

Aug. 12, 1952

J. T. KUNZ

2,606,474

MUSICAL INSTRUMENT

Filed Nov. 17, 1948

5 Sheets-Sheet 1

Diagram illustrating the musical notation for the instrument, showing five staves (1 to 5) and their corresponding components:

- 1: CARILLON BELL
- 2: ROD A
- 3: ROD B
- 4: SYNTHESISED BELL
- 5: TONE NAME

The notation includes notes for SEC. OCTAVE, FIFTH, MAJOR THIRD, FIRST OCTAVE, FIFTH, MINOR THIRD, STRIKE TONE, and HUM TONE.

Fig. 1

PARTIAL	FREQUENCY	NODAL
FUNDAMENTAL	f	
1 ST. PARTIAL	6.267 f	.2
2 ND. PARTIAL	17.55 f	.13, .5
3 RD. PARTIAL	34.39 f	.09, .36, .64
4 TH. PARTIAL	56.85 f	.07, .27, .5, .73
5 TH. PARTIAL	84.93 f	.06, .23, .41, .59, .79
6 TH. PARTIAL	118.3 f	.051, .19, .345, .5, .65, .81

Fig. 2

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ROD B			ROD A		
PARTIAL	NOTE	FREQUENCY	PARTIAL	NOTE	FREQUENCY
FUNDAMENTAL	B	15 APPROX.	FUNDAMENTAL	D	17.6 APPROX.
1 ST. PARTIAL	F #	92.5	1ST. PARTIAL	A	110
2 ND. PARTIAL	C	261.5	2ND. PARTIAL	D #	311
CHARACTERISTIC	A	440	CHARACTERISTIC	C	523
3 RD. PARTIAL	C	523	3RD. PARTIAL	D #	622
4 TH. PARTIAL	A	880	4TH. PARTIAL	C	1046
5 TH. PARTIAL	E	1318.5	5TH. PARTIAL	G	1568
6TH. PARTIAL	A #	1800 APPROX.	6TH. PARTIAL	C #	2100 APPROX.

Fig. 3

FREQ.	TONE	FROM ROD	TONE NAME
261.5	C	B	HUM TONE
523	C	B	STRIKE TONE
523	C	A	STRIKE TONE
622	D #	A	MINOR THIRD
1046	C	A	FIRST OCTAVE
1318	E	B	MAJOR THIRD OF OCTAVE
1568	G	A	FIFTH OCTAVE
1800	A # APPROX.	B	
2100	C # APPROX.	A	SECOND OCTAVE

