Jan. 3, 1939. E. R. HARRIS 2,142,563

SOUND RECORDING AND REPRODUCING HEAD

Filed Nov. 12, 1934 2 Sheets-Sheet 1

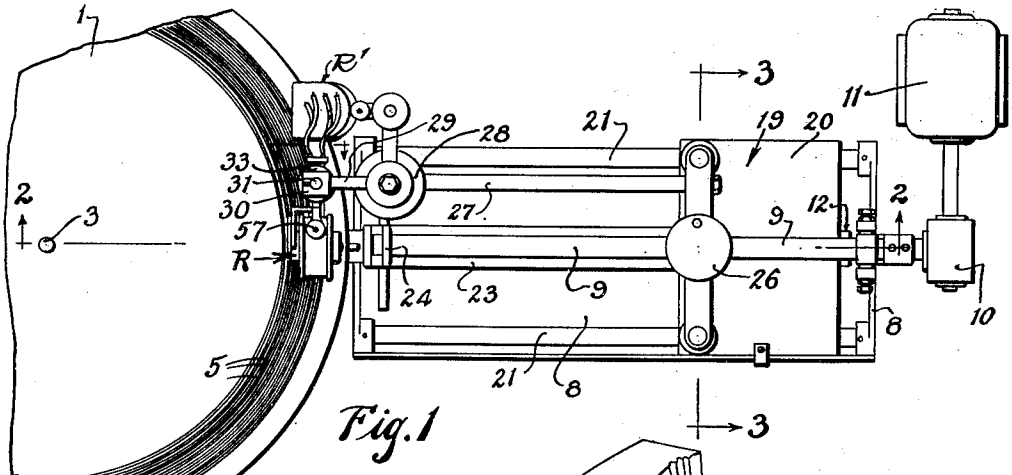


Fig. 1

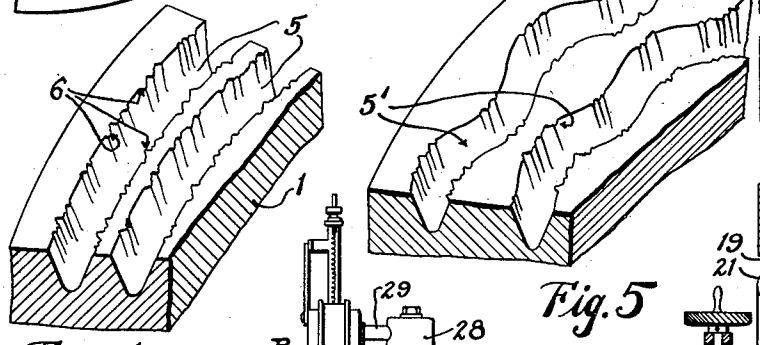


Fig. 4

Fig. 5

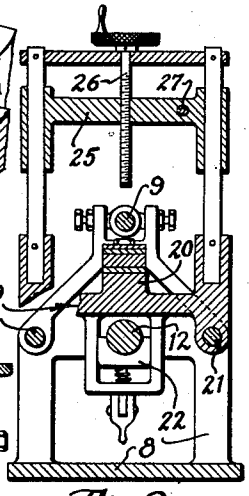


Fig. 3

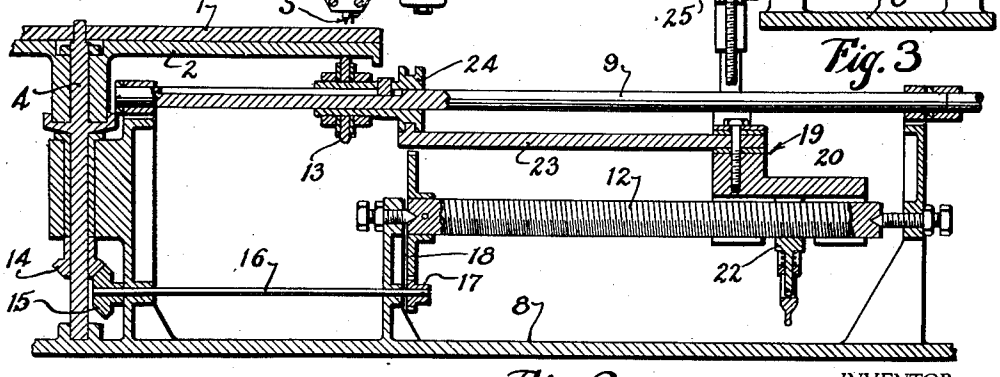


Fig. 2

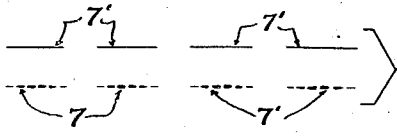


Fig. 6

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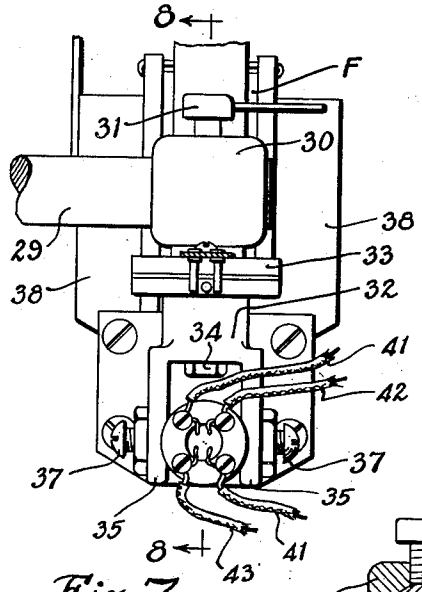


Fig. 7

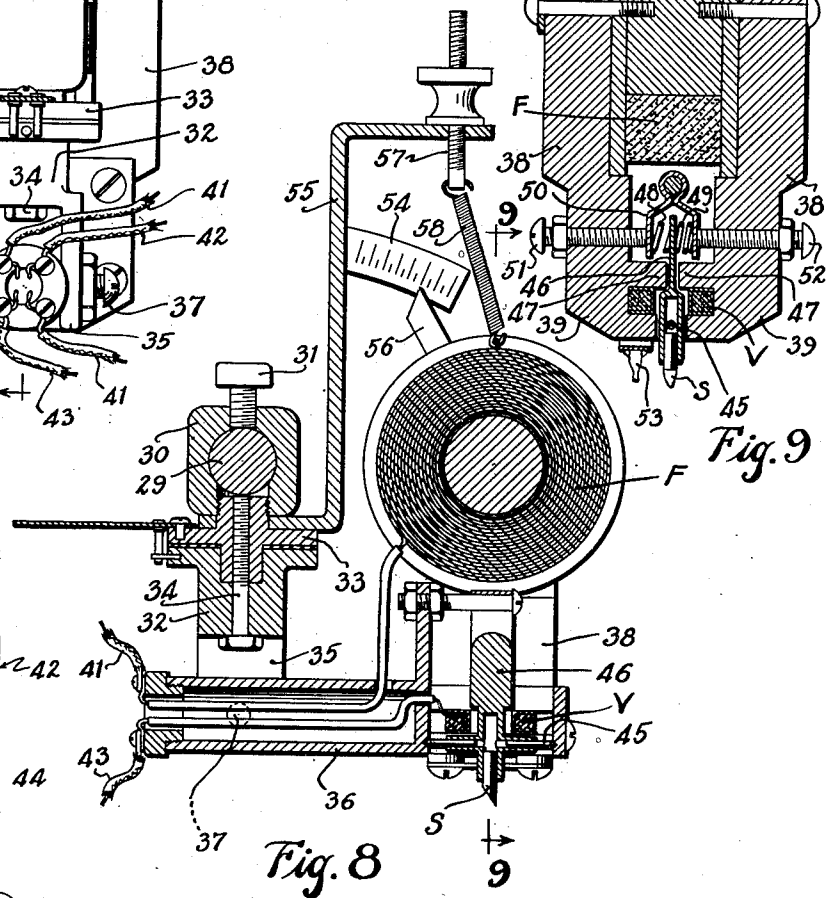


Fig. 8

Fig. 9

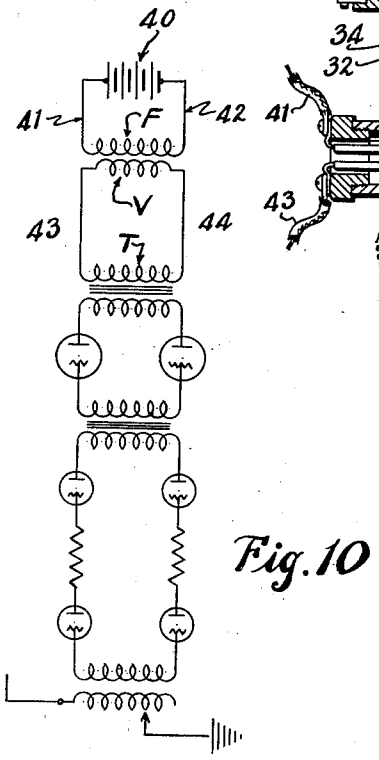


Fig. 10

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UNITED STATES PATENT OFFICE

2,142,563

SOUND RECORDING AND REPRODUCING HEAD

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Application November 12, 1934, Serial No. 752,582

2 Claims. (Cl. 274—27)

This invention relates to and has for an object the provision of an improved sound record of the disc type formed with regularly and closely spaced groove convolutions in which the sound impressions are broken up into rapidly formed and substantially shortened groups of impressions uniformly spaced apart throughout the length of the groove regardless of the radial distance from the axis of the record.

