July 24, 1956 B. F. MIESSNER 2,755,697

VIBRATORY REED

Filed Feb. 6, 1952

Fig. 1



Fig. 2

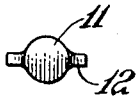


Fig. 4

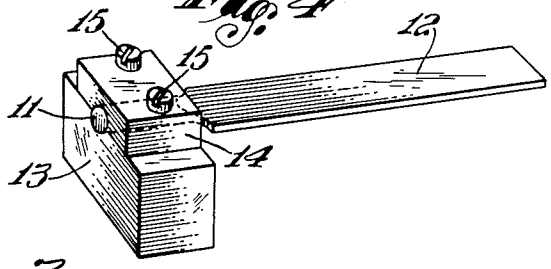


Fig. 3

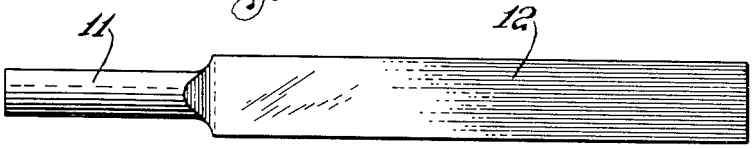


Fig. 5

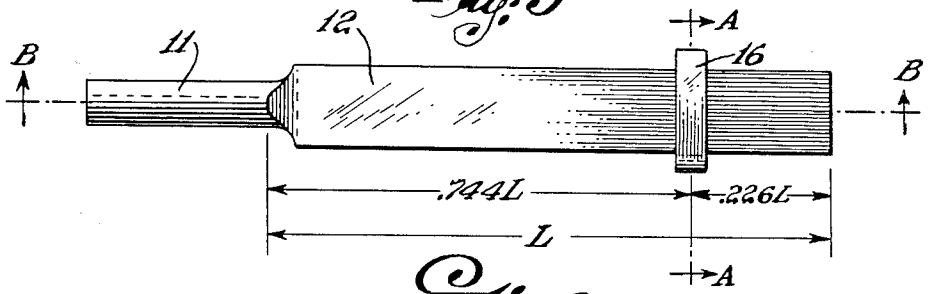


Fig. 6



Fig. 7

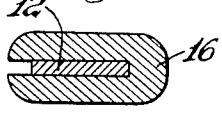


Fig. 8

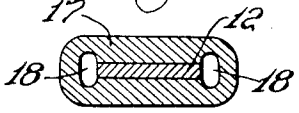
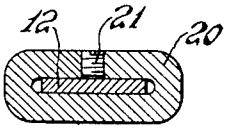


Fig. 9



INVENTOR.

Benjamin F. Miessner

BY

Taylor, Cifelli & Jurick

ATTORNEYS

United States Patent Office 2,755,697 Patented July 24, 1956

2,755,697

VIBRATORY REED

Benjamin F. Miessner, Harding Township, Morris County, N. J., assignor to Miessner Inventions, Inc., Harding Township, Morris County, N. J., a corporation of New Jersey

Application February 6, 1952, Serial No. 270,145

2 Claims. (Cl. 84—402)

This invention relates to reed type vibrators for musical instruments and more particularly to a novel arrangement for tuning such vibrators whereby they are especially suited for use in a particular type of electronic piano.

Vibrators of the general class useful in electronic pianos are disclosed in my copending United States patent application Serial No. 169,714, filed June 22, 1950. The referenced patent application discloses the general theory of such vibrators and a tuning thereof by damper-loading means which lower the relative frequencies of the second and third vibration partials relative to the fundamental vibration.

The present invention is directed to methods and means for lowering the frequency of the fundamental (partial I) relative to that of partial II in such a manner as to leave partial II substantially unchanged in frequency or, alternatively, to raise the frequency of partial II at the same time. In either case these novel tuning methods increase very materially the separation of these two frequencies (as distinguished from my prior disclosure) whereby the normal ratio of 6.27 between the vibration partials II and I is increased significantly.

My new method of adjusting the relative vibration frequencies of partials I and II is useful principally in the lower pitch registers of reeds designed for use with my electronic reed piano, as described in my above-referenced patent application, since it reduces the overall length of such reeds when they are of uniform thickness or cross-sectional area from the fixed to the free ends. It is not considered useful for the upper pitch registers as the maintenance of a uniform cross-sectional area in such reeds tends toward impractically short lengths, and a tapered cross-sectional area must be resorted to in order to obtain high pitches without undue shortness.

An important result of my invention, in addition to mere shortening of the lower pitch reeds, is the very considerable increase in separation of the frequency of the vibration partial II with respect to partial I and the corresponding diminution of the amplitude of partial II with respect to that of partial I. As disclosed in my above-cited copending application, a Fourier series of integrally-related partials is produced from the partial I of the reed by the electronic translating system. In view of this, and since the vibration amplitudes fall off rather rapidly with the higher numbered partials, it is advantageous to have partial II of the reed correspond exactly, or very nearly exactly, to a relatively high numbered partial of the Fourier series generated by the translating system such as, for example, the 10th, 15th, or higher such partial.

Furthermore, my loading method provides for adjustment of the reed's partial II to exactly the same frequency as a higher-numbered partial of the translator-generated Fourier series, in which case it will be harmonious therewith and will produce no discordant or otherwise objectionable beats. Alternatively, the second partial may be tuned to dissonance with specific, higher-numbered Fourier series partials in which case it will supply elements of piano tones as produced by conventional string vibrators, namely, the relatively high pitched ringing tone caused by the longitudinal, molecular vibration in the string. Such molecular vibration of the string is normally 10 to 20 times the fundamental frequency of the strings lateral vibration and, normally, is dissonant with that lateral vibration and of relatively low amplitude.

