

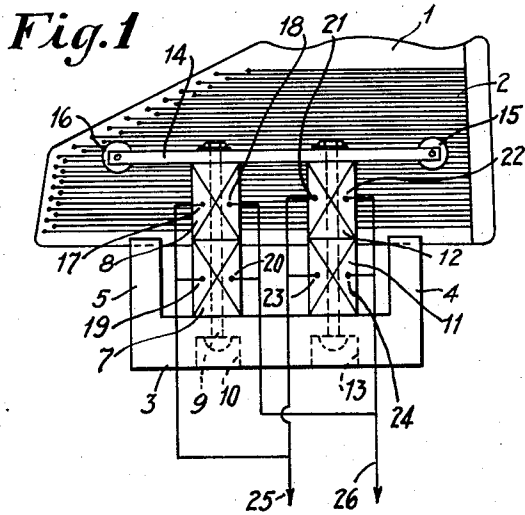
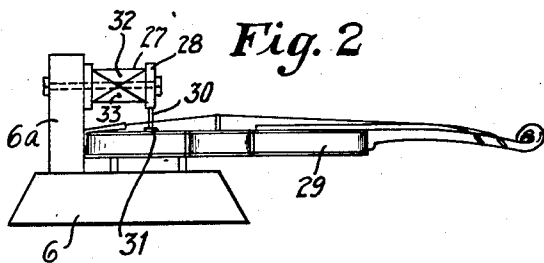
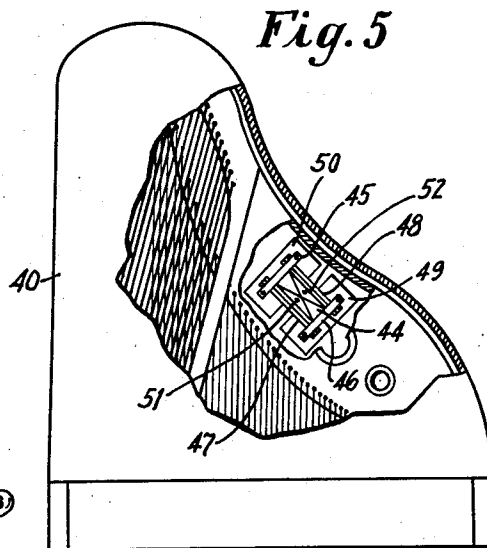
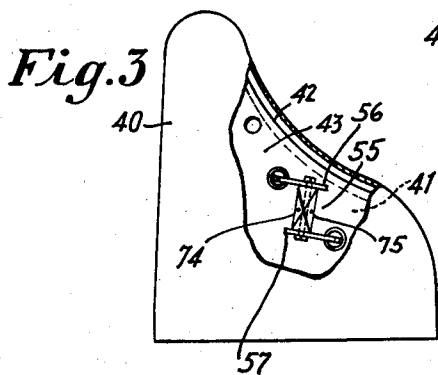
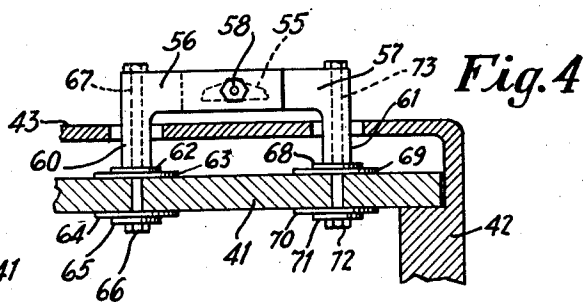
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A. McL. NICOLSON

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MUSICAL INSTRUMENT LOUD SPEAKER

Filed April 13, 1927



INVENTOR
ALEXANDER McLEAN NICOLSON
BY
Clyde A. Antors
ATTORNEY

UNITED STATES PATENT OFFICE

ALEXANDER McLEAN NICOLSON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FEDERAL TELEGRAPH COMPANY, A CORPORATION OF CALIFORNIA

MUSICAL-INSTRUMENT LOUD-SPEAKER

Application filed April 13, 1927. Serial No. 183,345.