Fig. 4

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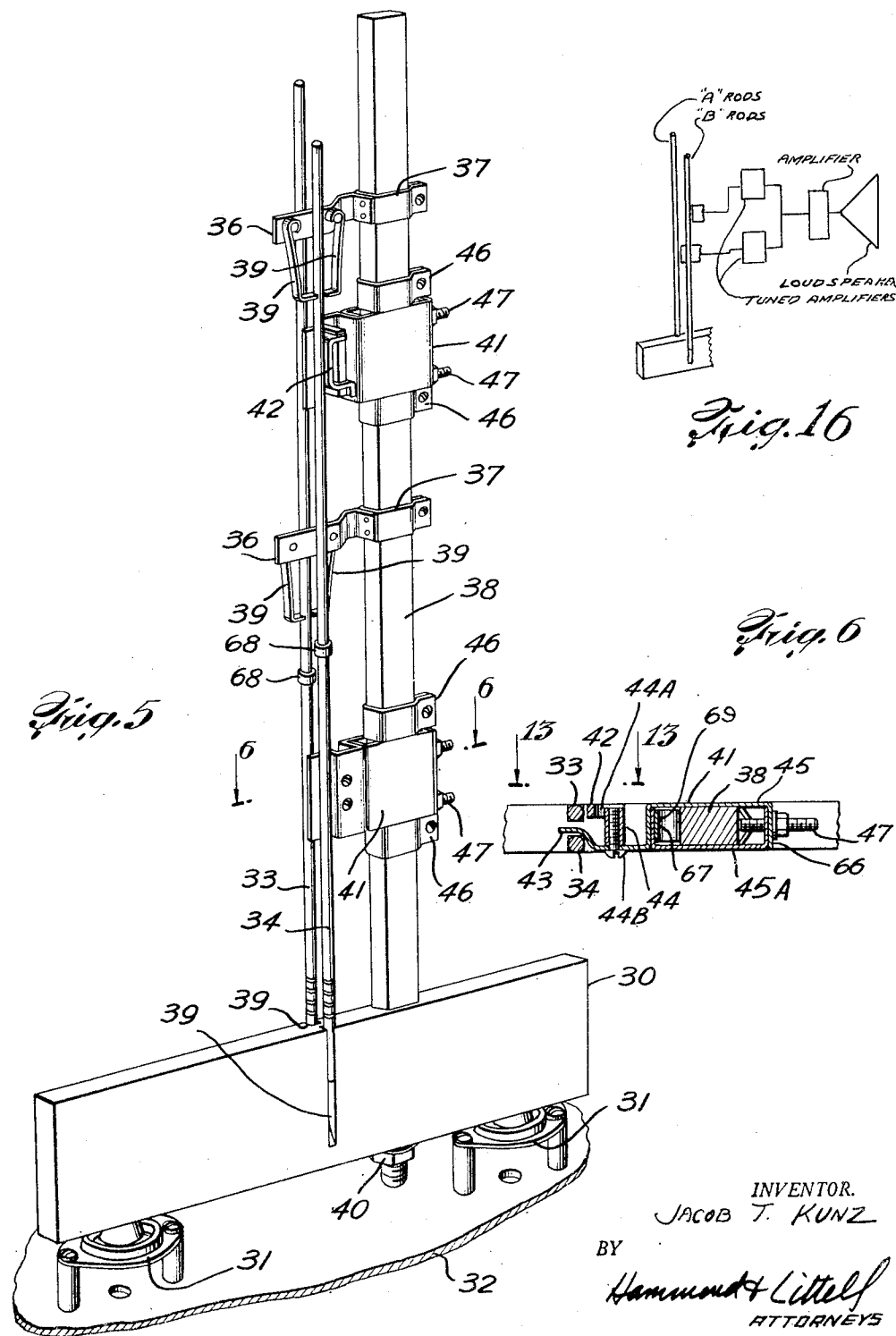
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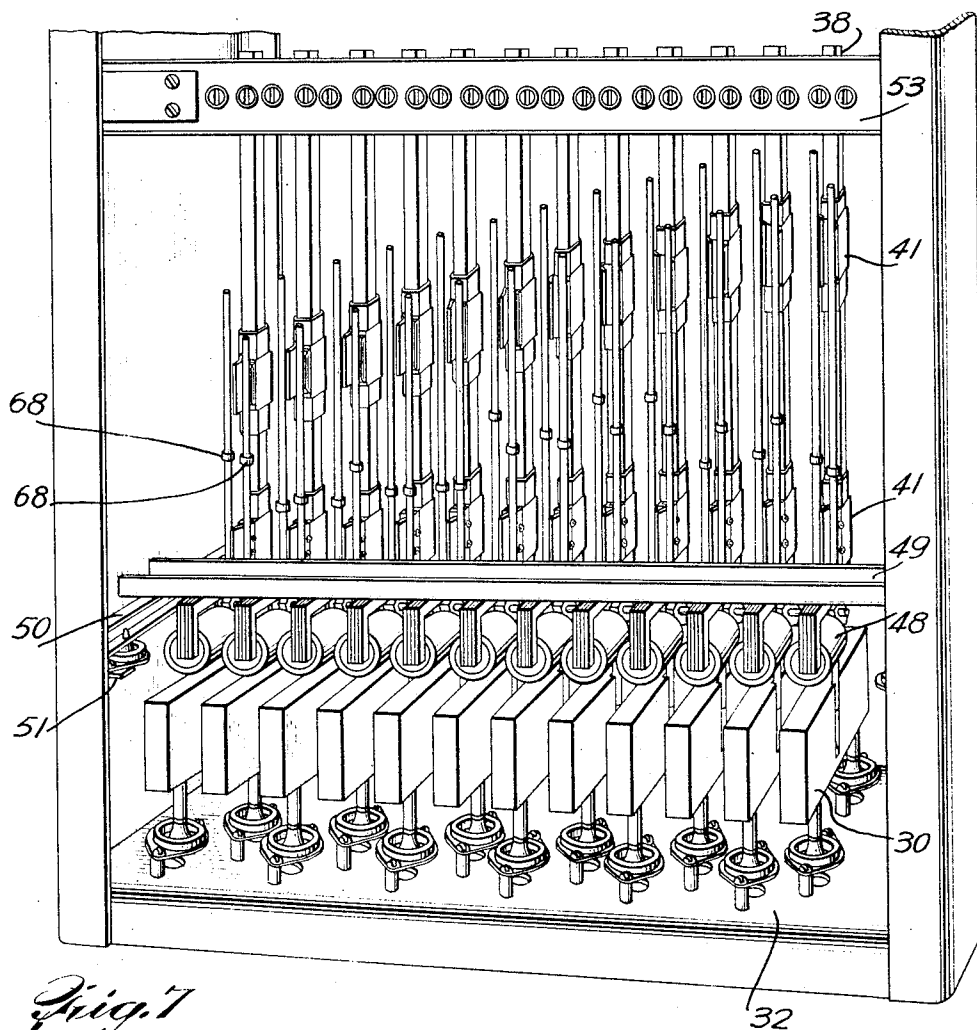


