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G. R. YENZER

2,531,242

ELECTRODYNAMIC PHONOGRAPH PICKUP

Filed Sept. 5, 1947

2 Sheets-Sheet 1

FIG. 1

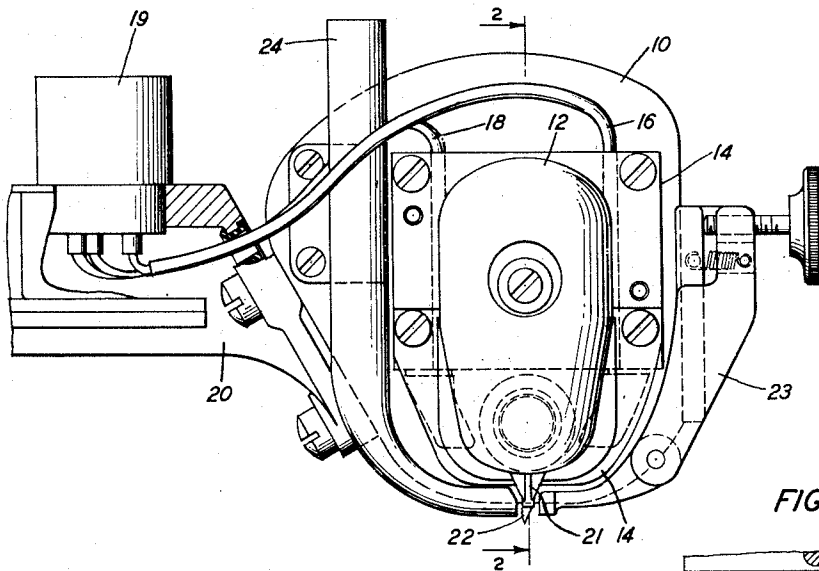


FIG. 2B

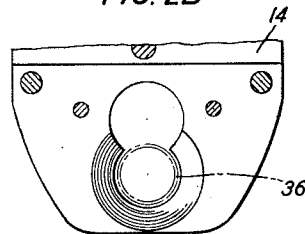


FIG. 2

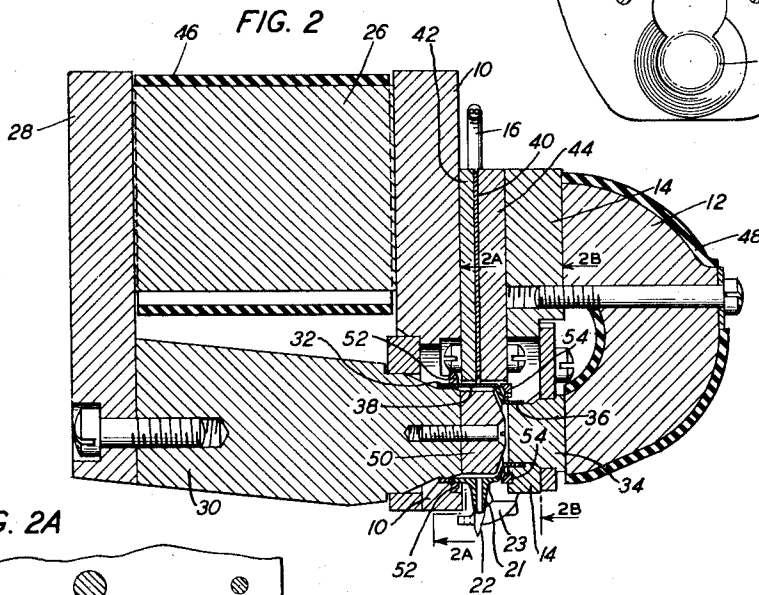
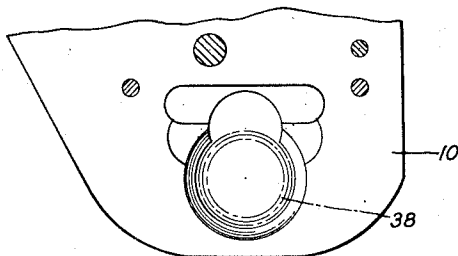


