Feb. 19, 1929. 1,702,438

J. S. HIGH

REPRODUCING DEVICE

Filed April 30, 1927

Fig.1.

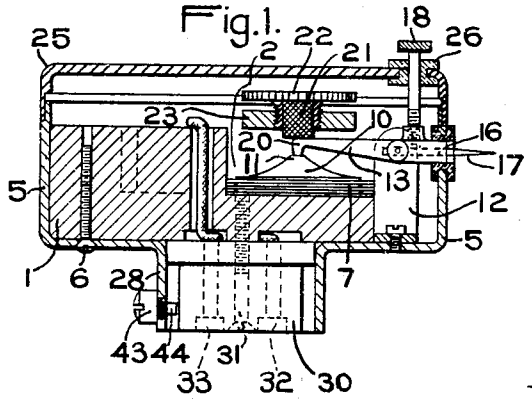


Fig 3.

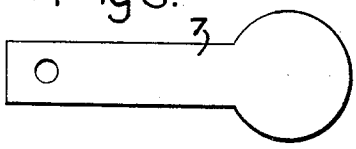


Fig.4.

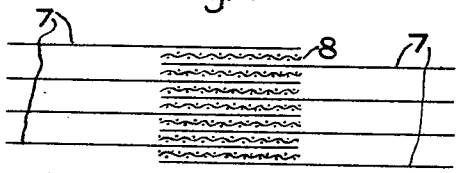


Fig.2.

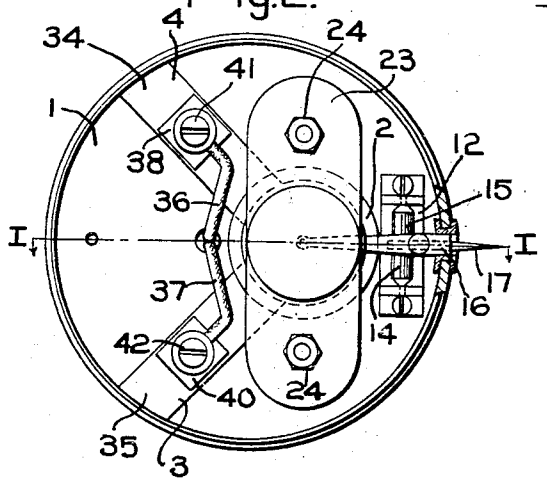


Fig.5.

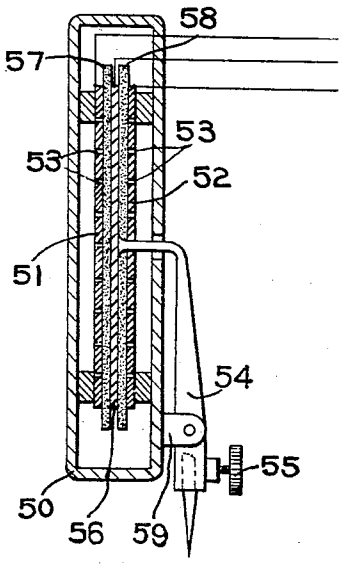
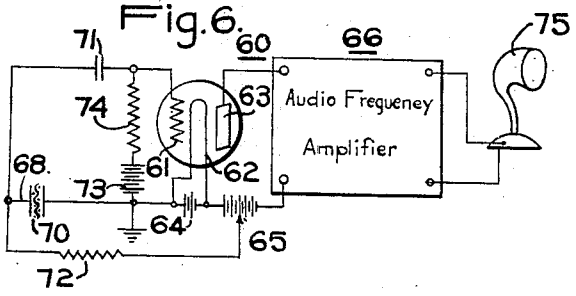


Fig.6.



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UNITED STATES PATENT OFFICE.

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REPRODUCING DEVICE.

Application filed April 30, 1927. Serial No. 187,800.

My invention relates to reproducing devices and more particularly to "pick-up" devices designed and intended to translate the sinuosities of the usual phonograph record into electrical fluctuations that are subsequently amplified and utilized to actuate a loud-speaking telephone or its equivalent.

One object of my invention is to provide a "pick-up" device that is responsive to the highest harmonic frequencies accompanying instrumental or vocal music.

Another object of my invention is to provied a "pick-up" device that will not overemphasize any particular frequency.

