

# PATENT SPECIFICATION

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## (54) TRANSDUCER TRANSPORT ARRANGEMENTS FOR DISC RECORDERS, AND DISC RECORDERS INCORPORATING THE SAME

(71) We, ARVIN INDUSTRIES, INC, a corporation organized and existing under the laws of the State of Indiana, United States of America, of 1531, East Thirteenth Street, Columbus, Indiana 47201, United States of America, 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:-

The present invention relates to disc recorders and, more specifically but not exclusively, to recorders in which video information is recorded on a flexible magnetic disc. The magnetic disc used typically may be a laminate construction in which a cloth material is sandwiched between two layers of thin flexible material. The layers of flexible material are coated with magnetic particles and define the recording surfaces of the disc. The recording disc is rapidly rotated and one or more transducer heads are positioned in contact with the disc to record and reproduce the video information. If desired, transducer heads may be provided for recording and playback on both sides of the magnetic disc.

Recording of video signals on a disc recorder may be accomplished with one of several formats. In one format, the video signal is stored in a number of circular concentric recording tracks and the transducer head is moved only intermittently to the desired track for recording or playback. In a second format, the transducer head is moved continuously in a radial path as the disc is rotated, thus defining a continuous, spiral recording track.

The flexible magnetic disc used in such a recorder is rotated at a speed which is sufficiently high to generate centrifugal forces making it unnecessary to support the disc at a point other than its center. It can be appreciated, however, that tension of the

disc, resulting from the outwardly directed centrifugal forces created during rotation, will be much less at a point near the periphery of the disc than at a point near its center. This is so because the mass of the material outward from a point near the periphery of the disc is much less. Since the transducer heads used in a flexible disc recorder actually make contact with the disc surface and exert a slight pressure on that surface, the recording surface of the disc will tend to be distorted more out of its plane of rotation by a transducer head when the transducer head is in contact with a point near the periphery of the disc surface than when the head is positioned radially inwardly of the periphery. This non-uniformity in the distorting effect of the transducer head on the flexible recording surface results in non-uniform transducer effectiveness unless some provision for compensation is made.

A typical transducer head consists of two cores on which one or more groups of windings have been wound. Each core is separated from the other by non-magnetic material, thus defining a gap. When the windings on the cores are energized, the fringing flux at the gap will magnetize particles in the coating on the recording surface of the disc. During playback, the magnetized particles passing adjacent the gap will generate flux flow through the cores and induce current flow in the windings. For effective recording and playback it is necessary that the recording disc be maintained in a closely coupled relationship with the transducer head on both sides of the gap. Distortion of the recording surface of the flexible disc as the transducer head moves radially toward the periphery of the disc may prevent the transducer head from maintaining the desired positional relationship with respect to the disc. This may occur even when transducer heads are positioned exactly opposite each other on both sides of

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the disc, since the center cloth lamination tends to isolate the recording surfaces from each other.

5 It is an object of the present invention to provide a flexible disc recorder in which proper transducer orientation with respect to the disc is capable of being maintained.

10 From one aspect, the present invention provides a disc recorder for use with a flexible recording disc, and operable, when a disc is assembled to the recorder, to rotate the disc about an axis, the recorder having a transducer generally radially movable with respect to the rotational axis of the disc and defining a transducing gap extending generally radially of said rotational axis and positioned so that, during a transducing operation, a disc operatively assembled to the recorder will be in closely coupled relation to the transducer on both sides of the gap, the recorder also having a transducer transport arrangement comprising:

25 a guide member extending generally transversely of said rotational axis and defining a guide surface,

a transducer assembly comprising transducer carriage means mounting the transducer,

30 means for moving said carriage means along said guide member in contact with said guide surface such that, in operation, the transducer is moved generally radially with respect to a rotating recording disc when operatively assembled to the recorder, and

35 means for adjusting said guide surface such that, after such adjustment, said transducer carriage means will be progressively tilted, relative to a rotating recording disc when operatively assembled to the recorder, as said carriage means is moved along said guide surface to maintain the desired closely coupled relation between the transducer and the operatively assembled and rotating disc.

40 From another aspect, the invention provides a disc recorder of the type which is adapted to utilise a flexible magnetic disc and is operable to rotate the disc about an axis and in a plane, the recorder having a transducer defining a transducing gap, the transducer being properly positioned when sufficiently magnetically coupled on both sides of the gap with an operatively assembled rotating disc, the recorder further comprising:

55 a transducer assembly holding the transducer,

60 a guide member, including positioning means determining the attitude of said transducer with respect to the plane of rotation of an operatively assembled disc and positioned transversely to such disc,

65 means for moving said transducer assembly along said guide member generally

radially of the axis of rotation of an operatively assembled disc, and

means for varying said positioning means along the length of said guide member such that, after such variation, the attitude of said transducer will be progressively varied with respect to said plane of rotation as said transducer is moved generally radially, whereby said proper positioning of said transducer with respect to the operatively assembled and rotating disc is maintained.

