

Description

This invention relates generally to improvements in video recorder-playback machines, and more specifically, to an improved rotatable drive spindle assembly for smooth relatively high speed rotation of a video information disc in a video recorder-playback machine.

Video recorder-playback machines in general are known in the art and include appropriate means for recording and/or playing back a video information signal utilizing a selected medium for storage of the signal. For example, in one type of machine, the video signal is recorded magnetically for storage and/or retrieval upon a length of so-called video tape. In another type of system, the video signal is recorded upon an information disc for retrieval by means of a stylus, in a manner generally analogous to that of sound reproduction from phonographic records. In still another type of system, the video signal is used to frequency modulate a beam of amplified light, such as a laser beam, with sufficient power for physically altering the surface characteristics of a light sensitive coating on a video information disc and thereby record the signal upon the disc. During playback, a lower power light beam is reflected from the disc and the resulting signal is demodulated to reproduce the recorded signal. In all of these types of systems, the video information signal can be combined with an appropriate audio signal for either recording or playback purposes to yield a composite audio-video signal of the type commonly used for television transmissions and the like. For convenience, however, the signal will be referred to herein as a video information signal.

Video recorder-playback machines utilizing amplified light beams for recording and playback purposes offer significant advantages in that all physical contact of the recording and playback elements with the storage medium, namely, the information disc, is avoided. This prevents wear and deterioration of the machine elements and the disc, resulting in a high quality stored video signal which can be played back repeatedly over a long period of time with unimpaired video resolution.

In video recorder-playback machines using amplified light beams for signal recording and playback, the recording and playback optical beams are focused upon the video information disc by a focusing lens which traverses the span of the disc in a radial direction simultaneously with relatively high speed rotation of the disc. In this manner, a spiral pattern of closely spaced tracks is formed on the disc to represent the video information. For maximum storage capacity for each disc, together with maximum signal resolution, the information tracks are formed to have a narrow width such as on the order of about 0.5 microns, and the center-to-center spacing between radially adjacent tracks in the spiralling pattern is on the order of about 1.5 microns. Accordingly, to prevent cross talk between the

tracks during recording and/or playback operation, it is imperative that the video information disc be rotatably driven about an accurate and consistent axis of rotation to avoid substantial radial eccentricities.

In the prior art, a variety of drive spindle assemblies have been proposed for rotatably driving the video information disc. However, many of these prior art proposals involve so-called direct drive arrangements wherein a rotatable spindle carrying the disc is rotatably driven through a mechanical connection by a high speed drive motor. These direct drive arrangements tend to impart undesired system vibrations from the motor to the spindle to cause relatively slight radial excursions of the spindle during rotation which in turn frequently results in cross talk during operation of the machine. Some attempts have been made to isolate the spindle from this system vibration by supporting a generally truncated and inverted conical journal in a complementary conically-shaped spindle housing within a vacuum chamber with a hydraulic fluid being supplied under pressure to the bearing interface. The necessity of operating the turntable in a vacuum atmosphere in order to provide a flutter-free and constant rotational velocity is extremely expensive and complicated (GB-A-1420 322).

US-A-3 201 181 describes a hydrostatic bearing comprising a base with a concave region where the fluid lubricant forms a fluid film which supports a rotatable sphere. In order to prevent "bleeding off" on the fluid lubricant an annular block is secured to the base providing stepped conformation within the bearing cavity. By selecting shims disposed between the base and the annular block of greater or lesser thickness the extent of the stepped conformation can be varied. An embodiment without a stepped conformation comprises an annular recess between the base and the annular block which communicates with an annular plenum chamber.

From US-A-36 06 501 it is known to provide a plurality of peripherally spaced recesses within a frusto-conically shaped bearing assembly and which form plenum chambers and restrict the effective bearing surfaces to very narrow strip-like areas. This reference also describes an annular flange which is located adjacent to the endpart of the frusto-conical bearing assembly and of which a side face forms a thrust face by acting against an annular thrust plate (Fig. 11).

In US-A-3 751 044 a record player is described the journal of the spindle shaft is positioned in a spindle housing having a radial bearing and a thrust bearing supporting the journal. The radial bearing is a static air bearing in which air is fed from an air supply source. Besides the air bearing a thrust bearing is needed in order to support the journal. This bearing does not function properly without the thrust bearing in form of a ball thrust bearing in order to limit the vertical displacement of the journal.

From FR-A-2 278 128 it is known to have a plurality of vertically spaced positions within the

bearing for communicating a substantially constant and annularly uniform flow of air under pressure to the bearing interface.

