June 30, 1959 J. R. BUTTS 2,892,371

PICKUP

Filed Jan. 22, 1957

FIG. 1.

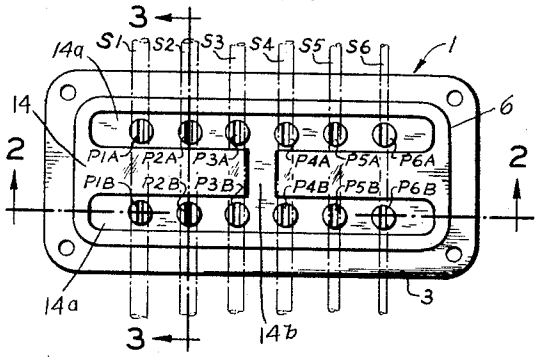


FIG. 3.

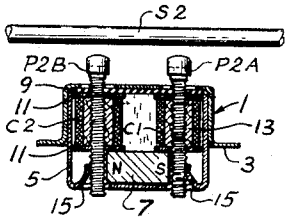


FIG. 4.

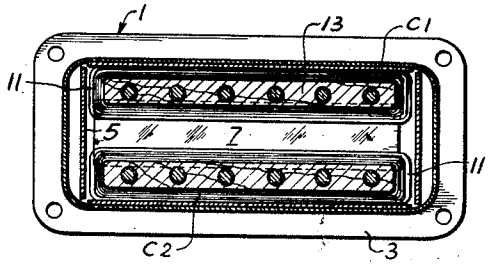


FIG. 2.

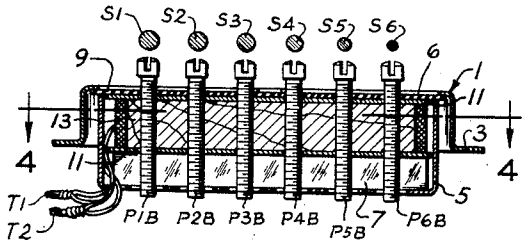


FIG. 6.

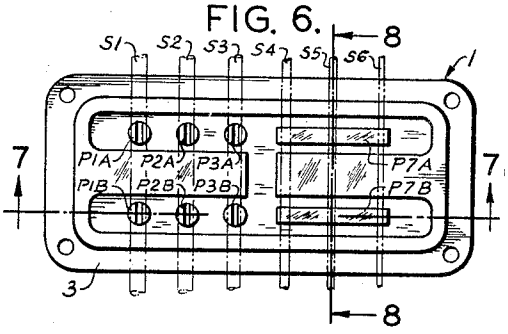


FIG. 5.

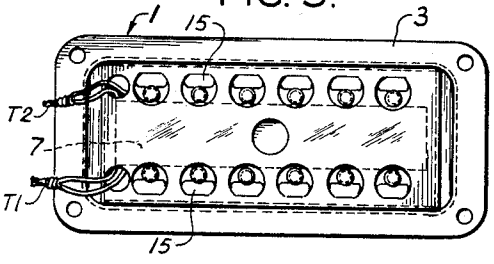


FIG. 8.

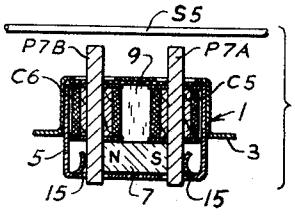


FIG. 7.

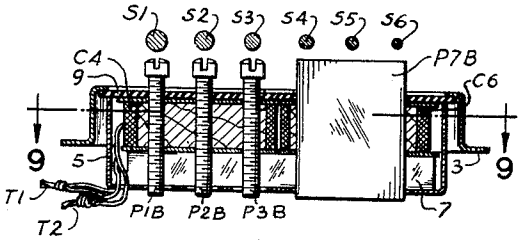
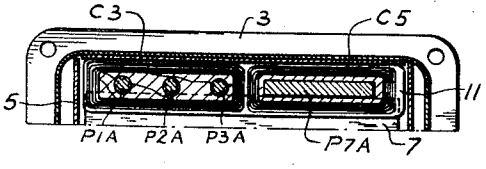


FIG. 9.



Joseph Raymond Butts,
Inventor.
Koenig and Pope,
Attorneys.

United States Patent Office

2,892,371

Patented June 30, 1959

2,892,371

PICKUP

Joseph Raymond Butts, Cairo, Ill.

Application January 22, 1957, Serial No. 635,296

7 Claims. (Cl. 84—1.16)

This invention relates to a pickup and more particularly to a pickup for musical instruments of a type having a plurality of vibrating magnetic members.

