United States Patent

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[32] Priority **Nov. 17, 1966**
[33] **Japan**
[31] **41/76,000**

[54] **ROTATION CONTROL DEVICE**
10 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **178/6.6,** 74/242.9; 179/100.2
[51] **Int. Cl.** **F16h 7/08,** G11b 15/50
[50] **Field of Search** ..... 178/6.6A; 74/217CV, 242.8, 242.9; 179/100.2T; 192/No Search Recommended; 318/310 No Search Recommended

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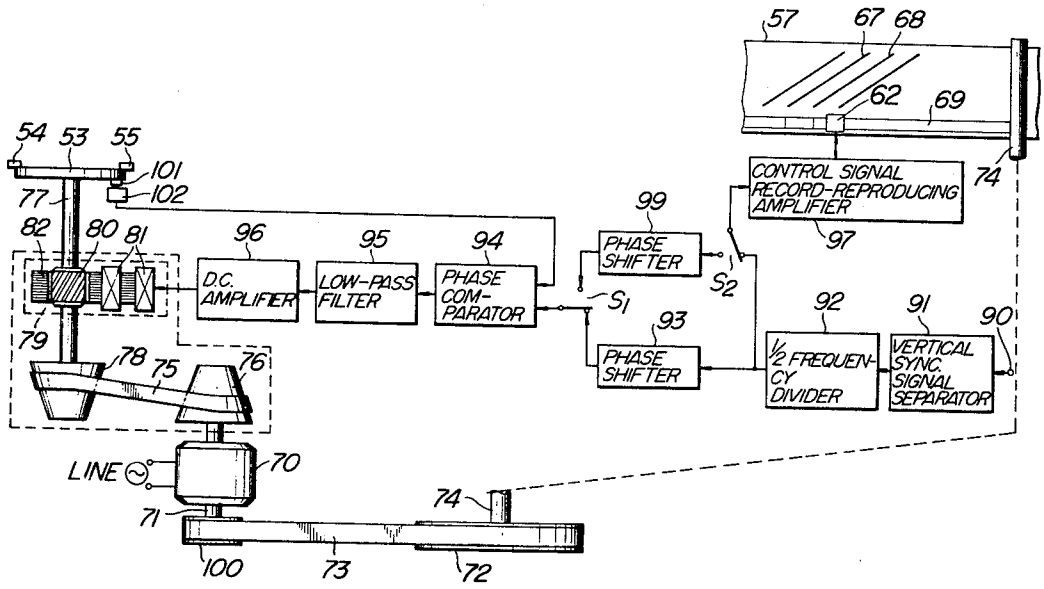
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ABSTRACT: A rotation control device having two pulleys, at least one of which is a conical pulley, mounted on a driving shaft rotating at a constant speed and a driven shaft to be driven in a fixed relation with the phase of a reference signal, and a torque-transmitting belt trained around the pulleys. In the device, a signal representing the phase difference between the reference signal and a signal detected in synchronism with the phase of rotation of the driven shaft is utilized to impart a brake torque to the driven shaft for varying the engaging position between the belt and the conical pulley to thereby ensure rotation of the driven shaft at a predetermined number of rotations.



