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REPRODUCER

John F. Nielsen, Forest Hills, N. Y., assignor to
Cinaudagraph Corporation, Stamford, Conn.,
a corporation of Delaware

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This invention relates to phonograph reproducers, and particularly to those using a stylus-driven voice coil to pick-up the undulations of the contour of the record groove and transform these into variations of the electromotive force in the voice coil.

The object of the invention is to provide a mechanism which will be simple in structure and effective in operation to reduce the weight carried by the stylus and increase the accuracy and efficiency of the reproduction.

In the accompanying drawing illustrating the invention as applied to a vertical reproducer

Fig. 1 is a partial vertical sectional view;

Figs. 2 and 3 are vertical sectional views on enlarged scale of portions of the structure shown in Fig. 1; and

Fig. 4 is a vertical sectional view similar to Fig. 3 and illustrating a modified form of mechanism.

In the apparatus shown in the accompanying drawing, the arm A of the reproducer carries the pick-up mechanism within its cup shape outer end 5, the pick-up unit designated generally as P being pivoted at 6 to each side skirt of the arm. The pick-up unit P is maintained in vertical position by link 7 pivoted at 8 to the unit and at its other end to the support for the arm A which in turn is pivoted at a point vertically below the axis of the link pivot and spaced therefrom a distance equal to the spacing of the centers of pivots 6 and 8.

In Fig. 1 the arm is shown tilted upward above its normal horizontal position and as if the record R being played was the uppermost of a number of superposed records.

The arm is supported on the surface of the record R by the ball or shoe B sliding on the record surface. The shoe B carries substantially the entire downward pressure of the end of the arm A and the unit P so that the downward pressure of the stylus point on the groove contour need only be sufficient to move the light voice coil structure and its associated parts. This permits the stylus point to be reduced in size, for instance, to approximately less than half the diameter of the usual stylus. This smaller point and correspondingly lighter weight of the movable parts actuated by it attain higher fidelity in reproduction without exceeding the permissible unit intensity of pressure of the stylus point on the material of the record.

The pick-up unit P is composed of the L-shape permanent magnet piece 10 having its vertical leg 11 pressed against the lower plate 12 com-

posed of magnetically permeable material, such as Swedish iron, and forming at its end the outer pole piece 13 surrounding the voice coil 14. The inner or center pole piece 15 has its lower end 16 concentrically suspended within the voice coil opening of the outer pole piece and is retained in place by a drive fit in the bushing 17 supported by the bracket member 18 of nonmagnetic material fastened to plate 12 by the screw means 19. The bushing 17 and pole piece 15 are of magnetically permeable material and the top of the bushing 17 is pressed into close contact with the under surface of the permanent magnet 10 by tension of the strap piece 20 tightened by the screws 21 on each side, drawing the pieces 10 and 12 together and gripping the terminal block 22 between the top of the bracket member 18 and the lower surface of the permanent magnet. This terminal block 22 at its ends carries the curved sleeves 23 for the leads 24 passing to the voice coil on each side.

The stylus S is mounted in bushing 25 and the support for it and for the voice coil 14 is provided by a double diaphragm construction comprising a lower disk 26 and an upper disk 27 shown as integral with the voice coil cup or cylinder 28. The upper disk 27 has its peripheral portion gripped between the rings 29 fastened in place by screw bolts 30 passing through the pole piece 13 and threading into the ring member 31 underneath. The lower disk 26 is gripped between ring 31 and end annulus 32 fastened in place by the screw bolts 33 threading into the ring 31.

The stylus bushing 25 is fastened vertically to the center of disk 26 and the end of the voice coil cylinder 28 by means of a screw 34 passing through holes in the disk and cylinder end and threading into the bore of the bushing 25. A small annular guide disk 35 may be provided seated in a recess 36 in the end annulus 32.

In initial assembly of the parts, the disks 26, 27 may be under very slight tension in one direction or the other depending upon the relative length of the cylinder 28; and the material and thickness of these disk parts are so chosen that with the stylus parts raised and the point of the stylus at the median line of a record groove (of .005" depth for instance), the pressure will be five to ten (preferably seven) grams on a stylus point.

The parts will be so arranged and proportioned and the advance ball or shoe B will be so set by retaining set screw 40, or by any desired micrometer adjustment, that as the pick-up unit is

rested on a record, the stylus and the parts movable with it will be lifted a sufficient distance against the resultant of the resiliencies of the diaphragms 26, 27 to create the desired counter pressure holding the stylus point to the undulations of the groove.

