April 5, 1966 C. E. HULL ETAL 3,244,791

ELECTRICAL STRINGED INSTRUMENT

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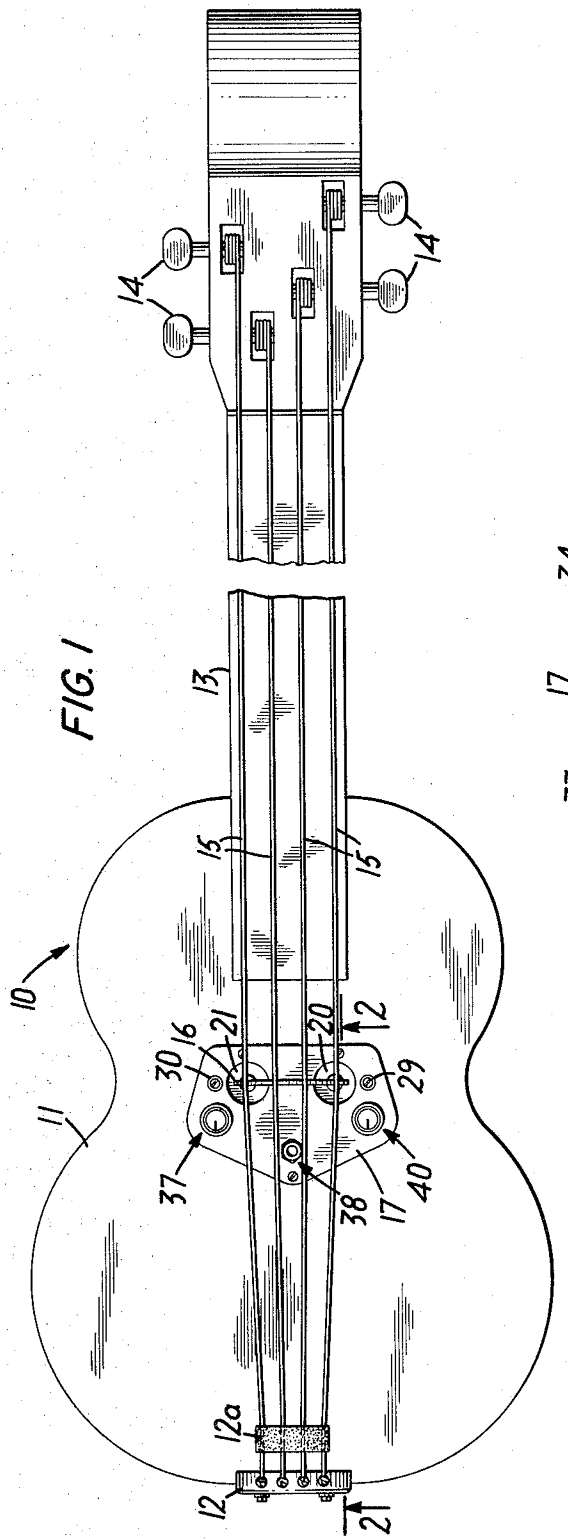