Another object of my invention is to provide a "pick-up" device that may be easily adjusted to preferentially respond to high or low frequencies.

Another object of my invention is to provide an improved "pick-up" device of the electrostatic type.

Another, and more specific, object of my invention is to provide an electrostatic "pick-up" device in which is incorporated damping means that is equally effective over a wide range of sound frequencies.

At the present time, there is a very decided tendency toward the electrification of phonograph reproducing devices. In other words, instead of having the phonograph reproducer convert the sinuosities of the record directly into sound, they are first translated into electrical potential, or current, fluctuations which, in turn, are utilized to control a thermionic amplifying system similar to those now well known in connection with radio receiving apparatus. A system of the type referred to is shown in the patent to Jones, No. 1,531,252, to which reference may advantageously be made.

The "pick-up" devices heretofore used have been of four general types, electrodynamic, electromagnetic, microphonic, and electrostatic. The electrodynamic type is exemplified in the Jones patent, the electromagnetic type is shown in a patent to Egerton, 1,284,623, the microphonic type in a patent to Moore, 1,583,067, and the electrostatic type in a patent to Groenbaum, 1,544,001.

My invention is concerned primarily with the electrostatic pick-up, or reproducer, such as is shown in the Groenbaum patent, and is in the nature of an improvement thereon. Specifically, I interpose sheets of textile damping material between the condenser-electrodes, and further provide resilient means whereby the initial pressure on the said electrodes may be fixed in order that the sensitivity of the device may be altered to suit the individual record it is desired to reproduce.

Among the novel features of my invention are those particularly set forth in the appended claims. The invention in its generic aspect, however, as well as further objects and advantages thereof, will best be understood by reference to the following description of certain specific embodiments taken in connection with the accompanying drawings, in which

Figure 1 is a cross-sectional view of a preferred embodiment of my invention, taken along a line approximating the line I—I of Fig. 2;

Fig. 2 is a top plan view of the same embodiment of my invention, showing the appearance of the device with the cover plate removed;

Fig. 3 is a plan view of a single condenser-plate element;

Fig. 4 is a diagrammatic elevational view of an assembly of condenser elements illustrating the textile dielectric interposed therebetween;

Fig. 5 is a view, partly in elevation and partly in cross-section, of an alternative form of my invention adapted for pushpull operation; and

Fig. 6 is a schematic view illustrating the manner in which a condenser type pick-up device may be associated with an audio-frequency amplifier.

Referring specifically to Figures 1, 2, 3 and 4, a preferred embodiment of my invention comprises a circular block 1 of insulating material provided with a cylindrical recess 2 with which are connected two rectangular recesses 3 and 4. The block 1 of insulating material is nested in a circular metallic casing 5 and held in position by a plurality of screws 6.

A plurality of metal-foil condenser plates 7 shaped as shown in Fig. 3, are positioned with their large ends resting in the cylindrical recess 2 and the elongated portions of each alternate plate lying in the rectangular recesses before mentioned. Between adjacent condenser plates is interposed a dielectric element 8 having damping properties, and, for this purpose, I have found silk to be the best

material. A conical member 10, preferably of bakelite or other insulating material and having a cup shaped depression 11 at its apex, rests upon the stack of condenser plates positioned in the cylindrical recess.

A self-adjusting bearing member 12 is affixed to the casing member and adjacent to the cylindrical recess by means of a plurality of screws or analogous devices.

A needle-carrying member 13 is provided with a plurality of trunnion members 14 and 15 having reduced conical end portions, by means of which the member 13 is mounted for oscillatory movement between the upstanding portions of the bearing member 12. The upstanding portions of the bearing member 12 are resilient and exert a pressure axially on the trunnion members 14 and 15. I characterize this bearing member as "self-adjusting", since all wear on the trunnion members 14 and 15 and all wear of the said bearing members within reasonable limits is compensated by the resilience of the said upstanding portions. In other words, the contact between the trunnions and the upstanding portions remains sufficiently tight during the entire life of the device to prevent it from rattling during operation. The needle-carrying member is provided with an axial opening 16 into which may be inserted a phonograph needle 17 which is maintained in adjusted position by means of a set screw 18.

