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STEREOPHONIC REPRODUCTION CONTROL APPARATUS

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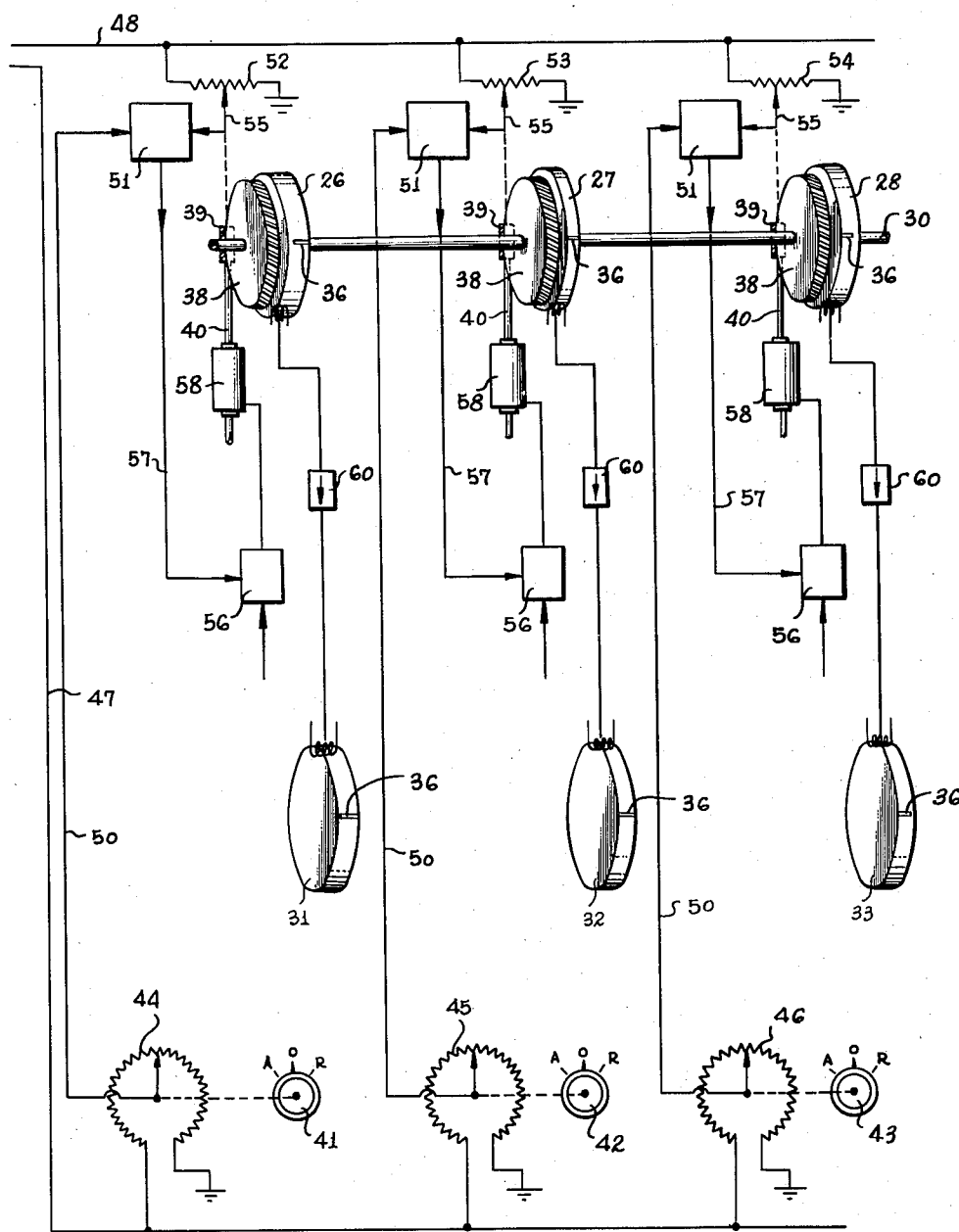


Fig. 4

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STEREOPHONIC REPRODUCTION CONTROL APPARATUS

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5 Claims. (Cl. 179—100.2)

My invention relates generally to the field of stereophonic sound, and more particularly to means for varying the reproduction time on multiple channel sound systems to correct and modify original recordings for creating the most effective stereophonic illusion.

