Nov. 3, 1964 H. E. W. BODE 3,154,997

REED WITH CURVED TAPER

Filed Oct. 3, 1962

Fig. 1.

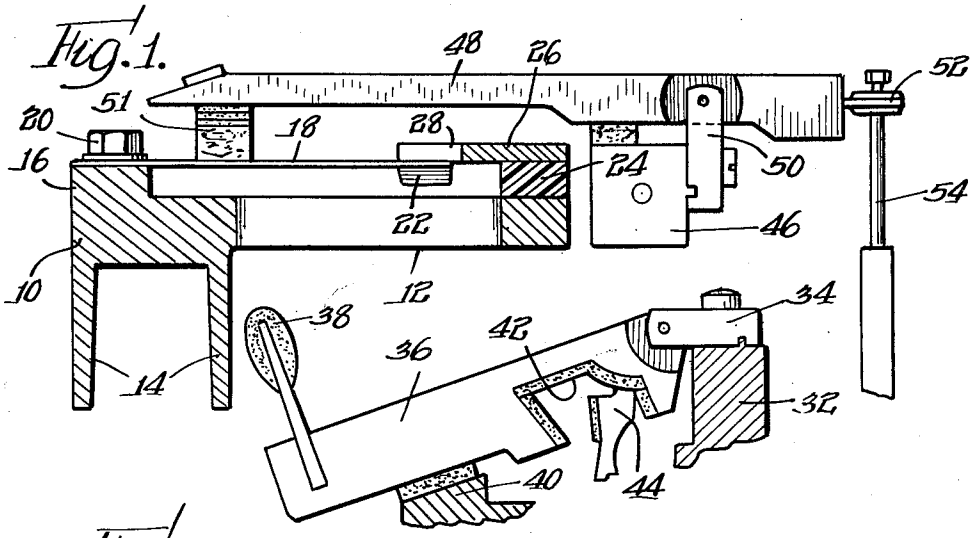


Fig. 2.

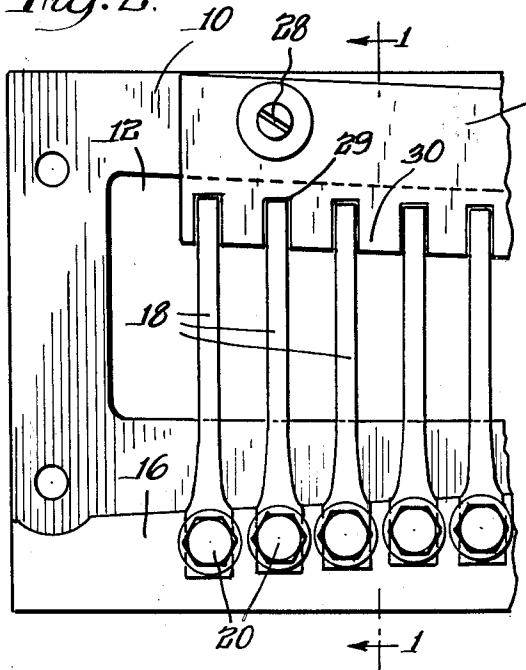


Fig. 5.

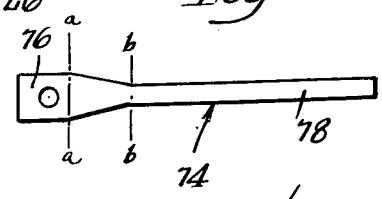


Fig. 4.

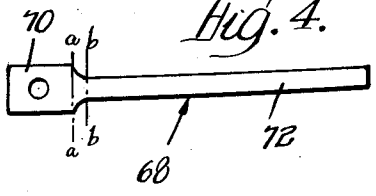
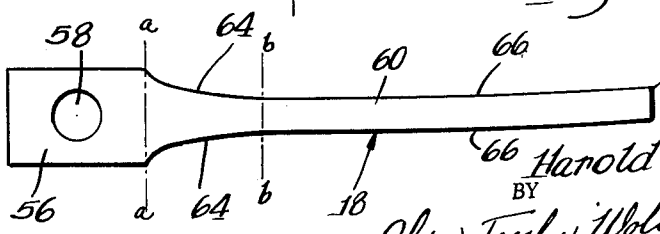


Fig. 3.



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REED WITH CURVED TAPER

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This invention relates to the art of electronic sound generation, and more particularly to a vibratory reed serving as an impulsively actuated electrostatic tone generator.

The use of a vibratory reed in capacitive relation with a pickup as an electrostatic tone generator is well known in the electronic musical art. Such reeds have long been used in wind driven electronic organs, and are generally similar in nature to the reeds which have been used for a great many years in reed organs and in accordions. More recently efforts have been made to utilize similar reeds in an electronic piano. Two difficulties have been encountered here; one in the stresses imposed on the reeds, and another in the inherently different vibrational characteristics of reeds as contrasted to strings.

An impulsively actuated reed is practically instantaneously driven to a large excursion, and thereafter is allowed to vibrate in free, decadent fashion. The shock of the impulse actuation is quite substantial, and both this shock and the initially rather great excursion of the reed tend to break the reed. As a result, the useful life of an impulsively actuated reed is quite substantially less than that of the practically infinite life of a wind driven reed which is not subjected to shock loading, nor to great excursions.

