Aug. 13, 1929. K. I. MARSHALL 1,724,099

APPARATUS FOR SOUND REPRODUCTION

Filed May 6, 1926 3 Sheets-Sheet 1

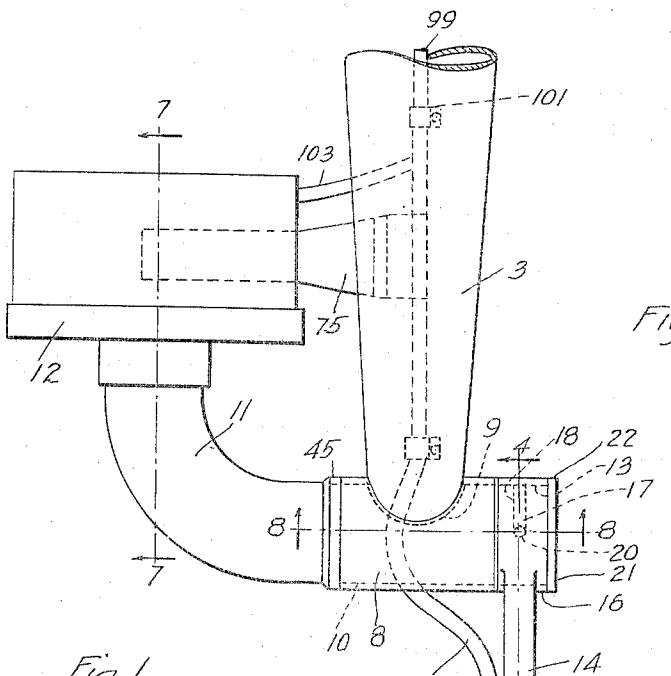

Fig. 2.

Fig. 1.

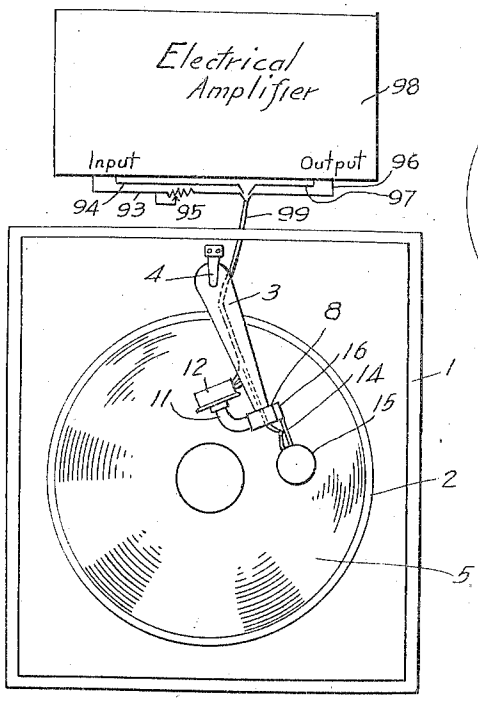

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Fig. 3.

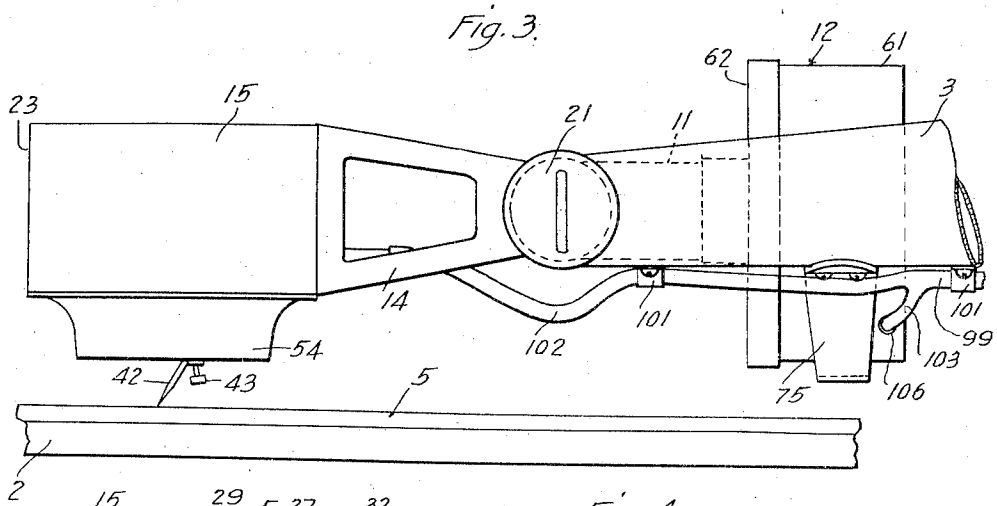

Fig. 4.

