April 28, 1936. A. F. SYKES 2,038,687

ACOUSTIC TRANSLATING DEVICE

Filed March 13, 1935 5 Sheets-Sheet 1

Fig. 1.

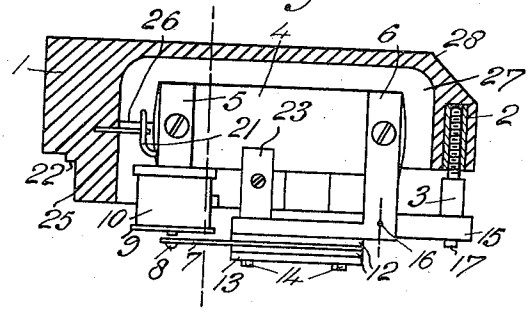


Fig. 2

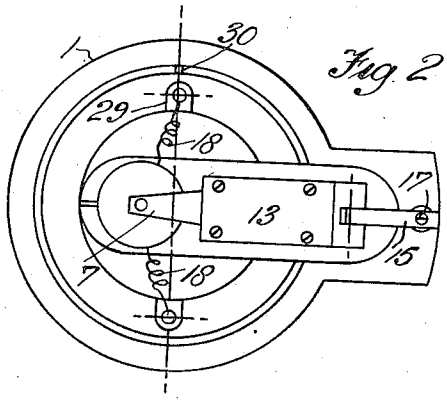


Fig. 3.

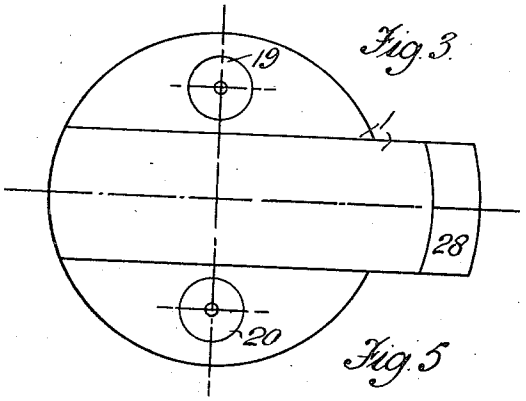


Fig. 4.

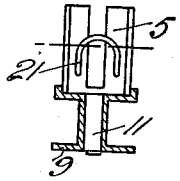


Fig. 5

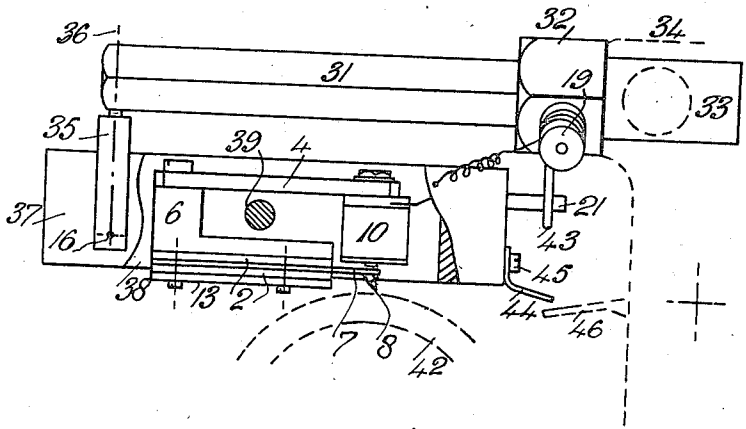
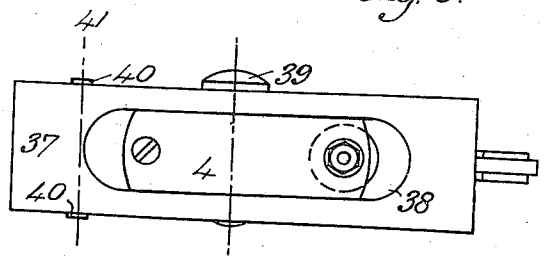


Fig. 6.



Inventor:
Adrian Francis Sykes;
By his attorneys,
Baldwin & Wight

April 28, 1936. A. F. SYKES 2,038,687

ACOUSTIC TRANSLATING DEVICE

Filed March 13, 1935 5 Sheets-Sheet 2

Fig. 7.

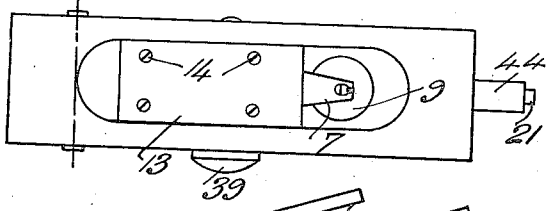


Fig. 8.



Fig. 9.



Fig. 10

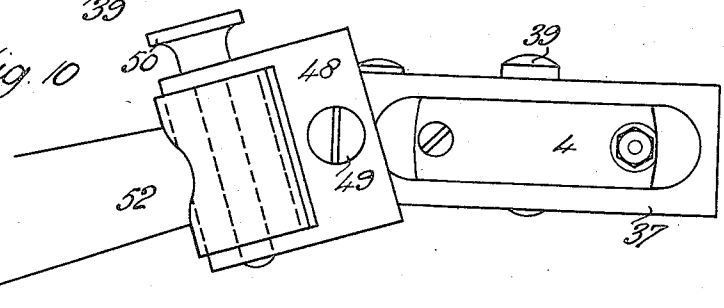


Fig. 11.

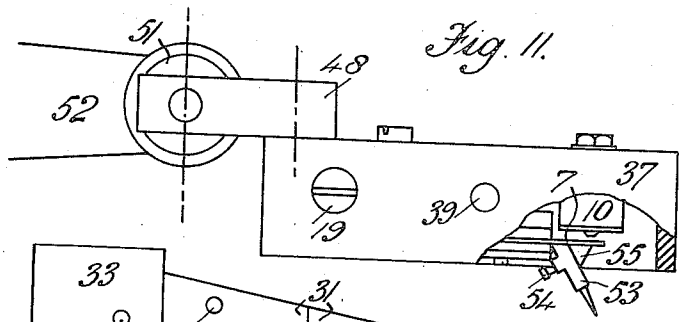


Fig. 12.

