

MAGNETIC TAPE RECORDING/PLAYBACK APPARATUS AND METHOD

The invention relates to a magnetic tape recording/playback apparatus comprising a rotatable magnetic head assembly of the type in which a magnetic tape is wound around the assembly over such an angle as to provide a helical scanning recording/playback mode, and means for moving the tape longitudinally around the assembly, the assembly comprising a rotatable supporting member which supports two diametrically oppositely located magnetic heads for rotation about an axis, the two magnetic heads each having two sub-heads with mutually parallel transducing gaps separated in both the axial and circumferential directions on the rotatable supporting member. The invention also relates to a method of magnetic tape recording and playback.

The present tendency is that a high-density recording technique is required, in particular for recording analogue signals by digitalization or for the manufacture of magnetic tape apparatus of smaller dimensions.

One of the methods of achieving such a high-density recording is currently used for video tape apparatus which is generally subdivided into types having one head, types having two heads and a 180° spacing, and types having four heads. Another technique which relates to this is the multi-track recording in which an input signal is divided into a number of channels and this is recorded simultaneously in a number of recording tracks. This method is used in PCM audio tape apparatus with fixed heads etc. Moreover, the above-mentioned two techniques can be combined to obtain recording and display devices of the rotatable scanning type as suggested in United States Patent Specification 3,604,847.

In one of the magnetic recording systems described therein there is disclosed the use of two diametrically oppositely located magnetic heads each in the form of a stack of two single sub-heads. The sub-heads of each magnetic head are stacked so that they are at a certain distance from each other and that their transducing gaps are situated on one line. Each magnetic head forms two oblique tracks on a magnetic tape with a protective band

on either side of each track, the tracks having a pitch of a track width + 3 protective band widths.

In case a higher density should be desired in recording, the sub-heads could be positioned so close together that no protective band is formed in between the tracks. The construction of the heads then must become different. In order to prevent cross-talk during the playback it is in fact necessary, in the case in which the recording has taken place without a protection band, that heads which form adjacent tracks should have different gap angles. This method is termed "azimuth recording". The cross-talk between adjacent tracks is prevented by the principle of azimuth loss of the recording.

The most important object of the present invention is to provide a new magnetic head assembly for use in a multi-channel magnetic tape device of the rotatable scanning type which enables a method of recording without the use of a protective band.

For that purpose, in accordance with a first aspect, the invention provides a magnetic tape recording/playback apparatus comprising a rotatable magnetic head assembly of the type in which a magnetic tape is wound around the assembly over such an angle as to provide a helical scanning recording/playback mode, and means for moving the tape longitudinally around the assembly, the assembly comprising a rotatable supporting member which supports two diametrically oppositely located magnetic heads for rotation about an axis, the two magnetic heads each having two sub-heads with mutually parallel transducing gaps separated in both the axial and circumferential directions on the rotatable supporting member the axial and circumferential separations of the transducing gaps of one magnetic head being equal respectively to the axial and circumferential separations of the transducing gaps of the other magnetic head, the transducing gaps of the sub-heads of one magnetic head being inclined at a first azimuth angle relative to the plane of rotation of the rotatable supporting member and the transducing gaps of the sub-heads of the other magnetic head being inclined at a second azimuth angle, opposite in direction to the

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first azimuth angle, relative to the plane of rotation of the rotatable supporting member and each gap forming a track of width W during recording, the two magnetic heads being situated in positions chosen on the assembly in relation to the helical scan angle, the tape longitudinal speed and the assembly rotation speed so that each magnetic head forms two tracks having a pitch of $2NW$ (where $N=1$ or 3) and so that during one half turn of the assembly one head forms two first oblique separated tracks simultaneously on the magnetic tape and during the following half turn of the assembly the other head forms two second oblique separated tracks simultaneously on the magnetic tape interleaved with said first tracks, adjacent tracks being formed without protective bands between them by subheads of opposite azimuth angle.

As a result of the special construction of the apparatus in accordance with the invention it is achieved that first (during half a revolution of the supporting member) one multi-track head forms two parallel

tracks on the magnetic tape with a given pitch (of, for example, two track widths). The two tracks are formed with the same azimuth angle of the transducing gaps (of, for example, $+15^{\circ}$). During the next half revolution of the supporting member the other multi-track head forms two parallel tracks on the magnetic tape with the same mutual distance as the first head. The two tracks are formed with the same azimuth angle of the transducing gaps (in this case, for example, -15°). One track of the second set is formed in the intermediate space between the first set. In this manner it is ensured that adjacent tracks on the magnetic tape are formed with different azimuth angles so that disturbing cross-talk is avoided. This manner of recording makes it possible to use very simple multi-track heads which are suitable for series production and which have only two transducing gaps parallel to each other.

