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C. L. FENDER

2,976,755

ELECTROMAGNETIC PICKUP FOR LUTE-TYPE MUSICAL INSTRUMENT

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Fig. 1.

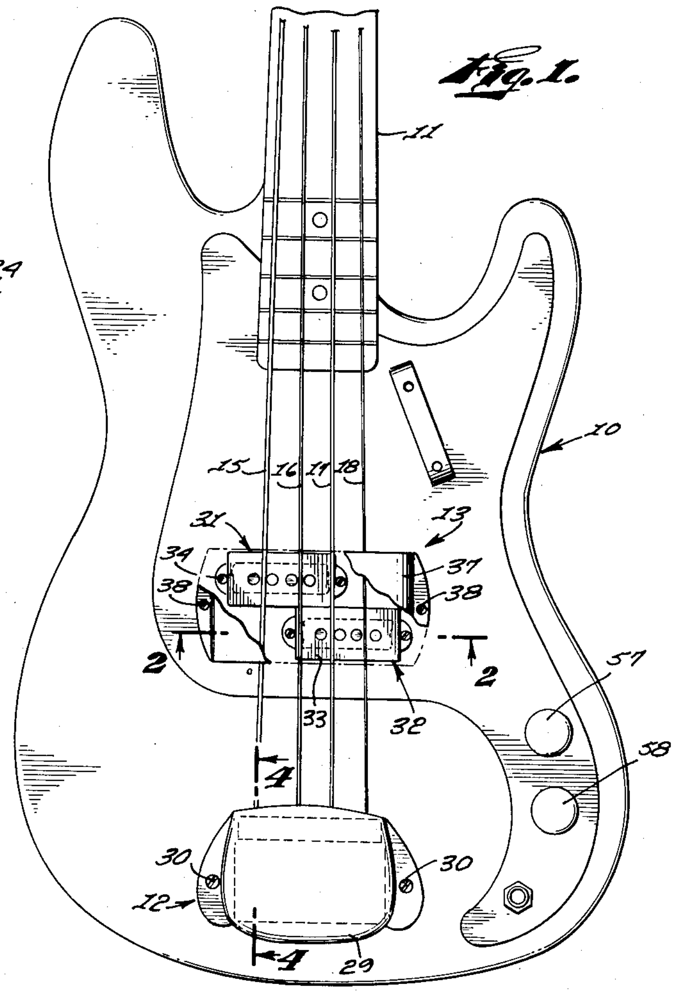


Fig. 3.

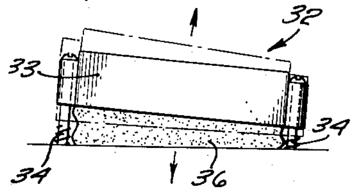


Fig. 4.

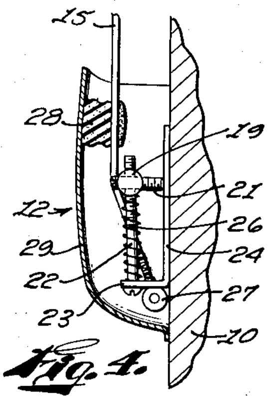


Fig. 2.

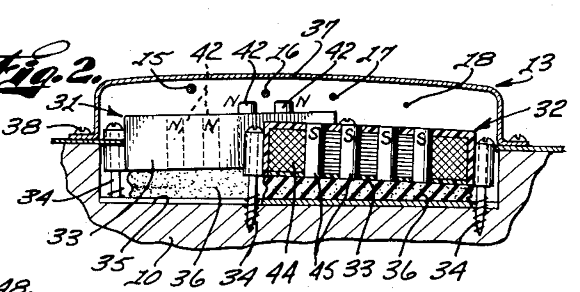
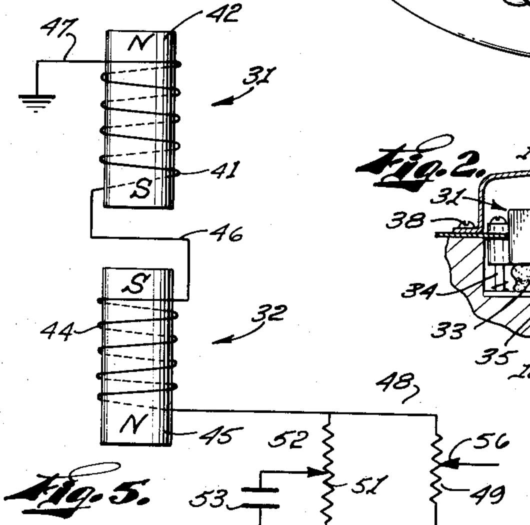


Fig. 5.



