

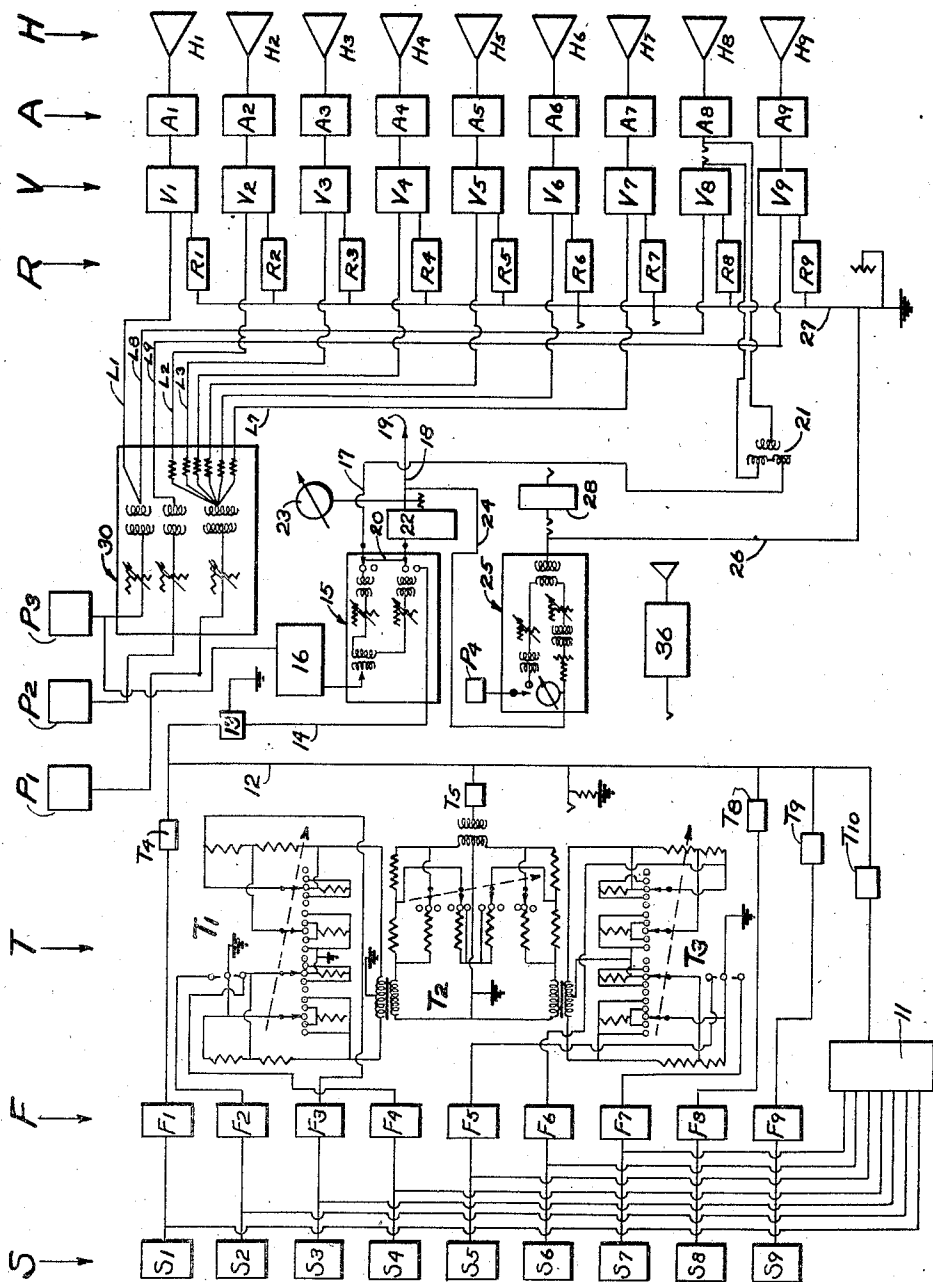
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SOUND RECORDING SYSTEM

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SOUND RECORDING SYSTEM

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This invention is directed toward the provision of means and methods of producing sound recordings and control recordings whereby the volume or amplitude and location of the reproducing source may be regulated and modified at will or automatically throughout the theatre or other enclosure in which the sound program is being reproduced.

