March 10, 1936. B. F. MIESSNER 2,033,440

APPARATUS FOR THE PRODUCTION OF MUSIC

Filed March 25, 1933

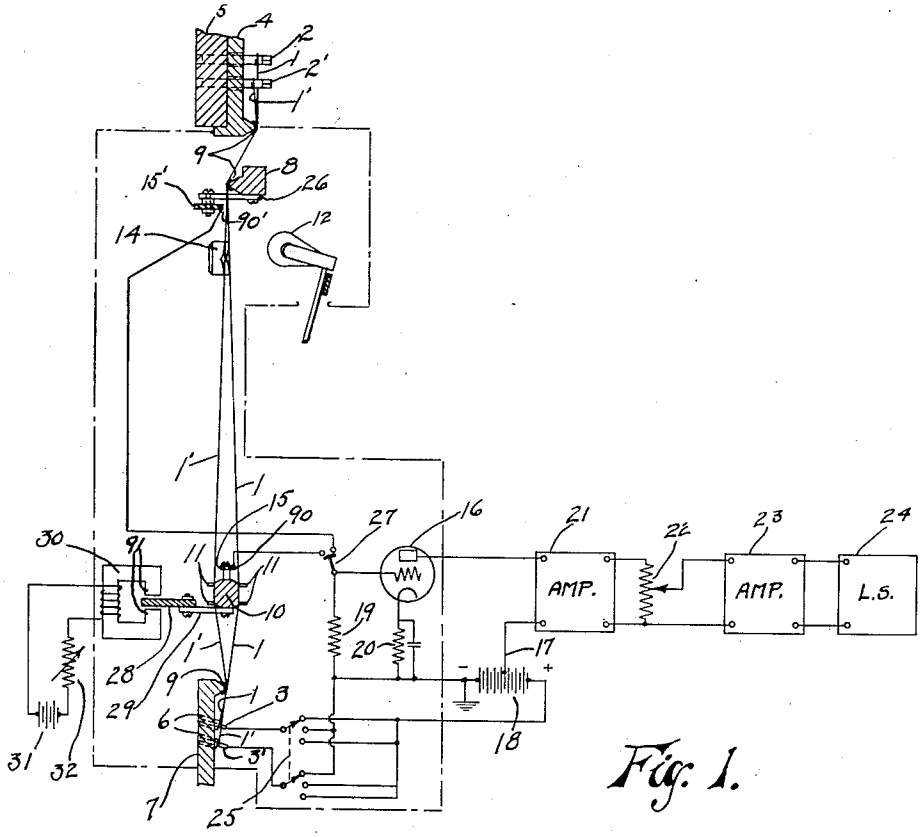


Fig. 1.

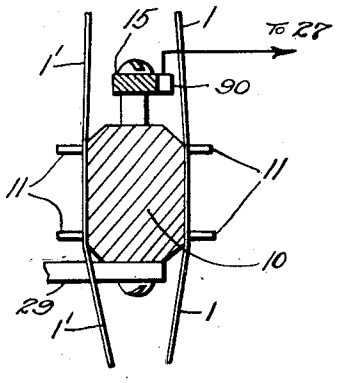


Fig. 2.

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Patented Mar. 10, 1936

2,033,440

UNITED STATES PATENT OFFICE

2,033,440

APPARATUS FOR THE PRODUCTION OF MUSIC

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Application March 25, 1933, Serial No. 662,697

14 Claims. (Cl. 84—197)

This invention relates to musical instruments employing a plurality of vibrators, and more particularly to those wherein electric currents are utilized in the process of translating their vibrations into sound.

It is an object of my invention to provide an improved instrument of the class described. A further object is the provision of improved means and methods for coupling the vibrators together. A still further object is the provision of improved means and methods for regulating the rate of damping of the vibrations of the vibrators. Other and allied objects will more fully appear from the following description and the appended claims.

In such description reference is had to the accompanying drawing, of which:—

Figure 1 is a view, partly cross-sectional and partly schematic, of an instrument embodying my invention in one form, wherein tuned strings, coupled together in a novel mechanical manner, are set into vibration by percussion, and their vibrations are controllably damped and translated into sound through the medium of electric oscillations; and

Figure 2 is an enlarged detail view of the bridge 10 and parts immediately adjacent thereto, including surface 90.

