

VIDEO REPRODUCING APPARATUS

This invention relates to video reproducing apparatus.

5 As shown in Figure 1 of the accompanying diagrammatic drawings, a known video recording and reproducing apparatus such as a video cassette recorder (VCR) is an apparatus for recording video signals on slant tracks 2 of a magnetic tape 1 and reproducing the recorded video signal therefrom. This apparatus records one field video signal for each slant track 2 by
10 scanning slant track 2 of magnetic tape 1 with a rotary head having a constant rotating speed whilst moving magnetic tape 1 at a standard speed (e.g. 33.35 mm/sec in the case of VHS standard of NTSC system) during a recording stage. This apparatus reproduces the video signal recorded on the slant tracks
15 by controlling the transport speed of the magnetic tape and the rotation speed of the rotary head in a similar way to that of the recording stage during a reproducing stage. Such a reproduction mode is called a standard speed playback.

20 In the case of standard speed playback, a clear picture screen is obtainable as shown in Figure 2A of the accompanying diagrammatic drawings. In a double speed playback mode, the tape transport speed is double that of the standard speed. Here, since the rotary head which is rotated with the same speed as that of the standard speed playback scans the magnetic tape while traversing two slant tracks, one noise bar appears in the
25 playback screen as shown in Figure 2B of the accompanying diagrammatic drawings. In a five-times speed playback mode, the tape transport speed is five times that of the standard speed. Accordingly, four noise bars appear in the playback screen as shown in Figure 2C of the accompanying diagrammatic

drawings. Such noise bars occurring in the high speed playback mode appear corresponding to the number of slant tracks which are traversed by the rotary head. Thus, in a variable speed playback or special playback mode other than standard speed playback mode, the scanning locus of the rotary head is not the same as the slant tracks of the recording stage, with a result that the noise appears in the playback screen. Accordingly, a clear picture screen can not be provided as in the standard speed playback.

To solve the above problem of the conventional technology, preferred embodiments of this invention aim to provide a video recording and reproducing apparatus capable of reproducing a clear picture screen free from noise in a special playback mode.

According to the present invention, there is provided a video tape reproducing apparatus having a predetermined track inclination angle during a standard speed tape transport of a magnetic tape and comprising;

a capstan servo circuit for controlling a capstan motor speed to control the magnetic tape transport speed;

a drum servo circuit for controlling a drum motor speed to control revolution speeds of rotary heads which are rotated so as to maintain the predetermined track inclination angle with respect to the magnetic tape transport direction;

a time base correction circuit for correcting a video signal reproduced through said rotary heads and converting said video signal into a standard format compatible with video signals generated during standard speed playback; and

a control circuit which receives respective frequency signals corresponding to speeds of said capstan motor and said drum motor and supplies speed control signals to said capstan motor and drum motor servo circuits so as to maintain said predetermined track inclination angle substantially constant, whether or not said tape transport speed is said standard speed, and which receives a horizontal synchronization signal of said reproduced video signal and supplies a time base control signal to said time base correction circuit.

10

Preferably, said control circuit calculates said predetermined track inclination angle (θ_1) by the following equation:

$$\theta_1 = \tan^{-1} \frac{W}{\frac{\pi D}{2} \cos \theta_0 - \frac{V_T}{f_v}}$$

15

where θ_0 is an inclination angle of the head locus when the tape stops, W is an effective width of the tape, D is a diameter of the rotary drum, V_T is a tape transport speed and f_v is a vertical synchronization frequency.

20

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to Figures 3 to 6 of the accompanying diagrammatic drawings, in which:

Figure 3 is a block diagram showing one example of a video reproducing apparatus according to this invention;

Figure 4 is a view for explaining an inclined angle of a head running locus when a magnetic tape is stopped or moved in the video reproducing apparatus;

5 Figure 5 is a view for explaining a basic concept of the video reproducing apparatus of Figure 3;

Figure 6A is a waveform diagram which shows a reproduced video signal during a standard playback; and

10

Figure 6B is a waveform diagram which shows a reproduced video signal during a special playback.

Referring to Figure 3, the video reproducing apparatus includes broadly
15 a capstan servo 10, a drum servo 20, a time base correction circuit 30 and a control circuit 40. Capstan servo 10 controls a revolution speed of capstan motor 11, thereby controlling the transport speed of magnetic tape 1 contacted to a capstan shaft (not shown).

