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DRAWINGS ATTACHED

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NATIONAL REFERENCE
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AND INVENTION

(54) MAGNETIC ERASING HEAD

(71) We, SONY CORPORATION, a Japanese Body Corporate of 351 Kitashinagawa-6, Shinagawa-Ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to a magnetic erasing head for erasing signals recorded on a magnetic tape.

A magnetic erasing head has been proposed in which a permanent magnet is utilized as the source of the erasing magnetic field, and this type of erasing head is referred to as a direct-current erasing head. Further, it has been proposed to provide such a direct-current erasing head with a permanent magnetization which presents a series or succession of alternately opposed poles at locations along the contact surface of the head to be engaged with the magnetic tape, and in which the strength of the magnetization at the successive poles decreases progressively in the direction of relative movement of the tape with respect to the head.

An erasing head which is permanently magnetized in the manner last referred to above provides substantially the same erasing effect on the tape as a so-called alternating current erasing head, but is apparently less costly than the latter by reason of its avoidance of the need to provide an alternating current power source, as required by an alternating current erasing head. Direct-current erasing heads of the described type are preferably formed of a ferrite, such as barium-ferrite or strontium-ferrite, because such substances have a high magnetic coercive force, and therefore can be permanently magnetized, and further because the mentioned substances have great hardness and strength so as to strongly resist wearing away due to the frictional contact with the magnetic tape.

However, if signals are recorded in a plurality of tracks on a magnetic tape, the previously proposed erasing heads are not suit-

able for erasing the signals in only a selected one or more of the recording tracks. When only the signals in a specified track or tracks of the tape are to be erased, the contact surface of the erasing head should be magnetized in only a limited portion of the width thereof which corresponds to the track or tracks from which the signals are to be erased, whereas the remainder of the contact surface should be non-magnetized and should act only as a guiding surface of the tape. However, if the head is formed completely of a magnetic material, it is extremely difficult to magnetize only a restricted portion of the head, and it is inevitable that the remaining portion of the head will be magnetized at least to a small extent. This small extent of magnetization in portions of the head which do not correspond with the track or tracks from which signals are to be erased inevitably leads to partial erasing or at least deterioration of the signals which are intended to be undisturbed by the erasing head. Signals of small wavelength are particularly susceptible to being easily erased by the low levels of magnetization that are inadvertently present in portions of the head that are not aligned with the track or tracks from which signals are intended to be erased. The foregoing problems are particularly acute in cassette-type tape recorders in which the recording tracks and/or the spaces between such tracks on the magnetic tape are of relatively small width.

If it is attempted to avoid the described inadvertent erasing of signals from the tape by providing an erasing head having a width, at its contact surface, that is only equal to the width of the track from which signals are to be erased, the fact that the contact surface of such an erasing head has a width substantially smaller than that of the overall width of the tape will prevent the smooth running of the tape over the contact surface of the erasing head.

According to the present invention there is provided the combination of a magnetic tape having a plurality of record tracks ar-

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ranged side-by-side and extending along the
 tape to receive recorded signals and each
 having a width that is substantially smaller
 than the width of the tape, and a magnetic
 erasing head having a contact surface that
 is at least as wide as the tape and is engage-
 able with the latter during relative move-
 ment of the tape and head in the longi-
 tudinal direction of the tape, the head com-
 prising a plurality of united ferrite layers
 superposed on each other to present exposed
 edge surfaces which combine to constitute
 the contact surface and which extend paral-
 lel to the direction of relative movement,
 each of one or more of the ferrite layers
 being magnetized and having a width sub-
 stantially equal to the width of one record
 track while the remainder of the ferrite layers
 are non-magnetic, each magnetized layer
 being aligned with one of the record tracks,
 in one position of the tape relative to the
 head, and with another of the record tracks
 when the tape is inverted relative to the
 head, each magnetized layer presenting a
 series of alternately opposed poles at loca-
 tions along the exposed surface thereof with
 the strength of the magnetization decreasing
 along the series of poles from a maximum at
 one end thereof for erasing signals from a
 record track with which the magnetized
 layer is aligned upon the relative movement
 of the tape and head.

