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H. BENIOFF

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TRANSDUCER FOR STRINGED MUSICAL INSTRUMENTS

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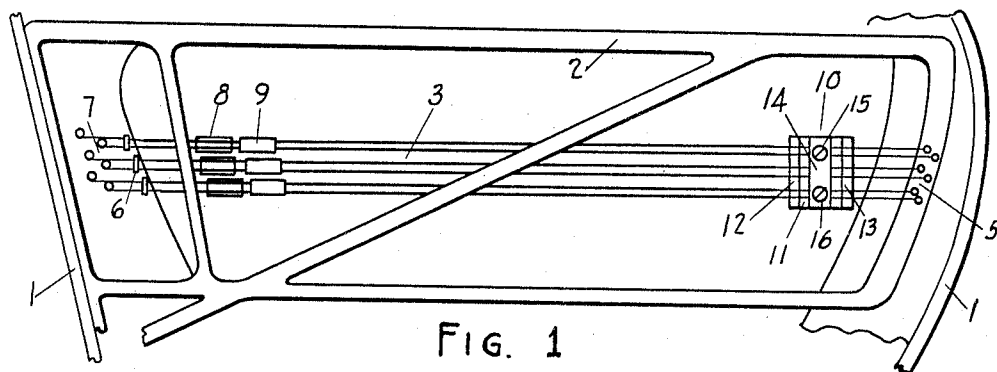


FIG. 1

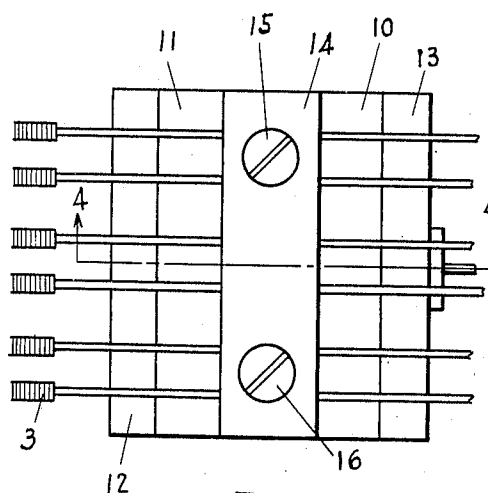


FIG. 2

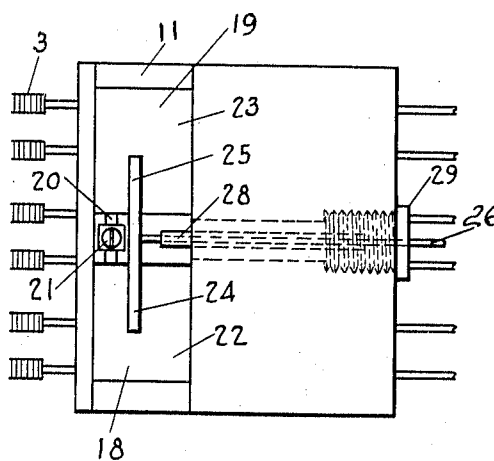


FIG. 3

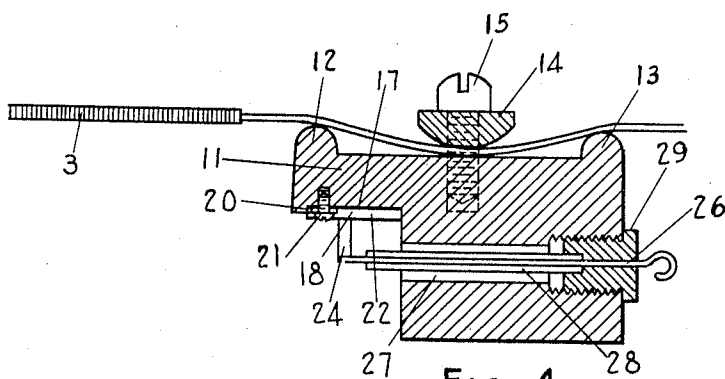


FIG. 4

INVENTOR
HUGO BENIOFF
Armand F. Knoblauch
ATTORNEY

UNITED STATES PATENT OFFICE

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TRANSDUCER FOR STRINGED MUSICAL INSTRUMENTS

Hugo Benioff, La Canada, Calif., assignor to The Baldwin Company, Cincinnati, Ohio, a corporation of Ohio

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5 Claims. (Cl. 84—1.16)

My invention relates to the conversion of the string vibrations of stringed musical instruments, into electric oscillations to be amplified and converted into musical tones. The invention is particularly applicable to instruments of the piano class and accordingly will be set forth in this description as incorporated in an electropiano.

