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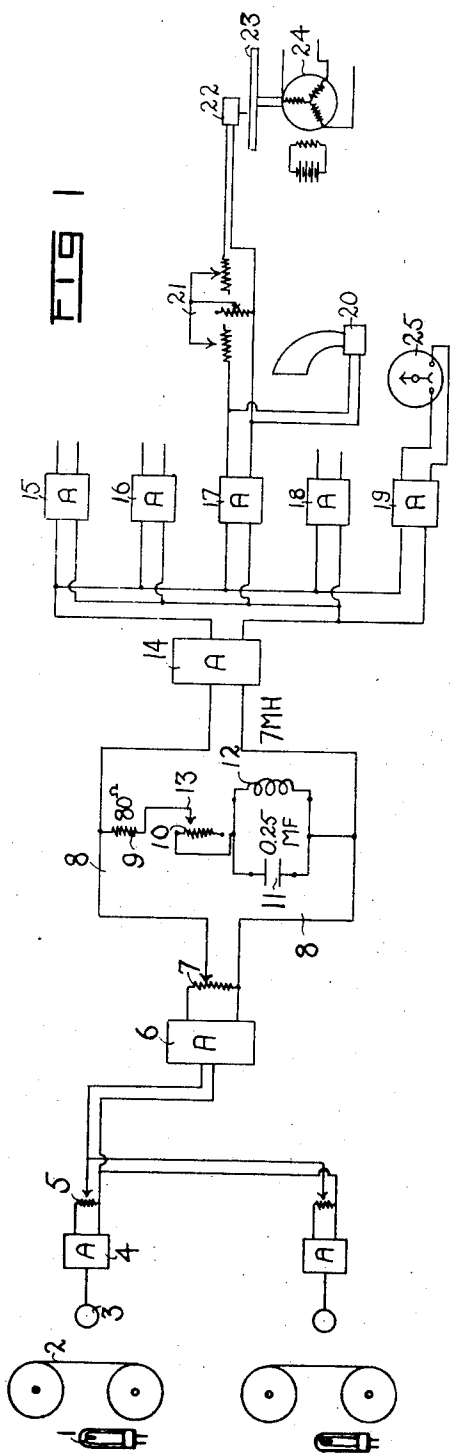
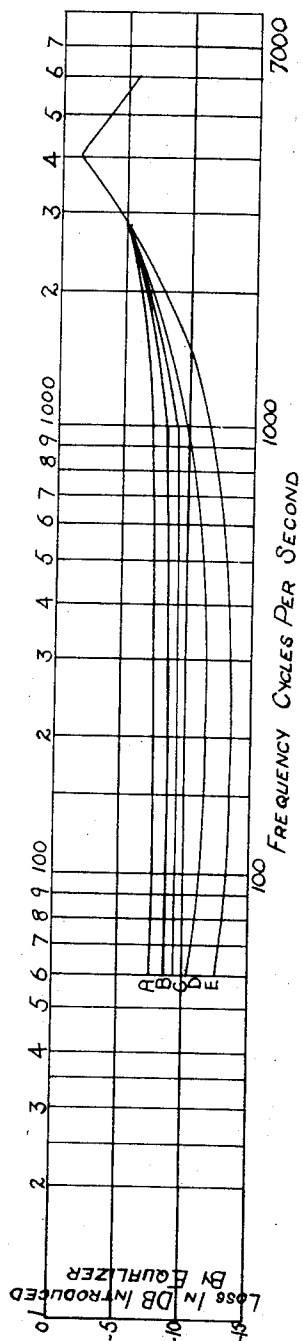
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1,940,282

SOUND RECORDING

Filed March 25, 1932

2 Sheets-Sheet 1



BY

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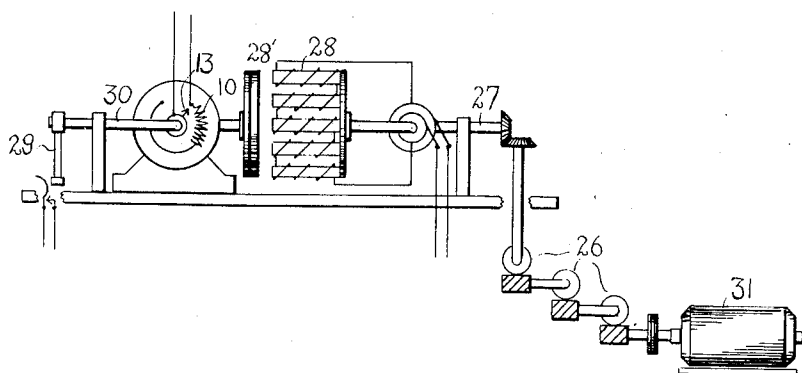
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FIG 3



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SOUND RECORDING

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6 Claims. (Cl. 179—100.4)

This invention relates to the art of recording sound, and to re-recording sound from a record, such as a film or disc, onto another disc record, wherein there is a large difference in the peripheral speed of the sound track at the inside and outside diameters, respectively.

