

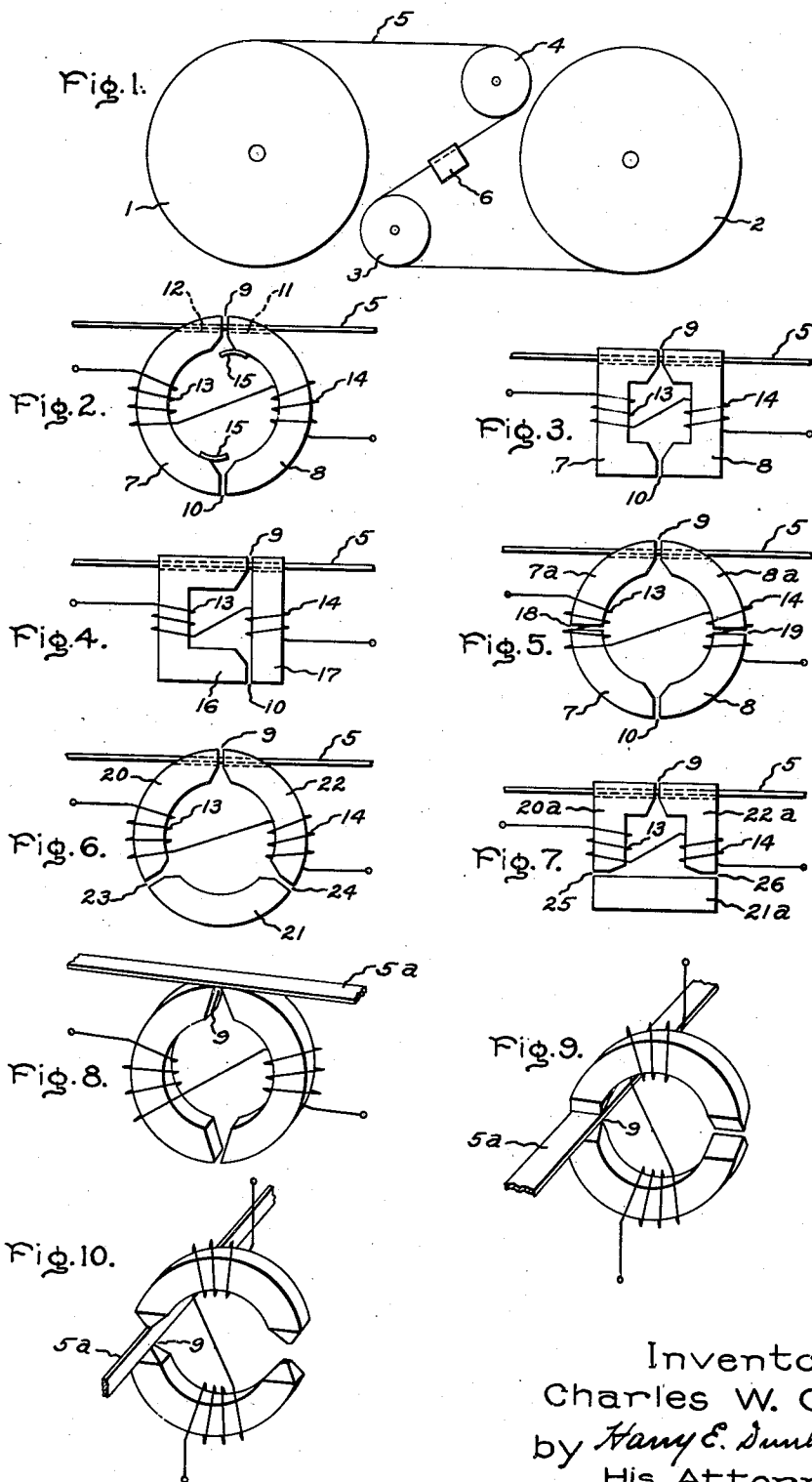
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HUMBUCKING ARRANGEMENT FOR MAGNETIC TRANSDUCERS

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HUMBUCKING ARRANGEMENT FOR
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My invention relates to improvements in magnetic recording and reproducing heads for use in connection with magnetic recording devices in which voice or other signals are recorded and ultimately reproduced, if desired, with a recording medium in the nature of an elongated magnetic member, such as a wire, tape, or the like.