Fig. 7

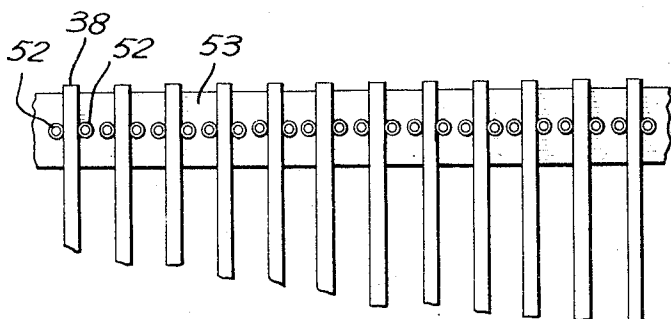


Fig. 8

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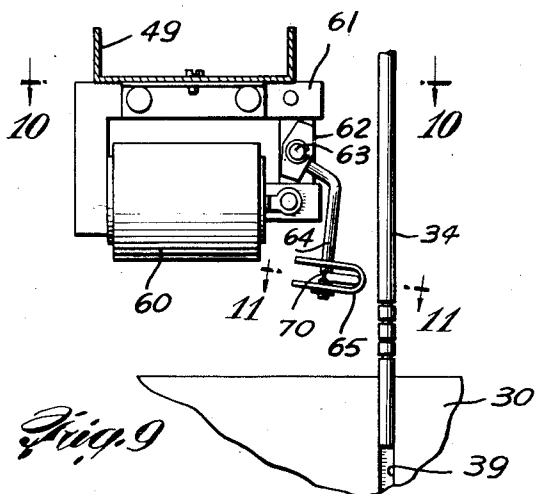
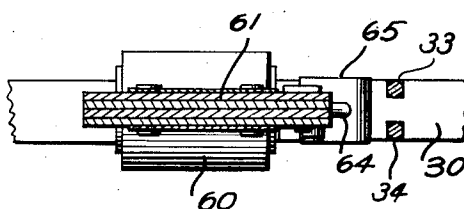
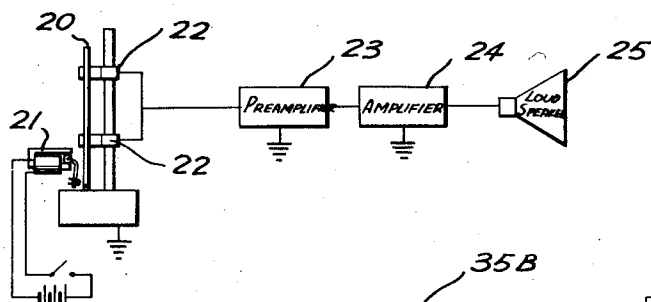
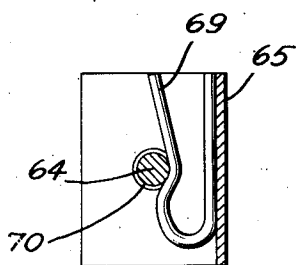
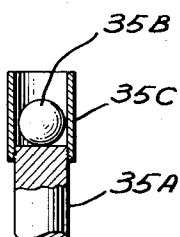
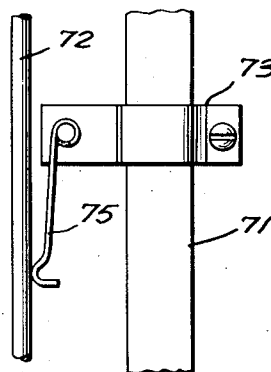
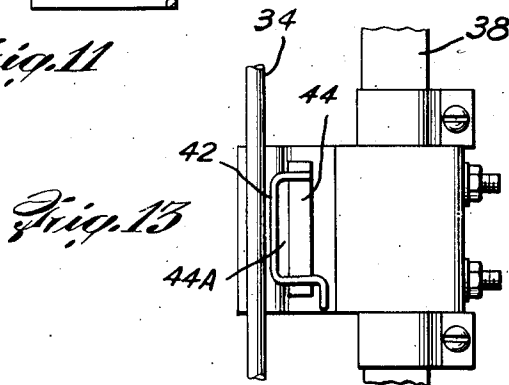
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MUSICAL INSTRUMENT

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5 Sheets-Sheet 5



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MUSICAL INSTRUMENT

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Application November 17, 1948, Serial No. 60,470

19 Claims. (Cl. 84—1.12)

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This invention relates to musical instruments and particularly to an electric musical instrument for producing bell or chime tones and the like.

Various means have been employed previously for producing electrically bell or chime tones. In the prior instruments, bars or rods, both solid and hollow, as well as other types of vibrating elements, have been used for the purpose of generating the vibrations. The vibrations produced have been picked-up electrically by various means, amplified, and then translated by an electro-acoustic mechanism to produce musical tones. The tone generated usually has been modified in the amplifier circuit in various manners. Instruments employing bars or rods have used fixed-free vibrators wherein one end of the vibrator is fixed and the other end of the vibrator is free to vibrate, and free-free bar vibrators wherein both ends of the bar are unrestrained and free to vibrate.

It has been difficult in the previous devices to obtain all of the desired partials in their proper relationship to correctly produce a bell tone, particularly a bell tone of the Flemish or harmony type bell.

One of the principal objects of the present invention is to provide an improved tone generator arrangement and instrument for producing a bell tone having the desired partials or tones therein.

Another object of the invention is to provide an instrument, especially a Flemish type bell tone instrument, arranged so that it can play carillon music in an improved manner.

Another object of the invention is to provide an improved collector plate and shield arrangement so that the collector plate or electrode has a minimum of capacity relative to the shield and adjacent vibratory bodies.

The terms "characteristic tone" or "note" are used herein to mean the whole sound which identifies the note involved to the listener. The term "fundamental tone" is used to mean the lowest vibration present in the vibrator. When a rod is struck, various tones appear as the result of the vibrating pattern of the rod. A person listening to the note produced as a result thereof will select a characteristic tone by which he identifies the note. As will be explained hereafter, the characteristic tone in the case of a fixed-free rod is a synthesized tone, not actually present in vibrations in the rod, formed by a combination of the fourth and fifth partials or tones of the rod. The term "partial" or "tone" refers to a single tone and not to a combina-

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tion of tones, "first partial" meaning the first tone above the "fundamental."

In one aspect of the present invention, a tone generator, which will be described in detail hereafter, has vibrations therefrom picked-up electrically to produce electrical vibrations or oscillations in an amplifier circuit. The vibrations picked-up are modified by locating the pick-ups in a predetermined relationship along the tone generator. Other vibrations in the tone generator can be modified in the amplifier circuit by suitable filters or electrical arrangements. The amplifier circuit used is connected to an electro-acoustic transducer or loud speaker to produce the desired note. A plurality of tone generators can be employed and actuated from a key board so that carillon music can be produced.

