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1,958,634

METHOD AND MEANS OF RECORDING SOUND

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2 Sheets-Sheet 1

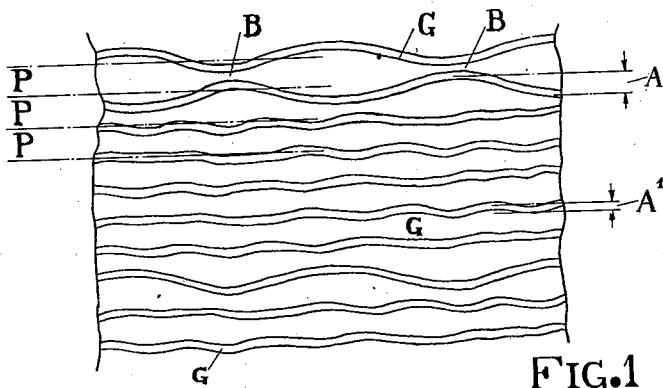


FIG. 1

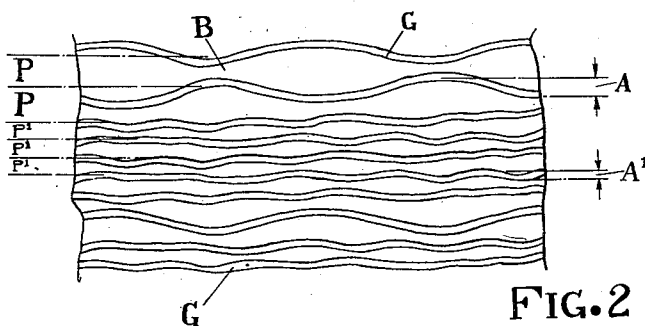


FIG. 2

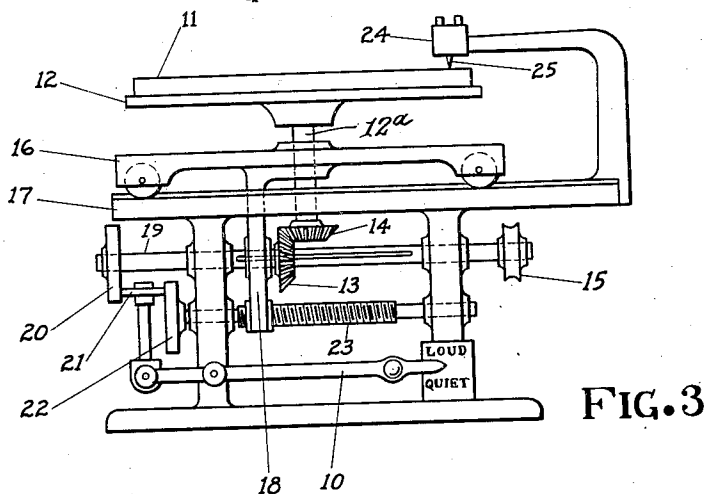


FIG. 3

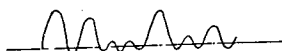


FIG. 8

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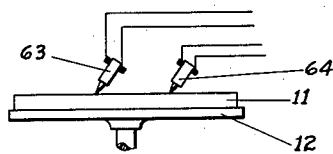
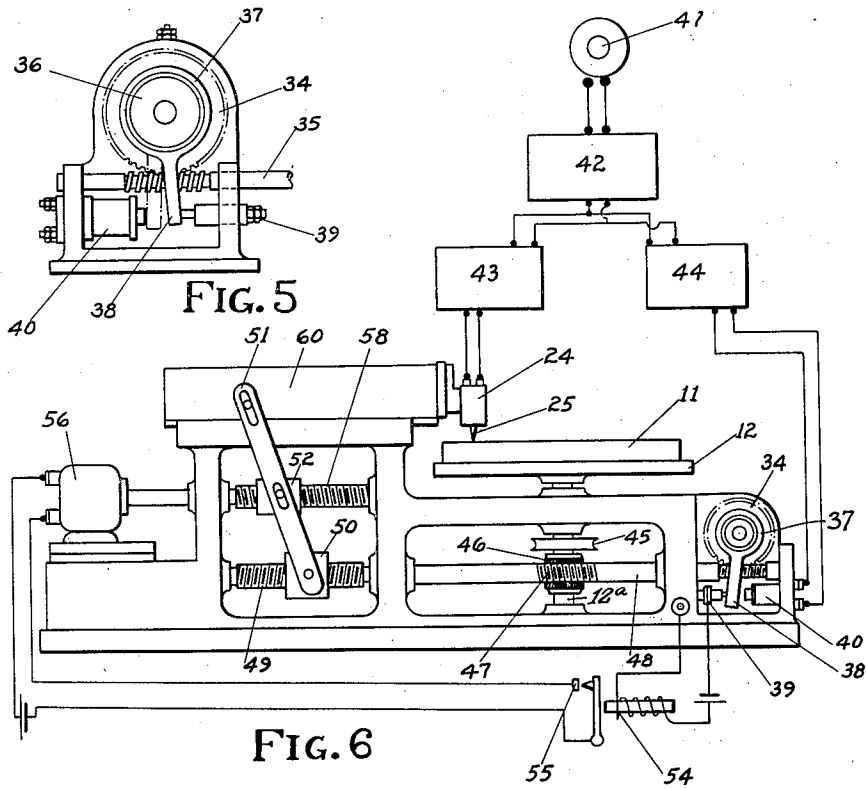
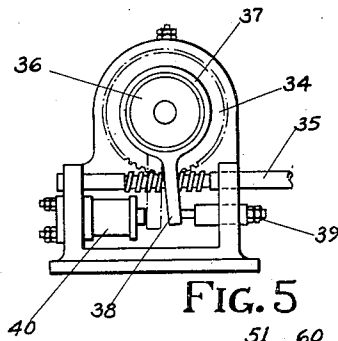
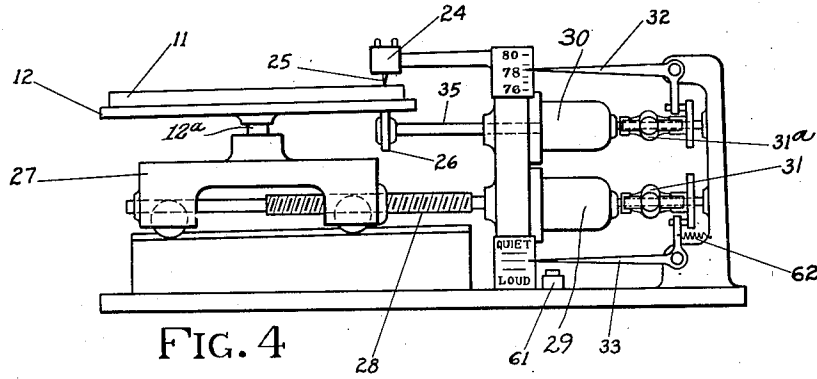
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METHOD AND MEANS OF RECORDING SOUND

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2 Sheets-Sheet 2



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METHOD AND MEANS OF RECORDING
SOUND

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In Great Britain April 19, 1928

4 Claims. (Cl. 274—9)

This invention relates to sound record discs or the like for use with talking machines or other sound-reproducing apparatus.

Hitherto in the manufacture of records it has been usual to engrave a spiral sound wave groove having a predetermined fixed distance between the consecutive turns, which distance is usually about .01" and is arbitrarily chosen without any regard to the question as to whether the available record space is utilized to the best advantage.

The object of the present invention is to enable a greater amount of sound than is usual to be recorded within a given area of record surface without reducing the amplitude of the loud passages relative to that of the quiet passages of music or other sound recorded thereon and without in any way interfering with the form of the record or with the speed at which the same is driven upon the machine.

A further object of the invention is to provide a new means and method of recording sound whereby more subject matter may be gotten onto a record of given diameter than has heretofore been possible without detracting from the size of the groove changing the speed of rotation and other expedients which result in weaker recordings.

