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TELEVISION APPARATUS

This invention relates to television apparatus and, more particularly, is directed to a television apparatus of the type including a television receiver and a video tape recorder (VTR) incorporated therein.

It is known to provide a television receiver with a VTR integrally incorporated in the cabinet of the television receiver which also houses or supports a loudspeaker or loudspeakers. Such arrangement provides a convenient and compact assembly. Moreover, with such an assembly, a television signal received by a tuner of the television receiver is recordable in a tape cassette by the VTR while the video information and audio information included in the television signal are respectively displayed by the display screen and reproduced by the loudspeakers of the television receiver. Similarly, the video and audio information recorded in a tape cassette can be reproduced therefrom by the VTR for display and reproduction by the display screen and the loudspeakers, respectively, of the television receiver.

However, when a television receiver has a VTR incorporated therein, as described above, it is usually unavoidable that, as the level of the audio output of the loudspeakers is increased, the cabinet, chassis and component parts are made to vibrate at inherent resonant frequencies thereof which are included in the reproduced sound, and this may cause noise or distortions in the reproduced picture, particularly when a mechanical resonant vibration frequency of the VTR is included in the reproduced sound during a recording operation. Such noise or distortion results from a harmful effect exerted on the transport of the tape by mechanical vibration of the VTR during its recording operation, as when the video information and audio information of a television signal are being recorded simultaneously with the monitoring of the television signal by the television receiver and there is a high-level audio output from the loudspeakers thereof which includes a mechanical resonant vibration frequency of the VTR.

According to the present invention there is provided a television apparatus comprising:

television receiving means for receiving a television signal that

includes video and audio information;

video recording and reproducing means for recording and reproducing said television signal in respective operating modes and having a mechanical resonant vibration frequency;

loudspeaker means for audibly reproducing said audio information of the television signal;

a single cabinet in which said television receiving means, said video recording and reproducing means and said loudspeaker means are integrally incorporated; and

audio signal processing means receiving said audio information of the television signal as received by said television receiving means and as reproduced by said video recording and reproducing means and providing an audio output signal for correspondingly operating said loudspeaker means, said audio signal processing means including suppression means operative in at least one of said operating modes of said video recording and reproducing means for relatively suppressing at least a component of said audio output signal having substantially said mechanical resonant vibration frequency of said video recording and reproducing means.

The suppression means may include filter means operative relatively to suppress the component of the audio output signal having substantially the mechanical resonant vibration frequency, and switch means connected with the filter means and actuable to render the latter operative, particularly when the video recording and reproducing means is in its recording mode.

The audio signal processing means may further include volume control means for varying the level of the audio output signal supplied to the loudspeaker means, and means responsive to the volume control means for determining the extent to which the suppression means is operative for relatively suppressing at least the component of the audio output signal which has substantially the mechanical resonant vibration frequency of the video recording and reproducing means.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 is a front elevational view of a television apparatus

of a type to which the invention may be applied;

Figure 2 is a vertical sectional view of another type of television apparatus to which the invention may be applied;

Figure 3 is a diagrammatic view illustrating the display screen of a television apparatus of the type illustrated in Figure 1 or Figure 2, and showing a distortion-free image displayed thereon;

Figure 4 is a view similar to that of Figure 3, but showing "image shake" or distortion;

Figure 5 is a block diagram of an audio signal processing circuit which may be used in a television apparatus of the type shown in Figure 1 or Figure 2 for avoiding the distortion shown in Figure 4;

Figure 6 is a graphic illustration of the relationship between a variable audio output control voltage and the loudspeaker output for different modes of the video recording and reproducing device of Figure 5;

Figure 7 is a graphic illustration of the manner in which the audio output signal is relatively suppressed in the device of Figure 5; and

Figure 8 is a block diagram similar to that of Figure 5, but illustrating another form of the invention.

