

March 12, 1929.

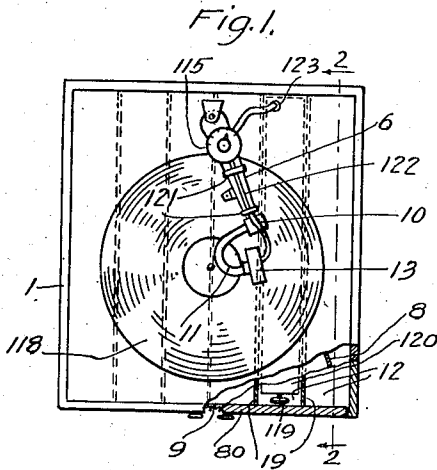
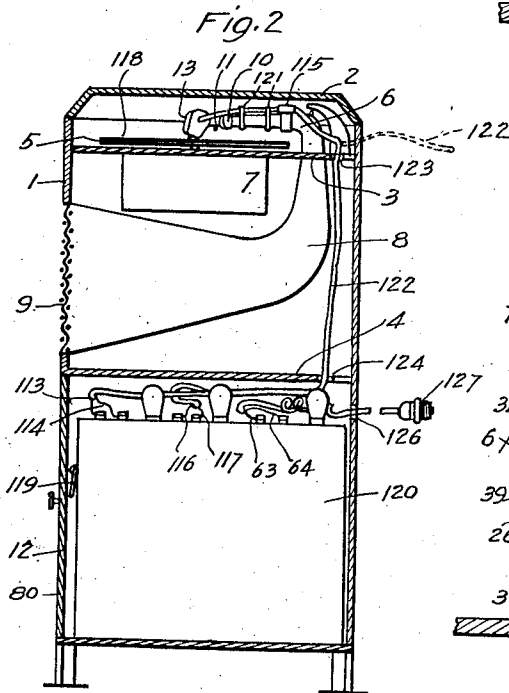
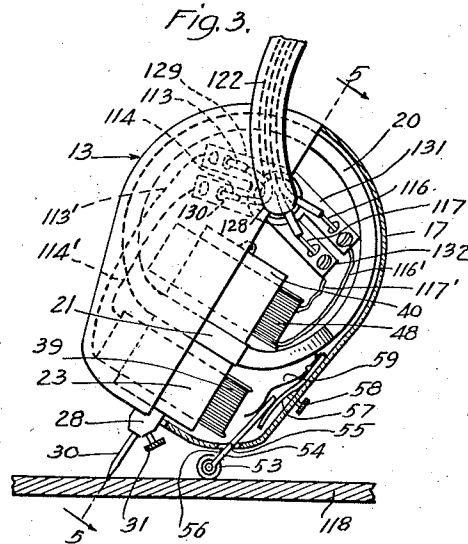
J. J. JAKOSKY

1,705,017

APPARATUS FOR SOUND REPRODUCTION

Filed March 23, 1926

3 Sheets-Sheet 1



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Fig. 5.

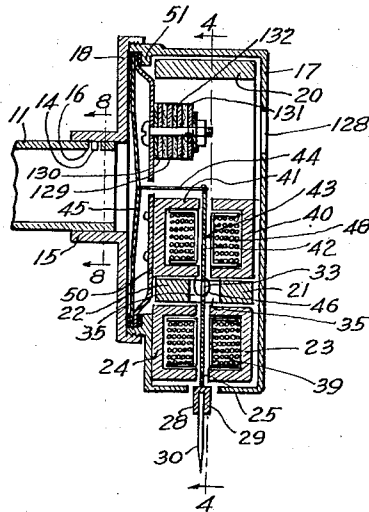


Fig. 6.

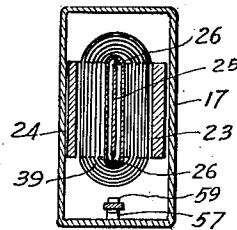


Fig. 7.

