Oct. 7, 1947. M. CAMRAS 2,428,449

MAGNETIC RECORDING HEAD

Filed March 2, 1945

Fig. 4.

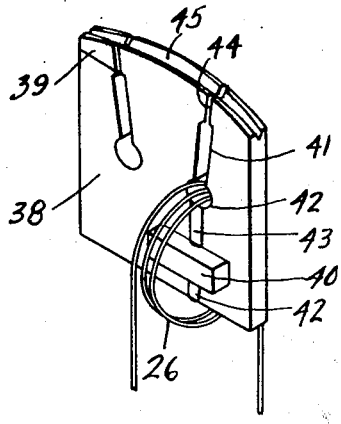


Fig. 1.

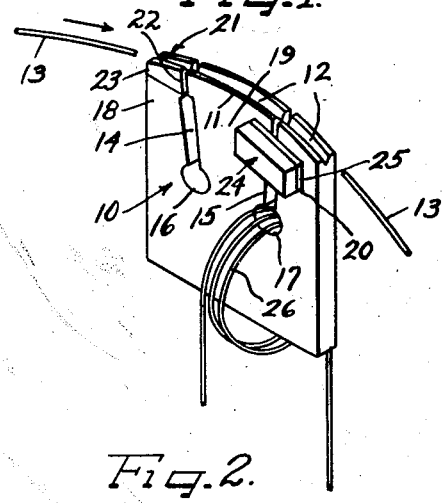


Fig. 5.

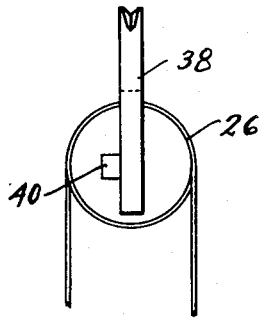
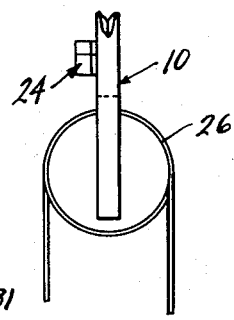


Fig. 2.



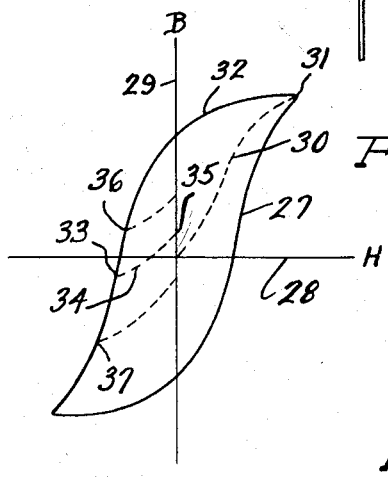


Fig. 3.

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MAGNETIC RECORDING HEAD

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4 Claims. (Cl. 179—100.2)

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This invention relates to a magnetic recording head and more particularly to a head having one or more permanent magnets incorporated therein and directly associated with the voice coil.

In devices which magnetically record fluctuating electric energy on an elongated magnetizable medium, such as wire, a magnetic head is employed. When energy is to be derived from an elongated medium having a magnetic recording already impressed thereon, a head is employed having an electric coil associated therewith. A fluctuating current is established in this coil due to the changing magnetic field of the record medium. Similarly, when a record is to be made on a wire, a head (and sometimes the same head as employed for reproducing) is employed to establish a strong magnetic field for substantially permanently magnetizing the elongated record medium as it passes thereover or therethrough, the coil of the head being excited by a fluctuating electric current.

One of the principal features and objects of the present invention is to provide a novel magnetic recording head having a core of material of high magnetic permeability but low magnetic retentivity with one or more permanent magnets directly associated therewith, in addition to an electric coil.

Another object of the present invention is to provide a novel magnetic recording head for longitudinally magnetizing a record medium.

A further object of the present invention is to provide a novel magnetic recording head having a strong permanent magnet disposed in the path of the wire to magnetically saturate the wire longitudinally, and having a second magnet polarized in the opposite direction from that of the first magnet disposed in such a manner that the record medium passes through the influence of the second magnet for partially demagnetizing the record medium.

