

Aug. 2, 1938.

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2,125,390

SOUND RECORDING

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2 Sheets-Sheet 1

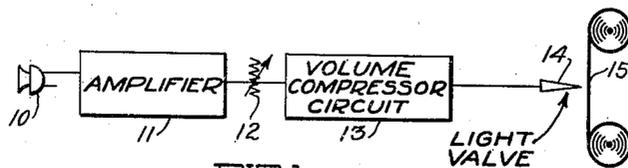


FIG. 1

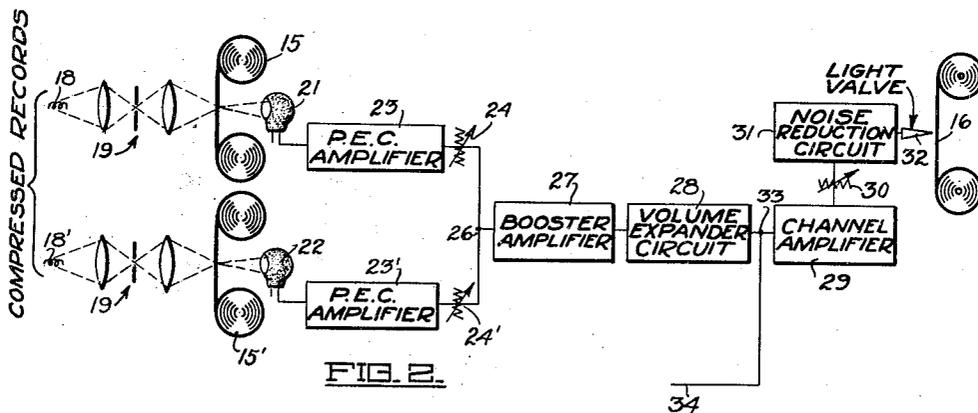


FIG. 2

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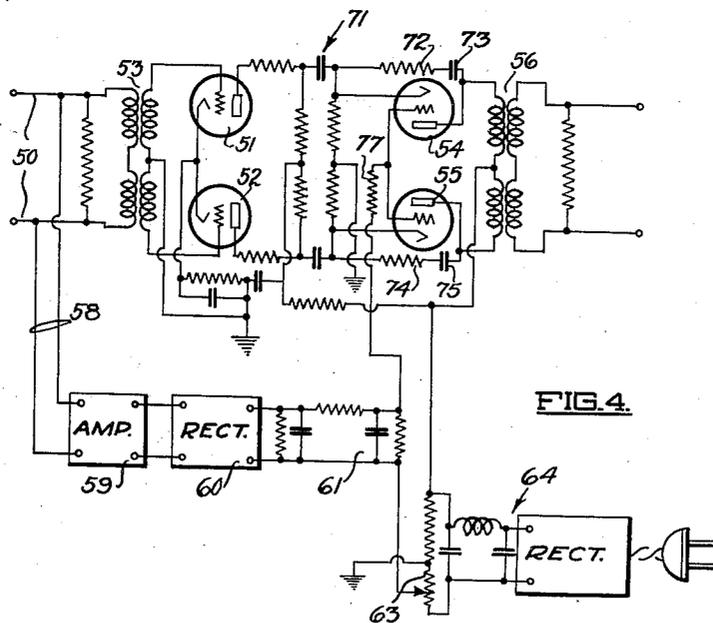
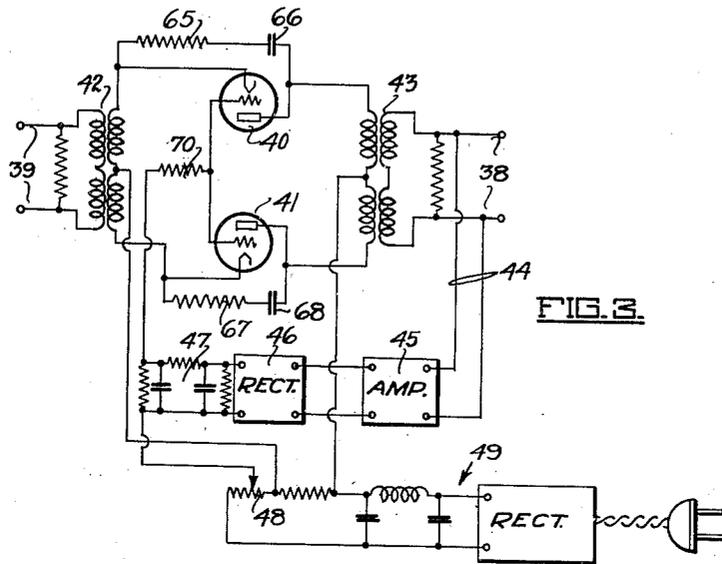
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# UNITED STATES PATENT OFFICE

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## SOUND RECORDING

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Application February 10, 1936, Serial No. 63,086

2 Claims. (Cl. 179—100.3)

This invention relates to sound recording and reproduction and particularly to the duping of the sound from one or more sound records to a single record.