The end of the driving member 13 opposite the needle-receiving opening is provided with a depending portion 20 which rests in the depression 11 formed in the apex of the conical member 10 and is retained thereagainst by means of a resilient element 21 carried by a screw-threaded device provided with a knurled adjusting head 22. The screw-threaded device is, in turn, carried by a member 23 which is affixed to the upper surface of the block of insulating material, straddling the cylindrical recess and being held in position by a plurality of bolts 24.

A cover plate 25 is provided which may either have a threaded connection with the casing 5 or may merely be press-fitted thereon. The needle-holding set screw 18 projects through an opening in the cover member and, at the point where it extends through the said member, it is surrounded by a flexible moisture-proof bushing 26, preferably made of soft rubber or of an analogous material.

The end of the driving member 13 which carries the phonograph needle projects through an opening in the side wall of the casing 5 and is also surrounded by a flexible waterproof bushing 27 at the point where it extends through the said wall.

The casing 5 is provided with a cylindrical extended portion 28 in which a block of insulating material 30 is held by a bolt 31. This block of insulating material carries a plurality of contact members 32 and 33 which are connected to the condenser-plate extensions 34 and 35, respectively, by means of conductors 36 and 37 which are firmly held in electrical contact with the said condenser-plate extensions by means of clamping plates 38 and 40 through which extend bolts 41 and 42.

It will be noted that the block 30 of insulating material is slightly less in diameter than the cylindrical extension 28 of the casing, the space therebetween being left to accommodate the small end of the usual phonograph tone arm. A screw 43, having a reduced end portion 44, extends through one side of the cylindrical extension 28 and is arranged to cooperate with the bayonet slot which is part of the standard equipment of substantially all phonograph tone arms.

When the device is to be used in connection with an electrical phonograph, the phonograph tone arm (not shown) is preferably provided near the interior of the small end thereof with a plurality of resilient contact members which cooperate with the members 32 and 33 carried by the insulating block to complete an electrical circuit.

Fig. 5 is a view illustrating a modification of my invention in which a single relatively rigid plate is arranged to be movable with respect to two fixed plates in order that the device may be utilized in the push-pull manner. This modification of my device comprises a casing 50 in which are fixedly mounted a plurality of plates 51 and 52 having any desired contour, and being provided with a plurality of passage-ways 53. The casing is provided with a resilient bearing device, comprising a plurality of upstanding ear members 59 between which is trunnioned a needle-carrying arm 54 provided with a needle-retaining set screw 55. The end of the arm opposite the needle-holding portion is bent at right angles to the long axis of the member and terminates in a relatively rigid plate 56 having a contour approximating the same as that of the fixed plates. Dielectric members, 57 and 58, preferably composed of silk, are interposed between the movable plate and the fixed plates.

The material composing the dielectric members 57 and 58, and the number and size of the openings 53 through the fixed plates 51 and 52 are so chosen that the device will have an even response over a wide range of sound frequencies.

Previous to my invention, it was proposed by Moore and disclosed in Patent No. 1,583,067, to interpose elastic coupling and damping means between the driving and the driven members of a pick-up device of the microphonic type. The coupling referred to preferably comprised a plurality of sheets of metal foil or paper loosely packed between the driving and the driven elements and serving to

dissipate sufficient of the impressed energy to provide the desired amount of damping. Such an arrangement has not been found to be efficient when the driven member is arranged to alter the capacity of a variable condenser in response to a phonograph record, for the reason that the higher harmonic frequencies are entirely lost, and objectionable noises are introduced.

According to my invention, I secure the requisite amount of damping by utilizing, as a dielectric between the condenser plates, a material such as silk, or the like. The damping effect I accordingly obtain is quite different from that obtained when paper is used as a damping material. The air entrained between the several condenser plates, when forced to escape radially under pressure transmitted to the plates from the driving member, encounters, in its passage, not only the friction between the various plates but also a definite amount of friction in the interior of the damping material itself. I am not prepared, at this time, to give the exact theory on which my device operates; I can state only that, as the result of numerous experiments and extensive observation, the interposition of textile damping material between the condenser plates gives rise to a much more even response at all necessary frequencies than any other type of damping means.