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FIG. 1

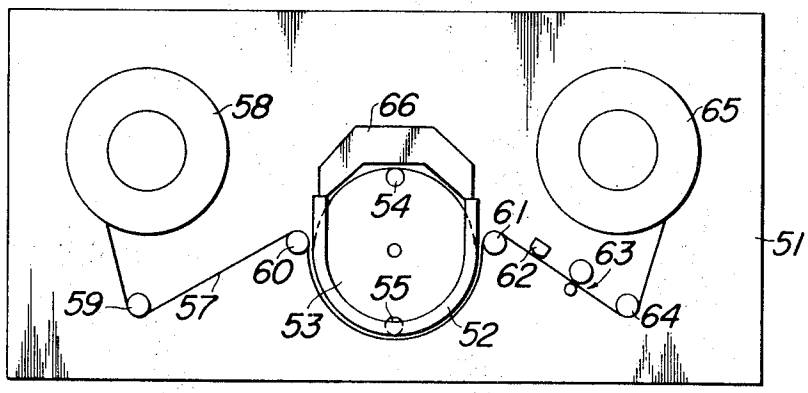


FIG. 3

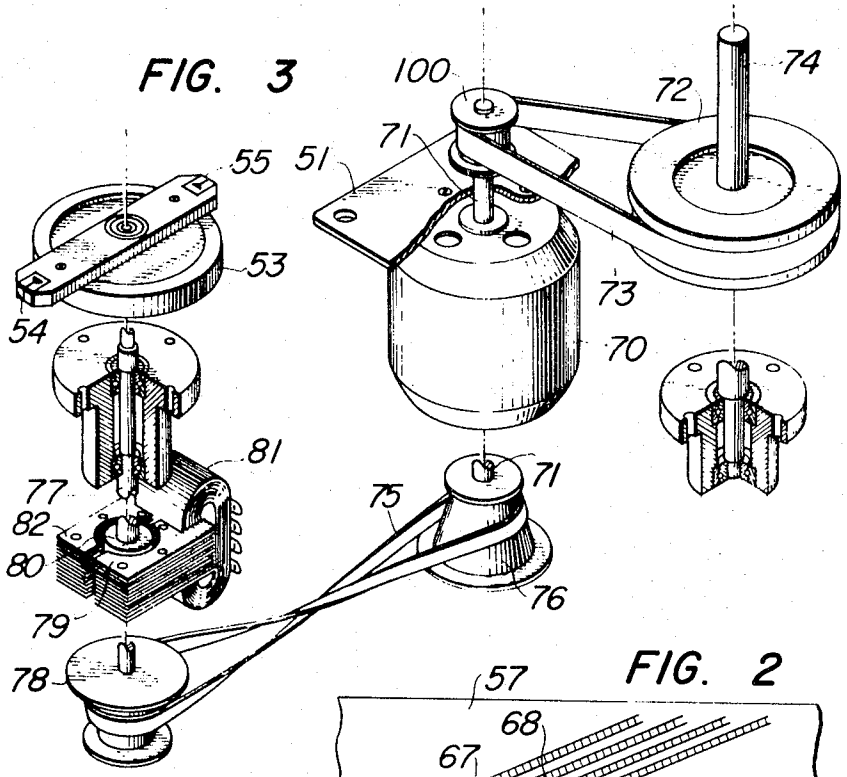


FIG. 2

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FIG. 4a

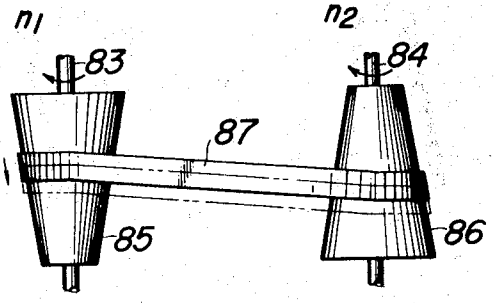


FIG. 4b

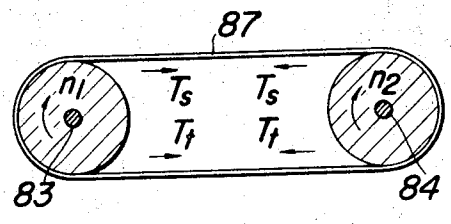


FIG. 4c

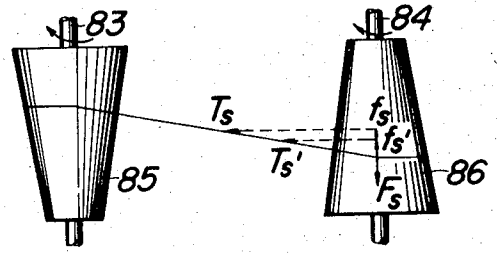
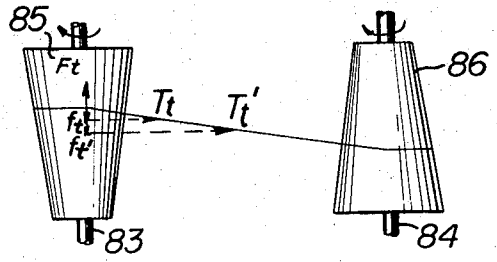


FIG. 4d



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FIG. 5

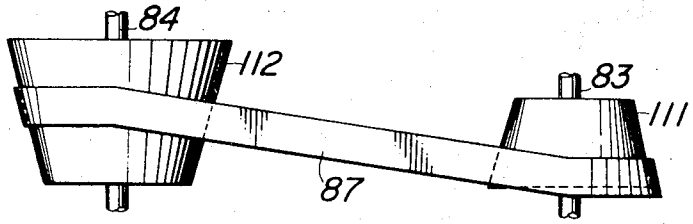


FIG. 6

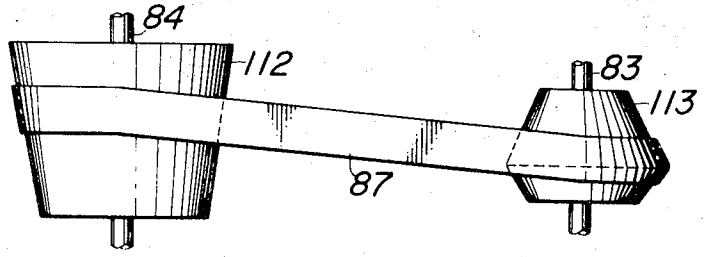
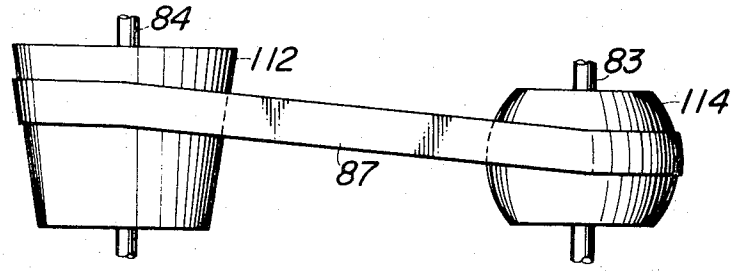


FIG. 7



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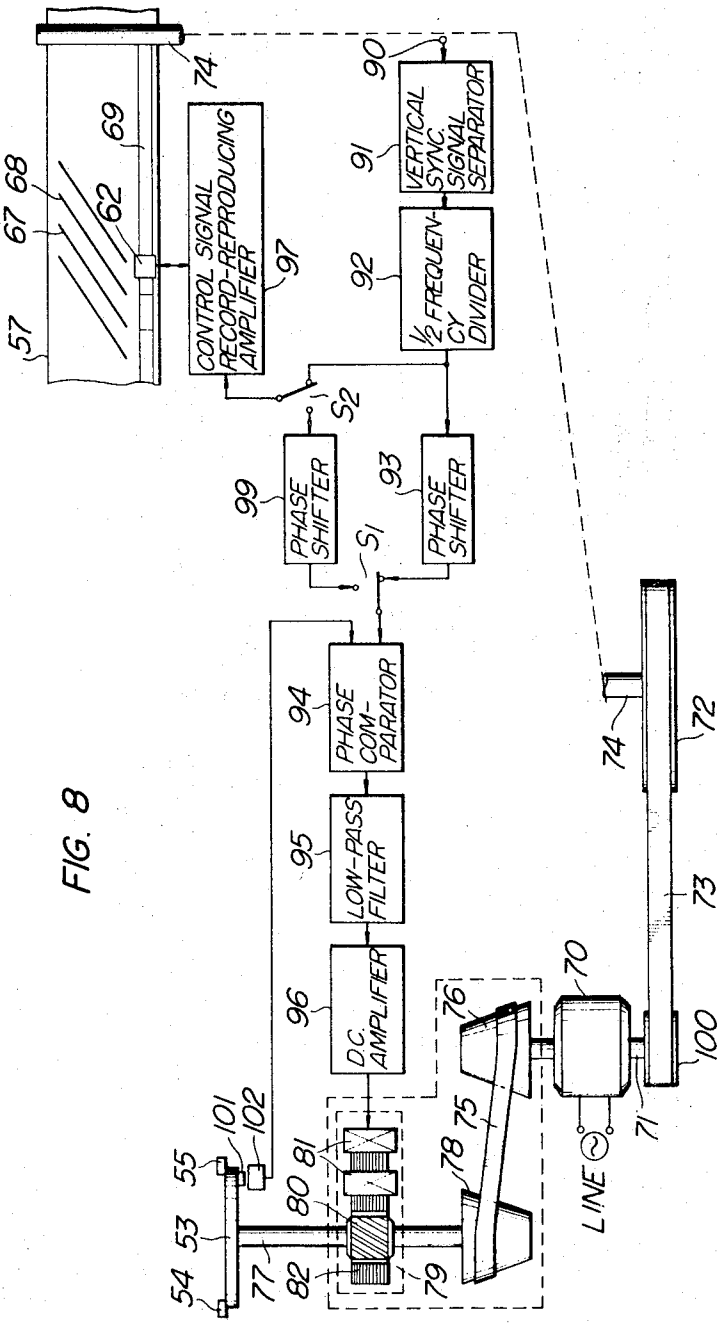