Among the several objects of this invention may be noted the provision of pickups which have an increased magnetic coupling with vibrating musical members, thereby producing a higher amplitude output voltage; the provision of such pickups which have a smooth linear response over the audible range; the provision of pickups of the class described which have an electrical output which is unaffected by external hum and noise pulses; the provision of pickups of the class described which are capable of a wide variety of tonal effects; the provision of pickups in which the relative volume of each vibrating musical member can be independently adjusted over wide latitudes; the provision of such pickups which have a resonant frequency greater than 20 kc.; and the provision of pickups of the class described enclosed in a metal casing without undesirable frequency discrimination effects. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

Fig. 1 is a plan view of a pickup of the present invention positioned relative to the steel strings of a musical instrument;

Figs. 2 and 3 are longitudinal and transverse sections respectively taken on lines 2—2 and 3—3 of Fig. 1;

Fig. 4 is a section taken on line 4—4 of Fig. 2;

Fig. 5 is a bottom view of the pickup illustrated in Fig. 1;

Fig. 6 is a plan view of a second embodiment of the present invention positioned relative to the steel strings of a musical instrument;

Figs. 7 and 8 are longitudinal and transverse sections respectively taken on lines 7—7 and 8—8 of Fig. 6; and,

Fig. 9 is a half section taken on line 9—9 of Fig. 7.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

It has been the practice in the past few years to amplify the sound produced by various musical instruments which have vibrating members of magnetic material, such as steel strings or reeds, by positioning a pickup near the vibrating musical members and thereby transforming the mechanical movement of the members into an electrical signal which is amplified and fed to an electro-acoustic transducer or loudspeaker. This is particularly true in regard to steel stringed instruments such as guitars and mandolins. However, there have been a number of disadvantages to this arrangement. For example, the pickups used were not only relatively inefficient but they produced electrical signals which were not an accurate representation of the acoustical output of the musical instrument. Thus, the ranges of these prior-art pickups were much more limited than that of the acoustical output of the musical instruments, and had response characteristics with peaks and valleys. Moreover, these pickups were notoriously susceptible to external magnetic disturbances such as A.C. hum and noise pulses which would be electrically reproduced and sometimes even override musical signals.

In accordance with the present invention pickups may be constructed which electrically reproduce the acoustical output of the vibrating musical members with full fidelity because they have response characteristics that are linear over a frequency range at least as great as that of the audible range of musical instruments. The resonant frequency of these pickups, in contradistinction to prior-art devices, which usually had a resonance within the audible range, is in the order of 20 kc. or more. Also, the electrical parameters of the new pickups of my invention are such that the linear response normally will provide the desirable constant velocity response characteristic, i.e., rises evenly and smoothly at 6 db per octave. Moreover, the extremely undesirable effect of external magnetic disturbances such as hum and noise is eliminated because any electrical signals thereby produced in the pickup are automatically cancelled. Additionally, the frequency discrimination effects normally attendant upon the usual enclosing of the electrical pickup components within a metallic shield or casing (due to the shunting effect of currents induced therein) are avoided in the pickups described herein.

One of the most important advantages of the pickups of this invention is their remarkable flexibility. By various convenient adjustments and the selection of particular embodiments of this invention, a practically unlimited range of tonal and coloration effects is available to the musician.

Referring now to the drawings, and more particularly to Figs. 1–5, reference numeral 1 indicates an elongate sheet metal case which partially encloses the various components of a unitary pickup of the present invention. This case comprises an elongate rectangular cup-shaped bottom 5 and a top 6 of inverted cup shape provided with a flange 3 including mounting holes whereby the pickup may be conveniently mounted under the steel strings S1–S6 of a guitar.

Disposed within the case 1 is an elongate permanent magnet 7 of Alnico or any similar high coercive force magnet material, polarized as indicated. A number of pairs of individual pole pieces P1A, P1B—P6A, P6B are positioned in two rows along opposite sides of the magnet 7, so that their lower portions touch or are in close proximity to the sides of the magnet. Each of these pole pieces is preferably constituted by bolts which are threaded in holes through a flat top insulator cover plate 9, a pair of insulated coil flanges 11 and a coil core 13 of nonmagnetic material. The top wall 14 of the top 6 of the case is provided with a pair of slots 14*a* extending parallel to one another lengthwise of the case in the planes of the rows of pole pieces. A slot 14*b* extending between slots 14*a* in the top wall 14 constitutes a gap for inhibiting circulating currents in top wall 14 around slots 14*a*. The pole pieces P1A—P6A extend out of the case through one of the slots 14*a*, and the pole pieces P1B—P6B extend out of the case through the other slot 14*a*. The bottom 5 includes an array of holes positioned in alignment with the pole pieces, and formed by partly cutting away and angling portions of the bottom wall of the bottom 5 to form tabs 15. These tabs engage the lower ends of the respective pole pieces and serve (1) to prevent rotation thereof which might otherwise be caused by vibration, (2) to insure maximum physical

stability and contact between the pole pieces and the magnet, and (3) to electrically ground the pole pieces.