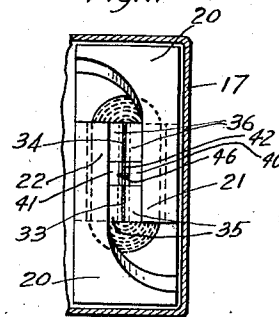


Fig. 9.

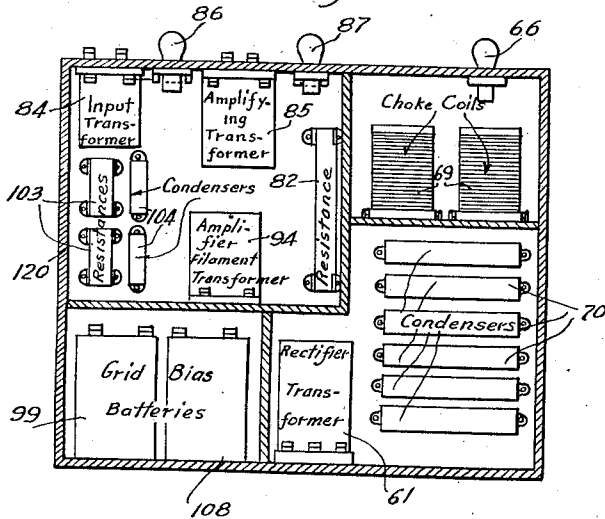
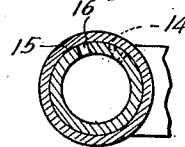


Fig. 8.



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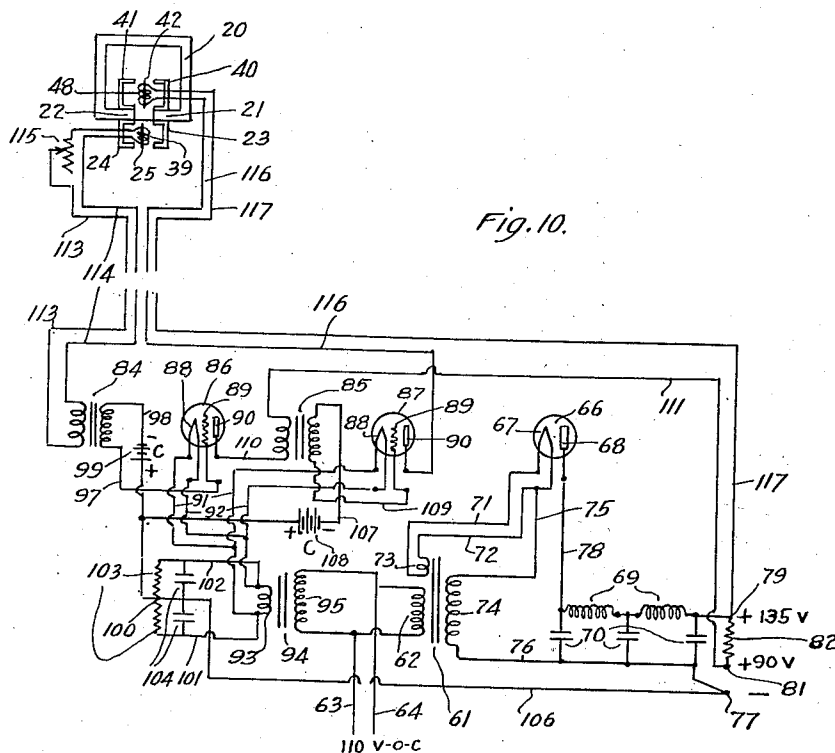
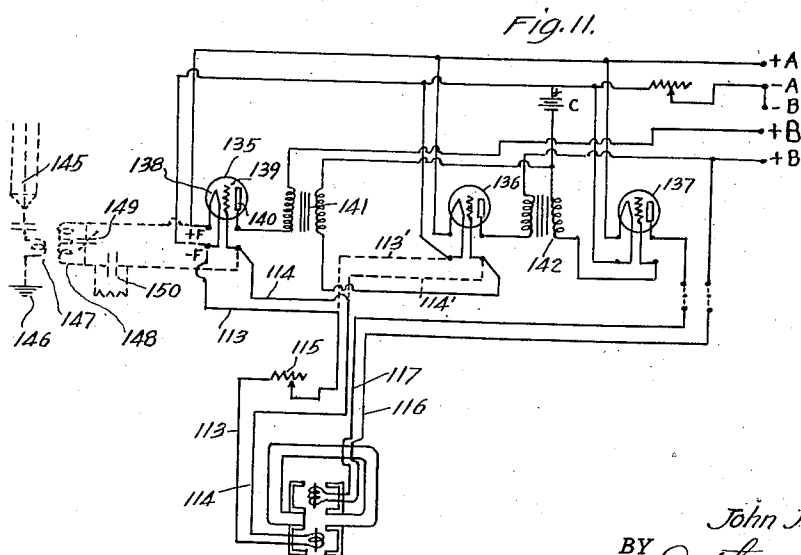
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

