J. L. McQUARRIE.

METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING SOUND.

APPLICATION FILED JAN. 8, 1918.

1,383,737. Patented July 5, 1921.

3 SHEETS—SHEET 1.

Fig. 1.

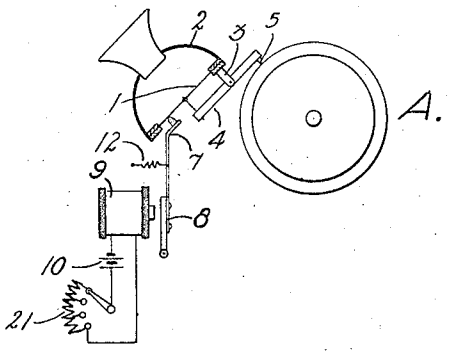


Fig. 3.

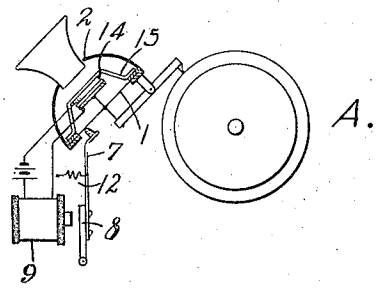


Fig. 2.

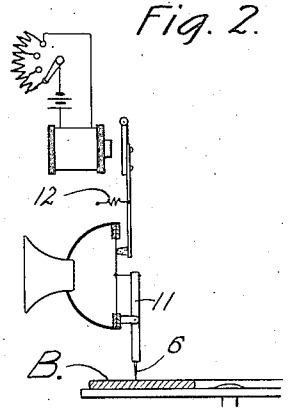
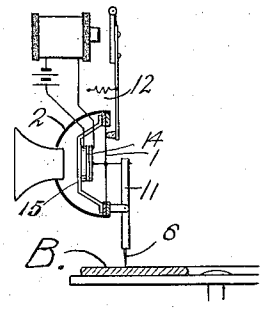


Fig. 4.



Inventor:
James L. Mc Quarrie
by J. H. Roberts Att'y.

J. L. McQUARRIE.

METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING SOUND.

APPLICATION FILED JAN. 8, 1918.

1,383,737. Patented July 5, 1921.

3 SHEETS—SHEET 2.

Fig. 5.

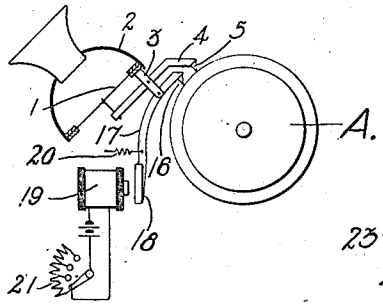


Fig. 6.

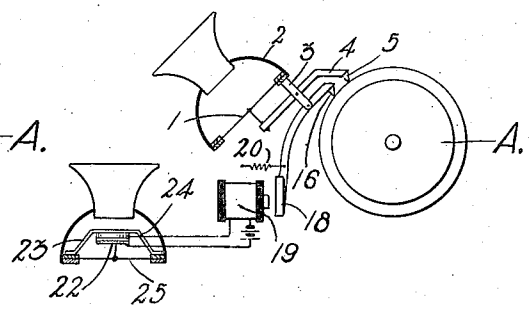


Fig. 7.

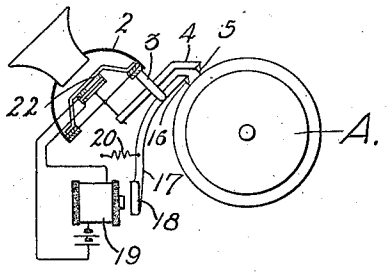
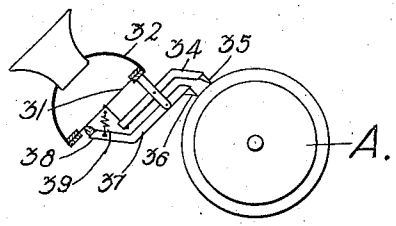


Fig. 8.



Inventor:
James L. McQuarrie
by J. L. Roberts Att'y.

