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L. KENT ET AL

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VIBRATING BAR TYPE MUSICAL INSTRUMENT HAVING STRIKERS

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2 Sheets-Sheet 1

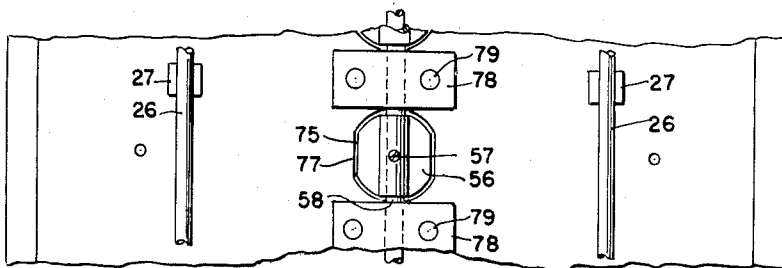
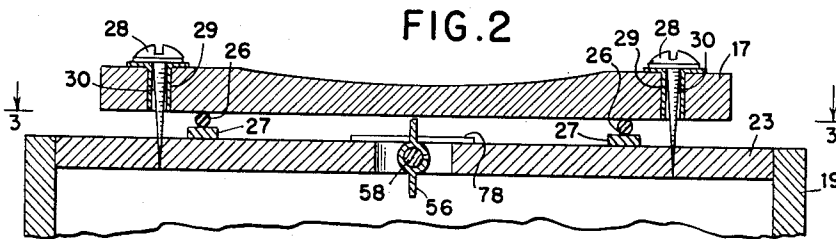
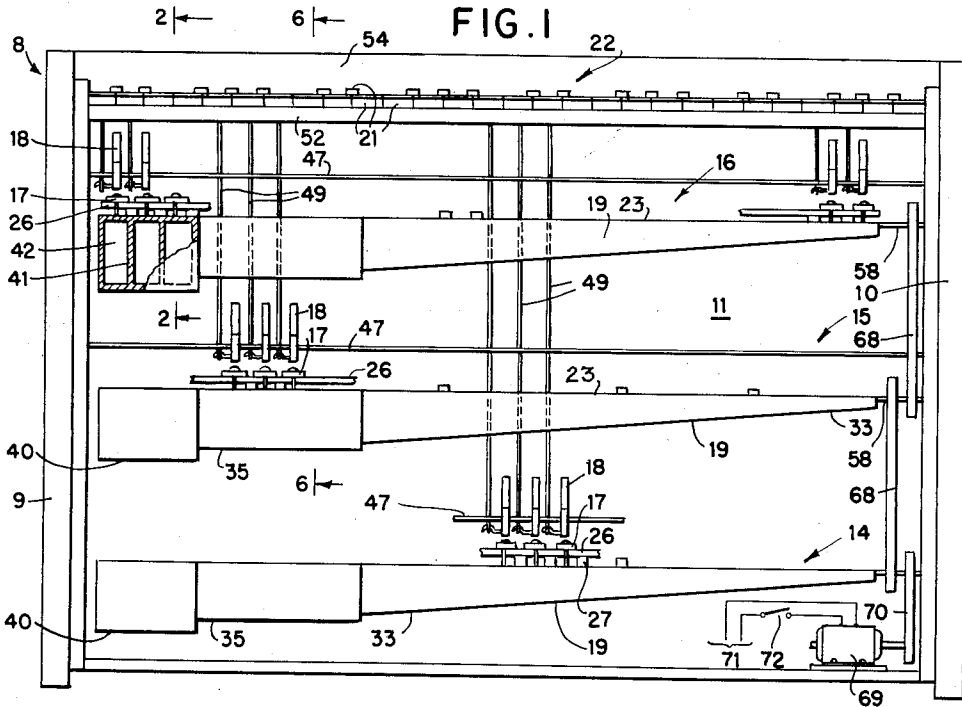