The invention also provides a disc recorder for use with a flexible magnetic recording disc, comprising:

80 means for rotating a disc when operatively assembled to the recorder,

a transducer including a transducing gap extending generally radially of the axis of disc rotation, the transducer, in operation, being magnetically coupled to an operatively assembled and rotating disc,

85 a guide member having a guide surface extending transversely of the plane of an operatively assembled and rotating disc,

90 a transducer assembly comprising transducer mounting means holding said transducer and movable along said guide surface such that said transducer is moved generally radially with respect to an operatively assembled and rotating disc,

95 drive means for moving said transducer mounting means along said guide surface, and

100 means for adjustably pre-setting the orientation of said guide surface along the length of said surface such that said transducer will be progressively tilted with respect to an operatively assembled and rotating disc as the transducer is moved in a direction from the centre towards the periphery of said disc by said drive means to maintain said transducing gap in essentially a constant coupled relation to the surface of said disc.

110 In one embodiment, the guide surface or positioning means is altered by spreading a slot in the guide member with a threaded adjustment screw extending across the slot.

115 In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:-

120 *Figure 1* is a plan view of a portion of a recorder showing a transducer mounting and transport mechanism to which the present invention may be applied. The mechanism forms the subject of copending applications Nos: 41917/77, (Serial No 1593304) 41918/77 (Serial No 1593305) and 42006/77; (Serial No 1593307)

125 *Figure 2* is a front view of the mechanism of *Figure 1* showing, in section, a cartridge containing a magnetic flexible recording disc operatively inserted in the mechanism;

130 *Figure 3* is a side view of a portion of the

mechanism as seen looking from left to right in Figure 2, the transducer assemblies of the mechanism, and the disc cartridge, being removed;

5 *Figure 4* is an enlarged sectional view taken generally along line 4-4 in Figure 2;

*Figure 5* is an enlarged front view showing the details of the mechanism;

10 *Figure 6* is a plan view of the portion of the mechanism shown in Figure 5;

*Figures 7A, 7B, and 7C* are enlarged partial sectional views showing the interaction between a transducer and a recording disc;

15 *Figure 8* is a plan view of the guide member used with a mechanism embodying the present invention; and

20 *Figure 9* is an enlarged sectional view taken generally along line 9-9 in Figure 8, with the transducer and carriage added

Referring now to Figures 1, 2 and 3, there is shown a portion of a disc recorder in which the present invention may be embodied. While disc recorders for recording video signals may use either rotatable rigid magnetic discs or flexible discs, those recorders using flexible discs offer greater versatility while reducing the possibility of damage to the disc during operation of the recorder. As seen in Figure 2, a cartridge 11 is provided in which a flexible magnetic recording disc 12 is housed. Radially extending slots 13 and 14, one in each side of the disc cartridge 11, permit access to the disc by transducers 15 and 20.

The recording disc 12 extends between a pair of guide members 38 and 40, one above and one below the disc as shown in Figure 2. The transducer assemblies 45 and 50 are moved along guide members 38 and 40, respectively, by stepping motor 53. A common drive pulley 57 is used to move both transducer assemblies with the result that they are stepped simultaneously to corresponding positions on opposite sides of the disc. Carriage belt means, including a first carriage belt 60, second carriage belt 62, and third carriage belt 65 move transducer assembly 45 when drive pulley 57 is rotated. Idler pulley 67 at the opposite end of the guide member 38 positions belt 65 as assembly 45 is moved. In like manner, belts 70, 72 and 74 and idler pulley 75 move transducer assembly 50 along guide member 40.

25 The extent of travel of transducer assemblies 45 and 50 is limited by photo sensors 76, 77, 78 and 79. Sensor 78 is used as a reset to detect when the transducers have been moved to an initial position. The sensors 76, 77 and 79 are provided to protect against overtravel and are not actuated during normal recorder operation.

30 Running parallel to guide members 38 and 40 are locating members 85 and 87 (Figures 1 and 3). Loading means 90 and 93,

mounted on transducer assemblies 45 and 50, interact with locating members 85 and 87 to assure the positional stability of the transducer assemblies, as is more fully explained below. The transports for the upper and lower transducers 15 and 20 are identical.