J. L. McQUARRIE.

METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING SOUND.

APPLICATION FILED JAN. 8, 1918.

1,383,737.

Patented July 5, 1921.

3 SHEETS—SHEET 3.

Fig. 9.

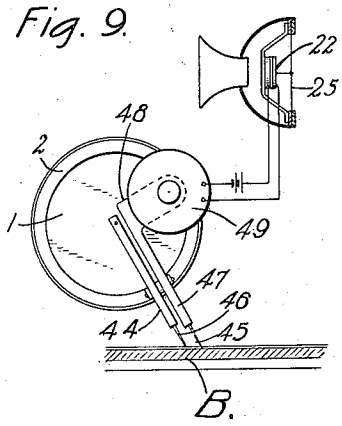


Fig. 10.

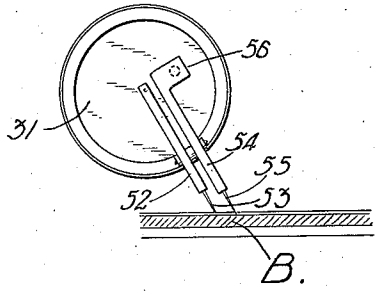


Fig. 12a.

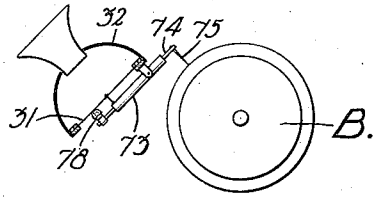


Fig. 12b.

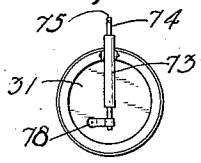


Fig. 14.

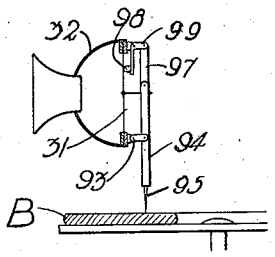


Fig. 11.

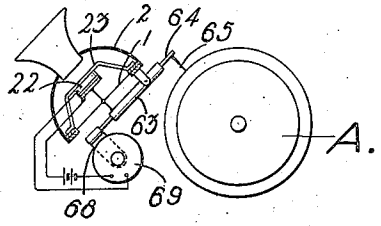
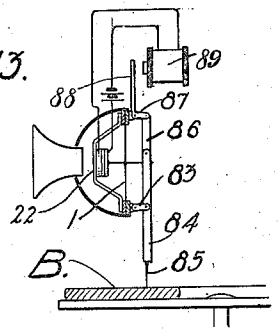


Fig. 13.



Inventor:
James L. McQuarrie
by J. G. Roberts Att'y.

UNITED STATES PATENT OFFICE.

JAMES L. McQUARRIE, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING SOUND.

1,383,737. Specification of Letters Patent. Patented July 5, 1921.

Application filed January 8, 1918. Serial No. 210,847.

To all whom it may concern:

Be it known that I, JAMES L. McQUARRIE, a citizen of the United States, residing at Montclair, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods of and Apparatus for Recording and Reproducing Sound, of which the following is a full, clear, concise, and exact description.

This invention relates to sound recording and reproduction and especially to the control thereof for the purpose of eliminating defects in the reproduced sound arising from the limited range of accurate responsiveness to sound vibrations or reproducing impulses characterizing recording and reproducing mechanisms now in use.

If a diaphragm, such as is used in sound recording and reproducing mechanism in connection with phonographs and the like, is of the requisite degree of sensitiveness to respond most effectively to impulses from a sound source or from record actuated means when such impulses are of a selected intensity, its response when these impulses are of a widely different intensity, is apt to be defective. Such defective response may also follow from the inability of the mechanism associated with the diaphragm for actuating it or for actuation thereby to transmit accurately impulses of widely different amplitudes.

The present invention is designed to overcome this defect by selectively supplementing the response of the diaphragm to the impulses to which it is subject and this is accomplished by arranging for varying the sensitiveness of the diaphragm upon the occurrence of impulses which differ greatly in strength from those impulses for which the diaphragm and associated mechanism are adjusted. Either the recording or the reproducing diaphragm may be so controlled.