Recording and reproducing heads currently in use in connection with magnetic wire or tape recording apparatus have been found to be particularly sensitive to stray magnetic fields originating externally of the recording heads. Ordinarily, a complete recording apparatus includes an alternating current motor for driving the wire reels and a power transformer from which unidirectional current for the voice modulation circuits is derived through a rectifier. Both the motor and transformer ordinarily operate at a readily available low frequency, such as 60 cycles per second. It is not always possible, particularly in portable apparatus, so to position or shield the power circuits that the stray magnetic fields arising therefrom have an inappreciable effect upon the recording and reproducing head. Such stray fields, if not neutralized, cause undesirable hum in reproduction.

It is also found that, if a recording and reproducing head is so unbalanced magnetically that it is affected by stray fields in reproducing, it usually establishes undesired external fields when used for the recording operation. Such external fields established in the recording operation interfere with any reproducing head operating in close proximity thereto.

Accordingly, it is a general object of my invention to provide new and improved means for magnetically balancing a magnetic recording and reproducing head.

It is a further object of my invention to provide new and improved means for preventing the establishment of appreciable external fields by a magnetic recording head.

It is another object of my invention to provide a new and improved magnetic recording and reproducing head which is substantially insensitive to magnetic fields originating externally of the head.

It is a still further object of my invention to provide means for rendering a magnetic recording and reproducing head substantially insensitive to stray magnetic fields originating outside the head, and more particularly to magnetic fields originating from power circuits in the recording apparatus, without reducing the sensitivity of the head to local fields associated with

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the magnetic recording medium passing there-through.

My invention will be more fully understood and its objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawing, in which Fig. 1 is a diagrammatic representation of a magnetic wire recording and reproducing apparatus; and Figs. 2-10, inclusive, are diagrammatic representations of a plurality of recording and reproducing heads embodying my invention in a variety of forms.

Referring now to the drawings, I have shown at Fig. 1 a wire reeling and recording system for a magnetic wire recording and reproducing apparatus comprising a pair of rotatably mounted spools or wire reels 1 and 2, a pair of idler pulleys 3 and 4 positioned between the reels 1 and 2, and a suitable magnetic recording medium, such as a wire 5, wound at opposite ends upon the reels 1 and 2 and passing over the pulleys 3 and 4 and through a magnetic recording and reproducing head 6 positioned between the idler pulleys. The idler pulleys 3 and 4 are rotatably mounted on fixed pivots thereby to preclude lateral movement of the wire where it passes through the head 6 as the wire is wound from one to the other of the reels 1 and 2. A suitable driving motor, not shown, is arranged for connection to either the reel 1 or the reel 2 so that the wire 5 may be wound in either direction. It will be understood that recording and reproduction are both carried out with the wire 5 traveling in the same direction, but it is necessary to run the wire backward between the two operations.

The recording and reproducing head 6 ordinarily comprises a substantially closed magnetic core ring having a pair of confronting pole faces defining an air gap therebetween and provided with a magnetizing winding. The traveling magnetic recording medium 5 traverses a path through the air gap, so that the wire acts as a shunt across the gap and is magnetized as it passes through the head. Signal modulated currents are supplied to the magnetizing winding, so that the magnetization of the recording medium is varied along its length as the wire travels through the head. The recording medium may be passed through or adjacent the air gap, and the wire is magnetized either longitudinally or transversely depending upon its direction of travel past the gap.

