MEANS FOR RECORDING

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This invention relates to electromagnetic transducer heads for use in magnetic recorders and like equipment and to a method of operating such transducer heads. It has been found that transients produced by switching audio or bias currents on or off, strong transients in the audio signal itself, or the presence of a magnetic field are often sufficient to produce a residual magnetization of present-day recording heads. A magnetized recording head records a D.C. flux on the tape that passes over it, and any irregularities in the tape or in the intimacy of contact between the tape and the head modulate the flux to produce noise on playback.

Present methods of demagnetization and of detection of thorough demagnetization are laborious. Even after the head has been demagnetized, if no audio limiter is used and the maximum signal level cannot be anticipated, there is no guarantee that the head will not become remagnetized during operation and spoil the recording.

It is therefore an object of the present invention to provide a method and means for continuously demagnetizing the core of a magnetic recorder head during recording.

It is another object of the present invention to provide a method and means for recording wherein head core magnetization no longer contributes appreciably to noise level.

It is still another object of the present invention to provide a method and means for recording which provides reduced hysteresis loss and reduced harmonic distortion.

It is yet a further object of the present invention to provide a novel high fidelity recording head and method.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic side elevational view of one embodiment of electromagnetic transducer head assembly according to the present invention;

Figure 2 is a diagrammatic side elevational view with certain parts in section illustrating a second embodiment of electromagnetic transducer head assembly according to the present invention;

Figure 3 is a cross-sectional view taken substantially along the line III—III of Figure 2; and

Figure 4 is a diagrammatic side elevational view of a third embodiment of transducer head assembly according to the present invention.

As shown on the drawings:

The present invention is based on the discovery that a magnetic recording head may be continually demagnetized during a recording operation by heating the core of the head, especially while applying a bias flux to this core. By the coaction of heat and bias current, it is possible to demagnetize the head without significant adverse effects on the recording characteristics of the head.

For a recording head with a typical nickel-iron core such as mumetal or permalloy, it was found that residual magnetization could be reduced to a point where it no longer contributed appreciably to the noise level by proper selection of bias and temperature.

If maximum efficiency bias (hereafter called M. E. bias) is defined as the value of bias current for maximum audio output, and if normal operating bias (hereafter called N. O. bias) is taken to be one and one-half times M. E. bias, it was found that when a mumetal core is heated to a temperature of approximately 280° F. at N. O. bias, head magnetization effects disappeared into the background noise. Important benefits were also obtained at lower temperatures. For example, with the same head at N. O. bias and at a temperature of 160° F., it was found that the noise was reduced to only about 3 db above that of an erased tape, which was satisfactory for all except the most critical applications. With M. E. bias, the mumetal core recorded no noise above background noise at 380° F. and noise reduced to within 3 db of the erased noise by operating at 310° F.

By selecting a core material having a low Curie-point, it is possible to operate the head at even lower temperatures and still demagnetize the head. For example, with a manganese-zinc-ferrite composition (Ferroxcube) head having a Curie-point of about 230° F., if the head is heated to 150° F., it is found that the head constants do not change enough to affect the bias or the recording characteristics, but the tape noise at N. O. bias level falls within 1 db of the erased noise. Slightly higher temperatures, but operating at a Curie point not critical as the Curie-point is approached. Unless special care is taken to insure temperature stability, it is well to operate a safe margin away from this point. The term "Curie-point" refers to the temperature at which the ferromagnetic material becomes non-magnetic.

Additionally it has been discovered that noise is reduced if the head is operated at conventional bias and at conventional temperatures near room temperature, but the core is made of a material having a Curie-point in the range of 100° F. to 150° F. A ferrite material can be fabricated to have a Curie-point within this range by known methods, but it has never been realized that the use of such a material for a recording head in conjunction with a high level of high frequency bias would effectively reduce noise level through the indirect process of lowering its ability to retain magnetization under such conditions. Certain nickel-iron alloys can be fabricated with a Curie-point in this range, notably alloys between about 30 to 45% nickel content. At the lower range of nickel content, the Curie-point is at or below room temperature, while at the higher range it may reach several hundred degrees Fahrenheit. Adjustment of composition and heat treatment to yield an alloy with Curie-point between 125° and 250° F. makes a suitable core for operation at or slightly above room temperature.

No appreciable adverse effects on the recording characteristics of the head studied were noted at elevated temperatures. However, at 380° F. it was necessary to increase the audio input about 3 db to maintain the same playback level as at room temperature, but audio and bias saturation levels of the head remained many times above the levels used in recording.

Figure 1 indicates diagrammatically a first embodiment of a magnetic recording head 10 for recording on an elongated magnetizable medium 11 travelling over a gap 12 in the core 13 of the head. For the heating the core 13 above the temperature of the magnetic head 10, a hairball heater 14 is used. The heater 14 is preferably of the filament or strip type, and is disposed around the core 13. The bias flux 15 includes an electromagnet 16, energized through the core by the audio signal 17, and is caused to pass through the core of the head by the bias flux 18, generated by the control bias current 19. The bias flux 15 acts on the core 13 to enhance the recording process.
Heat may be generated by means of a non-inductively (bifilar) wound resistance wire having input leads 16a and 16b connected across a suitable source of electrical current. The energization current may be D.C., with the residual stray field balanced out by an extra coil 18 in series with the winding and orientate with respect to the head. Alternatively the energizing current can be a high frequency A.C., for example bias current, in which case a residual stray flux will not noticeably change the operation. Alternating current of power frequency (60 cycles) may be used with a balancing arrangement, and/or a playback system that is insensitive to power frequency. The non-inductive heater may be a resistance wire covered with ceramic or other high temperature insulation. It may be wound on the core itself, with provision for adjusting the turns for accurate balancing out of the heater field, or it may be wound on a separate form held against the core.

By M. E. bias is meant the bias for maximum audio output, or maximum efficiency bias. N. O. bias is taken as one and one-half times M. E. bias. The contribution of head magnetization to recorded noise level is taken in comparison to the noise level of a completely erased magnetic record member.

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