FIG. 8

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ROTATION CONTROL DEVICE

This invention relates to a rotation control device which is effective for use in a magnetic recording and reproducing apparatus of the rotary head type. Generally speaking, the present invention contemplates the provision of a rotation control device for use in an apparatus of the kind comprising a magnetic tape and a rotary head assembly including a plurality of magnetic transducers for the recording and reproduction of a wide-band signal, in which, in lieu of a complex and expensive structure well known in the art which includes therein individual exclusive motors and associated power amplifiers for separately driving the magnetic tape and the rotary head assembly, a single motor which is driven from a commercial power supply is employed to drive both the magnetic tape and the rotary head assembly, and a unique stepless speed change mechanism whose speed change ratio can precisely be controlled by a very slight electrical power is operatively interposed between the motor and the shaft of the rotary head assembly.

In a prior method of magnetic recording in which a signal such, for example, as a television signal having extremely high frequencies or ranging over an extremely wide frequency band is directly recorded on a magnetic tape, the relative speed between a recording or reproducing head and a magnetic recording medium moving past the head gap had to be very high in order to satisfactorily record or reproduce the high frequency components of the signal. On the other hand, the magnetic recording medium such, for example, as a magnetic tape was requested to run at a normal low speed. As a compromise for satisfying both these contradictory conditions, the desired purpose for obtaining a relatively high speed between the magnetic tape and the recording head was obtained by causing the magnetic head to mechanically rotate at a high speed transversely across the magnetic tape. In U.S. Pat. No. 2,916,546, for example, a rotary head assembly having a drum including therein four magnetic transducers is provided and a magnetic tape is advanced perpendicular to the plane of rotation of the rotary head, and a guide means cups the tape for contact with the transducer units. More precisely, the magnetic tape is driven past the head in its longitudinal direction at a speed of 15 inches per second and a video signal is recorded in the form of a series of transverse lines or tracks.

In a magnetic recording and reproducing apparatus having such a rotary head, the rotating speed or the phase of rotation of the rotary head was controlled, if so required, by comparing a signal which is dependent upon the rotation of the rotary head with a reference signal to derive an error signal therebetween, and utilizing the error signal to control the rotation of the rotary head. Further, in view of the requirement according to which a specific relationship had to be established between the running speed of the magnetic tape and the rotating speed of the rotary head in the case of reproduction, a signal representing the running speed of the tape was compared with a signal which is dependent upon the rotation of the rotary head to thereby derive an error signal therebetween, and the error signal was utilized to control the rotation of the tape drive motor. As another prior example known in the art, U.S. Pat. No. 3,293,359 disclose a method in which a magnetic tape was helically driven to wrap up the substantially half periphery of a cylindrical tape guide, and a rotary head assembly accommodated in the cylindrical tape guide made sliding contact with the tape through a slit extending over the entire periphery of the cylindrical tape guide, thereby forming a series of skewed tracks on the tape.

From the two prior examples described above, it will be recognized that the rotary head assembly and the magnetic tape must be driven at a very precisely controlled speed. However, the drive system for the magnetic tape and the rotary head assembly in the prior art apparatus has been defective in its complexity, expensiveness and large size.

Having the prior defects as pointed out above in mind, it is the primary object of the present invention to provide a novel and improved rotation control device for use in an apparatus

of the kind comprising a magnetic tape and a rotary head assembly including therein a plurality of magnetic transducers for the recording and reproduction of a wide-band signal, in which an AC synchronous motor driven by a commercial power supply is employed to serve as a common drive means for the rotary head assembly and the magnetic tape, and a stepless speed change mechanism is employed to connect the common drive means with the shaft of the rotary head assembly thereby facilitating the desired control of the rotation of the rotary head assembly and the magnetic tape with a sufficient degree of precision.

Another object of the present invention is to provide a rotation control device for use in an apparatus of the above-described character, in which an AC synchronous motor driven by a commercial power supply is employed to serve as a common drive means for the magnetic tape and the rotary head assembly, and a unique stepless speed change mechanism whose speed change ratio can be precisely controlled by a very slight electrical power is interposed between the common drive means and the shaft of the rotary head assembly so that during the record mode the rotary head assembly can be driven in a synchronous relation with a reference signal delivered from a reference signal source having a periodicity thereby forming the desired tracks of record on the magnetic tape.

A further object of the present invention is to provide a rotation control device for use in an apparatus of the above-described character adapted for the recording and reproduction of a television signal, in which the synchronizing signal in the television signal having been recorded along one edge of the magnetic tape during the record mode is reproduced from the magnetic tape during the playback mode so that the reproduced signal can be utilized as a reference signal for driving the rotary head assembly for the reproduction of the tracks of record of the television signal provided on the magnetic tape.