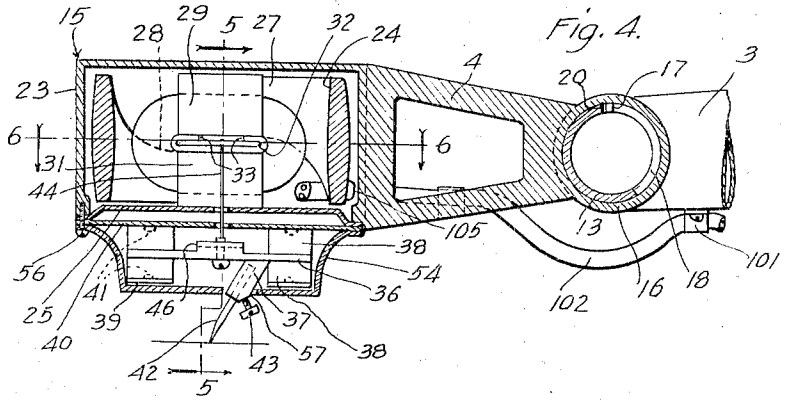

Fig. 5.

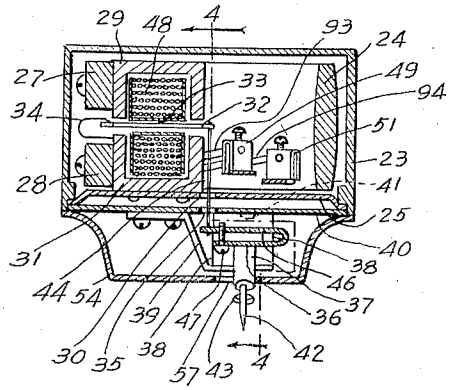

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Fig. 6.

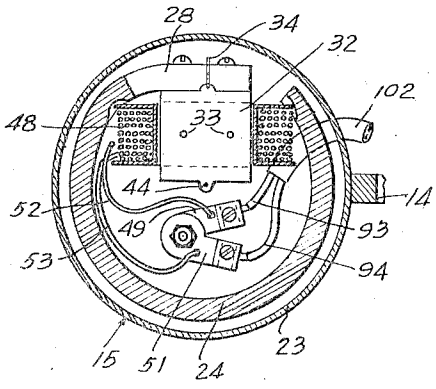


Fig. 7.

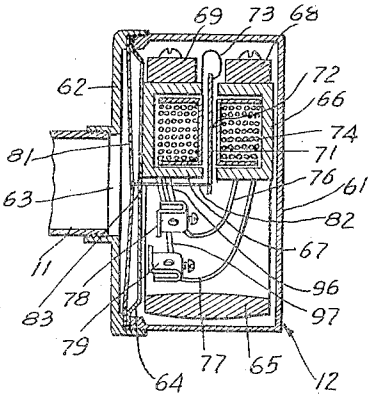


Fig. 8.

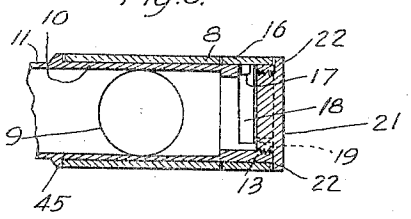
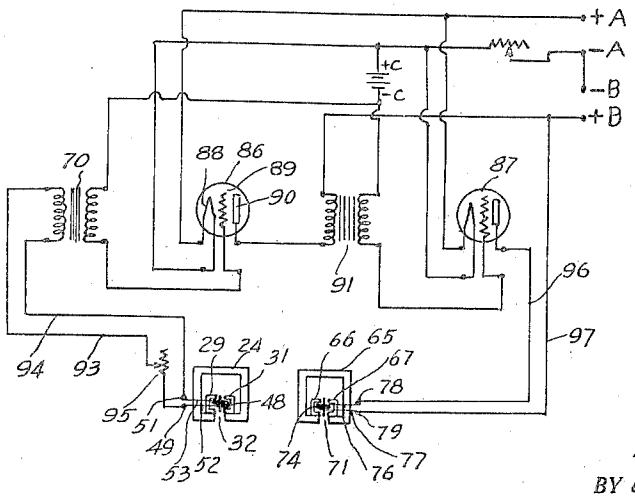


