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STEREOPHONIC AMPLIFIER SYSTEM

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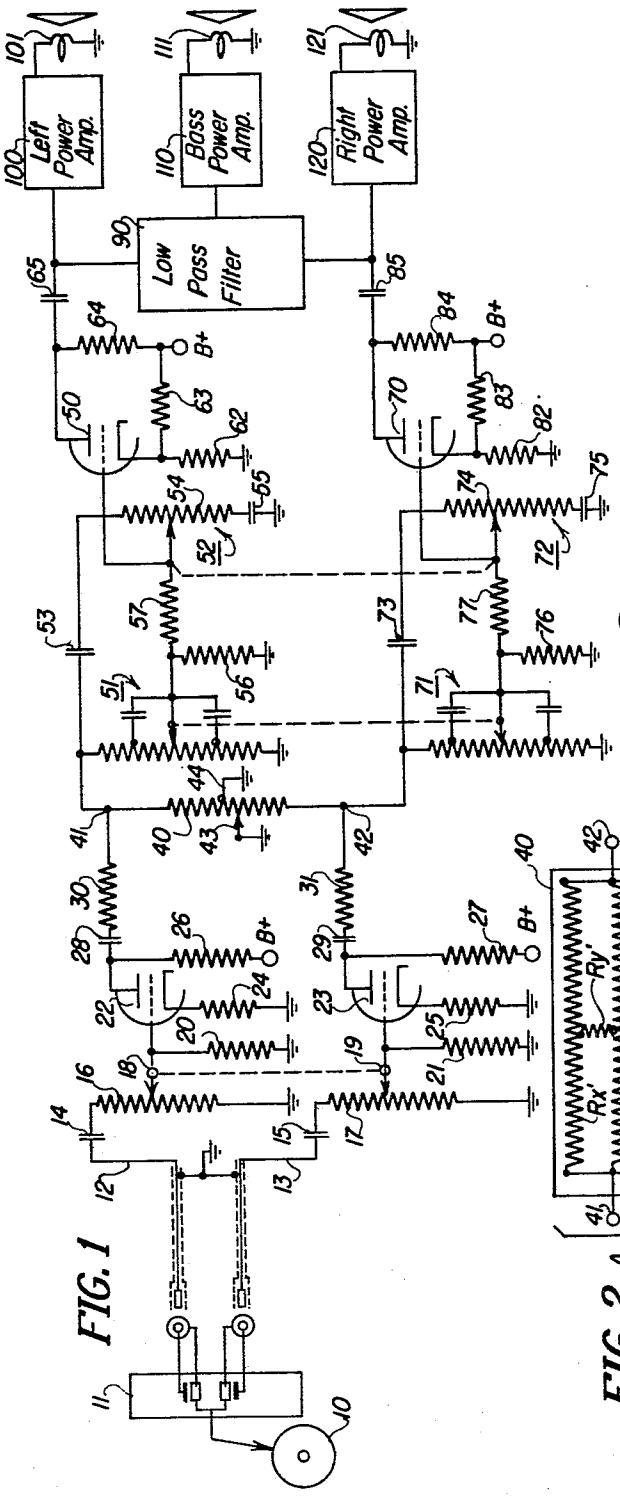


FIG. 1

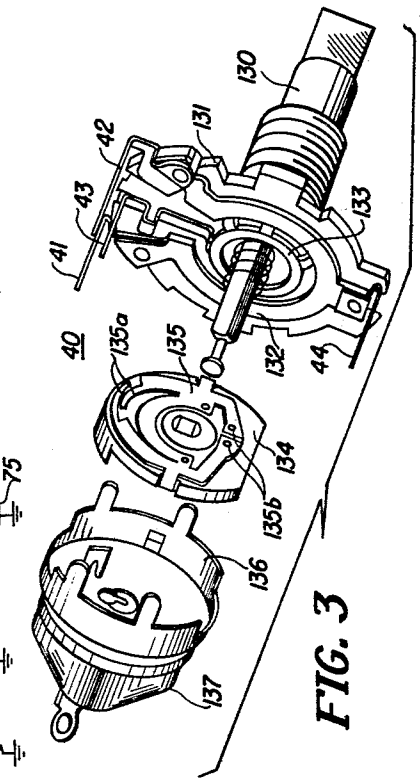

FIG. 3

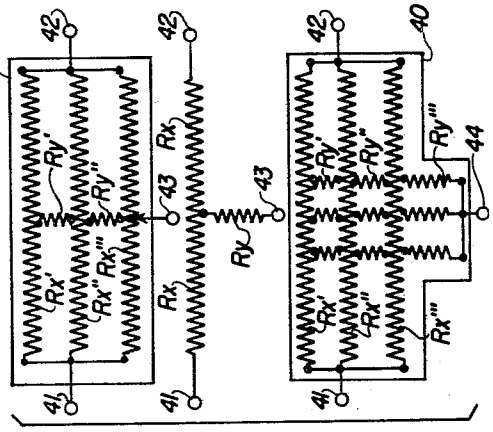


FIG. 2

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# STEREOPHONIC AMPLIFIER SYSTEM

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This invention relates in general to stereophonic sound reproducing apparatus and in particular to such apparatus with an improved balance control for separate stereophonic sound channels.

