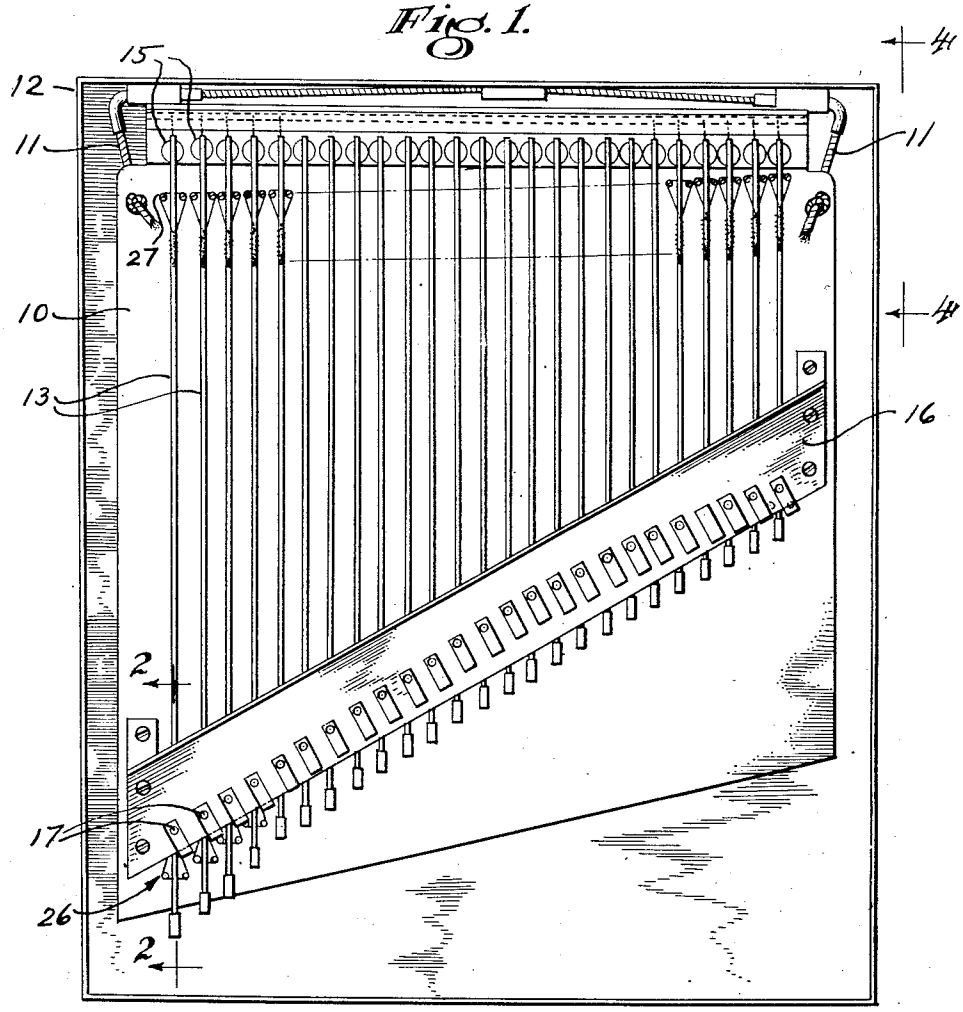
Nov. 6, 1956 J. T. KUNZ 2,769,361

RIGID VIBRATOR MUSICAL INSTRUMENT

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Fig. 1.



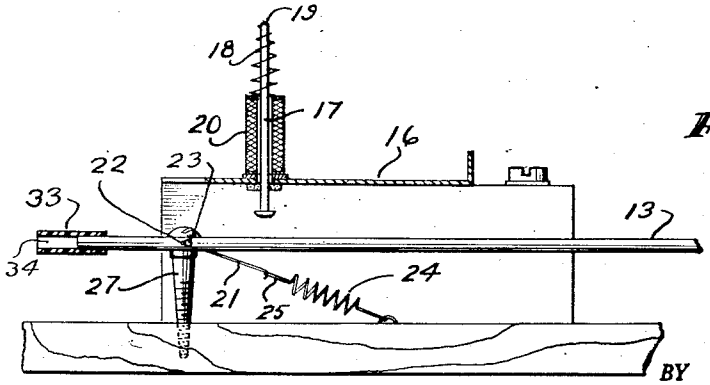


Fig. 2.

INVENTOR.
Jacob T. Kunz

BY

Pollard and Johnston
ATTORNEYS

Nov. 6, 1956 J. T. KUNZ 2,769,361

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Fig. 3.