Where the top surface of the record is not perfectly flat a secondary modulation may develop caused by the relative displacement of the pick-up unit with respect to the stylus position. To overcome this and to average out any such irregularities and reduce this secondary modulation to a frequency below the audible spectrum, it is desirable to position the supporting ball or shoe near the stylus or to use a plurality of supporting means located around the stylus point. Or if desired, the pad of the shoe B may be made of sufficient area and of soft material to even out the irregularities. The weight or downward pressure of the arm A will be sufficiently in excess of the stylus pressures to maintain the shoe B in snug contact with the record surface.

In Fig. 4 a modified construction is shown in which the end annulus 32' carries an annular shoe piece B' surrounding the stylus and having a smooth flat under surface 42 adapted to rest on the surface of the record so as to take the weight of the arm and the unit and lift the stylus and its associated movable parts free. By means of this annulus supporting surface around the stylus point, and with the parts arranged to permit a protrusion of the stylus point a sufficient distance below the lowest surface 42, the resulting combined resiliency of the diaphragms will be such as to impose a counter pressure within the desired amount on the stylus point in the record groove. Preferably, the annular shoe B' is of hard material, such as sapphire, or its equivalent.

It will be understood that in all of the figures of the drawing, the mechanism is shown to a larger scale than would be usual practice. For instance, the end 16 of the inner pole piece is intended to be about $\frac{1}{8}$ " in diameter with the remaining parts correspondingly proportioned.

The moving system vibrating the voice coil is thus very small and light, and the resilient supports have only sufficient strength to maintain the contact of the stylus with the contour of the record groove and without supporting the weight of the reproducer and tone arm.

The moving structure is under sufficient tension to maintain the stylus contact in the groove at all times. The design also utilizes an axially short stylus support reducing the tendency to transmit the lateral motion of the stylus rod to the voice coil.

The system of this invention, therefore, may employ a stylus point of very small diameter with a corresponding reduction in the pressure against the record surface since the weight of the reproducer is separately supported and may be neglected. For a given standard of rotational speed of the record ($33\frac{1}{3}$ R. P. M., for instance) the

frequency response due to limitations caused by wave length and amplitude relations of the highest frequencies is necessarily limited by the size of the stylus point, and this response can be increased with a decrease in the radius of the stylus point where, as in the present system, the total pressure on the stylus may be reduced proportionately in order to maintain normal record wear. Or conversely the decreased weight of the parts moving with a larger stylus reduces the unit pressure between the stylus point and the record and correspondingly reduces the wear.

The magnetic density in the air gap should be substantially uniform for sufficient length with respect to the axial length of the voice coil to keep the voice coil in a uniform field and make all adjustments of the reproducer evenly responsive. There is thus a very even and constant pressure of the stylus in the groove with the resistance to the stylus movement reduced to a minimum not only as to the resiliency of the stylus support, but also as to the inertia of the parts being moved.

I claim:

1. In a phonograph reproducer, the combination with a tone arm, of a pick-up unit carried thereby and having a stylus and voice coil, means adapted to rest on the surface of the record and support the downward pressure of the end of the tone arm from the record independently of the stylus during the entire operation of the device in reproducing, and a resilient mounting supporting the stylus and voice coil from the pick-up unit and acting to maintain the stylus point in operative reproducing contact in the record groove while the tone arm is so supported from the record.

2. A phonograph reproducer as set forth in claim 1 in which the stylus has a semi-ball point of a diameter approximately .001" or less and is under pressure of not over ten grams at the median line of the record groove.

3. A phonograph reproducer as set forth in claim 1 in which the means for supporting the pick-up unit and tone arm from the record is a shoe device adapted to slide on the surface of the record in advance of the stylus.

4. A phonograph reproducer as set forth in claim 1 in which the means for supporting the pick-up unit and tone arm from the record comprises a shoe device providing sliding surfaces bearing against the surface of the record preceding and following the stylus.

5. A phonograph reproducer as set forth in claim 1 in which the means for supporting the pick-up unit and tone arm is a shoe device surrounding and in close proximity with the stylus.

6. A phonograph reproducer as set forth in claim 1 in which the means for supporting the pick-up unit and tone arm is a shoe device with a soft surface adapted to slide on the record in advance of the stylus.

JOHN F. NIELSEN.