In order to realize a homogeneous covering of the magnetic tape with tracks it is essential for the tracks to be formed on the magnetic tape with a pitch which is equal to an odd number of times double the track width. As will be explained hereinafter, a pitch which is equal to three times the double track width proves to be a very suitable choice in practical recording/display systems.

In one embodiment the supporting member is assembled on a rotatable upperdrum which is mounted coaxially with a fixed lower drum, and a head window through which the heads can contact the magnetic tape and scan same when it is wound around the drums is formed on the circumference of the rotatable upper drum.

In accordance with a second aspect the invention provides a method of recording and playing back information on a magnetic tape in an apparatus comprising a rotatable magnetic head assembly around which the magnetic tape is wound over such an angle as to provide a helical scanning record/playback mode and means for moving the tape

longitudinally around the assembly, the assembly comprising a rotatable supporting member which supports two diametrically oppositely located magnetic heads for rotation about an axis, the two magnetic heads each having two sub-heads with mutually parallel transducing gaps separated in both the axial and circumferential directions on the rotatable supporting member, the axial and circumferential separations of the transducing gaps of one magnetic head being equal respectively to the axial and circumferential separations of the transducing gaps of the other magnetic head, the transducing gaps of the sub-heads of one magnetic head being inclined at a first azimuth angle relative to the plane of rotation of the rotatable supporting member and the transducing gaps of the sub-heads of the other magnetic head being inclined at a second azimuth angle, opposite in direction to the first azimuth angle, relative to the plane of rotation of the rotatable supporting member, the gaps of the sub-heads of each magnetic head forming tracks of a trackwidth W, the recording method comprising a selection of the helical scan angle, the tape longitudinal speed, the assembly rotation speed and the head positions in relation to one another so that during one half-turn of the assembly one head forms two first oblique separated tracks simultaneously with a pitch of $2NW$ (where $N=1$ or 3) on the magnetic tape and so that during the following half-turn of the assembly the other head forms two second oblique separated tracks simultaneously with a pitch of $2NW$ interleaved with said first tracks so that adjacent tracks have no protective bands between them and are formed by subheads of opposite azimuth angle, and the playback method comprising scanning each track once with the sub-head used to record that track.

An embodiment of the invention will now be described in greater detail, by way of example, with reference to the accompanying drawings. In the drawings:

Figure 1 is a diagrammatic perspective elevation of a rotatable drum device in which a magnetic head assembly is incorporated,

Figure 2 is a diagrammatic plan view which shows the situation in which a magnetic tape is wound around the rotatable drum device of Figure 1,

Figure 3 is a front view on an enlarged scale of an important part of the rotatable drum device in which a magnetic head assembly having two multi-track heads according to the invention is used.

Figure 4 is a sectional view taken on the line IV-IV of Figure 3,

Figure 5a is a front view on an enlarged scale of one of the two multi-track heads in one embodiment of the magnetic head assembly according to the invention,

Figure 5b is a front view on an enlarged scale of one of the other multi-track heads in one embodiment of the magnetic head assembly according to the invention,

Figure 6 is a plan view, partly broken away, of a magnetic tape in which an example of a track pattern is shown which is formed after half a revolution by the head assembly according to the invention, and

Figure 7 is a plan view, partly broken away, of a magnetic tape which shows a track pattern after one full revolution by the head assembly according to the invention.

A recording/playback apparatus according to the invention is equipped with a rotatable head assembly having the construction shown in Figures 1 and 2 in which a rotatable upper drum 1 and a fixed lower drum 2 form a tape guide system 3. The rotatable upper drum 1 is rotated by a motor 5 via a shaft 4. During the recording/playback of (television) signals the upper drum 1 is driven while a magnetic tape 6 is guided by a pair of guide pins 7 and 8, as shown in Figure 1, and is wound on the circumference of the tape guide system 3 over such an angle as to enable a helical scanning recording/playback mode.

The rotatable upper drum 1 has a head window 9 from which a multi-track magnetic head 12 of a head assembly 10 projects to scan the magnetic tape 6, and a head window 9' from which the other multi-track magnetic head 12' of the head assembly 10 projects. All this can better be seen from Figure 2 which is a plan view of the

drum device 3 of Figure 1. Figure 3 shows that the head assembly 10 within the upper drum 1 comprises a head support 11 and a multi-track magnetic head 12 of the type as shown in Figure 4. As shown in Figure 4, the multi-track head 12, which in this case is a two-track head, consists of a block-shaped central part 13 of a magnetizable material, for example, ferrite. Part 13 has two sides 14 and 15 which are accurately parallel. The width L of the central part 13 is brought to a desired value with great accuracy. A C-shaped core part 16 is provided against the side 14 and a C-shaped core part 17 is provided against the side 15, both parts being of the same magnetizable material as the central part 13. In one embodiment the parts 16 and 17 are adhered to the central part 13 by means of glass. On the front or tape contact side, transducing gaps 21 and 22 are formed between the parts 13, 16 and 13, 17, respectively. These gaps 21 and 22 are accurately parallel because the sides 14 and 15 are accurately parallel. The assembly is completed by write/read windings 19, 20.

