SOUND BALANCING APPARATUS

A sound balancing apparatus for a four-channel sound system having a rectangular grid display surface representative of a two-dimensional listening area defined by forward and rear pairs of right and left-hand loudspeaker units. Mechanical means are associated with the grid surface for moving an indicator means to any selected coordinate position on the grid surface which position simulates a corresponding position within the two-dimensional listening area. Electrical means are then associated with the mechanical means for balancing the input drive signal of each of four separate audio channels to a respective loudspeaker unit to thereby create an apparent balance of sound at the selected coordinate position within the listening area.

9 Claims, 5 Drawing Figures
SOUND BALANCING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to a sound balancing apparatus for four-channel sound systems, and more particularly, to balancing or centering the four-channel sound within a two-dimensional listening area through the selection of a set of coordinate points on a grid display surface representative of the listening area.

Two-channel stereophonic sound reproducing systems employ two audio drive channels for supplying input signals to right and left-hand spaced speaker means such as loudspeaker units, and often have a sound balancing control for selecting the proportion of drive signal level or amplitude gain to each of the loudspeakers. As commonly understood in the art, the adjustment of the sound that reaches a listener from one loudspeaker unit relative to the other is termed the "sound balance" between the units. The term "balance" would indicate that the sound output of the loudspeaker units is equal with the same signal input level from both drive channels. When the listener is closer to one of the loudspeaker units than the other, the sound balancing control may be adjusted so that the sound output level reaching the listener from both loudspeaker units appears to be equal, thus giving an "apparent balance."

Stereophonic sound systems utilizing dual spaced loudspeaker units greatly enhance the pleasure of the listener over monophonic sound systems through simulating conditions more akin to experiencing a live musical performance. The listener may use a sound balancing system to adjust the apparent balance of the speaker units to be left of the center of the room or right of center as desired by the listener. A variety of balance indicator devices are used to show the listener the degree of right or left-hand offset that he has chosen. However, neither these sound balancing controls nor the indicator devices are useful to adjust the sound or to indicate an apparent balance of sound along a dimension generally perpendicular to the alignment dimension of the speaker units.

Four-channel sound reproducing systems having four separate loudspeaker units defining four corners of a two-dimensional listening area are now being used to more fully surround the listener with sound to better simulate a live musical performance. However, because of the inadequacy of the stereophonic sound balancing controls to adjust the sound for two dimensions plus the lack of a suitable indicator for two-dimensional sound balance, it is now desirable to provide a sound balancing control system including a suitable two-dimensional indicator for a four-channel sound system.

SUMMARY

It is therefore an object of this invention to provide a two-dimensional sound balancing apparatus including a two-dimensional indicator therefor to be used with a four-channel sound system including four separate speaker means defining four corners of a two-dimensional listening area.

It is another object of the invention to provide a sound balancing control through suitable mechanical means which simultaneously adjusts the indicator device along each of the two dimensions as the sound balance along the respective dimension is accomplished by suitable electrical means.

A sound balancing apparatus for use with a four-channel sound system which includes forward and rear pairs of right and left-hand horizontally spaced speaker means defining four corners of a two-dimensional listening area. The four-channel sound system further includes four separate channels of input signals for driving the four speaker means, respectively. The sound balancing apparatus has a rectilinear grid display surface representing the listening area and a pair of elongated carrier members positioned mutually perpendicular to each other across the grid surface to form an axis of intersection. The elongated carrier members are movable across the grid surface in a direction traverse to their elongated axis. The axis of intersection is thereby movable and defines an adjustable set of coordinate points on said grid surface representative of selected positions within said two-dimensional listening area. An indicator means is carried by the pair of carrier members at the axis of intersection for continuously indicating the location of said set of coordinate points on said grid surface. A pair of adjustable potentiometer means are connected between each input signal and an associated speaker means for balancing the amplitude of the input signals between the forward and rear pair of speaker means and between the right and left-hand speaker means of the forward and rear pairs of speaker means, respectively. A pair of closed-loop cable means are connected between the pair of potentiometer means and the pair of carrier members, respectively, for selectively moving the carrier members across the grid surface with a corresponding adjustment of the potentiometer means to obtain a desired balance of amplitude between the four speaker means at the axis of intersection.

THE DRAWING

FIG. 1 is a frontal perspective view of a four-channel sound reproducing unit such as a tuner and partially showing a grid display surface for a sound balancing apparatus in accordance with this invention;

FIG. 2 is a rear perspective view of the sound balancing apparatus housed in the tuner unit of FIG. 1 and showing mechanical means associated with the grid display surface such as carrier members and indicator means and electrical means such as a pair of potentiometers associated with the mechanical means;

FIG. 3 is a bottom plan view of the sound balancing apparatus of FIG. 2 having a portion thereof removed for more clearly showing cable means and guide means forming part of the mechanical means of the invention;

FIG. 4 is an electrical representation partly in schematic and partly in block form of the sound balancing apparatus combined with the four-channel sound system of the tuner unit of FIG. 1; and

FIG. 5 is a schematic representation of an illumination network for the tuner unit of FIG. 1.

