May 22, 1945. C. M. SINNETT 2,376,456

SIGNAL TRANSLATING APPARATUS

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Fig. 1.

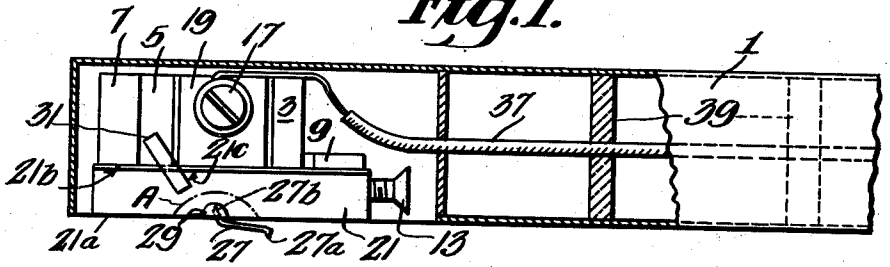


Fig. 2.

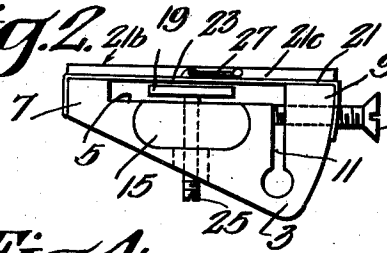


Fig. 3.

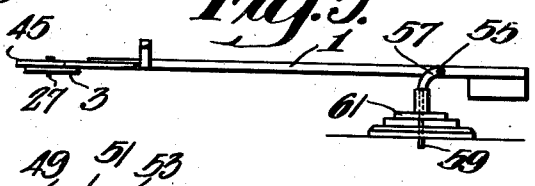


Fig. 4.

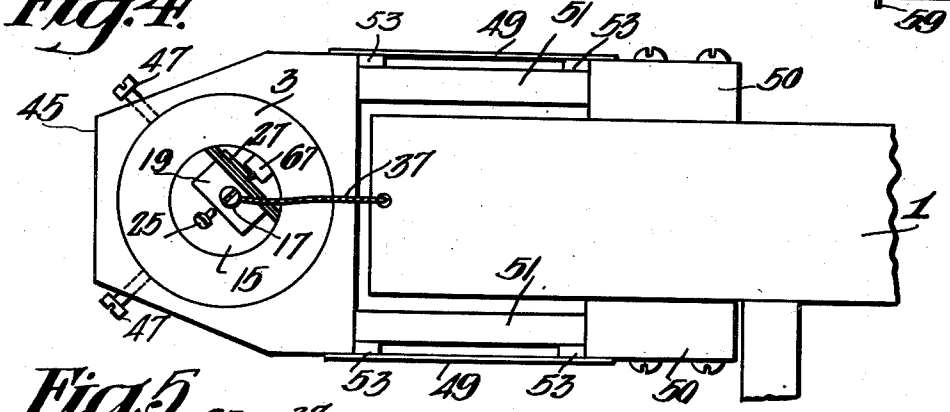
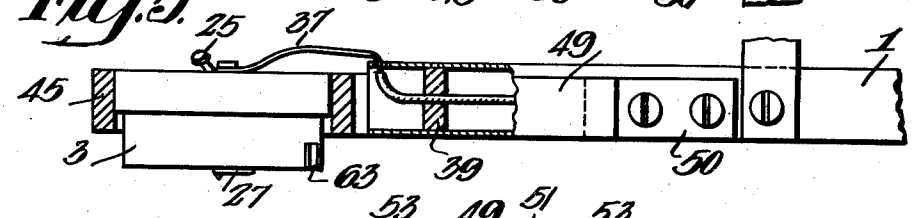


Fig. 5.



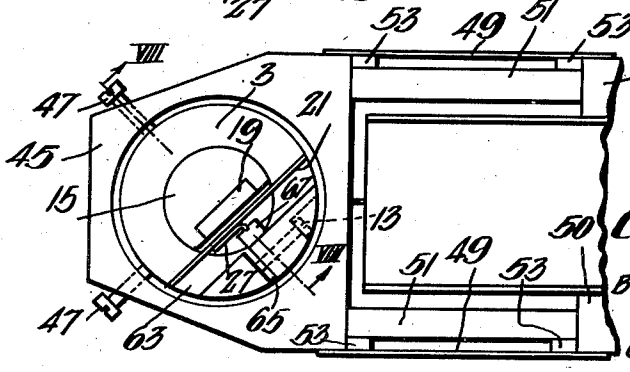


Fig. 6

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Fig. 7.