In order to make cross-talk as small as possible, in one embodiment the central part 13 has a slot 25. A magnetic screen 26 may be provided in said slot 25. Cross-talk can further be reduced by providing a short-circuit turn 27 around the magnetic circuit which is formed by core part 16 and a part of the central part 13 and a short-circuit turn 28 around the magnetic circuit which is formed by core part 17 and a portion of the central part 13.

The head 12' shown in Figure 2 is of the same type as head 12.

The transducing gaps 21, 22 of head 12 and the transducing gaps 23, 24 of head 12' are in a particular relationship to each other and to that of the other head, as is shown in Figures 5a and 5b which are front views on an enlarged scale of the two magnetic heads.

Figures 5a and 5b show the surface of the head support 11 with the position and the angle of the transducing gaps in each multi-track head 12, 12', in which

reference numeral 18 relates to the upper surface of the head support 11. As shown in Figure 5a, the transducing gaps 21, 22 have mutually different heights with respect to the upper surface 18. In the example of Figure 5a the width and the height of each transducing gap 21, 22 have been so chosen that a given space is formed between recording tracks formed by means of the head 12. In itself this space also depends on the angle the head 12 makes with the upper surface 18. In the present case this angle is 0° . The same applies to the tracks formed by the head 12' of Figure 5b provided with transducing gaps 23, 24. Head 12' is arranged relative to head 12 in such manner that the track formed by means of the transducing gap 23 just falls in the space between tracks formed by means of the transducing heads 21, 22 of head 12.

The embodiment shown permits of high-density magnetic recording, for example, digital recording of video signals, in which the recording is carried out without protective bands. For that purpose the transducing gaps 21, 22 and 23, 24 have mutually different angles (α and β , respectively) with respect to the normal to the upper surface 18 of the head support 11, as is shown in broken lines. In this construction the occurrence of cross-talk between adjacent tracks is avoided by the azimuth loss. The tracks may have a width, for example, of $11\mu\text{m}$, i.e. half the track width used in the known Philips V2000 recording system.

Figures 6 and 7 show track patterns which are formed by using the recording/playback apparatus according to the invention.

In the Figures 6 and 7 embodiment a recording which is entirely free from protection band is carried out. The tracks 38A, 38B are formed in one half rotation of the upper drum 1 and the subsequent half rotation thereof forms two subsequent tracks 39A, 39B. In this case the pitch L between two successive tracks having a width W is equal to $2W$.

It will be obvious that a variety of modifications may be carried out in this invention without departing from the gist and the scope of this invention.

The above-suggested recording system has been tested in a V2000 recording system in which the two conventional video heads were replaced by two track heads of the type indicated by reference numerals 12 and 12'. In a V2000 system the tape speed is 24.4 mm per second. At a "frame rate" of 50 frames/sec the distance L on the magnetic tape between the beginning points of the "twin" tracks is approximately $488 \times N \mu\text{m}$.

To ensure minimum cross-talk between the two magnetic circuits of a two-track head, the distance L between the two transducing gaps should be as large as possible. On the other hand, a good mechanical contact between the head and tape and a simple manufacture of the head require a small value for L. A suitable choice has proved to be that which corresponds to $N = 3$, so in the present case $L = 3 \times 488 \mu\text{m} = 1.464 \text{ mm}$. Other relevant dimensions of the "twin track" head are:

$$\underline{l} = 3 \text{ mm}; \underline{h} = 3 \text{ mm}; \underline{h}' = 0.6 \text{ mm}; \underline{h}'' = 1.25 \text{ mm}.$$