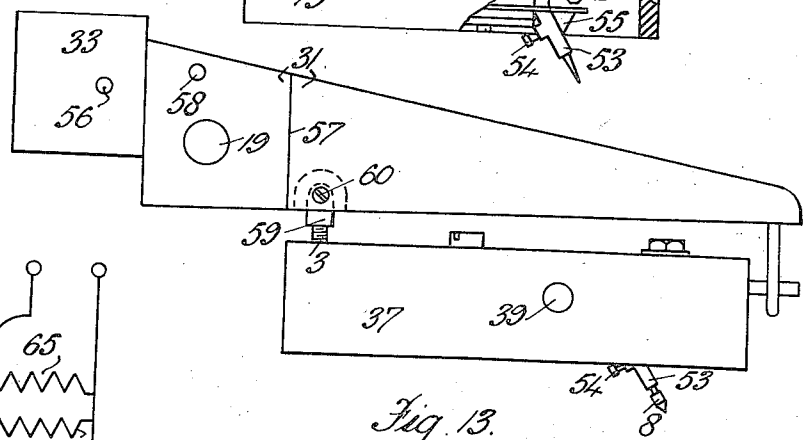


Fig. 14

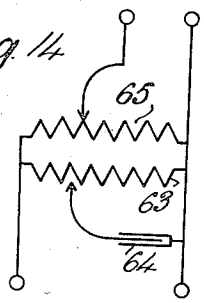
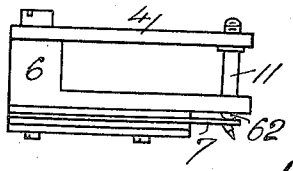


Fig. 13.



Inventor:
William Francis Sykes
By his Attorneys,
Baldwin & Wight

April 28, 1936. A. F. SYKES 2,038,687

ACOUSTIC TRANSLATING DEVICE

Filed March 13, 1935. 5 Sheets-Sheet 3

Fig. 15.

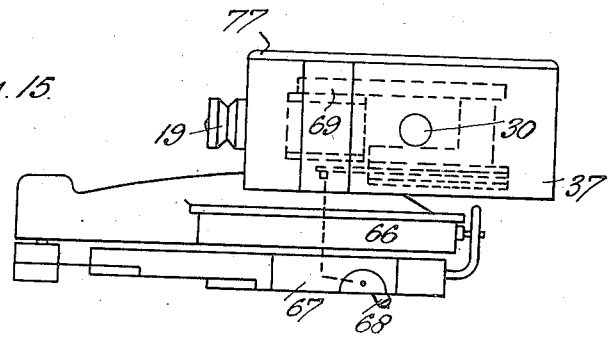


Fig. 16.

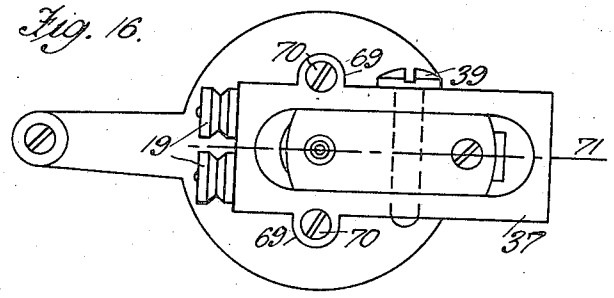


Fig. 17.

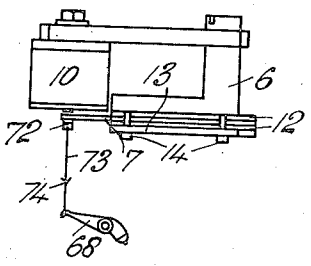


Fig. 18.

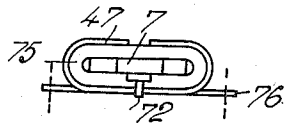


Fig. 23



Inventor:
Adrian Francis Sykes,
By his attorneys,
Baldwin & Wight

April 28, 1936. A. F. SYKES 2,038,687

ACOUSTIC TRANSLATING DEVICE

Filed March 13, 1935 5 Sheets-Sheet 4

Fig. 19.

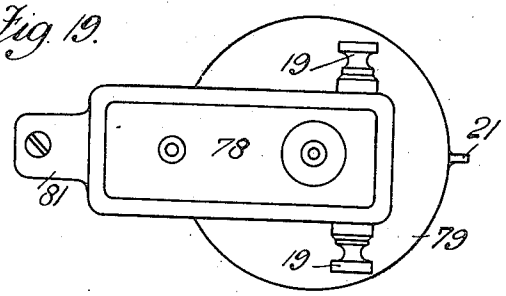


Fig. 20.

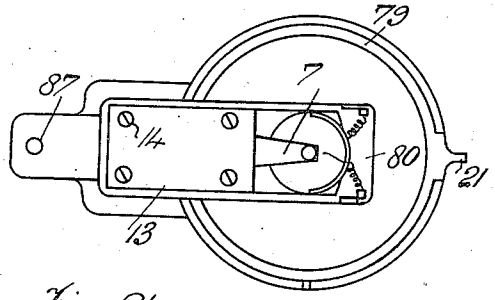


Fig. 21.