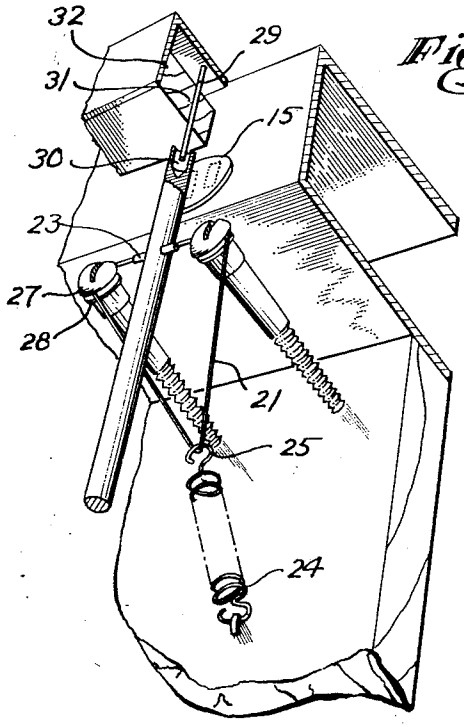


Fig. 4.

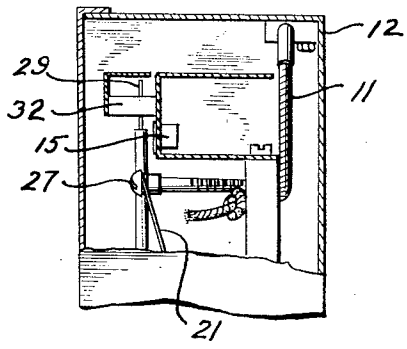
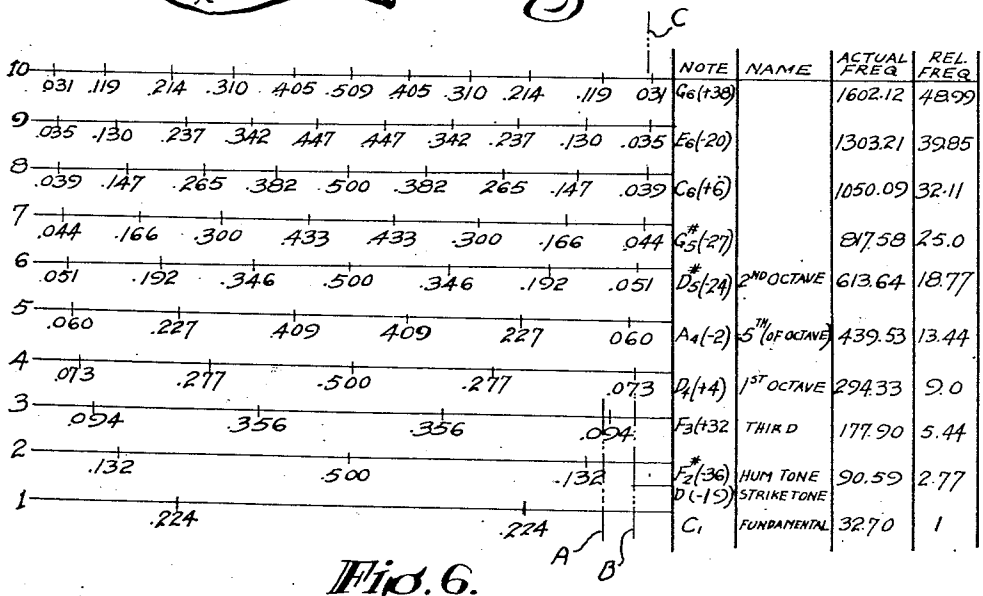
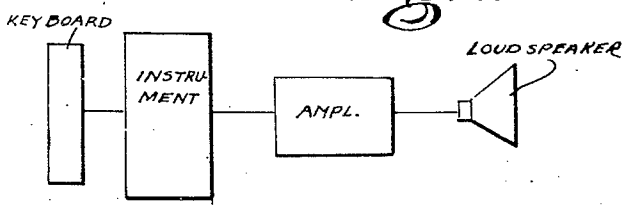


Fig. 5.



NOTE	NAME	ACTUAL FREQ	REL. FREQ
$G_6(+38)$		1602.12	48.99
$E_6(-20)$		1303.21	39.85
$C_6(+6)$		1050.09	32.11
$G^{\#}_5(-27)$		817.58	25.0
$D^{\#}_5(+24)$	2ND OCTAVE	613.64	18.77
$A_4(-2)$	5TH OF OCTAVE	439.53	13.44
$D_4(+4)$	1ST OCTAVE	294.33	9.0
$F_3(+32$	THIRD	177.90	5.44
$F^{\#}_2(-36)$	HUM TONE	90.59	2.77
$D(-15)$	STRIKE TONE		
C_1	FUNDAMENTAL	32.70	1

Fig. 6.