JOHN J. JAKOSKY, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO INTERNATIONAL PRECIPITATION COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA.

APPARATUS FOR SOUND REPRODUCTION.

Application filed March 23, 1926. Serial No. 96,702.

This invention relates to means for producing sound from phonographic records containing impressions corresponding to the sound to be produced and particularly to the production of such sound through the agency of electrical amplifying and sound producing means. The main object of the invention is to provide an apparatus which may be applied to an ordinary phonograph to convert the same into an electrical reproducing phonograph, while utilizing as many of the parts of the existing phonograph as possible, thereby reducing to a minimum the number of new parts required. It has been found that sound may be produced from phonograph records in a much more satisfactory manner and with better qualities of tone, clarity and volume through the utilization of electrical amplifying means and electrically operated sound-producing means than by the mechanical operation of the diaphragm by a phonograph needle as in the ordinary phonograph, and an object of this invention is to enable such a phonograph to be converted with the minimum possible expense to produce the improved qualities above mentioned.

The apparatus which I propose to use for this purpose consists essentially of a reproducing device, comprising a transmitting element adapted to carry a phonograph needle and to transmit electrical impulses corresponding in frequency to vibrating motion of such needle, and a receiving element adapted to receive electrical impulses and to produce sound corresponding in frequency thereto; and electrical amplifying means connected electrically between said transmitting element and said receiving element; said reproducing device being formed with a portion adapted to fit on the end of a phonograph tone arm in position to direct the sound produced by said receiving element into said tone arm.

The accompanying drawings illustrate embodiments of my invention and referring thereto:

Fig. 1 is a plan view of a phonograph with my device added thereto, the cover of the phonograph being removed.

Fig. 2 is a vertical section of such phonograph on line 2—2 in Fig. 1.

Fig. 3 is a partly sectional side elevation of a reproducing unit.

Fig. 4 is a vertical section of such unit taken on line 4—4 in Fig. 5.

Fig. 5 is a section on line 5—5 in Fig. 3.

Fig. 6 is a section on line 6—6 in Fig. 4.

Fig. 7 is a section on line 7—7 in Fig. 4.

Fig. 8 is a section on line 8—8 in Fig. 5.

Fig. 9 is a vertical section of an electrical amplifying means for use according to my invention.

Fig. 10 is a diagram of the electrical circuits involved in one embodiment of my invention.

Fig. 11 is a diagram of electrical circuits involved in another embodiment of my invention.