Stereophonic sound reproduction as the term is used herein, relates to sound reproduced on multiple loudspeakers in a listening area to create the illusion of angular sound direction. It is to be distinguished from binaural sound reproduction wherein two independent headphones for each listener, actually duplicate in the listener's ears sounds he would hear at the pickup point.

In a basic stereophonic sound system, multiple microphones are spread laterally in front of the sound source to record on separate sound tracks the sound as heard from each of these separate pickup points. Any number of channels may be used, but from a practical standpoint, a center and right and left pickups are conventional, and give good results. The recorded sound tracks are then reproduced through correspondingly located loudspeakers spaced apart in front of the audience.

The composite effect of these sound signals is interpreted by the listener's hearing mechanism as giving a sense of angular localization of the reproduced sound. This angle of apparent localization depends both upon the relative intensities of the direct sound arriving from the various loudspeakers and upon the relative time of arrival of the sound signals. For sounds of equal intensity the source appears to be nearer the loudspeaker from which the sound arrives first; whereas for equal arrival times the sound source appears to be nearer the loudspeaker which gives the most intense signal. By application of these principles an almost perfect illusion of space on a stage can be created for an audience.

However, the original recording of the sound cannot always be controlled to give the desired stereophonic effect. For example, it may be desirable to emphasize a certain section of a symphony orchestra by raising the amplification in the pickup channel located nearest that section. This frequently causes an associated, but unwanted change in the location of instruments in the orchestra. Also, it may be that the tonal balance of a sound passage is satisfactory, but it is desired to shift the apparent location of the sound from the conditions of actual recording.

This problem is particularly important in the mixing of several sound sources to produce a sound track to accompany a motion picture or television show. Here the various sound tracks and effects will not have the same or the desired localization pattern, and it is further necessary to change the intensity of the different sound signals to conform to the conditions of the scene being played.

In this rerecording or so-called "dubbing" art, it is the practice to provide the person mixing the various channels with controls permitting him to selectively vary the relative intensity of the channels. In this way it is possible to create an apparent shift in the angular location of the sound source. However, it can be seen that such a shift in apparent location may be accomplished at the expense of the tonal balance of the sound, creating unwanted intensity emphasis on particular sounds.

With the foregoing in mind it is the major object of

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this invention to provide means for creating changes in the apparent localization of recorded sound tracks without changing the intensity thereof. This is accomplished by varying the relative reproductive time in the various channels of a composite sound track. The effect of advancing or retarding the relative reproduction time of a channel, is to change the arrival time for the listener and thus create an apparent shift in the angular localization of that sound. By utilizing this invention in cooperation with existing control means for varying the relative intensities in the mixing equipment, the localization can be manipulated to be a better fit for the visual conditions without requiring changes in the original recordings.

An equally important object of the invention is to provide means for varying the relative reproducing time in various channels which are particularly adapted for use in conjunction with existing types of re-recording and mixing equipment.

A further object of the invention is to provide control means of the character described which are adapted for use with magnetic recording equipment such as is currently used extensively in motion picture and television sound systems.

It is also an object of the invention to provide means for shifting the relative position of a magnetic reproducing or recording gap or slit to advance or retard the reproduction or recording times.

Another object of the invention is to provide adjustable control means for mechanically shifting the position of multiple reproducing or recording heads which are of simple and practical construction.

These and other objects and advantages of the invention will become apparent from the following detailed description of a preferred embodiment thereof, and from an inspection of the accompanying drawings in which:

Figure 1 is a partial side elevation multitrack sound reproducer embodying my invention;

Figure 2 is a perspective view showing multitrack reproducing heads together with gear means for shifting the relative positions of the reproducing or scanning gaps thereon;

Figure 3 is a detail showing a typical multitrack magnetic tape passing over the reproducing heads;

Figure 4 is a schematic view showing the control and actuating means for making relative adjustments in the position of the reproducing heads; and

Figure 5 is a block diagram showing typical monitoring equipment provided in the recording equipment for the use of the operator.

