Nov. 12, 1963 K. BERTRAM 3,110,769

STEREO SOUND CONTROL SYSTEM

Filed Jan. 15, 1960 5 Sheets-Sheet 1

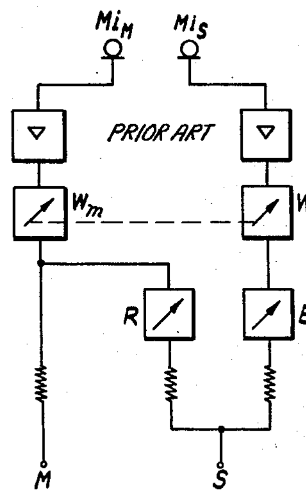

Fig. 1.

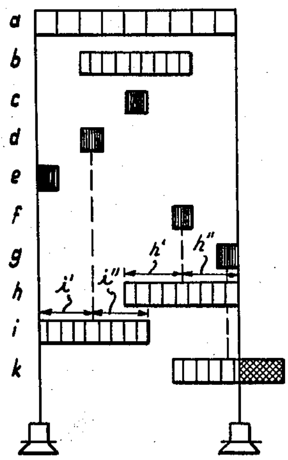

Fig. 2.

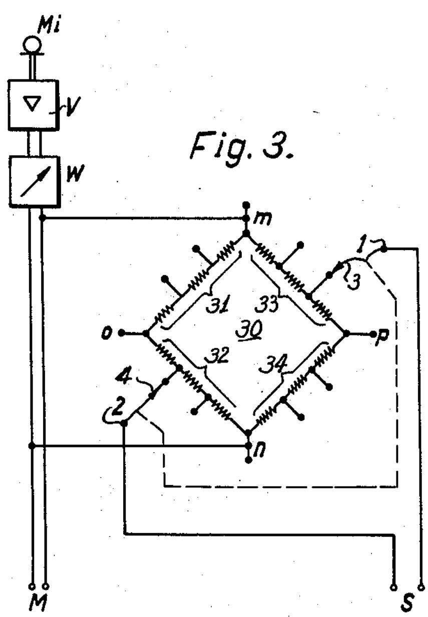

Fig. 3.

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STEREO SOUND CONTROL SYSTEM

Filed Jan. 15, 1960 5 Sheets-Sheet 2

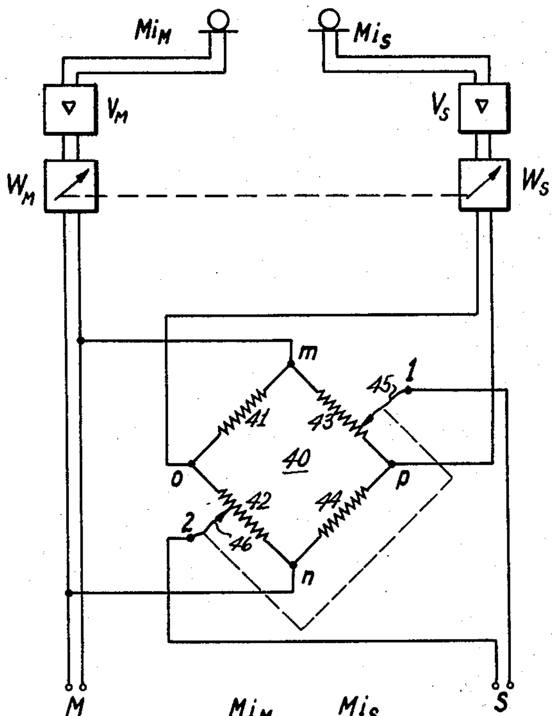

Fig. 4.

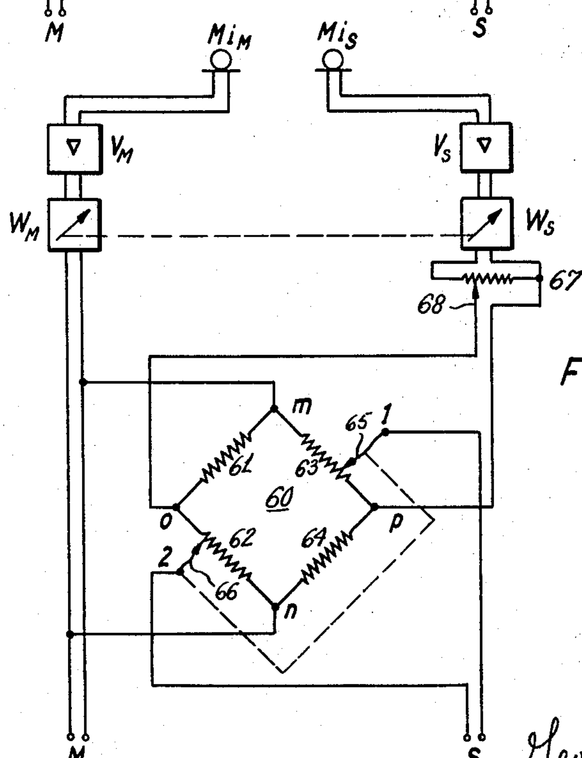

Fig. 6.