One of the features of the invention is a tone generator comprising a pair of vibrators for each note, preferably in the form of fixed-free rods, said pair of rods being strikable simultaneously by a striker. Merely as an example, twenty-five or more tone generators representing twenty-five notes of the chromatic scale can be employed for the production of carillon music, an instrument employing as many as sixty-one tone generators having been used. A greater or less number of tone generators may be employed as desired. The two fixed-free rods of each tone generator have their lengths or vibratory patterns selected relative to each other so that one rod will vibrate at a higher fundamental frequency than the other rod. As previously mentioned, the fundamental frequency is the lowest normal vibration in the rod.

The normal characteristic tone of such a rod or the tone identifying the note to the listener is not actually present in the vibrating pattern of the rod but is a tone which is synthesized as a result of the difference between two partials, such as the fourth and fifth partials of the rod.

As is well known, when an electric pick-up is placed at a point along a rod where the node of a particular tone or vibration occurs there will be no energization of the pick-up by this particular vibration because there will be no relative vibration between the pick-up and rod at this point. By placing the pick-up at a selected node of the fourth partial, the fourth partial will be eliminated from the electrical vibrations picked up and fed to the amplifier circuit. By such a placement of the pick-up, the characteristic tone, which is an octave below the fourth partial, also will be eliminated because the charac-

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teristic tone is a result of the difference between the fourth and fifth partials. The electrical vibrations in the amplifier circuit then will have a characteristic vibration or tone differing from the natural or normal previous characteristic tone. As will be explained hereafter, in a fixed-free rod, the new characteristic tone may be a minor third or a musical interval of one and one-half tones above the normal characteristic tone of the rod.

In a tone generator having two rods, one of the rods can have its electrical pick-up arranged as described in the preceding paragraph for the purpose of changing the characteristic tone thereof. The other, or second rod, is constructed and tuned so that the fundamental tone thereof is a minor third musical interval above the fundamental tone of the first mentioned rod. The pick-up for the second rod is arranged so as not to change the characteristic tone thereof. It is apparent that the changing of the characteristic tone of the first rod to a minor third above the normal characteristic tone thereof will cause the two rods to have the same potential characteristic tones in the electrical system thereof. The characteristic tones of both rods do not necessarily have to be used for the final amplified note as long as it is available from one rod. Thus, it is not absolutely necessary that the characteristic tone of each rod be exactly tuned as long as the particular partials therefrom are correct and bear the correct relationship to the characteristic tone that is utilized.

As will be explained in detail, at a later point, each of the rods will have certain of the desired partials, which are to be combined with the characteristic or strike tone so as to produce a true bell note, including a hum tone an octave below the characteristic tone.

The other undesired partials and the fundamentals of each rod can be removed by placement of the pick-up means, by damping means, and by the amplifier circuit arrangement. Also the electro-acoustic transducer can be selected so as to attenuate certain of the undesired partials. It is, of course, possible to use various other combinations of rods, or numbers thereof, struck simultaneously so as to attain the desired final note, such rods being initially tuned as required for the particular systems involved, and in accordance with the numbers of rods.

Another feature of the invention is the arrangement of said pairs of rods in bases or heavy blocks chosen of the proper weight relative to the rods so that the rods will develop their correct tones at all times while vibrating.

In one aspect of the invention, each base is mounted resiliently and independently of the others. In this manner, when a pair of rods is struck, the partials from one pair of rods are not carried into other rods. A small amount of pick up is not objectionable or noticeable and thus it is practicable to install two rods on a common block. The collectors or plates are mounted adjacent each rod so as to be in capacitative relationship with the rod, a suitable polarizing voltage being provided. The collectors can be mounted on a holder which in turn is fitted on a vertical support projecting upwardly from the base, the collector itself being insulated from the holder. The holder is arranged to be at ground electrical potential so that adjustments can be made without generating spurious noises in the connected amplifier circuit. The rods are firmly positioned in the base in such a manner that they can be hit simultaneously with a ham-

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mer, means being provided so that the hammer will correctly hit both rods.

The tone or vibrating pattern of a fixed-free rod is to some extent dependent on the mass of the block in which it is supported. If the mass of the block is considered to be infinite, the vibrating pattern will follow the theoretical sequence and values of tones of a fixed-free rod as will be explained hereafter. When the mass is finite, some tones will not develop as fully as with an infinite mass. The patterns, however, will be uniform and the rod will ring clear with all partials having the proper magnitude when the mass is finite, if the rods are securely clamped at the base and the collectors and stabilizer supports are arranged so that there is no damping or restraining of the portions of the vibrations of the rod which are in the block. Under these conditions, it is possible to control duration of tones by weight of the block. Light blocks will produce notes with less duration than a heavier block.

A collector plate or electrode is contemplated to be arranged so as to be electrostatically shielded and to collect vibrations only from the desired rod. The electrode can be made with a relatively wide face adjacent the rod and a narrow face facing the shield. Also the electrode may be held in a high dielectric block fastened to the shield with a large portion of the electrode itself separated from the block. By this means, the electrode will have a minimum of capacity relative to the shield and the electrode holder organization.

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

Figure 1 shows a G clef and F clef with the notes indicated thereon present in a bell and the bell tone produced by the tone generator of the present invention.

Figure 2 is a table showing the relationship of vibrations existent in a fixed-free rod.

Figure 3 shows the various tones present in a tone generator employing two rods made in accordance with the present invention for the characteristic tone or note C.