Reference being had to Figure 1, there will be seen a string 1 and a string 1', strung respectively from tuning pin 2 to hitch pin 3 and from tuning pin 2' to hitch pin 3'. The tuning pins may pass through clearance holes in plate portion 4 into wrest plank 5, and the hitch pins may be retained in insulating bushings 6 and these in turn set into plate portion 7. Each string may pass under capo or pressure bar 8, and may be electrically insulated from capo 8 and frame portions 4 and 7 by insulating members or strips 9. It will be understood that the plate portions 4 and 7 and capo 8 may each be part of an integrally cast plate or frame, or may be otherwise rigidly interconnected, according to common piano practice.

While only one string 1 and one string 1' have been illustrated, it will be understood that there will be employed at least one string 1 tuned to each note in the pitch range of the instrument. A similar number of strings 1', similarly tuned if desired, may be employed, but this number and condition of strings 1' may be varied according to principles hereinafter set forth. A bridge 10 is provided, to which all the strings are engaged as by conventional bridge pins 11. It will be seen, however, that while each string 1 bears on the top (right-shown side) of the bridge, each string 1' bears on the bottom (left-shown side) thereof. The strings themselves may form the sole support for the bridge, which is preferably a single one common to all the strings in the pitch range of the instrument.

For setting each string 1 into vibration there is provided a hammer 12. These may be actuated by a conventional piano action. For damping each string 1 may be provided a damper 14, actuated conventionally.

For translating the vibrations of each string 1 into electric oscillations I have shown mechanico-electric translating system beginning with a strip 15. This strip may have a narrow, electrically conductive surface 90 in slight spaced relationship to a point on each string 1 preferably a little forward of or above its contact with bridge 10. This conductive surface 90 may be electrically connected to the grid of a thermionic vacuum tube 16, whose cathode may be energized in any suitable manner and whose anode current may be supplied as from a positive tap 17 on high voltage vattery or other source 18, the negative terminal of which may be hereinafter referred to as "ground". The grid of tube 16 may be maintained slightly negative with respect to the cathode by connection through high resistance 19 to ground, the cathode of the tube being rendered slightly more positive than ground by virtue of anode current flow through condensively by-passed resistance 20. In the anode circuit of tube 16 may be provided in cascade amplifier 21, volume control or potentiometer 22, further amplifier 23, and loudspeaker or other electro-acoustic translating device 24. All the strings 1 are for ordinary purposes connected through the upper-shown blade of switch 25 to the positive potential of high voltage battery 18. They may thus be said to be polarized—i. e., maintained at a high potential difference from the mean potential of the conductive surface 90 or the grid of tube 16. At the same time the strings 1' may conveniently be grounded—i. e., maintained unpolarized.

The functioning of the translating system may be best understood by observing that between each string 1 and the conductive surface of strip 11 a small electrostatic capacity exists. These capacities in parallel with each other form a total capacity from strings to strip; and this capacity is charged through resistance 19 to the potential of source 18. Because of the high value of this latter resistance this charge cannot change rapidly. If now any string 1 be set into vibra-

tion toward and away from the strip 15, as results from striking by its associated hammer 12, the capacity from the string to the strip will be varied in accordance with the frequency and waveform of the point of the string opposite the strip; and the total strings-to-strip capacity will be likewise varied, though in reduced degree. By virtue of the relative constancy of the charge in this capacity, the voltage across it will vary correspondingly. The oscillation variations in this voltage are applied to the grid of the tube 16 and are thereby and by amplifiers 21 and 23 amplified, may be controlled in respect of amplitude by volume control 22, and are finally translated into sound by loudspeaker 24. It will be appreciated that any slight capacity from the conductive surface 90 to strings 1' will not be charged as long as strings 1' are not polarized, and that vibratory variations in this capacity are therefore not effective in producing electric oscillations or sound.

While the mechanico-electric translating system disclosed operates upon an electrostatic principle, my invention is not limited to the use of translating systems of this type, since it will be obvious that other types of mechanico-electric translating systems, such for example an electromagnetic, are equally capable of employment therewith.