Several forms of apparatus involving the employment of this invention are shown diagrammatically in the accompanying drawings, in which:— Figure 1 illustrates an apparatus for producing records of the perpendicularly undulating type, in which the responsiveness of the diaphragm actuating the recording stylus is modified by a manually controlled device. Fig. 2 illustrates a similar arrangement for producing records of the laterally undulating type. Figs. 3 and 4 show arrangements similar to Figs. 1 and 2, except that the modifying device is automatically controlled by the stylus actuating diaphragm. Fig. 5 shows a perpendicularly undulating record type of recording apparatus equipped with a manually controlled auxiliary stylus for cutting a supplementary record. Figs. 6 and 7 show modifications of the forms shown in Fig. 5 in which the auxiliary stylus is automatically controlled. Fig. 8 shows reproducing mechanism with which records formed by the apparatus in Figs. 5, 6 to 7, can be used, Figs. 9 and 10 show, respectively, recording and reproducing apparatus for laterally undulating records in which a supplementary amplitude record is formed. Figs. 11, 12^a and 12^b show recording and reproducing apparatus for perpendicularly undulating records in which the groove containing the principal record undulates laterally to form the supplementary record. Figs. 13 and 14 show a corresponding apparatus for records in which the principal record undulates laterally and the supplementary record undulates perpendicularly.

In the apparatus shown in Fig. 1 the diaphragm 1, which is sensitive to all sound vibrations desired to be recorded, is mounted in a suitable support 2. Pivoted in the bearing 3 is a carrier 4, bearing at one end the stylus 5 and having its other end so connected or otherwise related to the diaphragm 1 as to cause the carrier to vibrate therewith, whereby the stylus 5 cuts a "hill and valley", that is, a perpendicularly undulating, record on the rotating cylinder A.

Associated with the diaphragm is the damping member 7, carried on pivoted armature 8 of the electromagnet 9, the electric circuit of which comprises a battery 10 and manually variable resistance 21. By this means the attendant in charge of the recording apparatus, may, by inserting or removing resistance, vary the pressure of the damping device 7 against the diaphragm 1 and thus selectively supplement the response of the diaphragm to impinging sound vibrations of different amplitudes. The armature 8 and the damping member 7 may be held in balanced position by means of spring 12 adjusted so as to aid the electromagnet in holding the damping member 7 against the diaphragm with the proper degree of pressure.

Other manually controlled actuating means may be substituted for the electromagnet.

The apparatus shown in Fig. 2 is the same as that above described except that the stylus 6 is so mounted on the carrier 11 as to cut in the rotating disk B a "zig-zag" record, that is a record of the laterally undulating type.

Figs. 3 and 4 show modifications of the apparatus shown in Figs. 1 and 2 respectively, in which the current for the electromagnet is automatically varied by means of a microphone button 14 or the like, mounted in a bridge 15 in the diaphragm support 2 and having one of its electrodes connected with the diaphragm 1 so as to vibrate therewith. It is therefore apparent that, with this arrangement, as the diaphragm 1 vibrates in response to sounds of different degrees of loudness, the pressure in the microphone button 14 will vary, and as the pull of the electromagnet on its armature 8 will correspondingly vary, the damping effect of the member 7 will be automatically adjusted so as to prevent chattering of the diaphragm when the sound vibrations to be recorded are of considerable amplitude and yet will not interfere with the sensitiveness of the diaphragm when the sound vibrations are of small amplitude. Thus the supplementing of the response of the diaphragm to selected sound vibrations is automatically controlled.

The records made by the apparatus in Figs. 1 to 4 are suitable for use in present well-known forms of reproducing apparatus.

Figs. 5 to 14 illustrate several variations of a type of arrangement in which the diaphragm of the reproducing apparatus is damped, the diaphragm of the recording apparatus being undamped. The damping of the reproducing diaphragm is determined by selective mechanism operating in connection with the recording diaphragm, as follows: The sound vibrations are caused to form two records, a principal record which is of one of the present well-known types in which all of the sound vibrations to which the recording diaphragm is responsive are recorded as they occur, and a supplementary record of the occurrence of sound vibrations which are of such amplitude that it is desirable, during their reproduction, to modify the responsiveness of the reproducing diaphragm, as by damping. The principal and supplementary records may form separate grooves or may be combined in one compound groove.