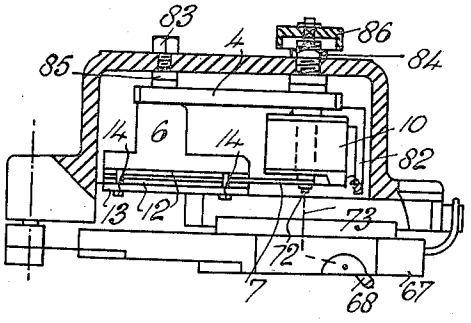
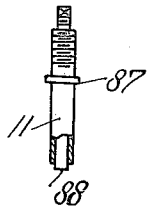


Fig 22



Inventor:
Adrian Francis Sykes;
By his Attorneys,
Baldwin & Wight

April 28, 1936. A. F. SYKES 2,038,687

ACOUSTIC TRANSLATING DEVICE

Filed March 13, 1935 5 Sheets-Sheet 5

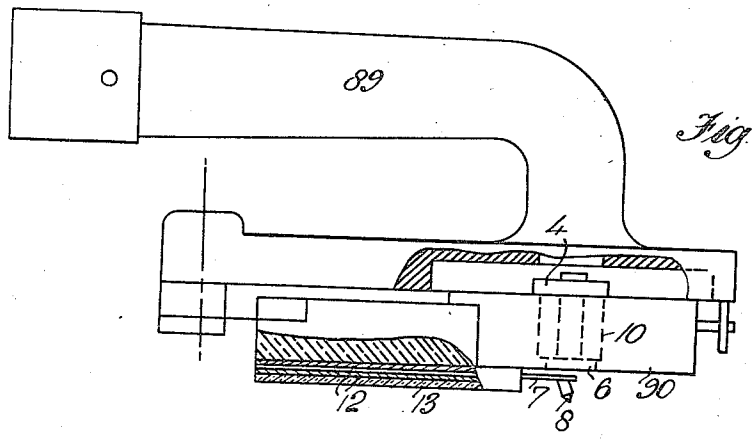


Fig. 24.

Fig. 25.

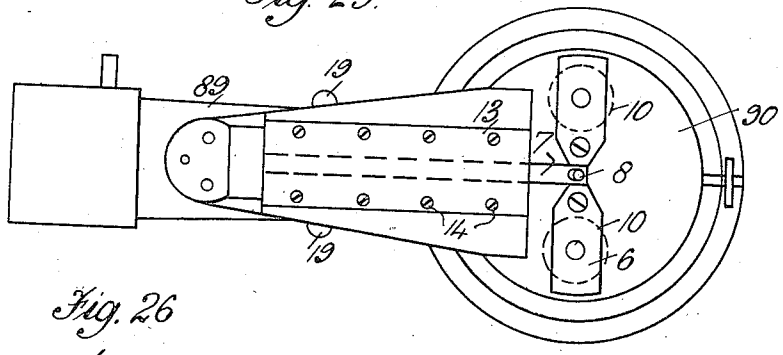


Fig. 26

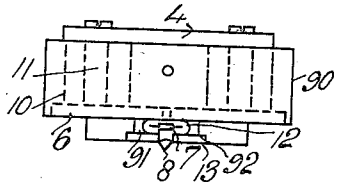


Fig. 27.

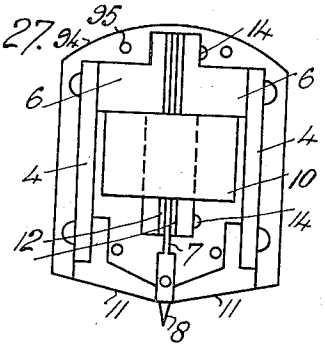
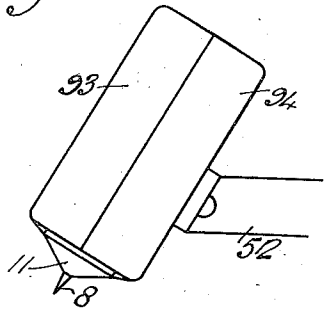


Fig. 28.



Inventor:
Adrian Francis Sykes,
By his attorneys,
Baldwin & Wight

Patented Apr. 28, 1936

2,038,687

UNITED STATES PATENT OFFICE

2,038,687

ACOUSTIC TRANSLATING DEVICE

Adrian Francis Sykes, St. Albans, England

Application March 13, 1935, Serial No. 10,922
In Great Britain March 15, 1934

16 Claims. (Cl. 179—100.41)

This invention relates to acoustic translating devices and more specifically to devices for translating sound frequency electric currents or voltages into mechanical movements for recording gramophone or phonograph records and to devices for translating recorded gramophone or phonograph records into sound frequency electric currents or voltages. Translating devices of the former type are generally termed "recording devices" and devices of the latter type are generally termed "pick-up devices".

Talking machine records as commonly used hitherto fall into one or other of two classes (1) gramophone records and (2) phonograph records. In the former class what is termed "lateral cut" is employed, i. e., the sound wave form recorded is lateral so that the recorded groove is a wavy groove with waves at right angles to its general direction while in the latter class what is termed "hill and dale cut" is employed, i. e., the depth of the groove is varied in dependence upon the acoustic waves recorded. The present invention is applicable to talking machine pick-ups and recorders for picking up from or recording records of either class.

The usual practice in present day design of talking machine pick-ups and recorders is to make the armature which carries the pick-up or recording stylus (as the case may be) as rigid as possible so that it vibrates as nearly as possible as a whole. Almost always the said armature will have at least one resonance within the acoustic frequency range to be handled and it is usual to avoid (so far as is possible) disproportionate response at and near such resonances by providing damping material such as rubber, to bear upon the armature at some suitable point or points in its length; e. g. in the case of a pivoted armature, the pivot may be surrounded by damping material. Pick-ups and recorders so designed, however, leave much to be desired in the matter of uniform response over a wide frequency range and sensitivity and although, by very careful manufacture it is possible to obtain fairly uniform response over a reasonably wide acoustic frequency range, known pick-ups and recorders have had to be made undesirably expensive in construction if they are to be both insensitive and able to handle a wide range of frequencies without appreciable distortion.

The main object of the present invention is to avoid the difficulties and disadvantages hitherto met with in known talking machine pick-ups and recorders and to provide improved pick-ups and recorders of simple and cheap construction, good sensitivity and high fidelity over a wide acoustic frequency range.

In accordance with this invention the above mentioned general principle of design is discarded and instead there is employed an armature which is sufficiently flexible to have sound frequency waves set up therein. This armature is so mounted that the sound energy to be recorded or picked-up (as the case may be) causes sound wave flexure to occur with the particle displacement at right angles to the direction of length of the armature (i. e., the armature has transverse or "bending" or "twisting" sound waves set up therein as distinct from tension and compression waves) and the waves thus set up in the armature are damped down by rubber or like material which is held in contact with the sides of the said armature over a substantial portion (at least half) of its length, the movements of the undamped end of the armature being utilized for recording or for generating electric waves (as the case may be) and the said armature being supported solely through the intermediary of the damping material.

