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S. COOPER

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ELECTRICAL SOSTENUTO PIANO

Filed March 25, 1927

2 Sheets-Sheet 1

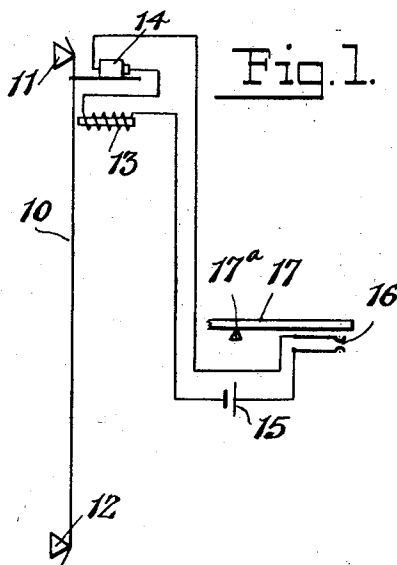


Fig. 1.

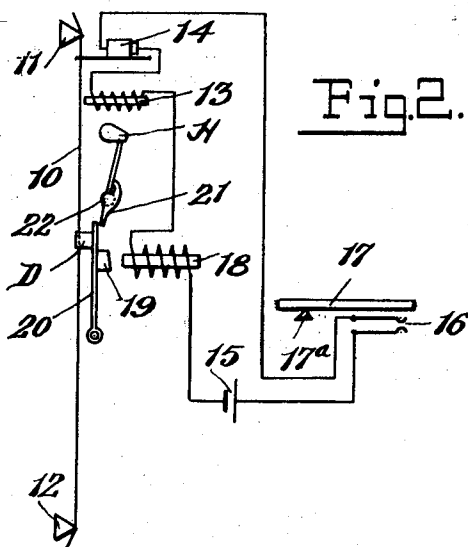


Fig. 2.

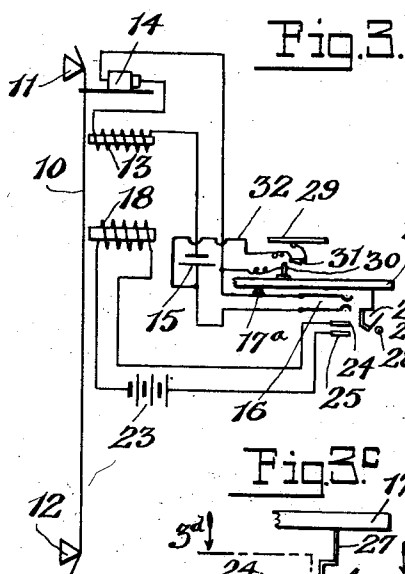


Fig. 3.

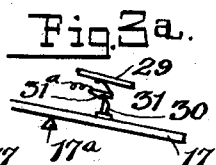


Fig. 3a.

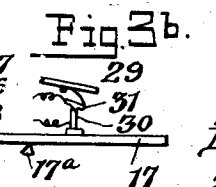


Fig. 3b.

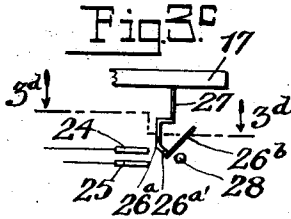


Fig. 3c.

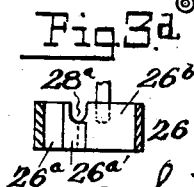


Fig. 3d.



Fig. 2a.

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ELECTRICAL SOSTENUTO PIANO

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This invention relates to the electrical operation of stringed instruments, and, more particularly, the invention aims to provide certain improvements in the art of electrical piano operation wherein there is employed a pulsator adapted to be acted on by string vibration and in circuit with an electro-magnet the fluctuating field of which acts on a string when such field is varied in strength.

Another object of the invention is to provide an improved method and apparatus for obtaining sostenuto as the result of the employment of such field.

