

SPECIFICATION

Apparatus for magnetically recording and/or reading signals on a magnetic tape

- 5 The invention relates to an apparatus for magnetically recording and/or reading signals on a magnetic tape in signal tracks which extend obliquely of the tape, comprising a rotatable drive spindle which has a free end and of which at least a portion extending from said free end is cylindrical, a magnetic head which is rotatable in a circular path around the axis of rotation of the drive spindle for writing and/or reading the oblique signal tracks on the magnetic tape, a head support for the magnetic head, which support is detachably secured to the drive spindle adjacent the free end thereof and is formed with a central opening for receiving the drive spindle and means for detachably mounting the head support on the drive spindle, which means comprise centring means for centring the head support relative to the axis of rotation of the drive spindle, and fixing means for rigidly connecting the magnetic head support and the drive spindle to each other.

- Such apparatus is employed in so-called helical-scan video recorders for magnetically recording and/or reading video signals. Such video recorders are mass manufactured for the consumer market and are a typical mass product. Among the known consumer equipment for magnetically recording and/or reading signals on a magnetic tape they constitute the most advanced type, and very stringent requirements are imposed on the accuracy with which signals are recorded on, and should subsequently be readable from, the magnetic tape by means of the rapidly rotating magnetic heads. The magnetic tape is practically always accommodated in a cassette which is of a specific standard type. An important requirement is that it should be possible that cassettes which have been used for making a recording on a certain video recorder can be used on another similar video recorder for the reproduction of the previously made recording without a perceptible reduction in the quality of reproduction in comparison with a reproduction using the video recorder with which the recording was made originally. In practice this requirement of interchangeability of standard cassettes and of video recorders of a specific type is generally referred to as the "compatibility requirement."

- For a most economic use of the magnetic tape employed in the cassettes, specifically by increasing the playing time obtainable with a specific cassette, it is necessary to maximize the density of the signals recorded on the magnetic tape with video recorders. In modern video recorders for the consumer market, oblique signal tracks are recorded on the magnetic tape by means of two magnetic

- heads, which tracks typically have a width of approximately 40 microns. The distance between successive tracks is approximately 30 microns, so that the tracks slightly overlap each other. The length of each track is approximately 100 mm and is consequently very large in comparison with the width of the track. These dimensions for the track width and the track distance should be maintained within narrow limits over the total length of the oblique track in view of the compatibility requirement.

- This means that a very high positional accuracy is required with respect to the position of the magnetic heads relative to those elements of the video recorder which guide the tape round the head support, so that the small tolerance limits of the tracks on the magnetic tape result in small tolerance ranges in respect of the position of the magnetic heads.

- For the most frequently used video recorders, which have a plurality of magnetic heads, it is furthermore of importance that the synchronism of the signals read by the magnetic heads is guaranteed within narrow limits. Synchronizing errors may manifest themselves as visible timing errors in the reproduced television picture, giving rise to instabilities at the upper edges of the pictures.

- During manufacturing the magnetic heads are positioned on the head support with the aid of special, for example optical, precision devices, the head support being mounted on a spindle. The height of the magnetic heads relative to the tape guide members of the video recorder should be adjusted with a tolerance of the order of 5 microns, so that the mutual difference in height between the magnetic heads should not exceed 5 microns. Moreover, if the head support comprises a rotary head disc with a diameter of 65 mm, the eccentricity of the magnetic heads relative to the axis of rotation of the head support should be less than 1 1/2 micron. A further requirement is that the magnetic heads are uniformly and accurately spaced around the circumference of the head support. For example, when two magnetic heads are used, the lengths of the arcs between the two magnetic heads should not differ more than 3 microns from each other.

- An apparatus of the above construction is known from, for example, United States Patent Specification 3,422,230. In this known apparatus a flange is secured to the drive spindle, on which flange a head support can be mounted by means of screws. The flange is accurately machined on its side which faces the head support and the latter is already provided with the magnetic heads, so that at least the distance between the magnetic heads can be accurately adjusted in advance. This is necessary as the compatibility of the video recorder should not be lost in the event of replacement or repair of a head support.