Another and further object of the present invention is to provide a novel method and means for magnetically recording on a traveling elongated medium.

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 manner of construction and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

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Figure 1 is a diagrammatic isometric view of one embodiment of the present invention;

Figure 2 is a diagrammatic end view of the recording head shown in Figure 1;

Figure 3 is a diagram showing a hysteresis loop for the material upon which the record is being made and illustrates the portion of the curve over which the head of the present invention is designed to operate;

Figure 4 is a diagrammatic isometric view of a second embodiment of the present invention; and

Figure 5 is a diagrammatic end view of the recording head shown in Figure 4.

Referring now to the embodiment of the invention illustrated in Figures 1 and 2, I have shown a flat piece 10 of magnetizable material which is of high magnetic permeability but low magnetic retentivity. This may be of any suitable size. By way of example but not by way of limitation this piece of magnetizable material 10 may be .020 inch in thickness, ¾ in. long and ¾ in. high at the crown point. These dimensions may, of course, vary widely without departing from the spirit and scope of the present invention, these dimensions being merely given as an example of one size which has been found extremely effective with a wire record medium which is .004 in. in diameter.

Referring again to Figures 1 and 2, the core plate 10 has a crowned top edge 11 which is suitably grooved lengthwise thereof as at 12 to receive the traveling wire record medium 13 (the wire 13 being broken away in the vicinity of the core member 10 and removed from the slot 12 for clarity of illustration). The core member 10 is also slotted as at 14 and as at 15, it being noted that the upper end of the slots are narrower than the main portions, thereby to provide salient poles. The inner ends of these slots 14 and 15 terminate in holes 16 and 17 which may be conveniently drilled or punched in the core plate 10. It will also be observed that the slots 14 and 15 lie substantially along radii of curvature lines of the crowned top edge 11 of the core piece 10. The slots 14 and 15 provide three upwardly projecting tongue portions 18, 19 and 20 in the core piece 10. The tip of the tongue portion 18 is removed and a strong permanent magnet 21 is secured in the place of the removed tip. This permanent magnet may be of any suitable permanent magnet material and is polarized in such a manner that one pole 22 forms a continuation of the wall of the slot 14 and the other pole 23 forms a portion of the side edge of the core piece 10. This permanent magnet 21 is inserted at the side of the head

at which the traveling wire 13 enters, and thereby subjects the wire to a longitudinal unidirectional field so that the wire is saturated longitudinally in a pre-determined direction. It has been found that by using one of the strong permanent magnet materials, the wire, as it enters the recording head, is magnetically saturated.

A second permanent magnet 24 is mounted across the slot 15 but is slightly spaced from the core plate 10 by a non-magnetic block 25. It will also be observed that the permanent magnet 24 is placed below the top edge of the core piece 10. This permanent magnet 24 is polarized in such a manner and disposed on the core piece 10 that its magnetic field at the point where it crosses the non-magnetic gap 15 is directly opposed to and opposite the magnetic field set up in the gap 14 by the permanent magnet 21. If, for example, the permanent magnet 21 is disposed so that its north pole is opposite the slot 14 while its south pole is opposite the side edge of the core piece 10, then the permanent magnet 24 is disposed so that its south pole lies over the central tongue portion 19 of the core piece 10 while its north pole lies over the end tongue portion 20 of the core piece 10. Due to the fact that the magnet 24 overlies the gap 15, the direction of the field across the gap is opposite to the direction of the field at the ends of the magnet.

This permanent magnet 24 is thus arranged so as to subject the traveling wire 13 to a magnetic field which is weaker than that set up by the permanent magnet 21 and opposing the same. Thus the permanent magnet 24 partially demagnetizes the wire 13. The degree and extent of the demagnetization of the wire 13 may be conveniently and easily controlled by controlling the spacing between the permanent magnet 24 and the core piece 10 as provided for by the block 25. Thus the greater the thickness of the block 25 the weaker will be the effect of the field set up by the permanent magnet 24 on the wire 13. This may be similarly controlled, to some extent, by the relative location of the permanent magnet 24 with respect to the crown edge 11 of the core piece 10.

