

June 7, 1938.

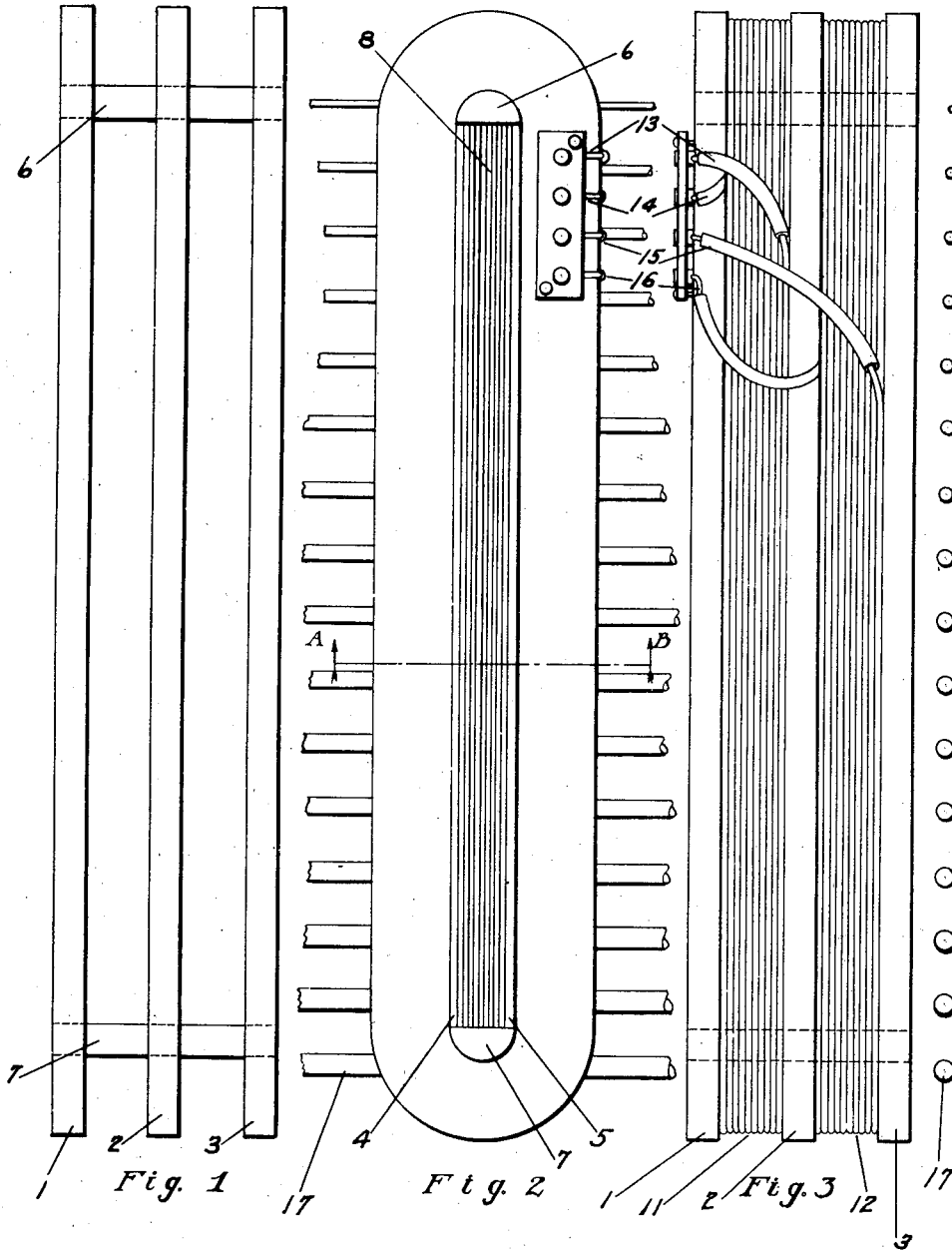
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2,119,584