JP—A—54-151004 equivalent to US—A—4256312 discloses an air distribution conduit system with tap lines formed in the housing for directing air under pressure through flow director means formed in the housing between the conical bearing surfaces.

It is an object of the invention to overcome the problems and disadvantages of the prior art by providing a spindle assembly which is simple in design and assembly as well as consistently smooth running without significant vibration and wear.

The solution according to the invention is stated in Claim 1.

Accordingly, a spindle assembly is provided for rotatably supporting and driving a video information disc in a video recorder-playback machine. The spindle assembly supports the information disc for relatively high speed rotation, such as on the order of about 1800 rpm, with little or no radial eccentricities during rotation. In this manner, the spindle assembly accurately and precisely drives the information disc for consistently accurate recording and playback of video information within the narrowly spaced information tracks on the disc, without signal cross talk. Moreover, the spindle assembly is substantially friction free during rotation resulting in little or no vibration or wear of components.

The spindle assembly comprises a vertically extending spindle shaft having a lower end rotationally driven by a relatively high speed dc motor. The spindle shaft extends upwardly to define an upper portion including an upwardly presented shoulder for vertically supporting a video information disc and an upwardly projecting stud for reception through a central opening in the disc for locating the disc upon the spindle shaft. If desired, clamping means can be provided for locking engagement with the stud and clamping engagement with the disc for centering the disc upon the stud.

The spindle shaft also includes an intermediate portion comprising a rotatable journal having an inverted truncated conical shape. This journal is supported for rotation within a generally complementary-shaped spindle housing.

Thus, the journal provides a relatively large bearing surface for supporting the spindle shaft against radial loads which could result in radial eccentricities during high speed rotation, and against downward axial thrust loads.

The spindle housing includes an inlet passage for communication of air under pressure to the interface between the journal and the bearing surface of the spindle housing. More specifically, appropriate vertically formed air passages in the spindle housing sections communicate the pressurized air without orificing to annular slots formed vertically adjacent the shims. The shims include radially inwardly open notches in pressure communication with the annular slot

whereby the air under pressure is supplied annularly to the interface between the journal and the housing bearing surface at a plurality of vertically spaced locations along the height of the spindle assembly for smooth, accurate rotation of the journal on a cushion of air.

The spindle housing is fixed to a base ring which in turn suitably anchors the spindle assembly upon the recorder-playback machine. A thrust plate is desirably secured to the lower extent of the journal for rotation therewith in running engagement with the lower face of the base ring in order to provide a bearing surface to accommodate axially upwardly directed thrust loads. A portion of the pressurized air is communicated to the interface between the thrust plate and the base ring to provide a cushion of air therebetween.

The disclosure of the present description overlaps with the disclosure of the co-pending EP divisional applications 85 111 046.1 (EP—A—0 182 021) and 86 111 858.6 (EP—A—0 213 603).

Other features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings which illustrate by way of example the principles of the invention.

The accompanying drawings illustrate the invention. In such drawings:

Fig. 1 is a fragmented perspective view illustrating, in partially exploded form, a video recorder-playback machine;

Fig. 2 is an enlarged perspective view, partially exploded, of the spindle assembly of this invention;

Fig. 3 is an enlarged perspective view in exploded form illustrating assembly of the spindle assembly of Fig. 2;

Fig. 4 is an enlarged fragmented elevation view of the spindle assembly, with portions broken away;

Fig. 5 is an enlarged vertical section taken on the line 5—5 of Fig. 4; and

Fig. 6 is an enlarged vertical section taken on the line 6—6 of Fig. 4.

As shown in the exemplary drawings, the present invention is embodied in a video recorder-playback machine 10 having suitable optical and electronic elements for recording and playback of video information from a video information disc 14. The information disc 14 is removably supported within the machine upon a spindle assembly 18 for controlled and accurate high speed rotation of the disc during the recording and playback operations. A clamp assembly 20 operates to clamp the disc 14 in a precisely centered position upon the spindle assembly 18 for accurate, high speed disc rotation without slippage.

The machine 10, including the spindle assembly 18 of this invention, comprises an improvement over the prior art in that the spindle assembly 18 is designed for consistent and accurate rotation of the information disc 14 with respect to the vertical axis of the spindle

assembly at a relatively high rotational speed without substantial radial eccentricities. The spindle assembly 18 is relatively simple in design and assembly, and is consistently smooth running without significant vibration or undue wear of components. The spindle assembly 18 is thus uniquely adapted for use in a video recorder-playback machine 10 wherein consistent and accurate rotation of an information disc 14 is a prerequisite to avoid cross talk between information tracks on the disc.

