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ELECTRIC BELL TONE GENERATOR
MECHANISM

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This invention relates to electronic musical instruments and particularly instruments including means for producing bell or chime tones.

Various means have been employed in the past for producing electrically bell tones. In prior instruments, bars or rods, both solid and hollow, as well as other types of vibrating bell elements have been used to generate the vibrations. The vibrations have been picked up electrically, amplified, and then reproduced by a loud speaker to produce the bell tone or tones as desired. Normally, the vibrations generated in the vibrating element have been modified in the amplifier circuit in various manners. It has been difficult in many of these devices to obtain the desired partials in their proper relationship, strength, and duration to correctly reproduce in the speaker the desired bell tone.

One of the principal objects of the present invention is to provide an improved tone generator arrangement for producing a bell tone having the desired characteristics.

Another object of the invention is to provide an acoustically integral rod and support arrangement so as to obtain the desired note or characteristic tone.

The terms "characteristic tone" or "note" are used in this application to mean the whole sound identifying to the listener the note involved. "Fundamental tone" is used to mean the lowest vibration present in the vibrator.

When the rod is struck by a striker, the rod will vibrate in a particular pattern and a person listening to the not produced as a result thereof will select a characteristic tone by which he identifies the pitch of the note. In the case of a fixed-free rod, the characteristic tone is a synthesized tone not actually present in the vibration of the rod, but formed by a combination of the 4th and 5th partials of the rod. The term "partial" refers to a single tone or vibration.

In one aspect of the invention, the tone generator has a fixed-free rod fastened to a supporting block of a relatively small size compared with supporting blocks previously used. The supporting block is mounted in such a manner as to isolate the acoustic system, including the block and rod, from the main frame or other carrying means. The electrical pick-up means, which may be in the form of a plate-like electrode, also

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is mounted on the supporting block. The pick-up and fixed-free rod must be mounted on the block in such a manner as to be acoustically integral therewith in order to produce partials having the desired damping and other characteristics to produce the correct note.

The electrical pick-up is mounted at predetermined point along the tone generator or fixed-free rod. A suitable spring stabilizer can be mounted on the block for the purpose of reducing the amplitude of the unused fundamental tone. The amplifier circuit connected to the pick-up can be arranged to modify by suitable filters or other electrical arrangements, the vibrations finally fed to the electro-acoustic transducer or loudspeaker.

Another object of the invention is to provide a simple economical unit which can be used to replace the conventional cast bell such as is found in church towers and the like.

A still further object is to provide an improved striker operating mechanism.

The striker can be arranged so as to be operable by a resilient plate or operator, said plate being depressible by hand and upon release, causing the striker or plunger to hit the fixed-free rod at a predetermined point.

By the use of the arrangement described herein, the loud speakers can be placed in a tower so as to eliminate the costly and heavy conventional campaniform cast bell equipment normally used for producing bell tones in a church tower or the like. These bells usually have a rope extending downwardly to be pulled by the sexton when the bell is to be rung. Considerable physical effort is necessary in the ringing of bells of the aforementioned type and this is substantially eliminated by use of the present invention, because it is merely necessary to depress and release a small spring plate in order to ring the bell.

In addition to the aforementioned aspects, a record player, a microphone, or other sound reproducing instruments can be connected and used as desired in conjunction with the amplifier and loud speakers.

These and other objects, advantages, and features of the invention will become apparent from the following description and drawings which are merely exemplary.

In the drawings:

Figure 1 is a side elevation with the front cover removed.

Figure 2 is an enlarged section taken along the line 2—2 of Figure 1.

Figure 3 is an enlarged section taken along the line 3—3 of Figure 1.

Figure 4 is a schematic block wiring diagram.

Figure 5 is a sectional view taken along the line 5—5 of Figure 1.

Figure 6 is a sectional view taken along the line 6—6 of Figure 1.

Figure 7 is a fragmentary circuit diagram.

Figure 8 is a fragmentary reduced size view of a modification of Figure 1.

The invention will be described particularly in conjunction with the single bell element operator, but it is to be understood that the principles and arrangement involved can be applied to electronic carillons and other bell instruments having a plurality of vibrating elements. This is particularly true of the arrangement of the fixed-free vibrator and its support. The striker also can be operated in various manners, the form shown and described specifically, being of use in conjunction with an instrument for producing a bell tone in a church tower.

The fixed-free vibrator 10 (Figures 1, 2) may take various forms, but is illustrated as a flat strip of a suitable metal. The fixed-free vibrator is made the correct length to produce the desired characteristic tone. The fixed-free vibrator is fastened to post 11 which is securely held to block 12 by means of a suitable bolt or stud 13 (Figure 5). Post 11 has a slot 14 cut therein snugly receiving the end of the fixed-free vibrator 10. The edges of the slot may be pressed inwardly or otherwise solidly joined with the surface of the vibrator so that there is an integrally acoustic joint. Also, post 11 is joined to supporting block 12 so as to be acoustically integral. This can be accomplished by relieving the inner face thereof at 11A so that the annulus 11B firmly contacts the block 12.