A further and more specific object is to provide a recording means and method whereby the pitch distance between consecutive turns of a spiral sound record line or groove may be varied to accommodate sounds of different amplitudes, the pitch distance being greater for sounds of large amplitude than for sounds of small amplitude.

Further features of the invention will hereinafter appear.

In the accompanying drawings:—

Fig. 1 shows sound grooves equally spaced apart as on ordinary records.

Fig. 2 illustrates sound grooves spaced according to the amplitude of the sound waves in accordance with the invention.

Fig. 3 is a diagrammatic sketch of a simple recording machine for obtaining the effect shown in Fig. 2.

Fig. 4 is a diagrammatic illustration of a recording machine for obtaining constant linear speed sound grooves having the characteristics of Fig. 2.

Fig. 5 shows a timing device for controlling the distance between grooves.

Fig. 6 is a diagrammatic sketch of a microphone, amplifiers and recording machine incorporating Fig. 5.

Fig. 7 shows a consecutive recording device for use in connection with the device illustrated in Fig. 6.

Fig. 8 illustrates a biasing effect.

With ordinary sound records as indicated by Fig. 1 having an arbitrarily chosen fixed distance P of .01" between consecutive turns of the sound groove G and having a groove the average width of which is .004", the maximum amplitude A of sound wave which can be recorded thereon is the pitch distance P less the width of the groove G and a reasonable clearance B between grooves (say .001") that is, about .005". Assuming that equal maximum intensity of sound is desired at all frequencies above 64 cycles per second (that is, C_1 of the musical scale) and that the maximum amplitude at this frequency is .005" as above referred to, we are able to obtain the approximate amplitude of sound waves of equal audible strength at any higher frequencies by the following rule, namely, total lateral deviation from the plain spiral path is equal to frequency $\times$ amplitude which in the example given is $64 \times .005" = .032"$ per second.

If, therefore, this resultant figure is divided by any musical frequency we obtain the corresponding amplitude A^1 to give approximately equal audible strength. For example, if we take the above figure and it be assumed that an orchestration is being recorded in which the major portion of the music is played at frequencies above 128 cycles per second (C_2) and that the average frequency is 256 (middle C) then the average amplitude A^1 will be

$$\frac{.32}{256} = .00125"$$

which together with the width of the groove G and the clearance B between the grooves of .001" gives a total average pitch distance between grooves of .00625" as indicated by p^1 in Fig. 2, thus enabling us to record an average of about 160 consecutive grooves per inch of record instead of the usual 100 per inch. We are thus enabled to record about 60 per cent more music in the space usually occupied in a record disc, as will be seen by comparing Figs. 1 and 2, without in any way reducing the amplitude, or speed of rotation of the record and such a record may be played on any standard instrument without any prearrangement or knowledge of the type of record being used and has the advantage that over seven minutes of music can be recorded in the usual $3\frac{1}{2}"$ zone of record groove instead of the present $4\frac{1}{2}$ minutes.

It is obvious that when required the maximum amplitude A can be increased above .006" and the pitch distance P between the grooves increased proportionately or if required the amplitudes A and A¹ may be very small so that an average of, say, 200 grooves per inch can be recorded, such recordings being particularly suitable for electric reproducing instruments in which the sound waves are amplified by thermionic valves and the like until the desired volume of sound is obtained.

The pitch distance between the consecutive grooves can be controlled to accommodate the varying amplitudes of sound waves as and when required by manual or automatic means. For example, Fig. 3 shows a recording machine constructed somewhat after orthodox practice, but modified so that it can be manually operated to vary the pitch distance between the record grooves after the manner shown in Fig. 2 by movement of the handle 10 up or down. The recording machine illustrated in Fig. 3 operates as follows:—