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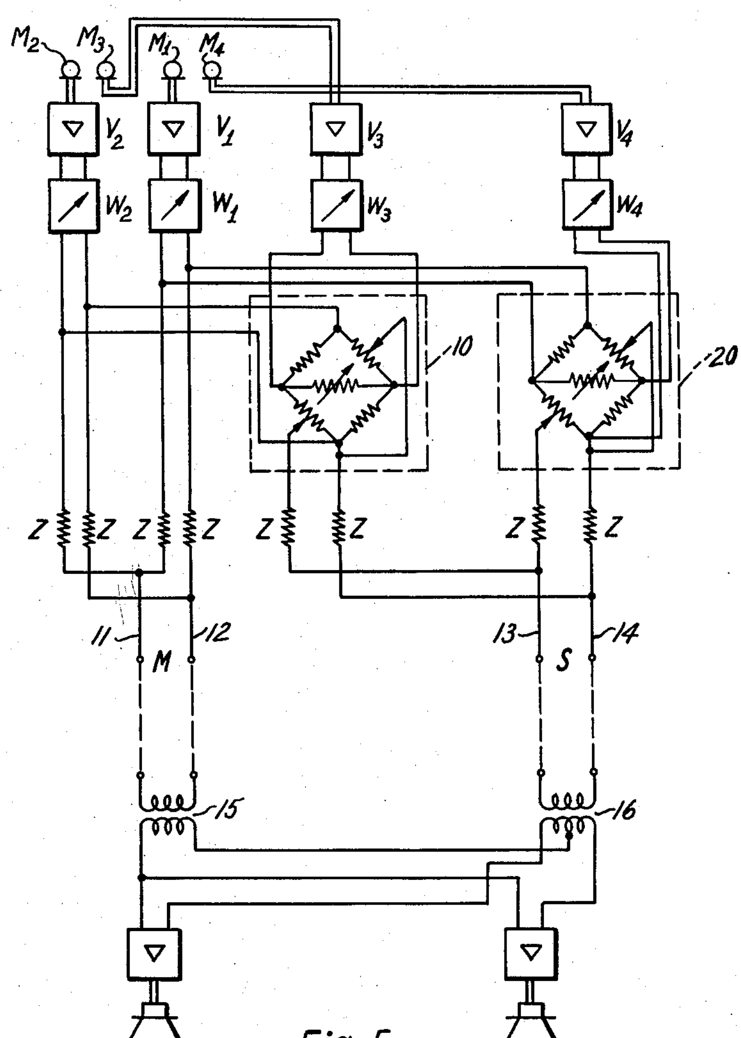

Fig. 5.

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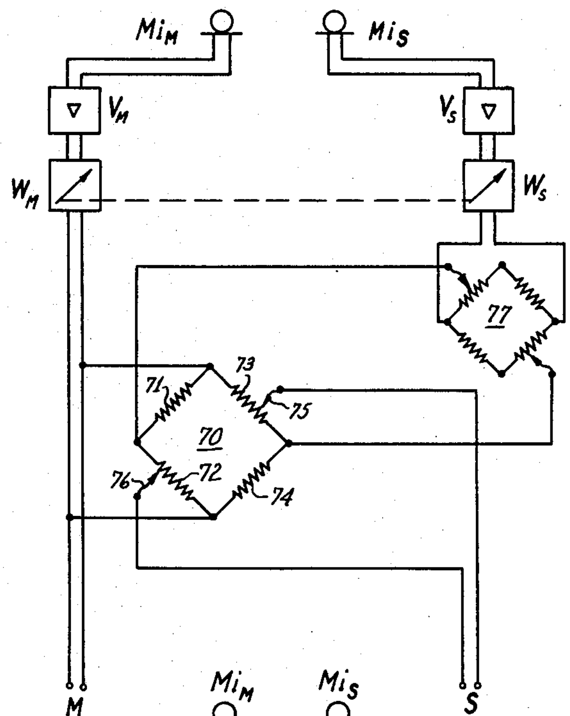

Fig. 7.

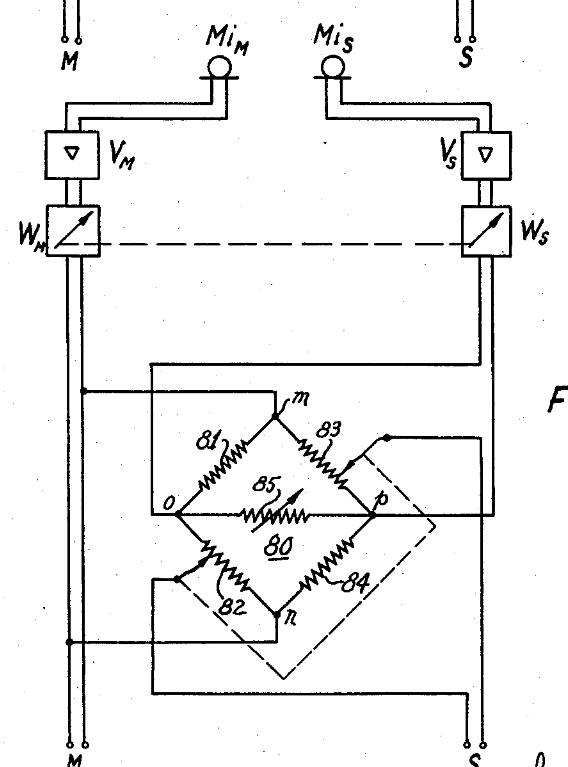

Fig. 8.