At Fig. 2, I have shown a preferred form of my invention in which the magnetic recording and reproducing head comprises a pair of similar

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semicircular magnetic core sections 7 and 8 spaced apart to define a pair of oppositely diametrically disposed air gaps 9 and 10. The pole pieces of the core sections 7 and 8 adjacent the air gap 9 are slotted at 11 and 12 to provide a path through the gap 9 for the magnetic wire 5 in a direction substantially perpendicular to the plane of the gap. The head includes also a divided electric conducting winding comprising a pair of similar coils 13 and 14 mounted in lateral spaced relation upon opposite sides of the magnetic core for use in both recording and reproducing operation. Preferably, the axes of the coils 13 and 14 are substantially parallel to the plane of the air gaps 9 and 10, as shown at Fig. 2. The coils 13 and 14, as shown, are oppositely wound and connected in series circuit relation, so that current traversing the coils in recording operation sets up magnetic fields in aiding relation in the two halves of the core. Conversely, in reproducing operation, flux established in the magnetic core by the wire 5, which acts as a small magnet of varying strength bridging the gap 9, induces voltages in like phase relation in the coils 13 and 14. It will of course be understood by those skilled in the art that, if desired, the coils 13 and 14 may be connected in parallel circuit relation and disposed on the core in aiding relation to establish flux in the core, whereby voltages induced in the coils by flux originating in the head will also be of like polarity with respect to the external circuit.

It may now be noted that the magnetic core ring 7, 8 of Fig. 2 provides two substantially parallel magnetic paths through the core for stray flux originating externally of the recording head and having any direction in the plane of the core. It will be evident that for components of stray flux in the plane of the core having a direction substantially parallel to the plane of the air gaps 9 and 10, the voltages induced in the series connected coils 13 and 14 will be in opposite phase relation and nearly equal in intensity. Such approximate balance of induced voltages will be attained when the core sections 7 and 8 have similar shapes and substantially the same reluctance, and the coils 13 and 14 have substantially the same number of turns and are symmetrically positioned upon the core sections, as shown at Fig. 2. Similarly, if the coils are connected in parallel circuit relation, such stray flux, being in opposing relation in opposite halves of the core, will induce in the coils voltages opposite in polarity with respect to the external circuit.

The reluctance of the air gaps 9 and 10 has no appreciable effect upon the intensity of voltages induced in the coils 13 and 14 by components of stray flux in a direction parallel to the axes of the coils. The induced voltages are, however, dependent upon both the reluctance of the core sections and the number of turns in the coils. If it is necessary to make any adjustment in order fully to balance the voltages induced in the coils, such adjustment may be made either by varying the reluctance of the core sections between the gaps, or varying the number of turns on the coils. In practice, if the core sections 7 and 8 are integral between the air gaps 9 and 10, adjustment for flux parallel to the axes of the coils is preferably made by varying the number of turns upon one of the coils. With the induced voltages thus balanced by the symmetrical construction of the head, the net voltage appearing at the terminals of the entire winding including both coils 13 and 14 will be substantially zero.

In the form of the invention shown at Fig. 2,

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components of stray flux originating externally of the recording head and in a direction perpendicular to the axes of the coils 13 and 14 in the plane of the core follow parallel paths through the air gaps 9 and 10. Thus, the head may be balanced for components of stray flux in this direction by adjusting the reluctance of one or both of the air gaps 9 and 10. It will be evident that, by proper adjustment of the reluctance of the air gaps, the stray flux flowing through opposite sides of the core in a direction perpendicular to the axes of the coils 13 and 14 may be so proportioned and distributed that equal and opposite voltages are induced in adjacent halves of each of the coils 13 and 14. With such adjustment, the net induced voltage at the terminals of the winding in response to components of stray flux perpendicular to the coil axes and parallel to the plane of the core will be substantially zero.

Adjustment of the reluctance of the air gaps 9 and 10 may be effected either by moving the core sections 7 and 8 relative to each other or by providing small magnetic shunts 15 attached to a pole piece on one side of each gap and bendable to provide the desired reluctance.

Components of stray flux in a direction perpendicular to the plane of the magnetic core 7, 8 link no turns of the coils 13 and 14, and therefore induce no voltage in these coils. Thus, it will be evident that when properly balanced the magnetic recording head of Fig. 2 is insensitive to components of stray magnetic flux originating externally of the head along three mutually perpendicular axes, and is therefore insensitive to stray magnetic fields in any direction in space. While my invention provides precise neutralization for homogeneous stray fields, it will be evident that effective balancing in non-homogeneous fields is also possible.