Heretofore, attempts have been made to reproduce a recorded program and to shift the point of reproduction during the program so as to create the effect of a moving source of sound, such movement being limited to points behind the projection screen on which the photoplay is being shown. Mechanical means for producing such shift as well as certain relay means have been employed for this purpose. The present invention distinguishes therefrom in that it is concerned with the production of a control record whereby the output of any desired sound recording may be divided between a plurality of loud speakers or the entire output reproduced through a single loud speaker, said loud speakers being positioned at multiplaner points in a theatre so that they substantially encircle the audience. By the provision of a plurality of loud speakers positioned at multiplaner points, it is possible to produce a great variety of novel effects so that the sound or desired portions of the sound program may be simultaneously reproduced in various portions of the theatre or in various three dimensional relations with respect to members of the audience.

More particularly, the present application is directed to means and methods whereby a control intelligence or control film may be prepared in an expeditious manner so that the various effects may be automatically produced without the necessity of careful manual control during the presentation of the photoplay and its accompanying sound effects.

Generally stated, the control means employed in the present invention comprise separate tones which are recorded upon a common control track, each of the tones being adapted to control the output of a given loud speaker means. (Strictly speaking, frequency is a parameter of a wave or tone, and should not be considered synonymous with tone.) The invention described hereinafter provides for a selection of tones for use in such control track whereby accuracy is assured. Means and methods are also provided whereby the formation of such control track in precise synchronism with a photoplay or other program or form of entertainment, is assured. The inven-

tion also provides for means whereby the reproduction of a sound program may be gradually shifted from one or more loud speakers to others while maintaining a substantially uniform total sound level.

The method of recording herein disclosed also permits sound to be reproduced from a series of loud speaking means arranged longitudinally of the theatre so that a fore and aft movement of the sound may be attained. In addition, the sound may be caused to move around the theatre or other enclosure, or particular components of a sound program such as, for example, reproduction of an aria, solo, rendition or sound from a specific section of an orchestra may be reproduced selectively from a particular location. Many novel effects may be produced.

In addition to effects which are dependent upon the shifting of sound from one loud speaker means to another, the method of recording herein described is also of value in controlling the amplitude or expansion of sound during reproduction. In the reproduction of concert music and other accompaniments for photoplays and the like, it is often desirable that the reproduced sound cover a greater range of amplitude than can be ordinarily recorded on the sound track itself. To accomplish this desired expansion, the present method provides independent automatic means which may be associated with the positional shifting equipment of the sound sources. In this manner a range expansion of from 35 to 50 decibels may be utilized above the range of the sound track or the volume range of a symphony orchestra.

An object of the present invention, therefore, is to provide a method of recording whereby the reproduction of sound may be controlled automatically.

Another object is to provide means and methods for automatically controlling three dimensional sound reproduction.

A further object is to provide means and methods whereby numerous novel sound effects may be produced and controlled.

A still further object is to provide means and methods for recording a control intelligence governing three dimensional sound reproduction or the range of expansion of program tracks.

An object of the invention is to provide means and methods for controlling the reproduction of one or more program tracks through a plurality of loud speaker means by a single control intelligence.

These and other objects will be apparent from

an exemplary form of the invention described hereinafter, and shown on the appended drawing.

Generally stated, the method of this invention includes the steps of generating a series of control frequencies or control tones. These control frequencies or control tones are correlated to predetermined loud speaker means. The loud speaker means may be arranged in any suitable manner, certain specified arrangements have been shown in applicants' co-pending application Serial No. 348,616, which is particularly directed toward methods and means for reproducing sound programs. The plurality of control frequencies generated in any suitable manner is then variably attenuated in accordance with the effect which it is desired to produce during the reproduction of a program. Variations in the amplitude of each of the control frequencies may be caused to control the gain of an amplifier associated with a loud speaking means correlated to such control frequency. During the formation of the control track, the outputs of the various tone sources are therefore manually controlled and modified in accordance with the ultimate effect desired during reproduction and the various control frequencies are then recorded in any suitable manner, preferably upon film. Since these control frequencies are preferably recorded in superimposed relation, it is desirable to carefully select the character of the control frequencies in the manner hereinafter described. Furthermore, during such recording, means should be provided whereby proper synchronization between the control track and the program track or tracks is assured.

During reproduction, as more fully described in the co-pending application above identified, the output of the control track pick-up is supplied to a plurality of band pass filters capable of separating the original control frequencies and each of the frequencies or control tones is then caused to automatically regulate and control the output of one or more loud speaker means.