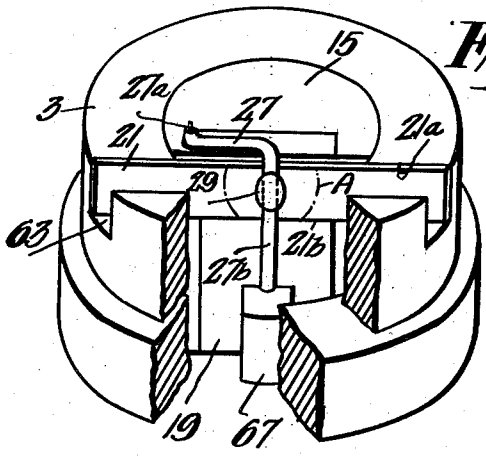


Fig. 8.

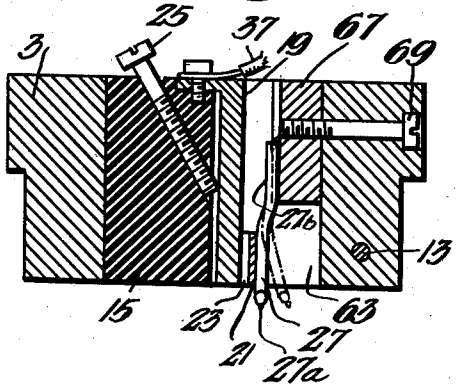


Fig. 9.

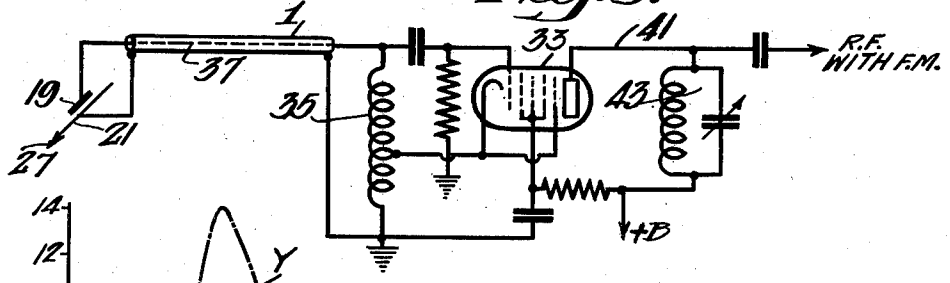
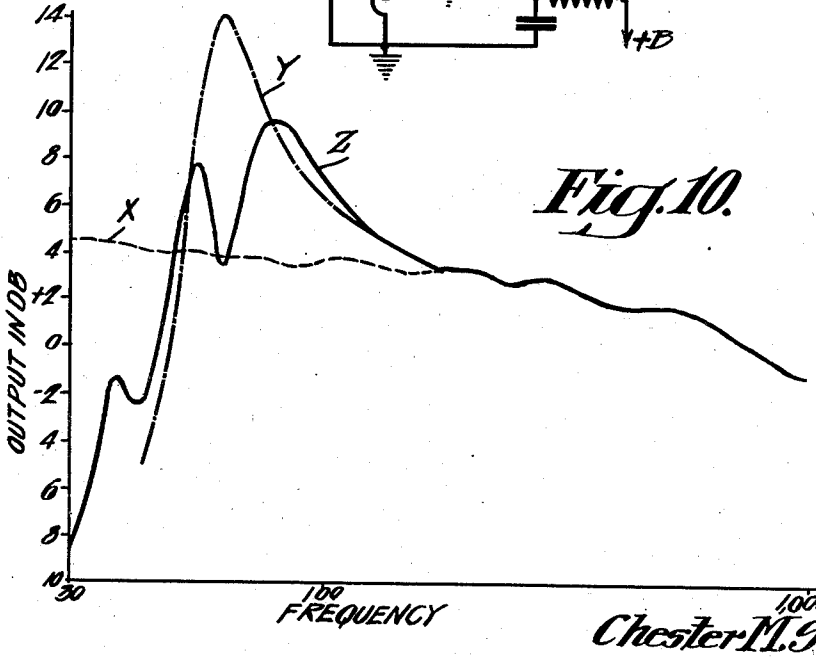


Fig. 10.