In the consideration of this invention it will be understood that in the production of sound record discs the audio frequency sound impulses are transmitted to and influence the vibration of a recording stylus which, in modern systems of recording, is arranged for lateral movement and forms slight indentations on the sides of the sound record groove to correspond to the varying intensity, pitch and quality of sound at a point of origin.

The sounds are more intense on the crests of the audio wave and are of gradually increasing intensity as the crests of the wave are approached and of gradually decreasing intensity beyond the crests. A recording stylus in usual recording mechanism rarely cuts a groove which is regular in contour but actually provides a groove with waves therein which prevents too close spacing of the adjacent groove convolutions, thereby limiting the length of a subject to be recorded on the sound record.

It is well known that when records are rotated at a constant axial speed the groove speed of the record is gradually increased as the stylus moves outwardly in the direction of the periphery, and the sound impressions in the record groove are correspondingly lengthened and spaced apart at greater distances. Hence, the purpose of this invention is two-fold: first, to provide a record adapted to reproduce a subject at a uniform groove speed throughout the length of the record; and second, to so form the sound impressions in the record groove that the original sound impulses are broken up into shorter and more rapidly formed impressions, arranged in groups which are uniformly spaced apart in the record groove throughout the entire length of the record.

The recording of a single tone in a groove convolution of, say four inch radius requires twice the groove length that a convolution of two inch radius requires, when the record is rotated at a constant axial speed, and the sound impressions are spaced farther apart in the larger convolution than in the smaller one. When, however, the speed of the record is variable to correspond to the position of the recording stylus on the record, a constant groove speed is provided by reason of which the sound impressions are uniformly spaced throughout the length of the record groove, and it is possible to record longer subjects than otherwise.

To this end, it is an object of this invention to provide a method of sound recording on a record blank in which the recording stylus is limited in its range of vibration, so that original sound impulses will be broken up and produce groups of shorter than normal impressions which correspond to the normal audio impressions. In practice, I actually set up counter vibrations in the stylus of a frequency in excess of the audio range which superimpose the groups of shortened and quickened impulses on the audio wave, thereby increasing fidelity of reproduction.

Other objects may appear as the description progresses.

I have shown a preferred form of my invention in the accompanying drawings, in which:

Fig. 1 is a plan view of a sound record in process of production including a composite recording and reproducing head associated therewith;

Fig. 2 is a sectional elevation on line 2—2 of Fig. 1;

Fig. 3 is a sectional elevation of the same on line 3—3 of Fig. 1;

Figs. 4 and 5, are respectively, fragmentary perspective views of a record embodying my improvements and a record of usual character;

Fig. 6 is a diagram illustrating graphically a comparison between the sound impulses of a modern commercial sound recording system and of my system of recording;

Fig. 7 is an end elevation of a sound recorder embodying elements and characteristics necessary to the practice of my method of sound recording;

Fig. 8 is a sectional elevation of the same on line 8—8 of Fig. 7;

Fig. 9 is a sectional elevation of the same on line 9—9 of Fig. 8; and

Fig. 10 is a circuit diagram of the elements of a sound recording system.

The improved sound record 1 is formed of the usual composite material and is adapted to be rotatably held on a turntable 2 during a recording operation and likewise during a reproducing operation, the record being centered by means of a pintle 3 formed on the turntable or on the upper end of a spindle 4 connected with the turntable.

A sound record groove 5 of V cross section is adapted to be formed in the upper surface of the

record 1 by means of a vibrating stylus S attached to a recorder R, and said groove consists of a maximum number of convolutions spirally formed on the record and closely spaced so that a subject of maximum length may be recorded on the record.

As will appear in Fig. 4 the record groove 5 is substantially regular in outline and the sound impressions 6 are formed on the opposite sides of the groove and the walls of the groove are uniform and regular as compared with the walls of the grooves 5' of the usual type of sound record as shown in Fig. 5. The regularity of the groove 5 is effected by limiting the lateral vibration of the stylus S and by breaking up the sound impulses into uniformly spaced groups 7, 7, etc. of relatively short and rapidly formed impressions, as illustrated in Fig. 6, in which also is shown the normal and longer impressions 7', 7' made by the unlimited movement of the stylus in the usual type of record groove shown in Fig. 5.