An embodiment of my invention herein disclosed is adapted for use with a conventional type of multichannel magnetic tape or film 10, as is best seen in Figure 3. The tape 10 has three recording tracks or channels, a left-hand track 11, center track 12, and righthand track 13. According to present standards, these tracks designate the sound which feeds the left, center, and righthand speakers, respectively, in a stereophonic sound system. Along the edges of tape 10 are sprocket holes 14 for driving the tape at a regulated speed. Such a tape 10 is frequently used to provide stereophonic sound in conjunction with motion pictures and is adapted for use with existing recording and reproducing equipment. It is to be understood, however, that the invention is not limited to use with any particular kind of multichannel tape, and can be used with photographic films having the sound tracks carried thereon equally well.

Figure 1 illustrates a portion of a typical stereophonic mixing and re-recording device such as is used in combining recorded material to form a multichannel tape or to improve the quality of a previously recorded tape. Associated elements not pertinent to this invention are

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omitted, but it can be appreciated that recording heads for "dubbing" recorded sound onto the various tracks of the tape, as well as intensity or volume control means may be provided. As shown, a rear mounting wall 20 supports a plurality of magnetic sound heads over which the tape 10 is adapted to travel. These sound heads are arranged in groups along the path of travel of the tape 10 which moves in a clockwise direction as indicated by the directional arrows. The first group of heads is designated as monitoring heads 21 to 23 which are mounted in side-by-side relationship on a common supporting shaft 24 which projects outwardly from mounting wall 20. A second group of heads 26 to 28 are designated as reproducing heads and are similarly mounted on a shaft 30, while a third group of heads 31 to 33 are mounted below the reproducing heads, and are designated as re-recording heads. Briefly considered, as tape 10 travels over the reproducing heads 26—28 the sound signals are taken off the tape, and then re-introduced on the tape at the re-recording heads 31 to 33. The purpose of monitoring heads 21 to 23 is to permit an operator to listen to the sound tracks in advance of their travel over the reproducing and re-recording heads, so that he can make desired changes in the recording when the tape passes over the reproducing heads. If desired, the operator may also listen to the adjusted sound on the reproducing heads so as to note the effect of such changes.

Between reproducing heads 26—28 and re-recording heads 31—33 I provide an erasing head 35 which serves to erase the sound channels from tape 10 so that the new sound channels can be recorded on the same tracks. The erasing head 35 may form a physical part of the reproducing or re-recording heads in some installations without changing its function. It should also be noted that the apparatus herein disclosed contemplates the erasing and re-recording of the sound channels on the same tape 10 as the original recording, but the arrangement is not necessarily so limited. In many studio installations the re-recording will be done on a separate tape from the original so that the latter is not erased. The invention disclosed herein will work equally well with any of such devices.

All of the sound heads have a gap or slit 36 therein which is laterally aligned with one of the sound tracks 11—13. The gaps 36 of the groups of heads 21 to 23, 26 to 28, and 31 to 33 are arranged in side-by-side order to pick off the sound signals from the tracks 11 to 13, respectively. It should be noted, that the position of gaps 36 along the length of tape 10 establish time reference points with respect to the reproduction time of the sound. In the case of monitoring heads 21—23 and re-recording heads 31 to 33, the individual gaps 36 of each group are arranged in exact lateral alignment. That is, the heads 21—23 and 31 to 33 are fixed in position on shafts 24 and 34, respectively, so that the gaps 36 of each group all have the same time reference point and they reproduce or record the sound signals simultaneously across the individual sound tracks. This, of course, is the conventional arrangement of multichannel sound heads.