Simultaneously with the partial demagnetization of the wire 13, the wire is also subjected to a fluctuating magnetic field established by the voice coil 26. This coil 26 is connected to a source of fluctuating audio current whose fluctuations are to be recorded on the wire 13.

A study of Figure 3 of the drawings, which illustrates the hysteresis loop, will show the manner in which the wire 13 is magnetized. More particularly, in Figure 3 a hysteresis loop for the wire 13 is indicated at 27. The coordinate axes 28 and 29 represent the values of the magnetizing field force and the extent to which the wire is magnetized respectively. When a wire, which is either demagnetized or magnetized, is passed in the direction of the arrow as shown in Figure 1 of the drawings, the wire is first saturated by the magnetic field set up by the permanent magnet 21. This is represented (in the case of a demagnetized wire) by the initial magnetization curve 30 in Figure 3 of the drawings. The point 31 represents a condition of approximate saturation of the wire. As the wire continues to travel across the recording head it moves into the presence of the field set up by the permanent magnet 24. Since this permanent magnet 24 sets up a field which is opposite in direction to that set up by the permanent magnet 21 the wire is demagnetized, or partially demagnetized, depending on the strength

of this field, set up by the permanent magnet 24. This demagnetizing operation is represented by the left side of the hysteresis loop as indicated at 32. If no current is flowing through the coil 26, let it be assumed that the permanent magnet is of sufficient strength to reach the point 33 on the hysteresis loop. If the wire is then withdrawn from the presence of the magnetic field, the amount of residual magnetism left in the wire is indicated by the point at which the broken line 34 reaches the zero field axis. That is to say, it is represented by the value of the ordinate at the point 35.

As a fluctuating electric current is impressed on the coil 26, the extent of the demagnetization brought about by the permanent magnet 24 will be modified. The amplitude of the normal maximum values of the fluctuating current supplied to the coil 26 is such that the recording takes place over the portion of the hysteresis loop between the points 36 and 37, as indicated in Figure 3.

It has been found that operating over this portion of the hysteresis loop gives much more satisfactory results than operating with a saturated wire and then partially demagnetizing the wire by half cycles of the audio current. It has further been found that the portion of the hysteresis loop at which the magnetization takes place may be very easily and conveniently controlled by controlling the degree of demagnetization affected by the permanent magnet 24. As previously explained, this can easily be done by varying the spacing between the permanent magnet 24 and the core piece 10.

In Figures 4 and 5 a modified form of the present invention is provided. More specifically, a core piece 38 is provided which is substantially the same shape and size as the core piece 10 shown in Figure 1. We thus are provided with a permanent magnet 39 mounted at one corner of the core piece 38 as shown. The second permanent magnet, indicated in this figure at 40, is placed in a different position, however. More specifically, the slot in the core piece indicated by the reference character 41 continues entirely through the core piece from top to bottom, it having a central hole 42, however, similar to the hole 17 as shown in Figure 1. The slot below the hole 42, however, is filled with a non-magnetic material such, for example, as silver solder, as indicated at 43, and this silver solder serves to unite the two cut parts of the core piece 38. The reason for cutting the core piece 38 and filling the connecting space with a non-magnetic material, as at 43, is to make a magnetic path of high reluctance in the region immediately below and above the permanent magnet 40, thereby to force a substantial portion of the flux path up into the upper portion of the core piece and across the air gap 44.

Since the direction of the lines of force of the magnetic field at the point where it crosses the slotted gap is opposite to the direction of the lines of force in immediate proximity to the ends of the permanent magnet 40, it will be apparent that in this form of the invention the permanent magnet has been mounted in the same way as in the first embodiment; i. e., with its north pole facing the same end of the core piece 38 as does the north pole of the permanent magnet 39. Similarly, the south pole of the permanent magnet 40 faces the same end of the core piece 38 as does the south pole of the permanent magnet 39.