Figure 4 is a table showing the composite tone resulting from the combination of tones of the rods of Figure 3.

Figure 5 is a perspective view of one of the tone generator assemblies of the present invention.

Figure 6 is a section taken along the line 6-6 of Figure 5.

Figure 7 is a perspective view of one side of a group of tone generators.

Figure 8 is a fragmentary elevation looking from the other side of Figure 7 showing the arrangement for supporting the upper part of the carrier bars.

Figure 9 is a fragmentary enlarged view showing a striker.

Figure 10 is a view looking in the direction 10-10 of Figure 9.

Figure 11 is an enlarged section taken along the line 11-11 of Figure 9.

Figure 12 is a schematic wiring diagram.

Figure 13 is an enlarged fragmentary view looking in the direction 13-13 of Figure 6.

Figure 14 is a fragmentary view showing an alternate type of stabilizer.

Figure 15 is an enlarged fragmentary view of the top of a rod showing a damping means thereon.

Figure 16 is an alternative schematic wiring diagram.

Describing the invention generally, the tone generators are seen diagrammatically indicated at 20 (Fig. 12), said generators being operable by strikers 21, only one rod being visible. The electrical pick-ups 22 are connected to a pre-amplifier 23 of suitable design, said preamplifier in turn being connected to an amplifier circuit 24. The amplifiers may have suitable circuits therein for attenuating the undesired partials or tones. Loud speaker 25 is connected to the amplifier 24, said speaker having the desired characteristics. Merely by way of example, speakers having an output of 1 kilowatt have been heard for more than two miles when connected to the apparatus disclosed herein.

First a set of tone generator rods will be described together with the manner in which they function, a pair of rods having the characteristic tone C being selected for this purpose. In Figure 1, column 1, the desired tones of a good bell are indicated together with the names of said tones in column 5. The "strike" tone is the characteristic tone or the one which is identified by the listener as the note of the bell. The lowest tone heard in a bell is not the characteristic tone of the bell but is an octave below said tone, and is known as the "hum" tone. In addition to the strike and hum tones, there will be found in a bell a minor third, a fifth, the first octave above the strike tone, a major third, and the fifth tone above the first octave. In addition, there may be a second octave as indicated.

When any fixed-free rod is struck, the partials and their nodal positions in relation to the rod are indicated in Figure 2, the fundamental tone being the lowest vibration present in the rod. If a fixed-free rod is made in accordance with the description herein and set into vibration and an electric pick-up or collector means placed near the rod, electric vibrations will be produced in an amplifier circuit connected to said pick-up containing all of the partials listed in the table of Figure 3. The rod thus constructed is grooved and can have a weight or weights adjusted along the length thereof to give this result, the weights being properly positioned relative to the various nodes of the partials involved. If the rod is grooved near its point of emergence from the block, the partials will fall into a substantially even harmonic pattern. The exact reason for this is not known. Placing of a groove or a plurality of grooves of even depths and widths adjacent the point of emergence of a fixed-free rod from the block has the effect of causing the partials to fall into the exact desired relationship in a rod.

When the amplified electrical vibrations are connected with a loud speaker, a person listening to the note therefrom will select from the composite tone a characteristic tone identifying the note. The characteristic tone is a synthesized tone resulting from a combination of the fourth and fifth partials as indicated, for example, in either rod A or B (Fig. 3). The synthesized characteristic tone actually can be seen in a stroboscopic analysis of the tones of the rods. The characteristic tone thus heard has the fourth partial as its octave which serves to augment the characteristic tone as far as the ear is concerned. Other tones may be generated in a similar fashion, but none of these are augmented by another partial and thus are not heard in strength by the listener.

The two rods may be mounted in a block and associated with an electric pick-up or collector as will be described later. The two rods are tuned so that the normal fundamental vibration of each rod will be a minor third apart or one and one-half steps or tones in the chromatic scale. It is to be understood that this will depend upon the particular scale used.

Referring to rod B (Fig. 3), the collector is set opposite one of the nodes of the fourth partial thereof, said partial in the example shown being tone A on the scale. It is desirable to select the node at which the collector is placed so that it is not the node for one of the other desired partials. The reason for this is that only the fourth partial is to be affected by this placement. The electric vibrations picked-up will not have the fourth partial therein and thus the fourth partial will be eliminated in the electric vibrations fed to the amplifier circuit. It becomes apparent that when the fourth partial in rod B is removed, that the synthesized characteristic tone derived from the fourth and fifth partials will disappear. The rod then will have a new characteristic tone which will be the tone C, because the second and third partials are an octave apart and will augment each other. These partials have sufficiently high amplitudes for the purpose inasmuch as they are lower partials of the rod.

As will be explained hereafter, the fundamental and first partials of rod B are not desired and can be eliminated in the amplifier circuit and stabilizer. It is thus apparent that the elimination of the fourth partial will raise the characteristic tone of rod B appearing in the amplifier circuit by a minor third or from 440 cycles per second to 523 cycles per second.

In the case of rod A, which was tuned a minor third above rod B, it is to be noticed that the characteristic tone is C (523 cycles per second), said characteristic tone being a synthesized tone derived from the fourth and fifth partials thereof. The characteristic tone of rod A is seen to be the same as the new characteristic tone of rod B and thus the two characteristic tones in the amplifier circuit will augment each other.

The electric pick-up for rod A can be placed opposite a suitable node of the second partial D# for the purpose of eliminating this partial. Through the use of suitable filters and stabilizers, the fundamental and first partials can be removed from rod A.