A coil of wire C1 is wound around the core form carried by pole pieces P1A—P6A, and an identical coil C2 surrounds the mid portions of pole pieces P1B—P6B. The two ends of the wire forming coil C1 and the two ends of the wire forming coil C2 are connected in phase electrically, either by physically connecting them in parallel, or connecting them in series (as shown at terminals T1 and T2). In either instance, whether a series or a parallel wiring connection is made, the electrical phasing is such that the signals generated in coils C1 and C2 by any one movement of a string are effectively complementary and made to aid each other in either a voltage or a current sense.

While I have shown a single coil of wire around each of the rows of pole pieces, it is to be understood that it is within the scope of this invention to use separate individual coils around each of the pole pieces and these twelve coils are electrically interconnected as noted above in regard to voltage or current addition and phasing.

The operation is as follows:

Assuming the pickup has been positioned in the guitar so that each of its strings S1–S6 is respectively aligned over the pairs of pole pieces P1A, P1B—P6A, P6B, any movement of any string will affect the magnetic field or circuit established between its associated pole pieces. The reluctance of each of the six magnetic circuits is therefore a function of the positioning and movement of the associated strings, and an electric signal is produced in each of the coils C1, C2 corresponding to the particular actuation of each string. The composite of these electrical signals produces an electrical output at terminals T1 and T2 which is a linear replica of the acoustic output of the musical instrument. This electrical output may be coupled in the customary way via a shielded cable to the input circuit of any conventional amplifier. Because several hundreds or thousands of turns of wire are used in each of the coils C1, C2, the impedance parameter presented at terminals T1 and T2 readily matches the high impedance input grid circuit of such amplifiers. Also, due to this organization of the pole pieces, magnet and coils surrounding each of the rows of pole pieces and the two coils being connected so that the respective desired signals produced in coils C1 and C2 are phased to aid each other, the inductance and distributed capacity of the pickup are such that its resonant frequency is 20 kc. or greater. Even with the usual length of coupling cable and the amplifier input component parameters considered, the resonance is still outside the normal audible range. Moreover, because of these electrical parameters a most flexible and separate bass and treble tone control arrangement can be conveniently provided.

Also, the musician can modify the normally smooth linear response characteristic, if he desires unusual tonal effects, by adjusting the individual pole pieces with a screwdriver. For example, if he wishes to emphasize the bass response he merely unscrews the P1A, P1B (and perhaps also P2A and P2B) pole pieces so that the top ends are positioned more closely to strings S1 (and S2). Thus, accentuation or attenuation of any portion of the tonal spectrum of the instrument can be easily accomplished by the musician without the need of electrically modifying the response characteristics of the amplifier.

Another important feature is the elimination of the undesirable effect of external hum and noise from the electrical output of the pickup. The electrical signals produced by the movement of the strings are in phase in the two coils C1 and C2, but any signal voltage generated externally is out of phase and is automatically cancelled. Thus, the musician can use his instrument in an environment such as a stage with fluorescent and neon lighting and not have the desired electrical signals corresponding to string vibrations mixed with or overridden by the electrical noise and hum.

It is important to note that the symmetrical arrangement of the coils within the metallic casing 1 formed by the two shielding and enclosing members 5 and 6 eliminates any possible shunting effects of currents induced in the metallic casing, and thus avoids discrimination by the attenuating of the higher frequencies. Any current induced in the casing due to the field of C1 is balanced or cancelled by the equal and out-of-phase current induced by C2.

The second embodiment of this invention, illustrated in Figs. 6–9, is identical to that shown and described in regard to Figs. 1–5, except for certain features. The individual pole pieces P4A, P4B—P6A, P6B have been replaced by two plates or bars P7A and P7B of magnetic material, such as soft iron, etc. Also, instead of there being a single coil C1 or C2 surrounding each of the rows of pole pieces, as in the first embodiment, there is a single coil C3 and an identical coil C4 surrounding pole pieces P1A—P3A and pole pieces P1B—P3B, respectively; and identical coils C5 and C6, each surrounding pole pieces P7A and P7B, respectively.

