

April 14, 1936.

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2,037,165

VIBRATION TRANSLATING DEVICE

Filed Oct. 4, 1933

FIG. 1

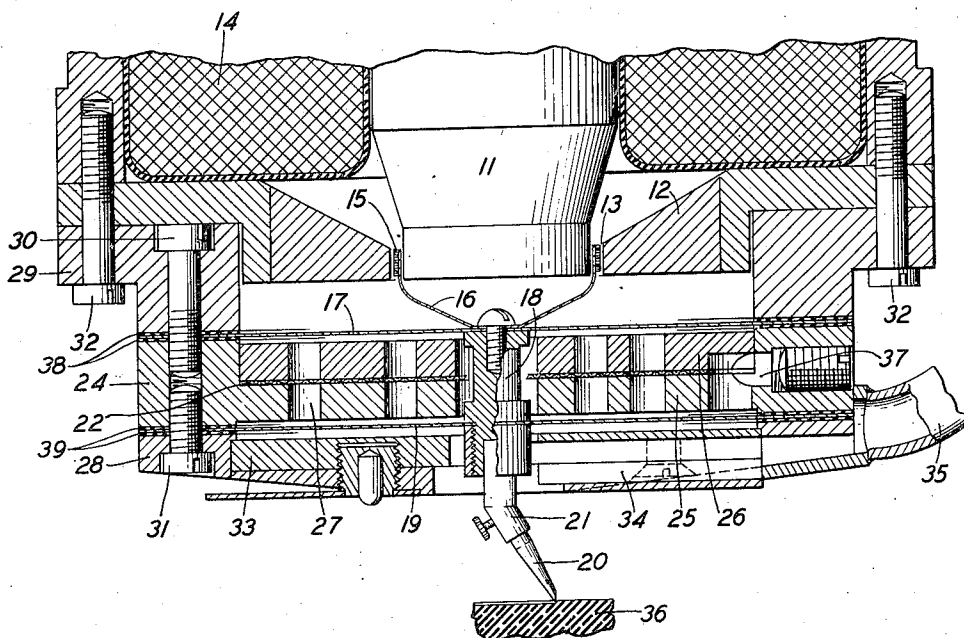
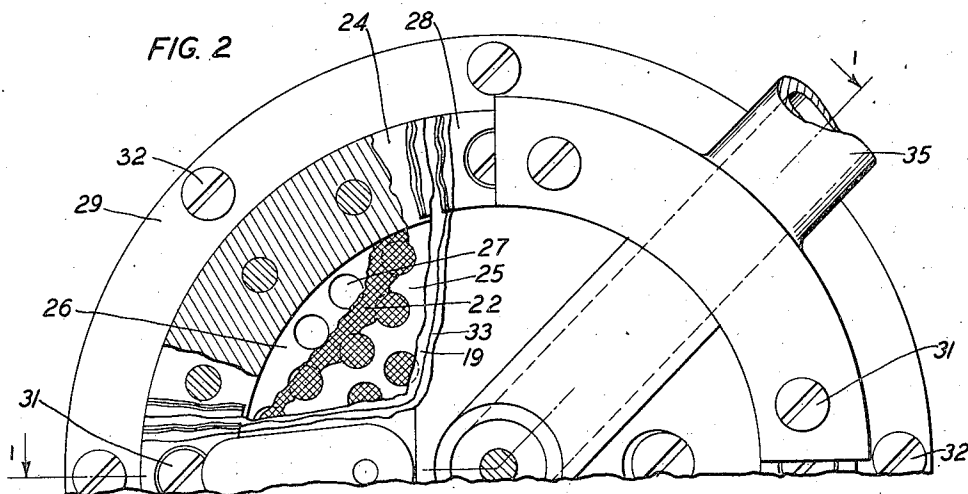


FIG. 2



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2,037,165

VIBRATION TRANSLATING DEVICE

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Application October 4, 1933, Serial No. 692,060

5 Claims. (Cl. 179—100.41)

This invention relates to vibratory translating devices and more particularly to electrodynamic recorders for making hill and dale records.

The object of the invention is a device of this kind which responds uniformly to a wide range of sound frequencies.

Among the general requirements for such a device are small effective mass for high frequencies, small effective stiffness for low frequencies, and adequate damping resistance at the resonant frequency of the moving system. These characteristics are attained according to the invention in a double stretched diaphragm construction in which a damping plate is disposed between the diaphragms, the coil is attached to the upper side of the top diaphragm, and the stylus is secured to the lower side of the bottom diaphragm. The damping plate contains a series of perforations which are partially sealed by porous members such as a sheet of fine wire gauze placed in the path of the damping fluid either within the plate or on one or both sides of the plate. The space between the diaphragms is entirely filled with oil which is displaced vertically through the porous members by the movement of the diaphragms. The coil is preferably secured to the center of one of the diaphragms which are held in proper relation by a central spacing member, an extension of which provides the attachment point for the cutting stylus.

For high frequencies only a small central portion of the diaphragm assembly moves so that a relatively small portion of the oil is displaced and the effective mass or high frequency mechanical impedance is low. For low frequencies substantially the whole assembly moves with the coil displacing a much larger volume of oil and increasing the effective mass of the system. This added mass in effect neutralizes much of the stiffness of the moving system with the result that it also responds readily to low frequencies.

A feature of the invention is the arrangement of the diaphragms and damping plate to provide a large damping area which makes possible the use of an oil of low viscosity and hence of low temperature coefficient so that normal variations in temperature cause no appreciable variation in the performance of the device.