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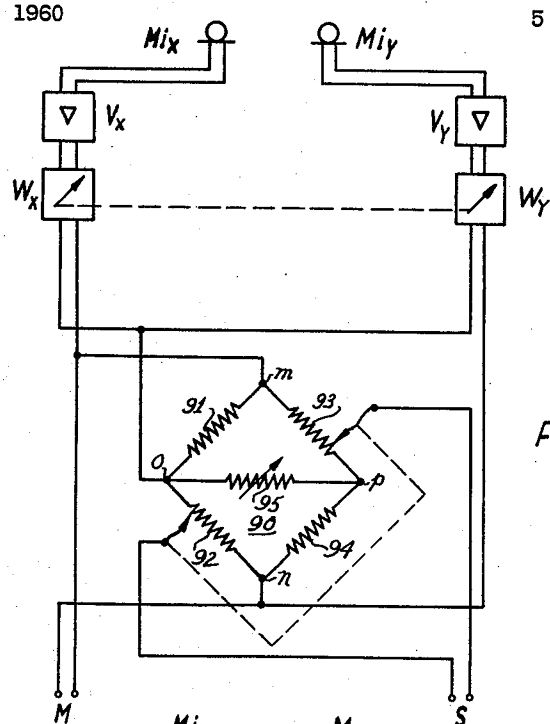

Fig. 9.

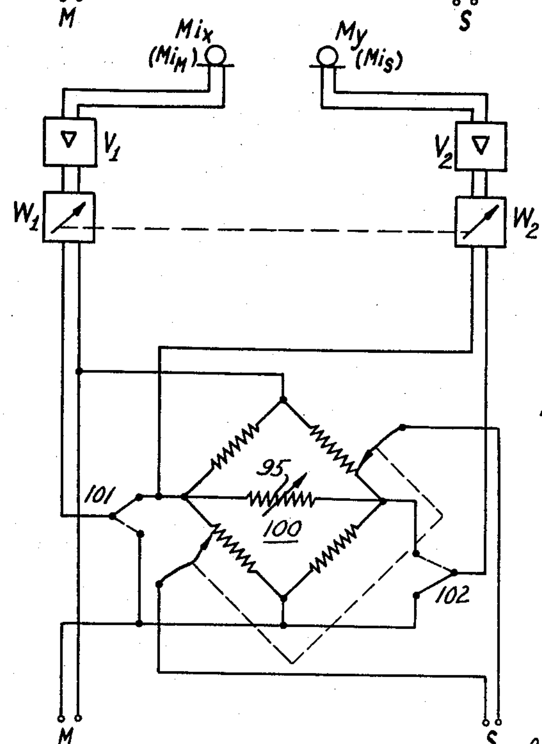

Fig. 10.

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United States Patent Office

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3,110,769

STEREO SOUND CONTROL SYSTEM

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Filed Jan. 15, 1960, Ser. No. 2,611
Claims priority, application Germany Jan. 17, 1959
11 Claims. (Cl. 179—1)

The present invention relates to a control circuit for compatible stereophonic sound recording wherein one channel comprises a sound channel and the other channel a direction channel.

It is known to produce stereophonic recordings by providing left and right microphones spaced from each other and to associate a channel with each microphone, thus providing right and left channels. With this type of recording, it is not feasible to obtain monophonic reproduction by playing back only one of these channels, because those of the sound signals which are primarily recorded in the unreproduced channel would be substantially suppressed. This is called non-compatible stereophonic recording.

For compatible stereophonic recording, it is advantageous to draw a distinction between a "sound signal" and a "direction signal" (see, for example, "Radio Mentor," 1958, pages 592–598), and to separately record these sound and direction channels. For example, in this type of recording, one may use two closely positioned microphones, one having a rather non-directional characteristic of the shape of a kidney, a sphere or a figure 8, whereby the entire sound source or sound-producing arrangement, such as an orchestra, is within the range of coverage in a completely symmetrical relationship. The other microphone has the characteristic of a transversely directed figure 8 having its axis pointed towards the sound source. The first one of these microphones produces the "sound signal" and is called the M-microphone; its associated channel is called the M-channel and will be designated as such in the following. The second one of these microphones produces the "direction signal" and is called the S-microphone; its associated channel is called the S-channel and will be designated as such in the following.

In case only monophonic reproduction is desired, only the signals of the M-channel are reproduced. In case of stereophonic reproduction, the signal M+S is fed to one loudspeaker, while the other loudspeaker is fed with a signal M−S.