PICK-UP DEVICE FOR ELECTRICAL MUSICAL INSTRUMENTS

Filed Dec. 9, 1935

2 Sheets-Sheet 1



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PICK-UP DEVICE FOR ELECTRICAL MUSICAL INSTRUMENTS

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2 Sheets-Sheet 2

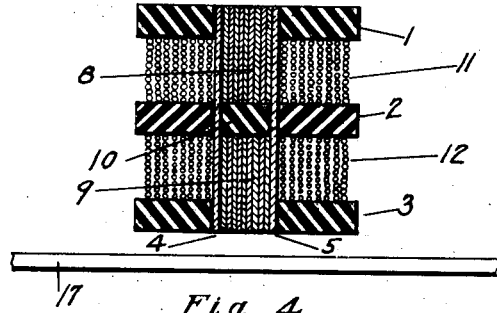


Fig. 4

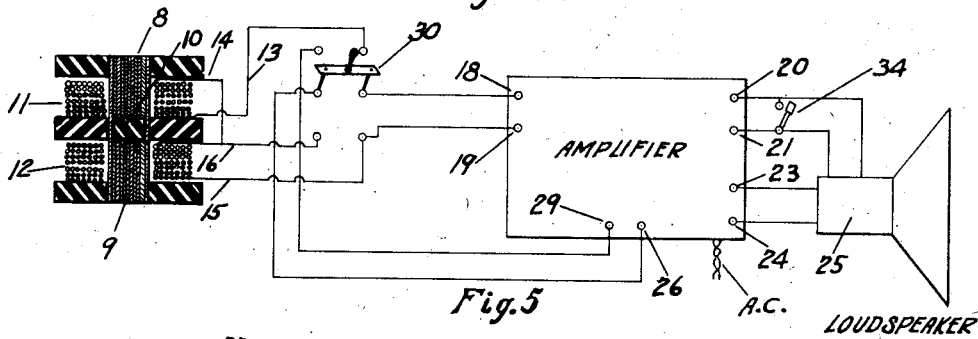


Fig. 5

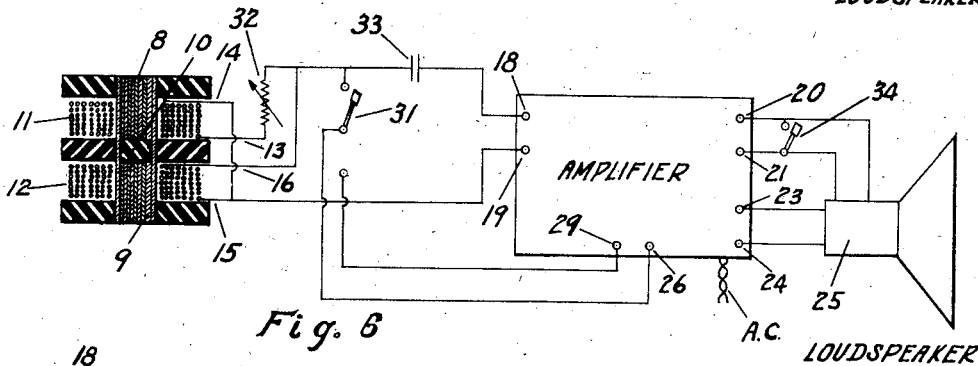


Fig. 6

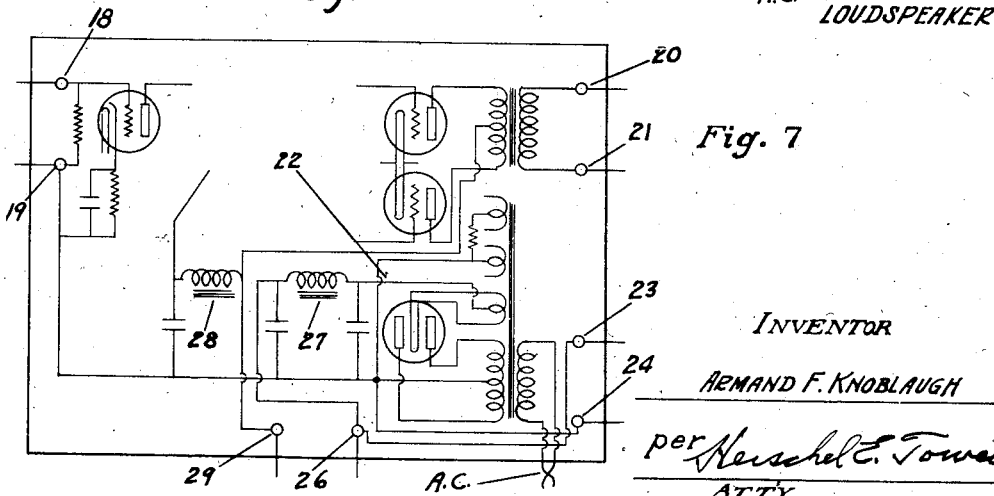


Fig. 7

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UNITED STATES PATENT OFFICE

2,119,584

PICK-UP DEVICE FOR ELECTRICAL MUSICAL INSTRUMENTS

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Application December 9, 1935, Serial No. 53,589

