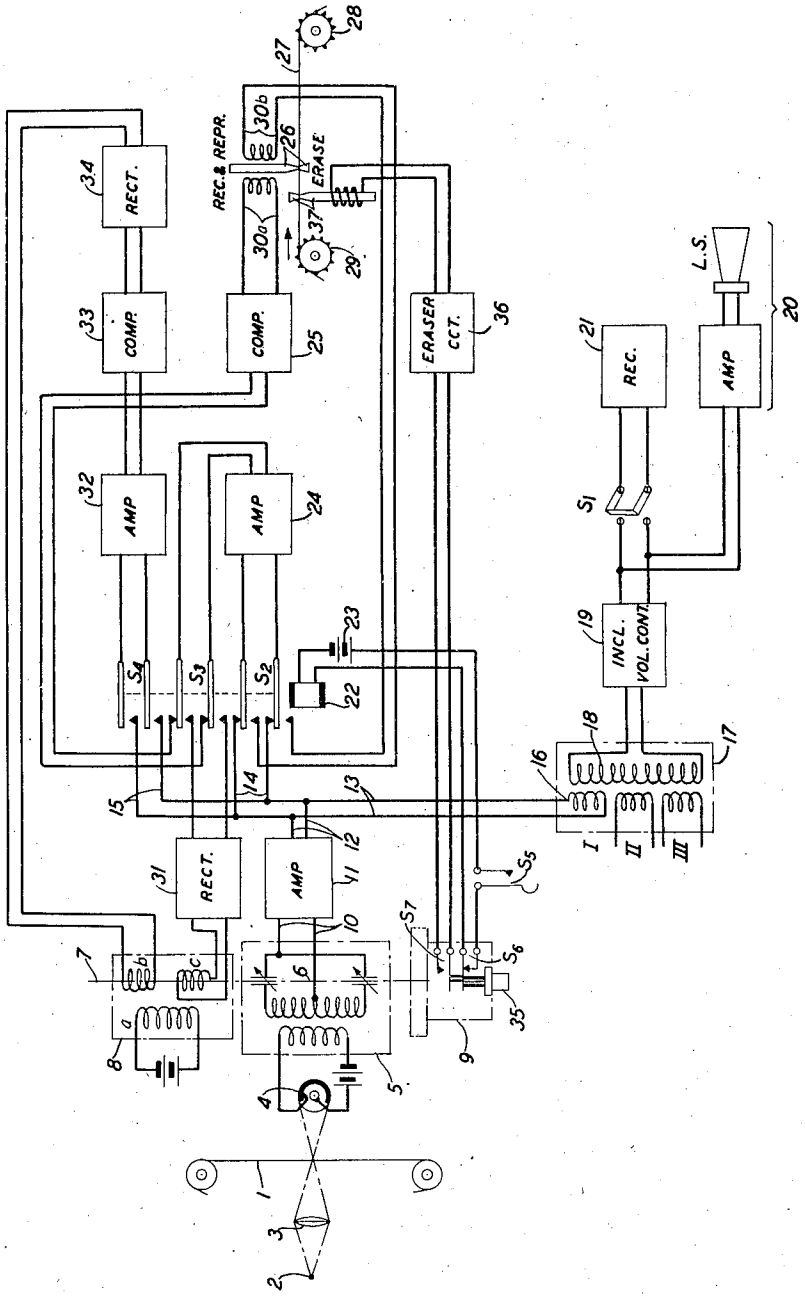
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SOUND RECORDING METHOD AND SYSTEM

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SOUND RECORDING METHOD AND SYSTEM

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This invention relates to a method and apparatus for the automatic control of level sequences in the transmission of electrical currents in accordance with a predetermined schedule and has particular reference to the electrical rerecording of sound records.

In the sound picture art it is the established practice to combine in rerecording various original sound records to provide a final composite record to accompany the picture. Of these sound records some may be of sounds occurring simultaneously with the action photographed, while others may be records of sound effects or of music recorded independently of the action. It is necessary to rehearse the separate audible reproductions of the contributing records to determine relative levels among them and the sequence of levels in each individually in order to produce a satisfactory final record. When this rehearsal has been completed, usually by the joint efforts of a number of mixer operators, the final record is ready to be rerecorded.

