United States Patent

Johnson et al.

[15] **3,670,114**

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[54] ELECTROMAGNETIC TRANSDUCER HEAD HAVING A BIAS FREQUENCY GAP AND AN INTELLIGENCE FREQUENCY GAP

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 786,293, Dec. 23, 1968, abandoned.

[52] **U.S. Cl.** .....**179/100.2 C**

[51] **Int. Cl.**.....**G11b 5/20**, G11b 5/24

[58] **Field of Search** .....179/100.2 C; 340/174.1 F; 346/74 MC

[56] **References Cited**

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[57] **ABSTRACT**

An improved electromagnetic transducer head is provided for high quality audio recording and which includes a folded shim mounted in the gaps of its magnetic core to enhance the recording operating characteristics of the head. The particular transducer head to be described includes a magnetic core having a first section of minimum volume, on which a high frequency bias winding is wound for recording purposes, with relatively low power and heating effects; and having a second section of relatively large volume on which the record/playback intelligence signal windings are wound, and which exhibits the desired low frequency response for high quality playback.

4 Claims, 5 Drawing Figures

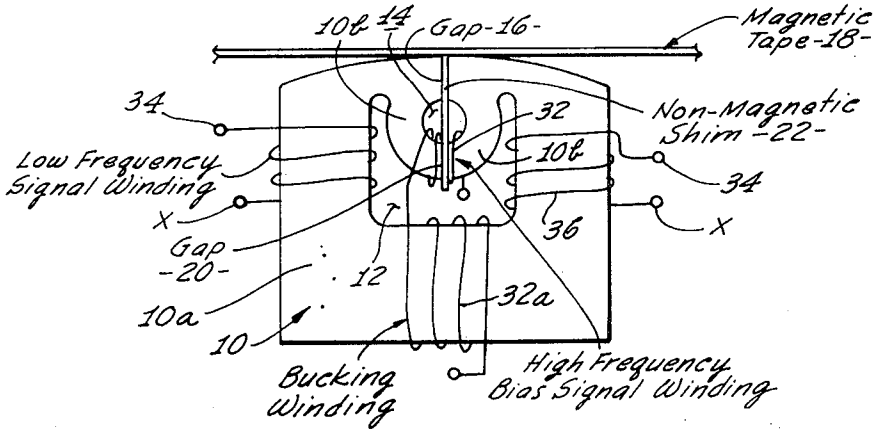

Fig. 1

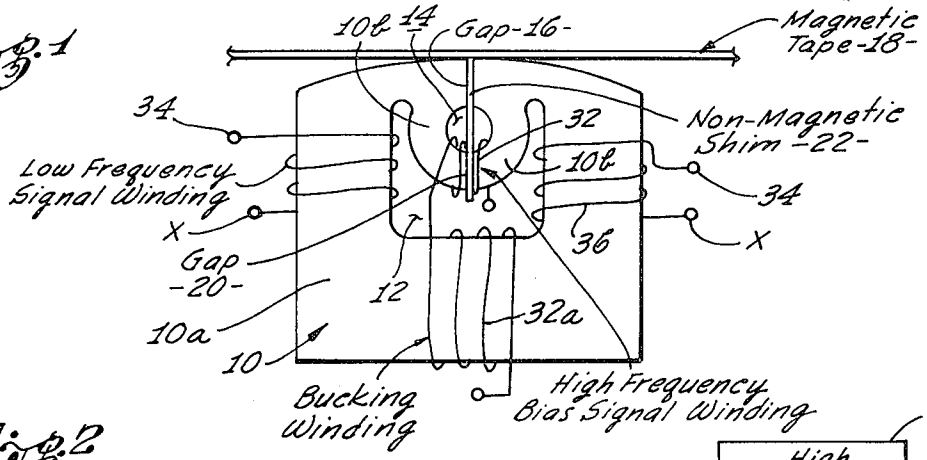

Fig. 2

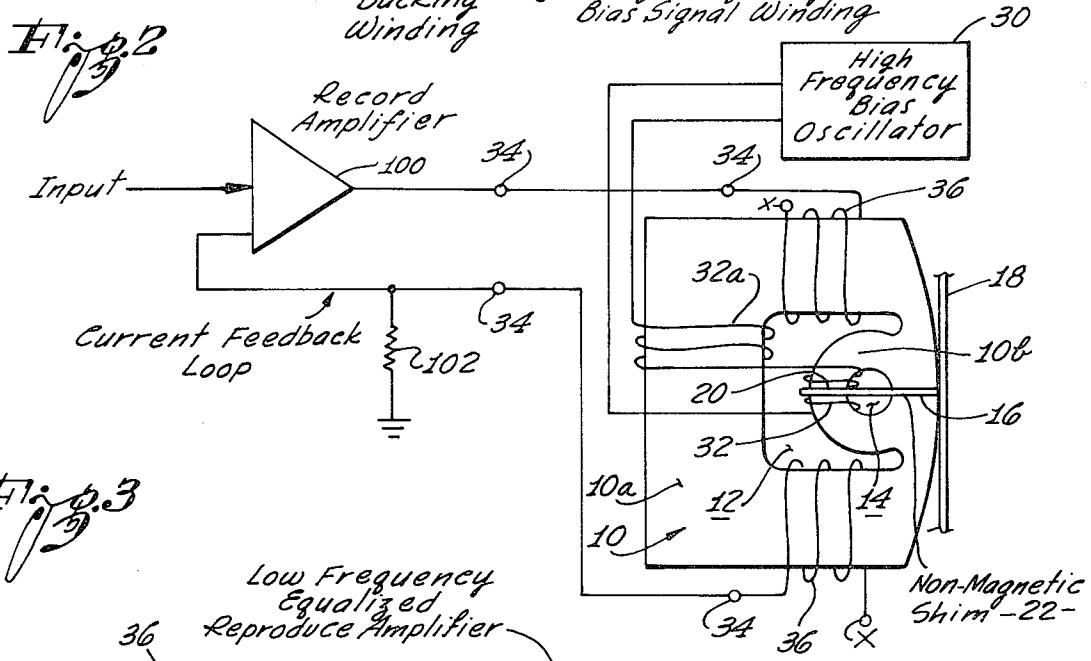

Fig. 3

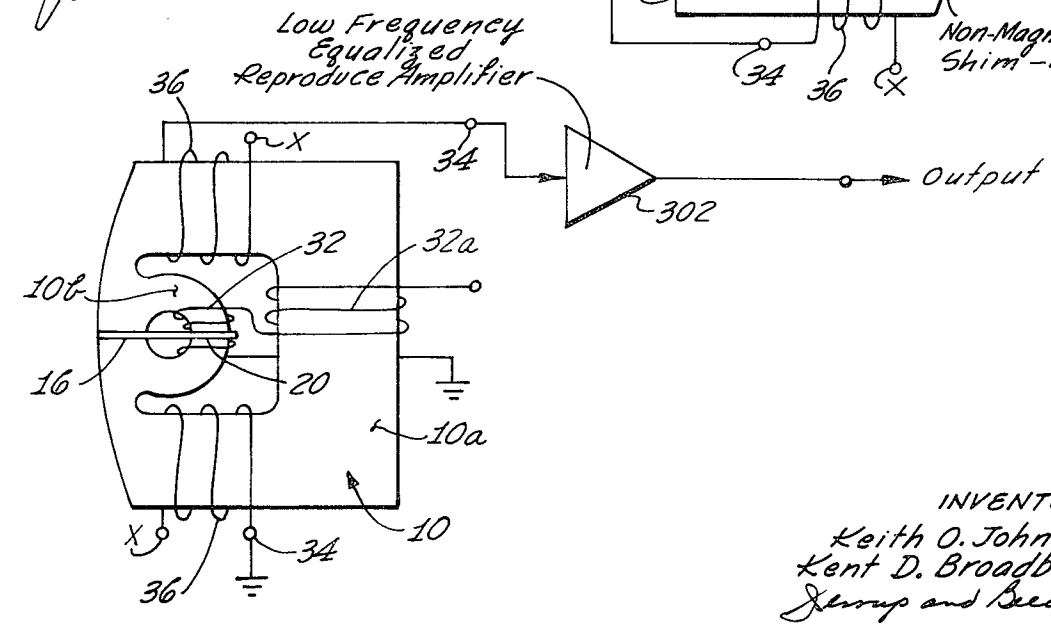

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Fig. 4

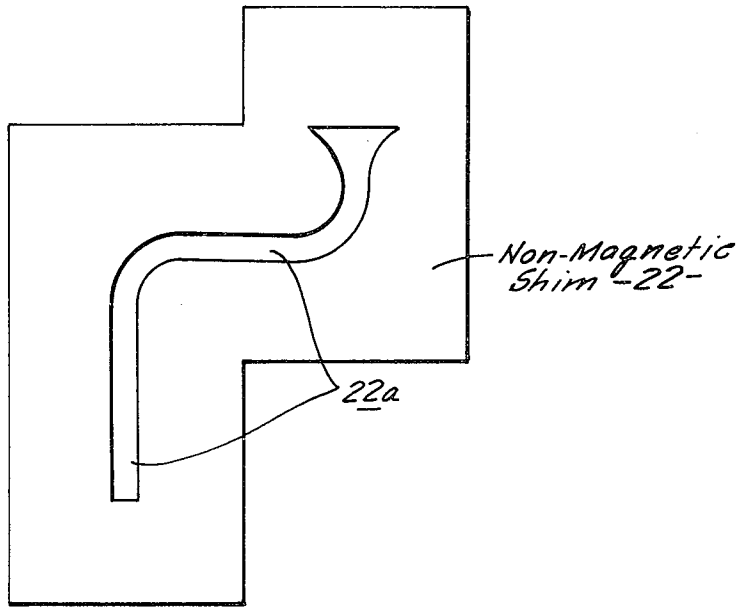