The necessary translation of electric waves into mechanical movements of the undamped end of the armature (for recording) or vice versa (for picking up) may be accomplished in any manner well known per se; for example the end of the armature may extend into an air gap of a permanent magnet and be itself of ferro-magnetic material so that movement of the said end varies the gap and thus induces currents in a coil wound about a limb of the magnet while conversely currents fed to the coil will cause movement of the said end; or a balanced magnet system may be used and the end of the armature arranged between the poles thereof; or the end of the armature may project into a gap in a magnetic system and be itself surrounded by a coil in which currents will be induced by movement of the said end or vice versa. As these and other forms of associated magnet systems are all well known, per se, in pick-up and recorder practice, and form, per se, no part of the present invention, it is not thought necessary to describe them individually further herein. In this connection it is to be understood that any of the embodiments of the invention to be hereinafter illustrated and described may be modified by substituting any known means (other than those shown) for translating movements of the armature end into electric currents or voltages or vice versa. Also all those illustrated embodiments which are adapted for working with

phono-cut (and vice versa) could be modified for working with gramophone cut merely by re-arranging the stylus or the like to take into account the different directions of the cut.

The invention is illustrated in the accompanying drawings in which:—

Figures 1, 2 and 3 are respectively an elevation in part section, a plan from beneath and a plan from above illustrating an electromagnetic pick-up, suitable for use with a cylinder phonograph with a feed carriage—such for example as the well known Edison standard phonograph.

Figure 4 is a view of the end of the polar extension 5 of Figures 1 to 3 showing the U shaped wire 21, the bobbin 9 in section and the chamfered cylindrical pole 11.

Figures 5, 6 and 7 are views in part sectional elevation, top and bottom plan respectively of a pick-up for use with phonographs of the travelling mandrel type.

Figure 8 is a plan view of the armature 7 of Figures 5 to 7 and

Figure 9 shows a detail modification which consists in replacing the rubber strips 12 of Figures 5 to 7 by a rubber tube 47.

Figures 10 and 11 are respectively a view from above and a side elevation of a pick-up used with the tone arm of a "goose-neck" gramophone.

Figure 12 illustrates a form of the invention as applied to the well known Edison diamond disc phonograph.

Figure 13 represents an embodiment utilizing a moving coil.

Figure 14 is a circuit diagram.

Figures 15 and 16 are a side view and a plan of an embodiment of the invention as fitted to an Edison diamond B reproducer.

Figure 17 illustrates the pick-up movement proper of Figures 15 and 16.

Figure 18 shows an alternative method for holding the armature of Figures 15 to 17.

Figures 19, 20 and 21 are respectively a view from above, a view from beneath, and a view in part section of another embodiment. In Figure 19 the floating weight depicted in Figure 21 is omitted as is also the case in regard to Figure 20.

Figure 22 illustrates the method of polar adjustment used in Figures 19 to 21 but is not to scale, being merely explanatory.

Figure 23 shows a preferred way of forming a driving cord such as the transmission device or cord of Figures 19 to 21.

Figures 24, 25 and 26 represent respectively an elevation in part section, a plan from beneath and an end view respectively of an embodiment of the invention as applied to the conversion of an existing mechanical reproducer to act as an electric pick-up.

Figures 27 and 28 show respectively a face view with cover removed and a side external view of a pick-up embodying the invention and adapted to operate with lateral cut records.

Referring first to Figures 1 to 3, 1 is a shell or housing moulded e. g. from the material known under the registered trade-mark "Bakelite" and provided with a threaded bush 2 in which is screwed so as to be freely rotatable therein, a screwed stud 3 which provides for the requisite freedom of movement for the pick-up movement proper. The magnetic structure of this movement comprises a fifteen per cent cobalt steel bar magnet 4 with slotted polar extensions 5 and 6 and an armature 7 cut from hacksaw steel 0.025 inch thick, to which is soldered the brass holder 8 of the diamond stylus normally provided in Edison standard phonographs. A bobbin 9 and winding 10 is friction tight on the cylindrical portion 11 of the polar extension 5. The armature 7 is clamped in position between rubber strips 12 by a copper plate 13 through which pass four screws which enter the polar extension 6 as at 14. By adjusting these screws the degree of clamping can be adjusted. A small bar 15 enters a slot in the polar extension 6 and a pin or axis 16 passes through the said bar so that the polar extension 6 and the bar 15 can pivot relatively to one another about the axis 16. The other end of the bar 15 is clamped to the rotatable stud 3 by the screw 17. Fine wire leads 18 which are preferably coiled as shown extend from the ends of the coil or winding 10 to terminals 19 and 20. A bent U shaped wire 21 pressed into holes in the extension 5 engages with a limit stop 22 and thus limits the movement of the pick-up proper relatively to the housing 1. A split strut 23 tightened by the screw 24 serves to brace together the magnetic structure. The housing 1 is turned at 25 to a diameter of approximately two inches to fit the normally provided ring of the feed carriage of an Edison standard phonograph and is counterbored inside up to the line 26 to provide clearance for the pick-up and for its necessary range of movement, and is recessed to form the elongated slot 27. The housing 1 is chamfered sufficiently at 28 to allow the instrument to remain in the phonograph with the usual dust cover in place and is recessed as at 29 to protect the junction of the fine wire connections with the terminals. A small depression 30 registers with a pin on the normal Edison feed carriage to secure ready location. About 5300 turns of wire are wound on the bobbin giving a resistance of 1000 or thereabouts, but, of course, if required e. g. if a transformer is to be used with the pick-up a so-called low resistance coil can be used. As previously stated Figure 4 is a view of the end of the polar extension 5 of Figures 1 to 3 showing the U shaped wire 21, the bobbin 9 in section and the chamfered cylindrical pole 11. Figures 5, 6 and 7 are views in part sectional elevation top and bottom plan respectively of a pick-up for use with phonographs of the travelling mandrel type. Here a hexagon rod 31 is screwed into a larger hexagon member 32 turned as at 33 so as to enter the reproducer post 34 which is indicated by the dotted line circle. A bracket 35 swivelled (in virtue of the screwed stud shown) about the axis 36 supports the housing 37 which is slotted at 38 to receive and clamp the pick-up mechanism by the screw 39 in adjustable relation. Brass bushes 40 are inserted to maintain a slight clearance between the limbs of the bracket and the housing. The bracket supports the housing by a pin 16 so that it is free to move about the axis 41 and follow the eccentricities of the record 42, shown dotted, as it rotates. A limit pin 21 in association with the U shaped wire 43 and a bent strip of metal 44 attached by a screw 45 engages with the lowering mechanism shown dotted at 46. The actual pick-up differs from that of Figures 1 to 4 only by reason of the horizontal positioning of the magnet as in this case the design is not restricted by the limitations of an already existing feed carriage. Figure 8 is a plan of the armature 7 and Figure 9 shows how the rubber strips 12 can conveniently be replaced by a rubber tube 47. Ripples of vibration in the armature are absorbed in the damping (12 or 47 as the case may be) as they travel along the armature and any reflected ripples from the end of the arma-