Referring initially to Figure 1, it will be seen that a television apparatus 1 of a type to which the invention may advantageously be applied comprises a television receiver 2 contained within a cabinet 3 and having the usual circuit arrangements for receiving a broadcast television signal and for extracting the video and audio information included in the signal. The television receiver 2 is shown to be of the direct-viewing type in which an image or picture corresponding to the video information in the received television signal is displayed on a screen or face plate 2A of a cathode ray tube that is exposed to view at the front of the cabinet 3. Loudspeakers 4A and 4B are mounted at the opposite side portions of the cabinet 3 below the television receiver 2, and a video recording and reproducing device 5, for example, constituted by an 8mm video tape recorder (VTR) or the like, is also disposed in the cabinet 3 centrally between the loudspeakers 4A and 4B. A suitable control panel 6 may conveniently be provided at the front of the cabinet 3 below the VTR 5. It will be appreciated that the above described

television apparatus 1 is symmetrical in appearance and functionally convenient as well as providing a very compact arrangement.

In the television apparatus 1, a broadcast television signal received by the television receiver 2 may be recorded in a tape cassette by the VTR 5 while the video and audio information included in the received television signal are simultaneously being displayed on the display screen 2A and reproduced by the loudspeakers 4A and 4B, respectively. Alternatively, in the reproducing or playback mode of the VTR 5, the video information and the audio information reproduced from a tape cassette by the VTR 5 can be displayed on the screen 2A and reproduced by the loudspeakers 4A and 4B, respectively.

However, in a television apparatus 1 of the type described above with reference to Figure 1, when the level of the audio output from the loudspeakers 4A and 4B is increased, the housing or cabinet, chassis and component parts of the apparatus may be made to vibrate mechanically at inherent resonant frequencies thereof which are included in the audio output. By reason of such vibrations, noise or distortion may appear in the reproduced picture, particularly when the vibrations are generated in the VTR 5. It has been particularly confirmed that, if the video information and audio information contained in a received television signal are simultaneously displayed on the screen 2A and reproduced by the loudspeakers 4A and 4B while the VTR 5 is in its recording mode for recording such video and audio information, and the level of the sound issuing from the loudspeakers 4A and 4B is sufficiently high to cause vibration of the VTR 5, upon subsequent reproducing of the recorded video information, there may be a so called "image shake" or distortion in the resulting displayed picture. For example, if video information corresponding to a picture or image having a vertical linear portion L1 when reproduced on a display screen DSP, as shown in Figure 3, is recorded by the VTR 5 while the latter is being subjected to a mechanical vibration, the subsequent reproducing of such recorded video information by the VTR 5 may result in a displayed picture having "image shake", that is, a picture in which the linear portion L1 is distorted horizontally particularly at its mid-portion, as shown in Figure 4. This phenomenon results from a disturbance of the transport of the record tape by the mechanical vibration to which the VTR is particularly

subjected when the broadcast television signal is being recorded while a high-level audio output is being provided by the loudspeakers 4A and 4B. Moreover, the noted distortion or noise in the recorded video information tends to increase with reduction of the width of the tape used in the VTR 5. Thus, an 8mm VTR is especially susceptible to the described image distortion when subjected to mechanical vibrations.

Referring now to Figure 5, it will be seen that, in accordance with an embodiment of this invention, the television apparatus 1 of Figure 1 is provided with an audio signal processing circuit 20 which includes an audio control circuit 10 receiving an audio input signal or information S_{AD} which is either separated from the received broadcast television signal by suitable circuits (not shown) of the television receiver 2 or separated from the television signal reproduced by the VTR 5 in the reproducing or playback mode thereof. The audio control circuit 10 further receives a left-right balance adjusting signal S_{BAL}, a high-range or treble adjusting signal S_{TRE} and a low-range or bass adjusting signal S_{BASS} and, in response thereto, is conventionally operative to vary the balance and frequency characteristics of the input audio signal S_{AD}. Moreover, as hereinafter described in detail, the audio control circuit 10 is responsive to a DC audio output control voltage S_{VOL} which is varied in response to actuation of a volume control on the panel 6 for changing the level of the resulting audio output signal S1 supplied over an output line LIN1 from the audio control circuit 10 through a low-frequency or audio amplifying circuit 11 to the loudspeakers 4A and 4B. It will be appreciated that, as the audio output control voltage S_{VOL} is varied, the level of the audio output signal S1, and hence, of the loudspeaker output is similarly varied, with the relationship of the varying audio output control voltage S_{VOL} and the loudspeaker output level being normally in accordance with the line L3 on Figure 6. In other words, the loudspeaker output level varies with changes in the audio output control voltage in accordance with the line L3 at least when the VTR 5 is inoperative, that is, when the audio input signal S_{AD} is derived from the received broadcast television signal.