The composite tone produced when rods A and B are struck simultaneously then will be that indicated in column 4 of Figure 1. These tones represent all of the tones necessary in a good bell except the fifth above the strike tone, said fifth not being of importance and its absence not detracting from the bell tone. The additional tone of C# is not of importance and does not add or detract from the bell tone. All of the other tones are in good proportion to the tones of a good bell and the strike tone is particularly clear because this tone is present and picked up electrically from both rods.

An alternate wiring arrangement is seen in Figure 16 wherein the A rods can be connected to one amplifier and the B rods to another amplifier, said two amplifiers then having their output connected together for feeding the loud speaker or other amplifier arrangements. If desired, separate amplifiers can be used for each set of rods in each octave.

In a preferred form of the invention, a sup-

port block or base 30 (Figs. 5, 7) is mounted on resilient supports 31 carried on plate or support 32. The rods 33 and 34 mounted on said block are tuned so that they have the proper frequency and tones for the particular note involved in the manner just described. Tuning can be accomplished by adjusting the length of the rod in any suitable manner such as by cutting off or by an adjustable element and weights can be adjusted along the rod as needed.

A damper arrangement may be provided on the end of each rod (Fig. 15) for the purpose of selectively damping the partials in the rod. The damping device may take the form of a sleeve mounted on the end of the rod 35A and having a ball 35B therein such as is indicated at 35C in Figure 15. Sand or other divided material may be used in place of the ball. Also a wire loosely mounted on the end of the rod can be used for the same purpose. The damping means is described and claimed in copending application Serial No. 60,469, filed November 17, 1948.

Stabilizers 36, consisting of plates 37 firmly clamped on a support 38 may have springs 39 mounted thereon engaging a rod. The stabilizers will serve to laterally retard the free motion of the rod. The stabilizing springs will serve to restrict the fundamental tone of the rod, there being less effect on the first partial and substantially no effect on tones higher than the first partial. It is necessary to select the stiffness of the spring so that it has a resonant frequency outside of the range of the note. Stabilizers must also be placed so that they will not interfere or attenuate any of the desired partials in the rod. The stabilizer will add to the mechanical stability of the rod because the amplitude of the fundamental and first partial is high. In addition to the low frequency attenuation described, the stabilizer also makes it possible to place the pick-up close to the rod without danger of the rod striking the pick-up.

The stabilizers can be placed at any desired point along the rods such as for example, near the centers. Inasmuch as the lower partials are removed in the amplifier circuit and not used, it is thus desirable to restrict the rod from vibration at these partials.

In the form shown, the rods 33 and 34 are supported in slots 39 located in base 30, said rods being tightly held therein so that the rods, block, and collector plate support 38 will vibrate as a unit. The collector plate support 38 is held tightly in place on the base 30 by means of nut 40.

Although certain of the partials are removed by proper positioning of the collectors and in the amplifier circuit, these partials are still present in the rod and in the block in which the rods are held. It is thus apparent that the unused partials may be picked up by the collectors of any other rod or group of rods if transmitted thereto. It thus is theoretically necessary to isolate each rod from each of the other rods. A small amount of pick-up is not too objectionable and therefore two rods can be installed in a common block, because the partial removed from one rod is picked-up by the other rod only to a limited extent.

The collector plates, shown generally at 41, are mounted on collector plate support 38. The collector plates include an electrode element 42 (Figs. 6, 13) arranged to be closely spaced relative to the rod from which vibrations are to be collected by the particular plate. Preferably, the

electrode has a flat relatively wide face next to the rod, and a relatively thin side surface parallel to the shield or support plate. Shield plate 43 is provided so as to shield the collector electrode 42 from the vibrations of the other rod. The collector electrode is mounted on an insulating block 44 carried by the collector frame in such a manner that it is insulated from the remainder of the collector structure. The block 44 may be made of "Bakelite" or other high dielectric material. The ends of the electrode are held in the block with a space 44A between a large portion of the electrode and the block. Screws 44B may be employed to hold the block in place on the collector frame. The collector frame may comprise two sheets of metal 45, 45A joined together in abutting relationship at 66 and 67. Clamps 46 may be placed on the collector plate support 38 above and below each electrode. A spring 69 may be used between the collector and the support 38. Clamping screws 47 located at end 66 clamp the collector in place on the support 38. The flat face of the electrode is opposite the rod 33 giving maximum capacity whereas the shield 43 is arranged so that only an edge of the electrode is in close proximity to an angularly disposed part of the shield.

A general assembly view of one form of the instrument is indicated in Figure 7 wherein the rods and supports are shown mounted on base plate 32. The strikers 48 are carried by a suitable channel or bar 49, the channel 49 being mounted on a cross bar 50 carried by rubber or vibration absorbing elements or bushings 51. The upper portions of the collector plate supports 38 are guided by the posts 52 (Fig. 8) carried on upper cross bar 53. The supports can move inwardly and outwardly relative to bar 53 but are prevented from moving sideways by said posts 52. The posts 52 may have an insulating or vibration absorbing material therein. A plurality of assemblies such as shown in Figure 7 can be provided as needed. In the form shown in Figure 7, an extension is indicated connecting the vibration absorbing element with the base, said extension not being shown in Figure 5 nor necessary in the functioning of the device. Weights 68 are indicated on the rods. The stabilizers are omitted from this figure, it being understood that they can be used if desired.