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Patented May 22, 1945

2,376,456

UNITED STATES PATENT OFFICE

2,376,456

SIGNAL TRANSLATING APPARATUS

Chester M. Sinnett, Westmont, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application October 9, 1941, Serial No. 414,305

16 Claims. (Cl. 179—100.41)

This invention relates to signal translating apparatus, and more particularly to a signal translating device of the capacity type adapted for use especially in connection with phonograph records, the primary object of my invention being to provide a capacity type pickup as aforesaid the capacity of which is varied in accordance with the record groove modulation to provide frequency modulation in an oscillator circuit wherein the pickup constitutes a tuning element.

More particularly, it is an object of my present invention to provide an improved capacity pickup as aforesaid the operating parts of which have a low mechanical impedance and the needle pressure of which is very low on the record whereby to provide long record and needle life.

Another object of my present invention is to provide an improved pickup as above set forth which has great sensitivity and is operable over a much wider range than pickups of this type heretofore known.

A further object of my present invention is to provide an improved capacity pickup which will afford a large gain in signal to noise ratio.

Still another object of my invention is to provide an improved capacity type pickup wherein the natural period of the vibrating electrode can be easily controlled.

A further object of my present invention is to provide an improved pickup as aforesaid which will not cause the record with which it is cooperating during reproduction to radiate extraneous sounds and which will not itself produce such sounds.

Still a further object of my invention is to provide an improved pick-up as set forth above which will operate with a minimum of distortion.

It is also an object of my present invention to provide an improved pickup device of the character set forth which is very simple, yet sturdy, in construction, which is economical in cost, which is highly efficient in use, and which will have a long life.

In accordance with this invention, I provide a suitable supporting member which carries a pair of electrodes in capacitive relation to each other, one of the electrodes being stationary and the other being mounted for movement relative to the stationary electrode. The movable electrode carries a needle adapted to cooperate with the groove of the record. Due to the wave shape form in the record groove, the capacity between the electrodes is caused to vary in accordance with the movements imparted to the needle by the record groove. The pickup may be connected in the tuning circuit of a 40–50 megacycle oscillator, and when its capacity is varied, frequency shift occurs in the oscillator circuit and frequency modulation results. This may be passed through the regular FM channel of a radio receiver, for example.

The movable electrode preferably consists of a relatively thin, narrow, flexible strip of metal extending across the stationary electrode and anchored at its ends. Suitable means are provided for tensioning the electrode whereby to control its natural period. The needle is preferably secured to the movable electrode substantially midway between its ends, and movement of the electrode is confined substantially to a region thereof in the vicinity of the needle. This avoids vibration reflections from other parts of the movable electrode back toward the needle, thereby substantially eliminating distortion and extending the range over which the pickup is operated with great efficiency. If desired, the fixed electrode may be arranged for adjustment relative to the movable electrode so as to control the normal air gap therebetween and thus the sensitivity of the device. The pickup device is extremely light in weight, having a needle pressure of approximately 20 grams, or about two-thirds of an ounce, as compared with about three-and-a-half or four ounces characteristic of the prior art pickups. Also, since the movable electrode is light and flexible, it has a low mechanical impedance. This, combined with the light weight of the needle on the record, affords long life to both records and needle.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of several embodiments thereof, when read in connection with the accompanying drawings, in which

Figure 1 is a side elevation of one form of pickup constructed in accordance with my present invention, the pickup being shown mounted on a suitable supporting arm shown partly in section,

Figure 2 is an inverted plan view of this form of my invention,

Figure 3 is a side elevation of a second form of my invention shown with its arm mounted in operative position,

Figure 4 is an enlarged, top plan view of the pickup device of Figure 3,

Figure 5 is a side elevation thereof with certain parts in section,

Figure 6 is a bottom plan view thereof,

Figure 7 is an enlarged, bottom, perspective view thereof with certain parts broken away for the sake of clearness,

Figure 8 is an enlarged sectional view taken on the line VIII—VIII of Figure 6,

Figure 9 is a wiring diagram illustrating one circuit in connection with which my improved pickup may be used advantageously and

Figure 10 is a set of curves showing the resonance of the pickup arm of Figure 3 under various conditions.