In Figs. 1 and 2 I have shown a phonograph which may be of any suitable type of manufacture comprising a housing or cabinet 1 having a lid or cover 2 and horizontal shelves or partitions 3 and 4 serving to divide the space within said cabinet into upper, middle, and lower compartments. Within the upper compartment there is provided a rotatably mounted record carrying plate 5 and a tone arm 6 pivoted to swing so that the outer end thereof passes across the record. Within the middle compartment there is provided a motor 7 which is operatively connected to the record carrier to rotate the same. Said motor may be either a spring motor or an electrical motor and may be provided with the usual devices, not shown, for starting and stopping and for controlling the speed thereof. The usual phonograph horn 8 is also provided within the middle compartment, said horn being connected at one end to the base of the tone arm 6 and communicating at its other end with an opening 9 in the front of the cabinet. Within the lower compartment of the phonograph there are usually provided a series of vertical partitions 19 dividing the same into a plurality of compartments 12 adapted to receive albums or books containing phonograph records, access to such compartments being permitted by the usual hinged door 80 at the front of the cabinet.

At the outer end of the tone arm of such a phonograph there is usually provided a sound box having means for carrying a needle in position to engage the impressions on the phonograph record and means for causing the vibrations produced in such needle to operate a diaphragm which is in position to direct the sound produced by vibration thereof into the end of the tone arm. According to my invention such sound box may be removed from the outer end of the tone arm and

an electrical reproducing unit 13 substituted therefor. The exact shape of such unit and the method of connecting the same to the tone arm do not constitute material parts of my invention and these factors will vary with different types of phonographs. I have shown in the drawings however one form of reproducing unit and a means for attaching the same to the tone arm of one particular type of phonograph and it will be understood that any suitable modifications may be made to adapt the same for use with other types of phonographs.

In the phonograph which I have shown in the drawings the outer end of the tone arm 6 is provided with a laterally extending tubular portion 10 within which is mounted a U-shaped hollow connecting tube 11 at the other end of which is mounted the sound box. It is customary to removably secure the sound box to such U-shaped connecting tube by means of a bayonet joint and according to my invention the sound box is removed at such joint and the reproducing unit 13 is provided with bayonet joint means of suitable form so that it may be slipped on the end of the tube 11 in place of the sound box. Such bayonet joint means, as indicated in Figs. 5 and 8 may comprise a pin or stud 14 on a sleeve 15 of the reproducing unit and an L-shaped notch 16 in the end of tube 11.

Said reproducing unit may comprise a casing consisting for example of a main portion 17 and a cover 18 adapted to be screwed onto or otherwise secured to the main portion 17. Within the casing means 17 I provide a permanent magnet 20, said magnet being for example substantially ring-shaped as shown and having its two end portions 21 and 22 overlapping but spaced from one another. A U-shaped pole-piece 23 may be connected to one end 21 of said magnet and a similar pole-piece 24 may be connected to the other end thereof, said pole-pieces projecting outwardly or downwardly from the magnet 20. Between the opposing faces of these two pole-pieces I may provide an armature 25 pivotally mounted as at 26 so as to permit the same to be tilted or vibrated in such manner as to move the ends thereof toward or away from the faces of the respective pole-pieces 23 and 24 and thus vary the intensity and direction of the magnetic flux through such armature. The lower end of said armature is provided with or secured to a needle-holding member 28 provided with a recess 29 adapted to receive a phonograph needle as indicated at 30 and with a set screw 31 for holding said needle in position within said recess. The upper end of armature 25 may be provided with two extensions 33 and 34 which may rest between blocks or pads 35 and 36 respectively, said pads consisting of resilient materials such as soft rubber. Such pads serve the purpose of damping to some

extent the vibrations of armature 25 and also provide a resilient support for the upper end of said armature so as to cause the reproducing device to be moved laterally across the face of the record by engagement of needle 30 with the groove thereon. A wire coil or winding 39 is provided around the armature 25 in such position as to cause alternating electric currents of small intensity to be set up therein upon vibration of said armature between the pole-pieces 23 and 24. There is thus provided within the reproducing device a transmitting element having means for carrying a needle in position to engage the phonograph record and adapted to transmit alternating electrical impulses corresponding in strength and frequency to the vibrations of such needle. Resilient pads 35 and 36 are partly broken away in Fig. 4, in order to show the extensions 33 and 34.