The strikers preferably comprise a magnet coil 60 (Figs. 9, 10, 11) carried on a U-shaped magnet 61, said U-shaped magnet being mounted on channel 49 (Figs. 7, 9). Armature 62 is pivotally mounted at 63, said armature carrying a striker rod 64 on which is mounted a bent plate hammer 65 (Figs. 9, 10, 11). The bent plate hammer can rotate relative to the axis of striker rod 64 so that when the striker is operated, each rod of a tone generator will be struck evenly by the hammer 65. In this manner it is not necessary to accurately adjust the position of the hammer 65 on rod 64 so as to insure the striking of both of the tone generator rods at the same time with the same blow because the hammer will turn. A spring 69 can be inserted within the plate 65, there being a groove 70 (Figs. 9, 11) cut into striker rod 64 to receive one side thereof.

An alternate form of stabilizer is seen in Figure 14 where collector plate support 71 is suitably mounted in a base (not shown) holding rod 72. A clamp 73 is mounted on said support 71, said clamp carrying a spring 75, said single spring functioning similar to the springs of the stabilizer illustrated in Figure 5.

The instrument described herein can be played from a keyboard and the various tone generators can be actuated singly or in suitable combinations. Various details of construction can be altered without departing from the spirit of the invention except as defined in the appended claims.

What is claimed:

1. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a pair of vibrators for a note, each of said vibrators having normally different characteristic tones, means changing the characteristic tone of one vibrator to a tone in predetermined relationship to the partials of the other vibrator, means striking said vibrators simultaneously and means eliminating undesired tones in each vibrator, so that the combination tone when both vibrators are struck will have the desired characteristic tone and partial tones for the note to be produced.

2. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising at least a pair of vibrators for a note, each of said vibrators having normally different characteristic tones, means on each rod tuning the various partials thereof to the desired relationship relative to a characteristic tone, means changing the characteristic tone of one vibrator to a tone in predetermined relationship to the partials of the other vibrator, means striking said vibrators simultaneously and means eliminating undesired tones in each vibrator, so that the combination tone when both vibrators are struck will have the desired characteristic tone and partial tones for the note to be produced.

3. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a pair of vibrators for each note, each of said vibrators having normally different characteristic tones, means changing the characteristic tone of one vibrator to a characteristic tone in unison with the characteristic tone of the other vibrator, means striking said vibrators simultaneously and means eliminating undesired tones in each vibrator, so that the combination tone when both vibrators are struck, will have the desired characteristic and partials.

4. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a pair of fixed-free rods for each note, each of said rods having normally different characteristic tones, the characteristic tone of one rod being synthesized from two higher partial tones in said rod, means eliminating one of said higher partial tones used in the synthesis of said characteristic tone so that the characteristic tone of said rod is changed to a tone in predetermined relationship to the partials of the other rod, means striking said rods substantially simultaneously and means eliminating undesired partial tones in each rod, so that the combination tone when both rods are struck will have the desired characteristic and partials for the note to be produced.

5. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a pair of fixed-free rods for each note, each of said rods having normally different characteristic tones, the characteristic tone of one rod being synthesized from two higher partial tones in said rod, means positively eliminating one of said higher partial tones used in

the synthesis of said characteristic tone so that the characteristic tone of said rod is changed to a tone in unison with the characteristic tone of the other rod, and means eliminating undesired partial tones in each rod, so that the combination tone when both rods are struck will have the desired characteristic and partials.

6. An electronic tone generator having mechanical electrical translating means, the combination comprising a pair of fixed-free rods for a tone, said rods having normally different characteristic tones, means holding an electro-mechanical pick-up at one of the partials of one rod which is used in synthesizing the characteristic tone of said rod, said rod being vibrantly so related to the other rod that the new characteristic tone of the rod will potentially be in unison with the potential characteristic tone of the other rod, and means eliminating undesired partials in each rod, so that the combination tone when both rods are struck will have the desired characteristic and partials.

7. An electronic tone generator having mechanical electrical translating means, the combination comprising a pair of separate fixed-free rods for a note, each of said rods having normally different characteristic tones separated by a minor third musical interval, means holding an electro-mechanical pick-up at a node of one of the partials of one rod which is used in synthesizing the characteristic tone of said rod, said rod being so vibrantly related to the other rod that the new characteristic tone of the rod will be predeterminedly related with the partials of the other rod, means for energizing said rods substantially simultaneously, and means eliminating undesired partials in each rod, so that the combination tone when both rods are struck will have the desired characteristic and partials for the note to be produced.

8. An electronic tone generator having electrical mechanical translating means, the combination comprising a pair of fixed-free rods for a note, said rods being separated by a minor third musical interval, means holding a mechanical electrical pick-up at a node of the 4th partial of one rod so as to positively remove the 4th partial and the normal characteristic synthesized tone of the rod, the picked-up electrical vibrations of the new characteristic tone of said rod being higher than the normal characteristic tone so that the picked-up characteristic tone of the rod is potentially identical to the characteristic tone of the other rod, a mechanical electrical pick-up at one of the partials of the other rod which is to be eliminated, amplifying means connected to said pick-ups, means for energizing said rods substantially simultaneously, and electro-acoustic translating means connected to said amplifying means.

9. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a support means, a pair of vibrators separately mounted on said support, said vibrators having normally different characteristic tones, means changing the characteristic tone of one vibrator to a tone predeterminedly related to the partials of the other vibrator by positively eliminating a partial, means positively eliminating a partial in the other vibrator, and means eliminating undesired partials in each vibrator, so that the combination tone when both vibrators are struck will have the desired characteristic tone and partial tones.