The audio signal processing circuit 20 is further shown to comprise a resonant-frequency component suppression circuit SUP1 and

an audio volume suppression circuit SUP2. The resonant frequency component suppression circuit SUP1 includes a normally open switch circuit 12 and a filter circuit 13 connected in series between the output signal line LIN1 and the earth. In the embodiment illustrated in Figure 5, the switch circuit 12 is closed in response to a recording mode signal S_{REC} which is obtained from the VTR 5 in response to establishing of the recording mode of the latter. Thus, when the VTR 5 is in its recording mode, the switch 12 is closed to connect the audio output line LIN1 to earth through the filter circuit 13. The filter circuit 13 has a frequency characteristic selected so that, if the audio output signal S1 is assumed to include frequency signal components represented by a frequency characteristic curve K1 in Figure 7, a component of the audio output signal S1 having substantially the mechanical resonant vibration frequency f_0 will be suppressed, as indicated by the frequency characteristic curve K2 on Figure 7. Such frequency f_0 is suitably predetermined to be a mechanical resonant vibration frequency of the VTR 5, that is, a vibration frequency that causes "image shake" in the VTR 5.

In the embodiment of Figure 5, the audio output control voltage S_{VOL} is applied to one end of a series circuit of resistors R1 and R3 which, at its other end, is connected to earth, and which has a junction point between the resistors R1 and R3 connected to the audio control circuit 10. The audio volume suppression circuit SUP2 is shown to include a resistor R2 connected in series with a normally open switch circuit 14 between earth and the junction point between resistors R1 and R3. The switch circuit 14 is also arranged to be closed in response to the recording mode signal S_{REC}, whereupon the resistor R2 is connected to earth in parallel with the resistor R1, so as to reduce the effective control voltage applied to the audio control circuit 10. In other words, when the VTR 5 is in its recording mode, the closing of the switch circuit 14 in response to the recording mode signal S_{REC} causes the loudspeaker output level to be varied along the line L4 of Figure 6 in response to changes in the audio output control voltage S_{VOL}.

In a normal reception display mode of the television apparatus 1, the VTR 5 is inoperative and video information included in the received broadcast television signal is displayed on the screen 2A,

while the input audio signal S_{AD} corresponding to audio information included in the received broadcast television signal is adjusted in the audio control circuit 10 in accordance with the audio output control voltage S_{VOL}, the left-right balance signal S_{BAL}, the treble-adjust signal S_{TRE} and the base-adjust signal S_{BASS} to provide the corresponding audio output signal S1 which is fed through the low-frequency amplifying circuit 11 to the loudspeakers 4A and 4B for audible reproduction.

In a reception display and recording mode in which the video information and audio information of the received broadcast television signal are displayed on the screen 2A and audibly reproduced by the loudspeakers 4A and 4B while being recorded simultaneously by the VTR 5, the switch circuits 12 and 14 are closed in response to the recording mode signal S_{REC}. As a result of the foregoing, at least a component of the audio output signal S1 having substantially the mechanical resonant vibration frequency f_0 of the VTR 5 is relatively suppressed, that is, suppressed relative to the frequency components of the output audio signal S1 apart from the frequency f_0. Moreover, as a result of the connection of the resistor R2 to earth, the level of the audio output signal S1 is suppressed across the full range of its frequencies.