I also provide another pair of pole pieces 40 and 41, connected respectively to the end portions 21 and 22 of magnet 20 and projecting inwardly or upwardly therefrom, and an armature 42 mounted between said pole pieces for example by means of fine flexible wires 43. Said armature is secured at one end by means of wire or rod 44 to the center of diaphragm 45, and a light spring consisting for example of a piece of spring wire 46 may be provided for exerting sufficient pressure against the other end of such armature so as to hold the suspension wires 43 tight at all times and thus tend to hold the armature in its normal position, that is, centrally between the pole-pieces. A wire coil or winding 48 may be provided around the armature 42 in such position that passage of electric current in said coil or winding causes a magnetic field to be set up in armature 42, and variations or alternations in such current cause the respective ends of said armature to be moved toward or away from the respective pole-pieces 40 and 41. There is thus also provided within the reproducing unit a receiving element adapted to produce sound corresponding in frequency and strength to the electrical impulses received thereby. The one magnet 20 serves to maintain the magnetic field for both the transmitting element and the receiving element. It will be understood that other suitable types of transmitting and receiving elements than those above described may be employed in my invention, said two elements being in any case combined to form a reproducing unit which is adapted to fit on the end of the phonograph tone arm.

The ends of magnet 20 may be secured in any suitable manner, as by means of bolts not shown, to pole-pieces 23, 24, 40, and 41, and pole-piece 41 may be bolted or riveted or secured in any other suitable manner to a supporting plate 50, which together with diaphragm 45 may be secured between flange 51

on the casing 17 and cover plate 18 when said cover plate is screwed on said casing. Since the reproducing unit is somewhat heavier than the ordinary sound box used on the phonograph it is desirable to provide some means for taking part of the weight thereof off of the needle 30 so as to prevent said needle from being pressed too forcibly into the grooves of the record. For this purpose I may provide a supporting cylindrical or spherical roller 53 rotatably mounted at the lower end of arm 54 which is pivotally mounted at 55 on casing 17 and extends through opening 56 in said casing. In order that the supporting roller 53 may be caused to bear any desired portion of the weight of the reproducing unit I prefer to provide resilient spring means such as leaf spring 57 bearing against the upper end of arm 54 and an adjusting screw 58 bearing against said spring for adjusting the pressure thereof against the upper end of arm 54. A relatively light spring 59 may also be provided bearing against the other side of arm 54 so as to hold the same at all times against spring 57. By suitable adjustment of screw 58 the supporting roller 53 may be caused to take any desired portion of the weight of the reproducing unit off of the phonograph needle 30 when placed upon the record so as to give any desired pressure upon such needle.

According to my invention the transmitting element is connected to the input terminals of an electrical amplifying means while the output terminals of such amplifying means are connected to the two ends of coil 48. The electrical circuits of an amplifying means which may be used for this purpose and the manner of connecting such amplifying means to the reproducing unit are shown diagrammatically in Fig. 10. The amplifying system therein shown is adapted for operation on alternating current and therefore includes or is connected to a rectifier or B-battery eliminator. Said rectifier may comprise a transformer 61 whose primary winding 62 may be connected by wires 63 and 64 to a suitable source of alternating current, for example, to an ordinary lighting circuit supplying 110 volts A. C. The rectifier may further comprise a rectifying thermionic tube 66 provided with filament 67 and plate 68 and may also include suitable choke coils 69 and condensers 70. Filament 67 may be connected by wires 71 and 72 to a low voltage winding 73 on transformer 61 while the main secondary winding 74 of said transformer may be connected by wire 75 to filament 67 and by wire 76 to negative terminal 77. Plate 68 may be connected by wire 78 through choke coils 69 to positive terminal 79, the condensers 70 being connected at suitable points between wire 78 and wire 76 so as to provide the necessary values of inductance and capacity in the circuit. A

second positive terminal 81 may also be provided and a resistance 82 of suitable value may be connected between terminals 79 and 81 so as to give the desired voltage relation between said two terminals.