Supporting block 12 is isolated from the frame or other supporting member in some suitable manner. As an example, rubber bushing 15 may have an annular groove 16 (Figure 3) therein engageable with the casing or frame 17. Stud 18 is screw-threadedly engaged in aperture 19 in supporting block 12 and nut 20 can be used to hold the elements in assembled relationship. At the end thereof, an electrical connection 21 can be made with screw or rivet 22 engaged in a suitable aperture in the supporting block 12. Preferably, nut 20 may have a locking arrangement of any suitable type holding the nut in any particular adjusted position.

A condenser type microphone electrical pickup arrangement is illustrated generally at 23 and may comprise frame 24 having a pair of legs 25 joined with portion 26 which is securely fastened by rivets 27 to supporting block 12. Frame 24 has a top extension 27 engageable by adjusting nut 28, said adjusting nut being screw-threadedly carried on upright 29, upright 29 being acoustically integrally fastened to supporting block 12. The collector plate or electrode 30 is mounted on frame 24, said electrode being suitably spaced from the vibrator or tone generator.

In order to adjust the distance of the electrode relative to the tone vibrator, adjusting nut 28 can be turned so as to move the electrode relative to said vibrator. Electrode 30 can be connected through wire 31 to ground potential, the wire 21

being connected to a source of polarizing voltage as will be explained hereafter.

It is to be understood that other types of pickup or mechanical-electrical transducers can be employed, such as magnetic means.

Spring stabilizer 32 can be mounted on slidable clip 33, said clip being adjustably movable along supporting block 12. The turned-in bottom portions 34 of clip 33 will serve to hold the clip firmly on the supporting block 12, and this causes it to be in acoustically integral relationship therewith.

Striker plunger 35 may be reciprocable through aperture 36 (Figure 2) in the supporting block 12. Spring plate element 37 is mounted at 38 on the casing 17, the end of plate 37 extending through a suitable opening in cover 37A. A piece of felt 39 or similar material may be located between the spring plunger operator 37 and the block 12.

When it is desired to operate the bell, spring 37 can be depressed and then released, thus causing the plunger 35 to move upwardly and strike the fixed-free rod 10. The fixed-free rod 10 preferably has a plurality of grooves 40 cut adjacent to post 11 so as to bring the various partials in their desired relationship.

Merely by way of example, the note C (261 cycles per second) can be used, and, if an English type bell tone is to be employed, the partials developed should be:

Frequency, cycles per sec.	Partial
155 approx.....	Hum tone (sixth below).
261.....	Strike tone (characteristic).
311 approx.....	Minor third.
523.....	Octave.
783 approx.....	Fifth of octave.
1,050 approx.....	Second octave.

The tones desired can be developed by a fixed-free rod made in accordance with the illustration in Figure 1. After grooving of the rod near the base, the deviation of the desired tones or partials from a true sixth below the characteristic tone, minor third, fifth of the octave above, and the second octave is so small that more exact tuning when a single bell is employed is not necessary. If a plurality of elements are employed, it may be necessary to tune the partials by means of weights at appropriate places along the rod.

The tones which are not desired from the vibrations produced by the fixed-free rod are the fundamental tone and the first partial. In the case of the characteristic tone of note C, the frequency of the fundamental tone is about 9 cycles per second and the frequency of the first partial is about 55 cycles per second. The fundamental is easily removed and the first partial can be removed by means of a resistance-capacitance sloping network including R₁ and C₁ such as illustrated in Figure 7. Also, the reduced low frequency response of a horn type reproducer 47 or other suitably designed reproducer can be used to further attenuate the undesired frequencies.

The illustrated sloping network also can be used to reduce the strength of the hum tone which has a high amplitude in a fixed-free rod.

The network of Figure 7 can have one connection to the polarizing lead for the pick-up, such as wire 21 (Figure 1), the out-put being fed to the amplifier such as schematically illustrated at 46 in Fig. 4, said amplifier being connected to loud speaker 47. Fig. 4 also illustrates a record player designated as R. P., a microphone designated as "Mic." or a bell connected to the ampli-

fler as desired. The potential of the pick-up electrode 30 itself is at ground so that adjustment thereof can be made without being heard in the loud speaker. Merely by way of example, condenser C₁ can have a capacity of .0005 microfarad and resistance R₁ can be 500 megohms when it is desired to attenuate a frequency of 60 cycles, 16 decibels. It is to be understood that the particular values of the resistances and condensers can be chosen according to the characteristic tone, design of the circuit, and other related factors. The total attenuation of the lower frequencies should be in the range of 20-25 decibels.

In operating the device as a bell, such can be accomplished by plucking or depressing and releasing striker 37. The technique of striking can be accomplished in various manners. In producing a swinging bell effect, one strike can be made hard and the next one soft, the interval between hard and soft being longer than the interval between soft and hard. A tolling bell tone can be produced by slow evenly spaced strikes.