It has been found that when a stylus is cutting a spiral path across a wax record, there is a variation in the frequency response between the inside and the outside diameters thereof. This variation is due to the fact that for any given angle, the distance to be traveled by the stylus, in order to traverse that angle, is much greater at the outside of a disc record than it is at the center of the same record. This means that for any given length of time, the stylus travels relatively faster at the outside diameter of the record than it does at the inside diameter, and by so doing causes, at the inside diameter, a loss of high frequencies, and consequently, a relative over-emphasis of the lower frequencies.

The invention overcomes this difficulty, so that a more even tone quality is obtained throughout the entire record.

The object of the invention is to eliminate the frequency variation in the recorded sounds between the inside and outside tracks of a disc record. This is accomplished by changing the frequency characteristic of the recording circuit, during recording and in timed relation therewith, so as to compensate for the frequency distortion that would otherwise be introduced, due to the different peripheral speeds at the inside and outside diameters, respectively, of a disc record.

While the invention will be particularly described with reference to recording on wax records, it is applicable to recording by light waves on a disc shaped film record.

Further objects and structural details of this invention will be apparent when read in conjunction with the accompanying drawings, wherein

Fig. 1 is a schematic view of a re-recording circuit embodying the invention.

Fig. 2 shows a set of curves indicating the loss in decibels introduced into the circuit to compensate for variation in frequency characteristic, the curves showing, respectively, the attenuation introduced for various frequencies at the different diameters of the sound track.

Fig. 3 illustrates an attenuator, or correcting network, driven in timed relation with the recording.

Referring to Fig. 1, there is a constant light

source 1 which penetrates a film 2, carrying a varying sound track, and energizes a photoelectric cell 3. The variable current so produced is strengthened by an amplifier 4, and passes through a potentiometer 5. The current is further strengthened by an amplifier 6, and a desired amount of amplifier current is led from a potentiometer 7, known as the mixer's master control, to an attenuation equalizer, or correcting network, 8 which is in shunt to the line. The attenuation equalizer 8 consists of a fixed resistance 9 of 80 ohms in series with a variable resistance 10 and a wiper arm 13. Said resistance 10 is a 100 ohm logarithmic wound resistance. The fixed resistance 9 and variable resistance 10 are in series with a branch reactive path, in one branch of which path is a condenser 11 of 0.25 m. f. capacity. In the other branch in parallel therewith is an inductance 12 of seven millihenries. The above values may be changed to suit conditions. The wiper arm 13 may be operated by hand, or by a motor, as shown in Fig. 3, or by other mechanical means.

Connected to the input side of the amplifier 6 is a similar arrangement for simultaneously producing current variations corresponding to sound from another sound record, whereby the sound records on one or more films may be re-recorded.

The current after leaving the attenuation equalizer 8 is amplified by a master amplifier 14, and from there is distributed to amplifiers 15, 16, 17, 18 and 19, which are in parallel in the output circuit of amplifier 14. Volume indicator 25 is connected to amplifier 19. The current passes from amplifier 17 to a monitoring loud speaker 20, and through a network of variable shunt and series resistance 21, to a cutter 22, traveling on a wax disc 23, rotated by a three-phase motor 24. The three-phase motor 24 and the similar three-phase motor 31 in Fig. 3 are connected to the same source of A. C. power whereby these motors run in synchronism.

The frequency characteristic of wax recording for twelve-inch records was determined by recording at pitches of 123, 133 and 143 per inch, the frequencies of 1000 cycles and 4000 cycles per second, at a plus 10 db. level relative to .006 watts on the wax recorder. The first set of frequencies was started at an inside diameter on the wax, of 6 inches. The frequencies were recorded by placing a few revolutions of 1000 cycle tone immediately followed by a few revolutions of 4000 cycle tone. The 1000 cycle and 4000 cycle frequencies were recorded in this manner at diameters of 6, 6½, 7, 7½, 8, 8½, 9, 9½, 10, 10½ and 11

inches. The wax was then processed and the finished product measured by playing the record with a reproducer including an amplifier which was terminated with 500 ohms and a volume indicator, both full tone and half-tone phonograph needles being used in different tests.