In a modification of the MS technique, two closely positioned microphones are used, each having the characteristic of a figure 8, while the axes of symmetry of these characteristics are inclined by 90° with respect to each other, and by 45° with respect to the center of the sound source (X, Y microphones) (see, for example, ETZ–B, Elektrotechnische Zeitschrift, 1958, pages 240 to 242). With such a recording arrangement, MS signals are obtained from these XY microphones for electrically producing a signal X+Y which is an M-signal, and an X−Y signal which is an S-signal. For stereo-reproduction of these recorded M=X+Y, and S=X−Y signals, one has to produce also an M−S and an M+S signal. Thus, it is clear that the compatible stereophonic recording includes all the components for monaural reproduction of satisfactory quality. In case of multiple pickup microphone systems for recording, the various signals have to be controlled separately to produce a proper and correct or intentionally modified sound picture. The control will be effective particularly for purposes of amplitude control and directional association. In German Patent No. 1,010,569, corresponding to U.S. Patent No. 2,845,491, an arrangement is disclosed teaching how one

can obtain a controlled direction signal, an S-signal, from the output voltage of an ordinary microphone. This arrangement comprises basically a single microphone and a single amplifier channel feeding a first signal to the M-channel. The same amplifier output is fed to a transformer having a center-tapped secondary and a load potentiometer, and the S-signal voltage is taken from the center tap of the transformer and the tap of the potentiometer. When the potentiometer tap is in its center position, no S-signal is produced, but in any deflected position of the potentiometer tap an S-signal is developed. For reproduction, these two M and S signals are combined and an M+S signal is fed to one loudspeaker and an M−S signal to another loudspeaker. If the wiper of the potentiometer is moved from one terminal position to the opposite terminal position, the apparent sound source reproduced in the two loudspeakers appears to move from one side to the other side. Thus, the potentiometer is a direction regulator.

The recording arrangement having only a single microphone, as outlined above, can be augmented with a second microphone which produces a true directional signal. This signal is electrically added via an attenuation regulator to the S-signal as developed from the first-mentioned microphone. This attenuation regulator is a device making it possible to widen or narrow the angle of the apparent sound source. In other words, with the aid of the attenuation regulator, a sound picture may be produced wherein the sound appears to emanate from one point or a very narrow zone, or appears to come from a wide area. The difficulty is that the two directional signal components—one derived from the first microphone via the center-tapped transformer and a potentiometer (direction regulator), the other taken directly from a direction-sensitive second microphone via the attenuation regulator—are regulated independently, and it has been found that such an arrangement operates properly only within limited ranges, both of the direction regulator and of the base regulator. If, for example, during recording the direction regulator is adjusted so that upon reproduction the sound source seems to coincide or almost coincide with one of the reproducing loudspeakers, and if the base is now spread by means of the attenuation regulator, then the entire sound picture becomes distorted.

It is an object of the present invention to provide a new control network for compatible stereo recording overcoming the abovementioned difficulties.

It is another object of the invention to provide a new direction regulator for compatible stereophonic recording.

It is another object of the invention to provide a new control network for compatible stereo sound recording in when the attenuation regulator and the direction regulator cooperate better with each other.

It is a further object of the invention to provide new control elements to be used in compatible stereo sound recording arrangements operating with a plurality of microphones, whereby expense and complications are reduced and high-fidelity transformers can be omitted.

According to one aspect of the invention, in a preferred embodiment thereof, a resistance network, preferably a bridge, is provided made up of tapped resistors or potentiometers and at two diagonal points of the bridge, a voltage depending upon an M-signal, sound signal, is applied. Two ganged potentiometer wipers or two resistor taps, positioned opposite to each other, tap off an S-signal from this bridge. The limit of the operation positions of the wipers is dimensioned so that the S-signal can be equal in amplitude and phase to the M-signal, or it can be equal in amplitude but opposite in phase thereto, or it can be zero.

According to a further improvement, the other two diagonal points of the bridge receive a signal derived directly from a direction microphone, said signal preferably being fed to the bridge via an attenuation regulator.

In another embodiment of the invention, the bridge may selectively be connected to a pair of MS microphones or a pair of XY microphones.

Still further objects and the entire scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

In the drawings:

FIGURE 1 illustrates in a block diagram the basic principle or regulated M, S compatible stereophonic recording;

FIGURE 2 is an illustrative diagram to explain the results to be achieved;

FIGURE 3 is a basic circuit diagram of a first embodiment of the invention;

FIGURE 4 is a circuit diagram illustrating how a circuit, as shown in FIGURE 3, can be used in a larger recording arrangement;

FIGURE 5 is a circuit diagram illustrating another embodiment of the invention, wherein two M, S microphones are used and a regulated directional signal, S-signal, is derived;

FIGURE 6 is an improved circuit diagram similar to FIGURE 5, using an additional base regulator;

FIGURE 7 is a further modified circuit diagram, similar to FIGURE 6;

FIGURE 8 is another modified circuit diagram, similar to FIGURE 6;

FIGURE 9 is a circuit diagram illustrating how the invention can be used to derive regulated M, S signals from X, Y microphones, and

FIGURE 10 is a circuit diagram illustrating how the circuits shown in FIGURES 8 and 9 can be combined.

Turning first to the block diagram of FIGURE 1, there are two microphones Mi_m and Mi_s which are a pair of MS microphones. Microphone Mi_m may, for example, have a spherical coverage characteristic, while microphone Mi_s, being closely positioned to microphone Mi_m, has a figure 8 directional characteristic. The outputs of the two microphones are amplified and fed to separate mixer control elements W_m and W_s, respectively. The output of element W_m serves primarily as an M-signal in an M-channel, so designated; and this same output is also fed to a direction regulator R which varies the amplitude and phase of its input. Regulator R may be a transformer with a center-tapped secondary and a load potentiometer, as mentioned above. The output of element W_s is controlled by an attenuation regulator B. The outputs of regulators R and B are then combined and serve as the S-signal in an S-channel, so designated. M and S signals may then be recorded; and from the recording, M+S signals and M−S signals will be reproduced for stereo reproduction. However, one can also reproduce the M-signal alone for monaural reproduction.