Each of the guide members 38 and 40 is generally U-shaped in cross section, as seen in Figure 4 and provides a guide surface 97 extending transversely of the disc 12 and including a groove 99 extending parallel to the disc. Figure 4, an enlarged sectional view of guide member 40, shows a transducer carriage 105 having a tab 106 which interacts with the photosensors as explained above. Carriage 107 likewise includes a tab 108 for actuating the appropriate photosensors.

A friction reducing bearing pad 110 is attached to carriage 105 and slides along guide surface 97. A pair of cylindrical bearing means 113 and 114 in the form of pads are mounted on the carriage 105 in spaced relation to bearing pad 110 and are positioned to be slidable in groove 99. Loading means 93 includes leaf spring 133 and roller 135 which engages locating surface 130 of locating member 87, the loading means 93 biasing carriage 105 toward guide surface 97. Groove 99 and bearing means 113 and 114 prevent relative vertical motion between carriage 105 and guide member 40 as the transducer assembly is moved along the guide member.

Referring now to Figures 5 and 6, the details of the transducer transport mechanism are shown. Guide member 40 extends between drive pulley 57 and idler pulley 75. The friction reducing cylindrical bearing means 113 and 114 and bearing pad 110 allow the carriage 105 to slide along guide member 40 on guide surface 97. As shown in Figure 4, groove 99 is engaged by the cylindrical bearing pads on the carriage as a result of the interaction between loading means 93 and locating surface 130.

The carriage 105 is moved along guide member 40 such that the transducer head 20 moves radially with respect to flexible recording disc 12. First and second carriage belts 70 and 72 are each attached at one end to carriage 105 and at the other end to drive pulley 57. Belts 70 and 72 will typically be pinned to drive pulley 57 and will be wrapped around the pulley a number of times. Also pinned to pulley 57 and wrapped around it is third carriage belt 74. Belt 74 is attached to carriage 105 and extends in the opposite direction from the first and second belts 70 and 72. It should be noted that the third belt 74 is attached to drive pulley 57 intermediate belts 70 and 72. As seen in Figure 4, belt 74 extends from idler pulley 75 to drive pulley 57 through cavity

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5 Belt 74 is pivotally attached by bolt 152 to carriage 105. On the opposite side of the carriage, a "T"-shaped linkage arrangement is connected to belts 70 and 72. A first linkage means 155 is pivotally attached to belts 70 and 72 at pivot points 158 and 161. A second linkage means 165, attached to the first linkage means 155 intermediate the first and second carriage belts 70 and 72, is pivotally secured to carriage 105 by bolt 167. The opposing forces applied to the carriage 105 by the first, second, and third belts are therefore aligned. Since the axes of the drive and idler pulleys are parallel, the friction between the belts and the pulleys is reduced and transducer movement may therefore be effectuated very rapidly. Additionally, since the carriage belts are not twisted, there is no twisting moment applied to the carriage.

25 Transducer carriage 105 includes a mounting surface 170 which is substantially perpendicular to the plane of the recording disc 12 and substantially parallel to the direction of movement of carriage 105. A transducer holding plate 175 is positioned adjacent and parallel to mounting surface 170, and is movable relative thereto. Parallel motion linkage means 177 includes a generally U-shaped wire which attaches the transducer holding plate 175 to carriage 105. The parallel motion linkage means confines the motion of the transducer holding plate 175 relative to the mounting surface 170 in a plane parallel to the mounting surface 170 to motion which is substantially perpendicular to rotating recording disc 12. Parallel linkage means 177 is attached to holding plate 175 by potting the wire along the side of flange 180. The ends of the wire are rigidly secured between bar 183 and backing blocks 185. It should be understood that two separate parallel wires could be used as the parallel linkage means with the first ends of the wires attached to the mounting surface 170 and the other ends attached to holding plate 175.

50 Spring means, including wire spring arm 187, biases the transducer holding plate 175 towards mounting surface 170 and also biases plate 175 toward rotating recording disc 12. Transducer 20 is rigidly attached to holding plate 175 and thus moves toward disc 12 with a biasing force determined by spring 187. Spring 187 extends through a bearing in the form of a glass bead 191 set in flange 180. The other end of spring 187 is adjustably secured by mounting 194 to bar 183. Glass bead 191 prevents twisting forces from being applied to holding plate 175 by spring 187.

65 The mechanism so far described and illustrated is particularly useful where rapid transducer movement is required due to its

low inertial mass. Additionally, the force exerted on the recording disc by the transducer head may be easily and precisely adjusted.

