Feb. 17, 1942. H. J. SCHLUTER 2,273,333

VIBRANT BAR AND METHOD OF TUNING THE SAME

Filed April 24, 1939

Fig. 1

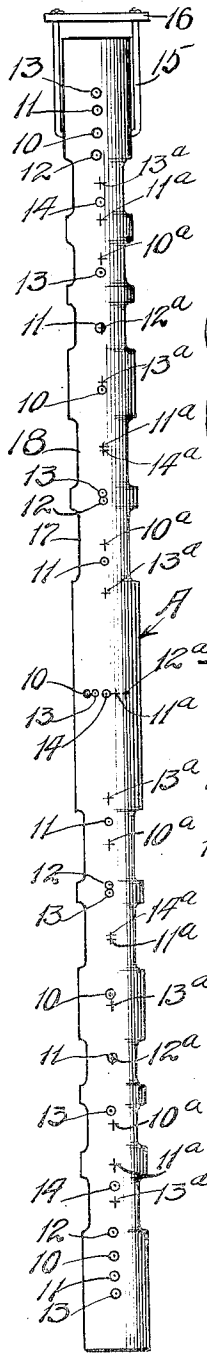


Fig. 2

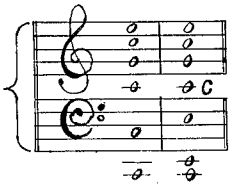


Fig. 3

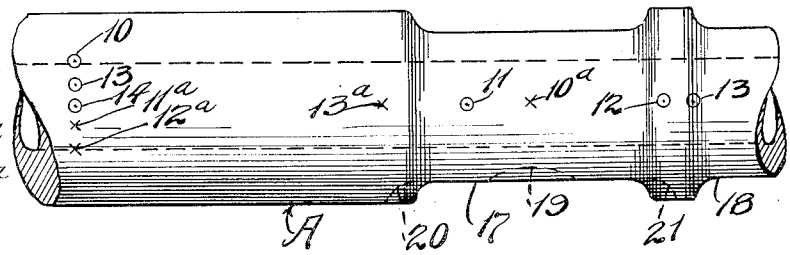


Fig. 4

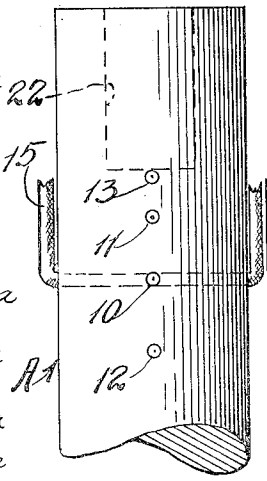


Fig. 5

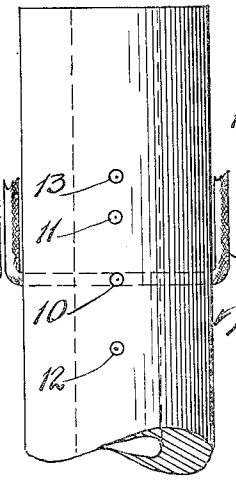
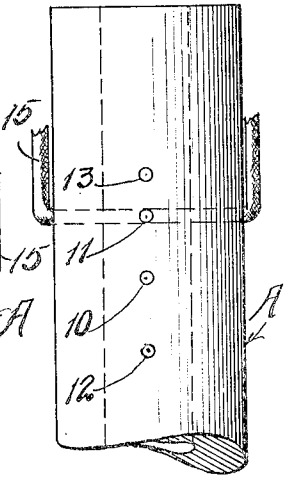


Fig. 6



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2,273,333

VIBRANT BAR AND METHOD OF TUNING THE SAME

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Application April 24, 1939, Serial No. 269,647

9 Claims. (Cl. 84—403)

The present invention relates in general to vibrant bars such as utilized in musical instruments of the percussion type such as bells, chimes, carillons and the like, and is particularly concerned with an improved method of tuning vibrant bars for such instruments so that a perfect consonance of their tone compounds may be obtained.

Heretofore, in the manufacture of vibrant bars for musical instruments, these bars being either of the solid or tubular type, it has been the usual practice, particularly in bells and chimes, to make the bars from tubular or solid stock of suitable material and finish these bars so as to have uniform diameter properly proportioned to the length of the bar to give the required key note, when the bar is set into vibration.