ture are similarly damped. As the armature does not touch the polar extension 6 the magnetic continuity is obtained by the large area air gap separating the armature 7 from the polar extension 6. The gap between the armature and the wound pole tip is not of a minute order and the vibration from the record is only a small fraction of this dimension, consequently the adjustment is not critical. In a practical example constructed as shown in Figures 5 to 7 the weight on the diamond point was about two ounces and a quarter as against about one ounce and a quarter for an actual pick-up constructed as illustrated in Figures 1 to 4.

Figures 10 and 11 are respectively a view from above and a side elevation of a pick up used with the tone arm of a "goose neck" gramophone. In this case an instrument of the type shown in detail in Figures 5 to 7 is screwed to the bifurcated member 48 by the screw 49 and a screwed pin 50 clamps the member 48 to a trunnion 51 with just sufficient clearance to permit free up and down movement. As shown the armature is equipped with a stylus holder 53, tightening screw 54 and web 55 arranged for a needle stylus (as shown) or for a diamond tipped stylus. This instrument when equipped with a diamond can reproduce e. g. from the well known Edison diamond discs or, by changing to a steel needle it can reproduce from a record such as that described and claimed in my British Patent No. 303,759. The weight on the point was, in a practical example, just over three ounces.

Figure 12 illustrates a form of the invention as applied to the well known Edison diamond disc phonograph.

A cylindrical portion 33 with registration pin 56 is provided to enter the reproducer post (not shown). To this portion is attached, as for instance by silver soldering, an arm 31, either solid or as a shell, hinged at 57 with hinge pin 58. This arm supports the pick-up housing as shown in a manner very similar to that of Figure 5 except that in this case the requisite two degrees of freedom are obtained by means of a trunnion 59 set between pivot screws as at 60 within the recess 61 and the screwed stud 3 (as in Figure 1). The function of the hinged arm 31 is to allow the pick-up to be swung up for changing a steel needle or for adjustment. Where reproduction is to be effected only by a permanent jewel provision for allowing such swinging up is more or less superfluous.

Figure 13 shows an embodiment generally similar to those already described but using a moving coil. Here the polar arrangement takes the form of the widely known annular magnetic gap with circular coil located therein. A coil drive element 62 is riveted to the armature holder 7 which may or may not be metallic.

Figure 14 is a diagram showing a shaping and control circuit comprising a resistance 63 across the pick up a condenser 64 variably tapped upon the resistance 63 and a potentiometer resistance 65 acting as a volume control. The pick-up terminals are connected to the lower terminals in Figure 14 and the input terminals of the reproducer amplifier are connected to the other terminals in Figure 14. It is found in practice that with pick-ups as above described the upper audio range is sufficiently strongly reproduced as to be regarded as excessive when such a pick-up is used in conjunction with an ordinary moving coil loudspeaker. Hence it is desirable to load the pick-up by the resistance 63 which may take the form of a graphited surface and may be of the order of 50,000 ohms for use with an instrument as described with reference to Figures 1 to 4. The action of the resistance load can be supplemented to a desired extent by the condenser 64 which may have a capacity of the order of 0.01 microfarad for example.

Instead of an armature of the type illustrated I may find it desirable for some purposes to adopt the general principle of the double pole telephone receiver and allow a small piece of iron attached to an armature holder to bridge the magnetic gap. The holder of the armature would be supported and disposed in a manner similar to that described for the member 7 illustrated.

Furthermore I may use an armature as illustrated but set between magnetic poles, the armature acting as a magnetic potentiometer finger between the flux in the magnetic gap and the neutral section of the magnet with a winding encircling the armature or central magnetic path. In any event the armature would be impulsed as above described i. e. in the immediate vicinity of the poles. For phonocut records either disc or cylinder the vibration could be transmitted by the floating weight method with cord and lever as well known per se, while for ordinary gramophone records a short stylus or semi-permanent type could be set in a local thickening of the armature.

Figures 15, 16 and 17 relate to a pick-up designed to operate in conjunction with an Edison phonograph. As will be seen, in this embodiment, substantially all the parts of the existing reproducer with the exception of the diaphragm are utilized, but the top of the reproducer shell, principally the short tubular portion communicating with the normally provided horn, is cut away, and on the reproducer shell so modified is mounted an apparatus in all essential particulars identical with the floating pick-up illustrated in Figure 5 above.