(16)

Thus, the steps to be taken for securing and centring the head support should be such that also after removal of the head support and refitting a new head support, for example for

5 service purposes, the compaibility is guaranteed. In view of the very small tolerances which are permissible in respect of the eccentricity of the magnetic heads relative to the drive spindle, the precise centring of the head
10 support within the range of the specified 1 1/2 microns is very important. Yet it is desirable that centring can be effected by a service engineer rapidly and without the use of position-alignment devices. In the known apparatus
15 the head support is centred on the drive spindle by mounting the head support on an annular projection of the previously mentioned flange, which engages in the central opening of the head support with a specific fit. Different
20 embodiments employ a centring member which is interposed between the spindle and the central opening of the head support. In view of the tolerances with which such spindles and openings can be made in mass
25 production, it is extremely difficult, if not impossible, with such constructions to comply with the said very small permissible eccentricity tolerances. Therefore, such centring methods are not satisfactory for the latest video
30 recorders.

It is an object of the invention to provide an apparatus in which the head support can be mounted on a drive spindle with very high precision without the need for separate special
35 precision measuring devices.

According to the invention there is provided an apparatus for magnetically recording and/or reading signals on a magnetic tape in signal tracks which extend obliquely of the
40 tape, comprising a rotatable drive spindle which has a free end and of which at least a portion extending from said free end is cylindrical, a magnetic head which is rotatable in a circular path around the axis of rotation of the
45 drive spindle for writing and/or reading the oblique signal tracks on the magnetic tape, a head support for the magnetic head which support is detachably secured to the drive spindle adjacent the free end thereof and is
50 formed with a central opening for receiving the drive spindle with clearance, and means for detachably mounting the head support on the drive spindle, which means comprise centring means for centring the head support
55 relative to the axis of rotation of the drive spindle, and fixing means for rigidly connecting the magnetic head support and the drive spindle to each other, wherein the centring means comprise a centring diaphragm which
60 is made of an elastic sheet material and which is formed with a central opening for fitting tightly on said cylindrical portion of the drive spindle adjacent the free end thereof, the opening in the diaphragm having a shape and
65 dimensions such that upon insertion of the

free end of the drive spindle into this opening, a portion or portions of the centring diaphragm adjacent said opening is or are subjected to an elastic deflection in the axial
70 direction as a result of the forces occurring between the centring diaphragm and the drive spindle, and wherein connecting means are provided for connecting the centring diaphragm to the head support at a distance
75 from the central opening of the centring diaphragm, so that a portion or portions of the centring diaphragm which is or are situated between the connecting means and the central opening of the diaphragm is or are elasti-
80 cally deflexible in the axial direction to a limited extent.

The use of the centring diaphragm enables the head support to be mounted absolutely free from play. When a hardened and ground
85 drive spindle is used with a nominal diameter of 6 mm and manufactured with a diameter tolerance of 4 microns, an undersize of between 11 and 21 microns will suffice for the transverse dimension of the central opening in
90 the centring diaphragm. The axial forces which need to be exerted during mounting can readily be obtained without the use of auxiliary means and without subjecting the drive spindle bearing to an impermissible
95 load.

In one embodiment of the invention the head support is provided with an annular contact surface which surrounds the central opening in the head support and with which
100 the centring diaphragm engages on one side thereof, and the connecting means for connecting the centring diaphragm to the head support comprise a clamping member which is disposed on the side of the centring diaphragm remote from said contact surface and
105 which is provided with an annular clamping surface, said connecting means further comprising screwthreaded means for pressing the clamping member against the centring member and thus clamping the centring diaphragm
110 between said contact surface and said clamping surface.

The axial forces which need to be exerted on the head support and thus on the drive
115 spindle during assembly and dismantling is reduced in an embodiment of the invention in which the central opening the central diaphragm is non-circular, the centring diaphragm making contact with the drive spindle
120 at at least three locations on the periphery of said opening. The central opening may be substantially polygonal, preferably substantially triangular.

Embodiments of the invention will now be described in more detail with reference to the accompanying drawings, in which:

Figure 1 is a side view, partly in cross-section, of a head drum unit of a video recorder according to an embodiment of the
130 invention,

Figure 2 is a plan view of the head drum unit of Fig. 1,

Figure 3 shows a detail of the head-support mounting of Fig. 1 on an enlarged scale, the centring diaphragm being shown deflected to an exaggerated extent for the sake of clarity,

Figure 4 is a plan view of a centring diaphragm with a circular central opening for use in the head-support mounting shown in Fig. 3,

Figure 5 is a cross-section of the centring diaphragm of Fig. 4 taken on the line V-V,

Figure 6 is a plan view of a clamping member for mounting the centring diaphragm of Figs. 4 and 5,

Figure 7 is a cross-section of the clamping member of Fig. 6 taken on the line VII-VII in Fig. 6,

Figure 8 is a plan view of an alternative version of a centring diaphragm, having a triangular central opening, and

Figure 9 is a plan view of another alternative with a non-circular central opening, the centring diaphragm being provided in this embodiment with three contact lugs.

