May 9, 1933. A. N. CURTISS 1,907,936

MUSICAL INSTRUMENT

Filed June 9, 1932

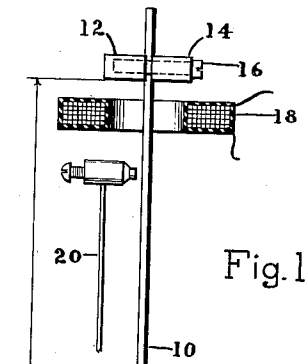

Fig. 1.

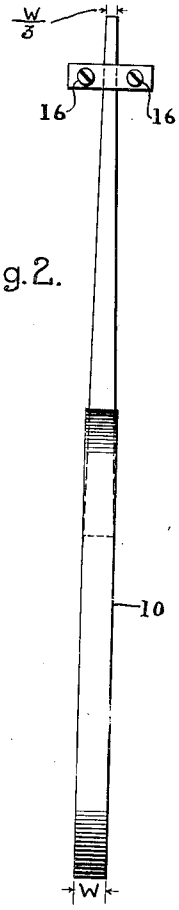

Fig. 2.

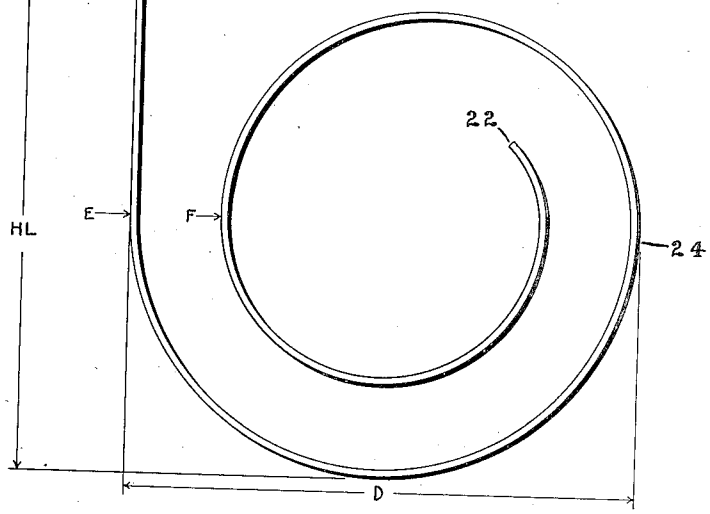

Fig. 3.

NOTE	PITCH FREQUENCY(χ)	HANGING LENGTH (HL)	TOTAL LENGTH (L)	OUTSIDE DIAMETER (D)	WIDTH(W)
C'	512 ~	7 7/16"	28 3/16"	5 1/4"	3/8"
D_b'	545 ~	7 1/4"	27 5/16"	5 1/8"	3/8"
D'	576 ~	7 1/8"	27"	4 7/8"	1/4"
E_b'	614 ~	7"	25 3/4"	4 13/16"	1/4"
E'	640 ~	7"	25 5/16"	4 3/4"	1/4"
F'	682 ~	7"	24 1/2"	4 11/16"	1/4"
G_b'	727 ~	6 13/16"	23 7/8"	4 1/2"	1/4"
G'	768 ~	6 1/2"	23 1/8"	4 5/16"	1/4"
A_b'	818 ~	6 5/16"	22 9/16"	4 5/16"	1/4"
A'	853 ~	6 1/4"	22 1/8"	4 5/16"	1/4"
B_b'	909 ~	6 3/16"	21 3/8"	4 1/8"	1/4"
B'	960 ~	6 1/8"	20 7/8"	4 1/16"	1/4"
C^2	1024 ~	6 1/16"	20 3/8"	4"	1/4"

INVENTOR

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1,907,936

UNITED STATES PATENT OFFICE

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MUSICAL INSTRUMENT

Application filed June 9, 1932. Serial No. 616,178.