Referring first to Figures 15 and 16 the reproducer comprises as main parts a shell 66, floating weight 67 and stylus lever 68. The top of the shell is cut away and the central hole suitably enlarged or trimmed up to bed the pick-up housing 37 with cover 77 which are both moulded e. g. in the material known under the registered trademark Bakelite, or in ebonite. This housing has protuberances 69 to accommodate screws 70 for securing the housing to the reproducer shell. A screw 39 clamps the magnetic structure of the pick-up in adjustable relation to the housing. This magnetic structure is indicated in dotted fashion in Figures 15 and 16 but is shown more fully in Figure 17. Terminals 19 communicate with the coil 10 of the pick-up. The housing may be made in halves joining along the centre line 71 in which case the top or lid may be formed in the moulding if desired. The pick-up movement proper (see Figure 17) consists of a cobalt steel magnet 4 a polar extension 6 a winding 10 on a suitable bobbin, an armature 7 clamped between ruber sheets as at 12 or alternatively set in a rubber tube, a clamping plate 13 of copper or German silver and four screws as at 14 for attaching and adjusting the plate. At or near the end of the armature 7 is soldered a brass crosshead 72 to which is attached the loop of thread 73 knotted at 74 engaging with the stylus lever 68. The magnetic flux passes into the armature by the large area leakage path.

Figure 18 shows an alternative method for holding the armature of Figures 15 to 17. Here the chamfered end of the armature 7 (the armature itself is set in a tube of rubber or folded sheet 47 corresponding to the rubber 12 of Figure 17) is ripped in the sheet iron holder 75 with a suitable number of holding down tabs as at 76 pressed out of the material itself and adapted for screwing the sheet iron holder to the polar extension 6. By squeezing the sheet iron the armature can be adjusted with reference to the wound pole. Adjustment of effective pole area by traversing the armature so that it does not completely mask the pole takes into account the thickness of the armature material.

Figures 15, 16 and 17 are drawings made from a model which was experimentally tested. The armature was of softened hard steel 25 mils thick and one quarter of an inch wide tapered to about one eighth of an inch. These figures are purely illustrative and are capable of considerable variation; e. g. an armature of about two-thirds the stated thickness or of about half the stated width may be used with apparently beneficial results as to the efficiency of the damping material (12 or 47). For reproduction from wax records it may be found desirable to adopt even smaller values and where necessary use a great degree of electrical amplification. Reduced thickness apparently allows the ripples set up in the armature to be spaced closer together for a given frequency and perhaps therefore contributes to the efficiency of the damping channel. This method of damping employed (contrary to sound-box practice) provides a much extended length of damping path. The waves or ripples set up apparently travel the length of the armature, are reflected from the end and return along the armature in attenuated form. It is found that the smaller armatures with a given transmission link 73 (e. g. cotton) require a condenser of greater capacity to counteract the enlargement of the high frequencies. It may be desirable to use one of the improved magnetic steels as the material for the armature.

Reproducers with floating weight have been constructed wherein the force exerted by the weight is increased or supplemented by the action of a spring. In this case the floating weight is generally lighter and the practice tends to help in the reproduction from cylinders which are not truly round. Such a method obviously can be applied to the practice of the present invention. It is found that the casual deformities existent in celluloid cylinders in greater or less degree show up in the electric reproduction, as bumping noises, to a much aggravated extent owing to the more adequate response in the bass register. To counteract this defect where necessary or desirable I may insert a series condenser in the pick-up leads in conjunction with a shunt resistance (of say 50,000 ohms) acting as a volume control and to reduce the bass response. Another method is to insert a small pad of rubber between the armature and the bobbin which tends to render the elastic action of the armature less extensive and thus throws the adjustment to low frequency deformities more on the inertia of the floating weight. This electric reproducer can also be used to reproduce from disc records of phono-cut type.

The armature could, of course, be arranged to work between poles on a push pull basis as well known, per se, but it is not thought that much would be gained by this complication in view of the small amplitudes normally prevailing.

If desired an existing double pole or single pole telephone receiver can be incorporated into the design. In particular a receiver as illustrated in my British Patent No. 227,391 with polar adjustment can be readily adapted by securing the armature holder to the post 127 of Figure 1 in that specification with such additional support as may be found suitable. Further the moving coil mechanism of Figure 13 could be substituted. To accommodate any of the foregoing variations it may be preferable to discard the existing reproducer shell and replace by a suitable moulded modification.

Figures 19, 20 and 21 show a construction in which a moulded shell comprises a rectangular hollow portion 78, a circular flange 79 nearly complete but cut away to correspond with the internal recess or slot 80 of the portion 78 and a tail piece 81 which serves to support the conventional, and well known, floating weight system on Edison phonographs. This tail piece projects below the bottom of the recess as above by about five sixteenths of an inch. A projection 21 integral with the moulding acts as a limit pin for the loop of the floating weight. The electromagnetic mechanism is closely similar to that illustrated in Figures 15 to 17. It consists of a cobalt steel magnet 4, a polar extension 6, a winding 10 on a suitable bobbin, an armature 7 clamped between rubber sheets as at 12 or alternatively set in a rubber tube, a clamping plate 13 of copper, German silver, or iron, and four screws as at 14 for attaching and adjusting the plate. At or near the end of the armature 7 is soldered a brass crosshead 72 to which is attached the loop of thread, twisted or otherwise, wire link, cord or other transmission device engaging with the stylus lever 68. The magnetic flux passes into the armature by the large area leakage path and the plate 13 allows the degree of restraint and amount of damping to be controlled. It, that is to say the plate, further permits the polar gap to be varied in the absence of or in conjunction with any other form of adjustment.

The terminals 19 are connected to brass laminæ as at 82 to facilitate soldering of the connections. A ridge is shown on the bobbin for anchoring in holes the fine wires and in Figure 21 this ridge or edging is partly cut away so as not to obscure the drawing. Nuts 83 and 84 support the electromagnetic system within the housing. Distance washers as at 85 provide an element of adjustment and these may be of metal or say vulcanized fibre. I may find it desirable to use soft washers both top and bottom to insulate acoustically to some extent the electromagnetic mechanism from the shell. The floating weight 67 and diamond tipped stylus lever 68 as depicted are representations of existing products and hence the invention while complete in itself is particularly adapted as an attachment for the conversion of existing machines; all that is necessary is for the shell or sound box of the reproducer as used for mechanical reproduction to be removed and replaced by the shell and associated mechanism as described. A cap 86, which may be of brass, engages with the central core of the pole and enables this to be rotated by hand and so vary the magnetic gap.