Referring more particularly to the bridge 10, supported solely by its engagement with the strings, it will be seen that strings 1' take the place of the more conventional bridge support comprising a resonator, or of the alternative support comprising substantially non-radiating wooden ribs as disclosed and claimed in my co-pending application Serial Number 573,319, filed November 6, 1931 (on which U. S. Patent 1,929,029 has now been issued). Their substitution for these other forms of coupling media offers certain advantages of control, in that for varying degrees of coupling the number, size and tension of the strings 1' may be variously chosen. Additionally, if the strings 1' are respectively tuned to frequencies identical with or harmonically related to the frequencies of certain of the strings 1—preferably those engaging the bridge near such respective strings 1'—the advantage of generation of extra high frequency vibrational components and their reaction on the strings 1 is obtained. This effect is aided by proportioning the length of each string 1', from its point of engagement with the lower-shown bridge pin 11 to its point of engagement with the insulation 9 on plate portion 7, as an integral fraction of the length of the same string from its point of engagement with the upper bridge pin 11 to its point of engagement with insulation 9 on capo 8.

If provided in number and pitch corresponding to those of adjacent strings 1, the strings 1' may be employed for the generation of tones relatively free of percussion components according to principles set forth in my co-pending application Serial Number 583,613, filed December 29, 1931. Under these conditions when a string 1 is set into vibration as by its associated hammer 12, the coupling existing by virtue of bridge 10 between that string 1 and the adjacent similarly tuned string 1' will transfer a portion of the vibratory energy of the string 1 to the string 1'. This transfer is not instantaneous, however, and thus the string 1' will go into vibration with a gradual, rather than abrupt, initial amplitude rise. If now the vibration of a point on the string 1', preferably near its rigidly supported (upper-shown) end, be translated into sound, this sound will resemble rather the tone of the organ or a like instrument than a piano or other percussion tone. I have therefore shown a mechanico-electric system for translating these vibrations of the string 1' into electric oscillations, from which of course they may be translated into sound.

This system comprises a strip 15' similar to the previously described strip 15, with narrow conductive surface 90' in slight spaced relation to the strings 1' near their points of engagement with insulation 9 on capo 8. This strip may conviently be mounted, as by rigid strips 26, to capo 8. The conductive surface 90' may be connected to the grid of tube 16 through switch 27, by the selective manipulation of which this connection may be effected either alternatively or additionally to the like connection to the grid of the conductive surface 90'. When strip 15' is substituted for strip 15 by switch 27, switch 25 may be reset (downwardly one contact) so that it grounds strings 1 and polarizes strings 1'. This charges the capacity between the conductive surface 90' and the strings 1', and renders it effective in translating the vibrations of strings 1' into electric oscillations. The strings 1 being unpolarized, their capacity to the surface 90 is ineffective in producing electric oscillations.

It may be noted that with the surface 90' alone connected by switch 27 to the grid, switch 25 may be further re-set to its down-most position, polarizing both the string 1 and the strings 1' and charging capacities from strings to both strip surfaces. Again, switch 27 may be set to connect both strip surfaces 15 and 15' to the grid, and switch 25 in this case employed to polarize either strings 1, strings 1', or both strings 1 and strings 1'. These various possibilities of switch settings afford various tone characteristics, both in respect of abruptness of tone inception and of harmonic structure, the latter being influenced of course by the position or positions along the strings from which translation is effected.

When strings 1' are translated from it is desirable that each damper 14, normally provided for a string 1, be made simultaneously operative on the similarly tuned string 1', and the dampers have been so illustrated in Figure 1.

The inherent effect of a string supporting system of the type described is that of coupling the strings together without exerting an appreciable damping influence thereon. The tones produced by the instrument as thus far described may therefore tend to have an abnormally slow rate of damping. For damping the vibrations of the strings I have shown a damping system associated with the bridge 10, it being understood that this system is not limited to use with the particular form of bridge and support above described. This damping system comprises a member 28, which may conveniently be in the form of a long strip, of high electrical conductivity, firmly secured as by bars 29 to the bridge 10 at frequent points along the latter. Through this strip at frequent points along its length may be maintained a strong, steady magnetic field. Thus I have shown in Figure 1 an electromagnet 30, which may be rigidly mounted, with its poles 91 in close proximity to and on respectively opposite sides of member 28.

This electromagnet, of which it will be understood a plurality may be employed, may be excited by a strong electrical current, preferably direct, as from battery or other source 31. A

variable resistance 32 or other current controlling device may control the strength of the fields maintained by the electromagnets through member 28.