This invention relates to sound reproducing apparatus and more particularly to such apparatus known as "loud speakers", and adapted to reproduce sounds from electrical oscillations corresponding thereto.

It is an object of this invention to provide improved apparatus of the class described, utilizing a series of resonant vibrating bodies each having one or more different natural frequencies of vibration, and a sounding board arranged to sustain and amplify the vibrations of such bodies, together with apparatus particularly adapted to cause vibration of such bodies and which will preferably although not necessarily, be in the form of one or more piezo-electric crystal devices arranged in a manner which I have found most effective.

It is a further object of this invention to provide a vibrating or driving apparatus in the form of a unit which may be easily and quickly attached to a musical instrument having a sounding board and a plurality of vibrating elements of different natural frequency, such for example as a piano, without making any alterations or changes in the instrument and particularly without the necessity of drilling or cutting into the sounding board.

Still other objects of my invention will be apparent from the specification.

The features of novelty which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its fundamental principles and as to its practical application will best be understood by reference to the specification and accompanying drawings, in which:

Fig. 1 illustrates one form of my invention as embodied upon a harp.

Fig. 2 illustrates a different form of my invention, as applied to a violin.

Fig. 3 is a top plan view of still another form of my invention showing my apparatus permanently secured in place upon a piano.

Fig. 4 is a detail view partly in section of the apparatus shown in Fig. 3; and

Fig. 5 is a plan view of still another form of my invention showing its adaption to a

piano in a manner requiring no drilling or cutting of any part of the piano.

In accordance with my invention I provide apparatus utilizing a sounding board having a preferably aperiodic characteristic and having associated with it a plurality of resonant vibrating bodies of different natural frequencies covering the band of frequencies which it is desired to reproduce. Musical instruments of the string and sounding board type, such as the harp, violin, piano, and the like, lend themselves particularly to my invention. I utilize a driving means which may, for example, and preferably will be one or more piezo-electric crystal devices adapted and arranged to be vibrated by electrical oscillations corresponding to the sounds to be reproduced. However, it will be understood that my invention is not limited thereto and that other driving apparatus may be employed, if desired.

I preferably secure the driving apparatus to the sounding board of the musical instrument in such manner that the sounding board is directly driven and the vibrations thereby communicated to the strings, although this is not essential, and I may connect the driving apparatus to some other part of the instrument or even to one or more of the strings, if desired. In cases where it is not objectionable to drill or cut the sounding board of the instrument, I may bolt or otherwise permanently secure the driving means to the sounding board in such manner that the sounding board is set into vibration by vibrations of the driving mechanism.

In cases where it is undesirable to mutilate the sounding board, I may provide driving apparatus in a form which may be laid upon or otherwise maintained in contact with the sounding board and held in position by gravity, detachable clamps, or the like.

Referring now more particularly to Fig. 1, I have shown my invention as embodied in a harp comprising a sounding board 1 carrying a plurality of strings 2 having successively differing natural frequencies as will be understood by those skilled in the art. A base 3 may be provided having extensions

4 and 5 adapted to carry the weight of the harp.

The driving means may be in the form of a pair of piezo-electric crystal devices 7 and 8, which may, for example, be Rochelle salt crystals exhibiting the well known "hour glass" configuration, drilled internally for bolt 9, by means of which they are secured to base 3 provided with an opening 10 to admit the head of the bolt 9. The crystals may be secured together in addition by means of Rochelle salt "melt" comprising Rochelle salt from which a suitable amount of water has been removed by heating the same at a temperature above its melting point. A second set of crystals 11 and 12 is similarly arranged to be secured by bolt 13, and a suitable stress plate of elastic metal such as steel is held in position at the top of the crystals 8 and 12. Opposite ends of the stress plate 14 are secured to suitable points upon the sounding board 1 as by bolting, and suitable metal bearing washers 15 and 16 are interposed to provide a relatively large stress transmitting surface against the sounding board. Suitable sound absorbing material such as felt or leather will be preferably interposed between any metal to metal joints to prevent rattle which might otherwise occur.