Fig. 9.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR SOUND REPRODUCTION.

Application filed May 6, 1926. Serial No. 107,064.

This invention relates to the electrical reproduction of sound from phonograph records and the main object of the invention is to provide means whereby the maximum number of parts of an existing phonograph of the mechanically reproducing type may be utilized in such electrical reproduction.

A further object of the invention is to provide an electrical reproducing device which may be conveniently applied to the ordinary tone arm of an existing phonograph of the mechanically reproducing type.

A further object of the invention is to provide a device which may be applied to the tone arm of a phonograph and which comprises both a transmitting device for producing electrical impulses corresponding to the phonograph record and also a receiving or loud speaking device for converting amplified electrical impulses into sound, the connection to the tone arm being made in such manner that such tone arm serves not only to support said device in position to engage the record but also to receive and amplify the sound produced by said receiving or loud speaking device.

A further object of the invention is to provide a construction in which the reproducing element and the loud speaking element are so mounted with respect to one another that the latter serves to partially counter balance the former and thereby decreases the effective weight with which the phonograph needle mounted in the reproducing device bears upon the record.

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

Fig. 1 is a semi-diagrammatic plan view of a phonograph provided with means for electrical reproduction of sound according to my invention.

Fig. 2 is a plan view of a device according to my invention applied to the tone arm of a mechanically reproducing phonograph.

Fig. 3 is a side elevation of the parts shown in Fig. 2.

Fig. 4 is a vertical section of the reproducing element on line 4—4 in Fig. 5.

Fig. 5 is a vertical section on line 5—5 in Fig. 4.

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

Fig. 7 is a vertical section of the loud speaking device on line 7—7 in Fig. 2.

Fig. 8 is a section on line 8—8 in Fig. 2 showing the means for mounting the device on the tone arm.

Fig. 9 is a wiring diagram of an electrical amplifying means suitable for use in connection with my invention.

In Fig. 1 I have shown an ordinary phonograph cabinet 1 provided with a record carrying plate or disk 2 and with means (not shown) for driving said record-carrying plate and for stopping and starting and regulating the speed of said driving means. In phonographs of the mechanically reproducing type it is customary to provide a hollow tone arm 3, mounted as at 4 so as to swing in a horizontal arc across a phonograph record 5 on the record-carrying plate. It is also customary to provide a sound box for the mechanical production of sound from the phonograph record, such sound box being mounted for example by means of a U-shaped hollow connecting tube, which is mounted in a laterally extending tubular bearing means 8 at the end of the tone arm so that the sound produced in sound box 6 passes through said connecting tube and thence into tone arm 3 and into the usual built-in phonograph horn, not shown, which is in communication with the base of tone arm 3.

According to my invention the above-mentioned connecting arm and sound box may be removed from the end of such tone arm and a device comprising electrical reproducing and loud speaking means is substituted therefor. Such device may comprise a tubular portion 10 adapted to fit within the lateral tubular bearing means 8 at the end of the tone arm, said tubular member 10 projecting at one end to form a hollow arm as indicated at 11, at the end of which is provided a loud speaking device 12. Tubular member 10 is provided with an opening 9 in its rearward wall communicating with the interior of tone arm 3, so as to permit passage of sound waves therethrough.