In the specific embodiment shown on the appended drawing, tone sources are generally indicated at S, band filters at F, manually controllable variable attenuators at T, sound reproducing pick-up means by P, tone rectifiers and filters by R, variable gain amplifiers by V, power amplifiers by A, and loud speaking means by H.

The various tone sources S may comprise oscillators, each being capable of generating a single and different frequency or tone in comparison with the output of other oscillators. In choosing the frequency for a control tone system of the character here described, it is desirable that the second and third harmonics of any tone shall fall outside of the passing band of all high frequency tone channels. The pilot tone frequencies which have been successfully used are those whereby each frequency represents an approximate constant percentage increase above the next lower frequency, this resulting in simplification of the band pass filter design and construction. Symmetrical, constant impedance type band pass filters have attenuation and phase characteristics which extend at equal percentages on each side of the pass frequency, this characteristic being often referred to as "logarithmic symmetry." For this reason, logarithmic spacing of the pilot or control tones allows the use of relatively simple filters and allows filter and oscillator frequency tolerances to be expressed in percentage regardless of frequency. The use of

logarithmic increments combined with the preferred number series also allows the number of channels to be increased or decreased easily without making any of the older oscillators or filters obsolete. In an illustrative example the tone sources comprise oscillators S1 to S9 covering the following frequencies: 160, 250, 400, 630, 1,000, 1,600, 2,500, 4,000 and 6,300 cycles. It is to be noted that each frequency is the next lower multiplied by about 1.6. If a smaller number of channels is needed, larger separation between control tone frequencies may be well employed as, for example, in a series of frequencies as follows: 100, 250, 630, 1,600, 4,000, 10,000 cycles.

It is to be noted that the lower harmonics of 250 cycles fall at 500 and 750 cycles and thereby miss the 400, 630, and 1,000 cycle channels. The magnitude of the harmonics above the third is usually so low that they need not be considered.

The outputs of the various oscillators or tone sources S are then sent through the "clean up" band pass filters F, the output of each oscillator being sent to its associated band pass filter, such band pass filters being identified as F1 to F9 inclusive. These "cleanup" filters serve to eliminate harmonics from the oscillators which might represent a spurious signal in a higher frequency tone channel. It has been found advantageous to use constant impedance filters to eliminate the necessity of incorporating isolating networks and expensively designed filters in the system. Proper selection of the control tones, as stated hereinbefore, permits the use of relatively simple filters of similar design characteristics.

In many instances it is desirable to also pass the output of all or a part of the tone sources into a combining amplifier 11. In the appended diagram the outputs of tone sources or oscillators S1 to S7 inclusive, are shown connected to the combining amplifier 11. One of the advantages of using a combining amplifier lies in that cross talk is prevented and a volume range may be attained during reproduction as well as during recording which can not be attained by the use of individual attenuators on the outputs of the corresponding band pass filters F1 to F7 inclusive.

Again referring to the appended diagram, it will be noted that the outputs of the band pass filters F2 to F7 are associated with an attenuation network including three pads T1, T2 and T3. These three pads may be either individually controllable or preferably T1 and T3 are mechanically interlocked or coupled and T2 is separately operable. The details of construction, operation, and many uses of variable attenuators of the type herein referred to are shown in a co-pending application Serial No. 267,416 filed by William E. Garity and John N. A. Hawkins.

At this point it is to be noted that the tone sources S2 to S7 inclusive which are modulated by the variable attenuators T1, T2 and T3, correspond to and control output of loud speaker means H2 to H7 inclusive. These loud speaker means may be positioned at the left front, left center, left rear, right rear, right center and right front zones in a theatre or other enclosure. It is to be noted, therefore, that the tone sources or control frequencies S2 to S7 are capable of controlling the reproduction of a program from the front, center and rear of a theatre and therefore control all fore and aft movements of sound reproduction in the theatre.

These reproducers also enter into any operation involving the movement of sound complete-

ly around the theatre. If it is desired that the sound encircle the theatre, the design and operation of the variable attenuators T1, T2 and T3 may have to be changed somewhat from the exemplary form shown in the drawing. Variable attenuators of the character shown at T1, T2 and T3 of the drawing are adapted to attenuate the output of their associated tone sources and maintain such attenuations in a complementary relationship, the attenuators being so coupled as to produce a complement of attenuations when expressed as power ratios which is constant throughout the attenuation devices' operating range. Other attenuation relationships may be found desirable and independent manual control may be substituted whenever the particular adaptation of the present invention does not require the specific form herein described.

