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S. CABOT

SOUND RESONATOR

Original Filed July 3, 1918

Fig. 2

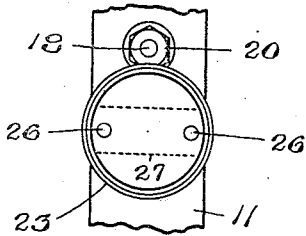


Fig. 1

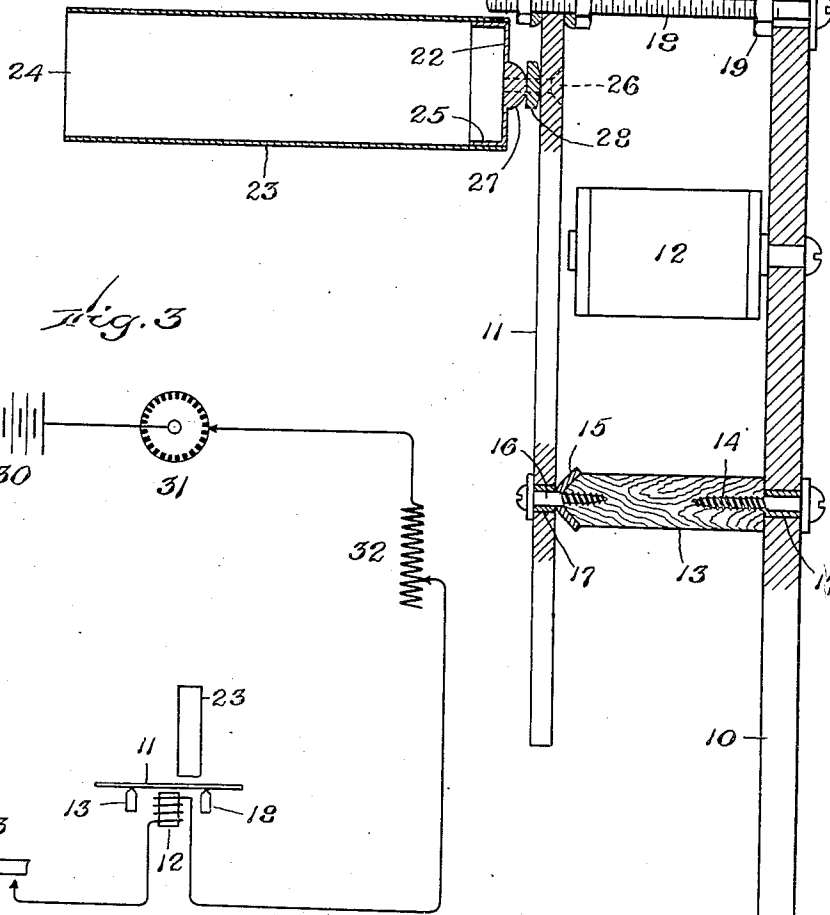
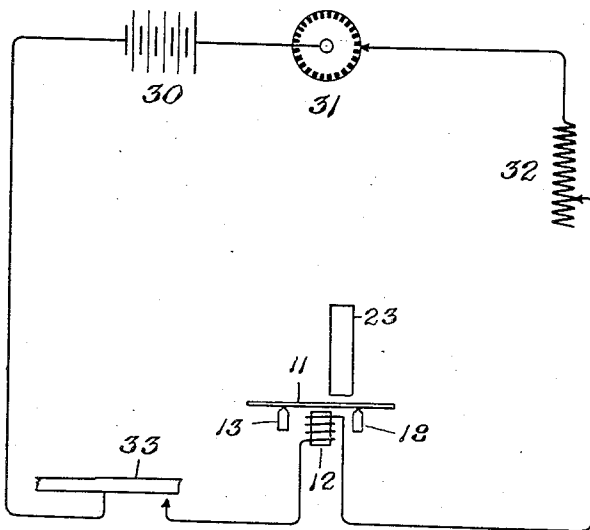


Fig. 3



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SOUND RESONATOR.

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This invention relates to resonators for musical instruments, and more specifically to a new construction whereby the resonator is made to produce tones that are greatly improved in quality and volume, and to increase the promptitude of beginning and ending the production thereof. In the present instance the tuned sonorous body is intended to be vibrated by pulsatory magnetic influence according to the principle disclosed in U. S. Letters Patent to Sinclair and Fiske, 1,167,663.

