

July 27, 1965

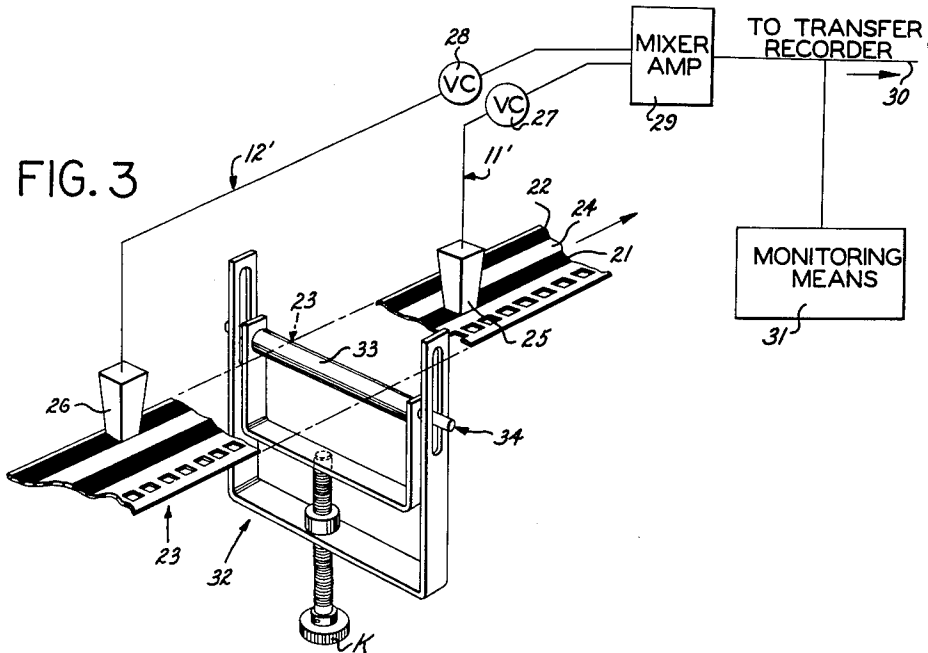
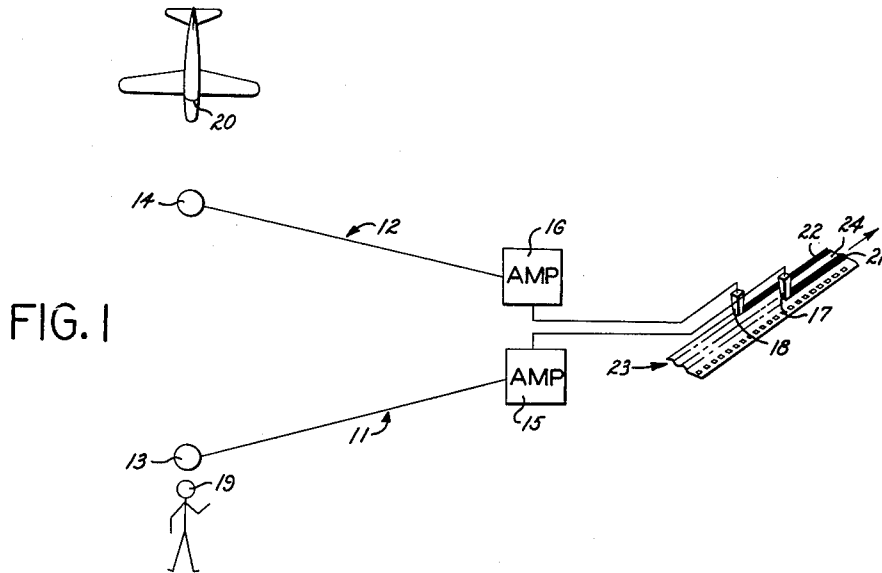
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3,197,574