At this point it may be well to note that by reference to "left front" and "right front" loud speaking means, reference is made to loud speaking means that are positioned in the front portion of the theatre but which are distinguishable from the screen sides or speakers at the sides of the screen or proscenium since the speakers H1 and H2 are ordinarily located at the screen.

Independent attenuation devices may be used to control the output of control tones generated at S1, S2 and S3 as well as the output of the combining amplifier 11. For example, T4 may modulate the output of S1; T5 may be a master attenuator controlling the output of the bank of attenuators T1, T2, T3; T6 may effect the output of S2; T7 may be associated with S3; and T10 may modulate the output of the combining amplifier 11. All of these various attenuators may include impedance matching devices.

The outputs of the various tone sources and variable attenuators may then be combined in a bus bar 12 leading to an attenuator, amplifier or other master control device 13. From such master control device 13 the combined modulated control tones may be supplied by lead 14 to a synchronizing panel generally indicated at 15.

During the recording of the control intelligence which is eventually going to automatically control the reproduction of a program in a theatre or other enclosure so as to produce sound effects suitable for use in accompanying photo-plays or any other purpose, it is desirable that the program tracks be reproduced at the time the control track is recorded so as to permit the recording operator to personally hear the effect which is being obtained by the control track at the time it is being recorded. Generally stated, the synchronizing panel 15 contains appropriate relays and attenuators and is used to transfer from one or more program tracks to the tone recorder, at the beginning of each recording, suitable marks, capable of being used in synchronizing the program track with the tone track when subsequently such tone control track is used in the control of the program track or tracks.

The program sound recordings may be carried on one or more individual tracks. In the creation of certain sound effects it may be highly desirable to have one sound or type of program circulate or move in a three dimensional manner around the theatre while another portion of the program is reproduced from the screen or some other fixed portion of the theatre. In order to attain this result, it is highly desirable that the various sound effects be carried by separate program tracks.

As shown in the accompanying drawing, three program pick-ups P1, P2 and P3 may be employed, each one of these pick-ups being adapted to act as a reproducing pick-up for a separate sound recording. For example, one of said recordings may carry dialogue, another may carry sound effects, while the third may carry musical accompaniment. These three program sound recordings are preferably synchronized with one another in any suitable manner as, for example, by the use of bloop marks. Any one or all of these pick-ups may be connected to an amplifier 16 supplying its output to the synchronizing panel 15. A dividing network is shown as embodied in the synchronizing panel 15 for the purpose of dividing the incoming program sound between a monitor speaker supplied by line 17 and a recording device supplied by line 18, the recording device being not shown and generally indicated only by 19. The output lines 17 and 18 are connected to a double pole, double throw switch indicated at 20. In the position shown, the program from P3 and amplifier 16 is being supplied by line 17 to a bridging coil 21 leading to the power amplifier A2 and loud speaker means H3. It is to be understood, however, that the output line 17 may lead directly to a separate loud speaker means located at any suitable place within audible distance of the recording operator or monitor. As soon as the recording operator or monitor hears the synchronizing mark or bloop of the program being reproduced by P3, he may actuate the switch 20 so as to connect the line 14 (supplying control tones) to the amplifier 22, said amplifier being inserted in line 18 leading to the recording device 19. The amplifier 22 may be of the variable gain type and provided with suitable control means as well as an indicating device shown at 23 adapted to indicate the overall level of the tones being recorded.

The control tones modulated by means of the variable attenuators T are then supplied by line 24 to a tone divider panel 25 containing appropriate apparatus to set output levels, and if desired, a visual volume indicator. From this panel 25 the modulated control tones are sent by line 26 to a bus bar 27, such bus bar being connected to the various tone rectifiers and filters R. An additional amplifier 28 may be inserted into the line 26 (when desired) to further amplify the control tones before they are selected by the filters R from the bus bar 27. Each of the filters and tone rectifiers R includes band pass filter particularly adapted to select and isolate a frequency from the range of frequencies passed by the filters F, and means for rectifying the selected control tone. An amplifier of any desired type may also be included in these units. Variable gain amplifiers are shown at V, the gain of each of these being controlled and regulated by the bias from the unit R. Generally stated, the units R and V taken jointly may be termed "varioloosers" and the term as used hereinafter and in the claims shall refer to any variable gain type amplifier or other device capable of introducing a variable transmission loss into an audio channel, which device is not manually operated. It is to be understood that the amplifiers then include a program channel, these channels being supplied from suitable program pick-up means.