In a preferred embodiment of the erasing
 head, each of the non-magnetic layers of the
 erasing head is of a ferrite, for example
 zinc-ferrite, manganese-ferrite, or manganese-
 zinc-ferrite, having a low magnetic coercive
 force and a high magnetic permeability for
 absorbing leakage flux from each adjacent
 magnetized layer, whereas each magnetized
 layer is of a ferrite, such as barium-ferrite
 or strontium-ferrite, having a very high mag-
 netic coercive force so as to be readily
 permanently magnetized.

The present invention will now be de-
 scribed, by way of example, with reference
 to the accompanying drawings, wherein:—

Fig. 1 is a perspective view showing an
 erasing head suitable for use in an embodi-
 ment of this invention:

Fig. 2 is a view similar to that of Fig. 1,
 but showing the relationship of the erasing
 head to a magnetic tape from which signals
 are to be erased:

Fig. 3 is a diagrammatic plan view of the
 head and tape appearing on Fig. 2, and
 graphically showing the arrangement of the
 magnetization of a portion of the erasing
 head:

Fig. 4 is a view similar to that of Fig. 1,
 but showing a head suitable for use with
 another embodiment of this invention; and

Figs. 5A—5E are schematic sectional
 views illustrating successive stages in the
 manufacture of an erasing head.

Referring to the drawings in detail, and
 initially to Figs. 1 and 2 thereof, it will be
 seen that the magnetic erasing head 10, as
 there shown, is intended to erase signals that
 are recorded in a track 11 (Fig. 2) extending
 along a magnetic tape 12 and having a width
 w that is only about one-half the overall
 width W of the tape. In order to erase
 signals only from such track 11, and to leave
 undisturbed signals recorded in a track 11'
 occupying the remainder of tape 12, the
 head 10 comprises two united or integral
 ferrite layers 13 and 14 which are respec-
 tively magnetized and non-magnetic and
 which have exposed edge surfaces 13a and
 14a combining to define the contact surface
 15 of the head across which the tape 12 is
 relatively movable.

The tape 12 is moved longitudinally rela-
 tive to erasing head 10 in the direction of
 the arrow 16 on Fig. 2, and it will be seen
 that exposed edge surfaces 13a and 14a
 which combine to form the contact surface
 15 extend generally parallel to the direction
 of such relative movement and each consti-
 tute only a part of the width of the contact
 surface considered transverse to the direction
 of the relative movement. The overall width
 W_1 of head 10 at its contact surface 15 is
 at least as large as the width W of the tape
 12 so that the latter will be smoothly guided
 and supported by the contact surface during
 the relative movement of the tape and head,
 and the width w_1 of the exposed edge surface
 13a of magnetized layer 13 is approximately
 equal to the width w of the track 11 on the
 tape from which signals are to be erased.

The ferrite of which the magnetized layer
 13 is formed is selected so as to have a high
 magnetic coercive force and thus be capable
 of being permanently magnetized. Prefer-
 ably, the magnetized layer 13 is formed of
 barium-ferrite or strontium-ferrite which
 have a magnetic coercive force of approxi-
 mately 1650 Oersted and a relatively low mag-
 netic permeability of approximately 1.5. On
 the other hand, the ferrite layer 14 is selected
 to have a very low magnetic coercive force,
 and preferably also a very high magnetic
 permeability. The low coercive force of the
 ferrite selected for the layer 14 ensures that
 such layer will not be magnetized during
 magnetization of the layer 13, and the high
 magnetic permeability of the ferrite selected
 for the layer 14 ensures that the latter will
 not only act as a guide for the tape 12 but
 will also act as a magnetic flux absorber.
 Thus, leakage magnetic flux from the mag-
 netized layer 13 will be absorbed by the
 layer 14 and will not penetrate the tape 12
 at the track 11' thereof when signals are to
 be erased only in the track 11. Accordingly,
 the high magnetic permeability of the ferrite
 of layer 14 ensures that the magnetized layer
 13 will effect erasure of signals only from

the track 11 which corresponds both in position and width to the magnetized layer 13. The ferrite for forming the non-magnetic layer 14 is preferably selected from zinc-ferrite, manganese-ferrite and manganese-zinc-ferrite. By way of example, it may be noted that manganese-ferrite has a coercive force of 4 Oersteds and a high magnetic permeability of 250, while manganese-zinc-ferrite has a coercive force of 0.2 Oersteds and a still higher magnetic permeability of approximately 1500 to 2500.