The amplifying system proper may comprise an input transformer 84, an amplifying transformer 85, and two thermionic tubes 86 and 87 each provided with filament 88, grid 89, and plate 90. The filaments 88 of said tubes may be connected by wires 91 and 92 to the low voltage secondary winding 93 of a step-down transformer 94 whose primary winding 95 is connected to wires 63 and 64. One side of the secondary winding of transformer 84 is connected by wire 97 to the grid 89 of tube 86. The other side of such secondary winding is connected by wire 98 through a grid bias or C-battery 99 to neutral point 100 which is connected by branch lines 101 and 102 to the filament connections 91 and 92 respectively for the two tubes 86 and 87. Resistances 103 and condensers 104 are connected between neutral point 100 and the branch lines 101 and 102, as is customary when using alternating current for energizing the filament. Negative terminal 77 is also connected to neutral point 100 by wire 106 and the secondary winding of transformer 85 is also connected by wire 107 through C-battery 108 to such neutral point. The other side of the secondary winding of transformer 85 is connected by wire 109 to the grid of tube 87. The plate 90 of tube 86 is connected by wire 110 to the primary of transformer 85 and the other end of such primary is connected by wire 111 to positive terminal 81.

The above described amplifying system is well-known and the specific construction or arrangement of such system forms no part of my invention, as any other suitable electrical amplifying system may be used in place of that shown. According to my invention, coil 39 of the transmitting element is connected by wires 113 and 114 to the input of such amplifying system; for example, in the case shown such wires are connected to the primary terminals of input transformer 84. Rheostat 115 may be connected in one of said wires for the purpose of regulating the flow of current there-through and hence regulating the volume of sound production. The output leads 116 and 117 of the amplifying system, which lead respectively from the plate of tube 87 and from positive terminal 79 are connected to the two ends of coil 48 of the receiving element.

The amplifying system above described or its equivalent may be located at any suitable point convenient to the phonograph but I have shown in Figs. 2 and 9 a particularly desirable embodiment of such amplifying system in which the same is built in a case or container 120 of such size and shape as to permit

insertion thereof in one of the record-holding compartments 12 of the phonograph cabinet. The general location of the box 120 containing the amplifying system is shown in Figs. 1 and 2 while the arrangement of the various parts of the amplifying system within such box is shown in Fig. 9. The wiring is omitted from Fig. 9 for the sake of clarity and because it is not considered essential to a proper showing of the invention.

As shown in Figs. 1 and 2, the wires 113, 114, 116, and 117 connecting the reproducing unit to the amplifying system may be included within a suitable cable or cord 122 which may extend along the tone arm and hence through openings 123 and 124 in the cabinet to the compartment 12 in which box 120 containing the amplifying equipment is located. Said cable may be strapped or otherwise secured to the tone arm as indicated at 121 and the rheostat 115 which is included in either the wire 113 or 114 may be mounted upon the tone arm near the base thereof as shown. The wires 63 and 64 may extend as shown through an opening 126 in the rear wall of the phonograph cabinet and may be provided with a connecting plug 127 for connection to a lighting or power circuit. The thermionic tubes 66, 86, and 87 may be mounted in such manner as to project through the top of box 120 to permit inspection and replacement thereof. Box 120 may be provided at its forward end with a ring or other handle 119 to facilitate removal thereof from its compartment 12. The provision of the amplifying system in a box adapted to fit within a record-holding compartment of the phonograph is of considerable advantage, as it enables a phonograph to be converted to play records electrically, without requiring the connection thereto of an external amplifier, and provides a unit which is self-contained, with a minimum disturbance of the existing parts of the phonograph.