Another object is to provide an improved method and apparatus for thus obtaining sostenuto without relying necessarily upon an initial impact or blow against the string such as is commonly delivered by the familiar hammer of the ordinary piano action; and in this connection it is also an object of the invention to provide a method and apparatus wherein, for very quick building up of the note to full volume, the equivalent of a vibration-initiating percussively-acting mechanical implement is employed. This equivalent, as I prefer to carry out the invention to attain the object last mentioned, is an electrical means which may be used as a complete substitute for said mechanically acting implement.

Another object is to provide an improved method and apparatus for obtaining sostenuto electrically, wherein, if such hammer blow or an equivalent be employed to start the string vibration, the hammer will be actuated in part at least by electrical means, and wherein, preferably, such electrical means is adapted to insure automatic damping of the string vibration at the cessation of the sostenuto.

Another object is to provide an improved method and apparatus as last stated, whereby a single simple movement may be performed, as the depression of a piano key, for the purpose of first initiating the string vi-

bration by a powerful blow or an equivalent, and then sustaining such vibration, as the result preferably of first setting up a more powerful magnetic field and then setting up a less powerful magnetic field.

Further to explain the various objects so far specifically mentioned:

In various copending applications of mine which relate to electrical sostenuto in pianos, I have disclosed and claimed various types of pulsators, various mounts for the same, and various methods and means for operating such pulsators by or with the string and for directly or indirectly connecting such pulsators to the string and to different portions thereof. These applications include Ser. Nos. 178,204, and others, filed on even date herewith.

In these applications, as sufficiently understood from the one particularly identified, the method disclosed in each case involved first the use of the piano hammer in initiating the vibration of the piano string and next the use of a pulsator for sustaining such vibration. I have discovered, however, that when the controllers are sensitively adjusted, according to the teachings of certain of said copending applications, it is not necessary to employ a hammer to strike the string, and that by closing the electric circuit containing the pulsator and magnet, the string is sufficiently put in motion, although beginning with a very slight amplitude, to actuate the pulsator, and rather quickly, by way of the magnetic field fluctuation thus initiated, increase the successive current undulations to the sound volume required. The magnet may be placed opposite the string in any portion of its length, but preferably at a point for sounding, not only the fundamental but also partials as desired from the string. The pulsator is located on any vibratile portion of the string, either a singing portion or a portion beyond a bridge. The operation of the instrument may then be like that of a

piano organ, that is a key may be depressed to bring about, directly, the sounding of the desired note, sostenuto. However, the attainment of the proper vibration of the musical member to a full musical tone is a cumulative process, occupying an appreciable period of time; and the invention also provides, where it is desirable to have the musical member or string attain full power extra quickly, a method and apparatus involving the employment of a striker or hammer implement to be impacted against the string, or a plectrum implement to vibrate the string as in a harpsichord, and involving the actuation of such implement by electrical and say electro-magnetic means. And the invention further proposes, as another example of a mode of causing the string to attain full power extra quickly, the employment of an auxiliary more powerful magnet, or a temporary increase of the current through the sostenuto causing magnet, during the initiatory stage of the string's vibration.

Another object of the present invention is to provide an improved method and apparatus having certain or all of the advantages just indicated, and wherein the equivalent of three-handed playing or piano organs or other musical instruments having practically no natural or inherent sostenuto, may be accomplished in the ordinary percussive-type of piano, so that one or more notes may be sustained as long as desired while the player's two hands are occupied with the piano keyboard to sound other notes or groups of notes.

Various other objects and advantages of the invention will be specifically pointed out or apparent hereinafter, in the course of a description of several preferred of the various possible forms of the invention as shown in the accompanying drawings; it being understood, of course, that such forms are merely illustrative of combinations and arrangements of parts calculated to attain the objects of the invention, pursuant to present preferences, and hence the detailed description of such forms now to be given is not to be taken as at all defining or limiting the invention itself. That is to say, the scope of protection contemplated is to be taken solely from the appended claims, interpreted as broadly as is consistent with the prior art, and with explanatory references to the specification only where a claim is ambiguous or to be impliedly limited beyond its express terms to avoid such art in order to save the validity of said claim.