Thus, I apply a superimposed frequency on the audio wave which is substantially above that of the audio range which makes more faithful reproduction possible than with other methods of recording.

In order that the record 1 may be rotated at a variable speed to correspond to the progress of the stylus I provide an effective power operating mechanism which is shown in Figs. 1, 2 and 3 and includes a base 8, a spindle 9 suitably mounted on said base and adapted for connection with a gear reduction unit 10 and a motor 11, and a rotatable feed screw 12. Spindle 9 slidably supports a friction driving pulley 13 for movement radially of the turntable and adapted to frictionally engage the lower surface of said turntable for applying power thereto. Feed screw 12 is geared to turntable 2 by means of a set of bevel gears 14 and 15 on shaft 4 and a countershaft 16, respectively, and shaft 16 is geared to feed screw 12 by means of gears 17 and 18 on shaft 16 and screw 12, respectively.

Screw 12 is threaded to correspond to the number of groove convolutions per radial inch to be cut on record 1 and is operated from the turntable. A carriage 19 embodying a cross head 20 is slidably mounted on a pair of rods 21, 21 and includes a nut 22 suitably arranged for detachably connecting the carriage to the feed screw 12. A bar 23 extends from crosshead 20 to and connects with a grooved collar 24 associated with pulley 13 so that said pulley is moved when and as the carriage is moved. When the nut 22 is detached the carriage may be manually moved to selectively position the pulley 13 relative to the turntable and when said nut is operatively connected with the screw 12 the pulley 13 will be automatically adjusted in position on the turntable.

The recorder head R and a reproducer R' are also supported on the carriage 19, as by means of an adjustable connection 25 vertically slidable on frame 8 through the operation of a manually adjustable screw 26, by means of which the head R may be bodily raised and lowered with respect to the record 1. The recorder R and reproducer R' are independently and selectively adjustable to and from operative position on the record 1.

A rod 27 connects member 25 with a swivel coupling 28 which permits the adjustment of head R on a vertical axis, and the upper portion of said swivel has an arm 29 which is adjustably connected with a fixture 30 by means of a set screw 31. A yoke 32 depends from and is frictionally connected with fixture 30 by means of a flanged friction plate 33 threaded into the fixture 30 and a screw 34 extending through the yoke and into the member 33, as shown in Fig. 8. Yoke 32 has spaced arms 35, 35 between which an extension 36 is pivotally held on pivot screws 37, 37 and said extension is attached to pole pieces 38, 38 forming a frame for the recorder R.

It will be noted that a field coil F is mounted between pole pieces 38 so that when said coil is energized the pole pieces will be in the magnetic field of said coil, and a voice coil V is mounted in the lower ends 39, 39 of said pole pieces so that a recording stylus S may extend through a central aperture of the voice coil. Field coil F has its opposite terminals connected with a battery 40 by means of wires 41 and 42 (see Fig. 10) while the opposite terminals of voice coil V are connected by means of wires 43 and 44 with one side of an output transformer T which is connected, as usual with the other elements of a sound recording system shown in the circuit diagram and not material to this invention.

Stylus S is pivotally held at 45 slightly below coil V and has an upwardly extended stem 46 which forms an armature and is positioned between the opposed pole portions 47, 47, on pole pieces 38, 38, and the upper end of said stem is held between a pair of opposing springs 48 and 49 carried by a bracket 50 and adapted to be tensioned by means of screws 51, and 52, respectively. Coil V being energized by an alternating current, the sound impulses transmitted by said coil serves to rapidly change the polarity of stem 46 of stylus S and causing the vibration of stylus S, due to the attraction by pole pieces 38, 38.

The normal frequency of vibration of stylus S, however, is substantially less than when the tensioning springs 48 and 49 are employed, and the effect of said springs is to limit the range of vibration of the stylus and break up the normal vibrations into more rapid and shorter ones, thereby superimposing a frequency on the audio wave which is above the audio range, as graphically indicated in Fig. 6. In other words, the operation of the stylus under the influence of the springs 48 and 49 may be likened to the pendulum of a clock which normally swings freely and vibrationless but when limited in its range counter vibrations are set up in the pendulum which cause it to quiver as it swings. Such is the action of the stylus under the influence of a suitable limiting medium. The counter vibrations set up in the stylus are shorter and far more rapid than the normal vibrations set up by the sound impulses imparted to the stylus through coil V and increase gradually in intensity as the crest of each wave is approached and then gradually decreased as the crests of the waves are passed. This action is indicated by the short broken lines 7, 7, etc. in Fig. 6, while the normal vibrations are indicated by the long broken lines in said figure.