The basic arrangement of FIGURE 1 is known in the art (see Radio Mentor, 1958, pages 592 to 595). The invention is concerned with a new design of direction regulator R and to its combination with an attenuation regulator B.

Having thus produced M and S signals, the reproduction thereof yields the possibilities demonstrated in FIGURE 2. In this figure, there are shown two channels fed with M+S and M−S signals, respectively. Above these signals, there are shown the various sound pictures they may produce when regulators R and B are adjusted during recording as follows. Suppose the regulator R has been blocked completely, so that no component of the S-signal is derived from the M-channel, the base regulator is opened completely, then the resulting S-signal is of such type as to produce a sound picture indicated in line *a* of FIGURE 2, i.e., the sound seems to come from the entire zone between the two loudspeakers. If now the regulator B is readjusted to an intermediate position between fully open and fully closed, then the sound source is narrowed as indicated in line *b*. If the regulator B is in its lowest position, the sound picture is narrowed nearly to a point as indicated in line *c* of FIGURE 2, so that the sound appears to come from an almost point-source positioned between the two loudspeakers. Keeping regulator B in its lowest position, as just mentioned, one may shift the position of this apparent point-source by changing the position of regulator R. If this direction regulator R is, for example, of the type mentioned above, i.e., centertapped transformer with a load potentiometer, and the potentiometer is shifted out of its center position (zero-signal position), then a signal derived from the M-channel may be introduced into the S-channel causing apparent movement of the sound source, as indicated in lines *d* through *g*. In lines *e* and *g*, the sound picture corresponds to the two extreme positions of the potentiometer, lines *d* and *f* represent intermediate positions thereof. If the regulator R is in such an intermediate position, producing sound sources, as illustrated in lines *d* and *f*, and if the attenuation regulator is now partially opened, sound pictures will be produced as denoted in lines *i* and *h*, respectively. Suppose regulator R is in one of the its terminal positions and a sound distribution as indicated in line *g* is produced, if the attenution regulator B is now opened, the sound picture will or should appear as indicated in line *k*. However, this is not the case, and unpleasant shifts and distortions occur resulting in a complete misreproduction. Also, in case of line *a*, the attenuation regulator was open, but the direction regulator R was in its zero position, as stated above. If the direction regulator R would be open, the broad sound picture of line *a* would not be moved to the right or left, but would be distorted.

The new inventive arrangement provides for direction and base regulation which automatically prevents such distortions, i.e., the regulators are so designed that there is no possibility to adjust them so that neither the distorted example of line *k* nor any other undesirable case may occur.

FIGURE 3 shows a first embodiment of the invention. A single microphone *Mi* feeds an elctrical audio signal to an amplifier V, the output of which is fed into a mixing regulator W. The output of regulator W first provides a sound channel or M-channel. The output of regulator W is also fed to connection points *m, n* which are the vertical diagonals of a resistor bridge **30** comprising four similar resistors **31, 32, 33** and **34**. As a matter of fact, only two adjacent resistors need to be similar, while the other two are also similar, but may be different from the first pair. Every one of these resistors is subdivided into smaller units. In the present case, every resistor **31** to **34** consists of three resistor elements, the junctions of which comprise taps connected to the contacts of a switch. The switch is provided with wipers **3** and **4** which are ganged and move in the same direction, for example, clockwise, around the bridge. The voltage between wipers **3** and **4** is fed to terminals **1** and **2** respectively, which are connected to the directional channel S. If the wiper **3** is at bridge point *m*, then wiper **4** is at bridge point *n*. In this case, the wipers **3** and **4** are directly at the output terminals of regulator W. Thus, terminals **1, 2** and the direction channel S receive a voltage which is equal in amplitude and in phase to the signal in the M-channel. If the positions of wipers **3** and **4** are reversed, i.e., if they are turned by 180°, so that wiper **4** is at point *m* and wiper **3** is at point *n*, then the S-channel obtains a signal which is equal in amplitude but opposite in phase to the signal in the M-channel. If wiper 3 is placed at *p* and wiper 4 at *o* position, or vice versa, the signal fed to channel S is zero, because the bridge is balanced. It will be appreciated that the particular position of the wipers, as shown in the drawing, corresponds to an intermediate position of the signal fed to the direction channel S. This signal is in phase with the signal fed to the M-channel, but is of a smaller amplitude.

If the information M+S is fed to one loud-speaker of a stereophonic reproduction device, while the information M—S is fed to the other loudspeaker thereof, a certain stereophonic effect is obtained which effect can be changed when the positions of wipers 3 and 4 are altered.

It will be understood that resistors 31 to 34 could be modified so that resistors 31 and 32 comprise one single potentiometer, while resistors 33 and 34 comprise another potentiometer. These potentiometers are connected in parallel and the M-signals is fed to their junctions. The ganged wipers of these potentiometers form the input for the S-channel.