Figs. 5 to 8 refer to a perpendicularly undulating record type of apparatus in which the principal and supplementary records are formed by separate styli in separate grooves. Diaphragm 1, responding to the sound vibrations reaching it, controls the formation of the principal record in the usual way by means of the pivoted carrier 4 and the stylus 5. A supplementary record is cut by the auxiliary stylus 16 carried on one end of the pivoted auxiliary carrier 17, at the other end of which is mounted the armature 18 of the electromagnet 19, the carrier, stylus and armature being resiliently held in balanced position by the spring 20. The depth of the supplementary groove cut by stylus 16 may obviously be varied by varying the current in the winding of the electromagnet. The varying of this current upon the occurrence of sounds of a selected character thus supplements the response of the diaphragm 1 and stylus 5 to impinging sound vibrations.

In Fig. 5, the current, and therefore the depth of the supplementary groove, is controlled by means of a rheostat 21 manually adjustable by the attendant upon the occurrence of sounds whose reproduction it is desired to modify. As in the case of Fig. 1, other manually controlled actuating means may be substituted for the electromagnetic and rheostat.

In the modification shown in Fig. 6, the manually controlled resistance is replaced by microphone button 22 or the like carried by a bridge 23 mounted in the support 24 of the auxiliary diaphragm 25, to which one electrode of the microphone is connected. The diaphragm 25 may be of a different degree of sensitiveness from the diaphragm 1. Fig. 7 illustrates a modification in which the microphone button 22 is mounted in the support 2 and connected to the diaphragm 1 which controls the principal stylus 5.

In the forms shown in Figs. 6 and 7, the depth of the groove cut by the auxiliary stylus 16, will be varied when the sound vibrations become of such amplitude as to produce a change in the resistance of the microphone 22 sufficient to cause the electromagnet to move its armature 18. The responsiveness of the auxiliary recording mechanism, and therefore the scope and exactness of the auxiliary record, is determined by the strength of the spring 20, the weight of the auxiliary stylus carrier and magnet, and the electric and magnetic characteristics of the electromagnet and its microphone.

Reproducing apparatus for records made by the recording apparatus in Figs. 5, 6 and 7, is shown in Fig. 8, in which 31 is a sensitive diaphragm suitably supported in the sound box 32 and operatively connected to pivoted lever 34 of the stylus 35. The stylus 36 is carried at one end of the pivoted lever 37, on the other end of which is mounted a damping member 38 which a spring 39 tends to pull into contact with the diaphragm 31. The principal sound record, operating through the medium of stylus 35 and arma-

ture 34, causes the diaphragm 31 to vibrate in accordance with the original sound vibrations, while variations in the depth of the supplementary record, operating through the stylus 36 and lever 37 and coöperating with the spring 39 change the position of the damping device 38 relative to the diaphragm 31. As the depth of the supplementary record varies to correspond with the occurrence in the principal record of undulations resulting from sounds of more than a predetermined amplitude, the damping device 38 is brought into operation at the same time as the diaphragm is subjected to the actuating impulses corresponding to such sounds, the relative positions of the styli 35 and 36 being properly chosen for this effect.

In the modification shown in Fig. 9, the main diaphragm 1 in the support 2 controls the principal stylus carrier 44 which carries the recording stylus 46 arranged to form a "zig-zag" or laterally undulating principal record on the disk B, and the auxiliary stylus 45 is carried by one end of the lever 47, on the other end of which is the armature 48 of the electromagnet 49. The attraction of the electromagnet for its armature 48 is controlled through the microphone 22 and auxiliary diaphragm 25 by variations in the amplitude of the vibrations to be recorded in the same way as described in connection with Fig. 6. If desired, the microphone element may be connected to the main diaphragm as shown in Figs. 3, 4 and 7, or may be replaced by a manually controlled rheostat as in Fig. 5. The double record formed by the apparatus in Fig. 9 essentially differs from the double record formed by the apparatus in Figs. 5, 6 and 7, only in being laterally undulating instead of perpendicularly undulating. The reproducing apparatus in Fig. 10 is designed for use with such a laterally undulating double record; the diaphragm 31 is caused to vibrate by means of the carrier 52 on which is mounted the principal stylus 53 which runs in the grooves forming the main record. The pivoted lever 54 carries at one end the auxiliary stylus 55, which runs in the supplementary groove, and at the other end the damping element 56.