Another object of the present invention is to provide a rotation control device for use in an apparatus of the above-described character adapted for the recording and reproduction of a television signal, in which an AC synchronous motor driven by a commercial power supply is employed to serve as a common drive means for the rotary head assembly and the magnetic tape, the common drive means being connected with the shaft of the rotary head assembly through a unique stepless speed change mechanism whose speed change ratio can be precisely controlled by a very slight electrical power, and during the record mode, the rotary head assembly is driven in a synchronous relation with a control signal responsive to the synchronizing signal in the television signal to be recorded thereby forming the tracks of record of the television signal on the magnetic tape and at the same time recording the synchronizing signal in the television signal on one edge of the magnetic tape, while during the playback mode, the synchronizing signal having been recorded on one edge of the magnetic tape is reproduced and is utilized as a reference signal so that a very slight electrical power representing an error between the phase of the reference signal and the phase of a signal responsive to the rotation of the rotary head assembly is used to control the stepless speed change mechanism which controls the rotation of the rotary head assembly, which is operative to reproduce the tracks of record of the television signal provided on the magnetic tape.

The above and other objects, advantages and features of the present invention will become apparent from the following description, in which preferred embodiments of the present invention are described in detail with reference to the accompanying drawings.

In the drawings:

FIG. 1 is a plan view of a magnetic tape recording and reproducing apparatus having a rotation control device embodying the present invention;

FIG. 2 is a diagrammatic view showing a series of tracks of a high frequency signal recorded on a magnetic tape by the magnetic tape apparatus shown in FIG. 1;

FIG. 3 is an exploded perspective view of a part of the drive system for the rotary head assembly and the magnetic tape;

FIGS. 4*a* to 4*d* are diagrammatic views showing the relation between pulleys and a belt in a stepless speed change mechanism which is the basic component in the device according to the present invention;

FIGS. 5, 6 and 7 are diagrammatic views showing other forms of the stepless speed change mechanism; and

FIG. 8 is a schematic block diagram showing one form of the rotary head drive control system in the device according to the present invention.

In FIG. 2, there is shown one form of the tape drive system in the device according to the present invention which is adapted to drive a rotary head assembly in a synchronous relation with the phase of a reference signal. The drive system is mounted on the base plate **51** which is generally called a tape transport panel. A tape guide **52** of cylindrical shape is provided with a housing **66** which is securely fixed to the panel **51**. The tape guide **52** is provided with a slit (not shown) through which the front end of two magnetic heads **54** and **55** mounted at diametrically opposite positions on the periphery of a rotary head drum **53** can protrude from the tape guide **52**.

A magnetic tape **57** fed from a supply reel **58** travels past an idler **59** and a guide post **60** to engage the tape guide **52** along an arcuate path in such a manner as to partly wrap up the tape guide **52** for receiving a recording thereon or for reproducing a recording therefrom by the action of the magnetic heads **54** and **55** mounted on the rotary head drum **53**. The magnetic tape **57** having been recorded or reproduced leaves the tape guide **52** to be guided past another guide post **61**, a control signal record-reproducing head **62**, a capstan means **63** and an idler **64** to be finally taken up on the takeup reel **65**. The supply reel **58**, the idler **59** and the guide post **60** are so mounted on the tape transport panel **51** that they have a different height relative to the height of the takeup reel **65** and the guide post **61**, with the result that the magnetic tape **57** moving past one guide post **60** toward another guide post **61** helically runs on the tape guide **52** while making a certain angle with respect to the surface of the tape transport panel **51**. Thus, the recording and reproduction of the helical scanning type can be applied to the magnetic tape **57**, and its apparent that magnetized bands **67** and **68** of the kind as shown in FIG. **2** are formed on the magnetic tape **57** by the magnetic heads **54** and **55**. It will also be apparent that, when the mounting positions of the guide posts **60** and **61** are suitably selected, the range of engagement between each magnetic head and the magnetic tape can be limited to a substantially semicircumferential range through which each magnetic head rotates in sliding contact with the tape. By this type of arrangement one of the magnetic heads starts to engage the magnetic tape **57** when the other is about to leave the magnetic tape **57**. In FIG. **2**, the reference numeral **69** designates a magnetized band formed by the stationary head **62**.

FIG. **3** illustrates in an exploded perspective fashion a system for driving the magnetic tape and the rotary head assembly in the magnetic tape apparatus having the rotation control device embodying the present invention. An AC synchronous motor **70** adapted to be driven by a commercial power supply is supported on the panel **51**. A pulley **100** is mounted on one end of the shaft **71** of the motor **70**, and a torque-transmitting elastic belt **73** is trained around the pulley **100** and a pulley **72** which serves both as a speed reducing means and a flywheel so as to drive a tape-driving capstan shaft **74** connected to the pulley **72** in a manner well known in the art. Thus, the capstan shaft **74** has its drive power supplied from the synchronous motor **70** to thereby rotate at a constant number of rotations.

On the other hand, a second elastic belt **75** is trained around a conical pulley **76** fixedly mounted on the other end of the shaft **71** of the synchronous motor **70** and a conical pulley **78** fixedly mounted on the shaft **77** of the rotary head drum **53**, so that the shaft **77** can be driven by the synchronous motor **70** through the second belt **75**. An eddy current brake means **79** is operatively associated with the shaft **77** of the rotary head drum **53** and serves to precisely control the rotating speed of the shaft **77** of the rotary head drum **53** independently of the number of rotations of the synchronous motor **70**. The combination comprising the two conical pulleys **76** and **78**, the elastic belt **75** and the eddy current brake means **79** is designated in the present invention as a stepless speed change mechanism. The eddy current brake means **79** may, for example, have such a structure that an exciting iron core **82** having thereon a DC exciting winding **81** surrounds a squirrel-cage induction rotor **80** of the aluminum die casting type which is generally used in an induction motor.

The stepless speed change mechanism which is the basic and essential component of the rotation control device according to the present invention will be described in more detail with reference to a model diagrammatically shown in FIGS. 4*a* to 4*d*, wherein FIG. 4*a* is a front view, FIG. 4*b* is a sectional view along the centerline of the belt and FIGS. 4*c* and 4*d* are explanatory front views, respectively, of the stepless speed change mechanism.