As shown in Fig. 1, the video recorder-playback machine 10 includes a machine base or a table 12 which provides support for a relatively high power laser generator unit 16, such as an argon ion laser, for use in recording a prescribed video information signal upon the disc 14. The high power laser generator unit 16 emits a highly amplified collimated beam of light for redirection by a suitable mirror assembly 22 to an electronically driven modulator 24. The modulator 24 is driven by a suitable frequency modulated electronic signal supplied via an input lead 26 wherein the electronic signal is representative of the desired video information. The modulator 24 responds to the electronic signal to interrupt appropriately the amplified beam of light to pass a correspondingly modulated optical signal beam. This resultant optical signal beam is therefore representative of the prescribed video information. Conveniently, in many instances, the electronic signal comprises a composite audio-video signal of the type commonly used in television transmissions and which, when supplied to the modulator 24, yields an optical signal beam representative of the composite audio and video information. However, for sake of clarity and ease of description, all further reference herein will be to video information.

The modulated optical signal beam is incident upon a second mirror assembly 28 for redirection to a mobile optics carriage 30. This optics carriage 30 includes an angularly disposed dichroic mirror 32 for reflection of the optical signal beam in an upward direction for passage through an optical record-playback head 34. The record-playback head 34 carries an objective lens assembly 36 for focusing the optical signal beam to a precise spot on the underside of the video information disc 14.

The optics carriage 30 is movably positioned by a carriage drive assembly 38 along a path in a radial direction with respect to the disc 14. In this manner, the record-playback head 34 is movably positioned with respect to the disc 14 along a radius of the disc to control the point of focusing of the optical signal beam upon the disc. The carriage drive assembly 38 comprises a precision lead screw 48 supported for rotation by a bracket 50 which can be secured to a frame 40 and to the machine table 12 by a plurality of bolts 42. The lead screw 48 threadably receives a lead screw nut 52 coupled via a nonrotational coupling indicated at 54 to a sleeve-type push block 46 received freely about the lead screw 48. As illus-

trated, this push block 46 is secured to an upright wall 44 of the optics carriage 30.

The lead screw 48 is oriented in a direction parallel with the required radial direction of movement of the optics carriage 30. A relatively slow speed reversible motor 56 and a relatively high speed reversible motor 58 are connected to the lead screw 48 through a selective clutch unit 60, and this clutch unit is operated to control driving of the lead screw 48 about its own axis either at a relatively slow or relatively fast speed of rotation.

As illustrated in Fig. 1, the optics carriage 30 is driven by the lead screw 48 in a radially outward direction with respect to the disc 14 whenever the lead screw 48 is rotated to cause the lead screw nut 52 to push against the push block 46. When the lead screw is rotated in an opposite direction, the lead screw nut 52 travels along the screw in an opposite direction. To assure that the optics carriage 30 follows in the opposite, or radially inward direction, the carriage 30 is secured by pins 62 to a linear slide member 64 which is urged in the radially inward direction with respect to the disc 14 by a constant tension band spring 66 wound about a barrel 68 secured to the frame 40. The slide member 64 is slidably mounted on a linear track member 70 secured to the frame 40 and adapted to accommodate linear movement of the optics carriage 30 in both the radially inward and the radially outward directions.

The video information disc 14 is received upon the spindle assembly 18 of this invention for relatively high speed rotation of the disc about the vertical axis of the spindle assembly 18, as will be described herein in more detail. This rotation of the disc occurs simultaneously with linear movement of the optics carriage 30 in response to operation of the carriage drive assembly 38. Thus, in operation, the optical signal beam is focused upon the underside of the video information disc 14 by the radially traversing record-playback head 34 on the optics carriage 30 simultaneously with high speed rotation of the disc. By appropriately controlling the relationship between radial traversal and rotational speed, the optical signal beam is focused upon the disc along a spiraling pattern of closely spaced tracks. Importantly, the disc 14 includes a photosensitive coating, such as a layer of thin metal or a photoresist material, adapted to be physically altered by the high power optical signal beam whereby the optical signal beam is physically recorded upon the disc as a pattern of discontinuities representative of the prescribed video information. In practice, the disc is rotated at a speed on the order of about 1800 rpm, and the closely spaced tracks are formed to have a width on the order of about 0.5 microns and a center-to-center spacing of about 1.5 microns.

The clamp assembly 20 is provided for clamping the video information disc 14 securely upon the spindle assembly 18 for accommodating the high speed rotation of the disc without slippage.

Importantly, however, the clamp assembly also includes means for centering the disc upon the spindle assembly for accurate high speed rotation of the disc without substantial radial eccentricities with respect to the spindle assembly.