By reason of the foregoing, the entire energy level of the sound generated by the loudspeakers 4A and 4B is decreased and, simultaneously, the energy level of the frequency signal component corresponding to the mechanical vibration resonant frequency f_0 most responsible for the "image shake" in the VTR 5 is further suppressed by the operation of the filter circuit 13. Consequently, sound induced mechanical vibrations in the VTR 5 are effectively avoided during its recording operation. Therefore, when the video information recorded by the VTR 5 in the absence of any mechanical vibration thereof is subsequently reproduced, the resulting picture or image displayed on the screen 2A is free of any "image shake".

Referring now to Figure 8, it will be seen that, in a television apparatus according to another embodiment of the invention and in which elements corresponding to those described above with reference to Figure 5 are identified by the same reference letters and numerals, an audio signal processing circuit 20' includes a

suppression circuit SUR1 in place of the suppression circuits SUP1 and SUP2 in the audio signal processing circuit 20 of Figure 5. In the suppression circuit SUR1, a variable resistor circuit 20 is interposed in the series circuit of the switch circuit 12 and the filter circuit 13. The variable resistor circuit 20 is controlled by the voltage at the junction point between the resistors R1 and R3, that is, the volume control voltage applied to the audio control circuit 10, so that the resistance value of the resistor 20 is varied inversely with respect to changes in the volume or level of the audio output signal S1 by the audio output control signal S_{VOL}.

In operation of the embodiment illustrated in Figure 8, when the VTR 5 of the associated television apparatus is in its recording mode, the recording mode signal S_{REC} closes the switch circuit 12 with the result that the variable resistor 20 and the filter circuit 13 are connected in series between the line LIN1 carrying the audio output signal S1 and earth. As in the first described embodiment, the filter circuit 13 functions relatively to suppress at least a component of the audio output signal S1 having substantially the mechanical resonant vibration frequency f_0, but, in this case, the extent of such suppression is determined by the variable resistor 20. More specifically, if the audio output control voltage S_{VOL} is adjusted to provide a high level or volume of the sound from the loudspeakers 4A and 4B, the resistance value of the variable resistor 20 is correspondingly decreased so as to increase the drain to earth through the filter circuit 13 from the output line LIN1, with the result that the audio output signal S1 is suppressed to an increased extent particularly with the reference to substantially the mechanical resonant vibration frequency f_0 of the VTR 5. In other words, in the embodiment of Figure 8, substantially only the component of the sound generated by the loudspeakers 4A and 4B which has the mechanical resonant vibration frequency f_0 is suppressed or reduced in volume to an extent determined by the adjusted volume of the sound from the loudspeakers 4A and 4B so as to achieve effective suppression of the resonant vibration of the VTR 5 for avoiding the previously described "image shake".

Although the audio signal processing circuits 20 and 20' of the embodiments of this invention previously described with reference to

Figures 5 and 8 are operative to suppress a component of the audio output signal S1 having substantially a mechanical resonant vibration frequency of the VTR 5 only during a recording operation thereof, it is to be noted that the present invention is not limited in that respect. In other words, the switches 12 and 14 in the audio signal processing circuit 20, or the switch 12 in the audio signal processing circuit 20' may be closed whenever the VTR 5 is operated in either its recording mode or its reproducing mode with sound being simultaneously generated by the loudspeakers 4A and 4B.

Furthermore, the present invention is not limited, in its application, to a television apparatus including a television receiver of the direct-viewing type as illustrated in Figure 1. More particularly, the audio signal processing circuits 20 and 20' of Figures 5 and 8, respectively, can be employed in any television apparatus in which loudspeakers of a television receiver are mounted in the same cabinet as a VTR which may thereby be subject to vibration when the loudspeakers generate sounds at relatively high levels. For example, as shown in Figure 2, the embodiments of the present invention described with reference to Figures 5 and 8 may be applied to a television apparatus 1' which includes a projection-type television receiver 2' in which an image or picture provided on the face of at least one cathode ray tube 2'B is projected, by means of an optical system including a lens 2'C and a mirror 2'D, against the rear of a translucent screen 2'A which may be mounted on the cabinet 3' containing the television receiver 2' or spaced therefrom. The television apparatus 1' is further shown to include loudspeakers 4', a VTR 5' and a control panel 6' all contained in or mounted on the cabinet 3' so that the generation of sounds at high levels by the loudspeakers 4' is again likely to cause vibrations in the VTR 5'. Thus, the provision of the television apparatus 1' with the audio signal processing circuit 20 or 20' for suppressing at least a component of the audio output signal having substantially a mechanical resonant vibration frequency of the VTR 5' is effective to reduce or eliminate the "image shake" that might otherwise appear in a picture displayed in response to reproducing of a television signal recorded by the VTR 5'.