In the accompanying drawings:

Fig. 1 is a diagrammatic view illustrating one form of apparatus according to the invention.

Fig. 2 is a similar view, showing another form of apparatus.

Fig. 2a is a detailed view showing on an

enlarged scale certain of the parts of Fig. 2.

Fig. 3 is a view similar to Figs. 1 and 2, but showing another form of apparatus.

Figs. 3a, 3b, 3c and 3d are detail views showing certain of the parts of Fig. 3, said Fig. 3d being a section, on a slightly enlarged scale, taken on line 3d—3d of Fig. 3c.

Figs. 4 and 5 are views similar to Figs. 1, 2 and 3, showing, respectively, other forms of apparatus according to the invention.

Referring to Fig. 1, which shows an elementary form of apparatus capable of carrying out the method of the invention according to which an ordinary sostenuto pulsator may be employed as the sole means for initiating string vibration and then for sustaining such vibration, there are disclosed, as in Figs. 2, 4 and 5, a piano string 10 stretched over bridge pieces 11 and 12. As in Figs. 2, 3 and 4, this string of Fig. 1 has associated therewith an electromagnet 13 and a pulsator 14 in a common circuit including a suitable source of energy 15 and a switch 16 operated by the piano key 17 when the latter is depressed, as by rocking it about its pivot 17a. The pulsator may co-act with a singing or non-singing portion of the string 10.

In operation, an arrangement such as shown in Fig. 1, I have found, results in the initiation of string vibration and the satisfactory building up of sostenuto, with the latter continued as long as the key 17 is held depressed, since thereby the switch 16 is maintained closed the same length of time. On first closing the switch, there is set up such an electrical disturbance and in such proximity to the string, due to the sudden setting up of a magnetic field in the electromagnet 13, that enough of a vibratory movement is imparted to string 10 to act on pulsator 14 to cause an appreciable current fluctuation in circuit 15. This in turn causes another change in the magnetic field, and one more pronounced so far as giving a vibratile impulse to the string is concerned. The result is a greater current fluctuation in the circuit than the first one. This cross-cumulative action continues, of course, much more rapidly than can be stated; and I have found that satisfactory musical performance of most if not all compositions may be had in this way on an electrical sostenuto piano.

Referring now to Fig. 2, an arrangement is here shown wherein a hammer H other than the ordinary hammer of the piano action, is employed for the initial blow against the string 10, when it is desired to build up the full sostenuto musical tone very quickly. This arrangement of Fig. 2 also includes a damper D for the string, operating at the proper instant by the same means which actuates the hammer, here an auxiliary electro-magnet 18 in the circuit including battery 15 and the sostenuto magnet 13.

This magnet 18 acts to attract an armature 130

19 when the key switch 16 is closed; said magnet 18, as shown, being more powerful than the sostenuto magnet 13.

Armature 19 and damper D are on a pivoted arm 20. The hammer H, and a latch 21, are pivoted, for relative movement when required, on a shaft 22. The pendent limb of latch 21 is engaged by the upper end of arm 20 when the armature is attracted by the magnet 18 upon the closing of the circuit; it being understood that suitable means, as springs (not shown), urge the parts to the normal positions illustrated. The attraction of magnet 18 for armature 19 is sufficient to carry the arm 20 beyond and out of engagement with the latch with the result that the hammer strikes a blow upon a string 10 and instantly rebounds. The sostenuto is set up and maintained, however, by magnet 13, as long as key 17 is held depressed. Arm 20 returns to its normal position when the key is released, and the arm 20 moves back past latch 21, without disturbing the hammer, but to seat the damper against the string to silence the latter.

Referring to Fig. 3, the arrangement here shown includes a powerful magnet 18 as in Fig. 2, but closer to the piano string; and a separate circuit including its own source of electric energy 23 and a pair of terminals 24 and 25. Attached to key 17 is a contact latch 26 which depends resiliently from a flexible arm 27.