It is commonly known that, in case an elastic belt is trained around two conical pulleys and is thereby driven, the belt runs along the peripheries of the two pulleys at positions of different heights from each other since the belt is dislodged toward the large diameter end of each pulley and thus makes a certain angle with respect to the horizontal plane. It is also known that the belt moves away from the apex of the conical pulley having a larger cone angle when these two pulleys have cone angles different from each other.

Suppose now that conical pulleys **85** and **86** of the same shape having a suitable cone angle are mounted in opposite directions to each other on two parallel shafts **83** and **84**, respectively, and a flat rubber belt **87** is trained under a suitable tension around the two pulleys **85** and **86**. When the shaft **83** is rotated from a suitable drive source at a constant number of rotations n_1, the belt **87** can be driven in a balanced state to follow a fixed path around the conical pulleys depending on the cone angle of the conical pulleys **85** and **86**, the tension developed in the belt **87** due to a load torque imparted to the shaft **84**, and the force of friction developed between the belt **87** and the surfaces of the conical pulleys **85** and **86**, with the result that a driving force is transmitted to the shaft **84** to rotate the shaft **84** at a certain number of rotations n_2.

In this connection, it will be apparent that the number of rotations of the driven shaft **84** is reduced as the position of the belt **87** moves in a direction as shown by the arrow in FIG. 4*a*. Under the state in which the position of the running belt **87** is stabilized as described above, the number of rotations of the driven shaft **84** can be varied by applying a torque load to the shaft **84** by means such as an eddy current brake means. The impartation of the torque load to the driven shaft **84** causes a variation in the tension of the belt **87** to thereby shift the balanced position of the belt **87** in the direction of the arrow so that the number of rotations of the driven shaft **84** can be varied without varying the number of rotations of the driving shaft **83**.

The above situation will be described in further detail with reference to FIGS. 4*b*, 4*c* and 4*d*. FIG. 4*b* is a cross-sectional view to show the engagement between the belt **87** and the pulleys **85** and **86** when viewed from the top ends of the shafts **83** and **84**. Suppose now that the pulleys **85** and **86** rotate in a direction as shown by the arrow depicted in each of them, and T_t and T_s designate the belt tension on the tensile side on the slack side, respectively, relative to each of the pulleys **85** and **86** under the running state of the belt **87**. Then, there is a relation $T_t > T_s$ between these tensions. On the other hand, the position at which the belt **87** engages the surface of each conical pulley is primarily determined by the point at which the belt **87** starts to engage the pulley. Therefore, the belt **87** at the entrance to the conical pulley **86** mounted on the driven shaft **84** is stabilized at a position at which an axial component fs of the belt tension T_s is balanced with an axial components F_s of the friction force of the conical pulley **86** as shown in FIG. 4*c*. Accordingly, as the load torque imparted to the

driven shaft **84** is increased, the belt tension T_s is reduced to T_s' with the result that its axial component is now represented by f_s' which is smaller than f_s, the belt **87** is shifted toward the larger diameter portion to be balanced thereat.

The belt **87** at the entrance to the conical pulley **85** mounted on the driving shaft **83** is also stabilized at a position at which an axial component F_t of the friction force of the conical pulley **85** is balanced with an axial component f_t of the belt tension T_t as shown in FIG. **4***d*. In this case too, with the increase in the brake torque, the belt tension T_t is increased to a value T_t' whose axial component f_t' also becomes greater than f_t, with the result that the belt **87** is shifted toward the smaller diameter portion of the driving conical pulley **85** to be stabilized thereat.

Thus, with an increased in the brake torque imparted to the driven pulley, the balancing position of the belt is shifted toward the larger diameter portion of the driven pulley and toward the smaller diameter portion of the driving pulley. Similarly, with a decrease in the brake torque from a certain state, the balancing position of the belt is shifted in a direction opposite to the above direction, and it is thus possible to control the number of rotations of the driven pulley by varying the value of the brake torque. Although the variation in the speed of the driven pulley due to the application of the brake torque includes an elastic slip of the elastic belt due to the application of the control load torque, in addition to the components variable depending on the engaging position of the belt with the surface of the pulley as described above, this elastic slip component works quite effectively as it varies in a cooperative manner with the above-described components which are variable by shifting the position of the belt.

The above description has referred to a case of one set of conical pulleys having the same shape, but in practical applications, it is difficult to make two conical pulleys having entirely the same physical as well as mechanical dimensions and to dispose these conical pulleys in an exact axially parallel relation with each other. For example, a slight difference between the cone angles of these pulleys would cause a shifting movement of the belt toward the larger diameter portion of the conical pulley having the larger cone angle, and a stable point corresponding to the desired number of rotations would hardly be obtained. For the above reason, it is desirable to arrange in such a manner as shown in FIG. **5** or **6** in which two conical pulleys are intentionally constructed to have a difference in their vertical angles in order to thereby bring the belt to a predetermined position on the pulleys, or in such a manner as shown in FIG. **7** in which one of two pulleys is made to have an intermediately bulged drumlike shape in order to thereby obtain a stable position of the belt. The belt in any of the pulley combinations shown in FIGS. **5**, **6** and **7** operates in the same manner as that described with reference to FIG. **4**. For example, in the case of the combination of pulleys having different cone angles, the belt takes its stable position within its elastic limit by wrapping up in such a manner as shown in FIG. **5** in which it protrudes partly beyond the large diameter end of the pulley having the larger cone angle.