I have observed in an electropiano, i. e., an electrical instrument of the class comprising a piano framework, strings, hammers, action, keys and case, but devoid of a soundboard, in which the string motions are converted into electric oscillations by transducers or pick-ups operatively associated with the strings, for reconversion into musical tones—that considerable sound issues from the instrument even when its associated electrical apparatus is not in operation. I have found that this residual or direct mechanical sound arises from the transfer of the string vibrations to the metal framework and the case of the instrument which in turn radiate them as sound. I have further found that the above mechanical sound detracts from the beauty of the tones electrically produced by the instrument.

It is therefore a primary object of my invention to provide an arrangement for stringed electrical musical instruments such that the vibrations of the strings are substantially impeded from being transferred to an instrument framework or case. Briefly, I accomplish this object by providing a transducer, for converting the vibrations of the strings into electric oscillations, supported solely by the strings intermediate their points of support on the instrument framework and having sufficient mass so that it effectively impedes the transfer of string vibrations to the framework or case.

It is a further object of my invention to combine with the isolation of the string vibrations a more perfect reproduction of the vibrations of the strings. To this end I provide a part of the transducer which is relatively vibratile as respects another part, and associate the first named part with the strings, and with a pick-up device as hereinafter set forth.

The transducer supported by the strings as thus outlined is located at a position corresponding, with reference to a piano, to the soundboard bridge of a piano. In this way, with the above-mentioned mass, the device functions as a speaking length terminus of the strings to determine their vibratory lengths. As a means for preventing transfer of string vibrations to the instrument framework the device may be said to behave as a low-pass filter impeding the transfer

of vibrations of any considerably higher frequency than that resulting from the combination of the transducer mass and the combined tensions of the strings supporting it. Such a limiting frequency can readily be made lower than the frequency of the lowest rate of vibration of any of the strings involved.

Various means may be operatively associated with the strings for converting their vibrations into useful electric oscillations or electromotive forces. I shall describe in the following one such means incorporated in an exemplary structure of the invention.

A detailed manner in which the above is attained and the attainment of those further objects of the invention which will be pointed out hereinafter or will occur to those skilled in the art on reading this specification, will now be described, reference being made to certain exemplary embodiments of the invention illustrated in the accompanying drawing, wherein:

Figure 1 is a plan view, taken from above, of part of a musical instrument, showing part of the instrument framework and case, strings and a transducer supported thereby;

Figure 2 is an enlarged plan view, likewise taken from above, of the transducer of Figure 1 supported by the strings;

Figure 3 is an enlarged plan view, taken from below, of the transducer; and

Figure 4 is a sectional elevation view of the transducer, taken on the plane 4—4 of Figure 2.

With detailed reference to Figure 1, an electropiano of grand piano form has a case 1 encompassing and supporting a string framework or piano plate 2. Stretched on the plate 2 are a series of tuned vibratile strings 3. For convenience I have illustrated partially only the bass section of the piano and have shown therein only the strings for three notes of the instrument. It will be understood that the principles and mechanism set forth herein are applicable to an entire instrument.

The strings 3 are hitched at their rear ends to the hitch pins 5, thence extending forward to be supported by agraffes 6 attached to the plate 2, terminating at their front ends on tuning pins 7 driven into a pin block (not exposed) likewise attached to the plate. Hammers 8, striking the strings from beneath, are operated by a conventional piano keyboard and action, not shown, with which are associated the string dampers 9.

In a rear part of the strings 3 and supported solely thereby is a device 10 which I shall call a

transducer, for converting the mechanical vibrations of the strings into electric oscillations. As shown it is located at a position with reference to the strings, corresponding generally to a soundboard bridge of a conventional piano. I compose it mainly of metal and give it sufficient mass relative to the strings and their tensions so as to be substantially immovable when the strings are vibrated (except for a relatively vibratile part 11 of the transducer which I shall later describe). In this way the speaking lengths of the strings for tone production extend essentially between the agraffes 6 and the transducer 10 and string vibrations are substantially prevented from extending rearward therefrom to vibratile susceptible portions of the plate 2 and case 1 wherefrom they would otherwise be radiated as sound. The electrically produced tones of the instrument are thus not degraded by mechanical sounds. As aforeoutlined the device 10 in impeding transfer of string vibrations to other parts of the instrument functions as a low-pass mechanical filter. Its limiting transfer frequency as determined by its mass and combined tensions of the strings supporting it, can readily be made much lower than the lowest mode of motion of any of the strings involved.

I have illustrated the transducer 10 in extending transverse to the strings 3, as associated with the strings for three adjacent notes of an instrument. It will be understood, of course, that a greater or lesser number of strings may be associated with a transducer as desired and that as many transducers may be incorporated in a complete instrument as required.