Although varioloosers of various types may be developed and used in systems of the character here being considered, it has been found that good results can be obtained by causing the tone rectifiers to deliver a positive bias to the grid

circuit of one or more stages of the amplifier. Either a positive or a negative grid bias may be used, depending upon whether expansion or contraction in the transmission characteristic of the amplifier is desired. Furthermore, attention is called to the fact that such system is applicable to any multi-grid tube. Instead of varying the grid bias, similar effects may be obtained by varying the plate resistance, varying one leg of a bridge attenuation circuit, varying the regeneration or degeneration of the amplifier, etc. All these general methods are hereinafter referred to as variolossers.

The sound records which comprise the program may be picked up from any or all of the units P1, P2 and P3 and pass into a program divider 30 containing component networks and other devices adapted to permit the program to be supplied to any one or more of the amplifiers V. In the specific form of arrangement shown in the drawing it will be noted that the pick-up P1 supplies program to V2 to V7 inclusive whereas P2 supplies its sound recording to V9, and P3 supplies program sound to V1 and V8. By the use of several pick-ups and a program divider 30, the program sound may be originally recorded in such manner that special effects are carried by one strip of film, dialogue by another strip and still further sound effects by the third strip. By associating these various pick-ups and their programs with suitable variable gain amplifiers and loud speaker units, desired effects can be obtained most readily.

Although separate program pick-ups have been indicated in the drawing and reference has been made to the fact that these program elements may be recorded upon separate strips of film, this invention also contemplates a method in which a single strip of film carries a plurality of parallel program tracks or program elements. The use of a multiplicity of program tracks on the same strip of film has advantages in that film cost is reduced and a more positive and accurate synchronization of the various program elements is attained. Ordinarily when two or more sound recordings carried on two or more separate strips of film are being reproduced through two or more separate reproducing heads and pick-ups, it is virtually impossible to obtain a synchronization between such program tracks which is more accurate than the distance between sprocket holes on the film advancing sprockets of the various machines. It is very possible, therefore, to have the recordings out of phase so that cancellation takes place during reproduction in various parts of the theatre or other enclosure in which the sound is being reproduced. Such cancellation is particularly noticeable and detrimental when so-called stereophonic or binaural reproduction is attempted. In the event these various program tracks are carried upon a single strip of film, however, the scanning points may be synchronized to a thousandth of an inch, and out-of-phase relationships thus eliminated and perfect synchronization attained.

It may be noted at this point that in the event the gain control characteristics of the variolossers R and V are not straight line functions, the R units may be designed to give an inverse characteristic to that of the amplifiers in response to the tone signal volume input. In this manner, the combined influence of R and V may then produce a change in program level which is equivalent, in decibels, to the change in control tone level. In other forms of these units, particu-

larly when it is desired to expand the volume beyond the volume ordinarily carried by the program sound record, the units R may be so designed as to cause a larger expansion or amplification of the program sound than the variation in level of the control tone, as by including a variable gain amplification stage in the R unit before its output is caused to control V.

The outputs of the various amplifiers V may then be fed to power amplifiers A before the program is reproduced through the loud speaker means H.

The operation of the recording system will be understood from the description of the apparatus given hereinabove but to review the operation, attention is called to the fact that a multiplicity of separate tones or control frequencies is generated in any suitable manner as by means of the oscillators S1 to S9. These tones are filtered by the band pass filters F, such control tones being then supplied to the synchronizing panel 15. During the production of the control record which will carry the various control tones, the program sounds which are to be controlled are picked up by the reproducing pick-ups P and sent through the program divider 30 to the various amplifiers V, each of the amplifiers being associated with a loud speaker means having a suitable multiplaner location within the theatre or other enclosure in which the sound effects are to be reproduced. The synchronizing panel 15 is used for the purpose of insuring suitable synchronization between the control record which is being formed and the program which is being modulated and controlled during the recording operation. The various tone sources are manually adjusted and attenuated either by a network employing variable attenuators such as T1, T2, T3, or by independent attenuators such as T4, T5 and T9. The recording operator may listen to the reproduction of the program sound in the theatre through the various loud speaker means H1 to H9 and in addition he may listen to the program sound by introducing a monitor speaker and its amplifier 36 into the line leading from the pick-up such as P3, to the synchronizing panel 15.