NOISE SUPPRESSION SYSTEM

Filed April 16, 1962

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 2

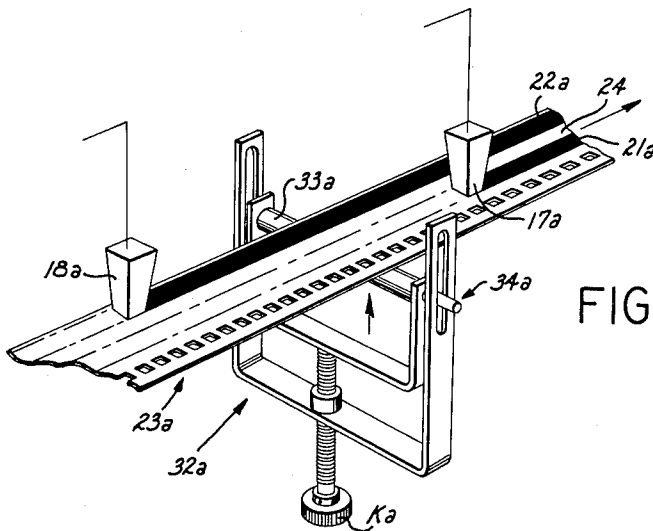
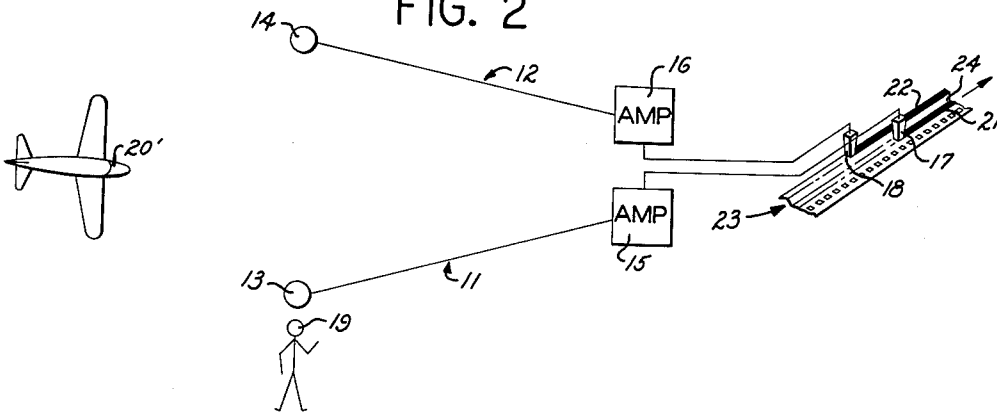


FIG. 4

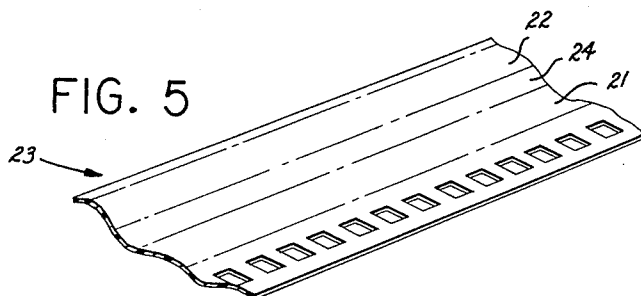


FIG. 5

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1

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NOISE SUPPRESSION SYSTEM
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Generally speaking, the present invention relates to the sound recording art and, more particularly, pertains to apparatus and method for producing a resultant electrical signal from electrical signal portions corresponding to a wanted sound passage and an unwanted noise passage, with the electrical signal portion corresponding to the unwanted noise passage being substantially minimized relative to the electrical signal portion corresponding to the wanted sound passage.

More specifically, the wanted sound passage will usually comprise dialogue, music, and the like being recorded on a motion picture or television set, location, sound stage, or the like while a story or play is being enacted by one or more actors.

In current practice, the wanted sound passage, comprising the words spoken by the actor or plurality of actors, music, or any other desired sound, is normally picked up by a conventional microphone appropriately placed as near as is feasible to the source of the wanted sound passage.

In a great many conventional sound recording situations of the general type referred to above, undesired background noise may also be picked up by the microphone and, if of a sufficiently great amplitude, may seriously impair the value of the sound recording of the entire scene of the story or play. Sometimes this result is not too apparent at the time of the enacting of the scene and the recording of the sound, but becomes immediately and saliently obvious when the sound recording is played back.

Indeed, this constitutes a great hazard because of the distracting effect of the undesired background noise and, because in certain instances it may comprise an embarrassing anachronism insofar as the supposed setting and period of time of the scene being enacted and recorded. For example, it quite obviously is extremely distracting, while watching a motion picture depicting events allegedly occurring in the medieval period and showing knights in armor or the like, suddenly to hear loud and clear the noise of a jet airplane or automobile horn in the background. This type of occurrence frequently requires re-shooting the entire scene.

Various other types of background noises are also undesirable, and various attempts have been made in the past to minimize or eliminate them. The most direct prior art practices in this connection consist in one way or another of getting away from the source of the undesired background noise, or of waiting until there is no background noise before beginning the shooting of the scene, which is to be photographed and sound recorded. This, of course, is a rather haphazard and wasteful procedure and may result in the loss of a great deal of so-called "shooting time" while salaries for various expensive actors, directors, crews, technicians and the like run on and continue to accrue, thus greatly increasing the cost of photographing and sound recording the scene in an acceptable manner with a minimum of undesirable background noise.