A wax disc 11 is placed on the turntable 12 which is adapted to be rotated by the gears 13 and 14 which are driven by an electric motor or any other kind of motive power operating on the pulley 15. The turntable 12 is mounted on a traveling frame 16 which is capable of movement in a lateral direction on the base frame 17, the frame 16 has a projection 18 adapted to keep the gear 13 in mesh with the gear 14, so that it can travel in a lateral direction along the shaft 19 which has a keyway adapted to drive the gear 13 whatever its position on the shaft. It will be seen that by this means the turntable is rotated at a constant angular velocity whatever its position may be, by its connection with the pulley 15. The end of the shaft 19 is provided with a friction gear 20 which in turn is connected by a disc driving wheel 21 to a second friction disc 22. It will be seen that by movement of the disc driving wheel 21 up and down relative to the friction discs 20 and 22 a different ratio of speeds can be obtained between the driving shaft 19 and the driven shaft 23, which is provided with a screw thread adapted to feed the frame 16 and 18 in a lateral direction as the turntable rotates.

The actual speed at which the turntable is fed laterally is governed by the position of the disc driving wheel 21 which is in turn controlled by movement of the handle 10 between the positions "Loud" and "Quiet", such that when the handle is moved towards "Loud" the speed of travel of the frame 16 is greater than when the handle is moved towards "Quiet".

In operation, the wax disc 11 will pass beneath the recorder 24 at a constant angular velocity and the recording stylus 25 will engrave a sound-wave groove on the wax disc which is being rotated by the turntable 12. Normally the handle 10 will have the pointer opposite "Quiet", at which position the feed of the turntable will be slow, and the grooves close together as shown at P' in Fig. 2 for example. But when the operator knows that a loud passage of music is about to be played he will move the pointer to "Loud", when the speed of lateral travel will be increased so that the pitch distance between the grooves is as shown at P in Fig. 2, and one second after the loud passage of music has ceased the operator will again move the handle to "Quiet", when the pitch will be decreased, and so on, such an arrangement resulting in a record having grooves of varying pitch distances, as shown in

Fig. 2, instead of the usual record having a fixed pitch distance, as shown in Fig. 1.

It is obvious that the recorder 24 may be of any known form, but it is preferred that it should be of the electro-magnetic type.

Further, it is obvious that instead of a screwed shaft 23 a rack or lever or other suitable mechanism may be substituted.

Fig. 4 shows a recording machine specially adapted to produce constant linear velocity recording, that is, recording in which the sound groove passes beneath the needle at constant speed, for example 18" per second, and in this construction I use two electric motors one of which 30 drives the turntable at a constant linear speed by means of the driving friction disc 26. The frame 27 which carries the turntable 12 and wax blank 11 is fed in a lateral direction beneath the recording stylus 25 by means of the screwed shaft 28 which is driven by the motor 29. The motors 29 and 30 which are preferably electrically driven are provided with ordinary speed regulating governors 31 and 31^a, so adapted that the linear velocity of the table can be controlled by movement of the lever 32 while the lateral feed of the turntable can be controlled by movement of the lever 33, in such a manner that when a loud passage of music is being played the lever 33 is moved downwards and allows the governor to speed up and increase the lateral feed of the turntable relative to its rotational speed; and when a quiet passage is being played the lever 33 is moved to the "Quiet" position and the speed of the motor 29 is reduced so that the lateral movement of the turntable is also decreased, thus bringing the recorded sound grooves closer together, and in effect producing a record similar to that shown in Fig. 2. When desired, an effect can be obtained by combining the two principles shown in Figs. 3 and 4, by which the relation between the driving friction gear 26 and the recording stylus 25 may be varied in a radial direction thus producing a compromise between the two styles of recording. Also, when desired, the recording may be of the hill-and-dale type instead of the type shown in the illustrations, Figs. 1 and 2.

Again, it is desirable that one revolution of the turntable should take place at the increased pitch distance after recording large amplitudes, and this may be provided for by means of a dashpot slow return or preferably by the means shown in Fig. 5, in which a gear wheel 34 is adapted to be driven at a constant speed by the shaft 35 connected to the turntable driving shaft on the recording machine. This gear wheel carries on its side a friction disc 36 adapted to engage a metal contact member 37 in such a manner that normally the contact end 38 is being pressed against the electric contact 39 by its friction connection with the rotating disc 34.