Hitherto it has been the practice to locate the air wave generator of a musical instrument at or near the opening of the resonator, at which place the pressure of the standing air wave is of minimum degree as compared to the degree of pressure in the other parts of the resonator. Consequently a relatively great amplitude of vibration of the generator is required to generate a sufficient volume of sound. Furthermore the production and cessation of sound are relatively slow in occurring because the inertia of the generator retards increase and decrease in the amplitude of vibratory motion. This is especially so as to the lower part of the musical scale where the vibratory mass is relatively heavy and the frequency of vibration is less than 250 per second.

An object of the invention is to provide an improved resonator having a bodily movable, non-flexible reflecting wall, in combination with means for imparting operative motion to said wall. A feature which, so far as I am aware, is novel and which has proved to have practical advantages consists in mounting the body or tube of the resonator to partake of the operating motion of the reflecting wall, and in making the body or tube so light that the effect of its inertia is negligible. Another feature consists in mounting the resonator so that its motion will be free from all extraneous resistances.

Still another novel feature consists in a stopped air resonator the reflecting wall of which is so located, relatively to the open end of the resonator, as to operate at a point where the pressure of the air wave against which it impinges is greater than the pressure at or near the opening. Con-

sequently the energy applied to the vibratory mass does not require so much of the kinetic form. As the air waves are transmitted toward the opening of the resonator their amplitude accumulates, and the volume of sound emitted at the opening is greatly increased.

The generator may, and preferably does, comprise something more than the reflecting wall of the resonator, and I have shown it as comprising a vibratory steel bar adapted to execute simple harmonic motion. The generator, built up of the reflecting wall and the steel bar, is, to all intents and results a unit, excepting that, for structural purposes, the two parts named are made separately and connected rigidly to each other.

Inasmuch as the aforesaid arrangement of the reflecting wall decreases the demand for energy of kinetic form, a relatively small amplitude of vibration accomplishes the desired result. This accelerates the production of sound because the vibratory mass acquires the necessary sound-producing amplitude more promptly since the mechanical resistance due to internal molecular friction in the steel bar is correspondingly less. Furthermore, when the motive force that vibrates the generator ceases, the latter loses its sound-producing degree of vibration more promptly for two causes. First, its maximum momentum is of relatively low degree, and, second, the damping effect of the standing air wave is of relatively high degree. The latter cause is due to the relatively high degree of pressure of the air waves against which the reflecting wall impinges in the resonator.

Another object of the invention is to provide improved means for producing simple harmonic motion to operate the resonator. In this respect a novel feature consists in a nodally mounted vibratory bar, a movable portion of which is rigidly connected to the aforesaid reflecting wall. To obtain the best results, in view of locating the reflecting wall to operate where the loop pressure is relatively great, as hereinbefore stated, another novel feature consists in attaching the reflecting wall to the vibratory bar at a point that has relatively little motion, and applying the moving force

to the bar at a point that has relatively great amplitude of movement.

Other novel features of the invention are hereinafter described and claimed and are 5 illustrated by the drawings.

Referring to the accompanying drawings.

Figure 1 represents an elevation, partly in section, of a musical sound generator and resonator made according to the present invention. 10

Figure 2 represents an end elevation of a portion of the same structure, as viewed from left to right with reference to Figure 1.

Figure 3 represents a diagram of electric wiring including the generator and resonator shown by Figure 1. The circuit represented by this diagram is reduced to its simplest form and includes only the fundamental elements required to operate the generator. 15

The same reference characters indicate the same parts wherever they occur. 20

The supporting base is indicated at 10. It may be made of cast iron. The vibratory steel bar 11 is of oblong cross section, and is supported at its nodal lines. It is arranged to be vibrated by an electro-magnet 12, the latter being affixed to the base 10 substantially midway between said nodal lines. The node block 13 is affixed to the support 10 by screws such as that indicated at 14, and is preferably capped with a strip of leather 15 for contact with the bar 11. The bar is fastened to block 13 by screw 16. Bushings 17 of soft material such as rubber are inserted in the base 10 and bar 11 to isolate the screws from contact with the base and bar respectively. 25 30 35

The other nodal support for the bar is a screw 18 which extends through the base and is clamped rigidly to the latter by a nut 19. The shank of the screw extends loosely through the bar 11 so that the latter will be capable of slipping lengthwise of the shank for the purpose of adjustment. Two cooperative clamping nuts 20, 20 are screwed on the shank 18, the bar being disposed between them. Washers 21 of soft material such as leather are interposed between the nuts and the bar. The adjustability afforded by the screw 18 and nuts 20 enables the bar to be adjusted to vary the width of the air gap between it and the core of magnet 12, such adjustment being necessary sometimes to obtain the desired effect of the magnet upon the bar. 40 45 50 55