Other prior art attempts to alleviate this problem have consisted primarily of employing so called "threshold gates" arranged in any one of a variety of ways to effectively through-pass for recording only sound occurring between the beginning and ending of a desired sound passage, such as a passage of dialogue or the like, while effectively minimizing the recording of any sound at all

2

other times. This type of prior art system has serious disadvantages because the only time that it really eliminates or minimizes undesired background noise is in between the recording of desired sound passages. It does not eliminate background noise during the period when a desired sound passage is being recorded. Indeed, it does not even minimize this type of background noise and provides no solution to the problem of this type of background noise at all. Furthermore, such threshold gates usually act in a clipping manner both at the beginning and ending of a desired sound passage, and the time involved in this clipping action may be such as to effectively clip either the first or last portion, or both, of the desired sound passage, thus producing artificial or unnatural sound at such beginning or ending portions of the desired sound passage when it is played back.

Another prior art method used in an attempt to eliminate background noise employs the laborious and obviously unsatisfactory technique of "notching" or actually cutting out by hand the portion of the recorded sound track between portions of the sound track bearing the wanted sound and rerecording the notched sound track. While this method effectively eliminates background noise during periods when there is no wanted sound on the sound track, it does not in any way diminish the background noise recorded with the wanted sound.

Indeed, the above-mentioned prior art problems are the principal reasons for the construction of fully acoustically insulated sound stages, which are extremely costly.

In view of the above, it should be apparent that a system which will substantially minimize undesired background noise picked up during the recording of wanted sound, while a scene is being enacted would be extremely desirable.

Such a system would eliminate the problems entailed in getting away from potential sources of undesired background noise by travel to remote locations, by waiting for a period when the undesired background noise does not exist, or by working inside expensive acoustically insulated sound stages. Such an improved system should avoid the above mentioned disadvantages of prior art "threshold gate" systems which are characterized by the above-mentioned "end clipping" and which minimize background noise only during the periods of time between the recording of desired sound passages. Ideally an effective noise-suppressing device should minimize background noise, not only during such periods but also throughout the recording of desired sound passages, and it should do so without substantially reducing the quality or level of the recorded desired sound passages. Such a system is completely and fully comprised in the apparatus and method of the present invention which, therefore, has all of the advantages implicit in such a system as referred to briefly hereinabove.

It should be noted that the apparatus and method of the present invention can effectively accomplish undesired background noise minimization equally as well during the actual shooting and recording of a scene being enacted, or subsequently during rerecording from original sound recording made at the time of the actual shooting. Substantially the same apparatus and method can be used either during the original shooting and recording or subsequently for the production of a final sound recording with an extremely high ratio of recorded wanted sound passages to recorded unwanted noise passages. In practice this ratio is so high that the resultant sound passage is effectively free of audible levels of unwanted noise when it is played for listening.

It is an object of the present invention to provide apparatus and method of a type referred to hereinabove, which produces effective minimization of undesired back-

ground noise by transducing (usually by microphone means) the undesired background noise twice, first as a portion of, or associated with, the wanted sound passage and secondly as an auxiliary background noise passage, and by then effectively opposing and balancing out the corresponding two different background noise electrical signal portions in the proper time-equivalent and phase relationship, thereby minimizing or substantially eliminating the background noise electrical signal portions, thus leaving for all practical purposes an electrical signal portion corresponding to the transduced wanted sound passage only. This resultant signal, with the undesired noise portion substantially eliminated therefrom, may then be recorded to produce a superior sound recording.

It should be noted that in a slightly varied form the invention contemplates an arrangement wherein prior to the balancing out of the opposed unwanted noise electrical signal portions, dual channel recordings may be made of the uncorrected wanted sound passage and unwanted noise passage electrical signal portions which may subsequently be transduced and reconverted into dual channels of electrical signals which may then be balanced out in the manner described above.

It is a further object of the present invention to provide apparatus and method of the character referred to above, wherein the two signal portions which are to be balanced against each other are recorded on two different recording channels and the channels shifted with respect to transducing means in order to correct the difference in sound travel time from the original source of the unwanted noise to the main transducer or microphone for the wanted sound, and the travel time from said source of said unwanted noise to the auxiliary transducer or microphone for said unwanted noise. Identical time-equivalent portions of any unwanted noise passage can thus be brought into direct opposition in the stage of the invention associated with the reproduction transducer means, usually two different transducer or pick-up heads, so shifted relative to the two original sound recording and noise recording channels as to produce a resultant electrical signal having all component portions corresponding to the unwanted noise passage substantially balanced out.