The other end of tubular member 10 may project somewhat beyond the bearing means 8 as indicated at 13, and upon said projec-

ing portion may be journalled an arm so as to swing in a substantially vertical plane, said arm carrying at its outer end an electrical reproducing device 15. The tubular member 10 and the projecting portion 13 thus constitutes a bearing member. In order to prevent lateral movement of arm 14 with respect to its bearing means 13 while permitting swinging movement thereof, the bearing portion 16 of said arm may be provided with an inwardly extending pin 17 engaging in an annular groove or slot 18 in the member 13. The groove 18 communicates at one end as indicated in Fig. 8 with an outwardly extending groove 19 so as to permit entrance of pin 17 into the groove 18 in assembling the device. The upper end 20 of groove 18 serves as a stop means for pin 17 as shown in Fig. 4, when the reproducing device is lowered into playing position, for the purpose hereinafter described. A retaining screw 21 having a flanged head 22 is screwed into the outer end of bearing portion 13 so as to cooperate with a flange 45 on member 10 to retain the parts in assembled position, there being however sufficient play between the bearing portion 17 of arm 14 and bearing means 8 and flange 22 and also between flange 45 and member 8 so as to permit free vertical swinging movement of arm 14.

The transmitting or reproducing device indicated at 15 may comprise, as shown in Figs. 4, 5, and 6, a cylindrical casing 23 within which is mounted a permanent magnet 24, said magnet being supported in any suitable manner for example by securing the same to supporting plate 25 which forms the lower end of cylindrical casing 23. The magnet 24 may be formed for example as a ring extending around the inside of the casing 23 and having its two oppositely charged ends 27 and 28 overlapping but spaced from one another. U-shaped pole pieces 29 and 31 may be secured to the respective ends 27 and 28 of said magnet and an armature 32 may be mounted for rocking motion between said pole pieces. Said armature may be mounted for example by means of flexible suspension wires 33 and a light wire spring 34 may be so mounted as to exert a downward pressure upon one end of said armature so as to preserve a slight tension on the suspension wires 33.

Beneath the supporting plate 25 is mounted a substantially rigid rocking member comprising for example a bridge or plate 36 and a needle carrying member 37 integrally or rigidly secured to said bridge. The ends of the bridge 36 may be mounted between resilient supporting pads or blocks 38 consisting for example of cylindrical pieces of rubber or other yielding or resilient material and said bridge may be clamped between said pads by means of brackets 39 which may be mounted for example on a second supporting plate 40. Said brackets serve to hold the supporting pads 38 and bridge 36 between the brackets and supporting plates 40 with the desired degree of firmness. In order to prevent lateral displacement of the supporting pads 38 suitable centering projections 41 may be provided on both the brackets and the supporting plates, for example by up-setting or punching the metal at these points.

Needle carrying member 37 may be provided with a suitable shaped recess for receiving a phonograph needle or stylus 42 and a set screw 43 may be provided for securing said needle within said recess. A link member 44 may extend through openings 30 and 35 in plates 25 and 40 and may be secured at its ends, by soldering or otherwise, to armature 32 and bridge member 36 so as to transmit rocking motion of said bridge to said armature as hereinafter described. In order to permit lengthwise adjustment of the link member with respect to the rocking member, the bridge 36 may be formed or provided with a bent-over portion 46 extending back above or beneath and somewhat beyond said bridge, and the lower end of said link member may be secured to the end of said bent-over portion. Said bent-over portion is formed of metal having a certain amount of resiliency and an adjusting screw 47 passes through the bridge member and screws into the bent-over portion so as to provide for adjustment of said bent-over portion toward or away from the bridge.

A wire coil 48 may be provided around the armature member 32 in such manner that changes in the magnetic flux in said armature member due to rocking motion thereof between the pole pieces 29 and 31 causes electric currents or impulses to be set up within said coil. Suitable terminal means such as insulated binding posts 49 and 51 may be mounted on supporting plate 25 and the two ends of coil 48 may be secured to said binding posts by means of wires 52 and 53 respectively.

A cover plate 54 may be provided for protecting the rocking member and other parts above described, said cover plate together with supporting plates 25 and 40 being secured to the casing 23 in any suitable manner as by means of screws 56. Said cover plate may have an opening 57 through which the needle carrying member 37 projects and through which access may be had to adjusting screw 47.

While I have described one particular form of reproducing element which may be used in connection with my invention I wish it to be understood that any form of electrical phonograph reproducer may be used in place of that above described. The construction of the reproducing unit above de-

scribed forms no part of my invention as it constitutes the basis of a co-pending application of J. J. Jakosky, Serial No. 102,100, filed April 15, 1926.