5 In the production of a talking motion picture having an accompanying sound record either on the film itself or in the form of a separate record it is common practice to record various portions of the desired sound effects such as dialogue and music on different records and combine these records upon a single final record which is to be reproduced in the theatre. Also, it is common practice to dupe the sound from one sound record onto another for the purpose of changing the volume or quality of the sound recorded upon the original record. In transferring the sound from one film to another film the undesirable background noise produced by the clear portions of the film is increased in reproducing the sound from the final record due to the combined effect of the background noise of the original record and that of the duped record. This effect is even more noticeable when duping several records upon a single final record.

25 Heretofore, the reduction of the background or film surface noise has been generally accomplished by the use of so-called noise reduction equipment employing shutters or means for biasing the light modulating elements of the recorder. The use of such arrangements incurs a certain amount of sound distortion due to time lag, clipping of the wave peak representations, ribbon clash, etc. Although this distortion is usually tolerable where the noise reduction circuit has been employed only once to obtain the final record, it may become unduly annoying in cases where the noise reduction has been employed both for the original duping records and the final duped record. Here the sound distortion may be multiplied by each noise reduction circuit so as to become noticeable to one listening to the sound reproduced from the final record. In all noise reduction circuits of which I am aware the sound distortion increases with increase in the amount of noise reduction. The noise reduction equipment is usually adjusted so as to effect a compromise between the maximum amount of noise reduction desirable and the maximum amount of sound distortion permissible. The allowable amount of noise reduction may vary with different types or sound being recorded; however, the maximum average value heretofore commonly used has generally been about 10 db.

55 While the background noise may be reduced to

a minimum without the usual sound distortion by employing a volume compression and expansion circuit such as that disclosed and claimed in the co-pending application of Burton F. Miller, Serial No. 42,116, filed Sept. 25, 1935, this type of recording and reproduction has the disadvantage that it does not result in a standard type of sound track, i. e., one in which volume is accurately recorded. The compressed type of track requires that the sound reproducer must be equipped with a special sound amplitude expansion circuit in addition to the standard sound reproducing equipment. If the compressed type of track were released for general use, it would be necessary to modify the sound reproducing equipment in many thousands of theatres.

One object of the present invention is to take advantage of the increased reduction in background noise afforded by the compression-expansion type of recording and reproduction while nevertheless resulting in a standard sound track which can be used without modifying the present standard theatre equipment.

This is accomplished by employing the compression-expansion type of recording and reproduction as a step in a duping operation, the final step of which produces a standard anti-ground noise record capable of being produced in a standard reproducer.

By employing, as a preliminary step to duping, a volume compression circuit as hereinbefore described the volume level range of the sound recorded on the original record may be compressed 20 db. On expanding the sound currents obtained from the compressed record to the normal volume level range by passing these currents through an expander circuit capable of a 20 db. volume expansion, a reduction of background noise of 20 db. will be realized without the usual sound distortion produced by the noiseless recording equipment. The use of this 20 db. noise reduction on the recording and reproduction of the original duping records by volume compression and expansion will allow sounds of the lowest practical volume to be recorded upon the final duped record without also recording the background or surface noise due to scratches, dirt, etc., on the sound track of the original duping records and without the usual sound distortion. I have discovered that the final duped record according to my invention will have about 3 db. less background noise than that commercially obtainable heretofore through noise reduction equipment (non-volume distorting) such as

a biased valve or galvanometer, or in other words a decrease of 100% in background noise.

One feature of the invention resides in recording the original sound upon a record without manually changing the volume of the sound as it is being recorded. If changes in volume are later desired along certain portions of the record, the record may be duped on a second final record by manually controlling the volume of the sound recorded on the final record during the duping process. With the present invention this may be accomplished without any noticeable increase in ground noise or increase in sound distortion. However, heretofore, the volume level of the sound to be recorded was generally controlled manually while being recorded on the original record to prevent overload or underload. In this case, if mistakes were made due to the human element in controlling the sound volume, the original sound was either rerecorded, resulting in a loss of time and greater expense, or the recorded sound was duped upon a second standard record while manually changing the volume during such duping operation. In this duping operation the background noise from the first standard record was transferred upon the second record, thus increasing distortion and background noise.

Other objects and advantages of the invention will be apparent from the following description when read in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic view of a sound recording channel for producing volume compression type of sound records.