70 Bale 200 is provided adjacent the upper edge of flange 180 and extends along the length of travel of transducer 20. A similar bale is provided for transducer assembly 45. As seen in Figure 1 these bales extend to pivots 205 and 210 and are linked to rotary solenoid 215 and dashpot 220. When solenoid 215 is actuated, the bales contact the transducer holding plates and move transducer heads 15 and 20 away from flexible disc 12. The motion of the recording heads is sufficient to allow disc 12 and cartridge 11 to be withdrawn from the recorder.

85 Referring now to Figures 7 to 9, there is shown a transducer transport arrangement embodying the present invention and applicable to the recorder mechanism of Figures 1 to 6. Figure 7 illustrates the interaction between a transducer head and a recording disc as seen looking outward from the center of the disc. The direction of disc rotation is indicated. As seen in Figure 7A, a typical recording disc is laminated in construction, with a layer of cloth material 225 sandwiched between flexible layers 227 and 229, which provide the upper and lower recording surfaces of the disc. Transducer head 235 defines a gap 237 which extends radially of the disc and is generally perpendicular to the disc.

100 Figure 7A depicts transducer head interaction with the disc when the transducer head is near the center of rotation of the disc. The large centrifugal forces acting on the central portion of the disc pull the disc material taut and transducer head 235 will therefore distort material 229 only slightly. As seen in Figure 7A, the recording surface of the disc impinges on the core of the transducer head 235 on both sides of the gap 237. Such an arrangement is optimal for recording since the fringing flux at gap 237 which is induced in the transducer core by current flow through transducer windings (not shown) is greatest near the gap. Likewise, this arrangement is optimal for playback.

115 If the transducer head 235 were to be held perpendicular to the plane of rotation of the disc as the transducer head is moved toward the periphery of the disc, the condition diagrammatically illustrated in Figure 7C would result. Since the centrifugal tensioning of the disc material near its periphery is much less than near its center, the periphery of the disc is more affected by the biasing force applied to the transducer head. Flexible material 229 is therefore distorted out of the plane of rotation of the disc more severely with the result that the recording surface moves away from the gap 237. The

effect of fringing flux in the recording surface is therefore impaired and recording (or playback) effectiveness is reduced.

5 The approach taken to solving the problem by the present invention is shown in Figure 7B. Transducer head 235 continues to be held as shown in Figure 7A when positioned near the center of rotation of the disc. However, as the transducer head is moved radially with respect to the disc toward the disc periphery, the transducer is progressively tilted or skewed as shown in Figure 7B with the result that the proper magnetic coupling between the transducer core near gap 237 and the recording surface is maintained.

10 An arrangement for tilting the transducer head is shown in Figures 8 and 9. Figure 8 is a plan elevational view, with portions broken away and in section, of a guide member 240. As with the recorder mechanism shown in Figures 1 to 6, the guide member defines positioning means comprising guide surfaces 245 which determine the orientation of a transducer carriage 248. As shown in Figure 9, cylindrical bearing means 250 interacts with a groove 255 to position carriage 248 vertically. The transducer mounting arrangement is identical with that depicted in Figures 1 to 6, with one exception-transducer head 235 is mounted obliquely to the mounting surface 257 of carriage 248. A threaded adjustment screw 260 is added to spread a slot 265 in guide member 240, thus providing an adjustment means for altering guide surface 245 such that transducer carriage 248 is tilted. The attitude of carriage 248 is therefore progressively varied as the transducer head is moved radially along the disc.

15 As shown in Figure 9, the spreading of slot 265 by screw 260 results in the transducer head 235 being held substantially vertical when it is near the center of rotation of the disc. As the transducer head is moved radially outward with respect to the disc, the carriage means 248 is tilted less and less until, near the periphery of the disc, surface 257 of carriage 248 is substantially vertical. Since transducer head 235 is mounted obliquely with respect to surface 257, the transducer head will be tilted slightly "up-stream" to the direction of disc rotation, as shown in Figure 7B. Effective magnetic coupling will therefore be maintained between the recording surface and the transducer head.

20 It should be understood, of course, that there are numerous ways of effecting transducer reorientation along the extent of its radial travel. A slot could be formed in another portion of guide member 40 and either widened or narrowed in order to selectively vary the plane of the guide surface.

As previously mentioned, various features of the mechanism shown in Figures 1 to 6 form the subject of co-pending applications Nos. 41917/77, 41918/77 and 42006/77 (Serial Nos. 1593304, 1593305, 1593307).