Referring to Figures 3c and 3d, this contact latch includes a conducting-bridge plate 26a bevelled at its bottom as indicated at 26a', and carrying a rearwardly extending guide plate 26b. Near the bottom of the V-trough between these two plates, as indicated in Fig. 3d, is a release opening 28a for the free end of a fixed pin 28 after the latter has been trapped in the V-trough. Such trapping is incident to a part of the operation of the contact latch as will now be explained.

When the key 17 is depressed the bridge plate 26a is forced into contact with the terminals 24 and 25, as the result of the pin 28 engaging the ramp constituted by the outside surface of plate 26b, thus causing a powerful momentary energization of magnet 18, and a considerable vibratory movement of the string 10.

Further and complete depression of key 17 first closes the switch 16, causing current to be supplied to pulsator 14 and magnet 13, thus energizing the sostenuto circuit; and then throws the plate 26b beyond the pin 28, permitting the bridge plate 26a to move away from the terminals 24 and 25 thus breaking the circuit through magnet 18.

Upon releasing the key 17, the pin 28 engages the inclined inner surface of the guide plate 26b and insures the clearing of the bridge plate 26a from the terminals 24 and

25; the pin passing through the opening 28a located in the V-trough, and all the parts thus becoming reset for another depression of key 17.

Referring to Figs. 3, 3a and 3b, there is shown an arrangement for three handed playing as in piano organs whereby key 17 may have associated with it an auxiliary key 29, which when once set into operative condition as an incident to a depression of said key 17, remains thus until the auxiliary key is again operated; whether or not the key 17 is then depressed or undepressed. In the present case this arrangement for three-handed playing includes, in addition to these two keys, two contacts 30 and 31. Contact 30 is an up-standing rigid stud on key 17, desirably bevelled at its top as indicated; and contact 31 is a fairly rigid horizontal wedge-piece, carrying a lug 31a, and suspended by a band-spring 31b or the like from key 29. These parts are so arranged that when the two keys are in normal position, that is, both undepressed as shown in Fig. 3 there is a break in the shunt 32 including magnet 13; and the arrangement of the parts is also such that with key 29 undepressed, key 17 may be depressed without contact 30 touching contact 31. When, however, key 29 is depressed while key 17 is already in depressed position, as when it is desired to lock the key 17 depressed to release the finger which depressed it for the depression of another key 17, the contacts 30 and 31 not only touch, but snap into temporary latch-lock as shown in Fig. 3a. When now the key 17 of Fig. 3a is released to return to its normal position as shown in Figs. 3 and 3b, the interlocking of the contacts 30 and 31 is still held; and will continue to be held, until key 29 is rocked in the opposite direction about say a central pivot (not shown), whereupon the parts 31a will snap free of contact 30, and the condition shown in Fig. 3 will be restored.

The described arrangement provides for what is sometimes called three-hand playing or for duet performances on a single piano since when a key such as 29 is depressed to close the shunt circuit, the sostenuto will be maintained for that particular string while the performer may remove his finger from the main key to depress other keys; and the sostenuto effect may be discontinued at any time by releasing the key 29.

Obviously, the elements 29 to 32, or equivalents, may be employed with the arrangement of Fig. 1; as also with the arrangements of Figs. 4 and 5 now to be described, as indicated at 29 to 32 on the latter.

These Figs. 4 and 5 have circuits somewhat like those of Fig. 3, yet but a single magnet, the sostenuto magnet 13, is employed. However, the equivalent of the arrangement of Fig. 3 is present, in that in Fig. 4 a more powerful battery 23' is employed for the in-

initial vibration and the usual magnet 15 is employed for the sostenuto; and in that in Fig. 5 a fairly powerful battery 23'' in its entirety is used for the initial vibration and a part only of this battery, as indicated at 23a, is used for the sostenuto.

Figs. 4 and 5 otherwise differ from each other, and from the other arrangements already described, in that certain switch arrangements different from the parts 26 to 28 of Fig. 3 are employed.