As illustrated in Fig. 1, a relatively low power laser generator unit 80, such as a helium-neon laser, is mounted directly upon the optics carriage 30 for use in retrieving or playing back the recorded video information from the disc 14. This low power laser generator unit 80 emits an amplified and collimated beam of light for reflection off the disc 14 whereby the reflected optical beam comprises a modulated playback beam which is alternately reflected and nonreflected in accordance with the recorded video information. This modulated playback beam is of sufficiently low power to avoid physical alteration of the photosensitive coating on the disc 14.

The amplified beam of light from the low power laser generator unit 80 is redirected by a suitable mirror assembly 82 on the optics carriage 30 for appropriate incidence upon an angularly oriented mirror 84 which reflects the beam upwardly through the dichroic mirror 32 for focusing upon the disc 14 by the record-playback head 34. The reflected modulated playback beam is returned through the head 34 and by the mirror 84 to appropriate optical and electronic components 86 for demodulating the playback beam to the form of an electronic signal representative of the prescribed video information. This electronic signal can be supplied to an appropriate video display device, such as a television receiver, for playback of the recorded video information. Importantly, playback can occur independent of the recording function or substantially simultaneously with the recording function to serve as a check of the recording resolution.

The spindle assembly 18 of this invention is provided for supporting the information disc 14 for rotation about a precise vertical axis without significant radial eccentricities so as to allow accurate rotation of the disc with respect to the record-playback head 34. The spindle assembly 18 thus maintains the proper position of the disc during rotation with respect to the optical beams for precision recording and playback without cross talk between the closely spaced tracks.

The spindle assembly 18 is shown in detail in Figs. 2—6, and comprises a vertically extending spindle shaft 72 supported for rotation about a precise vertical axis 71 within a complementary-shaped spindle housing 78. The spindle shaft 72 is formed from a unitary piece of stainless steel or the like, and is shaped to include a rod-shaped lower end 73 sized and shaped for reception downwardly into an electric drive motor 75 for driving the spindle shaft 72 at a relatively high rotational speed on the order of about 1800 rpm. This drive motor 75 comprises a high speed dc motor for applying a rotational torque to the lower end 73 of the shaft 72 without physical contact with the shaft. In this manner, the shaft is driven at the high rotational speed with minimum

frictional resistance and minimum vibration between the motor 75 and the shaft 72.

The lower end 73 of the shaft 72 merges upwardly into a journal 77 having a generally inverted and truncated conical shape for supportive engagement with the spindle housing 78. This journal 77 in turn is shaped to define an upwardly presented annular shoulder 74 for vertically supporting the information disc 14. An upper stud 76 projects upwardly from the journal 77 coaxially with the vertical axis 71 and is receivable through the central opening 15 of the information disc 14 for locating the disc upon the spindle assembly. As illustrated in Figs. 1 and 2, this stud 76 is adapted for cooperation with the clamp assembly 20 for centering and clamping the disc in position.

The journal 77 of the spindle shaft 72 includes at its lower end an axially and downwardly presented shoulder 88. From the shoulder 88, the journal 77 extends upwardly and radially expands continuously over its height to define the truncated inverted conical shape. This conical journal 77 is received within the spindle housing 78 which includes a radially inwardly presented bearing surface 90 of a truncated conical configuration. Importantly, this housing bearing surface 90 is formed to correspond matingly with the journal 77 whereby the journal 77 is supported within the housing 78 for accurate rotation about the vertical axis 71. Importantly, the relative conical shapes of the journal 77 and the bearing surface 90 enable the journal to accommodate both radial loads and downwardly directed axial thrust loads during operation. Moreover, the major portion of the bearing surface area of the journal 77, namely, the larger diameter upper portion of the journal, is located at the top of the journal adjacent the major portion of the load to be supported by the journal, namely, the information disc 14 on the stud 76.

As shown best in Fig. 4, the spindle housing 78 is formed by a vertical stack of a plurality of housing sections, with three sections 92, 94, and 96 being illustrated in the drawing. These sections all include a radially inwardly presented bearing surface formed coaxially with the vertical axis 71 of spindle shaft rotation, and which, together with the corresponding bearing surfaces of the other housing sections, combine to define the conical bearing surface 90 for supporting the journal 77. Importantly, upper and lower ones 92 and 96 of the housing sections are respectively secured to the intermediate housing section 94 by a plurality of bolts 91 and 93.