FIGURE 4 illustrates a modification of the circuit shown in FIGURE 3, whereby MS twin microphones comprising two closely positioned microphones Mi_m and Mi_s are used. A bridge 40 has resistors 4^1, 4^2, 4^3 and 4^4 which may, for example, be of the continuously variable type. However, bridge 40 could also be of the type as bridge 30 of FIGURE 3. *m, n, o* and *p* are again the bridge junction points. The output of microphone Mi_m is amplified in amplifier V*m*, the output of which is fed to a regulator W*m* which, in turn, feeds an output to the M-channel. This latter output is also applied to points *m* and *n* of bridge 40.

Throughout this specification and the drawings, elements V*s*, V*m*, W*s* and W*m* are the same type as in FIGURE 4 and will not be mentioned specifically hereinafter, but their presence is understood. The Mi_s part of the twin microphone feeds its output to an amplifier V*s* which, in turn, feeds an amplified output to a mixing regulator W*s*. A signal is derived from regulator W*s* and is fed to points *o* and *p* of bridge 40.

The wipers 45 and 46 at terminals 1 and 2, respectively, take off the S-channel signals assuming the wiper 45 is at point *p* and wiper 46 is at point *o*. In this case, no information of the M-channel is fed to the S-channel and the latter receives all information from the Mi_s microphone. This means that, in this wiper position, channel M obtains the information of microphone Mi_m and channel S obtains the information of microphone Mi_s. Thus, the outputs of microphones Mi_m and Mi_s are completely decoupled and are fed to separate channels.

However, if terminal 1 is connected to point *m* and terminal 2 is connected to point *n*, then no signals from the Mi_s microphone are fed to the S-channel, but the latter carries the same signals as the M-channel. It is apparent that, upon a reversal of this connection, the S-channel obtains signals equal in amplitude but opposite in phase as compared with the signals in the M-channel. If in two loudspeakers the signal combination M+S and M—S were formed, either one of the sound pictures of line *e* or *g* in FIGURE 2 would be obtained. Intermediate positions of the wipers 45 and 46 may produce sound pictures of lines *d* and *f* of FIGURE 2, while a connection of the wipers to points *o* and *p*, i.e., exclusion of the Mi_m information from the S-channel, gives sound picture *c*, FIGURE 2.

FIGURE 5 shows how a device as illustrated in FIGURE 4 can be used in a larger unit. There are two twin microphones M_1, M_3 and M_2, M_4 which may be positioned close to two different sound sources to be recorded together. Amplifiers V_1, V_2, V_3 and V_4 and mixing regulators W_1, W_2 W_3 and W_4 perform functions corresponding to the elements V and W in FIGURE 4. The outputs of mixing regulators W_1 and W_2 are fed first to a common pair of leads 11 and 12 via decoupling impedances to prevent audio feedback. Leads 11 and 12 serve as output terminals for channel M. The outputs of regulators W_1 and W_2 are also fed separately and independently to regulators 10 and 20, respectively. The regulators 10 and 20 are of the type as denoted by 40 in FIGURE 4 and operate correspondingly. The outputs of regulators W_3 and W_4 are also fed to bridge regulators 10 and 20, respectively. The output terminals of regulators 10 and 20 which are taken from the movable potentiometer wipers thereof are connected to a common pair of leads 13 and 14 which form the S-channel. Inasmuch as regulators 10 and 20 are separately adjustable, the directional effects of what the microphones M_1 and M_2 have picked up are separately adjustable.

To illustrate the further use of the M and S channels, FIGURE 5 also incorporates the reproduction arrangement of M and S signals. Input transformer 15 is supplied from the M-channel, input transformer 16 is supplied with the S-channel. The secondaries of transformers 15 and 16 are interconnected in such a way that the left-hand speaker obtains the signal M+S, while the right-hand speaker obtains the signal M—S.

FIGURE 6 shows an improvement of the circuit shown in FIGURE 4. Potentiometers 41 to 44 of bridge 40 and wipers 45 and 46 in FIGURE 4 correspond to potentiometers 61 to 64 of bridge 60 and wipers 65 and 66, respectively, in FIGURE 6. However, in FIGURE 6, an attenuation regulator or attenuation control 67 is connected to the output terminals of mixer stage W_s. With tap 68 of attenuation regulator 67, the magnitude of the signal from the Mi_s microphone as applied to the points *o* and *p* of bridge 60 can be controlled. Thereby, the intensity of the directional signal is controlled. When the wiper 68 is in its left-hand extreme position, the attenuation regulator is fully opened, and when terminals 1 and 2 are connected to points *o* and *p* of bridge 60 by means of the wipers 65 and 66, respectively, the apparent sound distribution corresponds to line *a* of FIGURE 2.

If wiper 68 is moved to the right, the base of the sound reproduction will be narrowed and the sound picture may in one of these wiper positions correspond to line *b* of FIGURE 2. Upon moving wiper 68 all the way to the right, the sound picture is concentrated to a point as shown in line *c* of FIGURE 2. As already stated above, terminals 1 and 2 were constantly connected to points *o* and *p* of bridge 60 during these operations. If now the wiper 63 at terminal 1 is moved along potentiometer 63 towards point *m* while, simultaneously, the wiper 66 of terminal 2 moves along potentiometer 62, the apparently concentrated sound source may be moved to the left, as indicated in line *d* of FIGURE 2. Of course, whether the sound source appears to be moving to the left depends upon the selection of the connection of M and S signals to the two stereo loudspeakers. Thus, it is only a question of line connection which particular wiper movement of bridge 60 corresponds to a right or a left movement of the sound source. This is true for all embodiments disclosed herein.