FIG. 2A



INVENTOR
G. R. YENZER
BY *G. H. Shupe*
ATTORNEY

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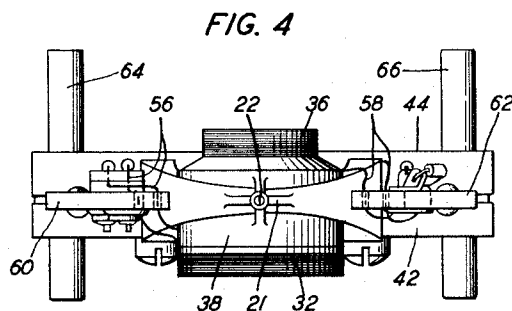
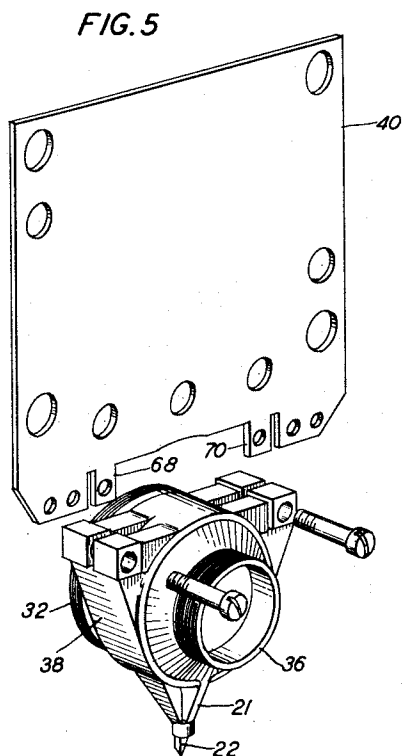
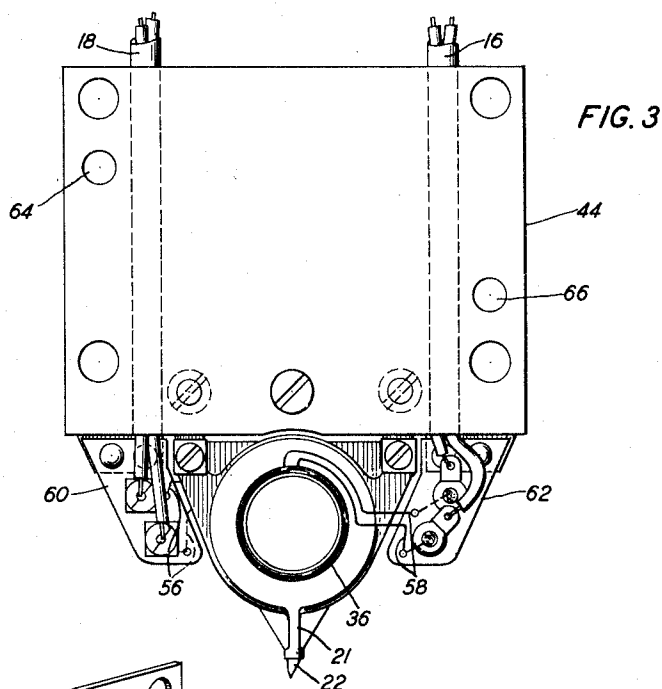
G. R. YENZER

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ELECTRODYNAMIC PHONOGRAPH PICKUP

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2 Sheets-Sheet 2



INVENTOR
G. R. YENZER
BY
G. H. Heydt.
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRODYNAMIC PHONOGRAPH PICKUP

George R. Yenzer, Westfield, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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4 Claims. (Cl. 179-100.41)

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This invention relates to electrically driven vibratory systems, particularly to systems for engraving on wax and direct recording materials.

It has been recognized for some time that the operation of amplifiers may be stabilized and the distortion in their outputs reduced by the utilization of negative feedback in the manner described by H. S. Black in the Bell System Technical Journal for January 1934, and in his Patent 2,102,671 granted on December 21, 1937.

The principle of negative feedback has also been applied to electrically driven mechanically vibrating systems by deriving the feedback energy from a generating element moving with the driven system. A stable, electromechanical vibrating system of the negative feedback type which is capable of substantially distortionless response over the high quality range of frequencies of speech and music is shown in Patent 2,161,489 granted to L. Vieth et al. on June 6, 1939.

It is an object of this invention to provide a high quality, stable, electromechanical vibrating system of the negative feedback type which may be readily used for recording lateral type records.

It is a fundamental requirement for the stable operation of a negative feedback recording system that the total phase shift in the amplifier and recorder shall be less than plus or minus 180 degrees over the entire band of frequencies to be transmitted for all conditions in which the gain around the loop comprising the amplifier, the recorder and the feedback coil is greater than unity.

It is also a fundamental requirement for true feedback action that the voltage generated in the feedback coil must be an exact representation of the stylus point velocity.

Experience has indicated that the negative feedback feature cannot be applied satisfactorily to the moving coil lateral type recording systems found in the prior art because it would be extremely difficult, if at all possible, to generate a feedback voltage in such systems which would be an exact representation of the stylus point velocity since there is a tendency for the moving system to rotate around its own center of gravity rather than around the established pivot.