DETAILED DESCRIPTION

Now referring to the drawing, FIG. 1 shows the right-hand portion of a standard commercial multi-mode tuner unit 10. The tuner unit 10 includes a cabinet housing 11 having a front wall or face 12 on which to mount a plurality of control knobs 13 through 16. These knobs conveniently provide such tuner functions as mode selector MS, base B, treble T and master loudness ML adjustments for the tuner unit 10. The tuner unit 10 contains the necessary internal components and
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3. electrical circuitry to provide in one of its modes a four-channel sound reproducing system. This four-channel sound system provides four separate input drive signals respectively to four separate sound reproducing devices such as loudspeaker units indicated at 51 in FIG. 4.

According to the present invention, a sound balancing apparatus 20 for use in adjusting the apparent sound balance of the four-channel sound system is mounted internal to the tuner unit 10. The sound balancing apparatus 20 includes a rectilinear grid display surface 21 in the form of a cross-hatched matrix provided on a transparent substrate such as clear plastic. Electrical means are provided through which to effect an apparent sound balance at a desired listening position in a two-dimensional listening area by varying the amount of input drive signals that are supplied to each of the associated ones of the four speaker units. Mechanical means are then provided for moving an indicator means 23 across the grid surface 21 so as to visually indicate a position on the grid 21 that is representative of the actual position of the apparent sound balance within the listening area.

The electrical and mechanical means are both simultaneously adjusted by employing a pair of balance control knobs 18 and 19 on the front wall 12 of the tuner unit 10. The balance control knobs 18 and 19 are attachable to rotatable balance control shafts 24 and 26, respectively through which the control knobs can be used to adjust the front-to-rear F-R sound balance and the left-to-right L-R sound balance, respectively, between the four loudspeaker units. The four loudspeaker units are positioned with respect to the two-dimensional listening area to define the four corners thereof and for the purposes of illustrating the invention can be considered to comprise forward and rear pairs of right and left-hand horizontally spaced speaker units.

The grid surface 21 is made readily visible from the face 12 of the tuner unit 10 through the use of a mounting frame 30 which positions the grid surface in a generally horizontal plane. The grid surface 21 is so positioned to better imitate a given two-dimensional listening area such as a four-sided room or an area bounded by the four speaker units. The mounting frame 30 includes a frame-like top wall portion 31 having an opening 32 therein in which to mount the grid surface 21 and a pair of opposite side wall portions 33 and 35 which together with the top wall portion 31 are used to support the mechanical and electrical means which comprise the sound balancing apparatus 20.

The grid surface 21 is provided on the transparent substrate so as to provide the visibility of the indicator means 23 therethrough. The indicator means 23 could as well be any suitable visual indicator device or stylus but is provided herewith in the form of a light source or device. The light device 23 therefore provides an easy visual reference throughout many different lighting conditions that may occur during the use of the tuner unit 10. As viewed from the face 12 of the tuner unit 10, the grid surface has its two forward-most corners labeled RF and LF to represent the right and left-front speaker units, respectively. These two speaker units comprise the forward right- and left-hand horizontally spaced speaker units for the listening area. The rear-most corners of the grid surface 21 are labeled RR and LR to represent the right and left-rear speaker units, respectively. These two speaker units comprise the rear right- and left-hand horizontally spaced speaker units for the listening area.

It is convenient to consider the grid surface 21 as being comprised of four quadrants of listening area, namely, the right-front, left-front, left-rear and right-rear quadrants. The light device 23 can be positioned at any desired location within any one of these quadrants simply through the appropriate manipulation of the balance control knobs 18 and 19 which comprise part of the mechanical means of the balancing apparatus 20 as will be later described. The electrical means of the present invention other than the light device 23 are comprised of a pair of potentiometer means 27 and 29. The potentiometer means 27 and 29 are used in connection with the sound reproducing system of the tuner unit 10 of FIG. 4 to adjust the amount of drive signals supplied to each of the four speaker units. The potentiometer means 27 and 29 can be selectively adjusted through an appropriate manipulation of the balance control knobs 18 and 19 to provide the apparent sound balance produced by the four speaker units to occur at a position within the listening area that corresponds to the selected grid location of the light device 23.