By properly manipulating the various variable attenuators, not only will the reproduction of the program sound through loud speaker means H1 to H9 be caused to include the desired effects of stereoscopic sound reproduction, movement fore and aft, movement from left to right, movement around the theatre, reproduction from the ceiling, etc., but at the same time the modulated control tones which create such effects will be recorded by the recording instrument 19.

After a recording of the control tones has been made, the apparatus shown on the appended drawing may be used for reproduction of the same program sound by the aid of the previously made control record. It will be noted that the tone divider panel 25 may be supplied with current from a pick-up P4. The previously made tone control film or record may be passed through the pick-up P4, the original tone sources S being either rendered inactive or the entire control tone circuit disconnected from the rest of the system by adjustment of the master attenuator 13. The program sound will then be reproduced and fed through the reproducing program divider 30 to the various amplifiers whereas the previously recorded control track will supply suitable modulated control tones from P4 through line 26 to the bus 27 leading to the various tone rectifiers

and filters R. Reproduction of the program through the loud speaker means H1 to H9 will be effected automatically.

The system described hereinabove is capable of many uses and modifications. For example, instead of attempting to produce a control track capable of controlling all of the program sound simultaneously, it may be desirable to make separate control tracks for various effects. For example, a separate control track may be made for the purpose of controlling only the sounds which are to emanate from the left and right screen horns, such as loud speaker means H1 and H2. In order to accomplish this result, it is only necessary to energize tone sources S1 and S2 and to use program pick-up P3 alone. The attenuation of the two tone sources can then be accomplished either by attenuators T4 and T5 or by combining such attenuators into a variable attenuator of the type T1 (or of the type described in the co-pending application hereinbefore identified).

Similarly, a separate tone control record may be made of certain effects which may be recorded on say a program record being reproduced through P1 so that all of the shifting of sources or reproduction in this particular record are controlled by a separate track.

During the recording of any one of the separate tracks, a previously made tone control for one of the other program sound tracks may be reproduced by P4 so that the combined effect is made evident to the recording operator.

The production of separate control tone tracks or separate channels is sometimes desirable inasmuch as the various effects may be separately edited and subsequently dubbed together onto one track. It also permits cutting and editing for the purpose of modifying levels, correcting placement of effects, etc. When a tone track has more than one frequency on it, it can be cut by dubbing such track through band pass filters to two or more new and separate tracks, cutting one or both of the new tracks and then dubbing the cut tracks together again.

It is to be understood that those skilled in the art will readily conceive of numerous uses and adaptations of the methods and arrangements herein discussed, in addition to those specifically referred to hereinabove. All changes, modifications and adaptations of the invention are embraced hereby.

We claim:

1. In a method of producing a control recording for controlling the reproduction of sound through a plurality of loud speaker means, the steps of: allocating a separate control frequency to control the response of each of a plurality of loud speaker means; each of said separate control tones being substantially pure and free from harmonics, said control tones being members of a logarithmic progression, no member of said progression being close to a second or third order harmonic of a lower; desirably modulating the amplitude of said sustained control tones while reproducing a sound program through loud speaker means controlled by said control tones.

2. In a method of producing a control recording for controlling the reproduction of sound through a plurality of loud speaker means, the steps of: allocating a separate control frequency to control the response of each of a plurality of loud speaker means; each of said separate control tones being substantially pure and free from harmonics, said control tones being members of

a logarithmic progression, no member of said progression being close to a second or third order harmonic of a lower; reproducing a sound program through loud speaker means controllable by such control tones; desirably modulating the amplitude of such sustained control tones while observing the effect of such modulation upon the program being reproduced, mixing said desirably modulated control tones, and making a single record of said tones.

3. In a method of producing a control recording for controlling the reproduction of sound through a plurality of loud speaker means, the steps of: allocating a separate control frequency to control the response of each of a plurality of loud speaker means; each of said separate control tones being substantially pure and free from harmonics, said control tones being members of a logarithmic progression, no member of said progression being close to a second or third order harmonic of a lower; reproducing a sound program through a plurality of loud speaker means arranged in multiplanar relation to each other, the output of each of said loud speakers being controlled by a direct current resultant of said control tones, desirably modulating the amplitude of said sustained control frequencies while reproducing a sound program through said loud speaker means; mixing said desirably modulated control tones, and making a single record of said tones.