This embodiment has the advantage of decreasing the tonal coloration (i.e., the inclusion of strong harmonics relative to the fundamental, due to the interaction between the pole pieces and the vibrating strings) as to the higher frequency portion of the spectrum. This is due to the modified magnetic field resulting from the use of elongate pole pieces P7A and P7B which diminish the sensitivity of the pickup to transverse or lateral vibration modes of the strings lying thereover, which modes generate these harmonics.

It will be understood that single individual coils (similar to coils C5 and C6) around each pole piece P1A, P2A, and P3A could be used in place of the coil C3, and similarly that coil C4 could be replaced by three single symmetrical coils around P1B, P2B and P3B. The coils would, of course, be electrically connected as specified above so that the electrical signals corresponding to string movement are in phase and reinforce each other. Also, if desired, instead of using two elongate bars P7A and P7B as shown in Figs. 6–9, the same effect could be obtained as respects tonal coloration by bridging the P4A, P4B—P6A, P6B bolts, respectively, with solid pieces of iron, or replacing them by two fittings so as to effectively provide two wide pole pieces under strings S4—S6.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above descripion or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A pickup for a musical instrument of a type having a plurality of vibrating magnetic members, said pickup comprising an elongate metallic case, an elongate permanent magnet extending lengthwise in the case, a plurality of pairs of individual pole pieces positioned in two rows along opposite sides of said magnet and substantially perpendicular to the longitudinal axis of said magnet, and coils of wire in said case in inductive relationship with the pole pieces, said case having a top wall provided with a pair of parallel slots extending lengthwise of the case in the planes of said rows of pole pieces and a slot extending between said parallel slots and constituting a gap for inhibiting circulating currents in said top wall, the pole pieces of one of said rows extending out of the case through one of said parallel slots and the pole pieces of the other of said rows extending out of the case through the other of said parallel slots, at least

one pair of pole pieces being included in a magnetic circuit the reluctance of which is a function of the positioning and movement of at least one of said vibrating members, whereby the vibration of any of said members produces a corresponding electrical signal in the coils and the electrical output of said coils is the composite of the electrical signals produced in response to the individual movements of each of said vibrating members.

2. A pickup as set forth in claim 1 in which there are four separate coils of wire, at least two of said coils being wound around at least two adjacent pole pieces in one row, said coils being electrically connected so that said electrical signals are in phase and complement each other, whereby any externally produced magnetic disturbances will generate like voltages in said coils which are out of phase and are thereby cancelled.

3. A pickup as set forth in claim 1 in which each of said pole pieces is threaded and may be mechanically adjusted in relation to its adjacent vibrating member by rotation thereof.

4. A pickup as set forth in claim 1 in which at least one pair of pole pieces comprises elongate plates of magnetic material which are positioned under at least two of said vibrating members.

5. A pickup as set forth in claim 1 which further includes at least one additional pair of pole pieces which comprise elongate plates of magnetic material positioned under at least two of said vibrating members, and an additional separate coil of wire around each of said additional elongate pole pieces.

6. A pickup as set forth in claim 1 wherein the case has a bottom wall portions of which are partly cut away

and angled inward to provide openings for said pole pieces, and which constitute tongues engaging the pole pieces and serve to prevent movement thereof which might otherwise occur due to vibration.

7. A pickup for a musical instrument of a type having a plurality of vibrating magnetic members which are located side-by-side, comprising an elongate permanent magnet, a plurality of pairs of individual pole pieces positioned in two rows along opposite sides of said magnet and substantially perpendicular to the longitudinal axis of the magnet, certain of said pairs of pole pieces comprising screw-threaded members, another of said pairs of pole pieces comprising elongate plates of magnetic material, a coil of wire around the screw-threaded members in one row of pole pieces, a coil of wire around the screw-threaded members in the other row, and separate coils of wire around the plates, each pair of the screw-threaded members being positioned under one of said vibrating members and said pair of plates being positioned under at least two others of said vibrating members.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 20,070	Lesti	Aug. 18, 1936
2,087,106	Hart	July 13, 1937
2,262,335	Russell	Nov. 11, 1941
2,683,388	Keller	July 13, 1954

FOREIGN PATENTS

239,550	Switzerland	Feb. 1, 1946