July 5, 1932. L. A. ELMER 1,866,403

PHONOGRAPH RECORDER AND REPRODUCER ARM

Filed July 22, 1931

FIG. 1

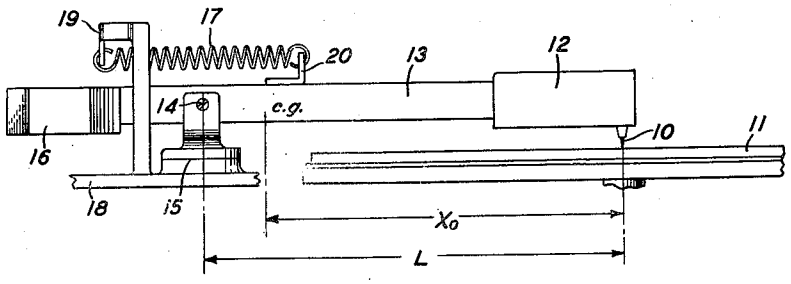
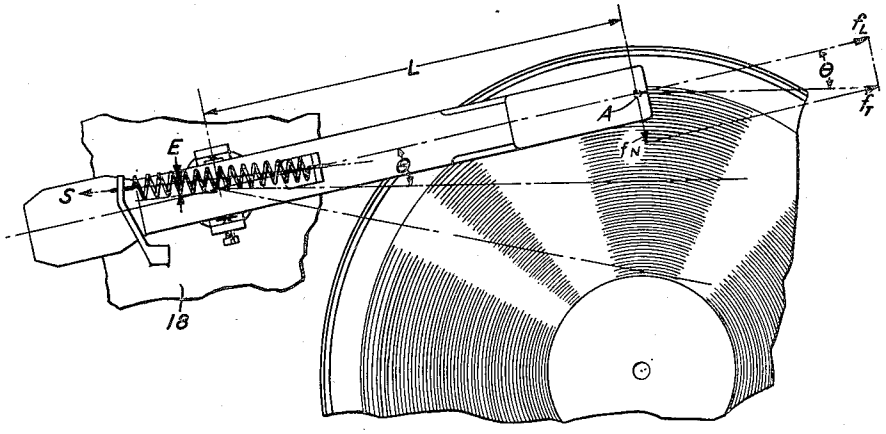


FIG. 2



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PHONOGRAPH RECORDER AND REPRODUCER ARM

Application filed July 22, 1931. Serial No. 552,371.

This invention relates to sound reproducing devices and particularly to the part thereof usually termed "reproducer arm".

The quality and continuity of reproduction from disc records are often impaired by the effects of extraneous vibrations and forces imparted to the stylus of the translating device either through the groove itself or through the reproducer arm support. When the reproducer arm is in any position other than the tangent position with respect to its cooperating groove the force of friction between the stylus and groove has a lateral as well as a longitudinal component which tends to turn the arm toward the tangent or neutral position. This has also been found to be a contributing factor to the discontinuity of reproduction, since very little force is required in addition to the lateral component to cause the stylus to leave its groove.

The object of this invention is to minimize noise in the reproduction of sound from disc type records, a feature of the invention being a means for decreasing the tendency of the reproducer to leave its groove.

In general the object is accomplished by distributing the mass of the arm in such a manner as to cause its center of percussion to fall over its point of support when the stylus is taken as the axis of rotation. Vibrations at the support are thus reduced to turning movements about the stylus upon which they have little or no disturbing effect. A spring suitably mounted and tensioned is used to compensate for the lateral components of stylus friction.

In the accompanying drawing are shown two views of a reproducer arm incorporating the novel features of this invention.

Fig. 1 is a side elevation of a reproducer with a friction compensating spring; and

Fig. 2 is a plan view of the same reproducer.

Referring now to Fig. 1, 10 is a stylus cooperating with a record 11 and actuating an electrical pickup 12. The record may be of either the lateral or hill-and-dale type. The pickup is supported by an arm 13 pivoted for vertical motion at 14 and for lateral motion at 15. It is counter balanced for a predetermined needle pressure by a weight 16.

To obtain a center of percussion located over the pivot the mass supported by the pivot must be so distributed that

$$L=\frac{I.g}{W.x_o}$$

where

L is the distance from the stylus to the pivot.
I is the moment of inertia of the pivoted portion about an axis through the needle.
W is the weight of the pivoted portion.
x_o is the distance from the center of gravity of the pivoted portion to the needle.
g is the acceleration of gravity.

Since it is difficult to make the arm so that its moment of inertia about the vertical axis is equal to its moment of inertia about the horizontal axis, L will be different in each case and will require a separate location of the vertical and horizontal pivots. In some instances however, the two can be made intersecting and for the purpose of illustration the pivots are so shown in the drawing.

With the center of percussion at the pivots and the axis of rotation taken through the stylus any vibration at the pivots which would normally be communicated through the arm to the stylus becomes merely a rotating movement about the stylus and therefore leaves the stylus unaffected. This holds true for either vertical or horizontal vibrations.