FIG. 1

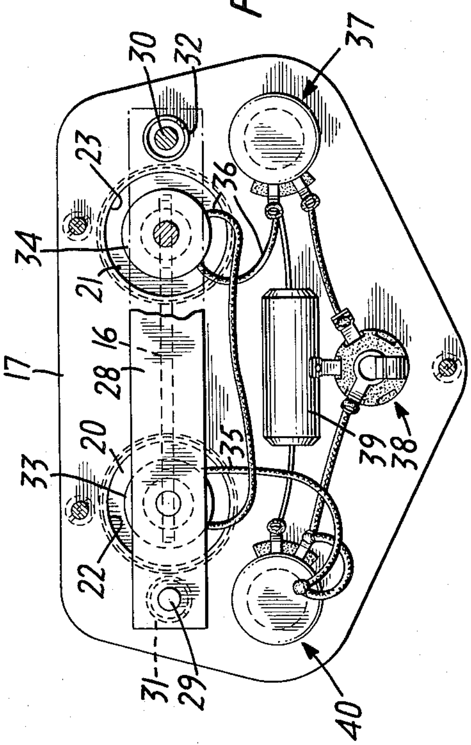

FIG. 4

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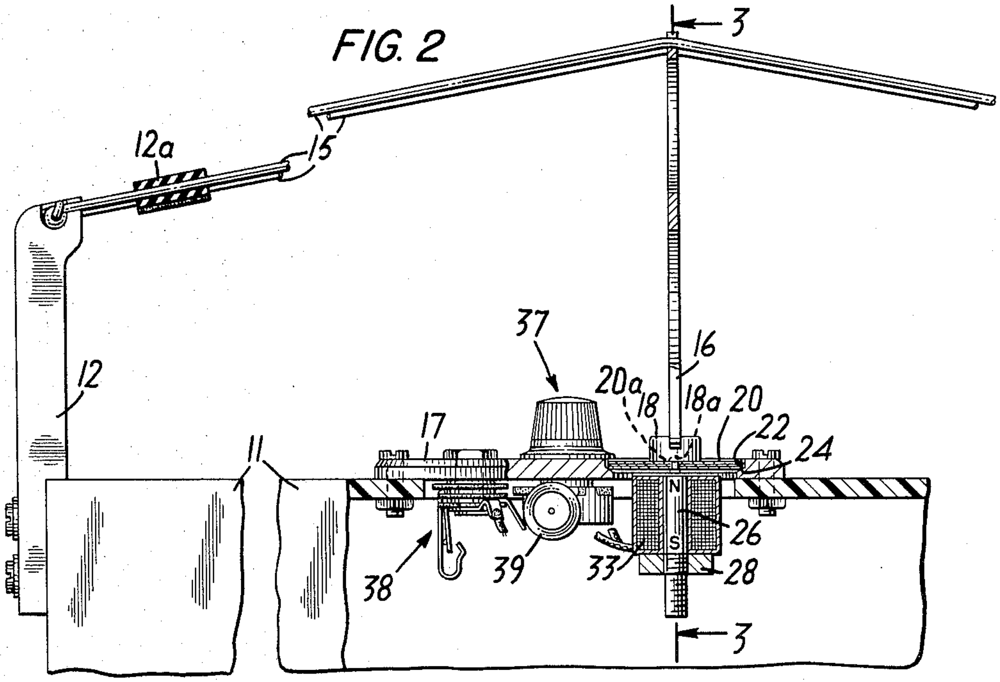
FIG. 2



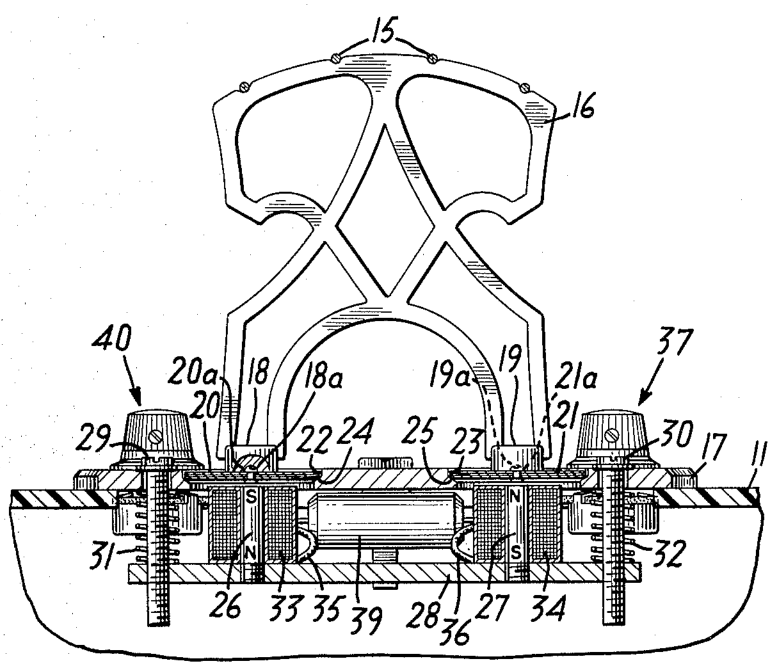


FIG. 3

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ELECTRICAL STRINGED INSTRUMENT

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6 Claims. (Cl. 84—1.15)

This invention relates to stringed musical instruments having an electrical pickup to provide amplification of the music produced thereby and, more particularly, to a new and improved stringed instrument which is indistinguishable in tone and quality of sound from a conventional string bass.

In electrical stringed instruments, a magnetic pickup is arranged to detect the vibrations produced by the strings and generate corresponding electrical signals for application to a loudspeaker after amplification. Most conventional electrical stringed instruments, however, respond according to the tonal characteristics of the instrument in which they are incorporated, thereby requiring, for maximum sonority and refinement of tone, a high initial investment and careful maintenance. Furthermore, none of the known electrical stringed instruments is capable of reproducing sounds having the characteristic tonal quality of a string bass.