Moreover, it has been discovered that, even though the material for the bars be selected with the greatest of care, two bars constructed of seemingly the same material and having the same dimensions will seldom have the same pitch nor will the partial tones be in consonance with the fundamental key tone of the bar. Such condition results in a large measure from differences in the homogeneity of the bar material.

As a consequence of the above, when the usual bar of uniform diameter is brought to the desired fundamental key tone pitch, the composite musical tone of the bar is found upon analysis to generally comprise a compound of dissonant partials manifesting plus and minus differences from their true intervalic relationship in a musical scale of equal temperament. Thus, the chord formed by the key tone and its resulting partial tones, even though the key tone may be of the correct pitch, may in fact produce a composite or compound tone which is dissonant and enharmonic, and which sounds "out of tune."

Having in mind the above as well as other objections to vibrant musical bars as presently constructed, the present invention contemplates as the primary object the providing of a musical bar of improved construction in which the partial tones of the bar will have their correct intervalic relationships to the fundamental key tone of the bar, whereby perfect consonance of the tone compound will result.

A further object of the herein described invention is to provide an improved process or method for the tuning of vibrant musical bars, such for example as bells, chimes and the like.

Another object of the present invention is to provide a novel process for tuning vibrant musical bars, which will permit of the partial tones of the composite bar tone being each treated and tuned as an individual factor, both as to its specific periodic vibration frequency and its intervalic relation of key-note consonance.

Still another object of the invention is to provide improved means for the tuning of musical bars, wherein the bar may be altered mechanically to change its composite musical tone to a desired degree.

Still another object of the herein described invention is to provide an improved supporting arrangement for vibrant bars, whereby the most desirable tones in the different registers of a musical instrument utilizing such bars, may be made to predominate.

Other objects of the invention will more fully appear from the following detailed description taken in connection with the accompanying drawing, which illustrates the embodiment thereof, and in which:

Figure 1 is a view in elevation illustrating a vibrant bar embodying the features of the herein described invention, and showing the manner in which it is suspended to form a chime or bell;

Figure 2 illustrates a musical staff showing a fundamental key tone and several arrangements of associated tuned partial tones comprising the several tones of the composite or compound tones of vibrant bars such as embody the features of the present invention, these tones being produced when the bars are set into vibration;

Figure 3 is an enlarged fragmentary view of a section of my improved bar, showing its novel shaping and illustrating the manner in which the individual tones of the bar may be tuned to bring them into consonance;

Figure 4 is an enlarged fragmentary end view of a solid bar showing an improved end construction thereof and the manner in which this bar may be suspended for use in a musical instrument;

Figures 5 and 6 are similar views illustrating the manner in which my improved vibrant bar may be suspended to produce different predominating tones in the different registers of musical instruments utilizing such bars.

As shown on the drawing:

Vibrant bars, such as disclosed in Figure 1, constitute bells or chimes which may be assembled into a musical instrument such as a carillon or chime which may be arranged for playing in any desired manner, such as by striking the bars with hammers or by providing suitable mechanism so that they may be played from a keyboard. It is thought that for purposes of

illustration, it will be sufficient to describe a single bar, as for example, a bar having a fundamental pitch tone or key note corresponding in the musical scale to middle C having a vibration frequency of 261.625. Such a bell or chime would have a length of substantially twelve feet four inches, and would be of suitable diameter to produce the desired fundamental tone.

Vibrant bars for utilization as bells, chimes and the like have heretofore been constructed to have uniform diameter. It is found, however, that bars so constructed are objectionable in that their composite musical tone is a compound of dissonant partials having improper intervalic relation to the fundamental key tone which produces a composite or compound tone that sounds "out of tune" when the bar is struck or played.

Referring to Figure 2, a bar of this character having uniform diameter would produce only approximately all the tones shown in either of the exemplary chords on the musical staff in Figure 2. In other words, the six major partials of the tone compound, exclusive of the fundamental key note, would manifest plus and minus differences in their relation to the musical scale of equal temperament. Some of the partial tones might be sharp and the others might be flat.

In my improved bar, as generally shown at A in Figure 1, the bar is undulated at predetermined intervals along its length, the positions of these undulated portions having a definite relation to the antinode points of the bar tones and being so shaped as to result in tuning the bar tones so that they will be in consonance, as will hereafter be described in detail.