It is a further object to provide novel apparatus and method of the character referred to in the preceding object wherein longitudinal shifting of the reproduction transducer heads relative to the two original sound recording and noise recording channels is accomplished by effectively lengthening or shortening the distance of said recording channels, which are physically joined together, between the position where one of said transducer means cooperates in transducing relationship with one of said recording channels and the position where the other of said transducer means cooperates with the other of said recording channels in transducing relationship relative thereto.

It is a further object to provide apparatus and method of the character referred to hereinbefore wherein the balancing out occurs at the time of original recording of the two channels of electrical signals produced by the main wanted sound transducer or microphone and the auxiliary unwanted noise transducer, and wherein said balancing out occurs by relative shifting with respect to the dual channels of a recording medium of recording heads for said main and auxiliary channels to bring about time-equivalent effectively balanced or opposed recordings on each of said twin channels with respect to the unwanted noise portions thereof, and which upon subsequent transduction into dual channel electrical portions can be directly opposed and balanced out without any further effective time shift being required.

It is a further object to provide apparatus and method of the type referred to hereinbefore employing electronic

means for accomplishing the required time delay and phase inversion.

It is a further object to provide apparatus and methods of the types referred to generically and specifically hereinabove which are of an extremely simple, foolproof, inexpensive, easy-to-operate and easy-to-maintain nature and which require no expensive installations or applications in the manner of prior art solutions for the problem of unwanted background noise, and are thus conducive to widespread use of the present invention.

For the purpose of clarifying the nature of the present invention, several exemplary embodiments of the apparatus form of the invention and of applications of the invention are illustrated in the figures of the accompanying drawings, and are described in detail hereinafter. It must be understood, of course, that these illustrations are not intended to be comprehensive of the method aspect of the present invention which is not limited to the particular apparatus shown.

FIGURE 1 is a diagrammatic or schematic view greatly reduced in size, illustrating one exemplary form of the present invention wherein two transducers comprising microphones are positioned at spaced locations such that one of them is near the source of the wanted sound, said wanted sound source comprising the actors of the scene being enacted, and wherein the other transducer means, also comprising a microphone, preferably having acoustical characteristics identical with those of the former microphone, is positioned considerably removed from the wanted sound source and closer to the source of an unwanted noise than the first mentioned microphone. The effect of this arrangement is to produce two sets of signals which have different ratios of unwanted noise electrical signal portions to wanted sound electrical signal portions, and which subsequently can be substantially balanced out insofar as the unwanted noise electrical signal portions are concerned.

FIGURE 2 illustrates in diagrammatic schematic form the arrangement of FIGURE 1 with the source of unwanted noise being differently located relative to the two microphones. It will be noted that in the case of FIGURE 1 the unwanted noise electrical signal portion of the signal in the auxiliary microphone will be greater than in the case of FIGURE 2. Even in the situation shown in FIGURE 2, however the ratio of the wanted sound electrical signal portion to the unwanted noise electrical signal portion in the first or wanted sound channel will be substantially greater than the ratio of wanted sound to unwanted noise electrical signal portions in the unwanted noise auxiliary channel connected to said auxiliary microphone.

FIGURE 3 illustrates in fragmentary, schematic, diagrammatic form, one particular arrangement for correcting and substantially balancing out the unwanted noise electrical signal portions by making this balancing correction at the transduction stage where first uncorrected dual recordings made from the dual channels of FIGURES 1 or 2 are transduced into corresponding electrical signals. The balancing correction shown is of a mechanical shifting type wherein the signals produced by the transducer means in each of the two reproduction or transfer recording channels will be in time equivalent and properly phased-for-balancing-out relationship suitable for opposition in a common mixer amplifier and for the production of a single composite fully corrected resultant signal which is normally fed to a transfer recorder for producing a single fully corrected sound track.

FIGURE 4 is a fragmentary, diagrammatic, schematic view illustrating another arrangement for effecting the balancing out of the unwanted noise electrical signal portions carried by the two different channels of FIGURE 1 or FIGURE 2. In this form this is accomplished at the time when the twin channel original recordings are produced, and is accomplished by mechanically shifting the

5

recording heads relative to the corresponding recording channels thereby bringing about desired time delay and phasing to produce time-equivalent recordings which, upon subsequent transduction into twin channels of the type shown in FIGURE 3 (but without requiring any further balancing adjustment of the recording medium), will produce electrical signals adapted to be combined in the common mixer amplifier in a manner such as to produce a single resultant signal having the undesired noise portions substantially fully balanced out.