The resilient element 21 carried by the screw-threaded member serves to maintain the rounded end 20 of the driving member 13 in intimate contact with the cone-shaped driven member 10 and also has the additional function of providing an initial adjustment of the sensitivity of the device. The response to differing frequencies may be materially changed by the exertion of more or less pressure on the free end of the driving member. This pressure alters the average or non-operating capacity of the condenser stack and also interposes a certain amount of resistance to the excursions of the driving member. It is thus possible to adjust the response of the pick-up device to suit the requirements of the phonograph record being reproduced, if desirable. In the event that the device is to be so arranged that it may be adjusted at will by the user, it is preferable that the knurled head 23 shall be accessible from the outside of the cover member 25. This modification is not shown, inasmuch as it is believed to be obvious.

The rubber gaskets interposed between the driving member and the casing and between the needle-holding set screw and the cover plate also assist to some extent in limiting the excursions of the driving member and introduce a certain amount of resistance to the said excursions. I have found these gaskets to be desirable in certain cases, but it lies within the scope of my invention to omit them entirely.

The manner in which my device is electrically connected to an amplifying system forms no part of the present invention. One possible mode of connection is exemplified in Fig. 6, which figure is substantially a copy of Fig. 2 of the patent to Fitch 1,307,862. A thermionic device 60 having a grid 61, a filament 62, and a plate 63 is provided with a source 64 of filament potential and a source 65 of plate potential, the plate or output circuit being connected in any well known manner to an audio-frequency amplifier 66. An electrostatic pick-up device comprising a plurality of electrodes 67 and 68 having textile or discontinuous dielectric material 70 therebetween, has one electrode thereof connected to the grid 61 of the thermionic device through a condenser 71 and the other electrode thereof connected to an intermediate point on the plate potential source 65 through a resistor 72. The pick-up device is illustrated as having but two electrodes, instead of the larger member actually used, this manner of illustration being chosen for convenience.

The grid of the thermionic device is maintained at the preferred operating potential by means of a C battery 73 and a gridleak resistor 74 connected between the said grid and the filament.

In the operation of the system shown in Figure 6, when the reproducing stylus or needle is caused to vibrate by following the groove on the record (not shown) this motion is transmitted to the condenser assembly and causes proportional changes in the capacity thereof. The variations in capacity of the condenser causes a corresponding variation in the charge on the blocking condenser 71 which, in turn, sets up potential variations on the grid. The potential variations are amplified in the plate circuit of the device and are further amplified in the audio-frequency amplifier and may be then utilized to actuate a loud speaker 75 of any conventional design.

By reason of the fact that the damping means I have provided is substantially as effective for high as for low frequencies, it has been found that the sound output from an amplifier energized by my improved pick-up device is practically free from distortion. In addition to the inherent characteristics of the condenser stack with its interposed textile dielectric, I have so arranged the driving member that it will have no natural period which corresponds to any frequency within the usual range of vocal or instrumental music.

I have accordingly provided an electrical reproducing device which will faithfully render all of the delicate overtones and hormonics accompanying the music recorded on phonograph records and one which is not subjected to appreciable deterioration during use.

Although I have illustrated and described only two specific embodiments of my invention, it is my understanding that many variations thereof are possible. My invention, therefore, is not to be limited except in so far as is necessitated by the prior art and by the spirit of the accompanying claims.

I claim as my invention:

1. A vibration responsive device comprising a driving member mounted in a self adjusting bearing, a driven member, a variable condenser having a discontinuous dielectric under the control of said driven member and resilient means for maintaining a portion of said driving member in contact with said driven member.

2. A vibration responsive device comprising a driving member adapted to receive a phonograph needle or analogous element, a driven member, a variable condenser under the control of said driven member, resilient means for maintaining a portion of the driving member in contact with the driven member and resilient means for limiting the excursions of the driving member.

3. A phonograph pick-up device comprising a driving member adapted to receive a phonograph needle, a driven member adapted to be actuated thereby, a variable condenser having a textile dielectric and so disposed with respect to said driven member that its capacity may be altered in response to movements thereof, and means for adjusting the average position of said driven member with respect to said variable condenser.

4. A phonograph pick-up device comprising a variable condenser having a plurality of plates with discontinuous resilient dielectric interposed therebetween, means comprising a driven member and a driving member adapted to receive a phonograph needle, said means being so disposed with respect to said variable condenser that the capacity thereof may be altered in respect to acoustic frequency vibrations received by said driving member from a phonograph record, and resilient means for adjusting the average capacity of said condenser.

In testimony whereof, I have hereunto subscribed my name this 21st day of April, 1927.

JURJEN S. HIGH.