In the bar shown in Figure 1, the nodal points of the key tone are indicated at **10** and its antinode points at **10***a*. The nodal points of the fifth, first hum and eighth partials are respectively shown at **11**, **12** and **13**, and the node points of the sub-hum partial, an octave below the first hum partial tone, are shown at **14**, with their corresponding antinodes shown at **11***a*, **12***a*, **13***a*, and **14***a*, respectively. The node points of the third overtone above the key tone and the second octave tone below the key tone have not been shown in Figure 1. While these tones are in evidence in the bar and can be tuned, if desired, they are so obscured in the composite tone as to have only slight effect upon it.

Bars of the herein described type are usually suspended in a vertical position by means of a suitable cord or cable **15** which is passed transversely through the upper end of the bar and has its ends anchored on a suitable support as shown at **16**.

From a study of the tones comprising the compound tone of the bar, it will be apparent that the partial tones having the most effect upon the tone qualities of the bar will be the fifth, eighth, first hum and the so-called sub-hum tone partials.

As shown in Figure 3, the central and adjacent central portions of the bar have been illustrated on a large scale. It will be noted from this section of the bar that node points of the fundamental key note, eighth partial, and first hum tone partial all fall at the mid point or center line of the bar, as do also the antinodes of the fifth and first hum partial tones.

In constructing a bar according to my improved method, the bar is first constructed with uniform diameter, except that the dimensions of the bar are such as to produce a bar in which the different tones are above those which are actually desired to be produced in the bar after it is tuned. For example, if the tuned bar is to have the fundamental key note C, the bar would be initially constructed with proper diameter and length to give it a key tone of approximately C-sharp. During the tuning process, the bar is undulated with reference to the antinode points to individually and collectively vary the different tones to bring them to the desired pitches, as will now be described.

To illustrate my tuning method, as shown in Figures 1 and 3, portions of the bar surface have been removed to form circumferentially extending groove portions adjacent the antinode points of certain of the partial tones. For example, the grooved portions as shown at **17** and **18** are in general symmetrically positioned with reference to the antinode points of the key tone, and the fifth and hum tone partials.

In general, I have discovered that the key tone and its accompanying partial tones may be varied as to their respective pitches and be brought into consonance or tuned relation by varying the widths and depths of these grooved portions in the different parts of the bar, depending upon the relative levels of the pitches of the tones, and the amount it is desired to change the pitch of a particular tone in relation to the others.

If the groove **17** is deepened as indicated at **19** this would have its most effect upon the adjacent antinode of the key tone and would lower its pitch. Other tones would be slightly changed, but their rate of change would not be as rapid as that of the key tone. Similarly, deepening of the groove **18** will have its greatest effect upon the adjacent antinodes of the fifth and sub-hum tone partials and decrease their pitches at greater rates than the other tones.

By widening the grooves **17** in the directions as shown by the dash lines **20** and **21**, the effect will in general be to decrease the pitch of the tones farthest from the key note at a greater rate than those which are closer to the key note. The widening of the groove at **20** would decrease the pitch of the eighth partial faster than the fifth and first hum partial tones, and the widening of the groove as shown at **21** would have its greatest effect upon the sub-hum tone partial and would not affect the first hum partial to any great extent.

Knowing the effects which may be secured by removal of material as described above, it will be readily apparent that by successive checking of the tones of the bar and the removal of the material in the proper portions of the bar, the bar tones may be tuned and brought into consonance with the fundamental key tone at the desired pitch.

It has heretofore been the usual practice to simply drill diametrically extending holes through the upper ends of the bars which were to be incorporated in a carillon or other musical instrument in which the bars are suspended from their uppermost ends, these holes being equally spaced in all the bars from the bar ends. It has been found that this manner of suspending the bars seriously interferes with the tone qualities in the different registers in which the bars might be mounted. In practice, it is desirable in the upper registers of the musical instrument to have the fundamental key tone predominate, whereas in the lower registers it is more desirable to have the partial tones predominate.