20 Drum servo 20 controls a revolution speed of drum motor 21, thereby controlling the revolution speed of heads 23 and 23' mounted on rotary drum 22. Rotary heads 23 and 23' are inclined by a predetermined angle θ with respect to the tape transport direction so as to scan track 2 of magnetic tape 1. When the tape is stopped, the track inclination angle θ has a standard
25 value of five degrees fifty six minutes and seven point four seconds ($5^{\circ}56'7.4''$), for the NTSC system. In a standard speed playback (e.g. in the case of the NTSC system the tape transport speed is 33.35 mm/sec and the relative speed of the rotary drum with respect to the tape is 5.8 m/sec), the

running locus of head 23 has a running angle of five degrees fifty eight minutes and nine point nine seconds ($5^{\circ}58'9.9''$) with respect to the tape transport direction.

- 5 Referring to Figure 4, running angle θ_1 can be calculated by the following equation (1):

$$\theta_1 = \tan^{-1} \frac{W}{\frac{\pi D}{2} \cos \theta_0 - \frac{V_T}{f_v}} \dots \dots (1)$$

- where θ_0 is an inclination angle of the head locus when the tape stops, W is an effective width of the tape, D is a diameter of the rotary drum, V_T is a tape transport speed and f_v is a vertical synchronization frequency. Here,
10 vertical synchronization frequency f_v is represented with respect to a relative speed of the head drum by the following equation (2):

$$f_v = \frac{V_H}{l} \dots \dots \dots (2)$$

where V_H is a relative speed with respect to the tape transport speed of the rotary drum, and l is a length of the head running locus in a tape run.

- 15 Therefore, it can be seen that the inclination angle θ_1 of the head running locus in the tape run is a function of the tape transport speed V_T and the rotary drum relative speed V_H from the above equations (1) and (2). Also, since rotary drum relative speed V_H is represented as $V_R - V_T$, in which V_R is a rotary drum revolution speed, it can be seen that the inclination
20 angle θ_1 of the head running locus is a function of the rotary drum revolution speed V_R and tape transport speed V_T .

Therefore, to remove the noise bars generated due to the result of the head traverse between the slant tracks during special playback having a different tape transport speed other than that of the standard speed playback, the revolution speed of the rotary drum is controlled to have a variable speed in response to the tape transport speed. That is, the tape transport speed and the rotary drum revolution speed are controlled in order that the inclination angle of the head running locus during the special playback equals that during the standard speed playback. As described above, if the revolution speed of the rotary drum is controlled to have a variable speed, the reproduced video signal format differs from (for example) the VHS standard. As a result, a normal picture is not displayed on the screen. Accordingly, time base correction is required to match the reproduced video signal to the VHS standard. For example, in the NTSC system, 1/60 seconds for one vertical synchronization period is required. However, during a variable speed control of the rotary drum, the above 1/60 seconds is not maintained, thereby causing difficulty in displaying the normal picture on the screen.

Therefore, referring to Figure 3, the video reproducing apparatus includes the time base correction circuit 30 in order to match the reproduced video signal to the VHS standard. The video signals reproduced through video heads 23 and 23' are amplified in amplifier 50 and the amplified signal is supplied to the time base correction circuit 30. Also, the amplified signal is supplied to sync separator 60. Sync separator 60 outputs a horizontal synchronization signal. Time base correction circuit 30 comprises an A/D converter 31 for receiving and converting the reproduced video signal into a digital video signal, a field memory 32 for storing the output data of A/D converter 31, a D/A converter 33 for converting the read-out data from the above memory 32 into an analog video signal, and an address generator 34 for

generating write and read address signals for field memory 32. In address generator 34, the write address signal period is different from the read address signal period. That is, the write address signal period has a period capable of writing the reproduced video data unmatched to the standard in the field memory. On the other hand, the read address signal period has a period capable of reading the video data matched to the standard from the field memory.