As shown in FIGS. 2 and 3, the mechanical means of the sound balancing apparatus 20 includes a pair of elongated carrier members 34 and 36 that are generally rod-shaped and that are mounted directly beneath the grid surface for supporting the light device 23. The carrier members 34 and 36 are positioned substantially perpendicular with respect to each other so as to form an axis of intersection and extend across the underside of the grid surface 21. The carrier members 34 and 36 are connected to the driving balance control shafts 24 and 26, respectively, through a pair of close-loop cable means 41 and 43, respectively.

The cable means 41 and 43 are connected to the end means of the carrier members 34 and 36 and are suitably supported on guide means in the form of two separate pulley arrangements 44 and 46 connected to the mounting frame 30 as shown in FIG. 3. Rotational adjustment of either the shaft 24 or 26 will cause a corresponding movement of either the carrier member 34 or 36 across the grid surface in a direction traverse to its elongated axis (in the extending direction of the other carrier member). The axis of intersection of the carrier members 34 and 36 is thereby movable and defines an adjustable set of coordinate points on the grid surface 21 representative of selected positions within the two-dimensional listening area. The light device 23 is carried by the carrier members 34 and 36 at their axis of intersection for continuously indicating the selected location of the apparent sound balance in the listening area.

The potentiometer means 27 and 29 have four separate resistive sections 27a through 27d and 29a through 29d, as shown in the drawing, with each section having its own pair of connecting terminal leads as indicated generally at 28. Each of the resistive sections 27a–27d and 29a–29d includes an adjustable wiper arm, FIG. 4, in selecting a desired resistive value for the respective section. The wiper arms for the potentiometer means 27 and 29 are mechanically ganged together as indicated at K5 and K6 in FIG. 4, respectively, for simultaneous adjustment thereof through the manipulation of the associated balance control shaft 24 or 26.
FIG. 4 shows the electrical diagram of the tuner unit 10 when operating in its four-channel sound system mode. There are presented four separate channels for developing four separate input drive signals to be supplied to the four loudspeaker units such as the front, left and right output speakers and the rear, left and right output speakers. For each of the four channels, correspondingly numbered pairs of resistive wiper sections 27a–29a, 27b–29b, 27c–29c and 27d–29d are connected in series through a coupling capacitor C2 between an input signal source AUX or TAPE and the associated output speaker. The adjustment of the resistive wiper sections K1 for the potentiometer means 29 controls the adjustment of the left-to-right sound balance and the adjustment of the resistive sections K2 for potentiometer means 27 controls the front-to-rear sound balance within the listening area.

Each sound channel of the four-channel sound system is connected through one of four ganged single-pole double-throw switches SW1 through SW4 to the selected input signal source. In one of the two selected positions of the switches SW1–SW4, the respective sound channels are connected to an auxiliary AUX position in which either a four-channel sound can be supplied or a hybrid-type stereo sound having four separate input drive signals. In the other of the two selected switch positions, the respective sound channels are connected to a four-channel tape TAPE position.

For each of the four-channels of FIG. 4, another potentiometer adjustment means K3 is provided for setting the desired level of master loudness through control knob 16. The four resistive sections of the potentiometer means K3. are mechanically ganged for a combined adjustment. Each of the input drive signals, following its adjustment for sound balancing and master loudness, are amplified by a first amplifier means 51 and a second amplifier means 52 and thereafter supplied through a driver section 53 to the voice coil 55 of a speaker unit 57.

FIG. 5 shows an electrical schematic diagram for various illumination lights used with the tuner unit 10. Parallel legs of the diagram are shown wherein one leg contains a function light for MS, B and T control knobs and a master loudness light. The other parallel leg of the diagram shows grid illumination lights and a grid indicator light synchronous with the light device 23 of FIGS. 2 and 3. Since the light device 23 is movable across the grid surface 21, the light device requires the use of a larger length of lead wires 38, FIG. 3, and an extension arm 39, FIG. 3, for gathering the lead wires to prevent possible entanglement thereof. A pair of grid illumination lights are shown in FIG. 2 at 60 for lighting the grid surface 21 for easy viewing reference. If desired, the grid lines only can be illuminated to better contrast the cross-hatched matrix against the transparent substrate.

It is to be understood that while the present invention has been shown and described with reference to a preferred embodiment thereof, the invention is not limited to the precise form set forth herein, and that various modifications and changes may be made therein without departing from the spirit and scope of the present invention.