INVENTOR.
Jacob T. Kunz
BY
Pollard and Johnston
ATTORNEYS

United States Patent Office

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RIGID VIBRATOR MUSICAL INSTRUMENT

Jacob T. Kunz, North Hills, Pa., assignor to Schulmerich Electronics, Incorporated, Carillon Hill, Sellersville, Pa.

Application August 6, 1952, Serial No. 302,958

2 Claims. (Cl. 84—1.15)

This invention relates to musical instruments and particularly to an electric musical instrument having free-free rods for producing chime tones and the like.

The invention especially is concerned with an instrument for producing tubular chime notes wherein a note may include a strike tone, a major third, a first octave, the fifth above the first octave and the second octave. This is in contrast to the note produced by a cup shaped bell wherein there is a hum tone, strike tone, a minor third, a fifth, a first octave, a second octave and certain other partials. In an instrument of the type concerned herein, the rod vibrations are picked up electrically, amplified, modified, and then changed into sound by a loud speaker so as to produce chime music. Such music is of particular use in conjunction with organ music in a church or the like. It has been difficult in previous devices to obtain all of the desired partials in an instrument of the character mentioned, in their proper relationship to produce a tubular chime tone.

One of the principal objects of the present invention is to provide a tone generator arrangement for producing notes having tubular chime characteristics.

Another object of the invention is to provide an electric musical instrument having an improved means for suspending the rods or tone generators.

The term "note" is used in this description to mean the whole sound identifying the note involved to the listener. The terms "first partial" or "fundamental tone" are used to denote the lowest partial or vibration actually present in the tone generator or rod itself, such not normally identifying the note involved which is to be reproduced in the loud speaker. The term "partial" or "tone" refers to a single tone and not to a combination of tones. "Free-free" rod or vibrator means a rod which is suspended in such a manner that its ends are not fixed.

In one aspect of the invention, a tone generator of the free-free type may have the vibrations thereof picked up electrically by placing a magnetic pick-up in proximity to the rod, variation in the magnetic field in the pick-up producing electrical vibrations or oscillations in an amplifier connected thereto. Other types of pick-ups or mechanical-electrical transducers can be used. The picked up vibrations can be modified in the amplifier so as to cut out or attenuate undesired partials. Strikers are used selectively to set the rods into vibration, each striker being located between the nodes of the second and third partials adjacent the end of its rod. Because of this location, the second and third partials are suppressed or attenuated. The rod is suspended at the node of the fourth partial so that it does not affect the same, but attenuates the first, second and third partials. The amplifier may have a sloping characteristic so as particularly to attenuate the first partial, such an amplifier being of any conventional design. The pick-up also can be arranged relative to the rod to attenuate the undesired high frequency partials in the final note. A plurality of rods or tone generators can be employed and can be actuated from a keyboard so that chime music

can be produced. It is to be understood that the principles of the invention can be employed when the pick-ups and strikers are located at other places, depending upon the partials desired.

These and other objects, advantages and features of the invention will become apparent from the following descriptions and drawings.

In the drawings:

Fig. 1 is a front elevation of one form of the tone generator instrument made in accordance with the invention.

Fig. 2 is a fragmentary enlarged sectional view taken in the direction of 2—2 of Fig. 1 showing the lower end of a rod.

Fig. 3 is an enlarged fragmentary perspective view of the mounting of a rod or tone generator showing the damping means.

Fig. 4 is a fragmentary enlarged sectional view taken in the direction 4—4 of Fig. 1.

Fig. 5 is a diagram of the tone structure of one of the free-free tone generators or rods of the present invention.

Fig. 6 is a block diagram of one manner in which the instrument can be employed.

Referring to Fig. 1, support **10** is carried by flexible means **11**, such as ropes (Figs. 1, 4), from casing **12**. Rods or tone generators **13** are made of the correct length to produce the desired note. In the instrument shown, **25** rods are used, it being understood, however, that a greater or fewer numbers of rods can be employed.

The rods **13** are free-free rods suspended adjacent each end in a manner which will be described presently. The rods preferably are vertically suspended but could be held horizontally. Adjacent the upper ends of each rod, magnetic pick-ups **15** can be located, said pick-ups being connected in the input circuit of an amplifier, said amplifier preferably having sloping characteristics so as particularly to attenuate the low frequencies. The block diagram of Fig. 6 illustrates the general relationship of the component parts of the musical instrument.

The strikers can be mounted on a plate **16** (Fig. 1). Referring to Fig. 2, striker plunger **17** is held in retracted position by a tapered spring **18**, tapered spring **18** being connected at **19** to the plunger **17**. One manner in which the spring can be connected at **19** is by the use of a suitable adhesive or paint. The tapered spring permits the coils thereof to nest within each other when the plunger **17** is drawn toward its rod. Striker plunger **17** can be activated by energization of solenoid **20** through operation of a suitable keyboard. As will be explained hereafter, plunger **17** is located at a predetermined point relative to the ends of the rods.