Accordingly, it is an object of this invention to provide a new and improved electrical stringed instrument which effectively overcomes the abovementioned disadvantages of the prior art.

Another object of the invention is to provide an electrical stringed instrument wherein the tonal characteristics are independent of the structure in which the magnetic pickup is incorporated.

A further object of the invention is to provide an electrical stringed instrument of the above character which is capable of producing sounds having the characteristic tonal quality of a string bass.

An additional object of the invention is to provide a magnetic pickup which is compact, light and adapted to be installed easily in any type of stringed instrument.

These and other objects of the invention are attained by providing a pickup having a resonating element made of magnetic material and arranged to respond directly to string vibrations which are transmitted to it. In a preferred embodiment, the resonating element comprises a silicon steel disc which is supported at its edges at the top wall of the instrument within the field of a magnet which is surrounded by a detecting coil. The bridge against which the strings of the instrument bear is supported centrally on the disc and, in one form of the invention, two spaced discs associated with separate magnets and detecting coils support the bridge at opposite ends. Additionally, to reduce the pressure of the bridge on the resonating elements and thereby improve the response thereof, the tailpiece of the instrument to which the strings are attached extends above the top wall of the instrument to a level just below that of the top of the bridge. The material of which the instrument is made, moreover, may be acoustically inactive so that no resonance is produced thereby, the magnet being supported from the instrument body in adjustable relation to the resonating element.

Further objects and advantages of the invention will be apparent from a reading of the following description in conjunction with the accompanying drawings in which:

FIG. 1 is a top plan view of one form of stringed instrument arranged according to the invention;

FIG. 2 is an enlarged fragmentary vertical cross-sectional view, taken along the line 2—2 of FIG. 1 and looking in the direction of the arrows;

FIG. 3 is a fragmentary vertical cross-sectional view,

taken along the line 3—3 of FIG. 2 and looking in the direction of the arrows; and

FIG. 4 is an enlarged bottom view of the magnetic pickup used in the embodiment in FIG. 1.

In the embodiment represented in the drawings, the invention is shown as applied to an instrument of the violin family (violin, viola, cello and bass viol) by way of illustration only, it being understood that the invention may be utilized in any instrument on which the strings set in vibration by playing are stretched across a bridge. Thus, banjos, guitars, ukuleles and the like may also be arranged according to the invention.

As shown in FIG. 1, the string instrument **10** includes a hollow body **11** having a tailpiece **12** mounted thereon, a neck **13** with the usual keys **14** at the end remote from the body, and a plurality of strings **15** extending under tension from the tailpiece over a bridge **16** across the body to the remote end of the neckpiece in the usual manner. The strings **15** may be of any material, for example, metal, gut, or gut wrapped with silk or wire, for example, as in conventional instruments.

Contrary to the usual practice, however, the body **11** need not be made of a material which is acoustically responsive and, in a typical embodiment, the body is made of a plastic material having sufficient rigidity and strength. Furthermore, for reasons which will be discussed in greater detail hereinafter, the tailpiece **12**, rather than being thin so as to have its top surface disposed closely adjacent to the top wall of the instrument body, projects a substantial distance above the top wall of the body to a location just below the level of the top of the bridge **16** so that the strings **15** are bent at a small angle in passing over the bridge, as shown in FIG. 2.

In accordance with the invention, a plate **17**, which may be made of aluminum approximately one-eighth inch thick, for example, is mounted over an opening in the top wall of the instrument body, and supports the magnetic pickup described below. The bridge **16**, which may be made of aluminum and have a weight of approximately one ounce, for example, is provided with two circular feet **18** and **19**, which may be integral with the body of the bridge as illustrated. These feet are preferably located directly below the G and E strings, respectively, and they rest on the central portions of two corresponding diaphragms **20** and **21** made of a material which is both magnetic and responsive to acoustic vibrations. These diaphragms may be disc-shaped, as shown, or may have any other suitable shape, e.g., hexagonal, square, or the like. The bottom surfaces of circular feet **18** and **19** are formed with central hemispherical depressions **18***a* and **19***a* adapted to receive the projecting heads of corresponding rivets **20***a* and **21***a* which are centrally disposed in the diaphragms **20** and **21**. In this way the bridge feet **18** and **19** are always centrally placed on the diaphragms **20** and **21**, assuring uniform fidelity and sensitivity, while allowing rapid removal of the bridge **16** and the entire magnetic pickup, if desired.