Since all of the layers 13 and 14 constituting the erasing head 10 are formed of ferrites, the entire contact surface 15 constituted by exposed edge surfaces of the ferrite layers has a substantially uniformly high strength and resistance to wear while desirably restricting the erasing action to the width of the magnetic tape 12 that corresponds to the width of the magnetized layer 13.

As indicated schematically on Fig. 1 and graphically at 17 on Fig. 3, the layer 13 of a ferrite having a high magnetic coercive force is magnetized so that its edge surface 13a presents a series or succession of alternately arranged opposed poles at locations along such edge surface, with the strength of the magnetization decreasing progressively along such series of poles in the direction of relative movement of the tape 12. Thus, the magnetization has a maximum strength at the end 18 of surface 13a first encountered by the track 11 on tape 12 and decreases to zero at the other end 19 of edge surface 13a. Accordingly, as the tape 12 is moved relative to head 10 in the direction 16, the signals recorded in the track 11 of the tape will be erased by a magnetic field which alternates and is of decreasing strength, so that the erasing action will be similar to that achieved with an alternating current erasing head. Although the head 10 has been described as erasing only the signals recorded in the track 11 of tape 12, it is apparent that inverting of either the head 10 or the tape 12 to bring the edge surface 13a of magnetized layer 13 into alignment with the other track 11' of the tape will then make it possible for the head to erase only signals recorded in the track 11' while leaving undisturbed the signals recorded in the first mentioned track 11. Thus, the head 10 is obviously adapted for the selective erasing of magnetic signals recorded in one or the other of the two tracks 11 and 11' on tape 12.

Of course, it will be apparent that a magnetic erasing head may be provided for selectively erasing signals recorded in more than one track of a magnetic tape. For example, as shown on Fig. 4, a magnetic erasing head 110 may comprise two magnetized ferrite layers 113 and two non-

magnetic ferrite layers 114 which are superposed and united, as by sintering, in an alternating arrangement with the exposed edge surfaces 113a of the magnetized layers and the exposed edge surfaces 114a of the non-magnetic layers combining to define the contact surface 115 of the head across which the magnetic tape is relatively movable. With the head 110, which is similar to the head 10 apart from the number of its ferrite layers, the magnetized layers 113 are effective to selectively erase signals from two correspondingly located tracks of a magnetic tape while the non-magnetic layers 114 of the head ensure that the signals in other correspondingly located tracks of the tape will not be disturbed or partially erased.

In manufacturing a magnetic erasing head, for example the head 10 described above with reference to Figs. 1 and 2, respective ferrite powders A and B are prepared initially for the magnetic and non-magnetic layers 13 and 14, whereupon such powders are formed into the respective layers which are united to each other by hot-pressing or sintering.

The powder A for forming each magnetic layer 13 may be produced by mixing powdered BaCO_3 powder and powdered Fe_2O_3 , approximately in the proportion of 20:80 (mol.%), such mixing preferably taking place in a ball mill with the addition of water thereto. After thorough mixing of the BaCO_3 and Fe_2O_3 powders, the resulting mixture is dried and then initially fired at a temperature in the range between approximately 600 and 1000°C, whereupon the frit thus formed is crushed and ground to a fine powder which is in turn mixed with a binder, such as, for example, polyvinyl alcohol, to provide the powder A from which each magnetic layer 13 will be formed.

The powder B for producing each non-magnetic layer 14 is formed by mixing powdered ZnO and powdered Fe_2O_3 , in the proportion of approximately 50:50 (mol.%), with the addition thereto of Al_2O_3 , in an amount which is approximately 3 wt.% based on the entire weight of the mixture, for the purpose of controlling shrinkage. The mixture is thoroughly agitated and mixed with water in a ball mill, and is then dried, initially fired and crushed or ground to a fine powder which is mixed with a binder to provide the powder B for forming the layer 14, in a manner similar to that described above for forming the powder A of layer 13.