CLAIMS

1. A television apparatus comprising:

television receiving means for receiving a television signal that includes video and audio information;

video recording and reproducing means for recording and reproducing said television signal in respective operating modes and having a mechanical resonant vibration frequency;

loudspeaker means for audibly reproducing said audio information of the television signal;

a single cabinet in which said television receiving means, said video recording and reproducing means and said loudspeaker means are integrally incorporated; and

audio signal processing means receiving said audio information of the television signal as received by said television receiving means and as reproduced by said video recording and reproducing means and providing an audio output signal for correspondingly operating said loudspeaker means, said audio signal processing means including suppression means operative in at least one of said operating modes of said video recording and reproducing means for relatively suppressing at least a component of said audio output signal having substantially said mechanical resonant vibration frequency of said video recording and reproducing means.

2. Apparatus according to claim 1 wherein said one operating mode of the video recording and reproducing means in which said suppression means is operative is said operating mode for recording the television signal.

3. Apparatus according to claim 1 wherein said suppression means includes filter means operative relatively to suppress said component of the audio output signal having substantially said mechanical resonant vibration frequency and switch means connected with said filter means and being actuable to render said filter means operative.

4. Apparatus according to claim 3 wherein said switch means is actuated to make operative said filter means in response to

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establishment of said operating mode for recording the television signal.

5. Apparatus according to claim 3 wherein said filter means and said switch means are connected in series in a circuit for said audio output signal extending to earth in parallel with said loudspeaker means, so that closing of said switch means decreases the output level of said loudspeaker means in respect of substantially said mechanical resonant vibration frequency.

6. Apparatus according to claim 3 wherein said suppression means further includes audio volume suppression means also made operative upon actuation of said switch means for decreasing the level of said audio output signal over the frequency spectrum thereof.

7. Apparatus according to claim 6 wherein said switch means includes a first switch connected in series with said filter means in a circuit for said audio output signal extending to earth and in parallel with said loudspeaker means, so that closing of said first switch decreases the output level of said loudspeaker means with respect to substantially said mechanical resonant vibration frequency, a second switch connected with said audio volume suppression means for decreasing said level of the audio output signal upon closing of said second switch, and means for closing said first and second switches upon establishing of said operating mode for recording the television signal.

8. Apparatus according to claim 7 wherein said audio signal processing means further includes audio volume control means for varying the level of said audio output signal in accordance with the level of an audio output control voltage applied to said audio volume control means; and said audio volume suppression means incudes a resistor connected in series with said second switch to earth and through which said level of the audio output control voltage is decreased in response to closing of said second switch.

9. Apparatus according to claim 1 wherein said audio signal

processing means further includes volume control means for varying the level of said audio output signal, and means responsive to said volume control means for determining the extent to which said suppression means is operative for relatively suppressing at least said component of the audio output signal.

10. Apparatus according to claim 1 wherein said video recording and reproducing means includes ~~helical scan~~ video tape recording and reproducing means which, at least in its recording mode, is susceptible to distortion of the video information recorded thereby while said loudspeaker means is audibly reproducing sound including said mechanical resonant vibration frequency.

11. Apparatus according to claim 1 wherein said television receiving means includes a picture tube also mounted in said cabinet and having an exposed face defining a screen for displaying said video information of the received television signal and the reproduced television signal.

12. Apparatus according to claim 1 wherein said television receiving means is of the projection type.

13. A television apparatus substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.

14. A television apparatus substantially as hereinbefore described with reference to Figure 8 of the accompanying drawings.