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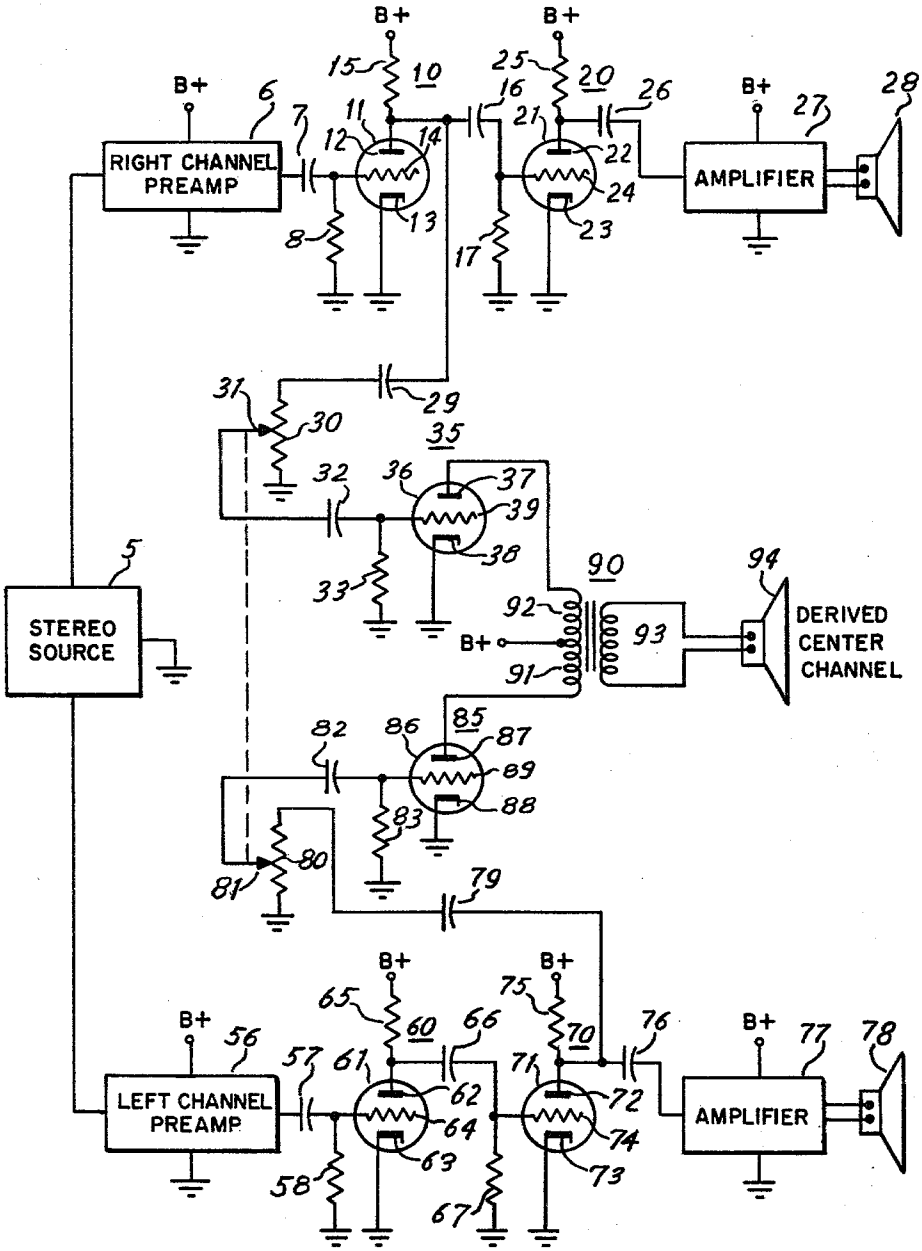

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STEREOPHONIC SYSTEM WITH DERIVED CENTER CHANNEL

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This invention relates in general to stereophonic music systems and in particular to such systems in which a third or center channel is derived from signals present in the left and right channels.

One of the main difficulties encountered in stereophonic music reproducing systems is that of maintaining sufficient acoustic separation between the channels thereof without developing a "hole in the middle" effect. To overcome this problem numerous solutions have been recommended, one of which suggests employing an additional, separate translation channel and feeding the resultant three channel system from a three channel source. This proposed system is expensive and must also await the advent of a commercial three channel phonograph pickup cartridge.

Another system adds the signals from the left and right channels to produce a third channel system. This is done in the output stages (transformers) of the left and right translation channels. Such a system, however, does not produce a realistic effect since the sums of the signals picked up by a left and right microphone system does not correspond to the signals picked up with an additional, centrally placed microphone system.

The system of the invention derives a third channel by combining portions of the left and right channel signals in a center channel push-pull amplifying stage to produce a realistic center channel, i.e. one which more nearly approximates the signal which a center microphone system would pick up.

Ideally, a derived center channel system should be able to discriminate between signals from the left side of the orchestra and signals from the right side of the orchestra and be fully operative only when both left and right signals are present in substantially equal measure.