The difference in response between 1000 cycles and 4000 cycles was then measured at the various diameters of the record and from these measurements the amount of equalization required, as shown in Fig. 2, was determined, thereby determining the rate at which resistance 10 must vary to accomplish the desired correction.

The difference in frequency response between the inside and outside diameters of the wax is corrected for by means of the equalizer 8 which progressively varies the amount of equalization at the inside diameter of the record until the recorder has moved approximately two inches toward the outside diameter, after which the equalization remains at a minimum throughout the remainder of the record, because the difference in characteristic due to cutter speed is negligible for the remainder of the record.

As the cutter arm 22 moves across the record 23, the wiper 13 rotates on the resistance 10 and increases the resistance in series with the equalizer and reduces the amount of equalization. With the values shown, the equalizer is tuned to 4000 cycles, although it may be tuned to higher or lower frequencies.

Curve E in Fig. 2 represents the condition that exists at the start of the record, or the maximum equalization that is introduced. After one minute has elapsed, the amount of equalization in the circuit is shown by curve D. After two minutes, a condition such as curve C exists, and at the end of three minutes, or at approximately the $7\frac{1}{2}$ inch diameter on the record, the equalization has been reduced to curve B. At the end of four minutes, i. e., at the 8 inch diameter, there is a minimum of equalization in the circuit, or a condition represented by curve A. This condition exists until the finish of the record.

The motor driven equalizer consists of a three-phase motor 31, connected through a series of gears 26 to a shaft 27. The gears 26 reduce the speed of rotation from 1200 revolutions per minute to 1 revolution in approximately 10 minutes. Connected to shaft 27 is a solenoid magnetic clutch 28 operating on clutch member 28' carried by shaft 30. This shaft 30 carries the wiper arm 13 which serves to vary the amount of resistance 10 in circuit as in Fig. 1. The magnetic clutch 28 is energized from the same source of power that drives the motors 31 and 24, and when energized, rotates the wiper arm 13 on the resistance 10 to increase this resistance and thereby progressively reduce the correction, or equalization, as the cutter 22 proceeds from the inside diameter of the sound track towards larger diameters. The resistance 10 and the correction introduced by network 8 are thereby varied in timed relation with the recording. After the shaft 27 has rotated the desired amount, the cutter 22 having reached the outside track the limit switch 29 opens the circuit

of and stops the motor 31, and a spring (not shown) connected to shaft 30 returns wiper 13 to its initial position when clutch 28 is deenergized by a manual switch in the power circuit at the recording position.

A particular advantage of the above arrangement is to avoid a noticeable difference in quality of reproduction when shifting from one record to another, as in standard talking motion picture reproduction. In this case, reproduction from the outside of one record is immediately followed by reproduction from the inside track of the next record. The invention equalizes the reproduction at the inside track of one record to the reproduction at the outside track of a companion record.

What I claim is:

1. A recording circuit comprising means for supplying current variations corresponding to sound waves, a variable correcting network therefor, means for recording current variations derived from said correcting network, and means responsive to said recording means for varying the effectiveness of said correcting network and for operating said recording means in timed relation with each other.

2. A recording circuit comprising means for supplying current variations corresponding to sound, a recorder therefor, a variable impedance between said supplying means and said recorder, and means responsive to said recorder for varying said impedance and for operating said recorder in timed relation with each other.

3. A recording circuit comprising the combination of means for supplying current variations corresponding to sound, an attenuation equalizer therefor comprising a path in shunt to said supplying means, said equalizer comprising a reactive network and a variable resistance in series, a cutter connected to said equalizer, a disc record associated with said cutter, and means for rotating said disc record and for varying said resistance in timed relation with each other.

4. A recording circuit comprising means for supplying current variations corresponding to sound waves, a variable correcting network therefor, means for recording current variations derived from said correcting network, means for progressing said recording means relatively to the record, and motive means for varying said network in timed relation with the progress of said recording means relatively to the record.

5. A recording circuit, a correcting network therefor, a power drive for varying said correcting network, a recorder, a power drive for said recorder, and means for operating said power drives in timed relation with each other.

6. A recording circuit comprising means for supplying current variations corresponding to sound waves, a variable correcting network therefor, means for recording current variations derived from said correcting network, and means dependent upon the recording time for varying the effectiveness of said correcting network.

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