FIGURE 5 is an enlarged fragmentary perspective view of one typical type of dual channel recording arrangement frequently employed by the motion picture industry, which may be used as a twin channel recording medium in the present invention. As stated earlier, the present invention is not specifically limited to this particular form of recording means or to any particular method of recording.

Referring to FIGURES 1-3, the invention is illustrated in one exemplary form wherein it comprises a first wanted sound channel indicated generally at 11, and a second auxiliary unwanted noise channel, indicated generally at 12, with each of said channels being provided with transducer means.

In the case of the first or wanted sound channel 11 the transducer means therefor comprises a first or wanted sound microphone 13, while in the case of the second or auxiliary unwanted noise channel 12, said transducer means comprises a second or unwanted noise microphone 14.

Preferably said first and second microphones 13 and 14 are of a conventional character-matched type so that similar sound or acoustic input into each one will produce substantially identical electrical signal outputs therefrom.

In the specific example illustrated, as best shown in FIGURES 1 and 2, said first and second channels are provided with amplifier means 15 and 16, respectively, which are likewise preferably of a matched character type suitable for producing optimum recording signals in each of said channels. If desired, in certain forms of the invention suitable pre-amplifier means may also be employed adjacent to the microphone means 13 and 14.

As best shown in FIGURES 1 and 2, said first and second channel means 11 and 12 are also provided with corresponding first and second recording transducer means which may be termed recording heads in accordance with conventional prior art practice and which are diagrammatically indicated at 17 and 18, respectively. It should be noted that said recording heads 17 and 18 may be of magnetic recording type, optical recording type, mechanical recording type, or comprise any other desired type of recording head or recording transducer, and preferably have matched characteristics.

Conventional means are employed for phase-inversion of one of the two channels 11 and 12. Preferably this may be accomplished by simple reversal of the polarity of the two channels, at the microphones, the amplifiers, pre-amplifiers, or recording heads, or at any other convenient stage within the circuits; however any other means for accomplishing such inversion would be acceptable.

The operation of the portion of the invention shown in FIGURES 1 and 2 is briefly described as follows: A source of wanted sound, such as the actor diagrammatically indicated at 19 in FIGURES 1 and 2, is physically close to the first or wanted sound microphone 13, while a source of undesired noise, such as the airplane indicated diagrammatically in one position at 20 in FIGURE 1, and at a second position by the reference numeral 20' in FIGURE 2, is located substantially more remote from said wanted sound microphone 13 than the actor 19. It will be readily understood that the acousto-electric transduction, by the microphone 13, of the wanted sound from the actor 19 will produce a wanted sound electrical signal portion in the first channel 11 of greater am-

6

plitude than the unwanted noise electrical signal portion produced in said first channel 11 as a result of the transduction, by said first microphone 13, of the lower amplitude unwanted noise passage produced by the more remote airplane (20 in case of FIGURE 1 and 20' in case of FIGURE 2) which comprises the source of the unwanted noise. In other words, the total electrical signal in the first channel 11 will have a relatively high ratio of the wanted sound electrical signal portion to the unwanted noise electrical signal portion, and conversely, a relatively low ratio of the unwanted noise signal portion to the wanted sound signal portion. For the purpose of further discussion, the combination of the wanted sound and the unwanted noise at either of the microphones will be described as a transducible input to such microphone.

It is readily apparent that the wanted sound electrical signal portion produced in the second or unwanted noise channel 12 as a result of the transduction, by the second auxiliary unwanted noise microphone 14, of the wanted sound emanating from the fairly remote actor 19, will be of substantially lower amplitude than the wanted sound electrical signal portion in the first channel 11. The unwanted noise electrical signal portion produced in said second or auxiliary unwanted noise channel 12 as a result of the transduction, by the unwanted noise microphone 14, of the unwanted noise emanating from the airplane (20 in the case of FIGURE 1 and 20' in the case of FIGURE 2) will be greater in the case of FIGURE 1 than the unwanted noise electrical signal portion produced in the first channel 11 and will be substantially equal in the case of FIGURE 2 to the unwanted noise electrical signal portion produced in said first channel 11.