The reproducing heads 26 to 28 are not, however, arranged with the gaps 36 fixed in exact lateral alignment. As is best seen in Figure 2, the heads 26 to 28 are rotatably mounted on shaft 30 and each head has affixed to it a side gear 38. A lower worm pinion gear 39 engages gear 38 and holds it and the attached head against rotation. Worm pinion gears 39 are mounted upon individual drive shafts 40, and are adapted to be rotated by suitable driving mechanism as will hereinafter be described. Rotation of drive shafts 40 causes relative rotation of heads 26 to 28 either in a clockwise or counter-clockwise direction, in accordance with the driving rotation. The amount of relative rotation of heads 26 to 28 is normally quite small, but the effect of such rotation is to shift gaps 36 along the length of tape 10 relative to each other.

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Figure 3 shows the effect of such movement of gaps 36 relative to each other and the tape 10. Normally, the gaps 36 will be in lateral alignment and the position of center gap 36 is on the normal reference line. The left-hand gap 36 is shown rotated forwardly, while the right-hand gap is rotated rearwardly. If the position of the center gap along tape 10 is considered as being the normal reproduction time for the center sound track 12, then the movement of lefthand gap 36 represents a time delay in the reproduction time on track 11, while the movement of the righthand gap represents an advance in the reproduction time on track 13. As will be remembered from the previous discussion, the sound in a stereophonic system appears to be nearer the loudspeaker from which the sound arrives first. Therefore, by changing the relative reproduction times on the various sound channels the apparent source of the sound can be made to shift back and forth between the speakers without changing the intensity of the sound.

The sound signals taken from the sound tracks by the reproducing heads 26 to 28 are fed back into heads 31 to 33 and re-recorded on the tape 10. Since the recording gaps 36 of the re-recording heads are held in fixed lateral alignment, the re-recorded sound tracks now have advanced or retarded reproduction times in accordance with the shift in position of the reproducing heads. It should be noted that the arrangement herein disclosed may be reversed if desired; that is, the reproducing heads may be held in fixed position and the relative positions of the re-recording heads shifted along the sound tracks to advance or retard the relative reproduction times. Such a modification is thought to be apparent, and is intended to be considered within the scope of my invention.

The positions of reproducing heads 26 to 28 are established by driving means which are under the control of an operator, who can pre-set the positions of the heads to create a particular effect, or vary them continuously along the sound tracks to shift the apparent angular localization of the sound. While the heads might be directly coupled to manual control means, I prefer to employ power amplifying servomechanisms, there being an independent mechanism for each head so that they may be independently advanced or retarded. Figure 4 indicates diagrammatically the arrangement of such driving means.

Each head 26 to 28 is provided with a manual control knob 41 to 43, respectively, which can be set to a zero position or rotated in either direction to advance or retard the heads. The control knobs 41 to 43 are mechanically coupled to control potentiometers 44 to 46, respectively, which are connected in parallel from a power line 47 to ground. The signal voltages from potentiometers 44 to 46, determined by the position of the control knobs, are conducted through leads 50 into voltage balancers 51.

Across a parallel power line 48 to ground are response potentiometers 52 to 54 for the heads 31 to 33, respectively. The positions of potentiometers 52 to 54 are determined by the positions of the heads 26 to 28, and the signal voltage therefrom goes through leads 55 into the opposite balancers 51. The output voltage of balancers 51 goes into reversing switcher 56 through conductors 57 and thence to servo motors 58. Switches 56 determine the direction of driving rotation of motors 58. The servo motors 58 are in turn connected to the drive shafts 40 to rotate heads 31 to 33 in accordance with the control signal voltage. Drive shafts 40 are also connected back to the response potentiometers 52 to 54 so as to stop the rotation of the heads when the indicated position of the control knobs has been reached. Thus, a very fine reversible control drive is provided for positioning the reproducing heads.

Also indicated in Figure 4 is the connection between the reproducing heads 26 to 28 and the re-recording heads 31 to 33. The pick-up coil of each reproducing

head is connected to an amplifier 60 and thence directly to the inducing coil of the corresponding re-recording head. It can, therefore, be appreciated that the sound signals taken from the tape channels are put back onto the tape in accordance with the reproduction times established by the relative positions of the reproducing heads.