I claim:

1. A sound balancing apparatus for use with a four-channel sound reproducing system including four separate speaker means defining four corners of a two-dimensional listening area and comprising forward and rear pairs of right and left-hand horizontally spaced speaker means and including four separate signal amplifier channels, herein referred to as first, second, third and fourth amplifier channels, for driving said four speaker means, respectively, including in combination:

   a rectilinear grid display surface representing said two-dimensional listening area,

   a pair of elongated carrier members positioned across each other for providing an axis of intersection therebetween and extending lengthwise across said grid surface in the directions of said two dimensions thereof, respectively, each carrier member being independently movable across said grid in the extending direction of the other carrier member and said axis of intersection being movable to any point on said grid surface and defining an adjustable set of coordinate points thereon representative of selected positions within said two-dimensional listening area,

   an indicator means carried by said pair of carrier members at said axis of intersection for continuously indicating the location of said set of coordinate points on said grid surface,

   a pair of potentiometer means, each said potentiometer means comprising a first, second, third and fourth ganged potentiometer, both potentiometer means being separable adjustable, the first potentiometer of one of said potentiometer means being connected in series with the first potentiometer of the other potentiometer means and input of the first amplifier channel, the second, third and fourth potentiometers of both potentiometer means and inputs to the second, third and fourth amplifier channels being similarly connected; and

   a pair of closed-loop cable means connecting said pair of potentiometer means and said pair of carrier members, respectively, for selectively moving each of said carrier members across the grid surface with a corresponding adjustment of each of said potentiometer means to obtain a desired balance of signal amplitudes between said pair of potentiometer means at said axis of intersection whereby balancing of signal amplitudes between said forward pair and rear pair of speaker means and between said right and left-hand speaker means within said listening area is continuously represented on said grid surface by the selected positions of said indicator means.

2. The sound balancing apparatus of claim 1 wherein said indicator means comprises a light device.

3. The sound balancing apparatus of claim 2 wherein said grid display surface comprises a cross-hatched matrix on a generally transparent substrate and said light device is carried by said pair of carrier members immediately adjacent to the underside of said transparent grid display surface and is visible therethrough.

4. The sound balancing apparatus of claim 3 wherein said cross-hatched matrix on said transparent substrate is lighted for easy viewing reference.

5. The sound balancing apparatus of claim 1 wherein said pair of closed-loop cable means are mounted for movement on a pair of guide means, respectively, and each of said potentiometer means includes a balance control shaft for adjusting the setting of said potentiometer means and includes one of said guide means con-
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connected to said control shaft for simultaneously moving said associated cable means with adjustment of said potentiometer means.

6. A sound balancing apparatus for use with a four-channel reproducing system including four separate speaker means defining four corners of a two-dimensional listening area and comprising forward and rear pairs of right and left-hand horizontally spaced speaker means and including four separate signal amplifier channels, referred to herein as first, second, third and fourth amplifier channels, for driving said four speaker means, respectively, including in combination:

a rectilinear display surface representing said two-dimensional listening area,

indicator means movable to any selected position on said display surface for representing a corresponding selected position within said listening area,

mechanical means associated with said display surface for positioning said indicator means and having said indicator means connected thereto for moving the same in any selected one of said two dimensions with selective adjustments of said mechanical means,

a pair of potentiometer means, each said potentiometer means comprising a first, second, third and fourth ganged potentiometer, both potentiometer means being separately adjustable, the first potentiometer of one of said potentiometer means being connected in series with the first potentiometer of the other potentiometer means and input of the first amplifier channel, the second, third and fourth potentiometers of both potentiometer means and inputs to the second, third and fourth amplifier channels being similarly connected; and

a pair of separately adjustable balance control means for adjusting said pair of potentiometer means, respectively, and interconnecting said mechanical means and said pair of potentiometer means for selectively moving said mechanical means and said

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indicator means across said display surface in said selected dimension with a corresponding adjustment of said associated potentiometer means whereby the desired balance of amplitude is obtained between said four speaker means at said selected listening position within said listening area.

7. The sound balancing apparatus of claim 6 wherein said mechanical means include a pair of elongated carrier members positioned across each other for providing an axis of intersection therebetween and extending lengthwise across said display surface in the directions of said two dimensions thereof, respectively, each carrier member being movable across said display surface in the extending direction of the other carrier member and said axis of intersection being movable and defining an adjustable set of coordinate points on said display surface representative of said selected position within said two-dimensional listening area, and further including a pair of closed-loop cable means connecting said pair of potentiometer means and said pair of carrier members, respectively, for selectively moving said carrier members across said display surface with a corresponding adjustment of said potentiometer means by said balance control means to obtain a desired balance of amplitude between said four speaker means at said axis of intersection.

8. The sound balancing apparatus of claim 7 wherein said pair of closed-loop cable means are mounted for movement on a pair of guide means, respectively, and said balance control means include a pair of rotatable shafts connected with said pair of potentiometer means, respectively, for adjusting the setting of said potentiometer means, said shafts including one of said guide means for simultaneously moving said associated carrier member through movement of said associated cable means with adjustment of said potentiometer means.

9. The sound balancing apparatus of claim 6 wherein said indicator means comprises a light device.

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