The operator's memories of desired level changes are not safely relied upon to duplicate the rehearsal in the final recording and cue sheets are troublesome to adhere to. Therefore, it has been proposed that some form of control record be made during rehearsal in accordance with the operator's judgment and later used to control automatically the electrical reproduction of the separate records to produce the same result as would an operator faithfully following a cue sheet. An example of such automatic control is disclosed in United States Patent 2,279,018 to W. V. Wolfe. So far as known, the automatic control methods hitherto proposed all require a control record of electric currents generated by a source external to the sound reproducing system. Oscillators have been used to generate single frequency currents which are varied in frequency or in amplitude concomitantly with the mixer's manual control of the sound levels reproduced during rehearsal as he listens to a monitoring loudspeaker which translates into sound the manually controlled currents from the original contributing records. The oscillator output thus varied is recorded and may be later reproduced in making the final record to control amplifier gain or mixer setting in duplication of the rehearsal. Such procedures, of course, involve an undesirable complexity of equipment.

Thus, the primary object of the present invention is to provide a novel arrangement of apparatus and method of operation adapted to the purpose of automatically controlling the rerecording of sound records in accordance with a predetermined schedule. It will appear from the description of the invention that no current source external to the sound system is required. Therefore, another object attained by the invention is to provide an automatic control system involving only the reproduction of the sound record itself as a source of control current, utilizing with the greatest economy known apparatus elements.

It is often desirable to revise the automatic control and a circuit is described which permits such revision without interruption of the controlled reproduction. Accordingly, another object of the invention is to provide means for intervening to revise the automatic control of one reproduction without interference to other records being rerecorded at the same time.

In the accompanying drawing, which is a schematic diagram of the apparatus suitable for the practice of the invention, the details of well-known elements are omitted. I, II and III indicate each a reproducing channel, of which the output is capable of being automatically controlled after manual control during rehearsal. The outputs of these and of additional channels not indicated are combined in a known manner to be jointly impressed on a monitoring loudspeaker and when desired on a recorder for making the final composite record. Since channels I, II and III differ only in the type of sound records, it suffices to describe channel I alone, in which the sound record to be reproduced is assumed to be sound film 1. It is to be understood that the electrical currents in any channel may be derived from the reproduction of any type of sound record or from any desired current source.

The film 1 is scanned in the usual manner by light source 2, optical system 3 and photocell 4. The sound currents generated in photocell 4 are impressed on volume control 5 which may conveniently be a voltage divider of the capacitance type, an example being that disclosed by G. E. Fleming in United States Patent 1,989,797. To shaft 6 of the movable condenser plates of such a voltage divider there is mechanically coupled rotor 7 of direct current motor 8. Motor 8 is suitably a motor similar to that disclosed by R. M. Rowell in United States Patent 2,110,680. Its field may be that of a permanent magnet or may be produced by direct current in a field coil *a*. Two rotor windings *b* and *c* are provided which may be either separate coils or a single coil with an accessible center tap. A rotation through 90 degrees of the movable plates of vol-

ume control 5 is capable of changing by more than 80 decibels the transmitted volume, so that windings *b* and *c* may be provided with pigtail connections to the output circuits of the rectifiers later to be mentioned. Motor 8 thus resembles a meter movement without a restoring spring. Likewise coupled to shaft 6 is manually operated control dial 9 which includes details to be described later. Output leads 10 of volume control 5 are connected to preliminary amplifier 11, of which the output circuit 12 divides into three parallel branches 13, 14, and 15.

Branch 13 is preferably as shown permanently connected to input winding 16 of transformer 17. Output winding 18 of transformer 17 is connected in the standard manner to include volume control 19 from the output of which the sound currents corresponding to all of channels I, II and III are fed to monitoring amplifier and loudspeaker 20. When switch S_1 is closed, the composite current is also supplied to a final sound recorder 21. It is clear that if no more than manual control is desired in the reproduction of record 1 the circuit so far described suffices for rehearsal and for final rerecording. Apparatus according to the invention for automatic rerecording control will now be described.

Switches S_2, S_3 and S_4 shown in the drawing in their rehearsal positions are simultaneously operable under control of relay 22, the winding of which is supplied with current by battery 23 when switch S_5 is closed. Switch S_6 of dial 9 is in series with switch S_5 and is normally closed. Switch S_5 remains open during the preliminary rehearsal of the reproduction of record 1, desired variations in this reproduction being effected by manipulation of the dial 9. During rehearsal switch S_4 is open. Switches S_2 and S_3 connect, respectively, output circuit 14 to the input of amplifier 24 and the output circuit of amplifier 24 to volume compressor 25, whereby sound currents reproduced from film 1 and compressed in volume range are applied over conductors 30*a* to be recorded by magnets 26 on magnetic tape 27 traveling in the direction of the arrow. Tape 27 is suitably provided with perforations enabling it to be driven by sprockets 28 and 29 in synchronism with film 1. Magnets 26 serve both for recording and for reproducing the record on tape 27. A preferred method of making such a magnetic record is disclosed by D. E. Wooldridge in United States Patent 2,265,831. By this means an auxiliary sound record, identical except for volume compression with record 1, is recorded on tape 27. As will later appear, volume compression is not invariably essential. If compression is omitted, the sound record of tape 27 will be a duplicate of record 1. Obviously, any other type of auxiliary record could be used. The advantages of a magnetic record are that it may be immediately reproduced and may be erased, as desired, to receive revisions.