It should be noted that the springs 48 and 49 are of unequal size whereby the force of one is greater than the other in restricting the lateral movement of the stylus. This provides, among other advantages, for the elimination of constantly applied superaudible frequencies which give rise to such innumerable harmonics and sympathetic frequencies as to render it almost impossible to make satisfactory recordings.

Furthermore, springs 48 and 49 make possible

the desired restriction and control of the movement of the stylus by a plurality of superaudible frequencies applied only when the stylus is in motion, whereby to create record undulations at nearly right angles to the direction of rotation of the record and to thereby provide more undulations per inch of lineal space.

Of further importance is the fact that the restriction of the lateral movement of the stylus in accordance with this invention provides for an increase rather than a decrease of the volume of the recorded sound, whereby a record groove of, say, .003 of an inch wide at the top and .002 of an inch in depth may be advantageously used. Thus, it is now seen that the variational superaudible frequencies applied as here noted cause a much quicker return of the stylus to the approximate center of both the mechanical and magnetic stresses whereby to increase volume and the economy of lineal groove space and also permit of the use of a reproducer of standard weight.

It is important to note that the restriction of the stylus, as here provided, permits of freer auxiliary or overtone movement and provides a better opportunity for recording said quality vibrations, primarily due to the fact that the stylus is nearer the center of both magnetic and mechanical stresses.

It is now seen that the several superaudible frequencies are so related as to check the lateral movement of the stylus in direct proportion to the extent of such movement and cause a change of pitch of said frequencies when said armature is moved, one of the springs tightening and the other loosening and thereby avoiding a constant frequency.

The advantage of the invention attributable to the superaudible frequencies are dependent also on the constant speed of cutting the record, as otherwise the necessary balance would be difficult, if not impossible.

In order to emphasize the advantages of the invention, attention is called to the fact that the angle of the record groove in relation to its direction of rotation determines the speed of the lateral movement of the reproducer stylus and that a large swing or lateral movement does not necessarily produce more volume. During reproduction of a record, the reproducer acts as a generator of varying voltages, this voltage depending upon the speed with which the armature moves between the poles or in any magnetic field.

An adjustable pilot 53 is provided on the bottom of one of the pole pieces 38 which is adapted to ride on the upper surface of record 1 and operate as a depth guide by means of which the cutting depth of stylus is limited, as indicated on a graduated scale 54 extended from a bracket 55 and over which scale an indicator 56 attached to the field coil frame is adapted to move.

The recorder R is adjustably and resiliently mounted on bracket 55 by means of an adjusting screw 57 which is connected with the frame by means of a tension spring 58.

From the foregoing description of the mechanism necessary to the practice of my improved method of producing sound records it will be obvious that when a record blank 1 is positioned on turntable 2 preparatory to a sound recording operation and the stylus is properly adjusted to the record, the driving pulley 13 will at all times be exactly beneath the stylus and at the same distance from the axis of the turntable. Thus, as spindle 9 is rotated at a constant speed the recorder R and pulley 13 are gradually moved inwardly or outwardly relative to the axis of the record by reason of the fixed ratio between the turntable and feed screw 12, and the axial speed of the turntable and record is correspondingly decreased or increased as the case may be.

By means of the mechanism shown in Figs. 1 and 2 a single mechanism may be used both for recording and reproducing when the recorder R is adjusted out of operative position and the reproducer R' is adjusted into position on a record 1, and in either case the groove speed of the record 1 is uniform instead of variable as in conventional types of machines.

In the production of the sound record, therefore, the speed of the successive portions of the record adjacent the stylus is constant while the axial speed of the record is constantly variable, thereby providing uniform sound record impressions throughout the length of the record groove. The superimposed frequency applied to the stylus prevents undue freedom and any wild diversion from a uniformly regular path with respect to the record, and enables me to employ a far greater number of groove convolutions per radial inch of the record than is possible without the limiting means for the stylus.

Thus, the increased number of groove convolutions per radial inch of record and the uniformly spaced sound impressions in the record groove makes it possible to record subjects on a single record which otherwise would require a plurality of records.

What I claim is:

1. In a sound head for producing and reproducing sound on a record, a pivoted armature adapted to vibrate in accordance with the sound frequencies, and resilient elements of normally unequal resiliency arranged one on each side of the armature in contact therewith for modifying the normal oscillations of said armature.

2. In a sound head for producing and reproducing sound on a record, a pivoted armature adapted to vibrate in accordance with the sound frequencies, and springs of normally unequal resiliency arranged one on each side of the armature in contact therewith for modifying the normal oscillations of said armature.

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