The cord 122 containing wires 113, 114, 116, and 117 may extend through an opening 128 in casing 17, and said wires may be connected respectively to binding posts or terminals 129, 130, 131, and 132 insulated from one another and mounted on supporting plate 50, as shown in Figs. 3 and 5. From said binding posts wires 113', 114', 116', and 117' may lead to the ends of the respective coils 39 and 48.

In the operation of the above described apparatus a phonograph record indicated at 118 is placed on the record carrier 5 and is set in rotation by operation of the motor 7 in the usual manner. The reproducing unit 13 with an ordinary phonograph needle 30 inserted as indicated is then lowered onto the record so as to traverse the groove therein. The undulations in the groove in the phonograph record cause the point of the needle to move rapidly back and forth in a direction

transverse to the directions of the groove, (or in some other direction, depending on the method of making the phonograph record), and such motion of the needle causes armature 25 to vibrate upon its pivots 26, such vibration being damped to a suitable degree by resilient pads 35 and 36. In the vibration of armature 25 the respective ends thereof are brought alternately closer to and further away from the respective pole-pieces 23 and 24 so that an alternating magnetic flux is set up within said armature. A small electric current corresponding in frequency and intensity to the vibrations of the needle is thus induced in coil 39 and such current is supplied to the input of the amplifying system above described. The strength of the current impulses so supplied may be adjusted by operation of rheostat 113 so as to produce the desired volume of sound production and the provision of such adjusting means is an important feature of my invention since by this means the volume of the sound is adjusted by control of the current in the initial circuit, that is the circuit in which the current impulses are first produced by operation of the phonograph needle, and the amplifying system may thus be permitted to operate at its maximum efficiency without producing too great a volume of sound. It is believed unnecessary to describe in detail the operation of the amplifying system since such operation is well-known and forms no essential feature of this invention. The operation of such amplifying system is such however as to produce in the output circuit thereof, including wires 116 and 117 and coil 48, alternating current impulses corresponding to but of much greater intensity than the electrical impulses initially set up in coil 39. An alternating magnetic field is thus induced in armature 42 and the respective ends of such armature are alternately attracted and repelled by the pole-pieces 40 and 41 so that said armature is caused to rock about its central point and the motion thereof is transmitted through wire or rod 44 to diaphragm 45. The resulting vibration of said diaphragm produces sound waves which are transmitted through the tube 11, tone arm 6, and horn 8 to the listener.

The sound thus produced is of much better quality than that which is produced by the ordinary phonograph relying upon mechanical actuation of the diaphragm by the needle and it is also possible to obtain a much greater volume of sound in this manner. A particular advantage of my invention is that the maximum number of parts of the original mechanically reproducing phonograph are utilized and consequently the number of new parts required is reduced to a minimum. In order for the owner of a phonograph to convert it to play electrically, it is only necessary to remove the sound box and substitute

therefor the above-described reproducing device, and make the necessary electrical connections to an amplifying set. The adjusting rheostat for effecting volume control may be readily attached to the tone arm as shown, or placed in any other convenient location. The record-carrying plate, motor, stopping and starting mechanism, speed regulation means, tone arm, horn, and cabinet, are all made use of, and it is therefore much less expensive to convert the phonograph in this manner than to buy an entirely new electrically reproducing phonograph. Furthermore, when the above-described amplifying apparatus is used, an existing compartment of the cabinet is used for containing the same, and all the connections are contained within the cabinet.

Any other suitable means of electrical amplification may be used in connection with my invention instead of that above described. For example as indicated diagrammatically in Fig. 11 the device may be connected to the electrical amplifying circuit therein shown. Such amplifying circuit comprises thermionic tubes 135, 136, and 137, each of which is provided with filament 138, grid 139, and plate 140, and also comprises transformer 141 and 142 each of which has its primary winding connected to the plate of one thermionic tube and its secondary winding connected to the grid of the succeeding electron tube. Suitable connections may be provided as indicated between the various parts of said circuits and said parts and the usual A, B, and C batteries for supplying the necessary electric current or voltage thereto. The transmitting element of the reproducing device may as before be connected by wires 113 and 114 to the input of such amplifying device for example to the negative filament and grid connections of tube 135, while the receiving element of such reproducing device may as before be connected by wires 116 and 117 to the plate circuit of the last tube 137. The amplifying system above described may be a separate amplifying system and may be located at any point within or convenient to the phonograph, the electrical connections between said amplifying system and the reproducing unit being made for example by carrying the cord or cable 122 containing wires 113, 114, and 116, and 117 out through the rear wall of the phonograph cabinet as indicated in dotted lines at 122' in Fig. 2 and connecting the said wires at suitable points in the amplifying system.