The generator is tuned to have a normal frequency of vibration that will produce a note of the musical scale, and a musical instrument equipped with such devices will have any desired number of generators, differing one from another in size, to provide a chromatic scale of any desired register. 60

The generator includes the circular reflecting wall 22 of a stopped air resonator. 65 The reflecting wall, for the purposes of car-

rying out the principles of this invention, is fastened rigidly to the bar at a point between the nodal lines of the latter. The exact location of this point of attachment may vary, according to existing conditions, although I have found by experience that a location between one of the nodes and the point of greatest motion, as shown, is approximately the most desirable and effective to obtain the greatest musical value. The resonator includes a tubular structure 23, which may be made of light pasteboard. Its diameter is preferably the same as that of the reflecting wall. The latter is arranged to close one end of the tubular structure, the remote end 24 being open to emit the air waves that are generated therein by the reflecting wall 22. The tube of the resonator is preferably supported by the reflecting wall so as to be free from extraneous contact. For this purpose and for the additional purpose of preventing leakage of air pressure the reflecting wall is provided with a cylindrical flange 25 that fits tightly in the former. The fastening may be strengthened by gluing the confronting surfaces of the flange and the tube. The reflecting wall 22 is rigidly fastened to the bar 11 by two screws 26, and a rib 27 of semicircular cross section is formed upon the wall, and extends diametrically thereof, to make the latter inflexible and to take the screws. This rib is bored and tapped to receive the shanks of the screws, as shown by Figure 1. I have shown a spacer 28 interposed between the bar 11 and the rib 27, the screws passing through this spacer. The only reason for including the spacer is to separate the wall from the bar far enough to provide clearance for the nut 20 and washer 21. In many cases there will be sufficient space available to dispense with the spacer, and in such cases the rib 27 will be in contact with the bar 11. In either event the convexity of the rib and the spacer, or of the rib alone, provides a rocking connection that dissipates the component of angular movement that would otherwise be transmitted to the resonator. 70 75 80 85 90 95 100 105 110

The length of the resonator is determined according to the frequency of the simple harmonic motion of the generator with which the resonator is associated. The wave length produced by the generators being different for every pitch, the length of the resonators will be different in corresponding degrees. Each resonator will have a length that will preferably locate the reflecting wall at, or approximately at, the point where the maximum degree of pressure change occurs in the standing air wave therein. Since the point of maximum motion of the air wave is at the mouth of the resonator, and since the point of maximum pressure change is one quarter wave-length from the point of maximum motion, the most effective length of 115 120 125 130

the resonator for the purposes of this invention would place the reflecting wall one quarter wave-length, or thereabout, from the open end of the resonator.

5 While Figure 1 shows the bar 11 extending vertically, and the resonator extending horizontally, this disposition is adopted solely to facilitate the drawing. In practice it would be preferable to have the bar 11 horizontal and the resonator upright, as shown by Figure 3.

10 Although the means for vibrating the generator has no special significance as to the construction of the generator and the resonator, I have included a diagram of electric wiring that shows a well known combination of elements for this purpose. In Figure 3 a battery indicated at 30 supplies direct current to energize the magnet 12, but the circuit includes a rotary interrupter 31 the surface of which is divided into a series of segments like those of a commutator. Variable resistance is indicated at 32 and a switch is indicated at 33. The latter is represented in the form of a manual key of a musical instrument. The circuit interrupter 31 is intended to be rotated at a speed that will cause electrical pulsations to occur with a frequency equal to the normal frequency of vibration of the bar 11, according to the principle more fully described in the afore-
said Letters Patent, 1,167,663.

I claim—

35 1. A musical sounder comprising a vibratory mass constructed and arranged to execute simple harmonic motion, and a tube joined to said mass so as to form a stopped air resonance chamber, said tube being open at one end to emit the air waves generated therein by said vibratory mass, and the distance between said open end and said vibratory mass being such as to localize the point of maximum pressure of the standing air wave substantially at the working surface of said mass so as to cause the latter to function also as the reflecting wall of the resonance chamber.