FIG. 3

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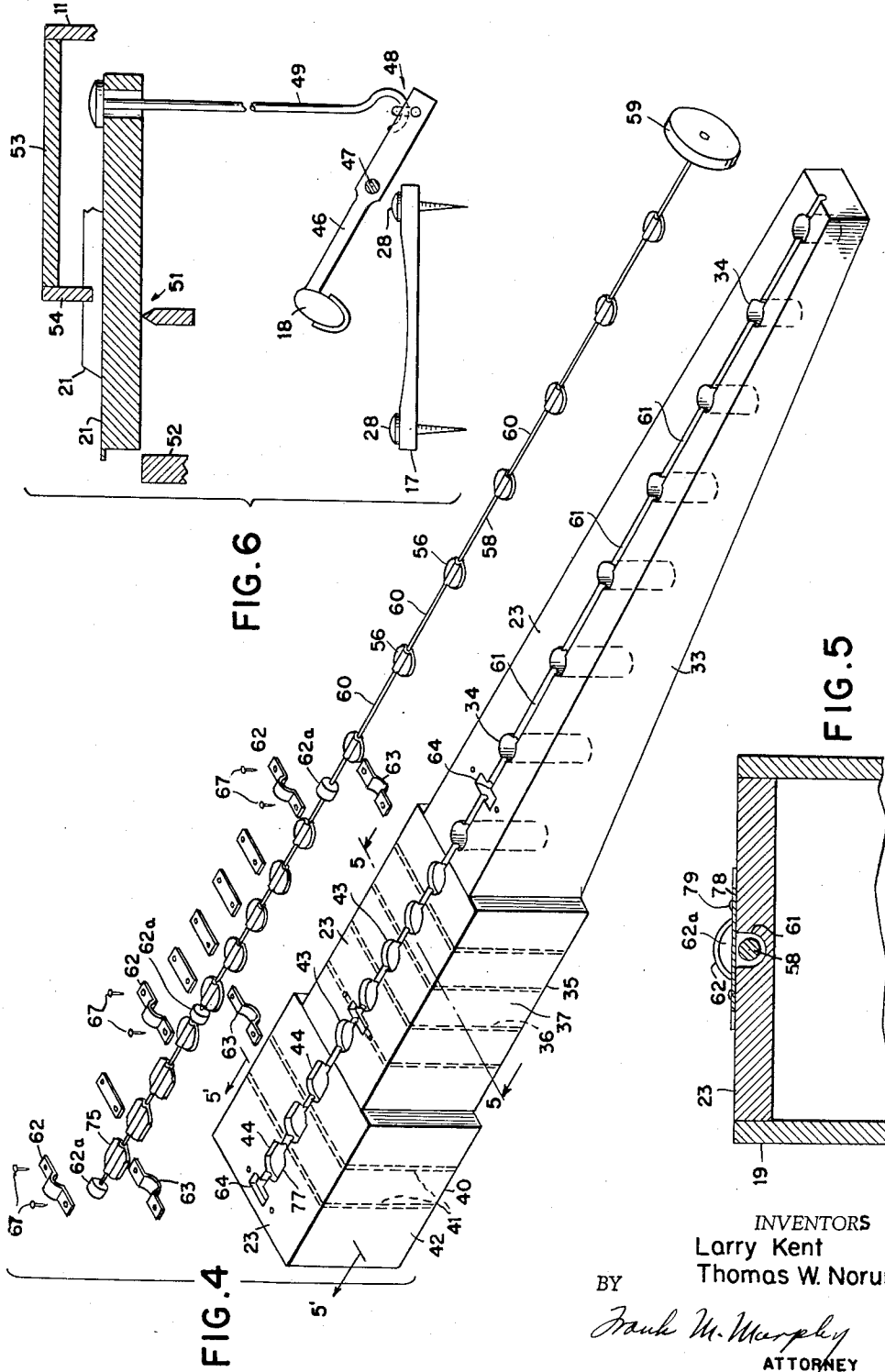
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VIBRATING BAR TYPE MUSICAL INSTRUMENT HAVING STRIKERS

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This invention relates to musical instruments of the type formed essentially by a series of bars having frequencies of a musical scale, means for striking the bars to institute vibration, and resonators coupled to the bars to improve the sound output of the instrument. More particularly, the invention relates to instruments of this type having, in addition to the elements mentioned, rotating closure plates, or air beating fan blades as they are sometimes called, associated with the resonators and serving to produce rhythmic pulsations giving a pleasing vibrato effect.