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ELECTROMAGNETIC PICKUP FOR LUTE-TYPE MUSICAL INSTRUMENT

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14 Claims. (Cl. 84—1.16)

This invention relates to lute-type musical instruments, such as guitars, and particularly relates to a pickup means and circuit for a bass guitar.

Electric guitars of the bass type have, in recent years, been coming into use as a replacement for the very large and clumsy string basses conventionally employed. Such bass guitars are sufficiently small to be held on the lap of a seated guitarist, and require relatively little transportation and storage space. Furthermore, such guitars are much simpler and less strenuous to play than conventional non-electric string basses.

In order to achieve the necessary low pitch, the guitar strings must be much more bulky and massive than those of a standard guitar. Furthermore, the excursion of each string on both sides of the neutral position, resulting from each plucking or picking action, is greater than that of a string of a standard guitar. These and other factors have made it exceedingly difficult to provide an electromagnetic pickup construction which will properly convert the string vibration into electrical impulses, and which may be adequately adjusted to the various strings in order to achieve the desired volume relationships.

The problem of pickup adjustment is compounded by the fact that each string has its own individual bridge element which is variable in elevation relative to the guitar body in order to achieve the desired string elevation above the fretted neck. Another important problem relates to the fact that the pickup should be so constructed that extraneous electrical signals received from power lines, for example, will be cancelled out and will not be transmitted to the loud speaker to produce hum. Furthermore, it is important that the pickup construction be such that the rotation of the plane of vibration of each string does not produce a beating effect.

In view of the above and other factors and problems relative to electromagnetic pickups for bass guitars and the like, it is an object of the present invention to provide an electromagnetic pickup construction and circuit which may be readily adjusted for the desired response to each string of the guitar, which operates to buck or cancel out signals produced by extraneous sources, which does not produce a beating effect due to rotation of the plane of string vibration, and which adequately senses the string vibrations despite the wide excursions and large sizes of the strings.

A further object of the invention is to provide an electromagnetic pickup apparatus in which the pickup elements for different pairs of strings are individually adjustable in position.

A further object of the invention is to provide an electromagnetic pickup construction in which two individual

pole pieces are disposed in straddling relationship relative to each string to thereby provide the proper response while minimizing or eliminating the effects of rotation of the plane of string vibration, and eliminating undesired drumming effects.

A further object is to provide a split-pickup construction so arranged and electrically connected as to eliminate signals produced by extraneous sources without resulting in damping or attenuation of signals produced by string vibration.

A further object is to provide an electric bass guitar incorporating means for damping excessive string vibration.

These and other objects and advantages of the invention will be more fully set forth in the following specification and the claims, considered in connection with the attached drawing to which they relate.

In the drawing:

Figure 1 is a top plan view of the body of a bass guitar incorporating the present invention;

Figure 2 is a fragmentary transverse section, on an enlarged scale, taken on line 2—2 of Figure 1;

Figure 3 is an elevational view of one of the split-pickup elements, showing the same in various adjusted positions;

Figure 4 is a fragmentary sectional view, on an enlarged scale, taken on line 4—4 of Figure 1, illustrating the individually-adjustable bridge elements and also the damping means for the strings; and

Figure 5 is a schematic wiring diagram of the electromagnetic pickup means.

Referring to the drawing, and particularly to Figure 1, a bass guitar is illustrated as comprising a body **10**, fretted neck **11**, and a plurality of strings (illustrated as four in number) tensioned between the head (not shown) at the outer end of neck **11** and a bridge assembly **12** located at the end of the body remote from the neck. An electromagnetic pickup assembly, indicated generally at **13**, is mounted on body **10** adjacent the strings in order to sense the vibrations thereof.

The strings are respectively numbered **15–18** and, as previously stated, are relatively large in diameter in order to aid in achievement of the necessary low pitch. Referring particularly to Figure 4, each string is provided with an individual bridge cylinder or barrel **19** which forms part of the bridge assembly **12**. Each barrel has threaded therethrough a pair of leg screws **21** which may be turned in order to adjust the elevation of the barrel above the body **10** as required by the particular neck construction and the desires of the guitarist. Furthermore, each barrel **19** may be adjusted longitudinally of the instrument by turning a screw **22** which is threaded therethrough perpendicularly to leg screws **21**. The screw **22** is rotatably (not threadedly) inserted through a flange portion **23** of a wear plate **24** mounted on the body. A compression spring **26** is seated between flange **23** and the barrel in order to maintain the latter the maximum possible distance from the flange as determined by the screw setting. The end of each string is inserted through a hole in flange **23** and secured in position by means of an eyelet **27**.

