Sept. 27, 1949. J. F. GORDON 2,483,196

PHONO-PICKUP

Filed April 11, 1947

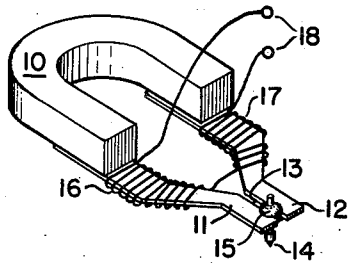

FIG. 1

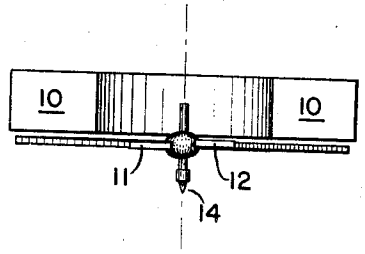

FIG. 2

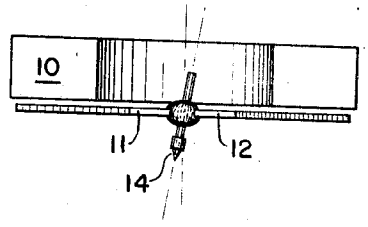

FIG. 3

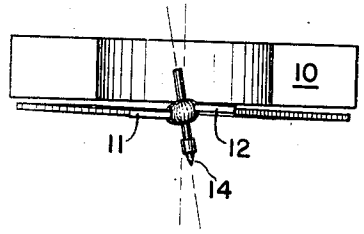

FIG. 4

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PHONO-PICKUP

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5 Claims. (Cl. 179—100.41)

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This invention is directed to phonograph pickups. More specifically it is directed to magnetic phonograph pickups of the type employing the modulated flux gap or variable reluctance principle.

There are many ways whereby the intelligence recorded on a conventional phonograph record by mechanical deformation or spatial modulation of a continuous groove or channel may be reproduced. The chief methods in use at this time use a sharp-pointed stylus which cooperates with the modulated groove in such a fashion as to mechanically displace the active elements of an electromechanical transducer, or, as it is more commonly termed, a phonograph pickup. The active or generating element in the pickup is often a piezoelectric crystal which generates a small electric current when its mechanical dimensions are altered, or often small coil of wire situated in a magnetic field. The piezoelectric type is usually referred to simply as a crystal pickup, and has found wide application.

The piezoelectric crystal used in such crystal pickups is unfortunately subject to considerable variation of its dynamic characteristics under varying conditions of temperature and humidity. This fact, among others, has accelerated the development of other types of pickups.

The magnetic pickup, as described above, is closely analagous to the conventional dynamo-electric generator of the type employing a permanent magnet to supply its field excitation, and a phonograph stylus to supply the relative motion between the armature, in this case a coil of wire, and the magnetic lines of force. As can be understood from the foregoing analogy, the construction of such a magnetic pickup is usually difficult and expensive if best results are to be obtained.

It is an object of this invention to provide a phonograph pickup which is not affected by changes of ambient temperature.

It is a further object of this invention to provide a phonograph pickup which is not affected by the relative humidity of its environment.

It is a further object of this invention to provide a magnetic phonograph pickup of simple construction.

It is a further object of this invention to provide a magnetic phonograph pickup having good vertical compliance.

These objects are attained by the use of fixed pickup coils associated with a magnetic circuit the reluctance of which is varied by a phonograph stylus.

The above and further objects and novel features will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for purposes of illustration only,

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and are not intended as a definition of the limits of the invention, reference for this purpose being had to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 illustrates one embodiment of the instant invention, and

Figs. 2, 3, and 4 are end views of the Fig. 1 arrangement showing the mechanical operation thereof.

Referring now to Fig. 1, there is illustrated a horseshoe magnet 10 having strips 11 and 12 secured to the arms thereof. The strips 11 and 12 are shaped to provide a narrow gap 13 between them, and a stylus 14 is elastically affixed to the strips 11 and 12 by a molded rubber piece 15. The stylus 14 is bonded to the piece 15 which is in turn bonded to the strips 11 and 12. A pair of pickup coils 16 and 17 are helically wound on the arms 11 and 12 respectively, and are connected in series. A pair of output terminals 18 are connected to the extremities of the single winding thus formed.

In Fig. 2 the relative juxtaposition of the ends of the strips 11 and 12 at the gap 13 may be seen in greater detail. It will be noticed that the strips 11 and 12 are not coplanar, but that one of the strips, in this case strip 12 is slightly higher than the edge of the strip 11 when the stylus 14 is in a vertical position. This is the rest position that the assembly maintains when no lateral force is applied to the stylus 14.