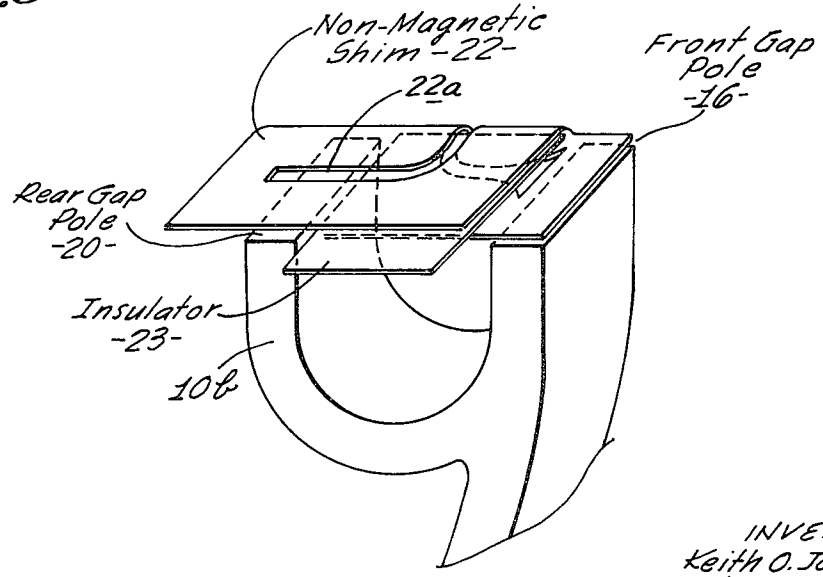


Fig. 5



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ELECTROMAGNETIC TRANSDUCER HEAD HAVING A BIAS FREQUENCY GAP AND AN INTELLIGENCE FREQUENCY GAP

This application is a continuation-in-part of copending application Ser. No. 786,293, filed Dec. 23, 1968, for "Electromagnetic Transducer Head", now abandoned.

BACKGROUND OF THE INVENTION

Copending application Ser. No. 758,213, filed Sept. 9, 1968, now U.S. Pat. No. 3,621,148; discloses and claims an electromagnetic transducer head in which a conductive shim is provided in the gap of the magnetic core thereof, and which in conjunction with a high frequency magnetic bias flux or field produces a focusing effect on the flux for optimum recording efficiency.