A further aspect of the invention is illustrated in Figure 8 which shows a means for temporarily holding the vibrator when the instrument is to be shipped or transported. Supporting block 12' may have a double clip arrangement 41 mounted thereon, the clip being held in place by turned-in bottom edges similar to the support 33 for flexible spring 32. Blocks of wood or other material 42, 42 can be slipped between the separated sides of clip 41 so as to clamp vibrator 10 therebetween. In the form illustrated in Figure 8, the supporting block 12' is shown lengthened out relative to the smaller block of Figure 1.

It is to be understood that details of construction can be varied without departing from the spirit of the invention except as defined in the appended claims.

I claim:

1. In an individual bell tone generator for electric musical instruments, the combination of an acoustic system including a fixed-free rod, an individual support for said rod in acoustically integral relationship with said rod, and resilient means for holding said support and isolating the acoustic system including said individual support and rod, so that said acoustic system will have the desired partial relationship.

2. In a tone generator for electric musical instruments, the combination of an acoustic system including a fixed-free rod, a relatively small supporting block for said rod, means connecting said rod acoustically integral to said block, and resilient means holding said block and isolating the acoustic system including the rod and block, so that said acoustic system will have the desired partial relationship.

3. In a bell-tone generator, the combination comprising a vibrator rod, a support for said rod, a plunger movable relative to said rod and into contact therewith, and a depressible spring plate upon which said plunger rides, said spring plate upon being released after pressure has been applied thereto causing said plunger to move and to strike the rod.

4. In a bell instrument, the combination comprising a vibrator rod, a supporting block for said rod, said rod being acoustically integral therewith, a plunger resting on a depressible spring plate, depressing means for said plate operable to cause said plunger to strike said rod, a collector plate adjacent said rod, amplifying circuits connected to said collector plate, control circuits

in said amplifying circuits removing undesired frequencies for a bell-tone, and an electro-acoustic means connected to said amplifying circuits.

5. A bell system suitable for towers or the like, comprising a tone generator including a fixed-free vibrator acoustically integrally mounted on a supporting block, a mechanical-electrical pick-up adjacent said rod and acoustically integrally mounted on said block, damping means in contact with said vibrator, a polarizing circuit connected to said pick-up, mounting means for said block and vibrator acoustically insulating the same, circuits including amplifiers connected with said polarizing circuit removing undesired frequencies, a remotely located electrical-mechanical transducer means connected with said amplifiers, and a reciprocable striker for said vibrator.

6. A bell system suitable for towers or the like, comprising a tone generator including a fixed-free vibrator acoustically integrally mounted on a supporting block, said vibrator having grooves adjacent its fixed end, a mechanical-electrical pick-up adjacent said rod and acoustically integrally mounted on said block, damping means in contact with said vibrator, mounting means for said block and vibrator acoustically insulating the same, amplifier circuits connected with a polarizing circuit for said pick-up removing undesired frequencies, a remotely located electrical-mechanical transducer means connected with said amplifier circuits, a spring plate, and a reciprocable striker normally resting on said plate and movable to strike said vibrator.

7. In a mechanical-electrical pick-up for an electric musical instrument vibrator, the combination comprising an electrode adapted to be held adjacent said vibrator, a resilient frame carrying said electrode, said frame having a portion adapted to overlie said vibrator, and an adjustable means contacting said portion to move it toward and away from the vibrator so as to adjust the proximity of the electrode thereto.

8. In a tone generator for an electric bell instrument or the like, the combination comprising a supporting block, a post acoustically integrally mounted on said block, the contacting face of said post with said block being of restricted area, and a fixed-free vibrator rod acoustically integrally mounted on said post, so that said rod, post and block will vibrate as a single acoustic system.

9. In an electric bell instrument, a casing, a cover, a block, means mounting said block resiliently on said casing, said block having a striker receiving aperture therethrough, a post having a restricted ring surface in acoustically integral contact with said block, a fixed-free rod acoustically integrally mounted on said post, said rod having grooves adjacent said post, an electric pick-up adjacent said rod, said pick-up being mounted on an adjustable spring frame, said frame being carried on said block, a stabilizer spring carried on said block, said spring contacting said rod, a striker plunger in said aperture, and a spring plate upon which said plunger rests, said plate being depressible and releasable to cause said striker to hit the rod.

10. In an electric bell instrument, a casing, a cover, a block, means mounting said block resiliently on said casing, said block having a striker receiving aperture therethrough, a post having a restricted ring surface in acoustically integral contact with said block, a fixed-free rod acoustically integrally mounted on said post, said rod having grooves adjacent said post, an electric

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pick-up adjacent said rod, said pick-up being mounted on an adjustable spring frame, said frame being carried on said block, a stabilizer spring carried on said block, said spring contacting said rod, a striker plunger in said aperture, a spring plate upon which said plunger rests, said plate being depressible and releasable to cause said striker to hit the rod, an amplifier circuit connected to said pick-up and an electrical-mechanical transducer connected with said amplifier.

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