Referring now to Figs. 5A—5E, it will be seen that a magnetic erasing head 10 is molded in a press 20 comprising a mold 21 formed with a cavity 22 opening at the top and bottom of mold 21, and vertically movable plungers 23 and 24 which are adapted to enter the cavity or recess 22 at the top

and bottom, respectively, thereof. The mold cavity 22 is shaped so as to correspond to the desired configuration of the finished erasing head, and the plungers 23 and 24 are similarly shaped to fit closely within the mold cavity.

As shown on Fig. 5A, a suitable quantity of the powder A is introduced into cavity 22 with the bottom surface of such cavity being constituted by the upper end of the plunger 24 inserting therein. Then, the powder A is initially pressed between plungers 23 and 24 (Fig. 5B), for example at a pressure of approximately 200 kg/cm². The resulting pressed layer 13¹ and the plunger 24 thereunder are lowered within cavity 22 and a suitable quantity of the powder B is introduced into cavity 22 above layer 13¹ (Fig. 5C). The powder B superposed on the pressed layer 13¹ is then pressed together with the latter between plungers 23 and 24 (Fig. 5D), for example at a pressure of approximately 1000 kg/cm². The resulting body 10¹ (Fig. 5E) comprised of the pressed layers 13¹ and 14¹ is then removed from the mold cavity by upward movement of the plunger 24 (Fig. 5E), and such body is fired or sintered at a temperature in the range from approximately 1100°C to 1200°C to provide the previously described head 10 having its layer 13 of barium-ferrite and its layer 14 of zinc-ferrite. The head 10 is completed by lapping the surface 15 thereof to a smooth, cylinder-like finish for contact with the magnetic tape. Further, in a manner that is conventional, the head 10 is magnetized and, during such magnetization, the small coercive force of the zinc-ferrite constituting the layer 14 ensures that such layer will not be permanently magnetized, whereas the high magnetic coercive force of the barium-ferrite constituting the layer 13 ensures that the latter layer will be permanently magnetized in the manner previously described. Further, since both layers 13 and 14 are formed of ferrites, they will have approximately the same mechanical properties such as hardness, and therefore will uniformly resist wear as a result of the relative movement thereacross of the magnetic tape during the selective erasing of signals in a track or tracks of the tape.

In the above described method of producing a head 10, the initial pressing of the layer 13¹ as illustrated in Fig. 5B has been provided in order to positively avoid distortion or peeling away of the layer 13 from the layer 14 in the finished head 10 due to any difference in the coefficient of expansion of such layers. However, if the powders A and B employed for producing the layers 13 and 14 are composed of particulate materials of the same sizes, the initial pressing of the layer 13¹ can be omitted from the

process. Further, if desired, the lower end surface of the plunger 23 which is used for the initial pressing of the layer 13¹ in Fig. 5B can be provided with a roughened surface so that the initially pressed layer 13¹ will have a similarly roughened upper surface for improving the bond between the layers 13¹ and 14¹.

WHAT WE CLAIM IS:—

1. The combination of a magnetic tape having a plurality of record tracks arranged side-by-side and extending along the tape to receive recorded signals and each having a width that is substantially smaller than the width of the tape, and a magnetic erasing head having a contact surface that is at least as wide as the tape and is engageable with the latter during relative movement of the tape and head in the longitudinal direction of the tape, the head comprising a plurality of united ferrite layers superposed on each other to present exposed edge surfaces which combine to constitute the contact surface and which extend parallel to the direction of relative movement, each of one or more of the ferrite layers being magnetized and having a width substantially equal to the width of one record track while the remainder of the ferrite layers are non-magnetic, each magnetized layer being aligned with one of the record tracks, in one position of the tape relative to the head, and with another of the record tracks when the tape is inverted relative to the head, each magnetized layer presenting a series of alternately opposed poles at locations along the exposed surface thereof with the strength of the magnetization decreasing along the series of poles from a maximum at one end thereof for erasing signals from a record track with which the magnetized layer is aligned upon the relative movement of the tape and head.