The crystals are preferably provided with a pair of electrodes each, such as 17, 18, 19, 20, 21, 22, 23, and 24 by means of which electrical oscillations may be impressed upon the crystal devices. The exact form and construction of these electrodes is not per se a part of this invention, and any suitable arrangement may be utilized: preferably the bolt 9 may constitute an internal electrode for each of the crystals 7 and 8 and the other electrode for each may be a suitable equatorial belt of conducting material such as metal foil applied around the crystal. Corresponding electrodes may be connected together and to a pair of leads 25 and 26, which will be connected to a source of electrical oscillations. Other arrangements of crystal devices may be utilized, such as those described and claimed in my copending applications, entitled "Composite piezo-electric torsion device," Serial No. 155,399, filed Mar. 11, 1927, "Internally clamped composite piezo-electric torsion device," Serial No. 155,900, filed Dec. 20, 1926, and "Orientation of component crystal in composite piezo-electric devices," filed Dec. 20, 1926, or if desired, electro-magnetic or electric-static driving means may be utilized.

In this connection, it is to be noted that since the internal motional impedance of the piezo-electric crystal devices is relatively high, in order to obtain the best results, the stress plate 14 is connected near a nodal point on the sounding board 1. If, however, driving means having a relatively lower motional impedance is used, the connection to the

sounding board will be correspondingly modified.

Referring now more particularly to Fig. 2, I have shown my invention as applied to a violin. In this instance, there is provided a base 6 suitably arranged to support a violin 29, and the base 6 may be provided with an extension 6^a upon which is mounted a suitable driving means such as piezo-electric crystal device 27 having a suitable stress plate 28 secured thereto to which is attached a driving rod 30 suitably secured to the sounding board of the violin as by means of a bearing plate 31. The crystal device 27 is provided with a pair of electrodes 32 and 33 which may be arranged in the same manner as described for Fig. 1.

Referring now more particularly to Figs. 3 and 4, I have shown my invention as embodied upon a piano 40 having a frame 42 supporting a sounding board 41 protected by a covering plate 43 having a series of openings therein. As this construction is the conventional piano construction, I do not believe it necessary to describe it in detail. A suitable driving means is provided such for example as piezo-electric crystal device 55 which may be in the form of a crystal of Rochelle salt as above described, provided with stress plates 56 and 57 secured thereto at opposite basal planes thereof and extending laterally on opposite sides of the crystal. The stress plates may be cemented to the crystal, and in addition a bolt 58 may be provided. As shown more particularly in Fig. 4, stress plate 56 may be provided with a downwardly projecting extension 60 and stress plate 57 with a similar extension 61. A metal plate 63 of relatively large surface is interposed between the extension 60 and the sounding board 41: and a suitable felt or leather washer 62 positioned between extension 60 and bearing plate 63. On the opposite side of the sounding board is provided a second bearing plate 64 corresponding to bearing plate 63 and washer 65 and the whole is secured in position by means of nut 66 engaging bolt 67 passing through stress plate 56, washers 62 and 64, bearing plates 63 and 65 and the sounding board 41. A similar construction is provided with reference to extension 61 of stress plate 57, the bearing plates being designated as 69 and 70, and the washers as 68 and 71: nut 72 engages bolt 73 to secure these members in position. Electrical oscillations may be supplied to the crystal by suitable electrodes 74 and 75 as before.