A thin disc-shaped shim 98 is interposed between the upper and intermediate housing sections 92 and 94, and another thin disc-shaped shim 100 is interposed between the intermediate and lower housing sections 94 and 96. These shims 98 and 100 are appropriately sized and shaped to adjust the elevational positions between their respective housing sections so as to yield close conformance of the housing bearing surfaces 90 with the shape of the journal 77. Thus,

accurate and constant rotation of the journal 77 about the vertical axis 71 is assured.

Pressurized air is communicated to the bearing interface between the journal 77 and the housing bearing surface 90 for smoothly supporting the journal for rotation upon a cushion of air. More specifically, as illustrated in Figs. 4-6, the intermediate housing section 94 includes a radially projecting air inlet port 102 for suitable coupling to a supply (not shown) of air under pressure. This inlet port 102 supplies the air to an open flow riser 104 extending the height of the intermediate housing section 94. This flow path in turn openly communicates without orificing with an upwardly open slotted annular recess or flow path 106 at the upper end of the section 94, and with a downwardly open slotted annular recess or flow path 108 at the lower end of the section 94.

As shown in Figs. 5 and 6, the two slotted recesses 106 and 108 are annularly positioned for open flow communication with a plurality of radially inwardly open notches 110 and 112 formed respectively in the adjacent shims 98 and 100. These notches 110 and 112 in the shims provide a plurality of flow paths for the air under pressure from the associated recesses 106 and 108 in a radially inward direction into direct communication with the interface between the journal 77 and the housing bearing surface 90. Thus, the pressurized air is supplied to the journal-bearing surface interface substantially uniformly about the journal and at a plurality of vertically spaced locations along the height of the journal. Importantly, to escape from the spindle assembly, this pressurized air is required to flow upwardly and downwardly along this interface whereby the journal is rotatably supported during operation by an annular and continuous film of air.

The lower housing section 96 of the spindle housing 78 includes a lower annular and recessed shoulder 114 for reception of a base ring 116. As shown, this base ring 116 is secured to the lower housing section 96 by the bolts 93, and is in turn secured to the machine table 12 by a plurality of bolts 118. In this manner, the spindle assembly 18 is securely fixed in position upon the machine.

A lower cylindrical thrust plate 120 is provided for accommodating vertically upward thrust loads upon operation of the spindle assembly 18. More specifically, this thrust plate 120 is secured to the downwardly presented shoulder 88 of the journal by a plurality of screws 122, preferably with an appropriately sized shim 124 interposed between the shoulder 88 and the thrust plate 120. This thrust plate is sized to include an upper bearing surface in running engagement with the underside of the base ring 116. Conveniently, as illustrated in Fig. 4, pressurized air is supplied to this bearing interface via a flow path 126 in the lower housing section 96 in alignment with the flow riser 104 in the intermediate housing section 94. This lower flow path 126 supplies a portion of the compressed air to an annular slot 128 which communicates via an annular leakage path 130 with the interface between the thrust plate 120 and the base ring 116.

The spindle assembly 18 of this invention thus provides a relatively simple and thereby relatively inexpensive assembly for accurately supporting a video information disc for accurate and smooth-running rotation about a precise vertical axis. The rotation of the spindle assembly is substantially friction free so as to isolate the information disc from machine and/or system vibrations which can otherwise create cross talk when the machine is operated in recording or playback modes.

The conical journal 77 rides on an air bearing surface to accommodate radial loads and axially downward thrust loads, and the thrust plate 120 rides on an air bearing surface to accommodate axially upward thrust loads. The pressurized air forming the air bearings is supplied without throttling or orificing through a plurality of internal flow paths and the slotted annular recesses formed within the spindle housing directly to the appropriate bearing surface. Importantly, the lack of orificing of the air prior to supply to the bearing surface yields substantially uniform air flow to all of the bearing surfaces to result in smooth vibration free spindle shaft rotation.

Claims

1. A spindle assembly for supporting a disc (14) for rotation, comprising: a spindle shaft (72) including a generally truncated and inverted conical journal (77) having an axis and defining an upwardly presented shoulder (74) for vertically supporting a disc (14), and a stud projecting upwardly from said shoulder along the axis of said journal for reception through a central opening formed in a disc (14) being supported; a spindle housing (78) defining a radially inwardly directed bearing surface (90) of generally truncated conical shape for complementary and supporting reception of said journal for rotation of said journal about a vertical axis, the journal and bearing surface cooperating to define a conical bearing interface, said housing having passage means formed therein; and characterized in that: said passage means includes an air inlet port (102), an open flow riser (104) provided in said housing and arranged extending generally vertically in flow communication from said air inlet port (102), and at least one axially presented air channel means (106, 108) formed in said housing (78) in open communication with said riser (104); that flow director means are formed in said housing (78) for directing air under pressure within at least one said axially presented air channel means (106, 108) to flow in a plurality of flow paths (110) substantially uniformly and annularly to said conical bearing interface; and that said spindle housing (78) includes an axially downwardly presented bearing surface (116); and further including a cylindrical thrust plate (120) secured to the lower end (88) of said spindle shaft (72) for axially bearing engagement with said axially downwardly presented bearing surface (116) on said housing.