Accordingly, it is an object of this invention to provide an improved reed for use in an electronic piano which will far outlast conventional reeds.

Yet another object of this invention is to provide a reed for use in an electronic piano, which reed has no well-defined breaking point.

As is well known, a vibrating string vibrates essentially with a fundamental and a plurality of harmonics. A reed, on the other hand, vibrates essentially with a fundamental and with a series of inharmonic partials. Thus, a reed piano inherently tends to sound somewhat different from a string piano.

In view of the foregoing, it is yet another object of this invention to provide a vibratory reed for an electronic piano which will produce a remarkably piano-like tone.

Other and further objects and advantages of the present invention will be apparent from the following description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a cross sectional view through a piano action constructed in accordance with the principles of the present invention;

FIG. 2 is a fragmentary plan view of the reed frame;

FIG. 3 is a plan view of a reed on an enlarged scale constructed in accordance with the present invention;

FIG. 4 is a plan view of a prior art reed; and

FIG. 5 is a plan view of another prior art reed.

Referring now in greater particularity to the drawings, and first to FIGS. 1 and 2, there will be seen a reed frame 10 of generally rectangular configuration having a substantially rectangular opening 12 therein. Actually, the reed frame tapers somewhat in depth (front to back) from a maximum at the bass end to a minimum at the treble end, since the treble reeds inherently are of shorter length than are the bass reds. One long side of the frame 10 is provided with depending reinforcing rib means 14, and with an upstanding shelf 16. A plurality of reeds 18 is secured to the top of the shelf 16 by means of a respective plurality of cap screws or bolts 20 extending respectively

through the reeds and threaded into the raised portion or shelf 16 of the reed frame 10. The reeds are made of metal, conveniently steel, although other resilient metals can be used. Each reed at its free end is provided with a weight 22 for tuning, and for emphasizing the fundamental mode of vibration.

The opposite long side of the reed frame 10 has an insulating spacer 24 extending therealong, and a capacitive pickup 26 is secured thereto. The pickup and insulating spacer may be held in place by means such as bolts and washers 28 extending through the pickup and through the insulation and threaded into the reed frame. As will be appreciated, the bolts 28 are electrically insulated from the pickup, as by means of a conventional bushing. The pickup 26 conveniently is of metal, aluminum being a preferred example, and is of generally comb-like configuration comprising a plurality of slots 29 into which the free ends of the reeds 18 extend for vibration. Fingers 30 are defined between the slots 29, and these fingers extend between adjacent reeds. As is shown in FIG. 1, the top of each reed is substantially coplanar with the bottom of the pickup 26. Furthermore, the thickness of the pickup is such that a reed generally does not vibrate above the top of the pickup, while it does vibrate below the pickup through at least 180 degrees of each vibrating cycle.

A rail 32 extends parallel to the frame 10, and is secured thereto through the intermediary of a case (not shown), or by means of suitable brackets (not shown). The rail 32 is provided with a plurality of butt flanges 34 on which is pivotally mounted a like plurality of hammers 36, each having a felt head or impulsing member 38. A padded rest 40 extends beneath the hammers, as shown. Each hammer is provided near the butt thereof with an underlying recess 42, and the upper end of a jack 44 bears within each recess. The jacks are respectively actuated by more or less conventional piano actions (not shown).

Another rail 46 extends parallel to the long dimension of the frame 10 and is disposed close thereto. A plurality of damper release levers 48 is mounted along the rail 46, respectively by means of damper flanges 50. Each damper release lever is provided with a pad 51 of resilient material, such as felt, bearing against a respective reed 18 to damp or inhibit vibration thereof. At the opposite end of each damper lever 48, there is a connection indicated at 52 with a damper release rod 54 suitably connected to the piano action in a manner not shown, whereby each damper pad 51 is lifted from engagement with the corresponding reed 18 before engagement of the corresponding hammer head 38 therewith.

Reference now should be had to FIG. 3 for a detailed understanding of the reed forming the subject matter of this invention. Thus, the reed 18 is provided with a generally rectangular base 56 having an aperture 58 therethrough through which the respective bolt or cap screw 20 extends to clamp the base 56 against the raised portion or shelf 16 of the reed frame 10. The reed further has a tongue 60 extending from the base 56 to a free end 62, beneath which is positioned the weight 22. The tongue is provided with parallel edges throughout the major portion of its length. The remainder of the reed comprises a long tapered portion. Specifically, the tapered sides 64 extend from the line *a—a* at the limit of the base 56 forming an external shoulder therewith, to the line *b—b*. The reed sides or longitudinal edges 66 are parallel from this point to the extremity or free end 62.

No definite limits can be set as to the length of the tapered portion of the reed relative to the portion having parallel sides. It will be observed in the drawing that the taper comprises roughly 25 percent of the reed tongue,

and this may be considered to be typical. The proportion is empirical and is not constant from one reed to another. However, it will be understood that the curved taper (the distance from line *a—a* to line *b—b*) would generally be on the order of 20–35 percent and would never be less than substantially 10 percent and would never be more than substantially 50 percent of the total length of the reed tongue. Typically, the hammer head strikes the reed tongue outwardly of the tapered area.