5 Claims. (Cl. 84—1)

My invention relates to features of an electromagnetic pick-up structure for an electrical musical instrument; namely, the producing of magnetic poles on tuned vibrators of magnetic material, the translation of the motion of the vibrators into corresponding electromotive forces, and the provision of a structure of such a nature as to be insensitive to stray electric and magnetic fields.

The electromotive forces generated in an electromagnetic pick-up device of an electrical musical instrument employing tuned vibrators have been found to be very small. In order to hear these induced electrical vibrations reproduced as musical tones from a loudspeaker of conventional type, some form of amplification involving thermionic vacuum tubes is necessary.

In general, the supply of electrical power for an amplifier can be furnished most economically and conveniently when a commercial source of supply is used; batteries require frequent inspection and replacement and there are obvious disadvantages in the use of other types of purely local power sources.

In an electrical musical instrument for use in a home, there are often advantages in placing the amplifier and loudspeaker in the case or cabinet of the instrument proper. When this is done, however, the amplifier and speaker will have been placed rather near the pick-up device. Since commercial electric mains usually supply alternating current, the pick-up device will be exposed to stray alternating electric and magnetic fields, due mainly to the leakage flux from the amplifier power transformer, to a lesser degree to flux from the choke coils of the amplifier filter system and from the loudspeaker field coil (in which structures there are usually some residual alternating currents flowing) and from any other sources in the vicinity. These stray fields act upon the pick-up device to produce an alternating electromotive force, which is amplified and reproduced as an objectionable hum.

The effect of the stray electric fields can be reduced satisfactorily by an electrostatic shield enclosing the pick-up structure. Magnetic shielding, however, has not been found to be so effective, and is not convenient to employ in my invention, as will be obvious in my future description. Therefore, another principle must be used to minimize the effect of the stray magnetic fields; the employment of this principle is the main object of this invention. This and other objects which will be evident to those reading this specification,

I shall now explain and shall describe my invention in detail.

In the drawings which form a part hereof:

Fig. 1 is a side view of the form on and in which are placed the elements of the pick-up device to be described.

Fig. 2 is a plan view of the assembled structure, showing in proximity the tuned vibrators, exemplarily indicated here as tuned strings.

Fig. 3 is a side view, showing the adjacent strings, in section.

Fig. 4 is a cross-section taken on A—B of Fig. 2.

Figs. 5 and 6 are wiring diagrams, showing two schematic arrangements for connecting the device to an amplifier.

Fig. 7 is a partial wiring diagram of an amplifier.

In making a pick-up device in accordance with my invention, holders 1, 2 and 3, of insulating material and having in each a central lengthwise slot, are properly spaced on two insulating strips 4 and 5, inserted and spaced apart in the slots of holders 1, 2 and 3. At the ends of the strips 4 and 5 are inserted half-round pieces 6 and 7, thus completing smooth forming surfaces.

In the space between the strips 4 and 5 and end pieces 6 and 7, two sets of silicon steel laminations 8 and 9 are fit tightly and spaced apart therein by an insulating, non-magnetic piece 10.

In the space between holders 1 and 2, on the smooth surface formed by strips 4 and 5 and half-round pieces 6 and 7, and around the laminated steel core 8, is placed a coil 11 of fine, insulated copper wire. In a similar manner a coil 12 of the same kind of wire is placed in the space between holders 2 and 3 on the surface formed by strips 4 and 5 and half-round pieces 6 and 7, and around the laminated steel core 9. The end wires 13 and 14 of the coil 11 and the end wires 15 and 16 of the coil 12 may be conveniently attached to terminal posts set in an insulating plate, as clearly shown in Figs. 2 and 3. An electrostatic shield of metal, not shown, can be used to enclose the device.