Present day stereophonic sound reproducing devices include separate stereophonic channels, usually referred to as the right and left stereo channels, which individually translate different sound signals. For depth and realism, the separate sound signals are reproduced in two separate loudspeaker systems which are spaced apart to recreate the effect of hearing the sound pattern as that of the original performance at multiple spaced locations. In such systems a control is usually provided so that the stereo channel may be balanced according to personal preferences and to compensate for different locations of the loudspeaker systems, or other differences in the amplifiers of the apparatus.

In the past, a problem was presented in maintaining desirable isolation between the separate stereo channels when a balance control is used. The control is usually a conventional potentiometer connected between the amplifier channels and having a slidable tap arm connected to ground. However, such an arrangement may not provide optimum isolation or separation between the stereo channels and there may be a degree of cross coupling of the sound signals. This cross coupling results in an inferior reproduction fidelity in the separate stereo channels.

It is therefore an object of the present invention to provide stereophonic sound reproducing apparatus with a balance control and wherein improved separation is provided between the stereophonic channels in a simple, inexpensive and expeditious manner.

A feature of the present invention is the provision of stereophonic sound reproducing apparatus having a potentiometer connected between separate stereo channels with a movable slider arm for balancing the same and a fixed tap at the electrical midpoint of the resistance element which is connected to ground thereby insuring optimum isolation between the stereo channels.

In the drawings:

FIG. 1 is a partial block and schematic diagram of stereophonic sound reproducing apparatus incorporating the present invention;

FIG. 2 is a series of diagrams useful in explaining the circuit of FIG. 1; and

FIG. 3 is an exploded view of a potentiometer control for use in the circuit of FIG. 1.

In practicing the invention, a stereophonic sound reproducing apparatus incorporates a balance potentiometer which is connected betwee the separate stereo amplifier channels. A slider arm is included as part of the potentiometer and is connected to ground such that movement of the slider arm will vary the relative outputs of the channels. A fixed tap is also included at the electrical midpoint of the potentiometer resistance element and is likewise connected to ground potential. Movement of the slider arm will therefore vary the output of one channel while the output of the other channel remains constant due to the fixed tap. This action occurs on either side of the fixed tap. The fixed tap makes contact with the resistance element over a substantial area which effectively reduces the impedance in common between the stereo channels, thereby minimizing cross-coupling and maintaining optimum electrical separation therebetween.



Referring now to FIG. 1, a stereophonic sound signaling apparatus is illustrated wherein separate stereo channels are included for translating and reproducing "right" and "left" stereophonic sound signals. The right and left stereophonic signals are derived from a disc type phonograph record **10**, by a dual channel audio signal source such as the stereophonic pickup cartridge **11**. A left channel output lead therefrom supplies left channel audio intelligence to the input lead **12** of amplifier **22**. Right channel audio intelligence is fed from the right channel output lead of cartridge **11** to the input lead **13** of right channel amplifier **23**.

In the respective input circuits of the stereo channel amplifiers, a coupling capacitor **14** is connected in series with a potentiometer **16** at the input of left channel amplifier **22** while a coupling capacitor **15** is connected in series with a potentiometer **17** at the input of right channel amplifier **23**. The variable taps **18** and **19** of potentiometers **16** and **17** are ganged for operation as a single volume control to tap off input signals developed across the respective potentiometers and ground. Variable tap **18** is connected to the input grid of amplifier tube **22** and variable tap **19** is connected to the iput grid of amplifier tube **23**. Operating voltage is aplied to the anode of tube **22** through resistor **26**. The cathode of tube **22** is connected to the reference potential through a cathode bias resistor **24** with a grid leak resistor **20** being connected between its control grid and the reference potential. Similiarly, the control grid of tube **23** is connected to variable tap **19** with resistor **21** forming the grid leak bias, resistor **27** supplying the operating voltage to its anode, and resistor **25** forming the cathode bias.