The head drum unit of Fig. 1 is shown only schematically, whilst all other components which are generally located in a video recorder in the vicinity of or on the head drum unit, when they do not directly relate to the invention, have been omitted for the sake of clarity. For a more extensive description of a head drum unit in a video recorder and of the tape guide means for guiding the magnetic tape around the head drum unit, reference is made to the comprehensive literature relating to this subject; see for example, the article "Mechanical Design Consideration for Helical Scan Videotape Recorders", SMPTE Journal, Volume 87, November 1978, pages 767-771, as well as the previously mentioned United States Patent Specification 3,422,230.

The apparatus of Fig. 1 for magnetically recording and reading wide band signals on a magnetic tape in interrupted signal tracks which extend obliquely of the tape and adjacent each other, comprises a drive spindle 2 which is rotatable about an axis 1 and which has a free end 3. The drive spindle may be substantially wholly cylindrical or it may be cylindrical only over a portion extending from the free end thereof. Two magnetic heads 4 and 5 are rotatable about the axis 1 for writing and reading signal tracks on the magnetic tape. A head support comprising a head disc 6 is mounted on the drive spindle 2 adjacent the free end 3 thereof, on which disc the magnetic heads 4 and 5 are mounted. Since the manner in which the magnetic heads 4 and 5 are mounted on the head disc 6 is irrelevant to the present invention, this is not shown in the drawing. The head disc 6 is formed with a central opening 7 for receiving the drive spindle with clearance. For deta-

chably mounting the head disc on the drive spindle there are provided means (Fig. 3) which comprise a centring means 8 for centring the head support relative to the axis of rotation 1 of the drive spindle 2, as well as

fixing means for rigidly connecting the head disc 6 and the drive spindle 2 to each other. These fixing means comprise a flanged collar 10 which is secured to the drive spindle 2 by means of a locking screw 11, and four bolts 9 which pass with clearance through holes 9a in the head disc 6 and screw into threaded bores in the flange of the collar 10. Via the drive spindle 2 the head disc 6 is rotated relative to a stationary drum 12 by a motor (not shown) which is accommodated in the drum 12, together with means for rotatably supporting the drive spindle 2. As the motor and the means for supporting the drive spindle are irrelevant to the present invention, they are not shown in the drawings. The stationary drum 12 is secured to a chassis part 14 of the apparatus by means of four screws 13 through a flange 23.

The centring means 8 comprise a centring diaphragm (Figs. 4 and 5) made of a thin elastic sheet material, which diaphragm has a central opening 15 for fitting tightly on the free end 3 of the drive spindle 2. The central opening 15 of the centring diaphragm has a shape and dimensions such that upon insertion of the free end of the drive spindle into the opening 15, part of the centring diaphragm adjacent the central opening 15 is subjected to an elastic deflection in the axial direction as a result of the forces which occur between the centring diaphragm and the drive spindle, as shown most clearly in particular Fig. 3. Connecting means are provided for connecting the centring diaphragm 8 to the head disc 6, at a distance from the central opening 15 of the centring diaphragm, so that the part of the centring diaphragm 8 located between these connecting means and the central opening 15 is elastically deflexible in the axial direction to a limited extent. The head disc 6 is formed concentrically with an annular contact surface 16 which surrounds the central opening 7 in the disc and against which the centring diaphragm 8 is positioned. The said connecting means for connecting the centring diaphragm 8 to the head disc 6 comprise a clamping member 17 which is disposed on the side of the centring diaphragm remote from the contact surface 16 and which is provided with an annular clamping surface 18. The connecting means further comprise three bolts 19 for pressing the clamping member 17 against the centring diaphragm 8 and thus clamping the centring diaphragm 8 between the contact surface 16 and the clamping surface 18, which two surfaces are thereby positioned concentrically with the drive spindle 2.

For the passage of the bolts 19 the centring

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diaphragm 8 is formed with three openings 20, which correspond to three openings 21 (Figs. 6 and 7) in the clamping member 17.