The elimination of vibration in the arm materially reduces undesirable changes in the magnetic flux between the poles of the electromagnets and thereby makes for a quiet record and more uniform reproduction with less tendency for a reproducer to leave its groove.

To make this invention applicable to the majority of recorders and reproducers now in use, all that is required is a suitable counterbalancing weight to give the proper location of the center of percussion. For economy of material some of the counter-balancing force can be supplied by means of a spring rather than by an added weight. Such a spring is shown in Figs. 1 and 2 at 17.

Referring particularly to Fig. 1, the spring

17 is supported at one end from the base 18 by a rigid member 19 which is bent to allow free movement to the weight 16. The other end of the spring is secured to the projection 20 of the arm 13. The tension in the spring at its working length makes up for the amount of balancing material needed.

Although the spring may be used to reduce the size of the counter-balancing weight, it can be designed to serve a more important function as mentioned previously. It is supported so that the pivot for horizontal motion is located between the ends. This means that when the center line of the spring is displaced so that it does not intersect the vertical axis of rotation of the arm, a turning moment is established which tends to increase the displacement. Now, the force of friction between the stylus and record has a lateral component which always tends to turn the arm to a position such that a line drawn through the stylus and vertical axis is tangent to the groove at the stylus. If the spring is so positioned that its center line intersects the pivot at the tangent position of the arm, any displacement of the arm from this position will cause the spring to become eccentric to the pivot and thereby establish a turning moment which will tend to increase the displacement. The lateral component of the force of friction varies very nearly as the displacement of the arm from the tangent position and since the eccentricity of the spring also varies as the displacement of the arm, these two forces can be made to balance one another to secure better tracking.

Referring to Fig. 2, let A represent an extreme position of the stylus. The needle friction for this position will be some force f_T acting tangentially to the groove. This force may be resolved into two components f_L acting along the center line of the arm and f_N acting normal to the center line. The spring tension S acts along the center line of the spring and for the position shown the center line will have an eccentricity E. If θ is the angle between the tangent and end positions of the reproducer arm and L is the distance from the stylus to the pivot, then for equilibrium $S.E. = f_T . \sin\theta . L$ or the spring force for any position will be

$$S = \frac{f_T . \sin\theta . L}{E}$$

f_T can be determined by experiment and for a given machine θ and L are known. Hence the only other variables are E and S. E can be assumed from the size and shape of the arm thus making it possible to determine the spring tension required.

By taking moments about the pivot for vertical movement the equivalent weight which the spring tension replaces can now be determined. Since the bearing pressure of the stylus is fixed, however, any excess or lack of tension must be adjusted for by changing the eccentricity of the spring relative to the pivot for vertical movement.

Although the invention has been described with reference to a particular embodiment for the purpose of illustration, its scope is not to be limited thereby but is to be determined by the appended claims.

What is claimed is:

1. A translating device for phonographs, an arm for the translating device pivotally mounted, and means for reducing vibrations at the pivot to turning movements about the stylus.

2. A translating device for phonographs, an arm for the translating device pivotally mounted, and means comprising a mass of predetermined size and distribution for reducing vibrations at the pivot to turning movements about the stylus.

3. A stylus actuated translating device for phonograph records, a record, and means for counter-balancing the lateral component of the force of friction between the stylus and the record.

4. A stylus actuated translating device for phonograph records, a record cooperating with the stylus, and a spring for counter-balancing the lateral component of the force of the friction between the stylus and record.

5. A stylus actuated translating device for phonograph records, a record cooperating with the stylus, an arm pivotally mounted for the translating device, and a spring for counter-balancing the lateral component of the force of the friction between the stylus and record, said spring being positioned so that its center line passes over the pivot when the arm is in a tangent or neutral position.

6. A stylus actuated translating device for phonograph records, a disc type record cooperating with the stylus, an arm pivotally mounted for the translating device, and a spring for counter-balancing the lateral component and the force of friction between the stylus and record, one end of said spring being secured to the arm at some point between the pivot and stylus and the other end being held by a rigid member on the opposite side of the pivot.

7. A stylus actuated translating device for phonographs, a support for the translating device pivotally mounted, a disc type record cooperating with the stylus, means comprising a mass of predetermined weight and distribution for reducing vibrations at the pivot to turning movements about the stylus and spring means for compensating for the lateral component of the force of friction between the stylus and record said spring cooperating with the mass to reduce the amount of bearing pressure on the stylus.

8. A stylus actuated translating device for phonographs, an arm for the translating device pivotally mounted, a disc type record co-

operating with the stylus, and a mass of predetermined weight and distribution secured to the arm such that the center of percussion of the combined translating device, arm and mass falls over the pivot when the stylus is taken as the axis of rotation.

In witness whereof, I hereunto subscribe my name this 17th day of July, 1931.

LLOYD A. ELMER.