Aug. 31, 1926. 1,598,056

S. COOPER

SOSTENUTO ELECTRICAL PIANO

Original Filed May 23, 1917

Fig. 1.

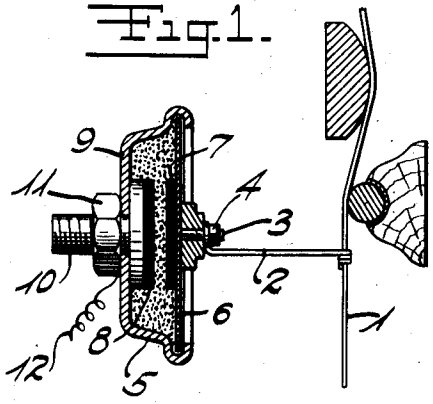


Fig. 2.

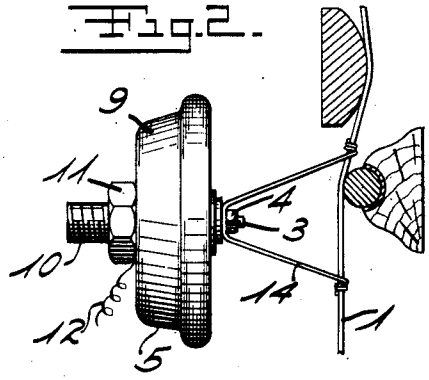


Fig. 5.

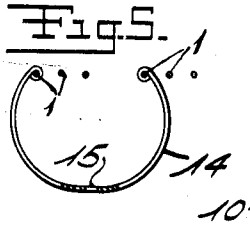


Fig. 7.

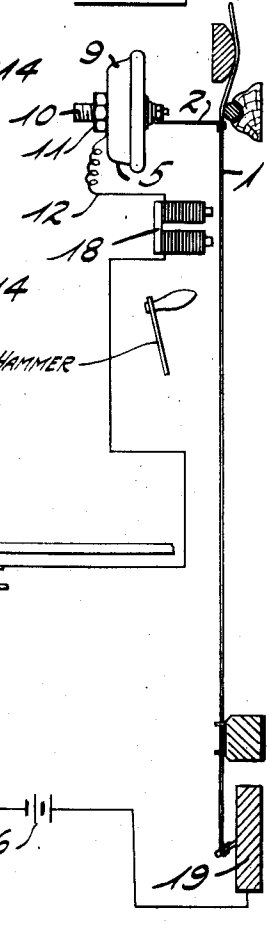


Fig. 3.

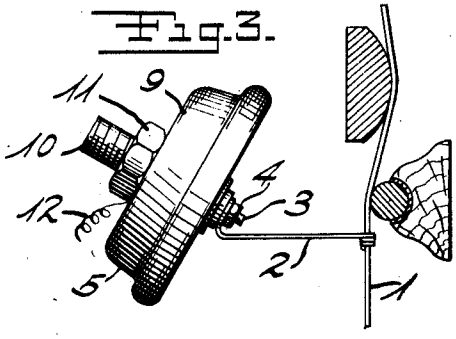


Fig. 6.

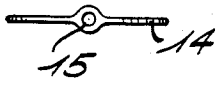
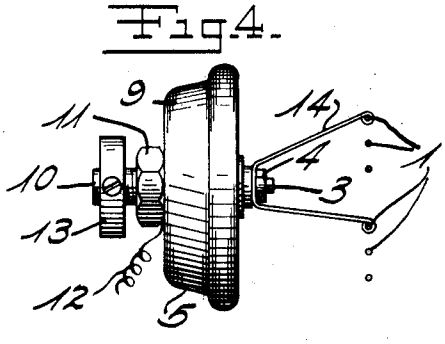


Fig. 4.



Inventor

Simon Cooper

By his Attorney

Frank & Cent

Patented Aug. 31, 1926. 1,598,056

UNITED STATES PATENT OFFICE.

SIMON COOPER, OF NEW YORK, N. Y.

SOSTENUTO ELECTRICAL PIANO.

Application filed May 23, 1917, Serial No. 170,357. Renewed November 19, 1925.