The means whereby the device 10 is supported solely by its strings comprises two upwardly extending metal ridges 12 and 13 integral with the device, and a pressure bar 14. As shown the strings 3 bear upon the ridges 12 and 13 extending transverse thereto, being held against the ridges by the pressure bar 14 attached to the transducer by screws 15 and 16 and bearing downward upon the strings between the ridges, thus suspending the transducer on the strings as desired.

The ridge 12 is located as illustrated at the forward edge of a forwardly extending cantilever bar or beam 11 of the transducer. As aforementioned this beam 11 is relatively vibratile compared with the main body of the transducer and thus vibrates under string vibrations. Cemented to its underside, with a metal foil electrode 17 interposed, are two piezoelectric crystals 18 and 19. The metal foil is electrically secured to the transducer through a foil strip 20 and a metal screw and washer 21 secured to the underside of the beam 11 as shown. The exposed faces of the crystals are covered by metal foils or electrodes 22 and 23 to which are connected the flexible foil strips 24 and 25. These strips 24 and 25 are connected to a wire 26 extending through the hole 27, the wire being supported by but electrically insulated from the transducer by the insulative sheath 28 and button 29 threaded into the hole 27. The vibratory strains set up in the crystals caused by the vibrations of the supporting bar 11 provide electromotive forces according to the usual piezoelectric principle, the output terminals for these electromotive forces being respectively the wire 26 and the transducer proper. Thus the string vibrations are converted into electromotive

forces which may be amplified and reconverted into sound.

I arrange the bar 11 to have a natural frequency considerably greater than the frequencies of any of the useful modes of motion of the vibrating strings affecting it, i. e., greater than the frequencies of the useful partials or harmonics of the strings in their transverse vibrations for musical tone production. The bar frequency, as a practical example, can be arranged to be above fifteen kilocycles (15,000 vibrations per second). The deflection of the bar is thus constantly proportional to the angular deflection of a string bearing upon it at the point of contact, irrespective of the exciting frequencies. The electromotive forces produced on the electrodes of the crystal are thus generated according to this proportionality, which I find advantageous in stringed electrical musical instruments. The principle has already been expressed in my United States Patent No. 2,222,057 issued November 19, 1940 for Stringed musical instrument.

It will be understood that modifications may be made in my invention without departing from its spirit. Being thus described, those features of the invention which I consider new and novel, and which I desire to protect by Letters Patent, comprise:

1. The combination in a musical instrument of a framework, a plurality of vibratile strings stretched on said framework, a member supported solely by said strings, said member having a body of sufficient mass to be substantially immovable upon vibrations of said strings whereby said member acts as a speaking length terminus for said strings and effectively impedes transfer of string vibrations to said framework, said member further having a part operatively associated with said strings and vibratile with said strings with respect to said body, and means for converting the vibrations of said strings into electromotive vibrations associated with said body and said vibratile element.

2. Apparatus as set forth in claim 1, wherein said member and said vibratile part are each formed with a ridge, said ridges spaced from each other and substantially parallel, and wherein said strings bear upon said ridges and are held thereagainst by holding means attached to said member between said ridges, whereby said member is supported as set forth.

3. Apparatus as set forth in claim 1, wherein said member has a vibratile projection extending as a cantilever from the main body of said member in the direction of the speaking lengths of said strings, said strings bearing upon said projection adjacent its outer end, and means attached to said projection productive of electromotive forces upon vibration thereof, whereby said means for converting the vibrations of said strings into useful electromotive forces is provided as set forth.

4. Apparatus as set forth in claim 1, wherein said member has a vibratile projection extending as a cantilever from the main body of said member in the direction of the speaking lengths of said strings, said strings bearing upon said projection adjacent its outer end, said projection having a vibration frequency considerably higher than the fundamental frequencies of said strings, and means attached to said projection productive of electromotive forces upon vibration thereof, whereby said means for converting the vibra-

tions of said strings into useful electromotive forces is provided as set forth.

5. In a stringed electrical musical instrument in connection with which vibrations are to be reproduced electrically rather than acoustically through a sound board, a string, spaced mounting means for stretching said string to permit it to vibrate, a member attached to said string between said spaced mounting means, said member being supported by said string and having in itself sufficient mass to act as a speaking length terminus for said string, and means in connec-

tion with said member for converting the vibrations of said string to electrical impulses, said member having a massive portion attached to said string and a second portion capable of vibrating with respect to said massive portion and also in contact with said string, said means for converting the vibrations of said string into electrical impulses being a means acted upon by the vibrations of said second portion of said member with respect to the said massive portion thereof.

HUGO BENIOFF.