By extended simulated life tests, it has been found that a reed as shown in FIG. 3, when impulsively excited to oscillations at extreme amplitude (as by striking with the hammer head **38**) eventually will break anywhere in the region bounded by the lines *a—a* and *b—b*.

A supposedly improved prior art reed is indicated at **74** in FIG. 5. This reed has a base **76** joined to a tongue **78** by straight tapered sides between the lines *a—a* and *b—b*. This reed also will break along the line *b—b*. In short, both of the reeds in FIGS. 4 and 5 are subject to fracture at a well-defined location, whereas the reed in FIG. 3, with the long curved taper has no well-defined area of fracture. Hence, by actual test, the reed of FIG. 3 lasts longer by a factor of about four to one than does the reed in FIG. 4 when submitted to impulse excitation.

Furthermore, in about the lowest twenty notes of a piano, the reed shaped as in FIG. 3 has been found to give a substantially better sound than that shaped as in FIG. 4. The reasons for this are not at the present time fully understood. However, it is thought that in the reed of FIG. 3, the fundamental mode of vibration tends to dominate somewhat more over the inharmonic partials than in the usual reed of FIG. 4 with the longer parallel sides.

It might be thought that a reed with straight tapering sides would be desirable as providing no definite fracture line. This would be the same as if the line *b—b* in FIG. 5 were moved all of the way out to the end of the reed, with a uniform straight taper from the line *a—a* to the line *b—b*. However, such a reed is highly undesirable. It provides a very low Q, and this leads to an extremely undesirable ringing time.

Operation of the combination shown in FIGS. 1 and 2 will be obvious to those skilled in the art. A more or less conventional piano key is depressed and acts through a more or less conventional action to raise the jack **44** thereby sending the hammer head **38** up into impulsive engagement with the reed **18**. At the same time, the action has lowered the damper release rod **54** to move the damper pad **51** up out of engagement with the corresponding reed **18**, to allow free vibration thereof. The action, as is usual, holds the damper in retracted position as long as the key is depressed.

An electrostatic field is established between the reeds **18** and the pickup **26** by establishing a direct current potential therebetween. Preferably, the reeds and the reed frame **10** are at ground potential, while the pickup is maintained at an elevated potential through a resistor from a suitable source of direct current potential. Upon vibration of one or more reeds, the capacity between the vibrating reed or reeds and the pickup **26** changes, thereby developing a complex alternating current potential across the resistor. The potential developed across the resistor is suitably amplified and transduced to provide an audible, piano-like sound.

Changes in structure relative to the specific example shown and described herein may well occur to those skilled in the art, and will be understood as forming a part of the invention insofar as they fall within the spirit and scope of the appended claims.

This invention is claimed as follows:

1. A vibratory reed for use as in a musical instrument comprising a base adapted to be secured to a mounting surface, and a flat tongue having lateral and longitudinal dimensions extending freely out from said base, said tongue having a curved inward taper extending out from said base merging into substantially parallel edges, said curved taper comprising a substantial portion of the total length of said tongue and having a length greater than the transverse dimension of said tongue.

2. A vibratory reed for use as in a musical instrument comprising a base adapted to be secured to a mounting surface, and a flat tongue having lateral and longitudinal dimensions extending freely out from said base, said tongue having a curved inward taper extending out from said base merging into substantially parallel edges, said curved taper comprising between substantially 10 and 50 percent of the total length of said tongue and having a length greater than the transverse dimension of said tongue.

3. A vibratory reed for use as in a musical instrument comprising a base adapted to be secured to a mounting surface, and a flat tongue having lateral and longitudinal dimensions extending freely out from said base, said tongue having a curved inward taper extending out from said base merging into substantially parallel edges, said curved taper comprising between substantially 20 and 35 percent of the total length of said tongue and having a length greater than the transverse dimension of said tongue.

4. A vibrating reed arrangement for use as in a musical instrument comprising a fixed mounting base, a reed including a base and a tongue having lateral and longitudinal dimensions extending freely out therefrom, means mounting said reed base on said mounting base, said reed tongue having a curved inward taper extending out from the reed base merging into substantially parallel edges of said tongue, said curved taper comprising a substantial portion of the total length of said tongue and having a length greater than the transverse dimension of said tongue, and a striker member adapted impulsively to engage said reed tongue to set said reed tongue in free, decadent vibration.

5. A vibrating reed arrangement for use as in a musical instrument comprising a fixed mounting base, a reed including a base and a tongue having lateral and longitudinal dimensions extending freely out therefrom, means mounting said reed base on said mounting base, said reed tongue having a curved inward taper extending out from the reed base merging into substantially parallel edges of said tongue, said curved taper comprising a substantial portion of the total length of said tongue and having a length greater than the transverse dimension of said tongue, and a striker member adapted impulsively to engage said reed tongue outwardly of said tapered portion to set said reed tongue in free, decadent vibration.

6. A vibratory reed as set forth in claim 3 wherein the curved taper is a non-circular arcuate curve.

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