In FIG. **5**, a conical pulley **111** is fixedly mounted on a driving shaft **83**, while a conical pulley **112** is fixedly mounted on a driven shaft **84**, and the cone angle of the pulley **111** is larger than that of the pulley **112**. In the above pulley combination, belt **87** trained around the conical pulleys **111** and **112** protrudes in a larger amount beyond the large diameter end of the conical pulley **111** as the difference in the cone angles of the conical pulleys is made larger. Suppose, for example, that the pulleys **111** and **112** are made from aluminum subjected to a hard alumite treatment and have respective cone angles of 20° and 18°, these pulleys having a diameter of about 45 mm. at a position at which the belt **87** is trained, the belt **87** is in the form of a sheet of polyurethane having a hardness of 65°, a thickness of 0.5 mm., a width of 8 mm. and a length of 450 mm. and the axial spacing between the pulleys is 180 mm. Then, with a normal torque load in the order of 40 gr.-cm., the belt **87** protrudes by an amount in the order of 15 percent of the 8 mm. width. The amount of protrusion of the belt **87** becomes smaller for the reason as described previously when the load torque imparted to the shaft **84** is made greater.

In FIG. **6**, an intermediately bulged conical pulley **113** of such a shape as may be made by bonding two driving pulleys **111** as shown in FIG. **5** to each other at their large diameter ends is fixedly mounted on a driving shaft **83**, and a belt **87** is trained around the driving pulley **113** and a driven conical pulley **112** fixedly mounted on a driven shaft **84**. In this case, the belt **87** is stabilized under a state as shown in FIG. **6** in which the belt **87** embraces the bulged middle portion of the driving pulley **113**. Needless to say that the pulley **113** has a larger cone angle than the pulley **112** in the above pulley combination. Suppose now that the pulleys and the belt in FIG. **6** are made from the same material and have the same dimensions as those of the pulleys and the belt shown in FIG. **5**. Then, the belt **87** is stabilized under a state in which it engages the pulley **113** with about 15 percent of the total width thereof on the lower side of the bulged middle portion of the pulley **113** and with about 85 percent of the total width thereof on the upper side of the bulged middle portion of the pulley **113**. When a torque load is applied to the driven shaft **84**, the belt **87** is shifted upwardly in FIG. **6** to engage the pulley **113** at a different position.

In FIG. **7**, there is shown a pulley **114** which, in its vertical section, has an arcuate shape having a certain curvature and is different in its shape from the shape of the pulley **113** which has a sharply defined, bulged, middle portion. The pulley **114** is fixedly mounted on a driving shaft **83**, and a belt **87** is trained around the driving pulley **114** and a driven conical pulley **112** fixedly mounted on a driven shaft **84**. The belt **87** operates in the same manner as that shown in FIG. **6**.

One of the pulleys in the above pulley combinations shown in FIGS. **5**, **6** and **7** may be axially adjustably mounted on the associated shaft.

It will be recalled that the previous description has referred to the fact that, in a drive system having a belt and two conical pulleys which have different cone angles, the belt is progressively shifted toward the large diameter end of the pulley having the larger cone angle. However, the description given with reference to FIGS. **5**, **6** and **7** has referred to the fact that a belt in such a drive system is stabilized at a certain position, and it seems that the previous description is contradictory to the description given with reference to FIGS. **5**, **6** and **7**. In this respect, it will be understood that there is no contradiction therebetween for the reason that, since the force to shift the belt is proportional to the width of the belt, partial protrusion of the belt beyond the large diameter end of the pulley or rideover of the belt on the ridge of the pulley substantially reduces the effective width of the belt which acts to shift the belt portion engaging the particular pulley, and the force to shift the belt portion engaging the particular pulley is balanced with the force to shift the belt portion engaging the other pulley.

Now, the amount of a load actually imparted to the driven shaft and the number of rotations reduced due to the impartation of the load will be considered with reference to FIG. **6** in which it is supposed that the pulleys and the belt have respective dimensions as described previously. Suppose that the load torque imparted to the driven shaft **84** is 250 gr.-cm. and the number of rotations of the driving shaft **83** is 1,800 r.p.m., then a speed reduction in the order of 110 r.p.m. can be effected on the driven shaft **84**, and the number of rotations of the driven shaft is reduced substantially in proportion to the amount of the imparted load torque. Suppose then that the eddy current brake for imparting the above-described brake torque comprises a squirrel-cage induction rotor which has a diameter of 20 mm. and a length of 16 mm. and is made from laminated silicon steel core with 20 aluminum wires die cast therein, and an exciting iron core having an exciting winding with 4.800 ampere-turns. Then, a DC power of 24 volts and 50 ma. supplied to the winding when the number of rotations is 1,800 r.p.m. can generate a brake torque of 250 gr.-cm. It

will thus be known that a very slight electrical power can easily control the number of rotations of the driven shaft in the system according to the present invention.

In order to therefore rotate the driven pulley at a desired predetermined speed, the shape of the pulleys forming one set may be suitably selected so that the driven pulley rotates at a number of rotations slightly higher than the desired value under a state in which the eddy current brake imparts to the driven shaft a zero torque or a suitably biasing torque, and the eddy current brake may then be suitably controlled to effect the rotation of the driven pulley at the desired speed. It will be understood, further, that the desired purpose of rotating the driven pulley at a number of rotations in conformity with the phase of a reference signal can easily be attained by detecting photoelectrically or magnetically the rotation of the driven pulley to thereby derive a signal representing the phase of rotation of the driven pulley, comparing the phase of the above signal with the phase of the reference signal to thereby derive an error signal, rectifying the error signal, and controlling the eddy current brake by supplying the rectified output thereto in a negative feedback fashion in a closed loop system.

The operation of the rotation control device according to the present invention when adapted to cooperate with the magnetic tape drive system and the rotary head control system in the magnetic recording and reproducing apparatus will be described in detail with reference to FIG. **8**.

A composite video signal derived from a television receiver or a television camera during the record mode is fed past an input terminal **90** into a vertical synchronizing signal separator **91** where the vertical synchronizing signal in the form of a pulse signal at 60 cycles per second is solely separated. The pulse signal is then fed into a one-half frequency divider **92** to be turned into a pulse signal at 30 cycles per second which is then suitably delayed and shifted in its phase by a phase shifter **93**. The signal is then passed through a switch S_1 to be supplied as one of the input signals to a phase comparator **94**. On the other hand, a permanent magnet **101** is fixedly mounted at a suitable position on the peripheral portion of the rotary head drum **53** in such a relation that it is closely opposite to a stationary pickup head **102** so that a signal is derived from the pickup head **102** by each rotation of the rotary head drum **53**. The above signal constitutes another input signal to the phase comparator **94**. The phase comparator **94** compares the phases of these two input signals with each other to deliver an error signal, which is smoothed out by a low-pass filter **95** and is suitably power amplified by a DC amplifier **96**, the amplified DC output being then supplied to the exciting winding **81** of the eddy current brake means **79**.