Analyzing the magnetic circuit now, where:

K=strength of the magnet 10
l_1=length of the magnet 10
l_2=total length of the strips 11 and 12
l_3=length of the gap 13
A_1=cross sectional area of the magnet 10
A_2=mean cross sectional area of the strips 11 and 12
A_3=cross sectional area of the gap 13
μ_1=permeability of the magnet 10
μ_2=permeability of the strips 11 and 12
μ_3=permeability of the gap 13
F=magnetic flux density surrounded by the coils 16 and 17.

$$F=\frac{K}{\frac{l_1}{\mu_1 A_1}+\frac{l_2}{\mu_2 A_2}+\frac{l_3}{\mu_3 A_3}} \quad (1)$$

Inspecting the above expression it will be seen that the only dimension changed by movement of the stylus 14 is l_3, the length of the gap 13 we may extract the first derivative of the expression with respect to l_3 and we have:

$$\frac{dF}{dl_3}=1 \quad (2)$$

or

$$dF=dl_3 \quad (3)$$

Which tells us that the change in magnetic flux surrounded by the coils 16 and 17 is a linear function of the changes of dimension of the gap 13. It will be seen from Figs. 3 and 4 that l_3 will be minimum when the stylus is deflected to the left, as in Fig. 3, and will reach a maximum when it is deflected to the right as in Fig. 4.

Considering now the voltage induced in the coils 16 and 17, by the law of induction

$$E=\frac{dF}{dt} \quad (4)$$

but, by Equation 3

$$dF=dl_3 \quad (3)$$

so

$$E=\frac{dl_3}{dt} \quad (5)$$

which states that the potential in the coils 16 and 17, or the potential available at the terminals 18 is equal to the time rate of change of deflection of the stylus. This is the same as the equation for the action of a conventional magnetic pickup.

Of course the strips 11 and 12 must be quite flexible to allow easy deflection of the stylus 14 by the record groove, and the piece 15 must be sufficiently resilient to prevent the generation of spurious mechanical modes. The piece 15 may serve the dual purpose of a mechanical linkage and mechanical damping.

Although only one embodiment of the present invention has been illustrated and described in detail, it is to be understood that the invention is not limited thereto. Various changes may be made in the design and arrangement of the parts without departing from the scope and spirit of the invention as the same will now be understood by those skilled in the art. For a definition of the limits of the invention reference will be had primarily to the appended claims.

What is claimed is:

1. In a phonograph pickup: a permanent magnet; a pair of resilient elements of magnetic material, one affixed to each pole of the said magnet, said elements terminating in flat portions lying in close proximity and forming a gap in an otherwise complete magnetic circuit, corresponding major surfaces of said portions defining spaced mutually parallel planes when said portions are in a position of rest, said elements being resilient only in directions normal to said planes; a stylus; and means cooperatively securing said stylus to said portions in a manner such that displacement of said stylus in a plane perpendicular to said major surfaces varies the spacing of said planes, said means comprising a body of resilient material formed around said stylus and bearing on the adjacent edges of said portions.

2. In a phonograph pickup: a permanent magnet; a pair of flat resilient elements of magnetic material, one affixed to each pole of said magnet, said elements terminating in mutual proximity to form a gap in an otherwise complete magnetic circuit, corresponding major surfaces of the terminating portions of said elements defining spaced mutually parallel planes when at rest; a stylus; and means resiliently securing said stylus between said portions with its axis lying in a plane substantially perpendicular to said planes, said means comprising a body of resilient material positioned between and bonded to said portions and having said stylus embedded therein, whereby movement of the point of said stylus laterally with respect to said portions in one direction progressively reduces the size of said gap while movement in the opposite direction progressively increases the size of said gap.

3. The combination as set forth in claim 2, said elements each having a coil formed around it, said coils being connected in series.

4. In a phonograph pickup: a permanent magnet; a pair of flat resilient elements of magnetic material, one affixed to each pole of said magnet, said elements terminating in mutual proximity to form a gap in an otherwise complete magnetic circuit, corresponding major surfaces of the terminating portions of said elements defining spaced mutually parallel planes when at rest; a stylus; and a resilient member surrounding and being bonded to said stylus; said resilient member spanning the space between said portions and supporting said stylus between said portions with its axis lying in a plane substantially perpendicular to said parallel planes, said resilient member transmitting force to said portions in response to lateral movement to said stylus, whereby movement of the point of said stylus laterally with respect to said portions in one direction progressively reduces the size of said gap while movement in the opposite direction progressively increases the size of said gap.

5. The combination as set forth in claim 4, said elements each having a coil formed around it, said coils being connected in series.

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