This invention relates to means for electromagnetically vibrating sonorous members, such as piano strings. In such instruments heretofore devised the means for pulsating the exciting currents have not proven satisfactory for various reasons, among which have been the inability, with commercially practical devices, to synchronize the vibrations of the sound-reproducing bodies and the pulsations of the exciting currents, the inability to establish and maintain a desired phase relation between the vibrations and pulsations, also the unreliable, irregular and uncontrollable character of the means for pulsating the currents and the difficulty of assembling them in an instrument.

It has heretofore been proposed to associate with a piano string or the like, an adjustable auxiliary vibrating member constituting a current pulsator in circuit with an electromagnet disposed so that the string intersects the magnetic field. In such devices the vibrating string caused forced vibrations to be communicated to the pulsator through the auxiliary vibrating member, which was to be adjusted to effect the production of the desired tone qualities by causing the pulsator to get in synchronism with, and in the desired phase relation to the vibrations of the strings. Such devices had the objection however that they required the assembly with a piano of a complicated mechanical and electrical organization, the cost of making and assembling and adjusting of the parts of which was very great.

By my invention I propose to carry directly on the vibrating string a substantially rigid but preferably bendable support which carries at its end a current pulsator which may take the form of an ordinary microphone, the movable member of the microphone being connected to the said rigid support with capacity for relative movement. I contemplate that the vibrating string shall be in the circuit of the electromagnet, as shall also the parts of the microphone. Such a device is readily attached as a unit to the vibrating string, may be fixed at any point along the length of the string as may be found desirable, as for instance, near the bridge, where there will be the least interference with the normal action of the string; and the microphone and its support may have any desired angular relation to the string which carries them. Furthermore, I provide the microphone with an adjustable weight, whereby, as well as by means of the bending or deflecting of the microphone support, the current pulsating action of the microphone may be retarded or accelerated as may be necessary to bring about the synchronization above referred to between the vibrations of the string and the energization of the magnet. It will be understood that other forms of current pulsator may be used, so long as the pulsator in its entirety and as a unit is carried directly by the string.

Other objects and aims of the invention, more or less broad than those stated above, together with the advantages inherent, will be in part obvious and in part specifically referred to in the course of the following description of the elements, combinations, arrangements of parts, and applications of principles constituting the invention; and the scope of protection contemplated will appear from the claims.

In the accompanying drawings, which are to be taken as part of this specification, and in which I have shown a merely preferred form of embodiment of the invention, Figure 1 is a side elevation and part sectional view indicating the equipment of one piano string; Figure 2 is a similar view showing a variation of one of the elements; Figure 3 is a like view with a further variation of some of the parts; Figure 4 is a plan view showing the invention applied to two strings; Figure 5 is a plan view in section of a modified form of stirrup connected to two piano strings. Figure 6 is another view of the stirrup; Figure 7 is a diagrammatic view of the electrical connections.

Referring to Figure 1, the upper portion of a string 1 is shown, and rigidly attached thereto is a bracket 2 composed of metal. The end of this bracket is formed into an eye which will fit over the stud 3 of the microphone and a nut 4 serves to fasten the microphone on said bracket.

The microphone 5 is of any approved type and in these drawings is shown as composed of a diaphragm 6 made of non-conducting material, electrodes 7 and 8 separated by particles of granular carbon, the electrode 7 being located on the center of the diaphragm and it and said central portion of the diaphragm being rigid with the end of the bracket 2, so that electrode 7 moves as the bracket and string move; a shell 9 carried by the flexible marginal portion of the

diaphragm and therefore movable relatively to the rigid central part of the diaphragm; and a stud 10, which stud passes through the shell 9 and is held in place by lock nut 11. A flexible conductor 12 is attached to the stud 10 by being fastened under the lock nut.

An electromagnet 18 is located in front of the string of the piano scale, Figure 7, and one terminal from this magnet is connected to the movable contact member 17' located beneath the piano key, the other terminal of the magnet is connected through the conductor 12, microphone 5, bracket 2, string 1, piano plate 19, battery 16 to the opposing stationary contact 17.

As the microphone is attached to the piano string through the center of the diaphragm by means of the rigid bracket 2 it is readily apparent that the portion 9 of the microphone will lag in its oscillations somewhat behind the piano string and behind the electrode 7, therefore the pressure of the electrodes 7 and 8 upon the granular carbon filling the inner spaces of the microphone will be subjected to successive increase and decrease of pressure which will alter the value of the current strength.