In Figure 3, reference numeral 40 designates the control means composed of a microcomputer, which receives frequency signals through frequency generators 14 and 24 positioned in the vicinity of capstan motor 11 and drum motor 21, respectively. Also, microcomputer 40 receives the horizontal synchronization signal separated in sync separator 60. Microcomputer 40 supplies speed control signals to capstan servo 10 and drum servo 20, respectively, and supplies an address signal period control signal to address generator 34 of time base correction circuit 30. Microcomputer 40 receives the capstan frequency signal and the drum frequency signal, and calculates the tape transport speed V_T and the rotary drum revolution speed V_R , respectively, in accordance with the following equations (3) and (4).

$$V_T = \frac{\pi d / N_c}{Wf_1} \dots\dots\dots (3)$$

where d is a diameter of the capstan shaft, Wf_1 is a pulse width of the capstan frequency signal and N_c is a number of pulses for each revolution of the capstan motor; and

$$V_R = \frac{\pi D / N_d}{Wf_2} \dots\dots\dots (4)$$

where D is a diameter of the rotary drum, Wf_2 is a pulse width of the drum frequency signal and N_d is a number of pulses for each revolution of the drum motor.

5 Therefore, microcomputer 40 calculates drum revolution speed $\bar{V}_R$ according to the above equation (4) and generates a speed control signal in order that head running locus inclination angle θ_1 which is calculated in accordance with tape transport speed V_T using the above equation (1) during a special playback is maintained as the inclination angle θ during the standard
10 speed playback.

When the revolution speed of the rotary drum is off the standard value, the reproduced video signal shown in Figure 6B is different from the video signal as shown in Figure 6A during the standard speed playback.

15

Accordingly, microcomputer 40 receives the horizontal synchronization signal separated from the reproduced video signal and calculates the reproduction horizontal period T_2 . That is, microcomputer 40 resets the set internal counter at the falling edge of the horizontal synchronization signal and
20 increases the value of the internal counter by 1 whenever the system clock is input, thereby calculating the reproduction horizontal period T_2 . Also, microcomputer 40 generates an address signal period control signal for address generator 34. Address generator 34 generates a read address clock and a write address clock for field memory 32 according to the following
25 proportional equation (5):

$$T_1 : T_2 = CLK_1 : CLK_2 \dots (5)$$

where T_1 is the reproduction horizontal period during the standard speed playback, CLK_1 is a read address clock and CLK_2 is a write address clock.

5

Accordingly, address generator 34 generates a write address clock CLK_2 by multiplying the ratio T_2/T_1 by reference clock CLK_1 being the read address clock in accordance with the address signal period control signal. Therefore, time base correction circuit 40 matches the non-standard video

10 signal to the time base of the standard video signal by maintaining the write and read address periods for the memory to be different to each other, thereby displaying the normal picture on the display unit such as a cathode ray tube.

The above-described video reproducing apparatus controls the

15 revolution speed of the head drum according to the tape transport speed during special playback, so as to maintain the inclination angle of the head running locus to be the same as that during the standard speed playback, thereby enabling the display of a clear picture without any noise bars.

20 Those skilled in the art will readily appreciate that the above-described embodiment of the invention may readily be adapted to standards other than NTSC - for example PAL or SECAM.



CLAIMS

1. A video tape reproducing apparatus having a predetermined track inclination angle during a standard speed tape transport of a magnetic tape and comprising;
5
- a capstan servo circuit for controlling a capstan motor speed to control the magnetic tape transport speed;
- 10 a drum servo circuit for controlling a drum motor speed to control revolution speeds of rotary heads which are rotated so as to maintain the predetermined track inclination angle with respect to the magnetic tape transport direction;
- 15 a time base correction circuit for correcting a video signal reproduced through said rotary heads and converting said video signal into a standard format compatible with video signals generated during standard speed playback; and
- 20 a control circuit which receives respective frequency signals corresponding to speeds of said capstan motor and said drum motor and supplies speed control signals to said capstan motor and drum motor servo circuits so as to maintain said predetermined track inclination angle substantially constant, whether or not said tape transport speed is said standard
25 speed, and which receives a horizontal synchronization signal of said reproduced video signal and supplies a time base control signal to said time base correction circuit.



- 11 -

2. A video reproducing apparatus as claimed in claim 1, wherein said control circuit calculates said predetermined track inclination angle (θ_1) by the following equation:

$$\theta_1 = \tan^{-1} \frac{W}{\frac{\pi D}{2} \cos \theta_0 - \frac{V_T}{f_v}}$$

5 where θ_0 is an inclination angle of the head locus when the tape stops, W is an effective width of the tape, D is a diameter of the rotary drum, V_T is a tape transport speed and f_v is a vertical synchronization frequency.

3. A video reproducing apparatus substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.