In Fig. 4 there is shown a switch means including a metal spring 33 normally contacting with a fixed stop 34 which connects with one terminal of the battery 23', the other terminal of this battery being connected to the lead 15' from battery 15 to pulsator 14. Upon first depressing key 17, the upper leaf 16a of switch 16 is forced into contact with spring 33, causing a heavy charge of current to flow from battery 23' through the pulsator 14 and magnet 13, and thus causing string 10 strongly to vibrate. Further depression of key 17 breaks the circuit for battery 23' at 33 and 34, again causing the string 10 to vibrate. Complete depression of key 17 brings leaf 16a into contact with spring 33 and leaf 16b, causing a flow of current from the battery 15 to flow through the pulsator and magnet, for the sostenuto.

In Fig. 5, the circuit for maintaining the sostenuto is through the pulsator, the magnet, a lead 35, the portion 23a of battery 23'', switch 16, and lead 36. A conductor 37 leads from magnet 13 to a spring 38 which bears upon another spring 39, connected by a rod 39a with key 17. A contact 40 leads to the end of battery 23'' opposite to the end thereof connecting with lead 35. A stop 41 prevents the spring 38 from moving all the way down with spring 39; so that spring 38 is left behind when springs 39 and 40 touch. Thus, during depression of the key, magnet 13 first receive a powerful surge of current from battery 23'', due to the contact of spring 39 with springs 38 and 40, and then said magnet receives the sostenuto current from battery-portion 23a only, due to the closing of switch 16 and the passing on of springs 39 and 40 beyond spring 38 when the latter engages stop 41.

Damper means, as in Fig. 2, may obviously be employed in the arrangements of Figs. 1, 4 and 5; as by using another magnet, in circuit with the sostenuto magnet and the pulsator, and acting when energized to attract an armature mounted for movement with the damper means, as in Fig. 2, so that when the two magnets are de-energized on releasing key 17, the damper is restored to its normal engagement with string 10.

Inasmuch as many changes could be made in the above constructions, 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 contained in the following claims is intended to cover all the generic and specific features of the invention herein described and all statements of the scope of the invention which, as matter of language, might be said to fall therebetween.

What I claim is:

1. In an electrical musical instrument, the combination of a vibrating string, a key, a source of current supply, an electro-magnet for giving the string an initial vibration when in circuit with said source, said magnet and source being normally out of circuit, and means operated by a single movement of the key for making such circuit and then for breaking such circuit.

2. In an electrical musical instrument, the combination of a vibrating string, a key, a source of current supply, an electro-magnet for giving the string an initial vibration when in circuit with said source, said magnet and source being normally out of circuit, and means whereby when the key is partially depressed said source and magnet are put in circuit and when the key is further depressed said source and magnet are restored to normal relation to said circuit.

3. In an electrical musical instrument, the combination of a vibrating string, a string-operated pulsator, a key, a source of current supply, an electro-magnet for giving the string an initial vibration when in circuit with said source, said magnet and source being normally out of circuit, and means operated by the key for making such circuit and then for breaking such circuit and then for damping the string vibration.

4. The instrument defined in claim 1, wherein there is provided a percussive hammer, and said magnet actuates said hammer when the key is operated to make said circuit.

5. The instrument defined in claim 1, wherein there is provided a percussive hammer, and said magnet actuates said hammer when the key is operated to make said circuit, there also being provided a mechanical damper for the string actuated when the key is operated to break said circuit.

6. The instrument defined in claim 3, wherein there is provided a percussive hammer, and said magnet actuates said hammer when the key is operated to make said circuit, there also being provided a mechanical damper for the string actuated when the key is operated to break said circuit.

7. The instrument defined in claim 1, wherein there is provided a percussive ham-

mer and a mechanical damper, and said magnet actuates said hammer when the key is operated to make said circuit, there being means associated with the hammer and damper whereby when the key is operated to make said circuit the hammer is retracted immediately after striking the string and the damper is actuated when the key is permitted to break the circuit.

8. In an electrical sostenuto piano, the combination of a vibration-initiating means for the string, and a sostenuto means for the string, said two means including three elements of which two are magnets and the third is a source of current supply.