However, the electromagnetic transducer head described in the copending application Ser. No. 758,213 requires a relatively small core structure because of its unusually high bias frequency, in order to maintain power consumption and the heating effects created in the core due to the high frequency bias current at a working level. However, the relatively small core structure of the head of the copending application impairs its efficiency during playback. This is because the relatively small core of the head reduces the audio frequency response at the lower frequencies during the playback mode. Also, the relatively small size of the core, as required for recording, makes it difficult to provide sufficient audio windings on the head for adequate response during playback.

An important object of the present invention is to provide an electromagnetic transducer head which exhibits the desired favorable characteristics of the head of the aforesaid copending application Ser. No. 758,213, insofar as recording is concerned, and yet which is constructed to provide adequate response so as to enable the head to be used efficiently for playback purposes. This is achieved in the construction to be described, by providing a head with two core sections.

The improved head of the present invention is provided with a double section core structure, as explained above, which defines a double aperture. It has been found possible with the double aperture head of the present invention, to construct a head exhibiting in effect the desired relatively large magnetic core requirements for playback purposes and the relatively small magnetic core requirements for recording.

The head has a first core section of minimum volume of magnetic material. The high frequency bias winding is wound on the first section, and this first core section synthesizes the small head required for recording purposes with high frequency bias. The relatively small first core section assures that the power required and the attendant heating of the magnetic circuit due to the high frequency bias current, which is a function of the volume of the core material, is as small as possible. The head also includes a second core section which contains the relatively low frequency intelligence signal windings for recording and playback. The second core section has a relatively large volume of magnetic material, and it permits intelligence signal winding to sense the relatively long wavelengths across the sensing face of the head for good low frequency response during playback.

In the embodiment to be described, a bucking winding is provided on the second core section in series with the alternating current bias winding on the first core section. The bucking winding serves to buck out any bias flux which may tend to pass through the second core section on which the intelligence signal windings are wound. Therefore, the reluctance of the second core section may be kept relatively low for optimum playback sensitivity without creating alternating current bias power problems during the recording operation.

Therefore, the structure of the present invention provides effectively a recording and playback magnetic transducer head with a large size sensing face for good playback characteristics, and yet one which has a small volume of magnetic material involved with the high frequency bias winding during the recording process so as to minimize the high frequency bias heating effects. The improved electromagnetic transducer head of the present invention also has the desirable feature of exhibiting a high impedance input and low current requirements. This renders the head most advantageous for use in conjunction with solid state circuitry, and so as to be compatible, for example, with integrated circuits.

In the practice of the invention, a non-magnetic electrically conductive shim is mounted in the gaps in the double section core structure. The shim is insulated from the core, and it has a folded configuration, as will be described in order to enhance the recording operating characteristics of the head. The folded shim produces a focussing effect in the bias flux in accordance with the principles explained in the copending application Ser. No. 758,213.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic representation of a magnetic transducer head assembly constructed in accordance with one embodiment of the invention;

FIG. **2** is a circuit diagram showing the improved magnetic transducer assembly of the invention incorporated into a recording circuit;

FIG. **3** is a circuit diagram showing the improved transducer assembly of the invention incorporated into a playback circuit;

FIG. **4** is a plan view of an appropriate configuration of a non-magnetic electrically conductive shim which is mounted in the gaps in the core structure of the head to be described; and

FIG. **5** shows the shim of FIG. **4** in a folded configuration and in place on the core of the head of FIG. **1**.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

As shown in the drawings, and particularly in FIG. **1**, the electromagnetic transducer head of the invention includes an electromagnetic core **10** of any appropriate magnetizable material. The core is constructed to have a first annular section **10***a* which defines a first aperture **12** and a second annular section **10***b* which defines a second aperture **14**. It will be appreciated that the annular sections **10***a* and **10***b* have a common portion at the sensing face of the head.