For the passage of the drive spindle 2 the clamping member is formed with a central opening 22 which receives the spindle with clearance.

The centring diaphragm 8 of Figs. 4 and 5 has a thickness of approximately 0.1 mm and is made of chromium-nickel (18 Cr 8 Ni) spring steel. The outer diameter of the centring diaphragm is approximately 20 mm, whilst the three openings 20 for the passage of the bolts 19 are located on a pitch circle of approximately 16 mm. As already mentioned, the openings 20 correspond to the openings 21 in the clamping member 17. The central opening 15 of the centring diaphragm 8 has a diameter of approximately 6 mm, whilst the inner diameter of the annular clamping surface 18 of the clamping member 17 is approximately 12 mm. The clearance between the periphery of the central opening 15 of the centring diaphragm 8 and the inner edge of the clamping surface 18 of the clamping member 17 is consequently 3 mm. The degree of deflection of the part of the centring diaphragm which is located between the central opening 15 and the clamping surface 18 is shown highly exaggerated in Fig. 3. In reality the axial deflection will not be more than approximately 0.2 mm. When a centring diaphragm as shown in Figs. 4 and 5 is used, i.e., a diaphragm with a circular opening 15 and with a thickness of approximately 0.1 mm, a force of approximately 1000 g is necessary for fitting the head disc 6 onto the drive spindle 2. For removing the head disc 6 it is found that a smaller force suffices. This is due to the manner of deflection of the centring diaphragm 8, which during removal of the head disc 6 is subject to buckling, which demands a smaller force than the force demanded by the deflection when mounting the head disc.

With a centring diaphragm 23 as shown in Fig. 8, which has a roughly triangular central opening 24, or a centring diaphragm 25 as shown in Fig. 9, which has a central opening 26 which is bounded by a wall formed with three deflexible radial projections 27, forces will suffice which may be several times smaller than the forces required in the case of the diaphragm shown in Figs. 4 and 5, depending on the design and the dimensions of the centring diaphragm and more particularly of the area around the central opening.

CLAIMS

1. Apparatus for magnetically recording and/or reading signals on a magnetic tape in signal tracks which extend obliquely of the tape, comprising a rotatable drive spindle which has a free end and of which at least a portion extending from said free end is cylin-

drical, a magnetic head which is rotatable in a circular path around the axis of rotation of the drive spindle for writing and/or reading the oblique signal tracks on the magnetic tape, a

head support for the magnetic head which support is detachably secured to the drive spindle adjacent the free end thereof and is formed with a central opening for receiving the drive spindle with clearance, and means for detachably mounting the head support on the drive spindle, which means comprise centring means for centring the head support relative to the axis of rotation of the drive spindle, and fixing means for rigidly connecting the magnetic head support and the drive spindle to each other, wherein the centring means comprise a centring diaphragm which is made of an elastic sheet material and which is formed with a central opening for fitting tightly on said cylindrical portion of the drive spindle adjacent the free end thereof, the opening in the diaphragm having a shape and dimensions such that upon insertion of the free end of the drive spindle into this opening, a portion or portions of the centring diaphragm adjacent said opening is or are subjected to an elastic deflection in the axial direction as a result of the forces occurring between the centring diaphragm and the drive spindle, and wherein connecting means are provided for connecting the centring diaphragm to the head support at a distance from the central opening of the centring diaphragm, so that a portion or portions of the centring diaphragm which is or are situated between the connecting means and the central opening of the diaphragm is or are elastically deflexible in the axial direction to a limited extent.

2. An apparatus as claimed in Claim 1, wherein the head support is provided with an annular contact surface which surrounds the central opening in the head support and with the centring diaphragm engages on one side thereof, and wherein the connecting means for connecting the centring diaphragm to the head support comprise a clamping member which is disposed on the side of the centring diaphragm remote from said contact surface and which is provided with an annular clamping surface, said connecting means further comprising screwthreaded means for pressing the clamping member against the centring diaphragm and thus clamping the centring diaphragm between said contact surface and said clamping surface so that the two surfaces are positioned concentrically with the axis of rotation of the drive spindle by the diaphragm.

3. An apparatus as claimed in Claim 1 or 2, wherein the central opening in the centring diaphragm is non-circular, the centring diaphragm being in contact with the drive spindle at at least three locations on the periphery of said opening.



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For the passage of the drive spindle 2 the clamping member is formed with a central opening 22 which receives the spindle with clearance.