Rods **13** can be suspended by means of flexible means **21**, such as nylon thread or the like, said thread passing through an aperture **22** in each rod **13**. A rod may be suspended on its thread and held in place by means of a wedge **23** inserted in aperture **22**, said wedge being of some suitable material such as wood or the like. The flexible suspending means is connected to spring **24** at loop **25**. Spring **24** can be chosen so that the proper tension will be present in the flexible thread or element to keep the rod **13** in its correct position. Screws **27** can adjustably hold the flexible threads **21**. An eyelet **28** can be forced onto the shank of screw **27**, the eyelet serving as a positioning means for the thread **21** where it passes around the screw.

A similar suspending arrangement can be located at **26** at the lower end of the rod. As will be explained hereafter, the location of the suspension points is made at predetermined places on each rod so as not to affect certain partials and so as to attenuate others.

In order to properly damp the partials in their correct relationship to each other, an intermittently acting damp-

ing element **29** (Figs. 3 and 4) can be mounted in an aperture **30** in one end of the rod, such an intermittent damping element being described in applicant's co-pending application, Serial No. 229,380, filed June 1, 1951. The damping element **29** passes through an enlarged aperture **31** in a fixed block **32**. The damping element is loosely held so that it acts intermittently relative to both the rod and block **32** at the beginning of the vibration and then remains in contact with block **32** during the last portions of the vibration. As a result, the correct partial structure is maintained.

Merely by way of example, the tone plan of a free-free rod is shown in Fig. 5 of the drawings, the nodes of the various partials and their relative locations on the rod being indicated thereon. The rod involved is one for producing note "D" in the loud speaker. The strike tone or note "D" is a synthesized tone resulting from the difference between the vibrations of the fourth and fifth partials. The suspension of the rod is at the node of the fourth partial at "B." This suspension will not affect this partial and thus the strike tone which is the result of the fourth and fifth partials. The striker is arranged to strike the rod at approximately "A" between the end nodes of the second and third partials so that it will attenuate the first, second and third partials. The first partial is attenuated by the suspension arrangement, the sloping characteristic of the amplifier and the striker position. The pick-up, for example, may be adjacent the end of the rod and in the vicinity of the line "C" so as to attenuate the undesired high frequency notes.

Although not required or necessarily used, a plastic material collar **33** can be put on the lower end of the rod, the collar providing an air space **34**.

The suspension is sufficiently stiff so as to attenuate all of the lower partials. In chimes, the low tones do not travel appreciably in the air but when there is an electrical pick-up, they become objectionable. The magnetic pick-ups are set in from the ends so as to attenuate very high partials except for the very high notes. Their position may be, for example, the mean of the sixth, seventh and eighth partials. The amplifier is sloped so as to attenuate low frequencies, such being, for example, 6 decibels per octave below 400 cycles per second and 12 decibels at 200 cycles per second. The second partial is difficult to remove in the sloping amplifier network but the striker position, between the nodes of the second and third partials, is such as to attenuate the same. The rods, for example, may be of a steel such as S. A. E. 1020 having a tensile strength of 55,000 #/sq. in. or less.

It should be apparent that changes can be made in the described details without departing from the spirit of the invention except as defined in the appended claims.

What is claimed is:

1. In an electric musical instrument having frame means, mechanical-electrical pick-up means, an amplifier and a loud-speaker connected to the amplifier, the combination including a free-free rod having an aperture extending therethrough transverse to the longitudinal axis of said rod at the node of a desired partial; thread suspending means passing through said aperture; supports mounted on said frame means on either side of said aperture around which said thread means passes in a loop arrangement, said rod being supported such that the thread means, aperture and supports are substantially aligned; and spring means connected at one end thereof to said frame means and at the other end thereof to said thread means opposite the point of support of said rod such that said thread means is maintained at a predetermined tension.

2. In an electric musical instrument having frame means, mechanical-electrical pick-up means, an amplifier and a loud-speaker connected to the amplifier, the combination including a free-free rod having an aperture extending therethrough transverse to the longitudinal axis of said rod at the node of a desired partial; thread suspending means passing through said aperture; wedge means located in said aperture for positioning said rod with respect to said thread means; supports mounted on said frame means on either side of said aperture around which said thread means passes in a loop arrangement, said rod being supported such that the thread means, aperture and supports are substantially aligned; and spring means connected at one end thereof to said frame means and at the other end thereof to said thread means opposite the point of support of said rod such that said thread means is maintained at a predetermined tension.

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