My invention relates to improvements in musical instruments of the type wherein a coiled spring or reed is struck and thereby caused to vibrate to produce a musical note, and, more particularly, to the construction of the coiled spring or springs.

Development work on musical instruments of the character referred to has been carried on with the object of obtaining an instrument, commonly referred to as an electric carillon, which faithfully reproduces the sounds of chimes and bells. In this connection, it has been found that the capability of the instrument to exactly reproduce the sound of a chime or bell depends on a number of structural and physical characteristics of the vibratory element. The various constructions of vibratory elements proposed heretofore have been capable of reproducing the sounds of chimes and bells with some degree of fidelity, but there has always been a very noticeable distortion of some kind. For example, the vibratory elements proposed heretofore have been too rich in harmonics to be of any use in exactly reproducing the sounds of bells and chimes, and, furthermore, these elements have lacked the characteristic harmonics of bells.

With the foregoing in mind, it is one of the objects of my invention to provide an improved vibratory element of the character referred to which is capable of faithfully reproducing a musical note of a chime or bell.

Other objects and advantages will hereinafter appear.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawing, wherein

Figure 1 is a front elevational view of a portion of a musical instrument constructed and set up in accordance with my invention;

Fig. 2 is an end elevational view, looking toward the left of the device shown in Fig. 1; and

Fig. 3 is a table of dimensions for a vibratory element constructed in accordance with my invention, and capable of faithfully reproducing the notes of chimes or bells through a range of one octave.

In Figs. 1 and 2, the vibratory element 10 is capable of reproducing a musical note having a definite pitch frequency, and may be considered as being one of a number of such elements mounted in bank formation and constructed and adjusted to reproduce the respective notes in the musical scale. One manner of supporting and operating the various elements is disclosed in the copending application of Carroll D. Kentner, Serial No. 574,961, filed November 14, 1931, and assigned to the Radio Corporation of America.

As shown, the end of the straight portion of the element 10 is clamped between suitable blocks 12 and 14 by screws 16 which pass loosely through the block 14 and thread into the block 12.

For the purpose of transforming the physical vibrations of the element 10 into electrical pulsations, the element is supported with its straight portion extending through an air gap in a magnetic circuit which may be provided by a permanent magnet of suitable form (not shown). A pick-up coil 18 is so disposed in the magnetic circuit that, as the element 10 vibrates in the air gap, a current is induced in this coil at a frequency corresponding to the frequency of vibration. This current is then amplified and supplied to a loudspeaker or other acoustic device (not shown).

A striker, which may be in the form of a hammer 20, is suitably supported for manual or electrical operation to strike the element 10 and to set it into vibration.

Coming now to the essence of my invention, this resides in the construction and adjustment of the vibratory element or elements such that any particular element for reproducing a musical note of a definite pitch frequency has characteristic relations between certain structural dimensions of this element and the pitch frequency.

One of these dimensions I refer to as the total vibrating length L of the element, and measure this from the edge of the clamping blocks 12 and 14 to the free vibrating end 22 of the element. In my improved construction, $L=Ax^n$, wherein x is

the pitch frequency, L is the total vibrating length of the element in inches, A is a factor within the range of 595 to 605, and a is an exponent of x within the range of $-.48$ to $-.495$. Very satisfactory results have been obtained by making A substantially equal to 598.3, and by making a substantially equal to $-.487$.

Another important structural dimension in my improved construction is the hanging length HL, which is measured, as shown in Fig. 1, from the edge of the clamping blocks 12 and 14 to a line tangent to the spiral portion 24 of the vibratory element, and perpendicular to the straight portion of the latter. In my improved construction, $HL=Bx^b$, wherein HL is the hanging length of the vibratory element in inches, B is a factor within the range of 70 to 75, and b is an exponent of x within the range of $-.335$ to $-.380$. Very satisfactory results have been obtained by making B substantially equal to 72.4, and by making b substantially equal to $-.36$.