At Fig. 3 I have shown another embodiment of my invention similar in all respects to that shown at Fig. 2 except that the magnetic core sections 7 and 8 are shaped to provide a rectangular, rather than a circular, multi-section core. It will be understood, of course, that if desired one or both of the air gaps 9 and 10 of the head shown at Fig. 3 may be provided with magnetic shunts 15, as shown at Fig. 2. Balancing of the head of Fig. 3 is carried out in the same manner as described in connection with Fig. 2.

At Fig. 4 I have shown a still further embodiment of my invention in which a rectangular magnetic core is formed of two dissimilar core sections 16 and 17 spaced apart to provide a pair of oppositely disposed air gaps 9 and 10 symmetrically disposed about an axis perpendicular to the plane of the gaps. In this form of the invention, the core section 16 forms three sides of the rectangular frame and the core section 17 forms the fourth side. With this arrangement, the core sections 16 and 17 are obviously of different reluctance so that, in order to balance the voltages induced in the coils 13 and 14 by components of stray flux having a direction substantially parallel to the axes of the coils, it is necessary that the coil on the section of greater reluctance have more turns than the coil on the section of smaller reluctance. As in Fig. 2, the coils 13 and 14 of Fig. 4 are disposed on opposite legs of the core with their axes substantially parallel to the plane of the gaps 9 and 10, so that balancing of the head for components of stray flux in the plane of the core and in a direction substantially perpendicular to the axes

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of the coils may be effected by adjusting the reluctance of one or both the air gaps 9 and 10. The head shown at Fig. 4, as well as all other embodiments of the invention herein described, is inherently insensitive to components of stray flux perpendicular to the plane of the core.

At Fig. 5 I have shown an embodiment of the invention similar to that shown at Fig. 2 except that the magnetic core is formed in four sections 7, 7a, 8 and 8a having an additional pair of air gaps 18 and 19 diametrically disposed and intermediate the gaps 9 and 10. The gaps 18 and 19 may be used to control the reluctance of the parallel magnetic paths through the core between the gaps 9 and 10 for components of stray flux in a direction parallel to the axes of the coils 13 and 14. Thus, balancing for stray flux in this direction may be effected by adjusting the reluctance of the gaps 18 and 19, rather than by changing the number of turns on the coils 13 and 14, as described in connection with Fig. 2.

At Fig. 6 I have shown an embodiment of my invention in which an annular magnetic core is formed of three similar sections 20, 21, and 22 spaced apart to form a main air gap 9 traversed by the magnetic wire 5 and a pair of auxiliary air gaps 23 and 24. The winding comprises coils 13 and 14 mounted upon the annular core in a manner similar to the coils 13 and 14 of Fig. 2.

If any one of the air gaps of the head shown at Fig. 6 is formed to provide a fixed reluctance, the head is adjusted for balance in the same manner as heretofore described in connection with Fig. 2. If, however, the three gaps 9, 23, and 24 of Fig. 6 are all adjustable in reluctance the head shown in this figure may be balanced for mutually perpendicular components of flux in the plane of the core either by the method outlined in connection with Fig. 2, or by adjustment of gap reluctance alone without regard to the number of turns upon the coils 13 and 14. It will be understood, of course, that an approximate balance is first obtained by building the coils 13 and 14 with substantially the same number of turns. For precise adjustment by gap reluctance alone, the induced voltages are first balanced for components of stray flux parallel to the axes of the coils 13 and 14 by adjustment of the air gaps 23 and 24. Following this adjustment, the head is balanced for components of stray flux in a direction perpendicular to the axes of the coils 13 and 14 by adjustment of the reluctance of the air gap 9.

At Fig. 7 I have shown another embodiment of my invention similar to that shown at Fig. 6, except that the magnetic core is rectangular rather than annular, being formed of a pair of L-shaped sections 20a and 22a defining the main air gap 9 and a straight section 21a spaced from the L-shaped sections to define a pair of auxiliary air gaps 25 and 26. Balancing of the head shown at Fig. 7 is accomplished in a manner entirely similar to that described above in connection with the head shown at Fig. 6.

