

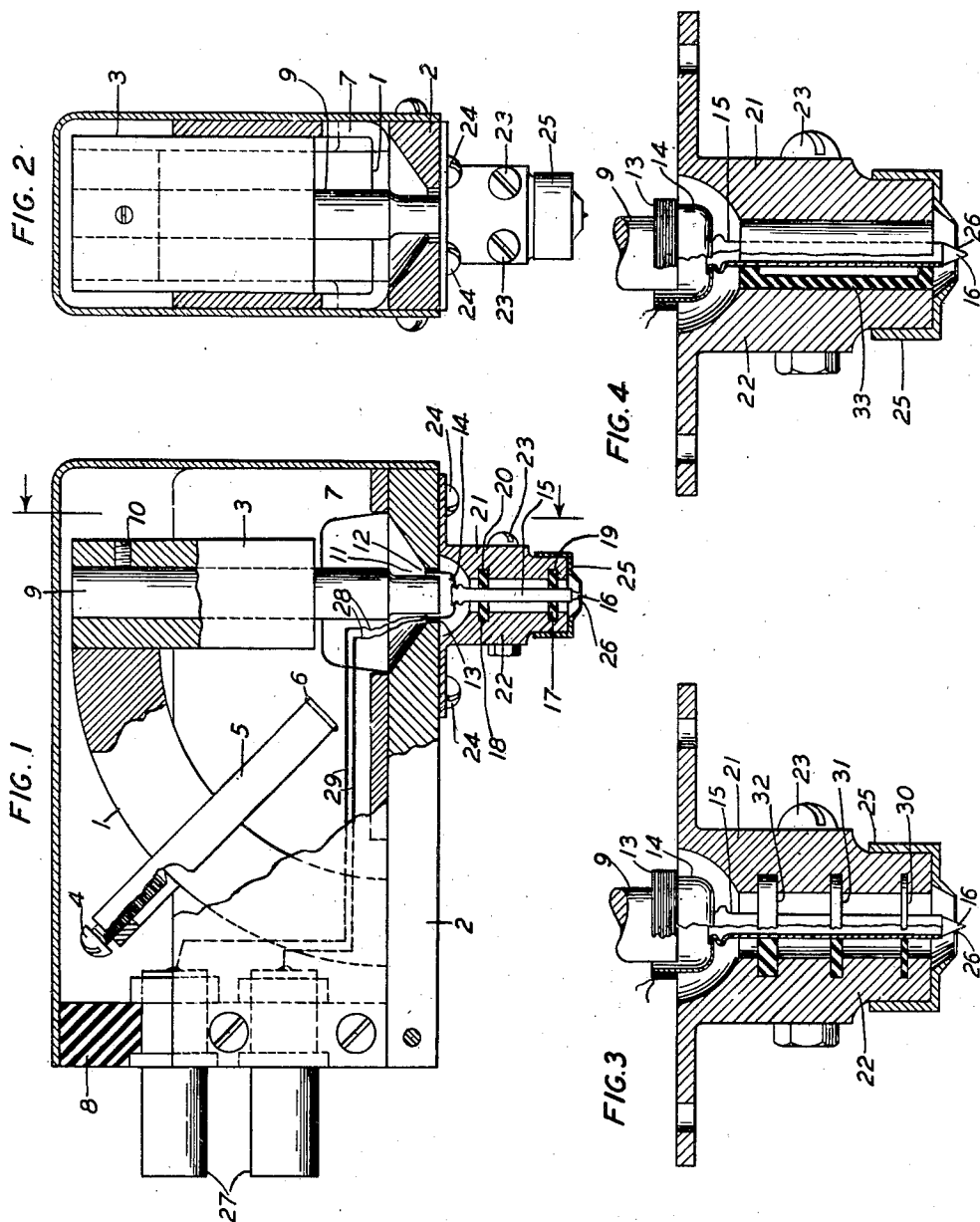
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PHONOGRAPH REPRODUCER

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PHONOGRAPH REPRODUCER

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This invention relates to phonograph reproducers and more particularly to the mounting of the moving system in electrodynamic reproducers for hill and dale records.

In a copending application of A. C. Keller Serial No. 402, 128, filed October 24, 1929, there is disclosed a reproducer which may be designed to give a linear response over a wide range of frequencies without the use of damping. In that reproducer a coil is elastically supported in the air gap and the stylus is maintained in contact with the groove at all times by means of the restoring force developed in the mounting when the reproducer rests on the record. According to the theory of that invention the necessity for damping is eliminated by preventing free vibration of the moving system within the recorded and reproduced band and this is shown to be accomplished if this elastic restoring force is at all times equal to or greater than the product of the velocity of the stylus and the mechanical impedance of the moving system.

In a structure of this kind it is of course essential that the connection between the stylus and the coil be very rigid so that the velocity of the coil will always be the same as the velocity of the stylus and also that the mounting be of low stiffness to vertical forces but of relatively high stiffness to lateral forces which tend to move the coil from its center position in the gap.