A movement of the wiper 65 at terminal along potentiometer 64 from point *p* towards point *n* and a corresponding movement of the wiper 66 at terminal 2 along potentiometer 61 from point *o* towards point *m* produces a movement of the concentrated sound source from a center position (line *c* in FIGURE 2) towards the right (lines *f* and *g* in FIGURE 2).

Looking particularly at the intermediate positions producing sound distributions, such as indicated at lines *d* and *f* in FIGURE 2, attenuation regulator 67 may now be opened by shifting wiper 68 thereof towards the left, while bridge 60 remains in a fixed adjusted position. Such opening of attenuation regulator 67 will result in a broadening of the sound basis, such as indicated in lines *h* and *i* in FIGURE 2. The case *k* of FIGURE 2 now is no longer possible, because in the position of bridge **60**, producing the sound picture of line *g*, the terminals **1** and **2** are connected to points *n* and *m* of bridge **60**, thus excluding the influence of microphone Mi_s completely from the S-channel. Thus, any movement of wiper **68** remains ineffective. As to the intermediate positions, attenuation regulator **67** can be opened only as far as the Mi_s is permitted to influence the S-channel. Therefore, only in a position as indicated in line *a* in FIGURE 2, the broadest base (wiper at *o* and *p* of bridge **60**) can be obtained; any intermediate position of the wipers **65** and **66** in bridge **60** produces a smaller apparent width of the base, i.e., a smaller maximum base, for completely opened attenuation regulator **67**. If the bridge and the associated switches are constructed as wipers in such a manner that the wiping path is circular, while the wipers themselves are always in phase opposition, i.e., 180° apart, the entire device can be made so as to cover a full circle.

Having recorded a selection using such a control network and a fixed stereo loudspeaker arrangement, a sound distribution can be produced in which the sources are exchanged, i.e., the wiper **65** of terminal **1** now could also move to and from point *o* on both sides thereof, while the other wiper could move to and from point *p* also on both sides thereof, in which positions the component of microphone Mi_s in the S-channel has obtained an opposite phase position, as compared with the range of wiper movement described before. In terms of the sound pictures of FIGURE 2, this would means that, for example, the portions *l'* and *l''* would exchange places with the portions *h''* and *h'* if the wipers were shifted by 180° from the position producing the sound picture according to line *i*, while sound picture portions *l'* and *l''* would substitute for portions *h'* and *h''*, respectively, upon a shift of 90° of both the wipers of the potentiometer **60**.

FIGURE 7 is a modification of the device shown in FIGURE 6. Elements **60** to **66** of FIGURE 6 correspond to elements **70** to **76** in FIGURE 7. Furthermore, in FIGURE 7, the attenuation regulator controller is a bridge arrangement **77** which is similar to the bridge arrangement of FIGURE 3. If the two wipers of bridge **77** are in the horizontal position, the full output of microphone Mi_s is fed to bridge **70**, while in the vertical wiper position of bridge **77**, no voltage is fed to the horizontal points of bridge **70**. Thus, bridge **77** need only to be controllable over an angle of 90° for its wipers. If the control range of bridge **77** is designed for 180°, the voltage fed from the wipers of bridge **77** to points *o* and *p* of bridge **70** can be reversed, i.e., the signals from microphone Mi_s can be shifted by 180° in phase. In this case, bridge **70** needs to have an adjustment range of only 180° and sound pictures can still be produced with reversed sides, as explained above with reference to FIGURE 6.

FIGURE 8 is another modification of the circuit shown in FIGURE 6. Elements **80** to **84** correspond to elements **60** to **64** in FIGURE 6, but the attenuation regulator **85** is an adjustable shunt for the output terminals of regulator W*s* or, stated differently, adjustable resistor **85** is connected between points *o* and *p* of bridge **80**. The mode of operation is the same as explained in connection with FIGURE 6.

FIGURE 9 is a modification of the circuit shown in FIGURE 8 for the case where the microphones are two XY microphones, i.e., they are microphones which have a directional sensitivity mutually displaced by 90° and their zero axes being displaced by 45° symmetrically at both sides of the center of the sound source during recording through 90°. Amplifiers V*x* and V*y* and mixing regulators W*x* and W*y* have corresponding functions as compared with the amplifiers V*s*, *V*m, and regulators W*s*, W*m* of the preceding figures. In FIGURE 9, a bridge **90**, comprising resistors **91**, **92**, **93** and **94**, is provided to perform a similar function as bridge **80** of FIGURE 8. In FIGURE 9, however, the voltage applied to the vertical diagonally spaced junction points *m* and *n* of bridge **90** is the sum of the outputs of regulators W*x* and W*y*, because the output of W*x* is applied across resistor **91** and the output of W*y* is applied across **92**. Thus, points *m* and *n* received an X+Y signal, while the horizontal diagonally spaced points are at potentials the difference of which is voltage which is the difference of the outputs of W*x* and W*y*, thus they obtain an X—Y signal. The X+Y signal corresponds to an M signal, while the X—Y signal correspond to an S-signal. Thus, bridge **90** receives in fact signals which correspond to the M and S signals as applied to bridge **80** of FIGURE 8.

It will be appreciated that no differential transformer is necessary in this arrangement, as was required prior to the invention, to produce M and S signals out of X and Y signals.