Since the diaphragm of a particular microphone will have its natural frequency of vibration which may not be of equal frequency to the piano string, it is necessary to arrange or adjust its frequency so that the resulting pulsation energizing the electromagnet will be in synchronism with the forward movement of the string toward the electromagnet.

Such energizing of the magnet need not be for every oscillation of the string but can be every second, third or fourth swing of the string or even less frequently provided its pull on the string synchronizes with the forward swinging of the same. Such adjustment of the frequency of the microphone is obtainable by methods as shown in Figure 3, in which the bracket 2 has its eye bent at an angle to its axis, thus supporting the microphone in a line at an angle to the longitudinal motion of the bracket. This will result in resolving the energy transmitted by the bracket 2 to the electrode 8 into two directions and only part of the said energy will be transmitted to the electrode 8 and said electrode will be set into motion or moved to a less extent than shown in Figure 1.

Another means for obtaining proper synchronism is by varying the mass of the relatively movable part of the microphone by attaching a weight 13 as shown in Figure 4. The varying of the mass of the movable part of the microphone renders it more or less lethargic, in other words, changes its period of movement; and by attaching the proper size weight to the shell of the microphone of a particular string it is possible to obtain the proper synchronism of the electromagnet. The lock nut 11 may also be utilized as an adjustable weight.

Another means for adjusting the frequency of the microphone is shown in Figure 5 where the bracket is made into the form of a stirrup 14 and is attached to two different note strings. By bending the curved portion of either half of the stirrup, the microphone being attached at the eye located on the center line 15, Figures 5 and 6, the actuations of said microphone due to the energy transmitted thereto by the vibrating string can be adjusted so that it is possible to attain synchronism between the microphone and the vibrating string.

It has been found in practice that the bracket 2 should preferably be of light section and as the weight of the microphone is comparatively great the motion communicated by the vibrating string causes the microphone to oscillate about the point where the said bracket is attached to the piano string and this interferes with the proper action of the microphone. To obviate this the construction shown in Figure 2 has been found desirable; in this case the bracket is formed into a stirrup, one leg of which is attached to the non-vibrating portion of the wire just above the upper bridge and the other leg fastened to the vibrating portion of the string. Each leg of the stirrup reinforces the other, resulting in a rigid structure.

Another form of this reinforcement is shown in Figure 4 where the double leg bracket or stirrup has one leg attached to one of the strings of the piano and the other leg attached to a string of the next note of the piano. Obviously, the bracket can have more than two legs, each one attached to a different string. With this form of device a single microphonic pulsator can be adjusted so as to bring about the desired synchronism between the several strings to which it is attached and the magnets belonging to those strings. This is because separate adjustment may be made of the separate legs; two immediately adjacent keys will seldom be struck simultaneously.

Figure 5 is a variation of Figure 4, in that the legs of the stirrup are curved instead of being straight.

The point where bracket 2 is fastened to the vibrating portion of the string varies from a small distance below the upper bridge to a point well down on the string for the middle register notes and even in contact with the over-windings for base notes, and it can also be located at the other end of the string near the lower bridge, and the point of attachment has a decided influence in attaining synchronism of the magnet with its string. Any form of mi-

crophone or "make-and-break" contacts can be used, and the only requisite is that one of the electrodes be carried by an elastic or resilient medium so that the inertia of its mass will serve to vary the electric conductivity of the contact.

Inasmuch as many changes could be made in the above construction, and many apparently widely different embodiments of my invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all the generic and specific features of the invention herein described.

I claim:

1. In a device of the kind described, a vibratory string, a rigid member connected at one end to the string, a microphonic current pulsator bodily attached to the other end of the rigid member, and a magnet in circuit with the microphone and adapted to actuate the string.

2. In a device of the kind described, a vibratory string, a rigid member connected at one end to the string, a microphonic current pulsator bodily attached to the other end of the rigid member, and a magnet in circuit with the microphone and with the string and adapted to actuate the string.

3. In a device of the kind described, a vibratory string, a stiff but bendable member connected at one end to the string, a microphonic current pulsator bodily carried by the bendable member, and a magnet in circuit with the microphone and adapted to actuate the string.