The modifications illustrated in Figs. 11 to 14 involve the use of a single recording or reproducing stylus for both the principal and the auxiliary record.

In the recording apparatus shown in Fig. 11, the diaphragm 1 is operatively connected to the pivoted tube 63 through which rotatably extends the rod 64 carrying at one end the groove cutting stylus 65 and at its other end the armature 68 of the electromagnet 69. The attraction of the electromagnet 69 for its armature 68 is caused to vary upon the occurrence of sound vibrations of more than a predetermined amplitude, in the same way as set forth in the description of Fig. 6. It will therefore be seen that under the influence of the vibrations of the diaphragm 1 the lever 63 so guides the stylus 65 as to cause it to cut in the cylinder A a groove whose varying depth provides a perpendicularly undulating principal record of the sound vibrations, while the movement of the armature 68, resulting from a considerable variation in the amplitude of the sound vibrations, rotates the rod 64 about its longitudinal axis whereby the groove cut by the stylus 65, is caused to vary in direction and thus affords an auxiliary laterally undulating record. Figs. 12^a and 12^b show a reproducing apparatus for this single groove record. As the groove in the rotating cylinder A varies in depth reproducing stylus 75 moves up and down and causes the hollow lever 73 to vibrate about its pivot, producing corresponding vibrations in the reproducing diaphragm 31, while by reason of the "zig-zagging" of the groove the stylus 75 moves from side to side, rotating the rod 74 and bringing the damping element 79 into appropriate relation with the diaphragm 1.

In the modified compound groove recording apparatus shown in Fig. 13, a pivoted link 83 pivotally supports the carrier 84 for the recording stylus 85. The upper end of the carrier 84 is connected by a link 86 to one end of pivoted lever 87, the other end of which carries armature 88 of electromagnet 89, the strength of the current of this electromagnet being controlled by a microphone 22 connected to the recording diaphragm 1, as in Figs. 7 and 11. As the diaphragm 1 vibrates in response to sound vibrations carrier 84 is caused to vibrate about its pivotal connection with the link 83 and thereby guides the stylus 85 so that the latter will cut a laterally undulating record groove in disk B. The vibration of diaphragm 1 in response to considerable variations in the amplitude of the sound vibrations varies the resistance of the microphone 22 sufficiently to cause the electromagnet 89 to move its armature 88 and to raise and lower the carrier 84, such movement being permitted by the link 86, whereby the groove cut by stylus 85 varies in depth and provides a supplementary record of the "hill and valley" or perpendicularly undulating type.

Fig. 14 illustrates a reproducing apparatus for use with the compound record formed by the recording apparatus shown in Fig. 14. The zig-zagging of the record groove causes the stylus 95 to vibrate laterally and its carrier 94 to oscillate about its pivotal connection with the pivotal link 93 which causes diaphragm 31 to vibrate and produce sound vibrations. Variations in the depth of the record groove cause stylus 95 and its carrier 94 to rise and fall and

through the medium of the link 97 to vary the relation to the diaphragm 31 of the damping device 98 on the bell crank lever 99.

If desired, the manually controlled rheostat of Fig. 6 may be substituted for the microphone shown in Figs. 11 and 13.

It is to be understood that in commercial embodiment of the invention there will be included such accessory devices as those skilled in the arts involved may find essential to its completely satisfactory operation under different conditions of use.

What is claimed is:

1. The method of forming sound records which consists in subjecting a sound responsive recording mechanism to sound vibrations to be recorded and reducing the sensitiveness of said recording mechanism upon the occurrence of sound vibrations exceeding a predetermined amplitude.