Referring more particularly to the drawings, wherein similar reference characters designate corresponding parts throughout, there is shown, in Fig. 1, a pickup arm 1 which carries on its free end a supporting block 3 recessed to provide a face 5 and a pair of lugs or projections 7 and 9 which terminate in a plane beyond the face 5. The block 3 is also formed with a slot 11 which substantially separates the projection 9 from the body thereof. A screw 13, which is threadedly received in the projection 9 and has its end bearing against the body of the block 3, as clearly shown in Fig. 2, is adjustable to more or less separate the projection 9 from the body of the block for a purpose presently to be set forth.

The block 3 is also cut away centrally to receive a block of the insulating material 15 which has its face flush with the face 5. Secured to one end of the block 15, as by a screw 17, is one end of a plate 19 which may be made of copper, for example, and constitutes the stationary electrode of the capacitor. The movable electrode 21 is constituted by a relatively narrow, thin, flexible strip of nickel-steel alloy or any other suitable material, having a thickness of about 3 mils and a width of about $\frac{5}{32}$ inch. The strip 21 extends across the lower part of the stationary electrode 19 and has its ends bent over the lugs or projections 7 and 9 to which they are secured, whereby the electrode 21 is anchored in place. By adjusting the screw 13, it is obvious that the tension of the electrode 21 may be varied, and therefore its resonance, or natural period of vibration, controlled at will. The projections 7 and 9 extend sufficiently beyond the stationary electrode 19 to provide an air gap 23 between the electrodes 19 and 21, whereby the two electrodes constitute a capacitor. If desired, any other suitable dielectric material may be interposed between the electrodes 19 and 21 instead of air, or, when they are spaced from each other by an air gap, they may each be coated with a thin layer of some suitable dielectric material, such as zinc chromate. The normal width of the air gap 23 is of the order of three or four mils. However, a set screw 25, which is threadedly received in the insulating block 15 and the end of which bears against the lower end of the plate or stationary electrode 19, may be adjusted to vary the width of the air gap so as to control the sensitivity of the pick-up.

Secured to the lower edge 21*a* of the movable electrode 21 at a point substantially midway between its ends is a needle 27 which is adapted to cooperate with the grooves of a phonograph record. The needle 27 has its major portion extending in a plane substantially parallel to that of the electrode 21 and terminates in a record engaging tip 27*a* which may be of sapphire or the like for long wear. Preferably, the major portion of the needle is rigid torsionally and is of the type disclosed and claimed in the copending application of Harold J. Hasbrouck, Jr., Serial No. 326,896, filed March 30, 1940, now Patent No. 2,280,763, and assigned to Radio Corporation of America. Such a needle may be made of piano wire or the like having a diameter of the order of 10 or 12 mils and having a length of about $\frac{3}{32}$" to $\frac{1}{8}$", its upwardly extending shank 27*b* being the portion by which it is secured to the electrode 21, as by solder 29 or the like.

When the needle tip 27*a* tracks the groove of a record of the laterally undulating type, the groove will cause the needle to move correspondingly, and since it is rigid in torsion, it will cause the flexible electrode 21 to move toward and away from the stationary electrode 19 to thereby vary the capacity of the capacitor. It is desirable to confine the movement of the movable electrode 21 to a region substantially in the vicinity of the needle 27, such as the region bounded approximately by the dotted line A and the lower edge 21*a* of the electrode 21, since this will prevent reflections of vibrational movements of the flexible electrode 21 between its opposed, free edges 21*a* and 21*b*. For this purpose, the edge 21*b* may be made much stiffer than the lower edge 21*a* by bending a marginal portion thereof adjacent the edge 21*b* out of its plane to provide a stiffening flange 21*c* in a plane substantially normal to the plane of the electrode 21. If desired, a block of damping material 31 may be secured to the block 3 and the flange 21*c*, as shown in Fig. 1, to damp the vibration of the upper portion of the movable electrode 21.