Any suitable form of electrically operated loud speaking or receiving device may also be used as the loud speaking unit 12 above referred to. For example as shown in Fig. 7 the loud speaking unit may comprise a cylindrical casing 61 provided with a cover plate 62 which is connected in any suitable manner to the end of the hollow arm 11 and which has an opening 63 opening into said arm. Within casing 61 is provided a supporting plate 64 upon which is mounted a permanent magnet 65 formed for example in the same manner as the magnet of the reproducing unit above described and provided in similar manner with pole pieces 66 and 67 secured to its respective ends 68 and 69 and with an armature 71 supported by suspension wires 72 and provided with means such as spring wire 73 for preserving tension on supporting wires 72. Coil 74 is provided around armature 71, with its two ends connected by wires 76 and 77 to binding posts 78 and 79 mounted within casing 61. A diaphragm 81 of suitable material such as mica or thin metal is mounted between supporting plate 64 and cover plate 62, and the center of said diaphragm is connected to one end of armature 71 by means of link 82 which extends through an opening 83 in supporting plate 64. Any suitable means may be provided for supporting the loud speaking unit when it is not held up by the reproducing unit as hereinafter described such supporting means comprising for example a bracket 75 secured to tone arm 3 and extending beneath the loud-speaking unit.

Any suitable means of electrical amplification may be used in connection with my invention. For example the thermionic tube amplifier shown in Fig. 9 may be utilized for this purpose. The amplifying system there shown comprises thermionic vacuum tubes 86 and 87, each provided with filament 88, grid 89, and plate 90, and further comprises step-up transformers 70 and 91, transformer 70 having its secondary winding connected to the grid of the first thermionic tube 86, and transformer 91 having its primary winding connected to the plate of the first thermionic tube 86 and its secondary winding connected to the grid of the second thermionic tube 87. Suitable connections may be provided, as indicated, between the various parts of the above described amplifying means and the usual A, B, and C batteries, for supplying the necessary electric current or voltage thereto.

The reproducing unit may be connected by wires 93 and 94 to the input terminals of the amplifying system for example in this case to the primary terminals of transformer 70. A rheostat or adjustable resistance means 95 may be included in one of the wires 93 or 94 for the purpose of regulating the current flow therein and hence regulating the volume of sound produced. The output terminals of the amplifying system may be connected by wires 96 and 97 to the loud-speaking receiving unit 12 above described. The amplifying system above described may be a separate amplifying system and may be located at any suitable point within or convenient to the phonograph. For example in Fig. 1 the electrical amplifier is shown as located within a separate box or cabinet 98 located adjacent the phonograph cabinet. The wires 93, 94, 96, and 97 leading to and from the amplifier may be enclosed in a suitable connecting cable or cord 99 which may be brought into the phonograph cabinet in any suitable manner and may extend along beneath the tone arm 3, being supported thereon in suitable manner, as by means of supporting clamps or brackets 101. Said connecting cable or cord may have two branches 102 and 103, the former containing wires 93 and 94 and extending through an opening 105 in the side of casing 23 so as to permit connection of wires 93 and 94 to binding posts 49 and 51, and the latter extending through an opening 106 in the casing 61 of the loud-speaking receiver so as to permit connection of wires 96 and 97 to binding posts 78 and 79.

In applying the above described device to the mechanically reproducing phonograph the sound box 6 and connecting tube 7 may be removed and the tubular portion 10 of the device inserted within the tubular bearing member 8 at the end of the tone arm. The reproducing device is then mounted on the other end of the tubular member 10 by inserting pin 17 through groove 19 and into groove 18, the loud-speaking receiver being if necessary lifted off of its support 75 and swung upwardly so as to permit said pin to be so inserted. Retaining screw 21 is then screwed into position to hold the members in the position shown and the electrical connections are made as above described.