Figure 22 shows the central pole 11 fashioned as a sleeve and provided with a kind of shoulder as at 87. The central core 88 is a sliding fit but both this core and the sleeve 11 are screwed at the top end so that rotation of the core causes a traversing movement. If desired the top of the core 88 in-

stead of being squared and tapped for the attachment of the cap **86** may simply be slotted for operation by means of a brass screw driver and a lock nut provided for locking it in position.

An important subsidiary feature of Figures 19–22 lies in the method of pole adjustment whereby the central core of the pole is traversed by a screw feed and thus facilitates assembly and can function as a volume control in use.

Difficulty may be sometimes met with in the pick-ups so far described by undesirable resonant notes or periods of vibration set up by mechanical transmission of sound from the record being reproduced. To prevent this a pad of rubber, insertion, cork or other damping material (not shown) may be placed between the pick-up movement proper and the casing in any of the embodiments illustrated so that there is damping material between pick-up and casing. For example, where nuts are used to clamp the pick-up to the top of the casing the clamping action may compress an interposed rubber pad over the length of the magnet. Thus a secure fixing is provided and also an agency acting in restraint of resonant vibration. In another method (not illustrated) the pick-up is wrapped with a rubber sheet covering the sides and also the top, with holes to clear any nuts or projections, and the pick-up so wrapped is forced into a slot in the housing. This also is a practical and comparatively effective procedure which has the advantage of insulating the mechanism from external shocks.

Preferably in embodiments, (see for example Figures 19 to 21) where the link connecting a stylus lever with the armature is of a cord nature the said link is fashioned from a series of slipping loops pulled tight as the threading of the cord (usually a silken cord) proceeds so that there is a sort of chain stitch effect as illustrated in Figure 23 which is purely schematic and not to scale. The final loop, for attachment to the back of the stylus lever, is left comparatively open and locked by stitching to the preceding loops or binding over. On the armature the commencing thread of the loop system is passed through the hole in the cross head and tied. Alternatively the cross head soldered to the armature may be adapted to grip the silken cord, and, if the length is approved on trial, made secure with shellac or other cement. In some cases I have found it advantageous to make the cross head of an elongated nature, resembling a web, thereby increasing the stiffness of the armature where it is not gripped by the combined rubber support and damping means.

The object of the chain knotted type of cord transmission link is to provide an element of damping in the connection between the stylus lever and the armature and thus minimize resonant vibration of a relative nature between these parts.

In the embodiment shown in Figures 24 to 27 the reproducer shell **89** of an Edison disc phonograph is shown as stripped of its normal floating weight, stylus lever, transmission cord, and diaphragm. For these parts are substituted a moulded floating weight **90** carrying a magnet **4**, magnet cores **11**, windings **10**, polar extensions **6**, armature **7** with stylus **8** soldered thereto, clamping plate **13**, rubber sheets or tube **12**, and terminal screws **19** which connect with the windings.

The moulding **90** is channelled as at **91** and the clamping plate **13** is tightened with screws as at **14** until it touches the ledge **92** of the channel **91**. This arrangement secures uniformity of compression in assembly and thus uniformity of damping per unit length. However if it is desired to use the clamping plate as a means for regulating the degree of proximity of the armature and the poles the ledge can be omitted. In the arrangement shown the polar gap can be adjusted in manufacturing assembly with the aid of paper washers or shims placed beneath the rubber of the damping channel or it can be adjusted in other ways e. g. by straining the armature. The armature shown is one eighth of an inch wide and one thirty second of an inch thick and is made of soft tool steel.

Figure 27 shows in front elevation with cover removed and Figure 28 shows in side elevation a pick-up constructed for reproducing from lateral cut or gramophone records. In this pick up there is a composite magnetic framework comprising magnets **4**, polar extensions **6** combining to form a single neutral region, and pole tips **11** tapered as shown and which provide magnetic air gaps on both sides of the armature **7**. The said armature **7** which is of elongated form is enlarged to receive a needle or stylus **8** and is clamped between rubber strips or in a tube of rubber (as in the previous embodiments) held under pressure so as to be flattened between the polar extensions **6** by means of screws as at **14**. A winding **10** produces an electromotive force when the armature vibrates between the pole tips. Conversely currents fed to this coil will set up vibration in the armature. A split casing or cover **93** and **94** of which the part **94** alone is shown in Figure 27 grips the magnetic structure and holds it rigid by means of four screws passing through holes as at **95**.

Figure 28 clearly shows the split casing **93** and **94** the pole tips **11** and the usual swinging arm **52** corresponding to the tone arm of a gramophone. The clamped rubber between the polar extensions **6** constitutes a damping channel for progressively annulling transverse vibration as it travels along the armature strip, which in this case may be for example one-eighth of an inch wide and one thirty second of an inch thick and made from tool steel.

It will of course be appreciated that although, for the sake of simplicity and convenience pick-ups only have been illustrated a pick-up and a recorder are essentially reversible devices in the energy conversion sense just as an electric motor and an electric generator are. Thus a pick-up can be used as a recorder and vice versa without any changes of a fundamental nature i. e. without any changes other than of obvious design details such as substituting for a needle (for picking up) a cutter (for recording). In fact it is possible in carrying out this invention to provide a single embodiment adapted to serve both purposes; e. g. the armature of the embodiment of Figure 1 might be provided with a stylus holder and a cutter side by side thereon. With such an arrangement the embodiment would be used in a tilted position—tilted in one direction so that the stylus engaged a record for picking up and tilted in the other so that the cutter engaged the record for recording. Such a dual purpose device would be very useful, for example, for use in offices to enable dictation to be recorded and afterwards reproduced for a typist.

In the claims which follow the expression "electro-acoustic record translator" is employed in a wide sense to include a device which is adapted to translate acoustic frequency electric currents into phonograph or gramophone sound records or to translate phonograph or gramophone sound records into acoustic frequency elec-

tric currents, or both. Similarly the term "record engaging member" includes either a stylus or a cutter.