In operation, when a loud or large amplitude recording is being made a magnet 40 is energized by suitable means, to be described later, and attracts the contact piece 38 into the position shown by dotted lines, and it is held in this position against the friction drive of the disc 34 as long as the magnet is energized by the loud recording. But immediately the amplitude of the recording drops below a certain value and the current through the magnet 40 is cut off, either manually or by means to be described later, the contact piece 37 will gradually return towards the contact 39 by its friction connection with the rotating disc 34, the distance between

the face of the magnet 40 and the contact 39 is so adjusted that it would take about one second for the contact 38 to move over to its normal position, and during its passage through space it functions to maintain the pitch distance between the grooves at its maximum for one second after the cessation of the heavy passage of music, and by this means prevents the sound groove following the said heavy passage from cutting through the crests of the large amplitude sound waves.

Fig. 6 shows a recording instrument adapted to work automatically in place of or in addition to the manually controlled device to obtain variations of the pitch distance between record grooves, according to the amplitude of the sound waves being recorded. A microphone 41 of a usual type is connected to an amplifier 42 which has a divided output, one set of leads feeding the amplifier 43, which in turn operates the electric recorder 24 to engrave the groove on the wax 11, and the other leads feeding a secondary thermionic amplifier 44 which may be provided with any well-known form of sensitive relay adapted to pass current through the magnet 40 whenever the output from the power valve exceeds a predetermined amount. The turntable 12 and wax blank 11 are revolved at a constant speed by means of the driving pulley 45 connected to a suitable motor. The turntable shaft 12^a is provided with a worm gear 46 engaging a worm 47 on a shaft 48, this shaft being adapted to operate the friction disc 34 on the current control contact piece 38, and also to operate the lateral feeding device for the recorder by means of the screwed extension 49 which engages a nut 50 operating a lever 51 about a pivot at 52 in such a manner that as the nut 50 is fed away from the turntable shaft the recorder carrier is fed across the record, and provided the shaft 58 is not rotating the feed would be constant and of small pitch distance.

While the recording of low amplitudes is in progress the contacts 38 and 39 remain as shown in Fig. 6, but should it be necessary to record a sound of large amplitude, the amplifier 44 will operate the magnet 40 and attract the contact arm 38 away from the contact 39, as described with reference to Fig. 5, and thereby cut off the current supply in the circuit operating the magnet 54 so that the secondary contact 55 is made, and either starts the motor 56 or, in the event of the motor being adapted to run constantly, or operates a magnetic clutch (not shown) to start rotation of the shaft 58, which in turn feeds the nut 52 towards the turntable and doubles or otherwise increases the speed of the lateral movement of the carrier 60 and recorder 24, thereby increasing the pitch distance between the consecutive grooves which are being recorded. As soon as the sounds of large amplitude cease the amplifier 40 cuts off the current supply to the magnet 40 and the contact arm 38 is allowed to return slowly, as before described, so that when about one second has elapsed the contact is again made with 39 and the circuit is closed so that the magnet 54 breaks the contact at 55 and stops rotation of the shaft 58, whereby the lateral feed falls back to its normal low speed.

With a construction as shown in Fig. 6 it is possible to cause the recorder to feed in very rapidly for about .005" every time the magnet 40 is operated, thereby widening the distance between the grooves immediately instead of waiting for the

complete revolution of the turntable. It is obvious that instead of the amplifier 44 we may use any other form of electrical relay; also instead of the contact 38 being driven back by a friction connection with the gear 34, we may use a solenoid or other slow return device. Further, when the normal pitch distance has to be altered to a considerable extent, such as a change from 100 grooves to the inch to 200 grooves to the inch, a suitable gear changing arrangement can be made at 46, 47 or at any other point; any well-known gear changing device can of course be used.