10. An electronic tone generator having elec-

trical mechanical translating means, the combination comprising support means, a pair of fixed-free rods separately mounted on said support means, said rods being vibrantly separated by a minor third musical interval, means holding a mechanical electrical pick-ups at the node of a 4th partial of one rod so as to remove the 4th partial and the characteristic synthesized tone of the rod, the picked-up electrical vibrations of said rod being raised so that the picked-up characteristic tone of the rod is potentially identical to the potential characteristic tone of the other rod, a mechanical electrical pick-up at a node of one of the partials of the other rod which is to be eliminated, amplifying means connected to said pickups, means for striking said rods substantially simultaneously and electro-acoustic means connected to said amplifying means.

11. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a support means, at least a pair of fixed-free rods for each note mounted on said support, said rods having normally different characteristic tones, the characteristic tone of one vibrator being synthesized from two higher partial tones in said rod, means positively eliminating one of said higher partial tones used in the synthesis of said characteristic tone so that the characteristic tone of said rod is changed to a tone bearing the relation to the partials of the other rod that the corrected characteristic tone of the other rod would bear, means for striking said rods substantially simultaneously, and means eliminating undesired partial tones in each rod, so that the combination tone when both rods are struck will have the desired characteristic and partials for the note to be produced.

12. An electronic tone generator having electrical mechanical translating means, the combination comprising support means, a resilient mounting for said support means, a pair of fixed-free rods for each note mounted on said support means, said rods being separated by a minor third musical interval, means holding a mechanical electrical pick-up at a node of the 4th partial of one rod so as to remove the 4th partial and the normal characteristic synthesized tone of the rod, the picked-up electrical vibrations of said rod being changed so that the picked-up characteristic tone of the rod is raised so as to be identical to the potential characteristic tone of the other rod, a mechanical electrical pick-up at one of the partials of the other rod which is to be eliminated, amplifying means connected to said pick-ups, means for striking said rods substantially simultaneously, and electro-acoustic means connected to said amplifying means.

13. An electric musical instrument having a plurality of tone generators, each tone generator comprising a pair of vibrators for each note, the vibrators of each pair having normally different characteristic tones relative to each other, means changing the characteristic tone of one vibrator of a pair to a characteristic tone in unison with the potential characteristic tone of the other vibrator of the pair, a plurality of strikers, each of said strikers being selectively operable to strike a pair of vibrators for a note, and means eliminating undesired tones in each vibrator, so that the combination tone when both vibrators of a note are struck will have the desired characteristic tone and partial tones for the particular note.

14. An electric musical instrument having a

plurality of tone generators, each tone generator comprising a pair of fixed-free vibrators for a note mounted on a base and having normally different fundamental tones, means changing the characteristic tone of one vibrator of a note to a characteristic tone bearing a predetermined relationship with the partials of the other vibrator of the pair, a plurality of strikers, each of said strikers being selectively operable to strike a pair of vibrators for a note, and means eliminating undesired tones in each vibrator of a pair, so that the combination tone when both vibrators are struck will have the desired characteristic tone and partial tones for a particular note.

15. An electronic tone generator having electrical mechanical translating means, the combination comprising a rod support means, a collector plate supporting bar mounted on said rod support means, a pair of fixed-free rods for a note mounted on said support means, said rods being separated by a minor third musical interval, means holding a mechanical electrical pick-up at a node of the 4th partial of one rod so as to remove the 4th partial and the normal characteristic synthesized tone of the rod, the picked-up characteristic electrical vibrators of said rod being changed so that the picked-up characteristic tone of the rod is raised so that it will be identical to the potential characteristic tone of the other rod, a mechanical electrical pick-up at one of the partials of the other rod which is to be eliminated, amplifying means connected to said pick-ups, and an electro-acoustic means connected to said amplifying means.

16. An electric musical instrument having a plurality of tone generators, each tone generator comprising a pair of fixed-free vibrators for a note mounted on a base and having normally different characteristic tones, means changing the characteristic tone of one vibrator of a pair to a characteristic tone predeterminedly related with the partials of the other vibrator of the pair, spring stabilizers contacting each of said vibrators, a plurality of strikers, each of said strikers being selectively operable to strike a pair of vibrators for a note, and means eliminating undesired tones in each vibrator, so that the combination tone when both vibrators are struck will have the desired characteristic tone and partial tones for the note.

17. An electric musical instrument having a plurality of tone generators, each tone generator for a note comprising a pair of vibrators having normally different characteristic tones, means changing the characteristic tone of one vibrator of a pair to a characteristic tone predeterminedly related to the partials of the potential characteristic tone of the other vibrator of a pair, a plurality of strikers, each of said strikers being selectively operable to strike a pair of vibrators for a note, resilient means supporting said strikers, means eliminating undesired tones in each vibrator, so that the combination tone when both vibrators are struck will have the desired characteristic tone and partial tones.

18. An electronic carillon tone generator having mechanical electrical translating means, the combination comprising a pair of vibrators for a note, a striker operator for said vibrator, a hammer rod operable by said operator, and a hammer plate having a striking surface adapted to contact said vibrators, said plate being rotatably mounted on said hammer rod, so as to be automatically adjustable to simultaneously strike both vibrators.

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19. The method of operating an electronic bell instrument having a pair of rods tuned a predetermined musical interval apart, comprising simultaneously striking said pair of rods, positively changing the characteristic tone picked-up electrically from one rod so that it bears a predetermined relationship with the potential characteristic tone and the partials of the other rod, eliminating undesired partial tones from said rods, and reproducing said composite tone. 10

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