A pickup device such as that described above may be employed to control the frequency of any tuned circuit and finds its particular application in modulating an oscillator in a phonograph reproducing circuit. By way of example, the pickup device, as shown in Fig. 9, is connected with such an oscillator which comprises a suitable oscillator tube 33 provided with an oscillator tuning inductance 35, the pickup capacitance being shunted across the inductance 35 and connected therewith through a shielded cable which may be constituted, for example, by the grounded pickup arm 1 within which is a conductor 37 connected to the stationary electrode 19. The capacity of the shielded cable should be relatively low with respect to that of the pickup 19—21, and it may be maintained constant by passing the conductor 37 through a plurality of spacers 39 of damping material such as printer's roll, Glyptal, Du Pont Viscaloid, etc., interposed between the conductor 37 and the pickup arm 1. The output circuit 41 of the oscillator tube 33 is provided with a tuned circuit 43 which is tuned off resonance with respect to the oscillation steady state—or mid-frequency. The variation of the capacity at the pick-up will cause the oscillation frequency to vary above and below the normal frequency, that is, the mid-frequency, thereby resulting in a frequency modulated signal which is delivered to a suitable output circuit and may be utilized in any suitable manner, as to operate a loudspeaker or the like (not shown). This type of circuit is more particularly disclosed and claimed in my copending application, Serial No. 459,375, filed September 23, 1942, and assigned to Radio Corporation of America.

In Figs. 3 to 8, inclusive, I have shown a modification of my invention wherein the supporting block 3 is constituted by an annular member which is removably carried by a head 45 to which it may be secured in operative relation by a pair

of set screws 47. The head 45 is preferably secured to the pickup arm 1 by means of a pair of leaf springs 49 of phosphor bronze, or the like, which are secured to and extend from the head 45 in parallel relation. The springs 49 straddle the adjacent end of the pickup arm 1 and their opposite ends are secured to a pair of blocks 50 which are carried by the pickup arm. Preferably, although not necessarily, a pair of strips or blocks of damping material 51, which may be of the same nature as the damping blocks 39 above described, are secured to the springs 49 by a suitable adhesive 53. The arm 1 is pivotally mounted on a horizontal pivot 55 which is formed on the upper end of the yoke 57 having a downwardly extending, vertical pin or post 59 received in a standard 61. Thus, the arm 1 and its translating device are capable of movement both in horizontal and vertical directions relative to the record.

The curve X of Fig. 10 shows what the response of the system would be if the head 45 were coupled rigidly to the pickup arm 1. When the springs 49 alone are interposed between the pickup head 45 and the arm 1, the resonance of the system becomes that represented by the curve Y, from which it will be seen that there is a fairly sharp peak at about 60 cycles. By providing a damping strip 51 on each of the springs 49, the resonance of the system is changed to that shown by the curve Z, from which it will be noted that there is a smaller peak at about 80 cycles, and that at the extreme, low frequency end, the response drops way down.

The insulating block 15 is made substantially semi-cylindrical in the form of my invention shown in Figs. 3 to 8 and it is recessed slightly to receive the stationary electrode 19. The set screw 25 in this modification extends down through the top of the insulating block 15, as clearly shown in Figs. 5 to 8, for the purpose of enabling adjustment of the air gap 23. The annular block 3 is formed with a groove 63 on its bottom surface, as clearly shown in Figs. 6 and 7, and the movable electrode 21 is secured to the block 3 within the groove 63, as best shown in Fig. 7. The block 3 in this modification is also formed with a radial slot 65 corresponding to the slot 11 of the first described modification of my invention, the screw 13 again serving to place the movable electrode 21 under more or less tension by expanding the annular block, or increasing its diameter slightly.