Also, this device may be connected to operate the magnet 61, in Fig. 4, for example, so as to change the pitch distance for large amplitudes, the governor control being returned to the "Quiet" position by means of the spring 62, in which case the contact arm might conveniently be controlled by the spindle 35 which drives the turntable.

In such cases the varying pitch recording may be produced by special adaptation of multiple or consecutive recordings, in which one recording controls the pitch distance for the other recording. Such a device is shown in Fig. 7, in which two electrical pick-ups are adapted to operate on the first ordinary recording to produce a second recording having the controlled pitch distance. For example, pick-up 63 may function to operate the amplifier 44 to control the pitch, while the following pick-up 64 is adapted to operate preferably in the next groove and functions to operate the amplifier 43 which operates the recorder 24, Fig. 6. It will be seen that by this means ordinary recordings can be transferred to a consecutive recording in such a manner that the pitch distance is in accordance with the amplitude.

As there is the possibility of sounds of large amplitude being recorded very suddenly, before the pitch controlling device has had time to function, it may be advisable to make the recording so that the recording stylus is biased, either by a specially arranged amplifier or mechanically, so that it produces the changes in amplitude to one side of the record groove, somewhat as shown diagrammatically in Fig. 8.

It must be understood that the foregoing examples are given by way of illustration and not limitation, and that the invention may be modified in many different ways to obtain the effect desired.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare what I claim is:—

1. In a recording machine, a recorder, a support, a record blank on said support, a spindle mounting said support, means for rotating said spindle, a shaft driven from the spindle, means driven by the shaft for shifting one of the recorder and supporting means laterally with respect to the other, a motor independent of said shaft and operable to vary the rate of said lateral feed to accommodate the different amplitudes of sound waves being recorded, a circuit to said motor, an electromagnet controlling said circuit, a shiftable contact element controlling the circuit to said electromagnet, means operated by the shaft and normally maintaining said contact element in position to close the circuit to said electromagnet and thereby maintain the circuit to the motor open, and means to shift said contact element to open the circuit to the electromagnet and permit the closing of the circuit to

the motor when sound waves of large amplitude are to be recorded.

2. In a recording machine, a recorder, a support, a record blank on said support, a spindle mounting said support, means for rotating said spindle, a shaft driven from the spindle, means driven by the shaft for shifting one of the recorder and supporting means laterally with respect to the other, a motor independent of said shaft and operable to vary the rate of said lateral feed to accommodate the different amplitudes of sound waves being recorded, a circuit to said motor, an electromagnet controlling said circuit, a shiftable contact element controlling the circuit to said electromagnet, means operated by the shaft and normally maintaining said contact element in position to close the circuit to said electromagnet and thereby maintain the circuit to the motor open, means to shift said contact element to open the circuit to the electromagnet and permit the closing of the circuit to the motor when sound waves of large amplitude are to be recorded, and said shaft having a frictional driving connection with the contact element whereby to return the same to normal position and bring about an opening of the circuit to the motor after the recording of the sound waves of large amplitudes.

3. In a recording machine, a recorder, a sup-

port, a record blank on said support, a spindle mounting said support, means for rotating said spindle, a shaft driven from the spindle, means driven by the shaft for shifting one of the recorder and supporting means laterally with respect to the other, a motor independent of said shaft and operable to vary the return of said lateral feed to accommodate different amplitudes of sound waves being recorded, and automatic means to bring said motor in operation when a sound wave of large amplitude is to be recorded.

4. In a recording machine, a recorder, a support, a record blank on said support, a spindle mounting said support, means for rotating said spindle, a shaft driven from the spindle, means driven by the shaft for shifting one of the recorder and supporting means laterally with respect to the other, a motor independent of said shaft and operable to vary the return of said lateral feed to accommodate different amplitudes of sound waves being recorded, a circuit to said motor, automatic means to close said circuit and place said motor in operation when a sound wave of large amplitude is to be recorded, and means to bring about an opening of said circuit and deenergizing of the motor at a predetermined time after the sound wave of large amplitude has been recorded.

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