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CLAIMS

1. A magnetic tape recording/playback apparatus comprising a rotatable magnetic head assembly of the type in which a magnetic tape is wound around the assembly over such an angle as to provide a helical scanning recording/playback mode, and means for moving the tape longitudinally around the assembly, the assembly comprising a rotatable supporting member which supports two diametrically oppositely located magnetic heads for rotation about an axis, the two magnetic heads each having two sub-heads with mutually parallel transducing gaps separated in both the axial and circumferential directions on the rotatable supporting member the axial and circumferential separations of the transducing gaps of one magnetic head being equal respectively to the axial and circumferential separations of the transducing gaps of the other magnetic head, the transducing gaps of the sub-heads of one magnetic head being inclined at a first azimuth angle relative to the plane of rotation of the rotatable supporting member and the transducing gaps of the sub-heads of the other magnetic head being inclined at a second azimuth angle, opposite in direction to the first azimuth angle, relative to the plane of rotation of the rotatable supporting member and each gap forming a track of width W during recording, the two magnetic heads being situated in positions chosen on the assembly in relation to the helical scan angle, the tape longitudinal speed and the assembly rotation speed so that each magnetic head forms two tracks having a pitch of $2NW$ (where $N=1$ or 3) and so that during one half turn of the assembly one head forms two first oblique separated tracks simultaneously on the magnetic tape and during the following half turn of the assembly the other head forms two second oblique separated tracks simultaneously on the magnetic tape interleaved with said first tracks, adjacent tracks being formed without protective bands between them by subheads of opposite azimuth angle.

2. Apparatus as claimed in Claim 1 wherein $N=3$.

3. Apparatus as claimed in Claim 1 or 2, wherein the supporting member is assembled on a rotatable upper drum which is



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mounted coaxially with a fixed lower drum and wherein a head window through which the heads can contact the magnetic tape and scan same when it is wound around the drums is formed on the circumference of the rotatable upper drum.

5 4. Apparatus as claimed in any one of Claims 1, 2 or 3, wherein each magnetic head comprises a central block on two oppositely located sides of which two C-shaped magnet cores each having an electric winding are provided in such manner that between each C-core and the central part a transducing gap is formed.

10 5. Apparatus as claimed in Claim 4, wherein a slit is formed in the central block between the transducing gaps.

6. Apparatus as claimed in Claim 5, wherein a short-circuit turn is wound around each C-core and also extends through the slot.

15 7. Apparatus as claimed in Claim 5 or 6, wherein a magnetic screen is provided in the slot.

8. A magnetic tape recording/playback apparatus substantially as herein described with reference to the accompanying drawings.

20 9. A method of recording and playing back information on a magnetic tape in an apparatus comprising a rotatable magnetic head assembly around which the magnetic tape is wound over such an angle as to provide a helical scanning record/playback mode and means for moving the tape longitudinally around the assembly, the assembly comprising a rotatable supporting member which supports two diametrically oppositely located magnetic heads for rotation about
25 an axis, the two magnetic heads each having two sub-heads with mutually parallel transducing gaps separated in both the axial and circumferential directions on the rotatable supporting member, the axial and circumferential separations of the transducing gaps of one magnetic head being equal respectively to the axial and
30 circumferential separations of the transducing gaps of the other magnetic head, the transducing gaps of the sub-heads of one magnetic head being inclined at a first azimuth angle relative to the plane of rotation of the rotatable supporting member and the transducing gaps of the sub-heads of the other magnetic head being
35 inclined at a second azimuth angle, opposite in direction to the



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first azimuth angle, relative to the plane of rotation of the rotatable supporting member, the gaps of the sub-heads of each magnetic head forming tracks of a trackwidth W, the recording method comprising a selection of the helical scan angle, the tape longitudinal speed, the assembly rotation speed and the head positions in relation to one another so that during one half-turn of the assembly one head forms two first oblique separated tracks simultaneously with a pitch of $2NW$ (where $N=1$ or 3) on the magnetic tape and so that during the following half-turn of the assembly the other head forms two second oblique separated tracks simultaneously with a pitch of $2NW$ interleaved with said first tracks so that adjacent tracks have no protective bands between them and are formed by subheads of opposite azimuth angle, and the playback method comprising scanning each track once with the sub-head used to record that track.

10. A method as claimed in Claim 9 wherein $N=3$.

11. A method as claimed in Claim 9 or 10, wherein the supporting member is assembled on a rotatable upper drum which is mounted coaxially with a fixed lower drum and wherein a head window through which the heads can contact the magnetic tape and scan same when it is wound around the drums is formed on the circumference of the rotatable upper drum.

12. A method as claimed in any one of Claims 9, 10 or 11, wherein each magnetic head comprises a central block on two oppositely located sides of which two C-shaped magnet cores each having an electric winding are provided in such manner that between each C-core and the central part a transducing gap is formed.

13. A method as claimed in Claim 12, wherein a slot is formed in the central block between the transducing gaps.

14. A method as claimed in Claim 13, wherein a short-circuit turn is wound around each C-core and also extends through the slot.

15. A method as claimed in Claim 13 or 14, wherein a magnetic screen is provided in the slot.

16. A method of recording and playing back information on a magnetic tape substantially as described with reference to the



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accompanying drawings.

17. A video recording/playback apparatus incorporating the method of recording and playing back information on a magnetic tape as claimed in any one of Claims 9 to 16 inclusive.

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