Referring now to Figure 4, there is shown an

arrangement which I have utilized in connection with bars of the solid type for producing predominating tones in the different registers. In this arrangement, the bar in general would be provided with undulated portions as shown in Figure 1. I have found that the tones of solid bars may be generally improved by providing a resonator which is tuned to the key note of the bar. This resonator comprises an internal end recess **22** which is of such diameter and depth as to effect tuning it to the key note of the bar. The bar, as shown, is supported upon a hanging cord or cable which is passed through the bar at the key node. In this arrangement, the key tone will predominate. On the other hand, if the hanging cable is passed through an adjacent partial node point instead of the key tone node, then that particular partial tone may be made to become more predominant.

As shown in Figure 5, the bar, in this case a tubular bar, is shown with the supporting cable **15** passing through the node of the fundamental key note at this end of the bar as indicated at **10**. With such suspension, the fundamental key tone would predominate, and this type of suspension would be preferably used for one of the upper registers of the instrument.

As shown in Figure 6, the suspension cable is at the node of the fifth partial, so that as thus suspended the fifth partial tone would predominate, thus making this type of suspension preferable for the lower registers of the instrument.

From the above description, it is thought that the method or process of tuning vibrant bars according to the principles of my invention, will be clearly understood.

From the foregoing description, it is apparent that the present invention provides an improved musical bar in which the partial tones will have their correct intervalic relationship to the key tone and produce perfect consonance of the tone compound; which embodies an improved process or method for the tuning of vibrant musical bars, such as bells, chimes and the like; which permits of the partial tones of the composite bar tone being each treated and tuned as an individual factor, both as to its specific periodic vibration frequency and its intervalic relation of key-note consonance; which provides improved means for the tuning of musical bars, wherein the bar may be altered mechanically to change its composite musical tone to a desired degree; and in which an improved supporting arrangement is provided for vibrant bars, whereby the tones in the different registers of a musical instrument utilizing such bars, may be made to predominate.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A percussion musical instrument bar shaped to provide sections of substantially uniform diameter spaced apart longitudinally of the bar, and sections interconnecting the first sections having surfaces undulated in a direction longitudinally of the bar, said latter sections being of different lengths and depths.

2. In an elongate round vibrant bar of initially uniform character having a fundamental and a plurality of partial tones initially in discordant relation, rugosities provided in the bar of such depths and widths as to bring the fundamental and partial tones of the bar into concordance.

3. The method of tuning a round vibrant bar of initially uniform cross section from end-to-end which comprises varying the cross-section of the bar at spaced intervals along its length to relatively change the pitches of the fundamental and partial tones of the bar and bring them into concordance.

4. The method of tuning an elongate musical bar having a fundamental node substantially at its center and a plurality of accompanying partial tones in non-concordant relation, which comprises varying the bar surface on either side of its center to tune the fundamental tone to a desired pitch and tune the partials with respect to each other and to the resulting pitch of the fundamental.

5. In a musical instrument having a plurality of vibrant bars defining upper and lower registers, and supports for said bars, the supports in the upper register being positioned with respect to their associated bars to have points of engagement substantially at the nodal points of the fundamental key tones of the bars, and the supports in the lower register having points of engagement with their associated bars substantially at node points of the partial tones.

6. A solid vibrant musical bar having an internal end recess extending axially into the bar end to form a resonator tuned to the key tone of the bar.

7. A solid vibrant musical bar having an internal end recess extending axially into the bar end to form a tuned resonator, and means for suspending said bar at a point adjacent said recess.

8. The method of changing the frequency of key note and partial notes of a cylindrical bell including the 5th and 8th harmonics and the hum and subhum partials thereof to tune the same to the key tone which includes providing formations on the peripheral surface of the cylindrical bell at predetermined points therealong having a different diameter than the initial diameter of the bell and then further altering the dimensions of the peripheral surface of the cylindrical bell at predetermined portions therealong to bring the partials into exact tune with the key tone of the bell.

9. The method of lowering the partial tones of a cylindrical vibrant bar including the 5th and 8th harmonics and the hum and subhum partials thereof to tune the same to the key tone of the bar which includes forming a relatively broad shallow groove in the peripheral surface of the vibrant bar at predetermined points therealong, including certain predetermined antinodal points of the key tone and the 8th harmonic, and then further removing metal at points in proximity to the antinodal points of the key tone and partials which are furthest out of tune to bring the partials into exact tune with the key tone.

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