2. The combination according to claim 1, in which each non-magnetic layer is of a ferrite having a low magnetic coercive force and a high magnetic permeability for absorbing flux from an adjacent magnetized layer.

3. The combination according to claim 1 or 2, in which each magnetized layer is of barium-ferrite or strontium-ferrite, and each non-magnetic layer is of zinc-ferrite, manganese-ferrite or manganese-zinc-ferrite.

4. The combination according to claim 1, 2 or 3, in which the head has equal numbers of the magnetized and non-magnetic layers, respectively.

5. The combination of a magnetic tape and magnetic erasing head substantially as hereinbefore described with reference to and as shown by the accompanying drawings.

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and bottom, respectively, thereof. The mold cavity 22 is shaped so as to correspond to the desired configuration of the finished erasing head, and the plungers 23 and 24 are similarly shaped to fit closely within the mold cavity.

As shown on Fig. 5A, a suitable quantity of the powder A is introduced into cavity 22 with the bottom surface of such cavity being constituted by the upper end of the plunger 24 inserting therein. Then, the powder A is initially pressed between plungers 23 and 24 (Fig. 5B), for example at a pressure of approximately 200 kg/cm². The resulting pressed layer 13¹ and the plunger 24 thereunder are lowered within cavity 22 and a suitable quantity of the powder B is introduced into cavity 22 above layer 13¹ (Fig. 5C). The powder B superposed on the pressed layer 13¹ is then pressed together with the latter between plungers 23 and 24 (Fig. 5D), for example at a pressure of approximately 1000 kg/cm². The resulting body 10¹ (Fig. 5E) comprised of the pressed layers 13¹ and 14¹ is then removed from the mold cavity by upward movement of the plunger 24 (Fig. 5E), and such body is fired or sintered at a temperature in the range from approximately 1100°C to 1200°C to provide the previously described head 10 having its layer 13 of barium-ferrite and its layer 14 of zinc-ferrite. The head 10 is completed by lapping the surface 15 thereof to a smooth, cylinder-like finish for contact with the magnetic tape. Further, in a manner that is conventional, the head 10 is magnetized and, during such magnetization, the small coercive force of the zinc-ferrite constituting the layer 14 ensures that such layer will not be permanently magnetized, whereas the high magnetic coercive force of the barium-ferrite constituting the layer 13 ensures that the latter layer will be permanently magnetized in the manner previously described. Further, since both layers 13 and 14 are formed of ferrites, they will have approximately the same mechanical properties such as hardness, and therefore will uniformly resist wear as a result of the relative movement thereacross of the magnetic tape during the selective erasing of signals in a track or tracks of the tape.

In the above described method of producing a head 10, the initial pressing of the layer 13¹ as illustrated in Fig. 5B has been provided in order to positively avoid distortion or peeling away of the layer 13 from the layer 14 in the finished head 10 due to any difference in the coefficient of expansion of such layers. However, if the powders A and B employed for producing the layers 13 and 14 are composed of particulate materials of the same sizes, the initial pressing of the layer 13¹ can be omitted from the

process. Further, if desired, the lower end surface of the plunger 23 which is used for the initial pressing of the layer 13¹ in Fig. 5B can be provided with a roughened surface so that the initially pressed layer 13¹ will have a similarly roughened upper surface for improving the bond between the layers 13¹ and 14¹.

WHAT WE CLAIM IS:—

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2. The combination according to claim 1, in which each non-magnetic layer is of a ferrite having a low magnetic coercive force and a high magnetic permeability for absorbing flux from an adjacent magnetized layer.

3. The combination according to claim 1 or 2, in which each magnetized layer is of barium-ferrite or strontium-ferrite, and each non-magnetic layer is of zinc-ferrite, manganese-ferrite or manganese-zinc-ferrite.

4. The combination according to claim 1, 2 or 3, in which the head has equal numbers of the magnetized and non-magnetic layers, respectively.

5. The combination of a magnetic tape and magnetic erasing head substantially as hereinbefore described with reference to and as shown by the accompanying drawings.

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