Under certain conditions, it may be desirable to leave the sounding board of the musical instrument intact. For the purpose of securing the benefits of my invention under such conditions, I may provide apparatus such as shown in Fig. 5, in which the driving means may, for example, be in the form of a piezo-electric crystal 44 provided

with stress plates 45 and 46 suitably secured thereto as by cementing and bolting, by means of bolts 47 and 48. Suitable bearing plates 49 and 50 may be secured to the stress plates 46 and 45 respectively, and may be secured thereto by being bolted or welded to the stress plates 45 and 46; and electrodes 51 and 52 of a suitable type such as already described, may be provided for the purpose of impressing electrical oscillations upon the crystal devices. The assembly may then be weighted by means of a lump of metal so as to be relatively ponderous, and will then be placed upon the sounding board of the piano, as may be found to produce the best results: when oscillations are supplied to the electrodes, stresses are developed by the crystal in accordance therewith, which stresses are transmitted through stress plates 45 and 46 to bearing plates 49 and 50 and thence to the sounding board of the piano.

It will be noted that since a piano comprises a set of strings tuned to a large range of fundamental frequencies and since each of the strings responds to a number of harmonics or overtones, which are different in the case of each string, the sounding board and its strings comprises an acoustic vibrator having an element having a natural resonant frequency of practically any frequency within the audible range, and by the use of such apparatus, it is possible to provide speech and music reproduction of considerable volume and of very excellent quality, without recourse to excessive power, as will be the case when non-resonant devices are utilized.

It will be understood that while I have shown and described the use of piezo-electric crystals for driving the sound reproducing apparatus, other means such as electro-magnetic or electro-static driving units may be utilized, and it will also be understood that while I have described my invention as a sound reproducer adapted to reproduce sound from electrical oscillations, that such apparatus is electrically reversible and may produce electrical oscillations from sound vibrations.

While I have shown and described certain preferred embodiments of my invention, it will be understood that modifications and changes may be made as will be understood by those skilled in the art, without departing from the spirit and scope of my invention.

I claim:

1. A loud speaker comprising a piezo electric crystal device, a pair of stress plates contacting with opposite ends of said device, and bolt members extending through said stress plates for connecting to a sounding board of a stringed musical instrument for causing vibrations of said strings and said sounding board at sound frequencies.

2. A loud speaker comprising a piezo electric crystal device, stress plates contacting with each end of said device, each stress plate

being independently and rigidly connected to the sounding board of a stringed musical instrument for causing vibration of said strings and said sounding board at sound frequencies.

3. A loud speaker comprising a piezo electric crystal device, stress plates each having a vertically extending supporting portion and a laterally extending portion, the contacting portion of each stress plate abutting with one terminal of said device, said supporting portion being secured to the sounding board of a stringed musical instrument for causing vibration of said strings and said sounding board at sound frequencies.

4. A loud speaker comprising a piezo electric crystal device, a pair of right angularly disposed metallic members having portions thereof directed toward each other and secured to said piezo electric crystal device and having other portions secured to a sounding board adjacent a nodal point thereof said piezo electric crystal device being rigidly secured to said right angularly disposed members for transmitting sound vibrations to said sounding board.

5. A loud speaker comprising a piezo electric crystal device comprising a plurality of piezo electric crystals, a stress plate contacting with each end of said device, a projection on each stress plate receiving a bolt member for rigidly securing said plate in position upon the sounding board of a stringed musical instrument to vibrate said strings and said sounding board at sound frequencies in accordance with sound frequency modulated energy fed to said piezo electric crystal device.

6. A loud speaker comprising a piano having a plurality of tensioned strings and a sounding board, a piezo electric crystal device, a pair of massive stress plates secured to said crystal, and connections between opposite terminals of said piezo electric crystal device and said sounding board for transmitting stresses from said stress plates to said sounding board and said strings at sound frequencies in accordance with modulated energy fed to said piezo electric crystal device.

Signed at New York, in the county of New York and State of New York, this 12th day of April A. D. 1927.

ALEXANDER McLEAN NICOLSON.