According to this invention, however, a vibratory system radially different from the type used heretofore has been designed in order to realize the advantages of the negative feedback feature. The drive and feedback generating elements are mechanically coupled to the stylus in such a manner that substantially true lateral displacement is provided therefor, the feedback voltage generated

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is an exact representation of the stylus point velocity, and proper phase relations are maintained in the feedback circuit.

Moreover, in order to simplify the problem of maintaining proper phase relations, the vibratory system of this invention has been designed to have only a single resonant peak over the operating range, and to avoid the formation of small air chambers which ordinarily produce secondary resonance effects. Provision has also been made for shielding against unwanted coupling between the drive coil circuit and the feedback circuit.

In the preferred structure for a phonograph recorder the moving system comprises a coil and stylus support, drive and feedback coils coaxially and laterally mounted on the support on either side of the stylus, and a vertically supported resilient member connected to the coil support. When assembled into the housing structure the resilient member is firmly clamped between two clamping plates so that only two small sections or hinges are free to vibrate. The coil support is attached to these hinges which, in effect, are cantilever beams.

The coil support is machined from a precision casting of a lightweight alloy such as magnesium alloy to achieve maximum stiffness consistent with low mass. The casting is reinforced to eliminate troublesome modes of vibration and to provide a solid support into which the hinges or cantilever beams are clamped. The resilient member, or hinge spring, is made from a material such as beryllium copper possessing the required stiffness to provide only a single resonant peak over the operating range. The coil mounting means is in effect supported by the cantilever beams, or hinges, in pendulum fashion with the laterally mounted driving and driven coils freely suspended in their respective gaps.

The drive and feedback gaps are defined by separate magnet systems. These gaps are not complete annular gaps but portions of annular gaps so devised that the available flux may be concentrated at that part of each coil nearest the stylus. Shielding between the drive and feedback coils is provided by a copper eddy current core attached to the drive central pole-piece and positioned between the drive and feedback central pole-pieces, and by two copper eddy current rings attached to the drive and feedback pole-plates.

These and other features of the invention will be more clearly understood from the following

detailed description and the accompanying drawings in which:

Fig. 1 is a view in front elevation of a recorder, according to the invention;

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1 showing the magnet and vibratory systems of the recorder;

Figs. 2a and 2b are views in front elevation of the drive and feedback pole-plates showing the sections cut away to provide the desired portion of an annular gap for each of the coils in the vibratory system;

Fig. 3 is a view in front elevation of the moving system and the hinge spring support;

Fig. 4 is a bottom plan view of the moving system and the hinge spring support; and

Fig. 5 is a view in perspective of the moving system with the hinge spring separated from the coil and stylus support.

Referring now to the accompanying drawings wherein like reference characters in the different figures designate similar elements, there are shown in Fig. 1 the pole-plate 10 of the drive magnet system, the magnet 12 and pole-plate 14 of the feedback magnet system, the feedback leads 16 which, with the drive leads 18, are connected to a receptacle 19 housed in the recorder arm 20, the stylus support 21, a stylus 22, an adjustable advance ball mechanism 23, and a suction tube 24 to dispose of the chip in the process of recording. Connection is made by means of a conventional cord and plug assembly from the receptacle 19 in the recorder arm 20 to an amplifier of the type shown in Patent 2,266,168 granted to T. H. Crabtree December 16, 1941.

As shown in Fig. 2, the drive magnet system comprises the magnet 26, the pole-plate 28, the pole-piece 30, and the pole-plate 10. The pole-piece 30 and the pole-plate 10 define the air-gap for the drive coil 32. The feedback magnet system comprises the magnet 12, the pole-tip 34, and the pole-plate 14. The pole-tip 34 and the pole-plate 14 define the air-gap for the feedback coil 36. The drive and feedback gaps formed by the respective pole-pieces and pole-plates are not annular gaps. In the embodiment shown in Fig. 2 a 270 degrees section of an annular gap has been provided for each coil by removing a 90 degrees section in pole-plates 10 and 14 as shown in Figs. 2a and 2b. The drive and feedback coils 32 and 36 are mounted on the support 38 which in turn is attached to the resilient member or hinge spring 40. The hinge spring 40 is held in position between the clamping plates 42 and 44.

Both drive and feedback magnets 26 and 12 have Vinylite shields 46 and 48 to prevent loss of flux due to the formation of secondary poles caused by accidental contacts between the magnets and ferrous objects. The feedback coil 36 is shielded from the field set-up by the drive coil 32 by a copper core 50 between the pole-piece 30 and the pole-tip 34, and the copper rings 52 and 54 which are attached to the pole-plates 10 and 14.