It is obvious that so long as unwanted noise microphone 14 is more distance from the source of the wanted sound 19 than is wanted noise microphone 13, as this invention provides, the ratio of the unwanted noise electrical signal portion to the wanted sound electrical signal portion in the second channel 12 is always relatively high and tends to become higher as the distance of unwanted noise microphone 14 from the source of the wanted sound increases or as the amplitude of the wanted sound decreases. It follows, also, that the ratio of unwanted to wanted signal portions will invariably be higher in channel 12 than in channel 11. It is the fact that these two ratios are invariably unequal which furnishes the operative theoretical basis for the subject invention. For in this condition, whenever the amplitudes of the signals in the two channels are adjusted relative to each other to equalize the amplitudes of the unwanted noise signal portions in the two channels, there will invariably be a difference in amplitude between the wanted sound signal portions in the two channels which, it will be seen in reading further, permits the balancing of the two unwanted noise signals without cancellation of the wanted sound signals.

After amplification of the complete signal in said first channel by the amplifier 15, and of the complete signal in said second channel 12 by the amplifier 16, said first and second channel signals are recorded by the corresponding recording head means 17 and 18 on corresponding recording channels 21 and 22 of a sound recording means indicated generally at 23.

In the specific example illustrated, said sound recording medium 23 comprises a single sprocketed tape having the two sound recording channel portions 21 and 22 separated from each other by a space 24. However, this is not to be construed in a limiting sense. Actually the invention may include separate recording media for the two channels and they may be sprocketed or not sprocketed and may comprise any type of recording medium suitable for recording by any type of recording apparatus or method.

FIGURE 3 illustrates the next stage of the apparatus and method of the present invention wherein the dual

recordings 21 and 22 carried by the common recording medium 23 shown in FIGURES 1 and 2 is illustrated fragmentarily at a reproduction stage where reproduction transducers or play-back heads 25, in the case of the first channel, and 26 in the case of the second channel, are placed in reproduction relationship with respect to the corresponding first and second channel recordings 21 and 22 for transducing them and producing a first channel reproduction or transfer signal in a first channel continuation portion 11', and for producing a second or unwanted noise channel reproduction or transfer signal in a second channel continuation portion indicated at 12'.

If these signals are not already phase-inverted, they are so inverted at this stage, as for example by reversal of the relative polarities of the circuits associated with the two channels.

These signals are then fed through corresponding first channel and second channel volume controls 27 and 28, respectively, and then fed into a common balancing mixer amplifier 29 for combination into a resultant signal in an output channel 30, with said resultant signal having the unwanted noise signal portions substantially fully balanced out.

FIGURE 3 also shows the connection of monitoring means 31 to the output channel 30 to be employed in ascertaining whether or not the optimum balancing out of the unwanted noise signal portions is occurring, and to allow continuous correction to be made, using the adjustable means diagrammatically indicated at 32, to assure that the unwanted noise is minimized in the output stage.

In FIGURE 3 said monitoring means 31 is shown in block diagrammatic form. In practice a pair of earphones or other equivalent device by means of which a sound recording engineer can listen to the level of the background noise to determine when it has been minimized would be preferable; however, various other monitoring and indicating devices may be employed in lieu thereof.

In the specific example illustrated in FIGURE 3 the balancing means, diagrammatically indicated at 32, comprises a roller 33 in engagement with the sound recording medium or tape 23 between the first channel and second channel reproduction heads 25 and 26 and vertically adjustably mounted relative to framework means, indicated diagrammatically at 34, for controlled up or down shifting movement in response to rotation of adjusting knob K in a manner such as to effectively vary the length of the recording medium 23 between said first and second reproduction transducers or pick-ups 25 and 26.

This will have the effect of relatively shifting the time points on the first and second channel recordings 21 and 22 which are being transduced at any given instance, thus mechanically and physically accomplishing the requisite time delay and phase control to compensate for the difference in sound travel time from the source of unwanted sound (20 in the case of FIGURE 1 and 20' in the case of FIGURE 2) to the first and second microphones 13 and 14.

This correction and appropriate phase inversion for direct phase opposition of the unwanted noise electrical signal portions in the first and second channels 11' and 12' results, as previously described, in the balancing out and effective cancellation at substantially time-equivalent points of the first channel and second channel unwanted noise electrical signal portions whereby to produce the hereinbefore mentioned resultant output signal in the single output channel 30 with an absolute minimum of background noise portion therein.

FIGURE 4 illustrates a slightly modified form of the invention, and because of the similar nature thereof, similar portions are indicated by similar reference numerals, followed by the letter "a" however.

In this modification the first channel and second channel recording heads 17a and 18a correspond to the recording heads 17 and 18 shown in FIGURES 1 and 2.