4. In a device of the kind described, a vibratory string, a rigid member connected at one end to the vibrating string, a current pulsator having one of its electrodes movably bodily secured to the outer end of the rigid member, and a magnet in circuit with the pulsator and adapted to actuate the string.

5. In a device of the kind described, a vibratory string, a rigid member connected at one end to the vibrating string, a current pulsator at the other end of the rigid member, said rigid member being bendable to assume various angular positions relative to the string for controlling the relative movements of the pulsator electrodes.

6. The method of regulating the relative movements of the electrodes in a current pulsator carried by a vibratory string, by angularly varying the position of the pulsator element on the string, whereby the impulsive movements of the electrodes are controlled, for the purpose set forth.

7. In a device of the kind described, a pair of vibratory strings, a rigid member comprising an attaching portion and a pair of legs connected one to one string and one to the other, a current pulsator carried by the attaching portion of the member, and a magnet associated with each of said strings in circuit with the pulsator and adapted to actuate the strings.

8. In a device of the kind described, vibratory strings of two different notes, a supporting member having a pair of legs connected one to one string, and one to the other of said strings, a current pulsator carried by said supporting members and a magnet associated with each of said strings in circuit with said current pulsator.

9. In a device of the kind described, a vibratory string, a supporting member attached at one end to said string, a current pulsator carried by the other end of said support, said pulsator having an inertia-controlled electrode therein, and a string-actuating magnet in circuit with said current pulsator.

10. In a device of the kind described, a vibratory string, an outstanding support attached at one end to said string, a current pulsator carried by the other end of said outstanding support and arranged thereon with its vertical axis in an angular position to the horizontal axis of the support for controlling the impulsive action of the pulsator, and a magnet in circuit with said current pulsator.

11. In a device of the kind described, a vibratory string, an outstanding support attached at one end to the said string, a current pulsator carried by the other end of said outstanding support with its vertical axis arranged thereon at an inclination, and a magnet in circuit with said current pulsator.

12. In a device of the kind described, a vibratory string and a bridge supporting the same, an outstanding support attached to the string adjacent said bridge, a current pulsator carried by said support and a string-actuating magnet in circuit with said current pulsator.

13. In a device of the kind described, vibratory strings, stirrup members having legs attached to said strings, current pulsators carried by said stirrup members and string-actuating magnets in circuit with said current pulsators.

14. The method of regulating the relative inertia movements of the electrodes in a current pulsator carried by a vibratory string by angularly varying the vertical axis of said pulsator relative to the string.

15. In a device of the kind described, a vibratory string, a supporting member attached at one end to the string, a current pulsator having one electrode rigidly secured to the other end of said supporting

member and a second electrode carried by the first mentioned electrode and movable according to its inertia toward and from the first mentioned electrode, a magnet in circuit with the pulsator and adapted to actuate the strings.

16. In a device of the kind described, a vibratory string, an outstanding curved support attached at one end to said string, a current pulsator carried by the other end of said outstanding support, and a string-actuating magnet in circuit with said current pulsator.

17. In a device of the kind described, a vibratory string, a rigid member connected at one end to the string near the bridge, a resilient diaphragm carried by the rigid member, an electrode rigidly attached to the diaphragm, a second electrode flexibly carried by the diaphragm, and a magnet in circuit with the pulsator and adapted to actuate the string.

18. In a device of the kind described, a vibratory string, a rigid member connected at one end to the string, a resilient diaphragm carried by the rigid member, an electrode rigidly attached to the diaphragm, a second electrode flexibly carried by the diaphragm, and a magnet in circuit with the pulsator and adapted to actuate the string.

19. The method of regulating the relative movements of the electrodes in a current pulsator directly carried by a plurality of vibratory strings, by angularly varying the position of said pulsator with reference to the several strings.

20. In a device of the kind described, a vibratory string, a rigid member connected at one end to the string, a current pulsator comprising a microphone having one electrode secured rigidly to the outer end of the rigid member, a second electrode also supported by the rigid member and movable relatively to the first electrode, a magnet in circuit with the microphone and adapted to actuate the string.

In testimony whereof I affix my signature.

SIMON COOPER.