The structure thus formed can be mounted adjacent to a set of tuned strings 17 in any suitable manner (for example, as shown in my U. S. Patent No. 2,015,363 issued September 24, 1935) and can be employed to magnetize the strings, as I shall later describe. The strings can be tuned to the pitches of a musical scale and can be set in motion by the impact of hammers as is done in instruments of the piano type, or can be excited in any other well known manner.

The motions of the magnetized strings (and

strings composed of the high carbon steel used for piano wire will retain their magnetism for a considerable length of time) and the consequent motions of the flux from the magnetic poles on the strings, cyclically toward and away from the pick-up device, induce corresponding electromotive forces in the coils 11 and 12 by electromagnetic induction, which can be amplified and reproduced as musical tones. It is to be noted particularly, in this respect, that essentially all of the induced electromotive forces are generated in the coil 12 which is nearer to the strings 17 (see Figs. 3 and 4) and that very little of the electromotive forces are generated in the farther coil 11, because of its greater distance from the strings and the magnetic isolation effected by the nonmagnetic piece 10.

The principal object of my invention is the elimination of effects caused by stray magnetic fields and such elimination can be brought about by the employment of the device of my invention, without affecting its sensitivity to the motion of the adjacent magnetized strings. For example, let the coils 11 and 12 be identically constructed and be connected in series in an opposite sense. According to the attached drawings (see in particular Fig. 3) this is done by joining the terminals of wires 14 and 16, the terminals of wires 13 and 15 becoming the output terminals of the device. The induction of electromotive forces by stray magnetic fields into coil 12 is then counterbalanced, part by part, by the induction of equal and opposite electromotive forces into coil 11, with the result that any reproduced extraneous noises, such as hum, are essentially eliminated. The functioning of the device as a pick-up structure is not affected, however, as has been explained in the preceding paragraph. It is to be noted, in this respect, that in practice, the cross-sectional dimensions of the device (such as the dimensions of Fig. 4) would be small as compared with the distance from it to any source of stray magnetic flux, but that these cross-sectional dimensions are large as compared with the distance from the strings to the device.

The main object of my invention can be also accomplished by connecting the two coils in parallel in an opposite sense. This can be done by joining the terminals of wires 13 and 16 to form one output terminal and by joining the terminals of wires 14 and 15 to form the other output terminal of the device.

In Fig. 7 is shown a partial wiring diagram of an amplifier. As the principles of operation of this amplifier are well known to those acquainted with the art and will be understood on examining this specification, I shall not describe it in complete detail, except to note that it has input terminals 18 and 19, output terminals 20 and 21, a rectifier-filter system 22, terminals 23 and 24 for supplying rectified current to a field coil 25 of a loudspeaker, and a terminal 26 which can be used (in conjunction with a return terminal such as 19) for supplying rectified current for magnetically charging the strings 17, with the use of the device of this invention.

As it is necessary to supply current for magnetic charging only for short periods of time, I have arranged that this current be furnished by diverting, when necessary, a part of the output current of the rectifier-filter system 22. This I accomplish by effecting external to the amplifier the connection between the first choke coil 27 and the second choke coil 28, of the system 22, by means of the terminal 26, attached to the output

point of the coil 27, and a terminal 29 attached to the input point of the coil 28. This connection can be made and broken by a switching arrangement.

In Fig. 5 is shown one such switching arrangement, with the co-related connections to the amplifier and pick-up device. When the double-pole-doublethrow switch 30 is placed in the downward position of Fig. 5, rectified current is conducted from the system 22 through the terminal 26, through coil 12 (the coil nearer to the strings) and through the return terminal 19 to furnish rectified current for magnetically charging the strings. For quietness of operation during the charging process, the input terminals 18 and 19 of the amplifier are connected together by the switch 30.

By placing the switch 30 in the upward position, terminals 26 and 29 are connected together, thus supplying rectified current to the amplifier, and end wire 13 of coil 11 is connected to the input terminal 18, allowing the device to function as a pick-up structure in accordance with my invention, coils 11 and 12 being connected in a series arrangement, end wire 14 being permanently attached to end wire 16, as shown.

In Fig. 6 is shown another arrangement. When the singlepole-doublethrow switch 31 is placed in the upward position, current is conducted from the system 22 through the terminal 26, through coils 11 and 12, and through the return terminal 19 to furnish charging current. By placing the switch 31 in the downward position the terminals 26 and 29 are connected together, supplying rectified current to the amplifier and allowing the structure to operate as a pick-up device in association with amplifying and reproducing means, the coils 11 and 12 being connected in a parallel arrangement, as shown. For simplicity, in Fig. 6, as also in Fig. 5, I have omitted the terminal posts and plate shown in Figs. 2 and 3.