However, in this modification they have balancing means 32a similar in all respects to that shown at 32 in FIGURE 3, but positioned between said first channel and second channel recording heads 17a and 18a rather than being positioned between the first and second channel reproduction pick-up heads or play-back heads 25 and 26 as shown in FIGURE 3.

In this modification, the balancing means 32a is manually adjusted in substantially the same manner as that described above in connection with FIGURE 3 for effectively changing the length of the recording medium 23a positioned therebetween, to bring about effective time delay and phase shift control of the first channel and second channel dual recordings 21a and 22a on the recording medium 23a to place time equivalent portions of each of said recordings in predetermined physical relationships such that the normal play-back reproduction thereof by play-back heads such as shown at 25 and 26 in FIGURE 3 and without any operation of the balancing means 32 of FIGURE 3 being employed, will produce in said first and second channels 11' and 12', signals adapted to be directly balanced out in the mixer amplifier 29 without further time delay adjustment and correction. As in the form of the invention illustrated in FIGURES 1-3, channels 11 and 12 or 11' and 12' are phase inverted in any stage in the circuitry in advance of mixer amplifier 29. In this modification of the invention, as shown in FIGURE 4, the monitoring means 31 of FIGURE 3 must be employed while the recording is being both made and played back by the play-back heads 25 and 26 so that the degree of balancing adjustment by the balancing means 32a of the relative position of the two recording heads 17a and 18a relative to the twin channels 21a and 22a of the recording medium 23a can be optimized in a manner generally similar to that described hereinbefore.

Numerous modifications and variations of the present invention within the broad scope and basic teachings of the present invention, as exemplified in a non-limiting sense by the particular illustrative embodiments shown in the drawings and described in detail hereinbefore, are intended to be included herein as fully as if specifically described and illustrated in detail provided that they are within the scope of the appended claims. This is true both with respect to the apparatus and method aspects of the invention.

It should be understood that the figures and the specific description thereof set forth in this application are for the purpose of illustrating the present invention and are not to be construed as limiting the present invention to the precise and detailed structure shown in the figures and specifically described hereinbefore. Rather, the real invention is intended to include substantially equivalent constructions embodying the basic teachings and inventive concept of the present invention.

What is claimed is:

1. Apparatus for producing a resultant electrical signal which is the electrical analog of a relatively maximized wanted sound passage and a relatively minimized unwanted noise passage, comprising: signal-carrying channel means including a first wanted sound channel and a second unwanted noise channel, said first and second channels being provided with transducer means for transducing a first transducible input having a relatively maximized ratio of wanted-sound-to-unwanted-noise portions for producing in said first channel a first electrical signal having a relatively maximized wanted sound electrical signal portion corresponding to a wanted sound passage and having a relatively minimized unwanted noise electrical signal portion corresponding to an unwanted noise passage, and for transducing a second transducible input having a relatively maximized ratio of unwanted-noise-to-wanted-sound portions for producing in said second channel an electrical signal having a relatively maximized unwanted noise electrical signal portion corre-

sponding to an unwanted noise passage and having a relatively minimized wanted sound electrical signal portion corresponding to a wanted sound passage, with the ratio of the unwanted noise electrical signal portion to the wanted sound electrical signal portion in said second channel being substantially greater than in said first channel; and amplitude and time balancing means for combining said unwanted noise electrical signal portions of said first and second electrical signals of said first and second channels in amplitude balanced relatively time-equivalent opposition to each other whereby to substantially reduce the net resultant unwanted noise electrical signal portion with respect to the wanted sound electrical signal portion.

2. Apparatus as defined in claim 1, wherein said transducer means comprises first acousto-electrical transducer means effectively coupled with respect to said first channel and second acousto-electrical transducer means effectively coupled with respect to said second channel, with said first and second transducer means being effectively in different transducing relations with respect to said first and second transducible inputs which effectively comprise first and second acoustic inputs having different acoustic ratios of a wanted sound passage to an unwanted noise passage, with the first acoustic input having a greater ratio of a wanted sound passage to an unwanted noise passage than said second acoustic input.

3. Apparatus as defined in claim 1, wherein said transducer means comprises first acousto-electrical transducer means effectively coupled with respect to said first channel and second acousto-electrical transducer means effectively coupled with respect to said second channel, with said first and second transducer means being effectively differently physically positioned with respect to said first and second transducible inputs which comprise first and second acoustic inputs having different ratios of a wanted sound passage to an unwanted noise passage, with this said first acoustic input having a greater ratio of said wanted sound passage to said unwanted noise passage than said second acoustic input by reason of closer physical proximity of said first transducer means to a source of the wanted sound passage than to a source of the unwanted noise passage, and said second acoustic input having a lesser ratio of said wanted sound passage to said unwanted noise passage by reason of closer physical proximity of said second transducer means to the source of said unwanted noise passage relative to the source of the wanted sound passage than said first transducer means.