Due to the remoteness of the permanent mag-

net 40 from the slot 45 through which the wire passes, it will be obvious that the wire is only partly demagnetized by this magnet even though this magnet 40 is of the same strength as the permanent magnet 39, which causes saturation of the wire. A voice coil 26 is also provided for this embodiment of the invention, and in this case it will be noted that the voice coil in part surrounds the permanent magnet 40. The effect of the operation of the embodiment of the invention shown in Figures 4 and 5 of the drawings is to cause operation along substantially the same portion of the hysteresis curve as discussed in connection with Figure 3 for the first embodiment of the invention.

While I have shown certain particular embodiments of my invention, it will, of course, be understood that I do not wish to be limited thereto, since many modifications may be made, and I, therefore, contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

I claim as my invention:

1. A magnetic recording head comprising a plate formed of material having a relatively high magnetic permeability and relatively low magnetic retentivity, one of the edges of said plate being grooved to receive a traveling magnetizable wire, said plate being cut out at two places along said one edge to provide two pairs of polar portions spaced longitudinally along one edge, a permanent magnet associated with one pair of polar portions to establish a magnetic field therebetween in one longitudinal direction of the wire, a second permanent magnet associated with the other pair of polar portions for establishing a magnetic field therebetween in the opposite longitudinal direction to that of the first field and weaker than the first field, and a signal coil for establishing a fluctuating magnetic field between said second pair of polar portions whenever a fluctuating electric current is impressed on said coil.

2. A magnetic recording head comprising a plate formed of material having a relatively high magnetic permeability and a relatively low magnetic retentivity, one of the edges of said plate being gradually curved from one end to the other and having a groove therein along said edge to receive a traveling magnetizable wire, said groove being generally V-shaped in cross-section, said plate having a pair of slots therein extending inwardly normal to said curved edge and having enlarged inner parts thereby to provide two pairs of polar portions along said curved edge, a permanent magnet associated with one of said pairs of polar portions to establish a magnetic field therebetween in one longitudinal direction of the wire, a second permanent magnet associated with the other pair of polar portions to establish a magnetic field therebetween in the opposite longitudinal direction to that of said first field and weaker than said first field, and a signal coil for establishing a fluctuating magnetic field between the second pair of polar portions whenever a fluctuating electric current is impressed on said coil.

3. A magnetic recording head comprising a plate formed of material having a relatively high magnetic permeability and a relatively low magnetic retentivity, one of the edges of said plate being gradually curved from one end to the other and having a groove therein along said edge to receive a traveling magnetizable wire, said groove being generally V-shaped in cross-section, said plate having a pair of slots therein extending inwardly normal to said curved edge and having enlarged inner parts thereby to provide two pairs of polar portions along said curved edge, a permanent magnet mounted on said plate to form an integral part thereof and lying in the same plane thereof, said permanent magnet forming one of the polar portions of one of said pairs of polar portions thereby to establish a magnetic field therebetween in one predetermined longitudinal direction of the wire, a second permanent magnet overlying a portion of said plate and associated with the other pair of polar portions for establishing a magnetic field therebetween in the opposite longitudinal direction to that of said first field and weaker than said first field, and a signal coil for establishing a fluctuating magnetic field between the second pair of polar portions whenever a fluctuating electric current is impressed on said coil.

4. A magnetic recording head comprising a plate formed of a material having a relatively high magnetic permeability and a relatively low magnetic retentivity, one of the edges of said plate being grooved to receive a traveling magnetizable wire, said plate being cut out at two places along said one edge to provide two pairs of polar portions spaced longitudinally along said one edge, a permanent magnet mounted on said plate to form one pole of one of said pairs of polar portions to establish a magnetic field therebetween in one longitudinal direction of the wire, a second permanent magnet mounted on said plate in spaced magnetic relation thereto, said second permanent magnet being positioned to establish a magnetic field between said second pair of polar portions in the opposite longitudinal direction to that of said first field, and a signal coil for establishing a fluctuating magnetic field between the second pair of polar portions whenever a fluctuating electric current is impressed on said coil.

MARVIN CAMRAS.

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The following references are of record in the file of this patent:

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