Assuming that the preliminary rehearsal has been satisfactory, record 1 and tape 27 are rewound to their respective starting positions and the system is restarted for the final rerecording. Switch S_5 is closed to energize relay 22 and throw switches S_2, S_3, and S_4 downward from the position represented in the drawing. In the downward position switch S_2 connects magnets 26 through conductors 30*b* to the input of amplifier 24, of which the output is now connected by switch S_3 to rectifier 31, compressor 25 being now inoperative. At the same time switch S_4 connects output circuit 15 of amplifier 11 to the input of amplifier 32, the output of which is supplied through volume compressor 33 to rectifier 34. It is requisite that amplifiers 24 and 32, compressors 25 and 33 and rectifiers 31 and 34 be similar each to each. If during the rerecording of record 1 the settings of volume control 5 follow exactly the sequence established during rehearsal, the unidirectional output currents from rectifiers 31 and 34 will be at all times equal. Those skilled in the art will understand how this equality may be insured by suitable adjustment of the reproducing circuit of magnets 26. The output circuit of rectifiers 31 and 34 are, as shown in the drawing, permanently and oppositely connected to coils *b* and *c*, respectively, of rotor 7. No currents flow in these output circuits when switch S_5 is open and switches S_2, S_3 and S_4 are in the rehearsal position so that during rehearsal there is no torque on rotor 7. During the second reproduction of record 1 the settings of volume control 6 will automatically conform to the corresponding rehearsal settings for the reason that any departure therefrom will result in a current from rectifier 34 different in value from the opposing current from rectifier 31 and the difference in these rectified currents results in a torque effective to turn the movable condenser plates of volume control 6 to assume the setting at rehearsal, whereupon the controlling torque vanishes. Switch S_1 being closed at the same time as switch S_5, the automatically controlled reproduction of record 1 is recorded by recorder 21.

The time lag with which shaft 6 driven by motor 8 moves to annul the current differential from rectifiers 31 and 34 can be made negligible by choosing for the volume control an element which is of small mass and rotates with minimum friction. Capacitance voltage dividers are well suited to this purpose and may be that disclosed in Fleming United States Patent 1,989,797 as shown in the drawing or the coupling system disclosed by L. A. Gebhard in United States Patent 1,890,034. Both of the mentioned disclosures afford control of transmitted level without frequency discrimination. In order that the differential current driving rotor 7 shall not greatly vary with the reproduction level from amplifier 11, compressors 25 and 33 are designed to raise the low and intermediate levels from amplifier 24 to be only some 5 decibels lower than the highest level therefrom. By this expedient the arithmetic difference between the outputs of rectifiers 31 and 34 for a given error of setting of volume control shaft 6 is prevented from decreasing to a value insufficient to provide the necessary control torque. When the torque required is small or when the volume range of the original record is narrow, compressors 25 and 33 are properly omitted.

Should there be a need for intervening in channel I to revise the automatic control, this may be done as follows:

Manual control dial 9 is provided with push-button 35 kept in its normal position by a spring, not shown. In this normal position, as in the diagram, switch S_6 is closed and switch S_7 is open. The operator, desiring to alter a part of the level sequence from that decided on during rehearsal, takes hold of dial 9, depressing as he does so button 35 to open switch S_6 and close switch S_7. Opening S_6 deenergizes relay 22, whereupon switches S_2, S_3, and S_4 return to their rehearsal

position. At the same time, closing S_7 energizes erasing circuit 36, whereby magnets 37 act to erase a portion of the auxiliary record and continue the process of erasure as long as button 35 is depressed. The situation is now exactly as during rehearsal, the reproduction is under manual control and magnets 26 are enabled to record the altered sequence of levels reproduced from record 1. When the operator releases dial 8, the automatic control is reestablished. Such intervention in the controlled reproduction of record 1, resulting in a revised auxiliary record on tape 27 may take place in a second rehearsal during which switch S_1 remains open. Repeated rehearsals may be carried out until the auxiliary record has acquired a finally satisfactory character.