What I claim is:—

1. In an electro-acoustic record translator, an elastic armature which is long relative to its width and thickness, said armature being sufficiently flexible to transmit acoustic frequency transverse waves along its length if transversely vibrated at acoustic frequency at or near one end, a record engaging member operatively associated with said armature at or near said one end thereof, means for smoothly and gradually damping out said transverse waves comprising resilient damping material in pressure contact with those opposite sides of said armature which include the length and width dimensions thereof, said damping material extending over not less than about one-half the length of said armature but not as far as the said end thereof, and energy converting means for translating vibratory movement of said end of said armature into acoustic frequency electric currents and vice versa.

2. In an electro-acoustic record translator, an elastic armature which is long relative to its width and thickness, said armature being sufficiently flexible to transmit acoustic frequency transverse waves along its length if transversely vibrated at acoustic frequency at or near one end, a record engaging member operatively associated with said armature at or near said one end thereof, means for smoothly and gradually damping out said transverse waves comprising resilient damping material in pressure contact with those opposite sides of said armature which include the length and width dimensions thereof, said damping material extending over not less than about one-half the length of said armature but not as far as the said end thereof, and energy converting means for translating vibratory movement of said end of said armature into acoustic frequency electric currents and vice versa, said armature being supported solely through the intermediary of said damping material.

3. A device according to claim 1 and further characterized in that the damping material is in the form of two strips of rubber one on each side of the armature.

4. A device according to claim 1 and wherein the damping material which forms the sole support for the armature is in the form of two strips of rubber one on each side of the armature.

5. In an electro-acoustic record translator, an elastic armature constituted by a ferro-magnetic blade which is long relative to its width and thickness, said armature being sufficiently flexible to transmit acoustic frequency transverse waves along its length if transversely vibrated at acoustic frequency at or near one end, a record engaging member operatively associated with said armature at or near said one end thereof, means for smoothly and gradually damping out said transverse waves comprising resilient damping material in pressure contact with those opposite sides of said armature which include the length and width dimensions thereof, said damping material extending over not less than about one-half the length of said armature but not as far as the said end thereof, and electro-magnetic energy converting means including a magnet system having at least one air gap with which said armature end is operatively associated for translating vibratory movement of said end of said armature into acoustic frequency electric currents and vice versa.

6. In an electro-acoustic record translator, an elastic armature constituted by a ferro-magnetic blade which is long relative to its width and thickness, said armature being sufficiently flexible to transmit acoustic frequency transverse waves along its length if transversely vibrated at acoustic frequency at or near one end, a record engaging member operatively associated with said armature at or near said one end thereof, means for smoothly and gradually damping out said transverse waves comprising resilient damping material in pressure contact with those opposite sides of said armature which include the length and width dimensions thereof, said damping material extending over not less than about one-half the length of said armature but not as far as the said end thereof, and electro-magnetic energy converting means including a magnet system having at least one air gap with which said armature end is operatively associated for translating vibratory movement of said end of said armature into acoustic frequency electric currents and vice versa, said armature being supported solely through the intermediary of said damping material.

7. In an electro-acoustic record translator, an elastic armature constituted by a ferro-magnetic blade which is long relative to its width and thickness, said armature being sufficiently flexible to transmit acoustic frequency transverse waves along its length if transversely vibrated at acoustic frequency at or near one end, a record engaging member operatively associated with said armature at or near said one end thereof, means for smoothly and gradually damping out said transverse waves comprising resilient damping material in pressure contact with those opposite sides of said armature which include the length and width dimensions thereof, said damping material extending over a substantial length of said armature but not as far as the said end thereof, and electro-magnetic energy converting means including a magnet system having at least one air gap with which said armature end is operatively associated for translating vibratory movement of said end of said armature into acoustic frequency electric currents and vice versa, a plate for clamping said armature and said damping material to a flat face on said magnet, said armature being supported solely through the intermediary of said damping material by clamping said armature by said clamp plate through said material against said flat face of said magnet, there being a portion of said material between said clamp plate and said armature and a portion between said armature and said flat face of said magnet.

8. A translator in accordance with claim 1 and wherein the damping material is in the form of a tube in which said armature is inserted.

9. A translator in accordance with claim 2 and wherein the damping material is in the form of a tube in which said armature is inserted.

10. A translator in accordance with claim 7 and wherein the damping material is in the form of a tube in which said armature is inserted.

11. In an electro-acoustic record translator, an elastic armature constituted by a ferro-magnetic blade which is long relative to its width and thickness, said armature being sufficiently flexible to transmit acoustic frequency transverse waves along its length if transversely vibrated at acoustic frequency at or near one end, a record engaging member operatively associated with said armature at or near said one end thereof, means

for smoothly and gradually damping out said transverse waves comprising resilient damping material in pressure contact with those opposite sides of said armature which include the length and width dimensions thereof, said damping material extending over not less than about one-half the length of said armature but not as far as the said end thereof, and electro-magnetic energy converting means including a magnet system having at least one air gap with which said armature end is operatively associated, said magnet having a pole adjusting screw member passing through a limb thereof in the direction of said armature for translating vibratory movement of said end of said armature into acoustic frequency electric currents and vice versa.

12. A translator in accordance with claim 1 and wherein the armature is formed to carry the record engaging member at or near its undamped end.

13. A translator in accordance with claim 7 and wherein the armature is formed to carry the record engaging member at or near its undamped end.

14. A translator in accordance with claim 1 and wherein the armature is formed to carry the record engaging member at or near its undamped end, said member extending at right angles to the length and width of said armature.

15. A translator in accordance with claim 1 and including a transmission link for operatively connecting the armature to the record engaging member, a housing, means for pivotally mounting the record engaging member in the housing and means for mounting the housing for movements with respect to the main body of the translator.

16. A translator in accordance with claim 1 and including a transmission link constituted by a chain knotted cord member for operatively connecting the armature to the record engaging member, a housing, means for pivotally mounting the record engaging member in the housing, and means for mounting the housing for movements with respect to the main body of the translator.

ADRIAN FRANCIS SYKES.