4. Apparatus as defined in claim 1, wherein said amplitude and time balancing means includes signal amplitude adjustment means for bringing about equal magnitudes of said unwanted noise signal portions of said first and second channels whereby time-equivalent opposition thereof will substantially completely inhibit said unwanted noise electrical signal portions carried by said two channels, thus substantially leaving only the wanted sound electrical signal portion.

5. Apparatus for producing a resultant electrical signal which is the electrical analog of a relatively maximized wanted sound passage and a relatively minimized unwanted noise passage, comprising: signal-carrying channel means including a first wanted sound channel and a second unwanted noise channel, said first and second channels being provided with transducer means for transducing a first transducible input having a relatively maximized ratio of wanted-sound-to-unwanted-noise portions for producing in said first channel a first electrical signal having a relatively maximized wanted sound electrical signal portion corresponding to a wanted sound passage and having a relatively minimized unwanted noise electrical signal portion corresponding to an unwanted noise passage, and for transducing a second transducible input having a relatively maximized ratio of unwanted-noise-to-wanted sound portions for producing in said second

channel an electrical signal having a relatively maximized unwanted noise electrical signal portion corresponding to an unwanted noise passage and having a relatively minimized wanted sound electrical signal portion corresponding to a wanted sound passage, with the ratio of the unwanted noise electrical signal portion to the wanted sound electrical signal portion in said second channel being substantially greater than in said first channel; and amplitude and time balancing means for combining said unwanted noise electrical signal portions of said first and second electrical signals of said first and second channels in amplitude balanced relatively time-equivalent opposition to each other whereby to substantially reduce the net resultant unwanted noise electrical signal portion with respect to the wanted sound electrical signal portion, said signal-carrying channel means including an original sound portion and a reproduced sound portion and additionally including sound and noise recording and storage means effectively positioned therebetween; said transducer means comprising first and second pick-up head means in transducing relationship with respect to said first and second channel portions of said sound and noise recording and storage means.

6. Apparatus as defined in claim 5, wherein said time balancing means comprises mechanical means for effectively relatively varying with respect to each other the length positions in the recording direction of the cooperative transducing relationships of said first and second channel portions of said sound and noise recording and storage means and the corresponding pick-up head means.

7. Apparatus as defined in claim 5, wherein said sound and noise recording and storage means includes first and second channel portions corresponding to said first and second channels and effectively comprising said first and second transducible inputs.

8. Apparatus as defined in claim 5, wherein said amplitude and time balancing means is effectively positioned between said original sound portion and said reproduced sound portion of said signal-carrying channel means.

9. Apparatus as defined in claim 5, wherein said amplitude and time balancing means is effectively positioned between said original sound portion and said reproduced sound portion of said signal-carrying channel means and comprises shifting means for physically shifting the relationship of said first and second channel portions of said sound and noise recording and storage means relative to said pick-up head means for effectively producing amplitude balanced time-equivalent opposition of the unwanted noise electrical signal portions of said first and second channels to produce effective cancellation thereof.

10. Apparatus as defined in claim 5, wherein said amplitude and time balancing means is effectively positioned between said original sound portion and said reproduced sound portion of said signal-carrying channel means and comprises shifting means for physically shifting the relationship of said first and second channel portions of said sound and noise recording and storage means relative to said reproducing head means for effectively producing amplitude balanced time-equivalent opposition of the unwanted noise electrical signal portions of said first and second channels to produce effective cancellation thereof and whereby to cause effective time delay of one of said undesired noise signal portions to compensate for different travel times from the original source thereof to original sound first and second transducer means.

11. Apparatus as defined in claim 5, wherein said amplitude and time balancing means includes signal amplitude adjustment means for bringing about equal magnitudes of said unwanted noise signal portions of said first and second channels whereby time-equivalent opposition thereof will substantially completely inhibit said unwanted noise electrical signal portions carried by said two channels, thus substantially leaving only the wanted sound electrical signal portion for recording on a sound recording medium.

11

12. Apparatus as defined in claim 5, wherein said amplitude and time balancing means is effectively positioned in said reproduced sound portion of said signal-carrying channel means.

13. Apparatus as defined in claim 5, wherein said amplitude and time balancing means is effectively positioned in said original sound portion of said signal-carrying channel means.

12

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