In the drawing, Fig. 1 is an enlarged sectional view of a hill and dale phonograph recorder according to this invention and Fig. 2 is a bottom view of the recorder broken away to show particularly the damping unit.

The central pole piece 11 and the annular pole piece 12 define a gap 13 in the path of the flux

produced by the winding 14. The coil 15 is supported in the gap by a duralumin cup member 16 which is secured to the member 18 through the upper diaphragm 17 as shown. The member 18 maintains the diaphragms 17 and 19 in the desired spaced relation at their centers and extends below the lower diaphragm to form an attachment point for the stylus 20 and its supporting arm 21.

Between the diaphragms is the steel damping plate 24, the central portion of which is formed in two parts 25, 26 the outer faces of which are spaced about 15 mils from the diaphragms. The parts are preferably made as shown with the lower portion 25 recessed to receive the upper part 26, the two parts having corresponding holes 27 about seventy in number and about one-sixteenth inch in diameter. Interposed between the parts is a disc of fine bronze wire gauze 22 which partially closes the holes 27 to increase the resistance of the holes to the flow of the oil. For the very light damping oils such as kerosene which are preferred because of their relatively stable viscosity with varying temperatures, the gauze should be of the order of 350 mesh. Fine silk may also be used for this purpose but it is somewhat less satisfactory because of its tendency to stretch and move slightly in the direction of the oil flow.

Alternatively the silk or wire gauze may be placed on one or both sides of the plate adjacent the diaphragm but the arrangement described is easier to assemble and provides more uniform clearance between the damping plate and the diaphragms.

In assembling the device, the diaphragms 17 and 18 are made larger than the clamping rings 28 and 29 so that they may be tensioned by external means and held under tension while the screws 30 and 31 are tightened. The portions of the diaphragms protruding beyond the ring 28 and the plate 24 are then cut away and the moving system assembly is secured in place by screws 32. In the structure shown the diaphragms are of duralumin about three mils thick tensioned to about five thousand pounds per square inch. The mechanical impedance of the oil is so high that the tension is not critical but in general the thicker the diaphragms the less tension is required. With little or no tension the rate of dissipation of energy will be so slow that insufficient damping will be obtained at the medium and high frequencies. On the other hand, excessive tension will make the moving system so stiff that

the recorder will be too inefficient for low frequencies.

The flange of the plate 24 has an opening 37 through which oil or other damping liquid may be poured into the damping chamber defined by the diaphragms. The lower diaphragm is protected from mechanical injury by a bottom plate 33 secured to the clamping ring 28 and provided with a radial channel 34 which connects with the tubing 35 leading to the suction apparatus. When the coil 15 is carrying signal currents the moving system is vibrated in the usual way to cut a corresponding record groove and the suction of air upwardly through the central opening of the bottom plate removes the shavings as they are cut from the record blank 36.

With a structure of the type disclosed substantially the whole free area of the diaphragm vibrates at low frequencies and oil is forced through all of the holes 27 thereby increasing the effective mass of the moving system for these frequencies. Since the mechanical impedance of the system for low frequencies is largely the stiffness reactance of the diaphragms, this additional mass reactance brings the system more nearly into mechanical resonance, and consequently improves the response of the device in the lower portion of the frequency range. As the frequency of the vibrations increases the proportion of the area of the diaphragms set into vibration decreases until for the highest frequencies only a small central portion of the diaphragms moves. Under this condition only a small portion of the oil near the center of the diaphragms is forced through the gauze in the central perforations. At high frequencies the mechanical impedance of such a vibrating system is largely mass reactance and the reduction in the amount of oil displaced produces a corresponding reduction in the mechanical impedance thereby improving the high frequency response.

Various modifications within the scope of the invention will occur to those skilled in the art. For example, considerable damping may be obtained without using the gauze by using a greater number of much smaller holes in the damping plate.

What is claimed is:

1. In a vibration translating device the combination with a driving element, a driven element and supporting means for the elements comprising

stretched diaphragms secured together at their centers to form a damping chamber of oil in the chamber and a stationary member having distributed perforations impeding the flow of oil between the diaphragms for damping the vibrations of the driven element.

2. In a vibration translating device the combination with a driving element, a driven element and supporting means for the elements comprising spaced diaphragms secured together at their centers, of a stationary plate having a plurality of distributed perforations and a viscous damping medium between the diaphragms and means for restricting the flow of the medium through the perforations for damping the vibrations of the driven element.

3. In a vibration translating device the combination with a driving element, a driven element and supporting means for the elements comprising stretched diaphragms secured together at their centers, of a perforated damping plate between the diaphragms having fine mesh gauze partially closing the perforations and a damping medium of low temperature coefficient between the plate and the diaphragms.

4. In a vibration translating device the combination with a magnetic circuit having a gap, a coil within the gap and a stylus member adapted to move with the coil, of a supporting system comprising stretched parallel diaphragms between the coil and the stylus secured together in spaced relation, and damping means comprising a perforated plate and a liquid damping medium of low viscosity interposed between the diaphragms and means for retarding the flow of oil through the perforations in the plate incident to the vibration of the diaphragms.

5. In a vibration translating device the combination with a moving system comprising a driving element, a driven element, spaced diaphragms secured together to form a damping chamber and a support for the elements, and a liquid damping medium within the chamber, of a damping member in the chamber comprising a two-section perforated plate with fine gauze between the sections for restricting the flow of oil through the perforations.

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