Fig. 2 is a schematic view of a duping channel for duping one or more compressed sound records upon a single record.

Fig. 3 is a schematic diagram of one form of compressor circuit adapted to be employed in the recording channel of Fig. 1.

Fig. 4 is a schematic diagram of one form of expander circuit adapted to be employed in the reproducer circuit of Fig. 2.

In the recording and reproduction of sound by employing volume compression and expansion the volume level range of the sound to be recorded is compressed, that is, the higher sound levels are decreased to a greater degree than the lower sound levels. Thus the lower levels are recorded upon the sound track of the film at comparatively higher levels while at the same time the inherent background noise level due to the scratches, dirt, etc., on the surface of the sound track portions of the film remains the same. This increase in signal to noise ratio thus obtained does not lower in reproduction; however, the volume level range is expanded, usually by an amount equal to the amount of compression applied to the original record. At this point, therefore, the lower recorded levels are decreased thus decreasing at the same time the film background noise while the upper levels are expanded so as to produce a sound of substantially the same characteristics, i. e., volume, etc., as that of the original.

It is to be understood therefore that the amplitude levels of the compressed record differ only a slight amount from constant amplitude, this slight amount being employed during expansion in the expander circuit to restore the sound amplitude range to its original value. Fig. 1 shows an arrangement for producing a compressed record wherein a microphone 10 converts the sound to be recorded into corresponding electrical impulses which are passed through a usual amplifier equipment 11 and into an automatic volume

level compressor circuit 13. A volume control potentiometer 12 or the like may be employed to manually control the volume of the sound being recorded in addition to the automatic volume control, it being understood that the control of the volume level at this point will produce corresponding changes in the sound as reproduced from the final duped record. However, as described hereinafter, it is preferable not to employ the potentiometer 12 but to manually control the volume during the duping of the final record. The compressed sound currents from the compressor circuit 13 are passed into a light modulating device 14 such as a light valve of a sound recorder to photographically record the sound wave representations upon the compressed record 15. None of the usual noise reduction equipment such as shutters or automatic biasing means for the light modulating elements are employed during the recording of the film 15 thereby reducing distortion of the sound through those sources.

Fig. 2 shows a circuit for recording the sound from one or more compressed duping records 15 and 15', as recorded by the apparatus shown in Fig. 1, upon a single final record 16 of the standard uncompressed type which is capable of being reproduced in any standard sound reproducing apparatus not adapted to automatically expand the volume levels of compressed records to their normal value. The apparatus for recording upon the record 16 comprises exciter light sources 18, 18' and lens and slit combinations 19, 19' to focus a narrow horizontal beam of light upon each of the films 15 and 15' respectively. The light beam thus modulated by films 15 and 15' is allowed to fall upon photo-electric cells 21 and 22 respectively. The speech currents produced in the photoelectric cells 21 and 22 are passed through amplifiers 23 and 23', through manual volume control devices such as potentiometers 24 and 24', and are combined at 26. The combined speech currents are then passed through a booster amplifier 27, and into a volume level range expander circuit 28. Here the amplitude level range of the speech current impulses is expanded by an amount substantially equal to the amount of compression applied in the recording of the records 15 and 15' by the compression circuit 13 (Fig. 1). It will therefore be apparent that the speech currents passing from the expander circuit 28 will have substantially the same amplitude level range as the original speech currents generated in the microphone 11 (Fig. 1). However, if desired, the amount of expansion may be varied so as to produce a speech current whose amplitude level range is different from that of the original sound recorded, for example, to obtain greater contrast between high and low levels than normal. From circuit 28 the speech currents pass through one or more channel amplifiers 29, through a manual volume control 30, and then preferably through an ordinary noise reduction circuit 31, of the well known shuttering or biasing type. The current then passes through a light modulator such as a light valve 32 to be photographically recorded upon the final record 16.

Speech currents from other sources, such as a microphone or sound reproducer (not shown), may be mixed with currents from records 15 and 15' by passing such currents through line 34 which is connected at 33 to the main channel between the volume expander circuit 28 and amplifier 29.

Although the volume of the sound to be recorded may be manually controlled as it is being originally recorded as by potentiometer 12 (Fig. 1)

1) it is of a distinct advantage to record without manual volume control upon the original duping record.

In this case, the exact shadings of level given by the actor are faithfully recorded. In the usual type of recording, the "mixer" who controls the recording level may change the relative levels in a scene so that the entire feeling is destroyed. This level control is necessary in order to compensate for limitations of the recording system but the effect is often to ruin a scene dramatically.

In the duping operation any errors occurring on the set due to improper microphone position or to the actors themselves can be corrected in the duping operation without any penalty due to increased background noise.