In the operation of the above-described apparatus a phonograph record indicated at 5 is placed on the record-carrying plate 2 and is set in rotation at the proper speed in the usual manner. The reproducing element 15 is then lowered onto the record so as to cause needle or stylus 42 to engage and traverse the grooves of the record. It will be seen that when the reproducing device is thus lowered onto the record the pin 17 comes into engagement with stop means 20 at the upper end of the groove 18 slightly before the needle or stylus 42 engages the record so that the last portion of the down-

ward motion of the reproducing device causes the loud-speaking element 12 to be lifted off of its supporting means 75. The weight of the loud-speaking element thus serves to partly counterbalance the weight of the reproducing element, these two elements being at this time pivoted about the substantially horizontal axis of tubular member 8. A very light pressure of the needle or stylus upon the phonograph record is thus obtained in spite of the considerable weight of the reproducing device, such light pressure being desirable in that it minimizes scratching and other objectionable noises and permits the needle or stylus to vibrate freely.

The undulations or impressions in the groove of the record which is adapted to be used with the particular reproducing device shown extend transversely of the groove so as to cause the point of the needle to move rapidly back and forth in the direction of such undulations and such motion of the needle causes rocking motion of bridge 36. Such motion is transmitted through link member 44 to armature 32 which is thus caused to vibrate or rock about its mid-line or the line upon which suspension wires 33 are connected. In such vibration of armature 32 the respective ends thereof are brought alternately closer to and further away from the respective pole pieces 29 and 31 so that an alternating magnetic flux is created within said armature. Small alternating or variable electrical impulses corresponding in frequency and magnitude to the vibration of the armature and hence to the movement of the needle are thus induced in coil 48 and such current is supplied through wires 93 and 94 to the amplifying system above described. The strength of the current impulses so supplied may be adjusted by operation of rheostat 95 so as to give the desired volume of sound production.

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 within the output circuit including wires 96 and 97 alternating or variable current impulses corresponding to but of much greater intensity than the electrical impulses initially set up in coil 48. Such electrical impulses pass through coil 74 cause an alternating magnetic fluxing to be set up in armature 71 of the loud-speaking receiver 12 so that the opposite ends of said armature are alternately charged positively and negatively and are caused to move toward and away from the respective pole pieces 66 and 67. The resulting rocking motion of armature 71 is transmitted through link member 82 to diaphragm 81 causing said diaphragm to vibrate and produce sound waves corresponding in frequency, intensity, and modulation to the original impressions or undulations on the phonograph record and hence to the original sound which it is desired to reproduce. Such sound waves pass through the tubular arm 11 into the interior of the member 10 and thence out through opening 9 into the tone arm 3 and through said tone arm and the phonograph horn to the ears of the listeners.

When it is desired to remove the record, the reproducing unit 15 may be lifted off the record. When lifted beyond a certain point, the receiving unit 12 comes to rest upon supporting means 75, and in the further upward movement of the reproducing unit, pin 17 moves in groove 18 and the reproducing unit moves independently of the receiving unit. In order to permit changing of the needle or stylus, the reproducing unit may be swung back and over so as to rest upon the tone arm 3.

The application of the device according to my invention to a mechanically reproducing phonograph in order to enable the same to reproduce sound electrically is of great advantage as it is well-known that the reproduction of sound from a phonograph record can be accomplished much more perfectly through the use of an electrical reproducing device associated with electrical amplifying means and a loud-speaker connected thereto than by means of the ordinary mechanically actuated diaphragm or sound box.

It is to be understood, as above mentioned, that any suitable type of electrical reproducing device adapted to produce electrical impulses corresponding to the impressions of a phonograph record and any suitable means for producing sound in response to current impulses supplied thereto may be employed in connection with my invention instead of the particular reproducing and receiving elements above-described. Furthermore many modifications may be made in the manner of mounting said devices with respect to one another and with respect to the tone arm of the phonograph, it being essential however to my invention that said two elements are so mounted that the receiving element partially counterbalances the reproducing element when in playing position and that the tone arm of the phonograph serves not only to support both of said elements but also to convey the sound produced by the receiving element through the phonograph horn. It will accordingly be understood that in applying my invention to phonographs having other types of tone arms than the above described suitable modifications may be made in the means of mounting the reproducing and receiving elements so as to conform to the

shape and construction of said tone arm while preserving the above mentioned essential relation. It is to be further understood that the reproducing element may be so constructed as to provide for movement or vibration of the needle or stylus in any desired direction corresponding to the direction of the undulations of the phonograph records with which it is to be employed.