A first gap **16** is provided in the common portion of the core, and a magnetic tape **18**, or equivalent magnetic medium, is drawn across the sensitive face of the head and across the air gap **16** as shown. A second gap **20** is provided in the section **10***b* of the core, the air gap **20** being diametrically opposite to the gap **16**. A non-magnetic electrically conductive shim **22**, having a configuration to be described and composed, for example, of silver or other electrically-conductive non-magnetic material, is positioned in the gaps **16** and **20**, and in insulated relationship with respect to the core material.

A high frequency alternating current bias winding **32** is provided on the section **10***b* of the core **10**, and a bucking winding **32***a* is provided in series with the alternating current bias winding **32**, the bucking winding being mounted on the section **10***a* of the core. The audio signal, or other intelligence signal to be recorded during the recording mode of the transducer head is introduced across a pair of input terminals **34**, these terminals being connected to an intelligence signal winding **36** which is wound on the section **10***a* of the core **10**.

During the recording process, and as shown in FIG. **2**, a high frequency bias oscillator **30** is connected through the bucking winding **32***a* to the bias winding **32**. The audio signal, or other intelligence signal to be recorded during the recording mode of the head is introduced to a recording amplifier **100**. The output of the amplifier is applied to one of the terminals **34** of the intelligence signal winding **36**. The other terminal **34** of the winding **34** is connected back in a current feedback loop to a second input terminal of the recording amplifier **100** and to a grounded resistor **102**.

During the recording process, the high frequency bias oscillator **30** impresses a high frequency bias signal on the windings **32** and **32***a*, and this alternating current bias signal operates in conjunction with the shim **22** to set up the desired focused bias flux across the gap **16** for optimum recording on the magnetic tape **18**, and as described in detail in the aforesaid copending application Ser. No. 758,213. The intelligence signal applied across the terminals **34** sets up a magnetic flux in the section **10***a* of the core **10** which combines with the alternating current bias flux in the section **10***b* to set up a flux across the gap **16** for optimum recording efficiency on the magnetic tape **18**, as described in the copending application.

In order to assure that the high frequency bias flux does not flow in the section **10***a* of the core with resulting heating problems, the bucking winding **32***a* sets up an opposing magnetomotive force so that a counteraction is set up to oppose the flow of the high frequency bias flux in the section **10***a*. The sense and number of turns on the bucking winding may be chosen to be such that the magnetomotive force around the annular section **10***a* due to the alternating current bias oscillator is effectively cancelled out so as to maintain the bias flux in the annular section **10***a* at a minimum. Therefore, most of the magnetic flux due to the high frequency bias oscillator **30** flows around the annular section **10***b* of the core **10**, and which exhibits the desired low volume so as to minimize the heating effects, and so that optimum playback characteristics are achieved in the relatively large core configuration.

During the playback operation, one of the terminals **34** of the intelligence signal winding **36** is grounded, and the other is connected to a low frequency equalized reproducing amplifier **302**, as shown in FIG. **3**. During the playback operation, it is desirable that the major part of the flux induced in the core **10** (as the head senses the magnetic recordings on the magnetic tape **18**) will flow through the annular section **10***a*, and that any flow of flux through the annular section **10***b* be minimized. This is achieved by providing the gap **20** which, in a constructed embodiment has a width of 0.5 mils so as to exhibit a relatively high reluctance to the playback flux, causing most of the flux to pass through the annular portion **10***a* to be applied to the amplifier **302**.

During the recording process, the configuration of the shim **22** provides for increasing the focusing action of the alternating current bias flux, as described in the aforesaid copending application Ser. No. 758,213. However, due to the folded configuration of the shim, and for the reasons expressed above, the recording characteristics of the head of the invention are enhanced as compared with the focused gap head described in the aforesaid copending application Ser. No. 758,213.

As shown in the plan view of FIG. **4**, the shim **22** has a configuration of a pair of adjacent integral rectangular strips, with a central slot **22a** extending longitudinally of the strips, and across the common area. When the shim is mounted across the pole pieces of the head sections **10***a* and **10***b* in the gaps **16** and **20**, the two rectangular sections are folded over one another, as shown in FIG. **5**, but are insulated from one another by means of an insulating strip **23** composed, for example, of paper or other suitable insulting material.