The centring diaphragm 8 of Figs. 4 and 5 has a thickness of approximately 0.1 mm and is made of chromium-nickel (18 Cr 8 Ni) spring steel. The outer diameter of the centring diaphragm is approximately 20 mm, whilst the three openings 20 for the passage of the bolts 19 are located on a pitch circle of approximately 16 mm. As already mentioned, the openings 20 correspond to the openings 21 in the clamping member 17. The central opening 15 of the centring diaphragm 8 has a diameter of approximately 6 mm, whilst the inner diameter of the annular clamping surface 18 of the clamping member 17 is approximately 12 mm. The clearance between the periphery of the central opening 15 of the centring diaphragm 8 and the inner edge of the clamping surface 18 of the clamping member 17 is consequently 3 mm. The degree of deflection of the part of the centring diaphragm which is located between the central opening 15 and the clamping surface 18 is shown highly exaggerated in Fig. 3. In reality the axial deflection will not be more than approximately 0.2 mm. When a centring diaphragm as shown in Figs. 4 and 5 is used, i.e., a diaphragm with a circular opening 15 and with a thickness of approximately 0.1 mm, a force of approximately 1000 g is necessary for fitting the head disc 6 onto the drive spindle 2. For removing the head disc 6 it is found that a smaller force suffices. This is due to the manner of deflection of the centring diaphragm 8, which during removal of the head disc 6 is subject to buckling, which demands a smaller force than the force demanded by the deflection when mounting the head disc.

With a centring diaphragm 23 as shown in Fig. 8, which has a roughly triangular central opening 24, or a centring diaphragm 25 as shown in Fig. 9, which has a central opening 26 which is bounded by a wall formed with three deflexible radial projections 27, forces will suffice which may be several times smaller than the forces required in the case of the diaphragm shown in Figs. 4 and 5, depending on the design and the dimensions of the centring diaphragm and more particularly of the area around the central opening.

CLAIMS

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dricial, a magnetic head which is rotatable in a circular path around the axis of rotation of the drive spindle for writing and/or reading the oblique signal tracks on the magnetic tape, a

head support for the magnetic head which support is detachably secured to the drive spindle adjacent the free end thereof and is formed with a central opening for receiving the drive spindle with clearance, and means for detachably mounting the head support on the drive spindle, which means comprise centring means for centring the head support relative to the axis of rotation of the drive spindle, and fixing means for rigidly connecting the magnetic head support and the drive spindle to each other, wherein the centring means comprise a centring diaphragm which is made of an elastic sheet material and which is formed with a central opening for fitting tightly on said cylindrical portion of the drive spindle adjacent the free end thereof, the opening in the diaphragm having a shape and dimensions such that upon insertion of the free end of the drive spindle into this opening, a portion or portions of the centring diaphragm adjacent said opening is or are subjected to an elastic deflection in the axial direction as a result of the forces occurring between the centring diaphragm and the drive spindle, and wherein connecting means are provided for connecting the centring diaphragm to the head support at a distance from the central opening of the centring diaphragm, so that a portion or portions of the centring diaphragm which is or are situated between the connecting means and the central opening of the diaphragm is or are elastically deflexible in the axial direction to a limited extent.

2. An apparatus as claimed in Claim 1, wherein the head support is provided with an annular contact surface which surrounds the central opening in the head support and with the centring diaphragm engages on one side thereof, and wherein the connecting means for connecting the centring diaphragm to the head support comprise a clamping member which is disposed on the side of the centring diaphragm remote from said contact surface and which is provided with an annular clamping surface, said connecting means further comprising screwthreaded means for pressing the clamping member against the centring diaphragm and thus clamping the centring diaphragm between said contact surface and said clamping surface so that the two surfaces are positioned concentrically with the axis of rotation of the drive spindle by the diaphragm.

3. An apparatus as claimed in Claim 1 or 2, wherein the central opening in the centring diaphragm is non-circular, the centring diaphragm being in contact with the drive spindle at at least three locations on the periphery of said opening.



4. An apparatus as claimed in Claim 3, wherein the central opening in the central diaphragm is substantially polygonal.

5. An apparatus as claimed in Claim 3 or 4, wherein the central opening in the centring diaphragm is substantially triangular.

6. Apparatus for magnetically recording and/or reading signals on a magnetic tape, substantially as herein described with reference to Figs. 1 to 7 or Fig. 8 or 9 of the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1983.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.