Another important dimension in my improved construction is the outside diameter D of the spiral portion 24, the relation being $D=Cx^c$, wherein D is the outside diameter in inches, C is a factor within the range of 65 to 75, and c is an exponent of x within the range of $-.365$ to $-.45$. Satisfactory results have been obtained by making C substantially equal to 70.4, and by making c substantially equal to $-.41$.

Another important structural characteristic of my improved vibratory element is the number of degrees through which the spiral portion 24 extends.

In the particular embodiment of my invention disclosed, the spiral portion 24 extends through one complete revolution from E to F in a counter-clockwise direction, and then continues on further through about 230 degrees. In vibratory elements constructed in accordance with my invention, the number of degrees through which the spiral extends is within the range of from 500 to 620 degrees. I have found that if the spiral extends beyond this range, the tone reproduced is too rich in harmonics, and that if the spiral does not come within this range the vibratory element lacks the characteristic harmonics of a bell of the corresponding note.

I propose to make the elements 10 from a very high grade tempered steel, the steel being tempered to between 1400 and 1500 degrees Fahrenheit, the material being $\frac{1}{16}''$ gauge. Any other material, or combination of materials, having the required characteristics, may be used to make the elements 10. The width W of the material is to be from $\frac{1}{8}''$ to $\frac{1}{2}''$. The width of the element does not affect the tone color, and is selected only to provide the desired stiffness.

For the purpose of preventing rusting of the elements, I propose to give the same a very light coat of cadmium. This is done without any run of temperature, or other conditions which might change the tonal qualities of the instrument. As is shown in Fig. 2, the tongue of each element, or that part which goes between the clamping blocks, is slightly tapered, the tapered length being approximately $\frac{1}{5}$ of the total length of the reed measured from the point of support. The width w of the reed at its clamped end is about $\frac{1}{3}$ of the width W. The reason for this shape is to prolong the sound from the reeds, or to reduce the attenuation of the sounds or vibrations as might be desired.

Any particular element is tuned exactly to the desired note by loosening the screws 16 and varying the hanging length HL, which also increases or decreases the total vibrating length of the reed, to the proper point.

The various dimensions given in Fig. 3 have been found to be satisfactory for a set of vibratory elements covering the various notes in the musical scale from the "C" one octave above "middle C" to "high C".

I claim as my invention:

1. A vibratory element of the coiled-spring type for producing a musical note having a definite pitch frequency, characterized by the existence of the following relations between the structural dimensions of said element and the pitch frequency: $L=Ax^a$; $HL=Bx^b$; and $D=Cx^c$; wherein x is the pitch frenquency, L is the total vibrating length of said element in inches, A is a factor within the range of 595 to 605, a is an exponent of x within the range of $-.48$ to $-.495$, HL is the hanging length of said element in inches, B is a factor within the range of 70 to 75, b is an exponent of x within the range of $-.335$ to $-.380$, D is the outside diameter of the coiled portion of said element in inches, C is a factor within the range of 65 to 75, and c is an exponent of x within the range of $-.365$ to $-.45$.

2. A vibratory element as claimed by claim 1, further characterized by the fact that the coiled portion of said element is in the form of a spiral wherein the number of degrees through which the spiral extends is within the range of from 500 to 620 degrees.

3. A vibratory element of the coiled-spring type, for producing a musical note having a definite pitch frequency, characterized by the existence of substantially the following relations between the structural dimensions of said element and the pitch frequency: $L=598.3x-.487$; $HL=72.4x-.36$; and $D=70x-.41$; where x is the pitch

frequency, L is the total vibrating length of said element in inches, HL is the hanging length of said element in inches, and D is the outside diameter of the coiled portion of said element in inches.

4. A vibratory element as claimed by claim 3, further characterized by the fact that the coiled portion of said element is in the form of a spiral extending through substantially 590 degrees.

In testimony whereof, I have hereunto subscribed my name this second day of June, 1932.

ARTHUR N. CURTISS.