In series with the end wire 13, of Fig. 6, is an adjustable resistance 32, which can be used to compensate for any electrical unbalance in the construction and assembly of coils 11 and 12. With the use of the resistance 32 as shown and with the coils 11 and 12 in a parallel arrangement it is not necessary that the coils be essentially identical. Coil 11 may have more turns and a greater inductance than coil 12; the resistance 32 can be employed to compensate for any lack of proportionately greater resistance of coil 11, and the device will function according to the teachings of my invention.

In Fig. 6 is shown a condenser 33. This serves to isolate the input system of the amplifier from the current of the magnetic charging process.

In both Figs. 5 and 6 are shown a switch 34, which can be used to short-circuit the output circuit of the amplifier, eliminating any of the reproduced noises caused by the operation of the switches 30 and 31. Many modifications in the construction of the switches 30, 31 and 34 are possible, the diagrammatic types shown being merely for clarity of description. One modification that I have found advantageous is operative to link the switch 34 and switch 30 (or 31). Such linking insures that the switch 34 be closed preceding the operation of the switch 30 (or 31) from the pick-up position to the charging position and that it be opened after the operation of the switch 30 (or 31) from the charging position to the pick-up position.

An additional modification that I have found advantageous for quietness of operation pertains

to the switch 30. This switch can be so constructed that in the operation from the pick-up position to the charging position, the following sequence is obtained: first, the input terminals 18 and 19 are connected together, then, the end wire 13 is disconnected from the input terminal 18, and terminals 26 and 29 are disconnected, and finally, the terminal 26 is connected to coil 12 through the end wire 16. In the operation from the charging to the pick-up position, the reverse of the above sequence occurs.

Many modifications may be made in structural features and wiring arrangements and still come within the scope of my invention. What I claim as my invention is:

1. In a musical instrument, the combination of a plurality of tuned magnetized vibratile members arranged substantially in a plane and a pick-up device for said members, said pick-up device including a frame work arranged transverse to said members, a coil of wire on said frame work in proximity to said members, a second coil of wire on said frame work and disposed between said first-mentioned coil and said members, the two said coils being electrically connected in phase opposition.

2. In a musical instrument, the combination of a series of tuned magnetized strings arranged substantially in a plane and a pick-up device for said strings, said pick-up device including a framework arranged in proximity and transverse to said strings, a coil of wire on said framework in proximity and transverse to said strings, a second coil of wire on said framework transverse to said strings, said second coil being located between said first-mentioned coil and said strings, the two said coils being electrically connected in phase opposition.

3. In a musical instrument, the combination of a series of tuned magnetized strings arranged substantially in a plane and a pick-up device for said strings consisting of a framework in proximity and transverse to said strings, a coil of wire of substantially planar turns on said frame-

work in proximity and transverse to said strings, the planes of which turns are substantially parallel to the plane of said strings, a second coil of wire of substantially planar turns on said framework transverse to said strings, the planes of said second turns being substantially parallel to those of said first turns, said second coil being located between said first coil and said strings, the two said coils being electrically connected in phase opposition.

4. In a musical instrument, the combination of a series of tuned vibratile magnetic members arranged substantially in a plane, means for magnetizing said members, and a pick-up device for said members including a framework arranged transverse to said members, a coil of wire on said framework in proximity to said members, a second coil of wire on said framework and disposed between said first-mentioned coil and said members, the two said coils being electrically connected whereby said second coil comprises a means for translating the motions of said members into electromotive forces and said first coil comprises a means for neutralizing any stray hum induced in said second coil.

5. In a musical instrument, the combination of a series of tuned vibratile magnetic members arranged substantially in a plane, means for magnetizing said members, and a pick-up device for said members, said pick-up device including a framework arranged transverse to said members, a coil of wire on said framework in proximity to said members, a core of magnetic material encompassed by said coil, a second coil of wire on said framework and disposed between said first-mentioned coil and said members, a second core of magnetic material encompassed by said second coil, the two said coils being electrically connected whereby said second coil comprises a means for translating the motions of said members into electromotive forces and said first coil comprises a means for neutralizing any stray hum induced in said second coil.

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