At Figs. 8, 9 and 10 I have shown embodiments of my invention similar in structure principle to the embodiment shown at Fig. 2, but in which the confronting pole pieces of the core defining the main air gap 9 are formed to accommodate for various directions of travel a magnetic recording medium in the form of a flat tape 5a. In each of these figures, the head is annular and formed of two semicircular sections providing diametrically disposed air gaps, as at Fig. 2. Fig. 8 shows the manner in which the flat tape

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5a may traverse the gap 9 for longitudinal magnetization; Fig. 9 shows the manner in which the tape 5a is accommodated in the gap 9 for transverse magnetization across its thickness; and Fig. 10 shows the manner in which the tape 5a traverses the gap 9 for transverse magnetization across its width.

While all the foregoing embodiments of my invention utilize only a single gap in the core for recording or reproducing, it will be understood that if desired additional recording media may be passed through other of the gaps without departing from my invention.

While I have shown only certain preferred embodiments of my invention by way of illustration, many other modifications will occur to those skilled in the art, and I, therefore, wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention. What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a magnetic recording and reproducing head, a multi-section magnetic core comprising a plurality of sections in spaced relation defining a main air gap and a plurality of auxiliary air gaps symmetrically positioned about the axis of said main air gap, said sections adjacent said main air gap being formed to accommodate a traveling magnetic recording medium traversing said main gap, a divided winding including a pair of similar coils mounted upon said core on opposite sides of said main air gap with the axes of said coils in substantially parallel spaced relation, said coils being so proportioned and positioned that substantially equal and opposite voltages are induced therein by components of stray flux in a direction substantially parallel to the axes of said coils, and means for adjusting the reluctance of said auxiliary gaps so that substantially equal and opposite voltages are induced in each half of each said coil by components of stray flux substantially perpendicular to the axes of said coils in the plane of said core.

2. In a magnetic recording and reproducing head, a magnetic core comprising a pair of dissimilar core sections disposed with their pole ends in confronting spaced relation to define a pair of aligned oppositely disposed air gaps therebetween, said core having an axis of symmetry substantially perpendicular to the plane of said gaps, said sections adjacent one of said gaps being formed to accommodate a traveling magnetic recording medium traversing said one gap, a divided winding comprising a coil mounted upon each said section with the axes of said coils in substantially parallel spaced relation, said coils being so proportioned that substantially equal and opposite voltages are induced therein by components of stray flux in a direction substantially parallel to the plane of said gaps, and means for adjusting the reluctance of the other of said gaps to render substantially equal and opposite the voltages induced in each half of each said coil by components of stray flux in a direction substantially perpendicular to the axis of said gap in the plane of said core.

3. In a magnetic recording and reproducing head, a substantially closed magnetic core having a pair of confronting pole pieces defining an air gap therebetween, said pole pieces being formed to accommodate a traveling magnetic recording medium traversing said gap, a winding on said core, and means for balancing voltages induced in said winding by stray flux originating external-

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ly of said head comprising an adjustable magnetic shunt mounted upon at least one of said pole pieces adjacent said air gap.

4. In a magnetic recording and reproducing head, a substantially closed magnetic core having a pair of confronting pole pieces defining an air gap therebetween, a divided winding on said core comprising a pair of coils mounted upon opposite sides of said core and connected to neutralize voltages induced in said coils by components of stray flux in a direction substantially parallel to the axes of said coils, and means for balancing voltages induced in said coils by components of stray flux in other directions in the plane of said core comprising an adjustable magnetic shunt mounted upon at least one of said pole pieces adjacent said air gap.

5. In a magnetic recording and reproducing head, a multisection magnetic core comprising a plurality of sections in spaced relation defining a main air gap and at least one auxiliary air gap therebetween, a divided winding comprising a pair

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of coils mounted upon opposite sides of said core with their axes substantially parallel to the plane of said main air gap and connected in aiding relation to establish flux in said core, and an adjustable magnetic shunt mounted upon at least one of said pole pieces and operable to vary the reluctance of the associated air gap thereby to balance voltages induced in said coils by components of stray flux in a direction substantially perpendicular to the axes of said coils in the plane of said core.

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