As is seen in Figure 5, the circuit connections of the monitoring heads 21 to 23 go through independent amplifiers 65 and thence to left, center, and righthand speakers 66 to 68, respectively, for obtaining an advance reproduction of the sound before it reaches the reproducing heads 26 to 28. It will also be noted that a gang switch 69 is provided permitting the sound taken off amplifiers 60 to be monitored through speakers 66 to 68. Thus, the operator may also listen to the changed or corrected sound tracks as they are taken off by reproducing heads 26—28. In practice, the sound tape will be played many times and appropriate notes made on desired changes. The corrections in the relative reproduction times to obtain the best possible effect will be made under the direction of a highly skilled technician, and may be shifted back and forth by trial and error until the best effect is obtained.

As may now be fully appreciated, the invention permits a wide variation in the apparent angular localization of stereophonic sound without affecting the relative intensity of particular sounds. Thus, sounds having different localization patterns may be adjusted and then combined to give any desired overall effect. While I have shown and described a particular embodiment of the invention, it is to be understood that modifications of construction for use with different types of recording equipment can easily be made. In particular, the shifting mechanism connected to the reproducing heads may be connected to the re-recording heads and the former held in a fixed position. Such a reversed device will function in substantially the same manner. Therefore, I do not wish to be restricted to the foregoing details except as defined in the appended claims.

I claim:

1. In stereophonic sound reproducing apparatus for use with a multichannel magnetic sound tape; a plurality of magnetic reproducing heads arranged in side-by-side coaxial relationship for simultaneously reproducing the individual channels from said tape; and servo mechanism means connected to each of said heads for rotating each of said heads relative to each other and about the common axis for shifting the position of the recording gaps and advancing or retarding the relative reproduction times in said channels.

2. In stereophonic sound reproducing apparatus for use with a multichannel magnetic sound tape; a plurality of magnetic reproducing heads arranged in side-by-side coaxial relationship for simultaneously reproducing the individual sound channels from said tape; and means for

rotating each of said heads relative to each other and about the common axis for shifting the position of the recording gaps and advancing or retarding the relative reproduction times in said channels; and hand control means for controlling the movement of said last-mentioned means.

3. In stereophonic sound reproducing apparatus for use with a multichannel magnetic sound tape: a plurality of magnetic reproducing heads rotatably mounted on a common shaft in side-by-side relationship for simultaneously reproducing the individual sound channels from said tape; gearing means connected to each of said heads for independently rotating said heads about said shaft and servo-mechanism means connected to said gearing means and reversibly drivable for rotating said heads about said shaft and advancing or retarding the relative reproduction times in said channels.

4. In stereophonic sound mixing and rerecording apparatus for use with a multichannel magnetic sound tape: a plurality of magnetic reproducing heads rotatably mounted on a common shaft in side-by-side relationship for simultaneously reproducing the individual sound channels from said tape; gearing means connected to each of said heads for independently rotating said heads about said shaft; servo-mechanism means connected to said gearing means and reversibly drivable for rotating said heads about said shaft and advancing or retarding the relative reproduction times in said channels; and a plurality of magnetic rerecording heads arranged in side-by-side coaxial relationship with aligned recording gaps, said rerecording heads being electrically connected to said reproducing heads for rerecording said sound channels on said tape in accordance with the relative reproduction times established by said reproducing heads.

5. In stereophonic sound mixing and rerecording apparatus for use with a multichannel magnetic sound tape: a plurality of magnetic reproducing heads rotatably mounted on a common shaft in side-by-side relationship for simultaneously reproducing the individual sound channels from said tape; a drive gear attached to each of said heads and rotatably mounted on said shaft; a driving gear engaged with each of said drive gears; and a servo-mechanism connected to each of said driving gears and reversibly drivable for rotating said head about said shaft and advancing or retarding the relative reproduction times in said channels in accordance with the position of a hand control knob.

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