The output of left channel amplifier **22** is applied through coupling capacitor **28** and resistor **30** to one side of stereo balance control **40** at junction **41**. The output of right channel amplifier tube **23** is applied through coupling capacitor **29** and resistor **31** to the other side of balance control **40** at junction **42**. Stereo balance control **40** includes both a fixed tap **44**, located at its electrical midpoint, and a variable tap **43**. Taps **43** and **44** are both connected to ground potential. Left stereo signals are developed across the series resistor **30** and a resistance portion of balance control **40** connected in shunt to ground. Right stereo signals are developed across series resistor **31** and a resistance portion of balance control **40** also connected in shunt to ground. By varying the position of the variable tap **43**, the value of the shunt resistance provided by potentiometer **40** will decrease the voltage drop across the series resistance in one channel and while maintaining the voltage drop across the series resistance in the other channel at a constant value due to the fixed tap **44**. This action may occur on either side of the fixed tap **44**. The change in voltage drop across series resistors **30** and **31** determines the level of signal applied to tubes **50** and **70** and thereby the amplification level of the stereophonic signal. The function of fixed tap **44** will be explained in more detail further on.

Left channel stereo signals are applied from junction **41** through low frequency blocking capacitor **53** to one side of the variable resistor **54**, forming a part of treble tone control **52**. The arm of resistor **54** is connected to the control grid of left tone amplifier **50** with the other side of resistor **54** being bypassed to ground through capacitor **55**. Variable treble control **52** controls the amount of high frequency components which are translated by tone amplifier **50**.

The lower frequency components of the signal, which are not passed by capacitor **53** appear across network **51** which serves as a base control operating in a known manner. The capacitive elements in network **51** determine the amount of low frequency components which are developed across the resistive elements which are

fed to the input of tone amplifier **50**. Base control **51** is isolated from the treble control **52** by series resistor **57** and shunt resistor **56**.

Cathode bias for left tone amplifier **50** is provided from the junction of the voltage divider network consisting of resistors **62** and **63** connected between B+ and ground. A plate load resistor **64** is connected between the anode of amplifier **50** and B+.

In a like manner, right stereo signals appearing at junction **42** are applied through low frequency blocking capacitor **73** and variable resistor **74** to the input of right tone amplifier **70**. The right channel includes a base control **71** and a treble control **72** which function in the same manner as described for the left channel. Base controls **51** and **71** and treble controls **52** and **72** are respectively ganged together for operation as single controls. Cathode bias for right tone amplifier **70** is provided by the voltage divider network consisting of resistors **82** and **83** connected in series between B+ and ground. Plate load resistor **84** is coupled between the anode of tube **70** and B+.

The output from left tone amplifier **50** is applied through coupling capacitor **65** to the left power amplifier **100** with the output from the right tone amplifier **70** being applied through coupling capacitor **85** to the right power amplifier **120**. A low pass filter network **90** is connected across the left and right stereo channels whereby the low frequency stereo signals, up to approximately 300 cycles, are derived and fed to base power amplifier **110**. The outputs from the power amplifiers are reproduced in separate loudspeakers, **100**, **110** and **120** respectively.

Returning now to a more detailed description of stereo balance control **40**, it will be noted that both a fixed tap **44** and a variable tap **43** are included. FIG. 2 portrays a series of graphic illustrations useful in the explanation of their purposes and function. In FIG. 2*a*, the resistive element of potentiometer **40** includes a series of parallel resistance paths, such as represented by R*x*', R*x*'' and R*x*'''. Additional paths will also be present which run perpendicular to the aforementioned parallel paths. One such group of paths are represented as R*y*' and R*y*'', occurring at the point of contact of variable tap **43**.

In electrical circuit terms, the arrangement can be represented by an equivalent T network as shown in FIG. 2*b*. It can be seen that the impedance represented by R*y* provides a common coupling between terminals **41** and **42**, thereby reducing the electrical separation of the circuits connected to these terminals and the terminal represented by variable tap **43**. As mentioned previously, this cross coupling between terminals **41** and **42** results in an inferior production fidelity in the separate stereo channels.

To reduce such undesirable cross coupling, a fixed tap **44** is incorporated to effectively reduce the value of cross-impedance R*y*. The tap is located at electrical midpoint in the resistive element of potentiometer **40** and makes contact over a relatively large area, as illustrated in FIG. 2*c*. By incorporating such a large contact area for fixed tap **44**, it can be readily seen that a substantial number of parallel cross-impedance paths will be provided which effectively reduces the value of the resultant cross-impedance R*y* whereby optimum electrical separation is maintained between the stereophonic amplifying channels connected to terminals **41** and **42** respectively. Cross-coupling between the separate stereophonic signals is thereby effectively prevented.