In order to reduce the amplitude of string vibration, without altering the pitch of the string, a damping pad **28** is engaged with the bank of strings **15–18** and seated beneath the cover element **29** of the bridge assembly

12. Preferably, the damping pad comprises sponge rubber and is adhesively secured to the underside of the cover element 29. The cover is fixedly secured to body 10 as by screws 30 indicated in Figure 1.

Proceeding next to a detailed description of the pickup assembly 13, this comprises two elongated units 31 and 32 mounted transversely beneath strings 15–18 in adjacent, partially-lapped relationship relative to each other. Each unit 31 and 32 comprises a casing 33, formed of non-conductive fibrous material, having screw openings at each end. Screws 34 are inserted downwardly through such screw openings and are threaded into body 10 in a generally rectangular recess 35 therein. A resilient cushion 36, formed of sponge rubber, is seated beneath each casing 33 and on the bottom wall of recess 35 in order to maintain the respective units in their uppermost positions permitted by the screws 34. A generally arch-shaped cover element 37 is bridged across recess 35 and over the strings 15–18, being secured in position by screws 38.

Pickup unit 31 has within its casing 33 an elongated coil 41 (Figure 5) formed of a large number of turns of fine wire. The coil is wound around four pole pieces 42 each of which is illustrated as being cylindrical, and which comprise permanet magnets. The pole pieces are maintained in a row by being press-fit through suitable openings in the casing 33. The spacing and positioning of the pole pieces 42, which have their axes perpendicular to the plane of coil 41 and also generally perpendicular to the face of the guitar body 10, are such that the pole pieces in each pair thereof are in straddling relationship relative to a string. Thus, the two pole pieces 42 at the left in Figure 2 are in straddling relationship relative to string 15, whereas the next two pole pieces 42 are in straddling relationship relative to string 16. The upper ends of the pole pieces are disposed beneath the plane of the strings 15–18, the spacing being dependent upon the setting of screws 34 and upon the length of the pole pieces. In the illustrated form, the two pole pieces 42 for string 16 extend somewhat above the casing 33 of unit 31.

Pickup unit 32 has a coil 44 and pole pieces 45 also comprising cylindrical permanent magnets. Two of such pole pieces 45 (a first pair) are in straddling relationship relative to string 17, and the next two (a second pair) are in straddling relationship relative to string 18. Unit 32 corresponds to unit 31 except for differences in magnet polarity, and winding direction.

Referring next to schematic Figure 5, the four pole pieces 42 of pickup unit 31 are indicated (for purposes of simplicity of illustration) as a single permanent magnet, whereas the pole pieces 45 of unit 32 are likewise shown as a single magnet. As indicated by the polarity signs in Figures 2 and 5, the polarity of the pole pieces of unit 31 is reversed relative to the polarity of the pole pieces of unit 32. Thus, the magnets in unit 31 are shown as all having their north poles adjacent the strings, and the magnets 45 in unit 32 are shown as all having their south poles adjacent the strings. Furthermore, and as best illustrated in Figure 5, the windings 41 and 44 are reversed relative to each other and are therefore in bucking relationship, being series-connected by means of a lead 46.

The remaining end of coil 41 is connected to ground, as indocated at 47, whereas the remaining end of coil 44 is connected to a lead 48 and thence through a resistor 49 to ground as indicated at 50. A second resistor 51 is connected to lead 48 and has a sliding tap 52 which may be moved to various settings. Tap 52 is connected through a capacitor 53 to ground as indicated at 54. A second sliding tap 56 is associated with resistor 49 and is connected to the input of a suitable amplifier, not shown, which in turn is associated with a loud speaker. Tap 52 may be controlled by a knob 57 shown in Figure 1, and tap 56 by knob 58.

Operation

In adjusting the guitar and pickup apparatus, the strings 15–18 are first tuned by turning the tuning screws (not shown) on the head of the guitar, and by turning the screws 22 (Figure 4) to shift the bridge barrels 19 longitudinally of the strings. The elevations of the individual strings above the neck are adjusted, as previously stated, by turning the bridge leg screws 21 for each string. This is performed, of course, after removal of the cover plate 29.