The vibraharp is an instrument of the type to which the invention particularly relates and which is highly popular when included among the instruments of a small social dance orchestra. One of us has found, however, that it is difficult, and indeed possibly inadvisable, to include a vibraharp among the pieces of a small social dance band as musicians skilled in playing this instrument are few, and hence the possibility of replacement of a vibraharp musician, when this becomes necessary, is uncertain. We have found, surprisingly, that a celesta, modified to include rotating closure plates for the resonators, can advantageously be used in place of a vibraharp by a small orchestra provided that certain precautions are observed in respect to the manner in which the closure plates are installed. These precautions are set forth in detail hereinafter.

The celesta is formed essentially by a series of bars, means for striking the bars and resonators coupled to the bars. It is characterized in that the striking means are individual hammers mounted over the bars and linked to keys of a keyboard. Hence, the celesta can be played by any musician skilled in playing the piano, and therefore musicians able to play the instrument are readily available. A further advantage of a celesta is its compactness. The sound producing elements are arranged in overlying tiers so that no single dimension is so large as to make the instrument cumbersome. For example, the instrument is of such size and weight that it can be conveniently handled by two men, and can be transported in a station wagon.

The celesta as such is a symphonic instrument adapted to produce upper register notes. The quality of the sound produced is ethereal, and hence it is well suited to depict fairy dances. Thus, it was used by Tchaikovsky to depict the dance of the Sugarplums in his Nutcracker Suite. The fundamental frequency range of the instrument is four octaves, from C4 to C8. The modified celesta of the invention produces a sound significantly different from that of the celesta. The sound simulates

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that of vibraharp though it is of somewhat higher pitch than the vibraharp. If desired, the fundamental frequency range of the modified celesta can be changed so that the lowest note is in the range of C4 to F3 and thereby the sound of a vibraharp can be more closely simulated.

The invention will now be described with reference to the accompanying drawings wherein an embodiment of the invention is set forth. In the drawings:

Fig. 1 is a front elevation view of a modified celesta according to the invention, the front cover having been removed so that the elements of the instrument can be seen;

Fig. 2 is an enlarged cross-section taken along line 2-2 of Fig. 1;

Fig. 3 is a cross-section taken along line 3-3 in Fig. 2 with the closure plate rotated 90° from the positions shown in Fig. 2;

Fig. 4 is an exploded perspective view of a resonator chamber included in the instrument shown in Fig. 1;

Fig. 5 is a cross-sectional view taken along line 5-5 or line 5'-5' in Fig. 4; and

Fig. 6 is an enlargement view taken along line 6-6 in Fig. 1 and representing schematically the linkage between the hammers and keys of the keyboard.

Referring to the drawings, the instrument of the invention includes an outer case 8 having sidewalls 9 and 10 and back wall 11. Within the outer case 8, there are disposed three tiers 14, 15 and 16 of sets of sounding elements, each set including a bar 17, adapted to produce a note of a musical scale, a hammer 18 for striking the bar, and resonator chamber 19 for improving the sound output of the bar. The hammers 18 are operatively connected with manually operable keys 21 of keyboard 22 and the instrument is played by manipulation of the keys in a manner generally similar to that in which a piano is played. The instrument covers four octaves from C4 to C8 and the sounding elements are arranged within the case so that the elements for producing each note are approximately aligned with the key on the keyboard for the note.