The configuration of the shim shown in FIG. **5** is such that the current which flows across the front, or tape, edge of the shim in front gap **18**, as a result of the eddy currents induced in that area, is aided by the current flowing up from the "single turn" transformer linkage of flux in gap **20** as a result of the special shape and configuration of the conducting shim. This optimizes the aforesaid flux focusing action. Also, the configuration of the slot **22a** is such that the positioning of the shim is not critical, in that longitudinal or transverse movement of the shim with respect to the pole pieces, and without certain limits, does not produce corresponding changes in the area of overlap of pole **20**.

The invention provides, therefore, an improved head configuration including a folded shim, whereby enhanced focusing effect is achieved in the alternating current bias flux during the recording process as compared with the head described in the aforesaid copending application Ser. No. 758,213. Moreover, as described above, the head may be constructed so that the head may be used with optimum efficiency for both recording and playback.

The use of the bucking winding **32***a* minimizes the bias flux in the section **10***a* of the core without increasing the reluctance of that section to the intelligence flux during playback or recording. With the bucking winding **32***a*, the playback sensitivity can be kept extremely high, and the bias power can be maintained at or below that of the record head described in the copending application Ser. No. 758,213.

What is claimed is:

1. An electromagnetic transducer head including:
- a magnetic core composed of magnetizable material and having a first section and a second section,
- the first and second sections of said core together circumscribing first and second apertures in the head,
- said apertures being displaced from one another,
- said first and second sections having a common portion with a first gap therein, said second section having a second gap therein;
- an alternating current bias winding mounted on said second section of said core, and
- an electrically conductive non-magnetic shim mounted in said first and second gaps, said shim having a slot therein, and folded about a longitudinal axis thereof, so that currents induced in said shim assist one another in producing a focusing action in the flux produced by said alternating current biasing winding at said first gap during recording operations of said head.

2. The electromagnetic transducer head defined in claim **1**, in which said shim is electrically insulated from said magnetic core.

3. An electromagnetic transducer head including:
- a magnetic core composed of magnetizable material and having a first section and a section section,
- the first and second sections of said core together circumscribing first and second apertures in the head,
- said apertures being displaced from one another, said first and second sections having a common portion with a first gap therein and a second section having a second gap therein, said second gap inhibiting the circulation of intelligence signal magnetic flux in said second section of said core during playback operations of said head;
- an intelligence signal winding mounted on said first section of said core;
- an alternating current bias winding mounted on said second section of said core;
- a further winding mounted on said first section of said core for inhibiting the circulation of magnetic flux in said first section of said core due to said alternating current bias winding during recording operations of said head, said further winding being connected in series with said alternating current bias winding, and
- an electrically conductive non-magnetic shim mounted in both said first and second gaps and electrically insulated from said core, said shim having a slot therein, and being folded about a longitudinal axis thereof, so that currents induced in said shim assist one another in producing a focusing action in the flux produced by said alternating current bias winding at said first gap during recording operations of said head.

4. An electromagnetic transducer head including: a magnetic core composed of magnetizable material and having a first section and a second section, the first and second sections of said core together circumscribing first and second apertures in the head, said apertures being displaced from one another, said first and second sections having a common portion with a first gap therein and said second section having a second gap therein, said second gap inhibiting the circulation of intelligence signal magnetic flux in said second section of said core during playback operations of said head; an intelligence signal winding mounted on said first section of said core; an alternat-

ing current bias winding mounted on said second section of said core; a further winding mounted on said first section of said core for inhibiting the circulation of magnetic flux in said first section of said core due to said alternating current bias winding during recording operations of said head, said further winding being connected in series with said alternating current bias winding; and an electrically conductive non-magnetic shim mounted in said first and second gaps electrically insulated from said core, said shim having a slot therein and being folded about a longitudinal axis thereof, so that eddy currents induced in said shim assist one another in producing a focusing action in the flux produced by said alternating current biasing winding at said first gap during recording operations of said head.

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