2. The spindle assembly of Claim 1, characterized in that said passage means formed in said

accurate and constant rotation of the journal 77 about the vertical axis 71 is assured.

Pressurized air is communicated to the bearing interface between the journal 77 and the housing bearing surface 90 for smoothly supporting the journal for rotation upon a cushion of air. More specifically, as illustrated in Figs. 4-6, the intermediate housing section 94 includes a radially projecting air inlet port 102 for suitable coupling to a supply (not shown) of air under pressure. This inlet port 102 supplies the air to an open flow riser 104 extending the height of the intermediate housing section 94. This flow path in turn openly communicates without orificing with an upwardly open slotted annular recess or flow path 106 at the upper end of the section 94, and with a downwardly open slotted annular recess or flow path 108 at the lower end of the section 94.

As shown in Figs. 5 and 6, the two slotted recesses 106 and 108 are annularly positioned for open flow communication with a plurality of radially inwardly open notches 110 and 112 formed respectively in the adjacent shims 98 and 100. These notches 110 and 112 in the shims provide a plurality of flow paths for the air under pressure from the associated recesses 106 and 108 in a radially inward direction into direct communication with the interface between the journal 77 and the housing bearing surface 90. Thus, the pressurized air is supplied to the journal-bearing surface interface substantially uniformly about the journal and at a plurality of vertically spaced locations along the height of the journal. Importantly, to escape from the spindle assembly, this pressurized air is required to flow upwardly and downwardly along this interface whereby the journal is rotatably supported during operation by an annular and continuous film of air.

The lower housing section 96 of the spindle housing 78 includes a lower annular and recessed shoulder 114 for reception of a base ring 116. As shown, this base ring 116 is secured to the lower housing section 96 by the bolts 93, and is in turn secured to the machine table 12 by a plurality of bolts 118. In this manner, the spindle assembly 18 is securely fixed in position upon the machine.

A lower cylindrical thrust plate 120 is provided for accommodating vertically upward thrust loads upon operation of the spindle assembly 18. More specifically, this thrust plate 120 is secured to the downwardly presented shoulder 88 of the journal by a plurality of screws 122, preferably with an appropriately sized shim 124 interposed between the shoulder 88 and the thrust plate 120. This thrust plate is sized to include an upper bearing surface in running engagement with the underside of the base ring 116. Conveniently, as illustrated in Fig. 4, pressurized air is supplied to this bearing interface via a flow path 126 in the lower housing section 96 in alignment with the flow riser 104 in the intermediate housing section 94. This lower flow path 126 supplies a portion of the compressed air to an annular slot 128 which communicates via an annular leakage path 130 with the interface between the thrust plate 120 and the base ring 116.

The spindle assembly 18 of this invention thus provides a relatively simple and thereby relatively inexpensive assembly for accurately supporting a video information disc for accurate and smooth-running rotation about a precise vertical axis. The rotation of the spindle assembly is substantially friction free so as to isolate the information disc from machine and/or system vibrations which can otherwise create cross talk when the machine is operated in recording or playback modes.

The conical journal 77 rides on an air bearing surface to accommodate radial loads and axially downward thrust loads, and the thrust plate 120 rides on an air bearing surface to accommodate axially upward thrust loads. The pressurized air forming the air bearings is supplied without throttling or orificing through a plurality of internal flow paths and the slotted annular recesses formed within the spindle housing directly to the appropriate bearing surface. Importantly, the lack of orificing of the air prior to supply to the bearing surface yields substantially uniform air flow to all of the bearing surfaces to result in smooth vibration free spindle shaft rotation.