In each tier of sounding elements, the resonator chamber 19 is disposed adjacent the bars 17 and is closely spaced therefrom with the upper wall 23 (Fig. 4) of the resonator chamber confronting the bars. The bars are mounted for transverse vibration on cords 26 which extend longitudinally over the resonator chamber and are supported above the resonator chamber by blocks 27 positioned at spaced intervals along the upper wall 23 of the chamber. The bars are loosely held in place by screws 28 which extend through holes 29 disposed adjacent the ends of the bars and are threaded into the upper wall 23 of the resonator chamber. Sleeves 30 formed of resilient material are disposed in the holes 29 and serve to isolate the bars from the screws.

Each resonator chamber includes a tapered section 33 in which there are bottomed holes 34 (Fig. 4) extending downward from chamber upper wall 23 and serving as resonators for high notes, a middle hollow rectangular section 35 provided with transverse partitions 36 serving to divide the section into resonator boxes 37 which serve as resonators for the intermediate notes, and an end hollow rectangular section 40 provided with transverse partitions 41 serving to divide the end section into resonator

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boxes 42 which serve as resonators for the low notes. Each resonator box 37 is provided with an opening 43 which extends through the upper wall 23 of the resonator chamber, and each resonator box 42 is similarly provided with an opening 44 which likewise extends through the upper wall 23. Each of the openings 43 and 44 is spaced from each next adjacent openings as can be seen in Fig. 4, and as can be seen in Fig. 2, is aligned with a bar 17 so that suitable coupling between bars and resonator boxes is obtained.

The hammers 18 provided for striking the bars 17 are each mounted on a lever arm 46 (Fig. 6) which is pivoted on pivot rod 47 and mechanically linked at its input end 48 with key 21 by connecting rod 49. In a manner well known in the art key 21 is pivotally mounted as is indicated at 51 and thus the hammer 18 can be actuated causing it to strike the bar 17 by manipulation of the key. Cross bar 52 serves as a frame for the instrument front cover (not shown) and top plate 53 together with its depending portion 54 serve to protect the linkage elements.

According to the invention, openings to the resonator chamber are provided with closure plates 56 and means are provided for continuously rotating the closure plates so that the openings are alternatively opened and closed and the desired sound effect is produced. As is shown in the drawings, closure plates 56 for each tier of sounding elements are fixedly secured by set screws 57 (Fig. 3) at spaced intervals along a rotatable shaft 58 which extends longitudinally of the resonator chamber with the portions 60 of the shaft intermediate next adjacent closure plates positioned in grooves 61 disposed in the upper wall 23 of the chamber and extending from each opening to the next adjacent opening. A pulley 59 for driving the shaft is mounted on one end thereof and bearings 62a are disposed at spaced intervals therealong and at the end thereof opposite the pulley end. Bearing journal boxes formed by upper bearing caps 62 and lower bearing caps 63 fit into recesses 64 disposed at appropriate positions along the upper wall 23. Screws 67 serve to secure the journal boxes in place.

The pulleys 59 of the shafts 58 of the various tiers are interconnected by drive belts 68 and an electric motor 69 is connected by belt 70 with one of the drive shafts 58 and serves to rotate the shafts and hence the closure plates. A suitable rotation rate for the closure plates is about 180 r.p.m. and advantageously this rate is selectively variable between 150 and 200 r.p.m. The motor 69 is energized from power lines 71 provided with switch 72. A feature of the instrument of the invention is that it can be played with the switch open, in which case it operates as a celesta, or with the switch closed, in which case the desired vibrato effect is realized.

The size of the openings to the resonator boxes 36 and 42 of each resonance chamber advantageously increases as the lower end of the scale is approached and since it is desirable, in order to obtain satisfactory coupling, to proximately position the bars 17 and the resonance chamber 19, it is advantageous to form the closure plates 56 for the openings 44 of the end rectangular section 40 of the resonance chamber, so that a peripheral portion 75 (Fig. 3) of closure plates 56 is parallel to the axis of rotation of the plates. This permits more closely positioning the bars 17 to the resonance chamber than would be possible if the closure plates were circular. Thus, as can be seen in Fig. 2, notwithstanding proximate positioning of the bars 17 and closure plates for openings 44, the closure plates clear the bars during rotation.