The details of construction of the moving system are more clearly shown in Figs. 3 to 5 inclusive. The leads 56 of the drive coil are connected to the drive leads 18 at the terminal plate 60. The leads 58 of the feedback coil are connected to the feedback leads 16 at the terminal plate 62. The terminal plates 60 and 62 are attached to the hinge spring 40. It has been found that this arrangement minimizes the possibility of shearing the delicate leads and contributes to longer lead life.

The positioning of the moving system, the components of which are shown in Fig. 5, is of necessity blind and requires, therefore, that some means be provided for accurate alignment of parts to insure that the moving coils have proper clearances in the gaps. This is accomplished through the use of two locating dowels 64 and 66 pressed into the clamping plates 42 and 44, and accurately located pilot holes in the drive pole-plate 10 and the feedback pole-plate 14. The gaps are aligned when the pole-plates are assembled by means of the pilot holes and the dowels. The moving system is positioned with respect to the clamping plates 42 and 44 and the dowels 64 and 66 by means of a suitable centering fixture. The coils are thereby centered in the gaps without requiring additional adjustment.

As shown in Fig. 5, the moving system comprises the resilient member or hinge spring 40 and the coil support 38. In assembling the moving system the coil support 38 is attached to the hinges 68 and 70 which are the only members of the hinge spring 40 free to vibrate with the moving coils 32 and 36.

While modifications in the structure shown may occur to those skilled in the art, the invention is intended to be limited only by the scope of the following claims.

What is claimed is:

1. A lateral type feedback recorder comprising a magnet system including a driving magnet, a magnet system including a feedback magnet, each of said magnet systems comprising two pole-pieces and having one of said pole-pieces surrounded by the other of said pole-pieces to form an air-gap the major portion of which is annular and of uniform radial width, the remaining portion of which has a radial width greater than that of said major portion, a vibratory system including a driving coil in one of said gaps carrying currents representing sounds to be recorded, a feedback coil in the other gap for generating voltages to control the motion of the vibratory system, a stylus, and rigid means connected to said stylus, said coils being coaxially mounted on said rigid means in lateral relationship on either side of said stylus for vibration in said gaps, a resilient support for said coil mounting means, said resilient support and coil mounting means having such mass and stiffness as to have a single resonant frequency within the operating range, and shielding means between said magnet systems for shielding the feedback coil from the field of the driving coil.
2. A lateral type feedback recorder comprising a vibratory system including a driving coil, a stylus, a feedback coil and rigid means connected to said stylus, said coils being coaxially mounted on said rigid means in lateral relationship on either side of said stylus, a magnet system including a driving magnet, a magnet system including a feedback magnet, each of said magnet systems comprising two pole-pieces and having one of said pole-pieces surrounded by the other of said pole-pieces to form an air-gap a substantially 270 degrees portion of which is annular and of uniform radial width, the remaining portion of which has a radial width greater than that of said 270 degrees portion, a resilient member connected to said coil mounting means, means for supporting said resilient member between said magnet systems so that said driving and feedback coils are disposed in said air-gaps, and shielding means between said magnet systems

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for shielding the feedback coil from the field of the driving coil.

3. A lateral type feedback recorder comprising a magnet system including a driving magnet, a magnet system including a feedback magnet, each of said magnet systems comprising two pole-pieces and having one of said pole-pieces surrounded by the other of said pole-pieces to form an air-gap the major portion of which is annular and of uniform radial width, the remaining portion of which has a radial width greater than that of said major portion, a vibratory system including a stylus, a driving coil therefor in one of said gaps, a feedback coil in the other gap for controlling the motion of said stylus, rigid means connected to said stylus, said coils being coaxially mounted on said rigid means in lateral relationship for vibration in said gaps, a resilient support for said coil mounting means, said resilient support comprising a cantilever spring member vertically positioned between said magnet systems, and shielding means between said magnet systems for shielding the feedback coil from the field of the driving coil.

4. A lateral type feedback recorder comprising a magnet system including a driving magnet, a magnet system including a feedback magnet, each of said magnet systems comprising two pole-pieces and having one of said pole-pieces surrounded by the other of said pole-pieces to form an air-gap a substantially 270 degrees portion of

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which is annular and of uniform radial width, the remaining portion of which has a radial width greater than that of said 270 degrees portion, a vibratory system including a stylus, a driving coil therefor in one of said gaps, a feedback coil in the other gap for controlling the motion of said stylus, rigid means connected to said stylus, said coils being coaxially mounted on said rigid means in lateral relationship on either side of said stylus for vibration in said gaps, a resilient support for said coil mounting means, said resilient support and coil mounting means having such mass and stiffness as to have a single resonant frequency within the operating range, said resilient support comprising a cantilever spring member vertically positioned between said magnet systems, and shielding means between said magnet systems for shielding the feedback coil from the field of the driving coil.

GEORGE R. YENZER.

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