Claims

1. A spindle assembly for supporting a disc (14) for rotation, comprising; a spindle shaft (72) including a generally truncated and inverted conical journal (77) having an axis and defining an upwardly presented shoulder (74) for vertically supporting a disc (14), and a stud projecting upwardly from said shoulder along the axis of said journal for reception through a central opening formed in a disc (14) being supported; a spindle housing (78) defining a radially inwardly directed bearing surface (90) of generally truncated conical shape for complementary and supporting reception of said journal for rotation of said journal about a vertical axis, the journal and bearing surface cooperating to define a conical bearing interface, said housing having passage means formed therein; and characterized in that: said passage means includes an air inlet port (102), an open flow riser (104) provided in said housing and arranged extending generally vertically in flow communication from said air inlet port (102), and at least one axially presented air channel means (106, 108) formed in said housing (78) in open communication with said riser (104); that flow director means are formed in said housing (78) for directing air under pressure within at least one said axially presented air channel means (106, 108) to flow in a plurality of flow paths (110) substantially uniformly and annularly to said conical bearing interface; and that said spindle housing (78) includes an axially downwardly presented bearing surface (116); and further including a cylindrical thrust plate (120) secured to the lower end (88) of said spindle shaft (72) for axially bearing engagement with said axially downwardly presented bearing surface (116) on said housing.

2. The spindle assembly of Claim 1, characterized in that said passage means formed in said



spindle housing (78) includes more than one said air channel means (106, 108) which are axially displaced with respect to each other, and said flow director means further couples air along a plurality of paths (112) between said axially displaced air channel means (106, 108) to said conical bearing interface.

3. The spindle assembly of Claim 1, characterized in that: said spindle shaft (72) further includes a lower shaft portion (73) projecting downwardly from said journal (77) along the axis of said journal (71), and including motor means (75) in association with said lower shaft portion (73) for rotatably driving said spindle shaft.

4. The spindle assembly of Claim 1, characterized in that: said passage means (102, 104, 106, 108) includes means (128, 130) for communicating a substantially constant and annularly uniform flow of air under pressure to the bearing interface between said thrust plate (120) and said axially downwardly presented bearing surface (116) on said housing.

5. The spindle assembly of Claim 1, characterized in that said inlet port (102), said riser (104), and said air channel means (106, 108) are formed for flow of air under pressure without orificing.

Patentansprüche

1. Spindelanordnung zur Halterung einer zu drehenden Scheibe (14), bestehend aus:

einer Spindelwelle (72) mit einem auf dem Kopf stehenden, eine Mittelachse umfassenden kegelstumpfförmigen Wellenzapfen (77), der eine nach oben gerichtete Schulter (74) zur vertikalen Abstützung der Scheibe (14) trägt;

einem nach oben über die Schulter längs der Achse des Wellenzapfens vorstehenden Zapfenstummel, der durch ein zentrisches Loch in der abzustützenden Scheibe (14) verläuft;

einem Wellengehäuse (78) mit einer ebenfalls kegelstumpfförmigen inneren Lagerfläche (90), welche komplementär zum Wellenzapfen verläuft und den Wellenzapfen in um die vertikale Achse drehbarer Lagerung aufnimmt, wobei zwischen Wellenzapfen und Lagerfläche eine konische Grenzschicht verläuft;

und im Gehäuse ausgebildeten Durchlaßkanälen,

dadurch gekennzeichnet,

— daß die Durchlaßkanäle einen Lufteinlaß (102), einen offenen, im wesentlichen senkrecht aufsteigenden sowie mit dem Lufteinlaß in Strömungsverbindung stehenden Strömungskanal (104) innerhalb des Gehäuses und zumindest einen axial zugeordneten sowie im Gehäuse (78) ausgebildeten Luftkanal (106, 108) umfassen, der in Strömungsverbindung mit dem aufsteigenden Strömungskanal (104) steht;

— daß Strömungsleitvorrichtungen im Gehäuse (78) ausgebildet sind, um Luft unter Druck zumindestens einem der axial zugeordneten Luftkanäle (106, 108) in eine Vielzahl von Strömungswegen (110) und von da aus im

wesentlichen gleichmäßig über den Umfang in die konische Lagergrenzschicht zu leiten;

— daß das Gehäuse (78) eine axial nach unten ausgerichtete Lagerfläche (116) umfaßt;

— und daß eine an dem unteren Ende (88) der Spindelwelle (72) befestigte zylindrische Druckplatte (120) mit der Lagerfläche (116) als Axialdrucklager zusammenwirkt.

2. Spindelanordnung nach Anspruch 1, dadurch gekennzeichnet,

— daß die Durchlaßkanäle im Wellengehäuse (78) mehr als einen Luftkanal (106, 108) umfassen, wobei die Luftkanäle axial gegeneinander versetzt sind,

— und daß die Strömungsleitvorrichtungen Luft entlang einer Vielzahl von Strömungswegen (112) zwischen den axial gegeneinander versetzten Luftkanälen (106, 108) in die konische Lagergrenzschicht einleiten.