It will be clear that the stated objects of the invention are attained by the described arrangement of apparatus and method of operation. The rerecording of record 1 under automatic control is effected by a minimum number of required apparatus elements without utilizing any current source external to the sound system and provision is made for revising the control of record 1 without stopping the system and without embarrassment to the simultaneous rerecording in channels II and III. While the description and diagram show an illustrative embodiment of the invention, it is to be understood that other elements capable of performing the various required functions may be substituted for those illustratively shown. For example, instead of separate windings rotor 7 may be provided with a single winding to which are applied in opposition the outputs of rectifiers 31 and 34. While the invention has been described with particular reference to the rerecording of sound records, it is obviously applicable in any case where one desires to repeat, under automatic control, any operation of electrical transmission.

What is claimed is:

1. The method of automatic control of the rerecording of an original sound record which comprises making a first electrical reproduction of said original sound record under manual control and simultaneously making an auxiliary record of said first reproduction, making a second electrical reproduction of said original sound record under control of said auxiliary record, and making a sound record of said second reproduction.

2. The method of rerecording with automatic control an original sound record which comprises making a first electrical reproduction of said original record under manual control of reproduced volume levels, simultaneously translating said first reproduction into sound with reference to which said manual control is determined and making an auxiliary sound record with volume compression of said first reproduction, making a second electrical reproduction of said original record with volume compression, electrically reproducing said auxiliary record simultaneously with said second reproduction, amplifying and rectifying the currents reproduced in said second reproduction and in the electrical reproduction of said auxiliary record, combining in opposition said rectified currents to control in accordance with said auxiliary record the volume levels before compression in said second reproduction, and making a second record of said original record in parallel with said second reproduction before compression.

3. The method of rerecording with automatic control an original sound record which comprises making a first electrical reproduction of said original record under manual control of reproduced volume levels, simultaneously translating said first reproduction into sound with reference to which said manual control is determined and making an auxiliary sound record of said first reproduction, making a second electrical reproduction of said original record, electrically reproducing said auxiliary record simultaneously with said second reproduction, amplifying and rectifying the currents reproduced in said second reproduction and in the electrical reproduction of said auxiliary record, combining in opposition said rectified currents to control in accordance with said auxiliary record the volume levels in said second reproduction, and making a second record of said original record in parallel with said second reproduction.

4. The method of rerecording with automatic control an original sound record which comprises the following steps: first, electrically reproducing said original record under manual control and simultaneously making an auxiliary sound record of said reproduction; second, electrically reproducing said original record under control of said auxiliary record and manually intervening to revise said auxiliary record; repeating said second step with progressive revision of said auxiliary record to a satisfactory final form; and, finally, electrically reproducing said original record under control of said auxiliary record in final form and simultaneously making a record of said original record so reproduced.

5. In a sound rerecording system, means for rerecording a composite record from a plurality of sound records including a reproducing channel individual to each of said records, control means in each of said channels for automatically controlling the reproduction of the sound record associated therewith independently of the other reproducing channels, said control means including an auxiliary record rerecorded from said associated sound record, means for combining the automatically controlled reproduction of said records, and means for making a record of said combined reproductions.

6. In a sound record reproducing system including a volume control means in circuit with a preliminary amplifier having a primary output circuit for monitoring and rerecording a reproduced sound record, means for automatically controlling the rerecording of said sound record including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits of said preliminary amplifier, one of said additional circuits including means for making with volume compression an auxiliary record of said sound record, the other of said additional circuits including amplifier means for reproducing with volume compression said sound record and means for rectifying the reproduction currents of said sound record, means for reproducing said auxiliary record including means for rectifying the reproduction currents of said auxiliary record, switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified reproduction of said sound record by said other additional circuit simultane-

ously and in opposition upon the armature coils of said rotor, and switching means for intervening to revise said auxiliary record during the reproduction thereof.

7. In a sound record reproducing system including a volume control means in circuit with a preliminary amplifier having a primary output circuit for monitoring and rerecording a reproduced sound record, means for automatically controlling the rerecording of said sound record including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits of said preliminary amplifier, one of said additional circuits including means for making an auxiliary record of said sound record, the other of said additional circuits including amplifier means for reproducing said sound record and means for rectifying the reproduction currents of said sound record, means for reproducing said auxiliary record including means for rectifying the reproduction currents of said auxiliary record, switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified reproduction of said sound record by said other additional circuit simultaneously and in opposition upon the armature coils of said rotor, and switching means for intervening to revise said auxiliary record during the reproduction thereof.