Preferably, the movable electrode 21 of Figs. 3 to 8 is formed of a very narrow, thin, strip of medium-hard phosphor bronze or any other suitable material, being, in fact, even narrower and thinner than the corresponding strip of Figs. 1 and 2, and again having its free, opposed edges 21*a* and 21*b* extending across the stationary electrode 19. In this modification of my invention, the strip 21 may have a thickness of about 1½ mils and a width of about $\frac{1}{16}$ inch. The purpose of making the electrode 21 so narrow is to make overlapping portions of the two electrodes as small as possible consistent with the desired results. The needle 27 of this form of my invention extends entirely across the strip 21 and terminates, as above, in the needle tip 27*a* beyond the lower edge 21*a* of the movable electrode. The other end of the needle 27 extends beyond the upper edge 21*b* of the movable electrode and terminates in a relatively long shank 27*b* which is secured to an anchoring block 67 held in place on the annular supporting block 3, as by a screw 69, best shown in Fig. 8. This arrangement, like the flange 21*c* of Figs. 1 and 2, confines the upper edge 21*b* of the movable electrode against movement to a greater extent than the lower edge 21*a* thereof, and confines the movement of the movable electrode substantially to a region thereof in the vicinity of the needle 27. An inspection of Fig. 8 will clearly reveal why this is so. Although rigid torsionally, the needle 27 is flexible in all directions. Consequently, when it is actuated by a groove laterally of the electrodes, that is, in a direction normal to the planes of the two electrodes, the needle will be caused to flex into a position illustrated by the dotted lines of Fig. 8, pivoting substantially about the adjacent, lower edge of the block 67 as a center. In such movement, it is obvious that the lower edge of the electrode 21 must move a greater distance than the upper edge 21*b* thereof. Furthermore, since the strip 21 is anchored at its ends, only substantially the mid-portion thereof in the region where the needle 27 is secured thereto (that is, the region bounded substantially by the edges 21*a* and 21*b* and the dotted lines A—A) will vibrate to any appreciable extent and sufficient to cause an appreciable change in capacity of the capacitor unit. The operation of this form of my invention is precisely like that of the first described form, but has a response up to between 25,000 and 30,000 cycles, whereas the modification of Figs. 1 and 2 has a response of only up to about 10,000 to 12,000 cycles.

Although I have shown and described but two embodiments of my invention it will be apparent to those skilled in the art that many other modifications thereof, as well as changes in those described, are possible without departing from the spirit of the invention. Therefore, I do not wish to be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. A phonograph record signal translating device comprising a pair of cooperating electrodes spaced from each other by a dielectric and constituting a capacitor, a needle carried by one of said electrodes and having a free end adapted to cooperate with a record, said needle being unconfined for free movement between its said free end and its point of attachment to said one electrode, said last named electrode being mounted for movement relative to the other of said electrodes in response to movements imparted to said needle by the record whereby to vary the capacitance of said capacitor, means confining the movement of said movable electrode substantially to a region thereof in the vicinity of said needle, and means for placing said movable electrode under more or less tension whereby to vary the natural period thereof.

2. A phonograph record signal translating device comprising a pair of cooperating electrodes spaced from each other by a dielectric and constituting a capacitor, one of said electrodes comprising a thin, flexible member mounted for movement relative to the other of said electrodes, a needle carried by said first named electrode and having a free end adapted to cooperate with a record to vibrate said first named electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, said needle being unconfined for free movement between its said free end and its point of attachment to said movable electrode, means for confining the vibratory movement of said first named electrode substantially to a region thereof in the vicinity

of said needle, and means for placing said movable electrode under more or less tension whereby to vary the natural period thereof.

3. A phonograph record signal translating device comprising a pair of cooperating electrodes spaced from each other by a dielectric and constituting a capacitor, one of said electrodes comprising a thin, flexible member mounted for movement relative to the other of said electrodes, a needle carried by said first named electrode adapted to cooperate with a record to vibrate said first named electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, and means comprising a portion of said first named electrode for confining the vibratory movement thereof substantially to a region in the vicinity of said needle.

4. A phonograph record signal translating device comprising a relatively fixed and a relatively movable electrode, said electrodes being spaced from each other by a dielectric and constituting a capacitor, said movable electrode comprising a thin, flexible member including a pair of opposed edges, a needle carried by said movable electrode adjacent one of said edges, said needle being adapted to cooperate with a record to vibrate said first named electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, and means for stiffening the other of said edges whereby to render said movable electrode more freely movable adjacent its needle carrying edge than along said other edge.