4. A sound recording system comprising a plurality of control tone generating means, each thereof including a "clean up" filter adapted to attenuate harmonics, each of the plurality of the frequencies so passed being a member of a logarithmic type progression, no frequency of such plurality being close to a second or third harmonic of another; a variable attenuating device associated with the output of each of said band pass filters; a common output for said attenuating devices, a recording machine connected to said common output, a program pick-up device and a loud speaker means; and a synchronizing control means in said common output for selectively connecting and disconnecting said recording machine, said synchronizing control means including means for connecting program pick-up means with said loud speaker.

5. In an electrical system for making a recording for the control of program sound through a plurality of loud speaker means, the combination of: a plurality of sources of control tones of differing frequencies; an attenuation system connected to said control tone sources and having a common output; a plurality of tone rectifiers connected to said common output, each of said rectifiers including filtering means receptive only to one of said control tone frequencies, a plurality of program amplifiers and associated loud speaker means and including a program channel, a program pick-up associated with the program channels of said amplifiers and loud speaker means, and means associating one of said rectifiers with a separate program amplifier whereby the amplification characteristics of said amplifier are varied by the output of said rectifier.

6. In a recording system for producing a control record, a plurality of control tone frequency sources, a constant impedance symmetrical band pass filter in the output of each of said sources, said sources and filters being adapted to produce a series of control frequencies, no one of which is close to a second or third harmonic of another;

a manually variable attenuating system connected to the output of said filters, said attenuating system including a differential attenuation network associating at least a part of said filter outputs; a common output for said attenuating system, and a single recording device connected to said common output.

7. In a recording system for producing a control record, a plurality of control tone frequency sources, a band pass filter in the output of each of said sources, said sources and filters being adapted to produce a series of control frequencies, no one of which is close to a second or third harmonic of another; a manually variable attenuating system connected to the output of said filters, said attenuating system including a differential attenuation network associating at least a part of said filter outputs; a common output for said attenuating system, a combining amplifier connected to a part at least of said band pass filter outputs and an attenuator in the output of said combining amplifier, said attenuator being connected to said common output.

8. In a recording system for producing a control record, a plurality of control tone frequency sources, a band pass filter in the output of each of said sources, said sources and filters being adapted to produce a series of control frequencies, no one of which is close to a second or third harmonic of another; a manually variable attenuating system connected to the output of said filters, said attenuating system including a differential attenuation network associating at least a part of said filter outputs; a common output for said attenuating system, and a recording device connected to said common output, a plurality of program variolossers, each thereof having a loud speaker means associated therewith, each of said program variolossers being responsive to a single control tone frequency, all of said program variolossers being connected to the common output from said attenuating system, and program pick-up means connected to the program variolossers.

9. In a recording system for producing a control record, a plurality of control tone frequency sources, a band pass filter in the output of each of said sources, said sources and filters being

adapted to produce a series of control frequencies, no one of which is close to a second or third harmonic of another; a manually variable attenuating system connected to the output of said filters, said attenuating system including a differential attenuation network associating at least a part of said filter outputs; a common output for said attenuating system, and a recording device connected to said common output, a plurality of program variolossers, each thereof having a loud speaker means associated therewith, each of said program variolossers being responsive to a single control tone frequency, all of said program variolossers being connected to the common output from said attenuating system, and program pick-up means connected to the program variolossers, a synchronizing control means in the common output from said attenuators for selectively connecting and disconnecting said recording machine, a loud speaker associated with said control means, and a program pick-up means connected to said synchronizing control means.

10. In a recording system for producing a control record, a plurality of control tone frequency sources, a band pass filter in the output of each of said sources, said sources and filters being adapted to produce a series of control frequencies, no one of which is close to a second or third harmonic of another; a manually variable attenuating system connected to the output of said filters, said attenuating system including a differential attenuation network associating at least a part of said filter outputs; a common output for said attenuating system, and a recording device connected to said common output, a plurality of program variolossers, each thereof having a loud speaker means associated therewith, each of said program variolossers being responsive to a single control tone frequency, all of said program variolossers being connected to the common output from said attenuating system, a plurality of program pick-up means connected to said variolossers and a selectively adjustable attenuation and distribution means between said pick-up means and said variolossers.

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