The conical pulleys **78** and **76** having their large diameter ends disposed in directions opposite to each other are mounted on the rotary shaft **77** of the rotary head drum **53** and the drive shaft **71** of the AC synchronous motor **70** driven from a commercial power supply, respectively, and the torque transmitting the elastic belt **75** is trained around the conical pulleys **78** and **76**. The conical pulleys **78** and **76** are so designed that the rotary head drum **53** is driven at a speed which is higher by a suitable amount, say, 20 to 30 r.p.m. than the rated speed, 1,800 r.p.m., under a state in which a zero brake current is supplied to the eddy current brake means **79**. During the video signal recording, the phase of the reference signal at 30 cycles per second which is derived by the frequency division of the vertical synchronizing signal at 60 cycles per second is compared in the phase comparator **94** with the phase of the signal at a frequency in the vicinity of 30 cycles per second which is derived by the pickup head **102** in response to each rotation of the head drum **53** rotating at a speed in the vicinity of 1,800 r.p.m. An error signal derived by the phase comparison between these two signals is smoothed out by the low-pass filter **95** and is then suitably amplified by the DC amplifier **96** to be supplied to the eddy current brake means **79** as a power for correcting any error in the phase for thereby rotating the head drum **53** in synchronism with the phase of the reference signal.

In the meantime, the composite video signal is modulated by a suitable modulator such, for example, as an FM modulator and is then passed through a recording amplifier (not shown) to be fed to the magnetic heads **54** and **55**. At the same time, the reference pulse signal at 30 cycles per second fed from the one-half frequency divider **92** is supplied through a switch S_2 into a control signal record-reproducing amplifier **97** which is connected to a control signal head **62** whereby the signal is recorded on one edge of the magnetic tape **57** as the control signal track **69**. The magnetic tape **57** is driven from the power source, which is the AC synchronous motor **70**, through the belt **73** trained around the pulleys **100** and **72** constituting a speed reduction means so that the magnetic tape **57** travels at a predetermined reduced speed. As described previously, FIG. **2** illustrates the magnetized bands recorded on the magnetic tape **57** by the above recording process, in which the obliquely running tracks **67** and **68** are produced by the magnetic heads **54** and **55**, while the track **69** running adjacent to the lower end of the tape **57** is produced by the control signal head **62**.

During the playback mode, the control pulse signal recorded on the magnetic tape **57** is reproduced by the control signal head **62** and is fed through the record-reproducing amplifier **97** and the switch S_2 into a phase shifter **99** where the signal is suitably subjected to a phase shift. The signal is then fed through the switch S_1 into the phase comparator **94** to constitute one of the input signals which corresponds to the reference signal supplied during the record mode. Therefore, the operation thereafter is similar to that described with regard to the recording operation.

In the recording operation, it is desirable that the time at which each of the magnetic heads **54** and **55** starts to engage the magnetic tape and the time at which such magnetic head starts to disengage the magnetic tape lie in the vertical blanking period of the television signal. In this respect, it will be understood that the period of the vertical synchronizing signal which is one-sixtieth of a second is equal to the time corresponding to each individual tracing section of the tracks **67** and **68** drawn by the magnetic heads **54** and **55** on the magnetic tape, and further the rotation of the head drum **53** carrying thereon the magnetic heads is so controlled as to be in synchronism with the phase of the vertical synchronizing signal. Therefore, by preliminarily selecting a suitable value for the delay time of the phase shifter **93**, it is possible to set the phase of rotation of the head drum **53** carrying thereon the magnetic heads in such a manner that the switchover position of the two magnetic heads lies within the vertical blanking period, and thus to satisfy the above requirement. By this arrangement, a possible disorder in the signal at the switchover position between the magnetic heads, can not appear on the screen of a television receiver during the reproducing operation.

Further, during the playback mode, the rotation of the head drum **53** carrying thereon the magnetic heads **54** and **55** is controlled in such a manner that its phase is in synchronism with the reproduced control signal as described previously. Therefore, when the delay time of the phase shifter **99** is adjusted to a suitable value, the magnetic heads **54** and **55** can exactly trace the tracks **67** and **68** drawn in the recording operation since the magnetic heads **54** and **55** can move directly above the tracks **67** and **68**.

From the foregoing description, it will be appreciated that the magnetic recording and reproducing apparatus equipped with the rotation control device according to the present invention has a tape drive system and a rotary head drum drive system which are remarkable simplified, inexpensive and easy to maintain compared with like systems in the prior magnetic recording and reproducing apparatus described previously. More precisely, in contrast to the prior form in which the capstan and the rotary head drum are driven from separate motors with associated power amplifiers, the device according to the present invention employs a method in which an AC synchronous motor driven from a commercial power supply is used to drive both the capstan and the rotary head drum. The

present invention is therefore advantageous over the prior art in that the number of the motors to be incorporated in the apparatus can be substantially reduced, and the complex electric circuit to drive the separate motors as in the prior art can be substantially eliminated, thus reducing the overall size of the apparatus and simplifying the structure of the apparatus.

The embodiments described hereinbefore are indicated merely as illustrating the present invention, and it will be apparent for those skilled in the art that the present invention is in no way limited to such specific embodiments, and changes and modifications may be made therein without departing from the scope of the claims appended hereto.