50 2. A musical sounder comprising a sonorous body constructed and arranged to generate motion of a predetermined pitch, and a tube joined thereto so as to form a stopped air resonance chamber, said tube being open at one end to emit the air waves generated therein by said body, and the distance between said open end and said body being such as to localize the point of maximum pressure of the standing air wave substantially at the working surface of said body so as to cause the latter to function also as the reflecting wall of the resonance chamber.

60 3. In combination, a vibratory bar, means to support the latter, a "stopped" air resonator having a cylindric resonance chamber and a reflecting wall to keep one end of said chamber closed the opposite end of said

chamber being open to emit the air waves generated therein, said bar and said reflecting wall being rigidly coupled to each other and being formed and arranged to execute, conjointly, simple harmonic motion, and means to excite such motion in said bar and reflecting wall.

70 4. In combination, a nodally mounted vibratory bar, a "stopped" air resonator arranged in cooperative relation to said bar, the reflecting wall of said resonator being rigidly coupled to a vibratory portion of said bar to vibrate in unison therewith, said bar and said reflecting wall, conjointly, being adapted to execute simple harmonic motion, and means to excite such motion in said bar and reflecting wall.

85 5. In combination, a vibratory element, means to support the latter, said element being formed and arranged to execute simple harmonic motion, a resonator tube supported at one end by said vibratory element, the other end of said tube being open to emit the air waves generated therein, and means to excite simple harmonic motion in said vibratory element.

90 6. A musical sounder comprising a sonorous element having a non-flexible portion, and a stopped air resonator consisting of a tube open at one end, said tube being rigidly joined to and supported by said non-flexible portion of the sonorous element and being physically isolated from all fixed structure so as to be free to partake of vibration of said sonorous element.

100 7. A musical sounder comprising a nodally mounted bar, and a stopped air resonator having a non-flexible reflecting wall affixed to said bar between one of the nodes and a point midway between the nodes.

105 8. A musical sounder comprising a nodally mounted bar, means arranged to act on said bar at a point substantially midway between its nodes to vibrate the bar, and a stopped air resonator having a reflecting wall affixed to said bar between said point and one of said nodes.

110 9. A musical sounder comprising a nodally mounted bar, means for vibrating the latter, and a stopped air resonator having a non-flexible reflecting wall affixed to said bar so as to be vibrated lengthwise of the resonator and so as to dissipate angular movement arising from flexure of the bar.

115 10. A musical sounder comprising a nodally mounted bar, means for vibrating the latter, a stopped air resonator having a tubular body and a non-flexible reflecting wall rigidly joined thereto, and means connecting said reflecting wall to said bar elsewhere than midway between the nodes of the bar, said connecting means being constructed and arranged to transmit lateral motion of the bar positively to said reflecting wall and affording relative rocking of
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the reflecting wall and the bar so as to dissipate angular motion arising from flexure of the bar.

11. A musical sounder comprising a sonorous element and an axially movable tube supported thereby, said tube being physically isolated from all other structure, said tube and an active portion of said sonorous element forming, conjointly, a stopped air resonance chamber.

12. A musical sounder comprising a nodally mounted bar, and a stopped air resonator rigidly joined to and supported by said bar and physically isolated from all other structure.

13. A musical sounder comprising a nodally mounted bar, and a stopped air resonator having a tubular body and a non-flexible reflecting wall rigidly related thereto, said reflecting wall being rigidly connected to said bar and said tubular body being free from extraneous physical resistance so as to be movable with said reflecting wall.

14. A musical sounder comprising a sonorous element and a bodily movable stopped air resonator affixed thereto and arranged to be moved axially by the operative motion of said element.

15. A musical sounder comprising a sonorous element and bodily movable means forming a stopped air resonance chamber, the reflecting wall of said chamber being

affixed to an active portion of said element and arranged substantially at right angles to the lines of operating movement of said element.

16. A musical sounder comprising a sonorous element and bodily movable means forming a stopped air resonance chamber having a non-flexible reflecting wall affixed to an active portion of said sonorous element, the plane of said wall being substantially at right angles to the lines of effective movement of said active portion.

17. A musical sounder comprising bodily movable means forming a stopped air resonance chamber the reflecting wall of which is a non-flexible element, and means for imparting simple harmonic motion to the first said means in lines at right angles to the plane of said wall.

18. A musical sounder comprising a sonorous element arranged to execute substantially vertical operative motion, and vertically movable means supported by said element to move in unison therewith, said means forming a stopped air resonance chamber the reflecting wall of which is at right angles to the lines of said operative motion.

In testimony whereof I have affixed my signature.

SEWALL CABOT.