In the preferred embodiment of the invention, the diaphragms **20** and **21** are made of several layers of silicon steel transformer lamination material held together by the rivets **20***a* and **21***a* and having a total thickness of about 0.040 inch and a diameter of about one and three-eights inches, the centers of the diaphragms being spaced by about two and three-quarters inches. These diaphragms **20** and **21** serve as resonators in the similar manner as the entire top and back of the conventional wood stringed instrument. At the same time, the diaphragms serve as armatures for the electromagnetic pickup elements to be described below. With this arrangement, the characteristic sounds of a string bass are accurately reproduced but it will be understood that the dimensions and materials of which the components are made may be varied to impart other tonal characteristics.

To provide good support for the bridge **16**, which is held against the diaphragms **20** and **21** by the tension of the strings **15** and, at the same time, permit the diaphragms to respond properly to vibrations transmitted by the bridge from the strings, the diaphragms are disposed in recesses **22** and **23** in the plate **17**. These recesses are formed with outwardly divergent conical surfaces **24** and **25** so that only the lower peripheral edges of the discs are in contact with the plate **17**. In the past magnetic pickups including armatures have required additional means, typically a rubber seat, to suspend the armature so that it may vibrate. The steel diaphragms **20** and **21** of the present invention are superior, since, being resilient, they do not require any such resilient support. Also, as mentioned above, the tailpiece **12** is raised above the top wall of the instrument sufficiently so that the strings **15**, in passing over the bridge **16** are bent at a small angle of about 20°, for example, in contrast to the much larger angle provided in conventional instruments. As a result, the stress applied to the discs **20** and **21** at any given string tension is substantially reduced, further facilitating the response of these elements to vibrations.

With this arrangement, the diaphragms are relatively free to resonate in the desired manner in response to string vibrations and, in so doing, to actuate the magnetic pickup of the instrument in the manner described below. Further, because the diaphragms **20** and **21** are capable of resonating, it is not necessary that the body **11** of the instrument be capable of resonating and, for this reason, it may be made from acoustically inactive materials as mentioned above, and the internal cavity therein need have no specific shape or dimension.

The tailpiece **12**, besides extending above the top wall of the body **11** as described above, is of rigid structure and is rigidly mounted on the body **11**. This arrangement substantially eliminates the interaction between strings which results from the pivotal support of conventional tailpieces. The typical conventional tailpiece is anchored to the instrument at a pivotal point on one end and to the strings on the other end, so that a change in tension of one string affects the other strings. This interaction of coupling between strings causes audible and undesirable overtones. In the present invention the distance between the bridge **16** and the tailpiece **12** may be increased to allow more freedom of motion or swing of the individual strings, since the rigid construction of the tailpiece **12** achieves a mechanical isolation between the individual strings. The point of attachment of the tailpiece **12** being fixed rather than pivotal, a vibrating string will generate less sympathetic vibration in the other strings.

To further minimize the objectionable overtones described above, a rubber damper **12*a*** is placed in contact with the strings **15** between the bridge and the tailpiece. In the preferred embodiment the damper **12*a*** is a solid rubber block of approximately 70 durometer, containing parallel holes to accommodate the strings **15**. These holes are arranged along an arc which is related to the arch of the top of the tailpiece **12** and that of the bridge **16**, so that the presence of the damper **12*a*** does not alter the positions otherwise taken by the strings **15**. The damper **12*a*** should preferably be situated close to the tailpiece **12**, thereby damping the objectionable overtones while allowing maximum freedom of motion or swing to the section of strings between the damper **12*a*** and the bridge **16**.

In order to detect the diaphragm vibrations and generate corresponding electrical signals for amplification and application to a loudspeaker, two permanent magnets **26** and **27**, which may be one inch long and one-quarter inch in diameter and made of Alnico V, for example, are supported within the body **11** perpendicularly to and directly below the centers of the diaphragms **20** and **21**, respectively. The ends of these magnets which are adjacent to the discs **20** and **21** are disposed just below the inner surface of the plate **17** and, in order to provide adjustment of the spacing between the magnets and the discs, both magnets are mounted on a cross-bar **28** supported from the plate **17** by two adjusting screws **29** and **30** threaded in the bar **28** and two coil springs **31** and **32** extending between the bar and the inner surface of the plate **17**. A coil of wire **33** surrounding the magnet **26** and another coil **34** surrounding the magnet **27** respond to flux changes caused by vibration of the discs **20** and **21** to generate corresponding electrical signals at two pairs of output conductors **35** and **36**, respectively, and, in the preferred embodiment, each of these coils comprises approximately 12,000 turns of No. 42 wire.