Referring to Fig. 3 the input 39 of the compressor circuit is coupled to the input of a pair of impedance tubes 40 and 41. Tubes 40 and 41 are placed in series in a circuit between the input transformer 42 and an output transformer 43. A pair of leads 44 is shunted across the output 38 of the transformer 43 to feed a portion of the output current, serially, through an amplifier 45, rectifier 46, and filter 47. The output of filter 47 is connected in series with the grid cathode circuit of tubes 40 and 41. A static negative grid potential is applied to the grids of tubes 40 and 41 by the drop in potential across a resistance 48 provided in series with a direct current power supply 49. It will thus be seen that a varying grid bias is provided by the rectifier 46 which changes in accordance with the amplitude of the currents passing through the compressor circuit. The polarity of the grid leads from filter 47 is so arranged that at higher amplitude levels the negative grid bias is increased, thus decreasing the final output levels for these high amplitudes.

In order to prevent the impedance of the tubes 40 and 41 from becoming too high, a resistance 65 of about 100,000 ohms and condenser 66 in series is shunted across the cathode and plate of tube 40 while a similar resistance 67 and condenser 68 in series is placed across tube 41. In order to prevent the transmission impedance from dropping to an extremely low value, approaching zero, a resistance 70 of about 100,000 ohms is placed in series in the grid circuit of tubes 40 and 41. By the use of resistance 70 any tendency for the grids to be driven positive by high signal levels will be counteracted by the voltage drop across this resistance caused by the grid current flow.

Referring now to the expander circuit shown in Fig. 4 the input 50 is coupled to the grid circuits of a pair of amplifier tubes 51 and 52 in push-pull arrangement through a transformer 53. A pair of impedance tubes 54 and 55 are provided in series between the plate circuits of the amplifier tubes 51 and 52 and an output transformer 56. Leads 58 are shunted across the input circuit 50 and feed a portion of the input current serially through an amplifier 59, rectifier 60 and filter 61. The output of filter 61 is provided in series with the grid circuits of tubes 54 and 55 to supply a grid bias which varies in accordance with the current passing into the expander circuit. In this case the polarity of the grid leads from the filter 61 and is so arranged that at higher amplitudes the negative grid bias is decreased.

A static negative grid potential is provided by the drop in potential across a resistance 63 in

series with a direct current power supply 64. Tubes 54 and 55 are coupled to the plate circuits of tubes 51 and 52 through a resistance condenser coupling 71. In order to prevent the transmission impedance of the tubes 54 and 55 from becoming too high, resistance 72 of about 100,000 ohms and condenser 73 in series are shunted across the cathode and plate of tube 54 while a similar resistance 74 and condenser 75 in series are shunted across the cathode and plate of tube 55.

In order to prevent the transmission impedance from dropping to an extremely low value a resistance 77 of about 100,000 ohms is placed in the grid circuits of the tubes 54 and 55, thus preventing the grids from becoming positive by high signal levels since any attempt to draw the grids positive will be counteracted by the voltage drop across this resistance caused by grid current flow.

Both the compressor circuit of Fig. 3 and the expander circuit of Fig. 4 are disclosed and claimed in the co-pending application of Burton F. Miller, Serial Number 42,116 filed Sept. 25th, 1935.

Although the above description and accompanying drawings have described and shown the invention in conjunction with the sound-on-film type of sound record, it is to be understood that any type of sound record may be employed for records 15, 15', such as wax, wire, etc., without departing from the scope of the invention.

The expression "standard sound reproducing apparatus" used in the description and claims is intended to mean any sound reproducing apparatus now in common use in theatres and which does not employ a special automatic volume level range controlling equipment. Also the expression "standard sound record" used in the description and claims is intended to mean a sound record not requiring a special automatic volume level range controlling equipment to reproduce the sound therefrom, and wherein the sound is recorded in its natural range of volume level, with or without modification due to manual operation of the usual mixer.

Having thus described my invention, what is claimed as new and desired to secure by Letters Patent, is:

1. An apparatus for re-recording sound from a sound record on which the sounds have been compressed comprising means for converting light impulses varying in accordance with the compressed record into corresponding electrical currents, means for varying the ratio of amplification or attenuation of said electrical currents substantially in accordance with the variation in the amplification or attenuation employed in compressing said record, and means for translating said electrical currents into a standard noise reduction sound film record.

2. The method of transferring a compressed sound record into a standard noise reduction sound film record comprising translating light modulated by said compressed sound film record into electrical currents varying in accordance therewith, varying the volume levels of said currents in an inverse ratio and by an amount substantially the same as the variation in volume levels during compression, and translating said currents into a standard noise reduction sound film record.

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