The "hole in the middle effect" is generally the result of a deficiency of signal corresponding to the middle registers or mid-range of the tonal scale. This may be the result of too much separation between the left and right microphone systems and/or the placement of the sound reproducers. The lower registers are not troublesome in this regard since low frequency signals are acoustically dispersed in wide patterns. Signals in the upper register are highly directional and, in the opinion of many, are largely responsible for the stereo effect achieved. Therefore it is not desirable to artificially augment these signals in a derived center channel since much of the stereo effect will be thereby lost. Further it seems apparent that a straight arithmetic combination of the signals in the left and right channels would also minimize the stereo effect.

A highly realistic third channel is derived in the preferred embodiment for illustrating the invention by providing a separate push-pull output stage including a pair of output tubes. A portion of the left channel signal is coupled to the input of one of these tubes and a portion of the right channel signal is coupled to the input of the other of these tubes. The signals are selected from points in the respective right and left channel amplifiers where they are in phase opposition with respect to each other. If the left and right channel signals are identical, the center channel operates as a conventional push-pull amplifying stage and has a certain overall amplification or gain associated with it. If a signal is present in only one of the channels, the center channel amplifying stage

operates as a single-ended amplifier and has a much smaller gain associated therewith. For left and right channel signals which differ in some respects and are alike in other respects, the like portions receive greater amplification than the dissimilar portions and consequently the center channel primarily reproduces the portions of signals common to both the left and the right channels, thus approximating the conditions prevailing at the center of the orchestra.

In furtherance of what was mentioned previously, it was found that excellent results were obtained by utilizing only a mid-range horn reproducer in the center channel.

The system about to be described produced a very realistic effect in the derived center channel since both left and right channel signals are reproduced therein, although at a much lower level than left and right channel signals having a high degree of similarity.

Accordingly an object of this invention is to provide an improved stereophonic reproducing system;

A further object of this invention is to provide means in a stereophonic reproducing system for deriving a third or center channel;

Another object of this invention is to provide means for deriving a center channel, in a two channel stereophonic reproducing system, including a novel arrangement for acoustically discriminating between similar and dissimilar signals in the respective stereophonic channels.

A still further object of this invention is to provide means for deriving a third channel in a two channel reproducing system including an amplifier stage operating in a push-pull manner for like signals in both channels and in a single-ended manner for unlike signals in both channels.

Further objects of this invention will become apparent upon reading the following specification in conjunction with the drawing which is a partial block and partial schematic diagram of a preferred form of the invention.

Referring now to the drawing, a stereo signal source 5 is shown for supplying signals to a right channel preamplifier 6 and to a left channel preamplifier 56. Stereo source 5 may comprise any of numerous sources of stereophonic program material available and in particular may comprise a stereophonic record reproducer. The output of preamplifier 6 is coupled via coupling capacitor 7 to the input circuit of an amplifier stage 10. Amplifying stage 10 comprises a vacuum tube 11 having an anode 12, a cathode 13, and a control grid 14. Capacitor 7 is connected to control grid 14 which also has a bias resistor 8 connected thereto. A load resistor 15 is connected from a source of positive potential B+ to anode 12. A signal emanating from right channel 6 is amplified by amplifying stage 10 and coupled via capacitor 16 to a succeeding amplifying stage 20.

Amplifying stage 20 is similar to amplifying stage 10 and comprises a vacuum tube 21 having an anode 22, a cathode 23 and a control grid 24. Likewise a biasing resistor 17 is connected between ground and the junction of coupling capacitor 16 and control grid 24. A load resistor 25, across which the amplified signal is developed, and a capacitor 26 couple the signal to a further amplifier 27. The output of amplifier 27 is coupled to a transducer 28, which is effective to convert the electrical signals into corresponding acoustical signals.

Similarly, left channel preamplifier 56 amplifies the left channel signal from source 5 and couples it via coupling capacitor 57 to amplifying stage 60 where it is further amplified. The output of amplifier 60 is taken from across load resistor 65 and coupled through capacitor 66 to amplifier 70. The output of amplifier 70 is coupled to a further amplifier 77 which in turn drives a transducer 78 for converting electrical signals into corresponding acoustical signals.

The circuit just described is conventional and depicts one common form of a two channel stereophonic sound reproducing system. What is to be described now is structure for deriving a third or center channel signal based upon the coincidence between the left and right channel signals.

A pair of amplifiers **35** and **85** are connected in push-pull output relationship with an output transformer **90**. Amplifiers **35** and **85** comprise, respectively, vacuum tubes **36** and **86** having anodes **37** and **87**, cathodes **38** and **88** and control grids **39** and **89**. Transformer **90** includes a primary winding having portions **91** and **92** and a secondary winding **93** which is coupled to a center channel transducer **94**.

A portion of the signal in each of the left and right channels is coupled to the input circuit of a respective one of vacuum tubes **36** and **86**. The individual signals are selected at points in the respective channels at which a monaural signal passing through both channels would be 180° out of phase.

The signal selected from the right channel is coupled through a coupling capacitor **29** to a level control having a fixed resistor element **30** and a movable tap **31**. Tap **31** is connected through a coupling capacitor **32** to control grid **39** of tube **36**. A biasing resistor **33** is connected to control grid **39** and cathode **38**.