3. Spindelanordnung nach Anspruch 1, dadurch gekennzeichnet,

— daß die Spindelwelle mit einer unteren schaftartigen Verlängerung (73) versehen ist, welche vom Wellenzapfen (77) aus entlang der Drehachse (71) verläuft und daß die schaftartige Verlängerung (73) mit Antriebseinrichtungen (75) zusammenwirkt, um die Spindelwelle zu drehen.

4. Spindelanordnung nach Anspruch 1, dadurch gekennzeichnet,

— daß die Durchlaßkanäle (102, 104, 106, 108) mit Luftführungsschlitzten (128, 130) verbunden sind, um einen im wesentlichen konstanten, gleichmäßig ringförmigen Luftstrom unter Druck der Lagerfläche zwischen der Druckplatte (120) und der nach unten ausgerichteten Lagerfläche (116) zuzuführen.

5. Spindelanordnung nach Anspruch 1, dadurch gekennzeichnet,

— daß der Lufteinlaß (102), der aufsteigende Strömungskanal (104) und die Luftkanäle (106, 108) derart ausgestaltet sind, daß sie unter Druck stehende Luft ohne Düsenwirkung übertragen.

Revendications

1. Broche d'entraînement pour supporter un disque (14) en rotation, comprenant: un arbre de broche (72) comprenant un tourillon (77) de forme générale tronquée et en cône inversé ayant un axe et définissant un rebord (74) tourné vers le haut pour supporter verticalement un disque (14), et un pion en saillie vers le haut à partir dudit rebord le long de l'axe dudit tourillon destiné à être reçu dans une ouverture centrale pratiquée dans un disque (14) devant être supporté, une enceinte de broche (78) définissant une surface d'appui (90) dirigée radialement vers l'intérieur de forme générale tronconique pour recevoir en appui et de façon complémentaire ledit tourillon pour la rotation dudit tourillon autour d'un axe vertical, le tourillon et la surface d'appui coopérant pour définir une interface conique d'appui, ladite enceinte comportant un moyen de passage, caractérisée en ce que: ledit moyen de passage comprend un orifice (102)



d'entrée d'air, un conduit ascendant d'écoulement ouvert (104) pratiqué dans ladite enceinte et disposé de façon à s'étendre généralement verticalement en communication d'écoulement à partir dudit orifice d'entrée d'air (102), et au moins un canal d'air (106, 108) disposé axialement formé dans ladite enceinte (78) en communication ouverte avec ledit conduit ascendant (104); en ce que des moyens pour diriger l'écoulement sont pratiqués dans ladite enceinte (78) pour diriger l'air sous pression à l'intérieur d'au moins un canal d'air (106, 108) précité disposé axialement afin qu'il s'écoule dans une pluralité de voies d'écoulement (110) disposées de façon sensiblement uniforme et annulaire par rapport à ladite interface d'appui conique; et en ce que ladite enceinte de broche (78) comprend une surface d'appui (116) dirigée axialement vers le bas; et incluant en outre une plaque de poussée (120) cylindrique fixée à l'extrémité inférieure (88) dudit arbre de broche (72) pour venir en prise axialement avec ladite surface d'appui (116) disposée axialement vers le bas sur ladite enceinte.

2. Broche d'entraînement selon la revendication 1, caractérisée en ce que ledit moyen de passage formé dans ladite enceinte de broche (78) comprend plus d'un canal d'air (106, 108) précité, déplacés axialement les uns par rapport aux

autres, et en ce que ledit moyen pour diriger l'écoulement met en outre en communication l'air le long d'une pluralité de voies (112) entre lesdits canaux d'air (106, 108) déplacés axialement et ladite interface conique d'appui.

3. Broche d'entraînement selon la revendication 1, caractérisée en ce que: ledit arbre de broche (72) comprend en outre une partie d'arbre inférieure (73) faisant saillie vers le bas à partir dudit tourillon (77) le long de l'axe dudit tourillon (71), et comportant un moteur (75) en association avec ladite partie inférieure (73) de l'arbre pour entraîner en rotation ledit arbre de broche.

4. Broche d'entraînement selon la revendication 1, caractérisée en ce que: ledit moyen de passage (102, 104, 106, 108) comprend des moyens (128, 130) pour communiquer un écoulement d'air sous pression sensiblement constant et uniforme en direction annulaire à l'interface d'appui entre ladite plaque de poussée (120) et ladite surface d'appui (116) disposée axialement vers le bas sur ladite enceinte.

5. Broche d'entraînement selon la revendication 1, caractérisée en ce que ledit orifice d'entrée (102), ledit conduit ascendant (104) et lesdits canaux d'air (106, 108) sont conçus pour un écoulement d'air sous pression non-débouchant.

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