FIG. 3 illustrates the physical properties of potentiometer **40**. The general construction of potentiometer **40** is effected in a known manner wherein a resistive element **132** is supported on a flat wafer **131** of insulating material. A rotatable shaft **130** extends through a center hole in the wafer **131** and receives thereon a rotating member **134** which includes a conductive spring member **135**. Spring member **135** makes contact with resistive element **132** at a contact point depending upon the position of shaft **130**. Electrical continuity is maintained from resistive element **132** through contacts **135***a* through contacts **135***b* to conductive washer **133** which is an integral part of terminal **43**. As illustrated, an additional terminal is included which is connected to the approximate electrical midpoint of resistive element **132**, thereby providing a fixed tap **44**. Mounting cover **136** encloses the internal component parts of potentiometer **40**. An electrical switch **137** is further provided as part of potentiometer **40** and operates in a known manner.

The invention therefore provides an improved balance control for a stereophonic sound signaling translating apparatus wherein both a variable tap and a fixed tap are included. The fixed tap is located at the electrical midpoint of the resistive element of the potentiometer and, when connected to ground, provides optimum isolation between the separate stereophonic channels to prevent cross coupling therebetween.

I claim:

1. Stereophonic sound signal utilization apparatus including in combination, first and second amplifier channels for conducting respective stereophonic sound signals, a balance potentiometer having a continuous resistance element with the ends thereof connected respectively to said amplifier channels, said potentiometer further having a fixed center tap and a manually variable tap both connected to a reference point for said apparatus, said variable tap being adjustable over substantially the full length of said resistance element to balance the amplification level of signals in either of said channels with respect to the other, said fixed center tap having a reduced impedance to the reference point with respect to said variable tap thereby improving the electrical separation between said channels and reducing cross coupling of signals therebetween.

2. Stereophonic signal translating apparatus, including in combination, first and second amplifying means for respectively amplifying first and second stereophonic signals, a variable potentiometer control for balancing the respective output signals from said first and second amplifying means and including a resistance element, said first and second amplifying means having output circuits connected to opposing terminals on said resistance element, said potentiometer further including a variable tap and a fixed tap, said variable tap being movable over the full length of said resistance element between said opposing terminals and connected to a reference potential whereby the stereophonic signals in said output circuits of said first and second amplifying means are developed across portions of said resistance element according to the position of said variable tap, and means coupled to the opposing terminals of said resistance element for utilizing the stereophonic signals developed across the portions of said resistance element, said fixed tap being located at the electrical midpoint of said resistance element and connected to the reference potential thereby improving electrical separation between said first and second amplifying means to reduce cross-coupling between first and second stereophonic signals.

3. Stereophonic signal translating apparatus, including in combination, first and second amplifying means for amplifying respective stereophonic signals, said amplifying means each including first and second electron discharge devices having input, output and common electrodes, said first electron discharge devices each having a series resistance and capacitance means coupled to said output electrodes, said second electron discharge devices each having an input circuit network coupled to said input electrodes, said series resistance and capacitance means being connected to common junctions with said input circuit networks, a variable potentiometer control for balancing the respective output signals from said first and second amplifying means, said balance potentiometer having a resistance element with the ends thereof connected respectively to said common junctions between

said series resistance and capacitance means and said input circuit networks, means for respectively applying stereophonic signals to said input electrodes of said first electron discharge devices, said potentiometer further including a manually variable tap and a fixed center tap, said variable tap being movable over the full length of said resistance element between the ends thereof and connected to a reference potential whereby the stereophonic signals from the output of one of said first electron discharge devices are developed across said series resistance means associated therewith and a portion of said resistance element according to the position of said variable tap, and means coupled to said output electrodes of said second electron discharge devices for utilizing said respective stereophonic signals, said fixed center tap being located at substantially the electrical midpoint of said resistance element and connected to said reference potential whereby the stereophonic signals from the output of the other of said first electron discharge devices are developed across said series resistance means associated therewith and the portion of said resistance element unaffected by said variable tap, thereby improving electrical separation between said first and second amplifying means to minimize cross-coupling between said stereophonic signals.

4. Stereophonic sound signal utilization apparatus including in combination, first and second amplifier channels for conducting respective stereophonic sound signals, a balance potentiometer having a resistance element of a given length and width with end portions thereof connected respectively to said amplifier channels, said potentiometer further having a fixed tap and a manually variable tap formed by first and second wipers on a rotatable member, said variable tap being connected to a reference point for said apparatus so that rotatable adjustment of said variable tap may balance the amplification level of signals in one of said channels with respect to the other, said fixed tap being located on one edge of said resistance element at approximately the electrical midpoint and having a width substantially the same as the width of said resistance element, said fixed tap being connected to said reference point whereby a reduced impedance is effected to said reference point with respect to said variable tap thereby improving the electrical separation between said channels and minimizing cross coupling of signals therebetween.



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