Similarly the signal selected from the left channel is coupled through a coupling capacitor **79** to a level control having a fixed resistor **80** and a movable tap **81**. Tap **81** is coupled to grid **89** of tube **86** through capacitor **82**. A biasing resistor **83** is connected between the grid and cathode of tube **86**.

It will be noted that the right channel signal is selected from the output of amplifier **10** and the left channel signal is selected from the output of amplifier **70**. As each succeeding stage of amplification introduces a 180° phase shift to the signal amplified, it will be seen that similar signals in both channels will be 180° out of phase when applied to the control grids of tubes **36** and **86**. This of course is a necessary condition for push-pull operation of these tubes.

Assuming that a signal occurs only in the right channel, it will be apparent that amplifying stage **35** will operate in a single-ended manner and a much smaller gain will be associated with the center channel translation system. Similar operation results with respect to amplifier stage **85** for a signal in the left channel only. Obviously for like signals in both channels complete push-pull operation of the center channel is obtained and a much larger center signal is available to drive transducer **94**.

In practice the system is adjusted by utilizing a monaural signal source and setting the movable taps **31** and **81** of the level controls for approximately equal acoustic output from all transducers (**28**, **78** and **94**). This procedure sets the maximum amplification characteristic of the center channel. That is, it will amplify at maximum efficiency when operating in a push-pull manner and therefore a monaural signal may be utilized to set its maximum output relative to the left and right channels.

Most signals are not entirely pure left or pure right, but rather have some similar components in both channels, though varying in amplitude and phase. When these signals are fed to the center channel, a discrimination process occurs based upon the coincidence in amplitude and phase of the selected signals. Those portions that coincide are amplified to a larger degree than those portions which do not coincide. Thus the center channel is not completely devoid of nearly pure left and right signals, it merely discriminates against them by reproducing them at much lower levels. This is really the essence of the realism achieved with the system.

What has been described is a novel stereophonic reproducing system with means for deriving a third channel signal. The particular form of the invention is a preferred one, but numerous modifications and changes will be readily apparent to those skilled in the art without departing from the true spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A musical system including a source of stereo signals; means amplifying said stereo signals; means coupled to said last-mentioned means converting said amplified signals into corresponding acoustic signals; further amplifying means including a pair of amplifier devices and an output transformer connected in push-pull configuration; a transducer coupled to said further means converting the output thereof into acoustic energy; means coupling a portion of one of said stereo signals to a first one of said pair of amplifier devices and a portion of the other of said stereo signals to a second one of said pair of amplifier devices, said coupling being at points in the respective channels where similar introduced stereo signals would be 180° out of phase with each other; said further amplifying means operating as a single-ended amplifying stage when only one of said stereo signals is present, and as a push-pull amplifying stage when both said stereo signals are present.

2. A stereophonic reproducing system comprising a stereophonic source for generating a left channel signal and a right channel signal; a left translation channel and transducer for translating said left channel signal and converting it to a corresponding acoustic signal; a right translation channel and transducer for translating said right channel signal and converting it to a corresponding acoustic signal; a center translation channel and transducer; said center channel including a pair of amplifying devices and transformer means connected in push-pull relationship; an input circuit for each of said amplifying devices; and means applying a portion of said left channel signal and said right channel signal to said input circuits, respectively, in a manner such that said signals are of opposite polarity.

3. In a stereophonic system including a source of stereo signals, a pair of translation channels for respectively translating said stereo signals, and a pair of transducers coupled to said pair of translation channels, respectively, for converting said translated signals into corresponding acoustic signals; means for deriving a center channel signal comprising; a center translation channel including first and second amplifying devices and an output transformer coupled thereacross in push-pull relationship; a center channel transducer coupled to said output transformer; means for selecting a portion of the signal in each channel of said pair of translation channels in a manner such that said signals are in phase opposition; and means for applying said selected signals to said first and second amplifying devices respectively, whereby said center channel variably translates said signals as a function of the magnitude and coincidence thereof.

4. In combination; a signal source for generating a first signal and a second signal; a first translation channel including at least a first and a second phase inverting amplifier stage for translating said first signal; a second translation channel including at least a third and a fourth phase inverting amplifier stage for amplifying said second signal; a third translation channel having an output transformer and a pair of amplifying devices coupled in push-pull arrangement; means for coupling a portion of the signal from said first amplifier stage to one of said pair of amplifying devices; means for coupling a portion of the signal from said fourth amplifier stage to the other of said pair of amplifying devices; and means for adjusting the signal level input to said third translation channel.

5. In a stereophonic reproducing system including a source of left and right channel signals, means for respectively translating said signals and means for respectively converting the translated signals into acoustic signals;

means for deriving a center channel signal as a function of similar portions of said left and said right channel signals comprising; a center channel push-pull connected amplifier including a pair of vacuum tubes having output circuits coupled to an output transformer and input circuits coupled to said means for respectively translating said signals; and means for introducing said left and said right channel signals respectively to said input circuits in opposite polarity with respect to each other, whereby said similar portions are amplified in a push-pull manner by said center channel amplifier and other portions of left and right channel signals are amplified in a single-ended manner.

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