2. The method of forming sound records which consists in subjecting a sound responsive recording mechanism to sound vibrations to be recorded and reducing the sensitiveness of said recording mechanism upon the occurrence of sound vibrations exceeding a predetermined amplitude by means of said vibrations.

3. The method of forming sound records which consists in causing the sound vibrations to form a principal sound record upon a record receiving member and forming in conjunction therewith a supplementary record upon such record receiving member indicating the occurrence of sound vibrations of a selected character.

4. The method of forming sound records which consists in causing the sound vibrations to form a principal sound record and manually forming in conjunction therewith a supplementary record indicating the occurrence of sound vibrations of a selected character.

5. The method of sound recording which consists in causing the sound vibrations to form a principal sound record upon a record receiving member and to form in conjunction therewith a supplementary record upon such record receiving member indicating the occurrence of vibrations of a selected character.

6. The method of sound recording and reproduction, which consists in causing the sound vibrations to form simultaneously a principal sound record, and a supplementary record indicating the occurrence of vibrations of a specific character, and modifying the reproducing effect of said first named record by means of said second named record.

7. The method of sound recording and reproduction which consists in causing the sound vibrations to form a principal sound record and forming in conjunction therewith a supplementary record of vibrations of more than a predetermined amplitude, and modifying the reproducing effect of said first named record by means of said second named record.

8. The method of sound recording and reproduction which consists in causing the original sound vibrations to form two associated records of different scope and modifying the reproducing effect of one of said records by means of the other record.

9. The method of sound reproduction which consists in subjecting a sound reproducing mechanism to the action of a record to be reproduced and in automatically varying the sensitiveness of the reproducing mechanism in accordance with selected variations in the amplitude of the sounds to be reproduced.

10. The method of sound reproduction which consists in subjecting a sound reproducing mechanism to the action of a record to be reproduced and in automatically reducing the sensitiveness of the reproducing mechanism when the actuating impulses imparted to such reproducing mechanism by such record exceed a predetermined amplitude.

11. In sound recording apparatus, a diaphragm responsive to sound vibrations, means for damping the vibrations of said diaphragm, and means responsive to vibrations of predetermined amplitudes for operating said damping means.

12. In sound recording apparatus, a record receiving member, a pair of record forming members, a sound sensitive diaphragm for causing one record forming member to vibrate in accordance with the sound vibrations to be recorded to form a record upon the record receiving member, and auxiliary means for controlling the other record-forming member to form a supplementary record upon the record receiving member.

13. In sound recording apparatus, a record receiving member, a pair of record forming members, a sound sensitive diaphragm for causing one record forming member to vibrate in accordance with the sound vibrations to be recorded to form a record upon the record receiving member, and auxiliary means for controlling the other record-forming member to form a supplementary record upon the record receiving member, said auxiliary means arranged to actuate said record forming member in response to occurrence of sound vibrations of a more than predetermined amplitude.

14. In sound recording and reproducing apparatus, recording mechanism comprising means responsive to substantially all sound vibrations reaching said mechanism, additional means responsive to vibrations of a selected character and record forming means actuable by said first and second means, in combination with reproducing mechanism

comprising means operable by the record formed by said first named means, other means operable by the record formed by said second named means, and a sound emitting element controlled by both of said last named means.

15. In sound recording and reproducing apparatus, a principal record forming mechanism, a record actuated mechanism, means associated with said record forming mechanism for producing, in conjunction with the principal record, a supplementary record indicating the occurrence of sound vibrations of predetermined amplitudes, a damping device associated with said record actuated mechanism, and means actuated by said supplementary record for controlling said damping device.

16. In sound recording and reproducing apparatus in combination, means responsive to sound vibrations for forming two associated records of different scope and record operable means comprising a sound producing member controlled by one of said records, and means controlled by said other record for modifying the operation of said sound producing member.

17. In sound reproducing apparatus in combination, a vibratable diaphragm, record actuated means for vibrating said diaphragm, and record controlled means for varying the responsiveness of said diaphragm.

In witness whereof, I hereunto subscribe my name this 29th day of December, A. D. 1917.

JAMES L. McQUARRIE.