9. In an electrical sostenuto piano, the combination of a vibrating-initiating means for the string, and a sostenuto means for the string, said two means including three elements a first of which elements is a magnet, a second of which elements is a source of current supply, and the third of which elements is a magnet more highly energized than the first named said first and second elements, said third element and the element whereof it is a type being of different powers.

10. In an electrical sostenuto piano, the combination with a string, and with means including a movable member and a normally inoperative electrical means rendered operative for sostenuto on moving said member from a first position to a second position, of a second movable member, and means associated with the two movable members whereby by both members may be moved to lock the first member in said second position, for three-handed playing.

11. The piano defined in claim 10, wherein the means last mentioned includes co-acting devices rendered inoperative by a predetermined movement of the second movable member, thereby to release the two members from the lock.

12. The method of producing sostenuto effect in a piano string which consists in establishing a preliminary strong electro-magnetic string plucking field adjacent the piano string and thereafter causing pulsator variations in said field in phase with the vibrations of the string.

13. The method of producing sostenuto effect in a piano string which consists in causing an electric current to produce a preliminary magnetic string plucking field and thereafter maintaining the current and causing the vibrating string to produce pulsator variations in the strength of the current to effect corresponding variations in the strength of the magnetic field.

14. The method of producing sostenuto effect in a piano string which consists in causing an electric current to produce a preliminary magnetic string plucking field and thereafter maintaining the current and causing the vibrating string to effect the production of a

second and variable magnetic field in phase with the vibrations of the string and acting on said string.

15. The method of producing sostenuto effect in a piano string which consists in causing an electric current to produce a preliminary magnetic string plucking field and thereafter maintaining the current and causing the vibrating string to effect the production of a second and variable magnetic field in phase with the vibrations of the string and acting on said string, the second field differing in intensity from the first.

16. In a sostenuto piano or the like, a string, a plucking magnet, a pulsator actuated by the string, a sostenuto magnet, a power source, a key, and switch means under control of the key for actuating the plucking magnet and for actuating the sostenuto magnet under control of the pulsator.

17. In a sostenuto piano or the like, a string, a plucking magnet, a pulsator actuated by the string, a sostenuto magnet, a power source, a key, switch means under control of the key for actuating the plucking magnet and for actuating the sostenuto magnet under control of the pulsator, a hammer, and a hammer actuator including a damper, the plucking magnet being arranged to operate on the hammer actuator.

18. In a sostenuto piano or the like, a string, a plucking magnet, a pulsator actuated by the string, a sostenuto magnet, a power source, a key, switch means under control of the key for actuating the plucking magnet and for actuating the sostenuto magnet under control of the pulsator, a hammer, and a hammer actuator including a damper, the plucking magnet being arranged to operate on the hammer actuator, and the hammer having a trip device giving a hammer stroke when the actuator is moved in one direction and permitting the actuator to move in the other direction to apply the damper without movement of the hammer.

19. In a sostenuto piano or the like, a string, a pulsator actuated by the string, a sostenuto magnet, a power source, a key, switch means under control of the key for actuating the sostenuto magnet under control of the pulsator, and means for maintaining the sostenuto without continued manual depression of the key.

20. In a sostenuto piano or the like, a string, a pulsator actuated by the string, a sostenuto magnet, a power source, a key, switch means under control of the key for actuating the sostenuto magnet under control of the pulsator, a shunt in the circuit of the sostenuto magnet and pulsator and a second key for closing and opening the shunt circuit, to maintain sostenuto without continued depression of the main key or to discontinue the sostenuto.

21. The piano defined in claim 16 with the

addition that the circuit and contact arrangements include a source of additional power in the plucking magnet circuit and means under key control for closing said circuit.

- 5 22. The piano defined in claim 16 with the addition that the circuit and contact arrangement include a source of additional power in the plucking magnet circuit and means under key control for closing said circuit, said
10 means being arranged to avoid closing the circuit during key return movement.

In testimony whereof I affix my signature.

SIMON COOPER.

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