We have discovered that in order to obtain satisfactory sound production from resonator boxes provided with closure plates having axially parallel peripheral portions 75, it is necessary that the periphery 77 of each resonator box opening 44 conform to the periphery of the closure plate positioned therein, as can be best seen in Fig. 3, and also that the periphery 77 of each of the openings be closely spaced from its closure plate when the closure plate

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is in the closed position. A clearance between closure plate and opening of not more than about $\frac{1}{16}$ " is satisfactory. We have also discovered that in order to obtain satisfactory sound production it is necessary to close the grooves 61 intermediate each next adjacent opening to resonator boxes 37 and 42. Appropriately, the grooves are closed by placing covers 78 thereover and securing them in place with brads 79. Advantageously, the covers 78 extend the entire length of the grooves. If desired, the passageways 10 for the shafts 58 intermediate resonator box openings can be made by drilling a hole through the upper wall 23 of the resonator chamber between next adjacent openings. This may not be convenient however, and we have found that the use of covers 78 as indicated in the drawings is satisfactory.

Having now described our invention, what is claimed is:

1. A musical instrument comprising bars mounted for transverse vibration, a hammer mounted adjacent each of said bars, and a manually operable key operatively connected with each said hammer whereby said bars can be struck with the hammers by actuating the keys, a resonator chamber disposed adjacent said bars closely spaced therefrom with a wall thereof confronting said bars, transverse partitions disposed in said chamber providing a resonator box for each bar, means defining an opening in said wall to each said resonator box, each said opening being spaced from the next adjacent openings and aligned with the bar of its resonator box, a shaft which is mounted for rotation and extends longitudinally of the resonator chamber and across the openings, a closure plate disposed in each said opening, the closure plates being mounted in spaced relationship on said shaft, each said closure plate having a portion of the periphery thereof on each side of its axis of rotation parallel to said axis, the periphery of each opening conforming to the periphery of its closure plate and being closely spaced therefrom when its closure plate is in the closed position, means defining a groove in said wall extending from each opening to a next adjacent opening each said groove being adapted to receive and having positioned therein the portion of said shaft intermediate the closure plates positioned in the openings joined by the groove, a cover plate over each said groove, and means for continuously rotating said closure plates whereby each said opening is alternatively open and closed.

2. A musical instrument according to claim 1 and including a lever arm for each of the hammers, the hammer of each lever arm being mounted on one end of the arm, and mechanical linkage means operatively interconnecting each lever arm with one of the keys.

3. A musical instrument comprising bars mounted for transverse vibration, a resonator chamber spaced from said bars having a wall thereof confronting said bars, transverse partitions disposed in said chamber providing a resonator box for each bar, means defining an opening in said wall to each said resonator box, each said opening being spaced from each next adjacent opening and aligned with the bar of its resonator box, a shaft which is mounted for rotation and extends longitudinally of the resonator chamber and across the openings, a closure plate disposed in each said opening, the closure plates being mounted in spaced relationship on said shaft, means defining a groove in said wall extending from each opening to a next adjacent opening each said groove being adapted to receive and having positioned therein the portion of the shaft intermediate the closure plates positioned in the openings joined by the groove, a cover plate over each said groove, means for continuously rotating said closure plates, whereby each said opening is alternatively open and closed.

4. A musical instrument according to claim 3, the cover plate over each said groove extending the entire length thereof.

5. A musical instrument according to claim 3, each said closure plate having a portion of the periphery thereof on each side of its axis of rotation parallel to said axis, the periphery of each opening conforming to the periph-

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ery of its closure plate and being closely spaced therefrom when its closure plate is in the closed position.

6. A musical instrument according to claim 3, including a hammer for each of said bars and a manually operable key operatively connected with each said hammer whereby said bars can be struck with the hammers by actuating the keys.

7. A musical instrument according to claim 6 and including a lever arm for each of the hammers, the hammer of each lever arm being mounted on one end of the arm, and mechanical linkage means operatively interconnecting each lever arm with one of the keys.

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