These lateral forces may be either steady or alternating. For example, the frictional force between the stylus and a blank groove may be practically constant while the horizontal component of the reaction of the groove undulations on the stylus will be of an alternating nature and will vary in magnitude with the steepness of the wave fronts. Due to the small clearance in the air gap either of these forces may cause the coil to scrape on the pole faces thereby introducing noise into the reproduction and sometimes destroying the coil unless special precautions are taken to prevent it. The alternating lateral forces set up by the groove undulations tend to vibrate the stylus in the direction of the record movement so that the time axis of

the reproduced wave is distorted. In other words the stylus moves forward and backward as well as vertically so that the recorded wave cannot be faithfully reproduced.

It is the object of the present invention to provide a reproducer structure in accordance with the general theory outlined above which is practically free from these various forms of distortion and which is at the same time relatively cheap and easy to manufacture.

In accordance with the general features of the invention, the moving system of the reproducer is supported at two or more positions by resilient material which is so proportioned and arranged as to constitute both an elastic mounting of the proper stiffness and a damping medium for undesired vibrations. In the preferred embodiment of the invention the stylus is connected to the generating element (such as a coil) by means of a hollow member which may be of duralumin and is of as high lateral and compressional stiffness as is consistent with the necessary low mass requirement of the moving system. The resilient material is in the form of spaced discs of rubber which surround this member thereby further increasing its effective stiffness and checking any tendency to free vibration due to the energy dissipation in the discs.

A moving system of this kind, as will be shown later, can be so proportioned that for lateral forces it tends to rotate about a horizontal axis near the upper disc. If the coil is located at or near this axis even relatively large lateral movements of the stylus will cause only small variations in the position of the coil from its proper central location in the gap.

By proper choice of materials and suitable proportioning of the discs and their spacing along the hollow member, the necessary high lateral stiffness may be obtained while keeping the vertical stiffness very low. This results in a low impedance to the desired vertical motion and a high impedance to lateral vibrations and due to the high inherent damping action of the rubber any slight lateral vibrations which are set up are quickly suppressed.

These and other features of the invention will be more clearly understood from the following detailed specification and the drawing in which

5 Fig. 1 is a sectional view of an assembled reproducer;

Fig. 2 is a cross-section of the same;

Fig. 3 is a detailed view of a modified form of the mounting for the moving system; and

10 Fig. 4 is a further modification, in the form of the resilient material for supporting moving system.

Referring now to Figs. 1 and 2, the magnetic circuit of this reproducer comprises a magnet 1 contacting at its ends the magnetic members 2 and 3 respectively and held firmly in this position by set screw 4 in the U-shaped bracket 5. This bracket is bent over at its ends to engage a hole 6 in each side of the U-shaped non-magnetic member 7 which is rigidly connected to the magnetic member 2 and the block 8 of insulating material by screws as indicated. A pin 9 of cobalt iron is secured in the member 3 by set screw 10 and projects downwardly into a circular hole 11 in the member 2 to form an annular air gap 12. The member 9 and the portion of member 2 adjacent the hole 11 are so shaped as to concentrate the flux in the gap 12.

The moving system for this reproducer consists of a coil 13 wound on a cup member 14 which is connected with a downwardly extending metal tube 15 terminating in the stylus 16. The coil 13 in a reproducer for general use consists preferably of two layers (about 40 turns) of No. 44 enameled copper wire wound on the outside of the cup member 14 but insulated therefrom by suitable insulation such as condenser paper. For a playback reproducer in which the effective mass must be kept low fewer turns may be used as desired. The cup member may be of duralumin about 3 mils thick and of the proper diameter to fit into the air gap 12 with the proper working clearance. The tube 15 may also be of duralumin about 3 mils thick and 50 mils outside diameter and the stylus 16 which is preferably of the permanent or semi-permanent type is cemented into the end of the tube. The supporting discs 17 and 18 fit tightly over the tube 15 and engage recesses 19, 20 in the members 21, 22 which are held together by screws 23 to form a housing for the moving system. This housing is attached to the main part of the reproducer before the pole piece 9 is put in place. The screws 24 fit loosely in holes in the members 21 and 22 so that the coil 13 may be accurately centered in the gap 12 by a mandrel inserted in the member 3 and fitting tightly into the cup-like member 14, after which the screws 24 are tightened to hold the moving system housing accurately in place. In order to keep

the dust from the record from accumulating in the reproducer a dust cover 25 fits snugly over the moving system housing and has an opening 26 just large enough to permit free movement of the stylus.

The reproducer is provided with plug terminals 27 embedded in the insulating material 8 which serve both as an electrical connection between the coil 13 and the external circuit and also as a mechanical connection for attaching the reproducer to its supporting arm. When the reproducer is used in connection with a hill and dale record the coil 13 will be driven by the stylus in accordance with the undulations of the record groove and, due to the flux in the gap 12, corresponding currents will be generated in the coil and transmitted to the external circuit by means of the coil leads 28 and the stiff connecting wires 29.