If desired, the two coils **33** and **34** may be connected in series so as to add the signals generated and thereby increase the sensitivity of the pickup. Alternatively, the coils may be independently connected to associated amplifying equipment (not shown) so that each detecting unit drives its own individual output device. In this manner, if there is any difference in the tonal quality of the signals produced by the two detecting units, the signals may be combined in any desired relation so as to produce the intended tonal quality, or they may be kept separate for stereo-type reproduction.

By way of example, FIG. 4 illustrates one method of connecting the two coils **33** and **34** to a simple control unit conveniently mounted on the plate **17** for adjustment by the musician. The coils **33** and **34** are connected in series. A variable resistor **37** between the coil **34** and an output jack **38** series as a volume control. A simple tone control, comprising a capacitor **39** and a variable resistor **40**, is connected across the coils **33** and **34**. One side of the coil **33** is connected to the plate **17** through the housing of the variable resistor **40**. The use of the jack **38** allows the coils and control circuitry mounted on plate **17** to be rapidly connected to the associated amplifying equipment (not shown).

Regardless of the way in which the coils **33** and **34** are connected to the output equipment, the provision of two detecting units permits compensation to be made for properties inherent in the particular stringed instrument, with which the invention is used. For example, if the strings at one end of the bridge produce stronger signals than those at the other end of the bridge, a resistance network may be inserted in the appropriate detecting unit output circuit to equalize the outputs from the different strings. Another advantage of the present invention results from the circular shape of the diaphragms **20** and **21** which are centered directly over the magnets **26** and **27**. This arrangement provides symmetry in each detecting unit in the plane parallel to the diaphragm so that each unit is equally sensitive to vibrations of the diaphragm about axes of rotation in the plane of the diaphragm as well as to vibrations along the axis perpendicular thereto. Finally, the mounting of the detecting units directly under the feet **18** and **19** of the bridge **16** contributes to the sensitivity of the magnetic pickup arrangement because the vibrations of the bridge are transmitted directly to the diaphragms, insuring the most sensitive and faithful reproduction of the string vibrations. Typically, in conventional electrical stringed instruments, a single pickup unit is placed at a point between the bridge feet with resultant attenuation and averaging of the lateral vibrations of the bridge.

In operation, vibrations induced in the strings **15** by plucking or bowing, for example, are transmitted through the bridge **16** to the magnetic diaphragms **20** and **21**, causing corresponding oscillations and resonances therein. As the diaphragms vibrate, they produce corresponding changes in the flux patterns of the magnetic fields of the magnets **26** and **27**, thereby inducing currents in the coils **33** and **34**. These currents, carried by the pairs of output conductors **35** and **36** to conventional amplifying equipment as described above, have been found to generate sounds of the highest sonority and refinement of tone, and in the particular embodiment described herein, to produce sounds having the tonal qualities characteristic of a string bass.

Although only one preferred form of the invention has been described herein, many modifications and variations therein will be apparent to those skilled in the art. Accordingly, all such variations and modifications are included within the intended scope of the invention as defined by the following claims.

I claim:

1. A stringed musical instrument comprising a rigid base member, magnetic diaphragm means including a flexible, magnetic diaphragm member directly coupled at its edges to the base member for vibration with respect thereto, whereby the diaphragm member flexes within its coupling points with the rigid base member, bridge means held in contact with the magnetic diaphragm member to transmit vibrations thereto, at least one vibratory string extending over the bridge means so as to transmit vibrations thereto, magnet means supported in spaced relation to the magnetic diaphragm means and having a flux field influenced by the magnetic diaphragm means, and winding means responsive to changes in the flux field so as to generate current signals in response thereto.

2. A musical instrument according to claim **1** wherein the diaphragm means comprises at least one disc-shaped member supported on the base member by peripheral contact therewith.

3. A musical instrument according to claim **2** wherein the diaphragm means comprises a pair of disc-shaped members supported on the base member by peripheral contact therewith and the bridge means comprises a member having two legs centrally engaging the disc members.

4. A musical instrument according to claim **3** wherein the legs of the bridge means terminate in circular feet.

5. A musical instrument according to claim **2** including recess means in the base member formed with a conical surface and wherein the disc-shaped member is supported in the recess means by peripheral contact with the conical surface.

6. A musical instrument according to claim **1** including a tailpiece means mounted on one end of the instrument and means for affixing one end of the vibratory string to the tailpiece, and damping means operatively associated with the vibratory string disposed closely adjacent the tailpiece means, said damper being formed of resilient material and having channel means to accommodate the string in its normal position.

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