FIGURE 10 illustrates how the circuits of FIGURES 8 and 7 can be combined in order to be used selectively with M, S microphones or with X, Y microphones. Bridge **100** corresponds to either one of bridges **80** and **90** in FIGURES 8 and 9, respectively. Two switches **101** and **102** are provided which, in their upper position, connect the sum of the outputs of regulators W_1 and W_2 between the *m*, *n* points of bridge **100** and connect the difference of these outputs between the *o*, *p* points of bridge **100**. This corresponds to FIGURE 9. In the lower position (dashed lines), the switches connect the output of regulator W_1 to the *m*, *n* points and the output of regulator W_2 to the *o*, *p* points. This corresponds to the arrangement of FIGURE 8. When using M—S microphones, the switches are placed in their lower position, and for X—Y microphones, the switches are placed in their upper position.

I claim:

1. A control system for use in compatible sound recording of the type employing a sound channel and a direction channel and at least one microphone, said system comprising, a resistance bridge circuit including four branch resistances, the microphone being coupled to said sound channel and to a pair of terminals located at one of the two bridge diagonals to supply input to the bridge; two output terminals coupled to the direction channel; separate adjusting means connecting each of said output terminals to two diametrically opposite resistances; and mechanical means linking said separate adjusting means together for ganged movement along said resistances, whereby at one end of the range of movement the output voltage across said output terminals is equal in phase and amplitude to the input voltage from the microphone and at the other end of the range of movement, the output voltage is equal in amplitude but opposite in phase to the input voltage.

2. In a system as set forth in claim 1, said resistances on opposite sides of said one diagonal comprising potentiometers each having a wiper connected with an output terminal.

3. In a system as set forth in claim 1, said two diametrically opposite resistances each comprising a chain of resistors, and said adjusting means comprising a multiple pole switch associated with each of said two diametrically opposite resistances and having its wiper connected to an output terminal and its poles connected with the junctions at the ends of said resistors.

4. In a system as set forth in claim 1, said bridge comprising, four resistance branches connected end-to-end to form two diagonals and a second pair of input terminals; a second microphone developing a signal representative of directional information and coupled to said second pair of input terminals; and said adjusting means being associated with resistances occupying two opposite branches of the bridge.

5. In a system as set forth in claim 4, attenuation control means connected between said second microphone and said second pair of input terminals.

6. In a system as set forth in claim 4, attenuation

control means comprising a variaible resistance connected across a diagonal of the bridge between said second pair of input terminals.

7. In a system as set forth in claim 5, said attenuation control means comprising a bridge circuit including resistances connected across a diagonal to two terminals thereon, said terminals being connected with said second microphone, and said bridge including output terminals connected with two resistances on opposite sides of said diagonal and connected with said second input terminals.

8. A control system for use in sound recording and reproducing comprising, at least two microphones having directional axes disposed at an angle with respect to each other, each microphone having an output; a bridge comprising four resistances connected end-to-end to form two diagonals with opposite pairs of terminals of the resistances; means for connecting said microphone outputs across two resistances, respectively, of the bridge adjacent a common terminal; first and second pairs of sound output terminals; means connected with the bridge at a pair of opposite terminals and with the first sound output terminals to feed the sum of the microphone outputs thereto, one of the adjacent resistances and the resistance there-opposite comprising potentiometers having wipers, and said wipers being connected to said second pair of sound output terminals.

9. In a system as set forth in claim 8, alternative means for connecting the microphone outputs respectively to opposite pairs of bridge terminals; and switch means connected with the microphones for selectively connecting them with said first mentioned microphone connecting means or with said alternative means.

10. A stereo sound control arrangement incorporating two control systems for use in compatible sound recording of the type employing a sound channel and a direction channel and at least one microphone, each system comprising a resistance bridge circuit having four resistance branches connected end-to-end to form two diagonals, a first pair of input terminals located at one of the two bridge diagonals and a second pair of input terminals, a first microphone coupled to said sound channel and to said first pair of input terminals, a second microphone developing a signal representative of direction information and coupled to said second pair of input terminals, two output terminals coupled to the direction channel, separate adjusting means connecting each of said output terminals to two resistances occupying opposite branhes of the bridge, and mechanical means linking said separate adjusting means together for ganged movement along said resistances, whereby at one end of the range of movement the output voltage across said output terminals is equal in phase and amplitude to the input from said first microphone and at the other range of movement the output voltage is equal in amplitude but opposite in phase to the last-mentioned input, the microphones of the two systems being distributed in mutually adjacent relation, the sound channel terminals of the two systems being connected mutually in parallel and the direction channel output terminals of the two systems being connected mutually in parallel.

11. Stereophonic sound apparatus comprising: a first channel for a sound signal; a second channel for a directional signal; and an adjustable impedance coupling said channels for producing in said second channel a signal which is at least partly derived from a signal in said first channel, said adjustable impedance comprising a bridge having four resistive arms so connected that a signal derived from said first channel is applied across a diagonal of said bridge and the signal fed to said second channel is derived from a pair of oppositetly disposed contacts which are movable together to make contact with points on respective pairs of opposite arms of said bridge, whereby the signal fed to said second channel is adjustable in magnitude and phase relative to the signal derived from said first channel.

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