5. A phonograph record signal translating device comprising a relatively fixed and a relatively movable electrode, said electrodes being spaced from each other by a dielectric and constituting a capacitor, said movable electrode comprising a thin, flexible member including a pair of opposed edges, a needle carried by said movable electrode adjacent one of said edges, said needle being adapted to cooperate with a record to vibrate said first named electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, and means formed integrally with said movable electrode along the other of its said edges for stiffening said other edge whereby to render said movable electrode more freely movable adjacent its needle carrying edge than along said other edge.

6. A phonograph record signal translating device comprising a relatively fixed and a relatively movable electrode, said electrodes being spaced from each other by a dielectric and constituting a capacitor, said movable electrode comprising a thin, flexible member including a pair of opposed edges, a needle carried by said movable electrode adjacent one of said edges, said needle being adapted to cooperate with a record to vibrate said first named electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, and a flange on said movable electrode along the other of its said edges for stiffening said other edge whereby to render said electrode more freely movable adjacent its needle carrying edge than along said flanged edge.

7. The invention set forth in claim 6 characterized in that said movable electrode is formed of flat, sheet material, and characterized further in that said flange is formed by bending said material out of its plane along a marginal portion adjacent said other edge.

8. A phonograph record signal translating device comprising a pair of cooperating electrodes spaced from each other by a dielectric and constituting a capacitor, one of said electrodes comprising a thin, flexible member mounted for movement relative to the other of said electrodes and including a pair of opposed, free edges, a needle carried by said first named electrode adapted to cooperate with a record to vibrate said first named electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, and means for so confining the movement of said movable electrode in response to said needle that one of its said edges will move to a greater extent than the other of its said edges.

9. A phonograph record signal translating device comprising a pair of cooperating electrodes spaced from each other by a dielectric and constituting a capacitor, one of said electrodes comprising a thin, narrow, flexible strip mounted for movement relative to the other of said electrodes and including a pair of opposed, free edges, a needle carried by said movable electrode adapted to cooperate with a record to vibrate said movable electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, said needle extending across said movable electrode beyond said free edges thereof and terminating in a shank beyond one of said edges, and means anchoring said shank whereby said last named edge is confined against movement to a greater extent than the other of said edges in response to movement of said needle.

10. In a phonograph record signal translating device, the combination of a supporting member, a pair of cooperating electrodes carried by said member and having an air gap therebetween whereby to constitute a capacitor, one of said electrodes comprising a stationary plate and the other of said electrodes comprising a flexible strip movably mounted on said supporting member for movement toward and away from said stationary electrode and having a pair of opposed, free edges, a needle carried by said movable electrode for cooperation with a record to vibrate said movable electrode relative to said stationary electrode in accordance with movements imparted thereto by the record and thereby to correspondingly vary the capacitance of said capacitor, and means for so confining the movement of said movable strip in response to said needle that one of its said edges will move to a greater extent than the other of its said edges.

11. The invention set forth in claim 10 characterized in that said strip is anchored at its ends to said supporting member, said opposed edges extending across said plate between said anchored ends, and characterized further in that said needle is secured to said strip substantially mid-way between its ends.

12. The invention set forth in claim 10 characterized by the addition of means on said supporting member for placing said strip under more or less tension whereby to vary the natural period thereof.

13. The invention set forth in claim 10 characterized by the addition of means on said supporting member for adjusting the position of said plate electrode whereby to vary the normal air gap between said electrodes.

14. The invention set forth in claim 10 characterized in that each of said electrodes is coated with a dielectric material.

15. The invention set forth in claim 10 characterized in that said confining means is constituted by a flange formed on said strip along a marginal portion adjacent one of its edges.

16. The invention set forth in claim 10 characterized in that said needle extends across said strip beyond its said opposed edges, said needle terminating in a shank beyond one of said edges, and characterized further in that said confining means is constituted by an anchoring member on said supporting member to which said needle shank is secured.

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