I claim:

1. An apparatus for sound reproduction comprising supporting means mounted to swing horizontally across and above a phonograph record, an electrical reproducing device pivotally mounted on the outer end of said supporting means, and an electrical receiving device pivotally mounted on the outer end of said supporting means, said reproducing device and said receiving device being mounted to swing about a common substantially horizontal axis and being mounted at opposite sides of said axis and being mechanically interconnected in such manner that the receiving device partially counter-balances the reproducing device.

2. In combination with the tone arm of a phonograph, said tone arm being mounted to swing horizontally across and above a phonograph record, an electrical receiving device mounted at the outer end of said tone arm so as to swing about a substantially horizontal axis, means for directing sound from said receiving device into said tone arm, and an electrical reproducing device also mounted at the end of said tone arm so as to swing about the aforesaid axis, said reproducing device and receiving device being located at opposite sides of said axis, and said reproducing device being free to swing upwardly independent of said receiving device and having means adapted to engage means connected to said receiving device, upon lowering the reproducing device into position to engage a record, so as to cause the receiving device to partially counterbalance the reproducing device.

3. An apparatus comprising in combination with the tone arm of a phonograph, fixed supporting means secured to said tone arm, an electrical receiving device pivotally mounted at the outer end of said tone arm so as to swing about a substantially horizontal axis and in such position as to rest when lowered, upon said fixed supporting means, means for directing sound from said receiving device into said tone arm, an electrical reproducing device pivotally mounted at the end of said tone arm to swing about said axis, said reproducing and receiving device being mounted at the opposite sides of said axis, and means mechanically interconnecting said reproducing and receiving devices in such manner as to permit the reproducing device to be swung upwardly independently of the receiving device so that the receiving device is lowered into position on said fixed supporting means while causing the reproducing device when lowered into a certain position to lift the receiving device off of said fixed supporting means in such manner as to cause said receiving device to partially counterbalance the reproducing device.

4. In combination with a phonograph tone arm having a substantially horizontal tubular member at its outer end, a hollow arm having a portion adapted to fit rotatably within said tubular member and opening into said tone arm, an electrical receiving device connected at one end of said hollow arm to direct sound into said hollow arm, an electrical reproducing device mounted to swing in a substantially vertical plane on said hollow arm and having means for carrying a phonograph needle, and means connected to said reproducing device and adapted, when the reproducing device is lowered beyond a certain point, to engage means connected to said hollow arm so as to cause the receiving device to move with the reproducing device and partially counterbalance the same.

5. An apparatus for attachment to phonographs comprising a bearing member provided with a portion adapted for mounting on the tone arm of a phonograph and with a hollow arm having means for communication with said tone arm, an electrical receiving device mounted on said hollow arm to direct sound into the same, an electrical reproducing device mounted to swing on said bearing means and having means for carrying a phonograph needle, and means connected respectively to said bearing member and to said reproducing device and adapted to permit limited swinging movement of said reproducing device independently of said receiving device and to engage one another when the reproducing device is swung beyond a certain point so as to cause the receiving device to swing with the reproducing device.

6. An apparatus for sound reproduction comprising supporting means, an electrical reproducing device pivotally mounted on said supporting means, an electrical receiving device pivotally mounted on said supporting means, and means electrically connecting said electric reproducing device to said electrical receiving device, said reproducing device and said receiving device being mounted to swing about a common substantially horizontal axis and being mounted at opposite sides of said axis and being mechanically interconnected in such manner that the receiving device partially counterbalances the reproducing device.

7. In combination with the tone arm of a phonograph, an electrical receiving device mounted at the outer end of said tone arm so as to swing about a substantially horizontal

axis, means for directing sound from said receiving device into said tone arm, an electrical reproducing device also mounted at the end of said tone arm so as to swing about the aforesaid axis, and means electrically connecting said reproducing device to said receiving device, said reproducing device and receiving device being located at opposite sides of said axis, and said reproducing device having means adapted to engage means connected to said receiving device so as to cause the receiving device to partially counter-balance the reproducing device.

In testimony whereof I have hereunto subscribed my name this fourth day of May, 1926.

KENNETH I. MARSHALL.