The amplifying system just described may advantageously constitute a part of a radio receiving set, such set comprising in addition to the parts above described, suitable means for reception of radio messages comprising for example antenna 145, ground connection 146, primary and secondary coils 147 and 148, variable condenser 149, and grid

leak and condenser 150. In an ordinary radio receiving circuit the secondary coil 148 may be connected at one side to the positive filament terminal of tube 135 and at the other side through grid leak and condenser 150 to the grid of such tube. The reproducing unit may according to my invention be connected to such a radio receiving set in the same manner as above described, thereby utilizing the detector tube of the radio receiving set as an amplifying tube, or the wires 113 and 114 may be connected, as indicated in dotted lines at 113' and 114', to the filament and grid terminals of the first amplifying tube 136 of the radio set. It is to be noted that when the reproducing unit is connected to the detector tube of the radio set the connection of wire 114 is made between grid 139 and grid leak and condenser 150. When so connected the grid leak and condenser 150 serve to prevent the passage back into the receiving circuit of the audiofrequency current from the reproducing unit and hence ensure all of said current being confined to the grid circuit of electron tube 135.

It will be understood that the above described radio circuit is one ordinarily employed in radio reception and its particular arrangement forms no part of this invention. When used for reception of radio messages the first electron tube 125 constitutes a detector and the remaining electron tubes constitute amplifiers. When the set is to be used for phonographic reproduction according to my invention it is simply tuned by adjustment of variable condenser 149 or otherwise to a point where no radio reception is obtained, and the portions indicated in dotted lines at the left of Fig. 11 are not included in the operating circuit and play no part in the reproduction. The manner of operation of the reproducing device when connected to such amplifying system is substantially the same as when the amplifying system first described is employed.

I claim:

1. An electrical reproducing device for phonographs comprising a single magnet, two pairs of pole-pieces secured to the respective ends of said magnet, two armatures each mounted to vibrate between one of said pairs of pole-pieces, a separate electric coil around each of said armatures, means operatively connected to one of said armatures and adapted to carry a phonograph needle, a diaphragm connected to the other of said armatures, a casing enclosing all of the parts above mentioned and having an opening opposite said diaphragm and means on said casing around said opening and adapted to fit on the end of a phonograph tone arm.

2. A construction as set forth in claim 1, the armature which is operatively connected to said needle carrying means being provided

with resilient damping means engaging the same at one side of its center of vibration so as to resiliently resist the vibration of such armature.

5 3. A construction as set forth in claim 1 and comprising in addition a rotatably mounted roller resiliently supported beneath said casing in position to rest upon a phonograph record and to resiliently support the weight of said reproducing device.

10 4. An electrical reproducing device for phonographs comprising an electromagnetic transmitting element having means for carrying a phonograph needle and adapted to transmit electrical impulses corresponding to vibrating motion of such needle, an elec-

tromagnetic receiving element adapted to receive electrical impulses and produce sound corresponding to such impulses, a common magnet for said transmitting and receiving 20 elements, and the casing enclosing said transmitting and receiving elements and having means adapted to engage the end of a phonograph tone arm in such position as to direct 25 sound from said receiving element into said tone arm while disposing said phonograph needle in position to engage a phonograph record.

In testimony whereof I have hereunto subscribed my name this 16th day of March, 1926.

JOHN J. JAKOSKY.