We claim:

1. A rotation control device comprising means including a pulley mounted on a driving shaft which is rotated in a predetermined direction at a constant speed, a pulley mounted on a driven shaft which is desired to be driven in a fixed relation with the phase of a reference signal, one of said pulleys being a conical pulley and the other being an intermediately bulged pulley, and a torque-transmitting elastic belt trained around said pulleys for transmitting the rotation of said driving shaft to said driven shaft, means for deriving a signal which is in synchronism with the phase of rotation of said driven shaft, means for comparing the phase of the signal which is in synchronism with the phase of rotation of said driven shaft with the phase of said reference signal for thereby deriving a control signal which represents the phase difference between said signals, and means operative in response to the application of said control signal to impart a corresponding brake torque to said driven shaft for thereby automatically varying the engaging position between said torque-transmitting belt and said conical pulley.

2. A rotation control device comprising means including a pulley mounted on a driving shaft which is rotated in a predetermined direction at a constant speed, a pulley mounted on a driven shaft which is desired to be driven in a fixed relation with the phase of a reference signal, at least one of said pulleys being a conical pulley, and a torque-transmitting elastic belt trained around said pulleys for transmitting the rotation of said driving shaft to said driven shaft, one of said pulleys being so adapted as to be adjustably movable in the axial direction of the shaft on which it is mounted, means for deriving a signal which is in synchronism with the phase of rotation of said driven shaft, means for comparing the phase of the signal which is in synchronism with the phase of rotation of said driven shaft with the phase of said reference signal for thereby deriving a control signal which represents the phase difference between said signals, and means operative in response to the application of said control signal to impart a corresponding brake torque to said driven shaft for thereby automatically varying the engaging position between said torque-transmitting belt and said conical pulley.

3. A rotation control device comprising means including a pulley mounted on a driving shaft which is rotated in a predetermined direction at a constant speed, a pulley mounted on a driven shaft which is desired to be driven in a fixed relation with the phase of a predetermined reference signal, at least one of said pulleys being a conical pulley, and a torque-transmitting resilient belt trained around said pulleys for transmitting the rotation of said driving shaft to said driven shaft, means for deriving a signal which is in synchronism with the phase of rotation of said driven shaft, means for comparing the phase of the signal which is in synchronism with the phase of rotation of said driven shaft with the phase of said reference signal for thereby deriving a control signal which represents the phase difference between said signals, and brake means operative in response to the application of said control signal to impart a corresponding brake torque to said driven shaft, said brake means including a squirrel-cage induction rotor fixed to said driven shaft and an exciting iron core for applying to said rotor a DC magnetic field of the strength corresponding to said control signal, said brake torque imparted to said driven shaft by said brake means being operative to automatically vary the engaging position between said torque-transmitting belt and said conical pulley.

4. A rotation control device comprising means including a pulley mounted on a driving shaft which is rotated in a predetermined direction at a constant speed, a pulley mounted on a driven shaft which is desired to be driven in a fixed relation with the phase of a reference signal, at least one of said pulleys being a conical pulley, and a torque-transmitting elastic belt trained around said pulleys for transmitting the rotation of said driving shaft to said driven shaft, means for deriving a signal which is in synchronism with the phase of rotation of said driven shaft, means for comparing the phase of the signal which is in synchronism with the phase of rotation of said driven shaft with the phase of said reference signal for thereby deriving a control signal which represents the phase difference between said signals, and means operative in response to the application of said control signal to impart a corresponding brake torque to said driven shaft for thereby automatically varying the engaging position between said torque-transmitting belt and said conical pulley.

5. A rotation control device according to claim 4, in which said torque-transmitting elastic belt is stabilized at a position slightly protruding beyond one end of said conical pulley when the brake torque imparted to said driven shaft is zero or has a suitable biasing value.

6. A rotation control device comprising means including a conical pulley mounted on a driving shaft which is rotated in a predetermined direction at a constant speed, a conical pulley mounted on a driven shaft which is desired to be driven in a fixed relation with the phase of a reference signal, said conical pulleys being mounted in directions opposite to each other, and a torque-transmitting elastic belt trained around said conical pulleys for transmitting the rotation of said driving shaft to said driven shaft, means for deriving a signal which is in synchronism with the phase of rotation of said driven shaft, means for comparing the phase of the signal which is in synchronism with the phase of rotation of said driven shaft with the phase of said reference signal for thereby deriving a control signal which represent the phase difference between said signals, and means operative in response to the application of said control signal to impart a corresponding brake torque to said driven shaft for thereby automatically varying the engaging position between said torque-transmitting belt and one of said conical pulleys.

7. A rotation control device according to claim 6, in which said two conical pulleys disposed in the directions opposite to each other have cone angles different from each other, and said torque- transmitting belt is stabilized at a position slightly protruding beyond one end of one of said conical pulleys when the brake torque imparted to said driven shaft is zero or has a suitable biasing value.

8. A rotation control device for use in a magnetic recording and reproducing apparatus of the kind having a magnetic tape and a rotary head assembly including therein a plurality of magnetic transducers for the recording and reproduction of a television signal; said device comprising means for deriving a control signal responsive to the synchronizing signal in said television signal, a single drive source for delivering a drive force to drive both said magnetic tape and said rotary head assembly, said drive source being an AC synchronous motor, a current-controlled stepless speed change mechanism connecting the shaft of said rotary head assembly with the shaft of said drive source, said stepless speed change mechanism comprising a pulley fixedly mounted on the shaft of said rotary head assembly, a pulley fixedly mounted on the shaft of said drive source, at least one of said pulleys being a conical pulley, a torque-transmitting resilient belt trained around said pulleys, and brake means mounted on the shaft of said rotary head assembly, means for deriving a signal which is in synchronism with the phase of rotation of the shaft of said rotary head assembly, means for comparing the phase of the signal which is in synchronism with the phase of rotation of the shaft of said rotary head assembly with the phase of said control signal for

thereby deriving a second control signal, and means operative in response to the application of said second control signal to control said brake means for thereby imparting a brake torque to the shaft of said rotary head assembly and automatically varying the engaging position between said torque-transmitting belt and said conical pulley.

9. A rotation control device according to claim 8, in which both said pulleys are conical pulleys.

10. A rotation control device according to claim 8, in which one of said pulleys in a conical pulley and the other is an intermediately bulged pulley.