The operation of this damping means depends on the induction of currents in a conductor upon motion of the latter in a magnetic field. When any of the strings are vibrated the bridge 18 is likewise vibrated, principally in a horizontal direction as shown in Figure 1. Member 28 consequently vibrates in and out of the gap formed by the poles 31, and electric currents are consequently induced therein. These currents produce a power loss in the form of heating of member 28, and this power loss represents energy originally abstracted from the strings and not returned to them. This energy loss suffered by the strings increases their rate of damping. The strength of the currents induced in the member 28, the power loss in this member, and hence the rate of damping of the strings, increase with the strength of exciting current supplied to the electromagnets, and hence with a decrease of the resistance of 32. The latter therefore provides a means of control of the rate of damping. It will be understood that alternatively the member 28 may be rigidly mounted and the electromagnets 30 secured to the bridge.

It will be appreciated that the foregoing description is in its nature exemplary rather than comprehensive, and that the scope of my invention is to be determined rather by the appended claims than by the details of the description.

I claim:—

1. In a musical instrument, the combination of a plurality of tuned vibrators, and mechanical coupling means engaging all of said vibrators and supported solely thereby.

2. In a musical instrument, the combination of a plurality of tuned strings, and a bridge engaging all of said strings and supported solely thereby.

3. In a musical instrument, the combination of two groups of tuned vibrators, and mechanical coupling means interposed between the respective vibrators of said two groups and solely supported by said vibrators.

4. In a musical instrument, the combination of two groups of tuned strings, and a bridge interposed between the respective strings of said two groups and supported solely by said strings.

5. In a musical instrument, the combination of two groups of tuned vibrators; mechanical coupling means interposed between the respective vibrators of said two groups and supported solely thereby; means for exciting vibrations of the vibrators of one of said groups; and means for translating into sound the resulting vibrations of the vibrators of the other of said groups.

6. In a musical instrument, the combination of two groups of tuned vibrators; mechanical coupling means interposed between the respective vibrators of said two groups and supported solely thereby; means for exciting vibrations of the vibrators of one of said groups; and means selective with respect to said two groups for translating vibrations of the vibrators thereof into sound.

7. In a musical instrument, the combination of a group of tuned strings, a bridge against one face of which said strings bear, a second group of tuned strings bearing against a face of said bridge opposite said first mentioned face, selective means for exciting the strings of said first group whereby to initiate gradually rising vibrations of strings of said second group, and means for translating electric oscillations from said last mentioned vibrations.

8. In a musical instrument, the combination of a group of tuned strings, a bridge against one face of which said strings bear, a second group of tuned strings bearing against a face of said bridge opposite said first mentioned face, said bridge being floatingly held between said two groups of strings, selective means for exciting the strings of said first group, and means for translating electric oscillations from vibrations of the strings of said first group.

9. In a musical instrument, the combination of a group of tuned strings, a bridge against one face of which said strings bear, a second group of tuned strings bearing against a face of said bridge opposite said first mentioned face, means selective with respect to the several strings of said first group for producing vibrations thereof whereby to initiate gradually rising vibrations of strings of said second group, and means selective with respect to said two groups of strings for translating electric oscillations from their said vibrations.

10. In a musical instrument, the combination of a plurality of tuned vibrators, a vibratile bridge engaging said vibrators, and electromagnetic means associated with and influencing said bridge for damping said vibrators.

11. In combination in a musical instrument: a tuned vibrator and means for exciting the same into vibration, and means, including an electrically conductive member and means for maintaining therethrough a strong magnetic field, for damping said vibration.

12. In combination in a musical instrument: a tuned vibrator and means for exciting the same into vibration; means, including an electrically conductive member and means for maintaining therethrough a strong magnetic field, for damping said vibration; and means for varying the strength of said field.

13. In a musical instrument, the combination of a plurality of tuned vibrators, a vibratile bridge engaging said vibrators, and means for damping said vibrators, said means comprising an electrical conductor and means for maintaining a strong magnetic field through said conductor, one of said two last mentioned elements being mounted to said bridge and the other being rigidly mounted, whereby said conductor is vibrated relative to said field upon vibration of said bridge.

14. In a musical instrument, the combination of a plurality of tuned vibrators, a vibratile bridge engaging said vibrators, and means for damping said vibrators, said means comprising an electrical conductor, means for maintaining a strong magnetic field through said conductor, one of said two last mentioned elements being mounted to said bridge and the other being rigidly mounted, whereby said conductor is vibrated relative to said field upon vibration of said bridge, and adjustable means for varying the strength of said field.

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