It has been found satisfactory to form the discs 17 and 18 of rubber about 50 mils thick but it is essential that a very resilient rubber be used and that it be of such a nature that it does not age appreciably in use. In the modification just described only two discs have been shown but as pointed out above a number of discs may be employed to increase the effective stiffness of the tube thereby preventing free vibration and permitting the discs to be arranged along the tube in such a way that the effective axis of rotation is approximately coincident with the axis of the coil. While in many cases it may be satisfactory to use discs of but one thickness, in other cases, particularly where a very small air gap is used, it may be desirable to use very thin rubber for the discs near the stylus and increasing in thickness upwardly toward the coil. A structure of this kind is shown more in detail in Fig. 3 according to which the disc 30 is made relatively thin, disc 31 somewhat thicker and disc 32 thicker than either of the other two. In this way the lateral stiffness of the lower part of the mounting is less than that at the upper end so that for lateral forces the tube tends to rotate about an axis substantially at the upper disc and since the upper disc is located as closely as the mechanical construction of the device will permit to the coil it will be evident that these lateral forces will have very little tendency to cause the coil 13 to vary from its proper motion so that the distortion in the reproduced sound due to parasitic vibrations is reduced to a minimum.

Essentially the same effects may be obtained by making the resilient mounting 33 all in one piece as shown in Fig. 4. As in the constructions already described this piece may be so formed as to support the tube at two, three or even more positions as desired and the relative thicknesses of these projecting portions may be varied to give the required lateral stiffness at each supporting point.

In all of these modifications it will be apparent that for small vertical movements such as those imparted to the moving system by the stylus contacting the record the stiffness of the system in a vertical direction will be very low whereas for the various lateral forces already discussed the stiffness of the disc in a transverse direction will be relatively high. The lateral stiffness may be further increased by making the recesses, such as 19 and 20, of slightly smaller diameter than the discs 17 and 18 so that when the housing is assembled the tightening of screws 23 compresses the discs toward the tube 15. In this way it has been found that a ratio of lateral to vertical stiffness for the mounting of four or five to one may be readily obtained. Such a system, having essentially but one degree of freedom or mode of vibration, namely, vertically, will be held in substantially its central position at all times and any slight deviations which do occur will be quickly suppressed due to the high inherent damping action of the soft rubber used.

Moving systems of the kind disclosed in Fig. 1 are found to have an effective needle point mass of about .030 grams and an effective stiffness for vertical forces of about 106 dynes per centimeter. When a system of this kind is incorporated in a very small reproducer of such dimensions that the total mass is of the order of 50 grams and the reproducer is applied to the record with a force of about 10 grams, it is found that original recordings in soft wax may be played back directly without noticeable injury to them. On the other hand if this moving system is incorporated in a reproducer of somewhat greater mass such as 200 grams so that a larger magnet system may be used for obtaining high efficiency, it is found that commercial pressings are played satisfactorily with negligible wear with bearing pressures of from 15 to 25 grams.

While the invention has been described with reference to particular embodiments it will be understood that numerous modifications may be made within the scope of the following claims. For example, any other suitable resilient material may be used for the discs and their shape may be modified so that they are no longer properly discs but made, for instance, to be in the form of segments of a circle contacting the tube over only a portion of its circumference. While specific constants have been given in several instances it is not intended that the invention should be limited to these particular figures since the optimum values will vary with the application to which the invention is to be put.

What is claimed is:

1. In a phonograph reproducer the combination with a moving system comprising a coil, a stylus for driving the coil and a con-

necting member of a support for the system including two discs of resilient material, one of which is located near the coil and has a higher lateral stiffness than the other.

2. In a phonograph reproducer, a stationary structure, a moving structure in operative relation thereto and comprising a generating element, a stylus for driving the element and a connecting member between the element and the stylus and at least two resilient supports for the member differing in lateral stiffness so that a lateral displacement of the stylus produces no substantial lateral displacement of the element.

3. In a phonograph reproducer the combination with a moving system comprising a coil, a stylus for driving the coil and a connecting member of such small mass that when unsupported intermediate its ends, parasitic vibrations are set up in it by the stylus, of resilient material contacting the member at a plurality of positions along the member to support the system and dampen the parasitic vibrations, the lateral stiffness of said material at each position being greater than that at the next position below whereby the coil is substantially undisturbed by lateral forces applied to the stylus.

4. In a phonograph reproducer for hill and dale records, a main stationary structure, a moving system in operative relation thereto comprising a coil, a stylus and a lightweight tubular member connecting the coil and the stylus, and means for supporting the system comprising a plurality of discs of resilient material surrounding the member and a split housing removably attached to the main structure and having recesses for receiving the discs.

5. In a phonograph reproducer for hill and dale records, a main stationary structure, a moving system in operative relation thereto comprising a coil, a stylus and a lightweight tubular member connecting the coil and the stylus, means for supporting the system comprising resilient members having a high ratio of lateral to vertical stiffness spaced along the tubular member adjacent to the coil and the stylus, a split housing supporting the resilient members and removably attached to the main structure, and means associated with the housing for preventing dust from accumulating around the coil.

6. In a phonograph reproducer, a stationary structure and a moving structure in operative relation thereto and comprising a generating element, a stylus connected to the element and upper and lower resilient stylus supports, the lower support being of lower lateral stiffness than the upper so that a lateral displacement of the stylus produces no substantial lateral displacement of the element.

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