WHAT WE CLAIM IS:-

1. A disc recorder for use with a flexible recording disc, and operable, when a disc is assembled to the recorder, to rotate the disc about an axis, the recorder having a transducer generally radially movable with respect to the rotational axis of the disc and defining a transducing gap extending generally radially of said rotational axis and positioned so that, during a transducing operation, a disc operatively assembled to the recorder will be in closely coupled relation to the transducer on both sides of the gap, the recorder also having a transducer transport arrangement comprising:

a guide member extending generally transversely of said rotational axis and defining a guide surface,

a transducer assembly comprising transducer carriage means mounting the transducer,

means for moving said carriage means along said guide member in contact with said guide surface such that, in operation, the transducer is moved generally radially with respect to a rotating recording disc when operatively assembled to the recorder, and

means for adjusting said guide surface such that, after such adjustment, said transducer carriage means will be progressively tilted, relative to a rotating recording disc when operatively assembled to the recorder, as said carriage means is moved along said guide surface to maintain the desired closely coupled relation between the transducer and the operatively assembled and rotating disc.

2. A disc recorder of the type which is adapted to utilise a flexible magnetic disc and is operable to rotate the disc about an axis and in a plane, the recorder having a transducer defining a transducing gap, the transducer being properly positioned when sufficiently magnetically coupled on both sides of the gap with an operatively assembled rotating disc, the recorder further comprising:

a transducer assembly holding the transducer,

a guide member, including positioning means determining the attitude of said transducer with respect to the plane of rotation of an operatively assembled disc and positioned transversely to such disc,

means for moving said transducer assembly along said guide member generally radially of the axis of rotation of an operatively assembled disc, and

means for varying said positioning means

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along the length of said guide member such that, after such variation, the attitude of said transducer will be progressively varied with respect to said plane of rotation as said transducer is moved generally radially, whereby said proper positioning of said transducer with respect to the operatively assembled and rotating disc is maintained.

3. A disc recorder for use with a flexible magnetic recording disc, comprising:

means for rotating a disc when operatively assembled to the recorder,

a transducer including a transducing gap extending generally radially of the axis of disc rotation, the transducer, in operation, being magnetically coupled to an operatively assembled and rotating disc,

a guide member having a guide surface extending transversely of the plane of an operatively assembled and rotating disc,

a transducer assembly comprising transducer mounting means holding said transducer and movable along said guide surface such that said transducer is moved generally radially with respect to an operatively assembled and rotating disc,

drive means for moving said transducer mounting means along said guide surface, and

means for adjustably pre-setting the orientation of said guide surface along the length of said surface such that said transducer will be progressively tilted with respect to an operatively assembled and rotating disc as the transducer is moved in a direction from the centre towards the periphery of said disc by said drive means to maintain said transducing gap in essentially a constant coupled relation to the surface of said disc.

4. A disc recorder as claimed in claim 1, 2 or 3, wherein the guide surface or positioning means of the guide member includes first and second guide surface portions extending transversely of the plane of an operatively assembled rotating disc, the second surface portion including a groove extending generally parallel to said plane, a friction reducing bearing pad being mounted on the transducer assembly and movable along the first guide surface portion, and friction reducing cylindrical bearing means being mounted on the transducer assembly in spaced relation to said pad and movable in the groove.

5. A disc recorder as claimed in claim 4, wherein one of the surface portions is adjustably pre-set relative to the plane of the other surface portion, thereby to produce the progressive tilting or variation in attitude of the transducer assembly.

6. A disc recorder as claimed in claim 5, wherein said one of the surface portions comprises the first surface portion.

7. A disc recorder as claimed in claim 4,

5 or 6, including a locating member having a locating surface, and loading means mounted on said transducer assembly and engaging said locating surface to bias said carriage member toward the guide surface portions such that said bearing pad engages the first guide surface portion and said cylindrical bearing means engages said groove.

8. A disc recorder as claimed in any preceding claim, wherein the transducer is mounted obliquely to the guide surface or positioning means of the guide member such that the transducer will be oblique to the plane of rotation of an operatively assembled disc when the transducer is positioned near the periphery of said disc and will be moved to an orientation essentially perpendicular to said plane when the transducer is moved toward the centre of said disc.

9. A disc recorder as claimed in any preceding claim, wherein the adjusting or varying means comprises a slot in said guide member and a threaded adjustment screw extending across said slot for changing the width of said slot and thereby affecting the orientation of the guide surface or positioning means of the guide member.

10. A transducer transport arrangement for a disc recorder, constructed substantially as hereinbefore described with reference to Figures 1 to 6 as modified by Figures 7A, 7B, 8 and 9 of the accompanying drawings.

11. A disc recorder incorporating a transducer transport arrangement as claimed in claim 10.

12. A disc recorder constructed substantially as hereinbefore described with reference to Figures 1 to 6 as modified by Figures 7A, 7B, 8 and 9 of the accompanying drawings.

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