The pickup cover 37 is then removed in order that the individual pickup units 31 and 32 may be adjusted by turning the respective screws 34. Referring particularly to Figures 2 and 3, it will be understood that the distance between each pair of magnets or pole pieces 42 or 45 and the associated string may be adjusted by turning the various screws to effect tilting of each unit 31 or 32. Since each unit 31 or 32 is intended to be associated with only two strings, the pole pieces associated with such strings may be accurately spaced therefrom to achieve the desired volume response. This would not be possible if the pole pieces for all of these strings were mounted in a single casing. In the described manner, the pole pieces are positioned until the volume response produced in the loud speaker is substantially the same for each string.

The tone control knob 57 is adjusted to determine the position of tap 52 on resistor 51 in order to effect selective shorting of the high frequencies to ground. Thus, if tap 52 is relatively high on resistor 51, a larger proportion of the high frequencies will be shorted through the capacitor 53 to ground than in situations where tap 52 is relatively low on the resistor, as viewed in Figure 5. The volume control knob 58 is turned to adjust tap 56 and thus determine the volume.

Let it be assumed that string 15, for example, is then plucked or picked. Such string (and the others) is formed of magnetizable material, and, when it vibrates, operates through the two associated pole pieces 42 to induce a voltage in the coil 41 of pickup unit 31. Because of the straddling relationship of the pole pieces relative to the string 15, such induced voltage is relatively independent of the plane of vibration of the string so that no beating effect results from the natural rotation of the plane of string vibration. The two permanent magnet pole pieces effect a satisfactory response (pickup action) despite the fact that the amplitude of vibration may be relatively large, particularly on the lower-pitched strings. Furthermore, the use of the straddling pole pieces has other beneficial effects including the minimization of drumming noise and rapid attenuation immediately after the string is released. Such factors are discussed in detail in my co-pending application Serial No. 677,896, filed August 13, 1957, for Electromagnetic Pickup for Lute-Type Musical Instrument.

Let it next be assumed that the string 16 is picked strongly or sharply, so that the amplitude of vibration is relatively great. This produces a strong response in the adjacent pair of pole pieces 42 of pickup unit 31. In addition, since the string 16 is relatively close to at least one of the pole pieces of unit 32, a certain amount of voltage is induced into the coil 44 of the unit 32. The voltages thus induced in the coils 41 and 44 are additive instead of bucking, thereby producing the maximum response in the loud speaker. Such voltages add, despite the fact that the coils 41 and 44 are reverse-wound or in bucking relationship relative to each other, since the polarities of the pole pieces 42 and 45 are reversed.

Although the voltage induced in coils 41 and 44 due to the vibration of an associated string 16 are additive, the voltages induced in such coils due to the effects of an extraneous field, such as that produced by a power line, are in bucking relationship. This is because the coils 41 and 44 are reverse-wound relative to each other, and the magnet polarities are not important in regard to extrane-

ous fields. The coils are preferably of approximately equal size and have approximately the same number of turns, so that the voltages induced therein from an extraneous source substantially completely cancel each other, in hum-bucking relationship, to prevent a humming noise from being produced in the loud speaker. This operation is somewhat analagous to that described in my Patent No. 2,817,261, issued December 24, 1957, for a Pick-up and Circuit for Stringed Musical Instrument.

In the appended claims, the word "pick-up" is employed to denote the individual elements such as **42** and **45**, for example, and does not denote the entire magnet and coil assembly.

Various embodiments of the present invention, in addition to what has been illustrated and described in detail, may be employed without departing from the scope of the accompanying claims.

I claim:

1. An electrical musical instrument of the string type, including a plurality of electromagnetic type pick-ups operatively associated with the strings of said instrument and lying in a plane spaced from the common plane of said strings, each of said strings being disposed in a plane extending through a space between two adjacent ones of said pick-ups, four of said pick-ups being operatively associated with two of said strings, said two strings being adjacent each other, two of said four pick-ups being disposed between said planes in which said two adjacent strings are disposed and being respectively operatively associated with said two adjacent strings, the remaining two of said four pick-ups being disposed on opposite sides of said planes in which said two adjacent strings are disposed and being respectively operatively associated with said two adjacent strings.

2. The invention as claimed in claim 1, in which said four pick-ups each comprise a permanent magnet, and in which coil means are operatively associated with said four magnets to sense disturbances in the fields thereof due to movement of said two adjacent strings.