8. In a sound record reproducing system including a volume control means in circuit with a preliminary amplifier having a primary output circuit for monitoring and rerecording a reproduced sound record, means for automatically controlling the rerecording of said sound record including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits of said preliminary amplifier, one of said additional circuits including means for making with volume compression an auxiliary record of said sound record, the other of said additional circuits including amplifier means for reproducing with volume compression said sound record and means for rectifying the reproduction currents of said sound record, means for reproducing said auxiliary record including means for rectifying the reproduction currents of said auxiliary record, and switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified reproduction of said sound record by said other additional circuit simultaneously and in opposition upon the armature coils of said rotor.

9. In a sound record reproducing system including a volume control means in circuit with a preliminary amplifier having a primary output circuit for monitoring and rerecording a reproduced sound record, means for automatically controlling the rerecording of said sound record including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits of said preliminary amplifier, one of said additional circuits including means for making an auxiliary record of said sound record, the other of said additional circuits including amplifier means for reproducing said sound record and means for rectifying the reproduction currents of said sound record, means for reproducing said auxiliary record including means for rectifying the reproduction currents of said auxiliary record, and switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified reproduction of said sound record by said other additional circuit simultaneously and in opposition upon the armature coils of said rotor, and switching means for intervening to revise said auxiliary record during the reproduction thereof.

10. Apparatus for automatically controlling the reproduction of an original sound record from a sound reproducer including a volume control means in a reproducing circuit, an auxiliary sound record of said original record made during a previous reproduction thereof, means for reproducing said auxiliary record simultaneously with a subsequent reproduction of said original record, an additional reproducing circuit of said volume control means operative during said subsequent reproduction, means for rectifying the reproduced output of said auxiliary record, means for rectifying the output of said additional circuit, and means for combining in opposition said rectified outputs to regulate said volume control means during said subsequent reproduction in accordance with said auxiliary record.

11. Apparatus as in claim 10, including means for intervening during said subsequent reproduction to revise said auxiliary record.

12. In an electrical transmission system including a volume control means in circuit with a preliminary amplifier having a primary output circuit including monitoring means, means for the automatic control of the transmission of said primary circuit in accordance with a schedule determined in preliminary monitoring including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits in said preliminary amplifier, one of said additional circuits including means for making with volume compression an auxiliary record of said preliminary monitoring, the other of said additional circuits including amplifying means for reproducing with volume compression the output of said preliminary amplifier and for rectifying said output, means for reproducing said auxiliary record including means for rectifying the currents reproduced from said auxiliary record, switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified output of said other additional circuit simultaneously and in opposition upon the armature coils of said rotor, and switching means for intervening to revise said auxiliary record during the reproduction thereof.

13. In an electrical transmission system including a volume control means in circuit with a preliminary amplifier having a primary output circuit including monitoring means, means for

the automatic control of the transmission of said primary circuit in accordance with a schedule determined in preliminary monitoring including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits in said preliminary amplifier, one of said additional circuits including means for making an auxiliary record of said preliminary monitoring, the other of said additional circuits including amplifying means for reproducing the output of said preliminary amplifier and for rectifying said output, means for reproducing said auxiliary record including means for rectifying the currents reproduced from said auxiliary record, switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified output of said other additional cricuit simultaneously and in opposition upon the armature coils of said rotor, and switching means for intervening to revise said auxiliary record during the reproduction thereof.

14. In an electrical transmission system including a volume control means in circuit with a preliminary amplifier having a primary output circuit including monitoring means, means for the automatic control of transmission of said primary circuit in accordance with a schedule determined in preliminary monitoring including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits in said preliminary amplifier, one of said additional circuits including means for making with volume compression an auxiliary record of said preliminary monitoring, the other of said additional circuits including amplifying means for reproducing with volume compression the output of said preliminary amplifier and for rectifying said output, means for reproducing said auxiliary record including means for rectifying the currents reproduced from said auxiliary record, and switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified output of said other additional circuit simultaneously and in opposition upon the armature coils of said rotor.

15. In an electrical transmission system including a volume control means in circuit with a preliminary amplifier having a primary output circuit including monitoring means, means for the automatic control of transmission of said primary circuit in accordance with a schedule determined in preliminary monitoring including a direct current motor having a rotor coupled to said volume control means and provided with armature coils, a pair of additional output circuits in said preliminary amplifier, one of said additional circuits including means for making an auxiliary record of said preliminary monitoring, the other of said additional circuits including amplifying means for reproducing the output of said preliminary amplifier and for rectifying said output, means for reproducing said auxiliary record including means for rectifying the currents reproduced from said auxiliary record, and switching means selecting in a first switch position said one additional circuit for making said auxiliary record and selecting in a second switch position said other additional circuit simultaneously with said means for reproducing said auxiliary record and impressing the rectified reproduction of said auxiliary record and the rectified output of said other additional circuit simultaneously and in opposition upon the armature coils of said rotor.

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