provide two pairs of confronting end portions, a support for said pole pieces, a shim fixedly mounted on the support and disposed in engagement with one of said pairs of end portions, and a boss arranged on the support and disposed in engagement with the other of said pairs of end portions to maintain the first-mentioned pair of end portions in engagement with the shim.

2. In a magnetic head, a pair of substantially C-shaped pole pieces and a generally cylindrical support therefor, said pole pieces having end portions disposed in confronting relationship, and said support having means extending radially therefrom and arranged in engagement with said end portions of the pole pieces to provide a gap of definite length therebetween.

3. In a magnetic head, a pair of substantially C-shaped pole pieces and a support therefor, said support consisting of a body having surfaces corresponding to the inner surfaces of the pole pieces so as to support said pole pieces in such a manner that the end portions of one pole piece

confront the end portions of the other pole piece, and gap-defining sections extending radially of said body and disposed in abutting engagement with said end portions of the said pole pieces.

4. In a magnetic head, a pair of substantially C-shaped pole pieces, a generally cylindrical member supporting said pole pieces so that the end portions of one pole piece confront the end portions of the other piece, a shim embedded in and extending radially from the support and having a portion in abutting engagement with adjacent end portions of the pole pieces to provide a gap therebetween, and a boss integral with and also projecting radially from the support and having a portion in engagement with other adjacent end portions of the pole pieces to separate said other end portions and to maintain the first-mentioned end portions in engagement with the shim.

5. A magnetic head comprising a yoke structure including a magnetic core having a gap in one portion thereof, a pole-piece unit received in said gap and including companion pole pieces and a support therefor, said pole pieces having end portions arranged in adjacency, and said support having means disposed in engagement with adjacent end portions of the pole pieces to provide a gap of definite length therebetween.

6. A magnetic head comprising a yoke structure including a magnetic core having a generally circular-shaped gap in one portion thereof, a generally cylindrical pole-piece unit received in said gap and including a pair of substantially C-shaped pole pieces and a support therefor, said pole pieces having end portions arranged in adjacency, and said support consisting of a body provided with rounded surfaces in concentric engagement with the inner curvature of the pole pieces and also provided with gap defining sections extended radially of said body and in abutting engagement with said end portions of the pair of pole pieces.

7. A magnetic head comprising a yoke structure including a magnetic core having a generally circular-shaped gap in one portion thereof, a generally cylindrical pole-piece unit received in said gap and including a pair of substantially C-shaped pole pieces and a generally cylindrical member supporting said pole pieces so that the end portions of one pole piece confront the end portions of the other pole piece, a shim embedded in said support and extending radially therefrom and having a portion in abutting engagement with adjacent end portions of the pole pieces to provide a gap of definite length therebetween, and a boss integral with said support and projecting radially therefrom and in engagement with other adjacent end portions of the pole pieces to separate said other end portions and to maintain the first-mentioned end portions in engagement with the shim.

8. In a pole-piece unit for magnetic heads, a pair of magnetic substantially C-shaped pole pieces having end portions arranged in adjacency, a substantially cylindrical non-magnetic support in concentric engagement with the inner curvature of said pole pieces, a non-magnetic shim of predetermined thickness disposed to extend between adjacent end portions of said pole pieces and in abutting engagement therewith to define a gap of definite length therebetween, and a projection of predetermined width extending radially of said support and in engagement with other adjacent end portions of the pole pieces to effect abutting engagement between the first-men-

tioned end portions of the pole pieces and the shim.

9. A support for generally C-shaped pole pieces of a magnetic head, said support consisting of a body having non-magnetic rounded surface portions adapted to receive such pole pieces and to align end portions thereof, and a pair of gap defining non-magnetic extensions radiating from said body for abutting engagement with said end portions of the pole pieces when received on the mentioned surface portions of said body.

10. A magnetic head comprising a yoke structure including a magnetic core with a gap therein, said gap having a generally circular shaped portion and a generally rectangular shaped portion, the latter providing the core with end sections disposed in generally parallel confronting relationship, a generally cylindrical pole-piece unit mounted in said circular shaped portion of the gap and including a pair of substantially C-shaped pole pieces and a generally cylindrical member supporting said pole pieces with their end portions in adjacency, a shim disposed on said support and extending radially therefrom and in engagement with adjacent end portions of the pole pieces to establish a definite spacing therebetween, a boss disposed on said support and projecting radially therefrom and in engagement with other adjacent end portions of the pole pieces to separate said other end portions and to effect seating engagement between the first-mentioned end portions and the shim, and an element provided on said boss and extending in the rectangular portion of the gap between the mentioned end sections of the core to prevent the pole-piece unit from rotating beyond desired limits in said circular gap portion.

11. For a magnetic head including a magnetic core provided with a gap having a generally circular portion and a generally rectangular portion, the latter providing the core with end sec-

tions disposed in generally parallel confronting relationship, a generally cylindrical pole-piece unit mountable in said circular portion of the gap and including a pair of substantially C-shaped pole pieces and a generally cylindrical member supporting said pole pieces with their end portions in adjacency, a shim disposed on said member and extending radially therefrom and in engagement with adjacent end portions of the pole pieces to establish a definite spacing therebetween, a boss disposed on said support and projecting radially therefrom and in engagement with other adjacent end portions of the pole pieces to separate said other end portions and to effect seating engagement between the first-mentioned end portions and the shim, and an element provided on said boss and adapted for insertion in the rectangular portion of the gap between the end sections of the core to guide the mounting of the pole-piece unit in the circular portion of the gap and to prevent the pole-piece unit, when so mounted, from rotating beyond desired limits in relation to the circular gap portion.

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