3. The invention as claimed in claim 1, in which said planes respectively containing said strings are generally perpendicular to said common plane of said strings, and in which all portions of all of said magnets lie on one side only of said common plane of said strings.

4. The invention as claimed in claim 1, in which said four pick-ups comprise permanent magnets disposed generally along a line which extends transverse to said strings, and in which a single coil of wire is mounted around said four magnets to sense variations in the fields thereof.

5. The invention as claimed in claim 4, in which means are provided to mount said magnets and coil in fixed relationship relative to each other, and in which means are provided to effect pivotal adjustment of said mounting means relative to said common plane of said strings to thus vary the spacing between two adjacent ones of said four magnets and the string with which they are operatively associated, and also between the remaining two adjacent ones of said four magnets and the string with which they are operatively associated.

6. The invention as claimed in claim 1, in which said four pick-ups comprise elongated permanent magnets, in which said two adjacent strings are formed of magnetizable material, and in which like poles of the two magnets associated with each of said two adjacent strings are relatively near such string and the remaining like poles of said two magnets are relatively remote from such string.

7. The invention as claimed in claim 6, in which said four magnets all have like poles disposed relatively adjacent the common plane of said strings, and in which a single coil of wire is mounted around said four magnets.

8. The invention as claimed in claim 1, in which means are provided to adjust the spacing between two adjacent ones of said four pick-ups and the string with which they are operatively associated, and also to adjust the spacing between the remaining two adjacent ones of said four pick-ups and the string with which they are operatively associated.

9. The invention as claimed in claim 8, in which said adjustment means includes means to mount said pick-ups in fixed relationship relative to each other, and means to tilt said mounting means relative to the common plane of said strings and about an axis which is generally parallel to said strings.

10. The invention as claimed in claim 1, in which said four pick-ups each comprise a permanent magnet, in which coil means are operatively associated with said magnets to sense disturbances in the fields thereof due to movement of said strings, and in which means are provided to cancel from said coil means hum created by extraneous fields.

11. The invention as claimed in claim 1, in which said four pick-ups comprise elongated permanent magnets, in which said two adjacent strings are formed of magnetizable material, in which like poles of the two magnets associated with each of said two adjacent strings are relatively near such string, in which coil means are wound around said two magnets, in which additional ones of said pick-ups comprise additional permanent magnets operatively associated with additional magnetizable ones of said strings, said additional magnets having like poles disposed adjacent said additional strings, said last-mentioned like poles having polarities opposite to the polarities of said first-mentioned like poles, and in which coil means are wound around said additional magnets and are connected to said first-mentioned coil means in bucking relationship relative thereto.

12. The invention as claimed in claim 1, in which said electrical musical instrument is an electric guitar including a body having a face; in which means are provided to mount said strings in tensioned relationship generally parallel to each other and generally in a plane parallel to said face and spaced thereabove, said strings being formed of magnetizable material, said strings being substantially equally spaced relative to each other; in which said four pick-ups operatively associated with said two adjacent strings include a plurality of elongated permanent magnets disposed generally parallel to each other and generally perpendicular to said common plane of said strings, all portions of all of said four magnets being disposed on only one side of said common plane of said strings, the ends of said magnets which are nearest said common plane of said strings being sufficiently close to said common plane of said strings that vibration of said two adjacent strings disturbs the fields of said four magnets, said four magnets respectively straddling said two adjacent strings in such manner that extensions of the axes of the two magnets operatively associated with each of said two adjacent strings pass on opposite sides thereof; and in which an electric coil is wound around said four magnets to sense the vibrations of said two adjacent strings.

13. The invention as claimed in claim 12, in which a non-conducting casing is provided to mount said four magnets and said coil in fixed relationship relative to each other, and in which fastener means are provided to connect said casing to said guitar body in adjustable relationship, said fastener means being adjustable to tilt said casing relative to said body about an axis which is generally parallel to said two adjacent strings.

14. The invention as claimed in claim 12, in which said guitar is a bass guitar having four magnetizable strings, in which four additional permanent magnets are operably associated with the remaining two of said strings in a manner corresponding to the manner of operative association between said first-mentioned four magnets and said two adjacent strings, in which said first-mentioned four magnets have like poles disposed adjacent said common plane of said strings, in which said additional four magnets have like poles disposed adjacent said common

plane of said strings, said last-mentioned like poles having polarities opposite to the polarities of said first-mentioned like poles, and in which an additional electric coil is wound around said additional four magnets and series-connected to said first-mentioned electric coil in bucking relationship.

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