In carrying out my invention, I apply the vibrator loading device exactly at, or very close to, the nodal point for vibration partial II, which point, for a flat vibratory reed, is at a point 0.774L from the fixed end of the reed, where L is the actual vibratory length of the reed. When the loading, or tuning, means is thus applied and such means has a minimum contact with the reed in the reed's axial direction, the load will not materially alter the normal stiffness of the reed at such contact point. From a practical standpoint the load must be anchored securely to the reed as by a spring gripping action, or by a set screw. or by soldering, welding, or the like.

An object of this invention is the provision of a novel method and means for tuning a musical vibrator to materially increase the frequency separation between the first and second vibration partials.

An object of this invention is the provision of means for tuning a vibratory reed, to be used in an electronic musical instrument, whereby the vibration ratio between the second partial and the fundamental is increased significantly above the normal value of 6.27.

An object of this invention is the provision of a simple method for lowering the fundamental vibration frequency of a vibratory reed without materially altering the vibration frequency of the second vibration partial.

An object of this invention is the provision of vibratory reed having a fixed end and a vibratory portion, and a load secured to opposed surfaces of the vibratory portion of the reed, said load contacting the reed at the nodal point for the second vibration partial and lying in a plane normal to that of such vibratory portion of the reed.

An object of this invention is the provision of a vibrator having a predetermined ratio between the vibration frequencies of partial II and partial I, said vibrator comprising a fixed end and a vibratory portion, and a load disposed transversely with respect to the said vibratory portion and engaging the opposed surfaces thereof, said load having a mass approximating or exceeding that of the vibratory portion of the reed.

These and other objects and advantages will be apparent from the following description when taken with the accompanying drawings illustrating several embodiments of the invention. The drawings are for purposes of illustration and are not to be construed as defining the scope or limits of the invention, reference being had for the latter purpose to the appended claims.

In the drawings, wherein like reference characters denote like parts in the several views:

Figure 1 is a side view of a vibratory reed of the type to which my invention may be applied;

Figure 2 is an end view showing the normally-fixed end of the reed;

Figure 3 is a top plan view of the reed;

Figure 4 is an isometric view of the reed clamped in operative position on a mounting block;

Figure 5 is similar to Figure 3 but shows my vibration tuner applied to the reed;

Figure 6 is a longitudinal, cross-sectional view taken along the line B—B of Figure 5;

Figure 7 is a transverse, cross-sectional view taken along the line A—A of Figure 5 and drawn to an enlarged scale;

Figure 8 is a sectional view similar to Figure 7 but showing a modification of the vibration tuner; and

Figure 9 is a sectional view similar to Figure 7 but showing another modification of the vibration tuner.

Referring now to Figures 1–3, there is shown a vibratory reed having a solid, round attachment end **11** and a vibratory section **12**. As is well known, the reed can be made from round wire stock, of suitable material and having a suitable diameter, the vibratory section being formed by a flattening operation in a hydraulic press to a predetermined thickness. The vibratory section may then, if desired, be processed in a grinder to provide straight edges, a square end and a uniform thickness. I prefer to use annealed, Swedish iron base, high carbon, music wire for the reed material and to harden and temper the reed after the forming operations have been completed. A finally tempered hardness in the range of 40 to 60 Rockwell-C has been found satisfactory. A reed so formed has low internal hysteresis and is satisfactory as to low damping characteristics. As shown in Figure 4, such a reed can be clamped securely at the round end **11** that is disposed in aligned, arcuate notches in a mounting block **13** and a plate **14** joined together by the screws **15**. The mounting end of the reed may take other appropriate forms, some of which are shown in my above-mentioned copending application.

Figures 5–7 illustrate a load member attached to the reed in accordance with this invention. Such member **16** may comprise a generally C-shaped piece of hard metal spring material with the ends normally spaced apart a distance less than the thickness of the associated reed to provide a gripping action against the opposed reed surfaces when the load is in position. The gripping force provided by such construction is sufficient to retain the member in place; yet the member may still forcibly be moved along the reed, longitudinally, in the original factory adjustment. In practice, the mass of the load will depend upon the particular reed to be used therewith. As the load is increased in mass, it being only about two-tenths the reed length from its free end, will lower the frequency of partial I of the reed with at first but little effect on the frequency of partial II. However, as the mass of the load is increased to values measured, for example, in terms of many times the mass of the reed's vibratory section, the frequency of the reed vibration partial II will rise as the frequency of partial I is lowered. This is due to the fact that the load begins to act like a more and more massive support (or a tying-down of the reed) at the loading point. For example, if the mass of the load were to be increased to a degree where it is equal to that of the fixed-end support of the reed, it would cause the reed to act like a fixed-fixed vibrator with the free end (0.226 times the original reed length) still coupled to it. No such massive loading is here contemplated, it merely being desired to lower the frequency of partial I and to increase that of partial II so that the ratio of these two partials is of the order of 10 to 20, and so that the partial II may be made consonant or dissonant with partial I. More specifically, I desire to make partial II purposely consonant or dissonant with the higher numbered partials of the Fourier series as generated by my electronic translating system described in my abovementioned copending application Serial No. 169,714.

A typical, tempered-steel reed of this type, having a length of 2⅜ inches, a thickness of 0.032 inch and a width of ⅛ inch, has a partial I vibration frequency of 174 cycles per second, a partial II vibration frequency of 1090 C. P. S. and a partial III vibration frequency of 3060 C. P. S., without loading. When a loading device, as above described, is attached to the reed at the nodal point for the vibration partial II (that is, at point 0.536 inch in from the free end) and such loading device has a weight approximately twice that of the reeds vibratory portion, the vibration frequency of partial I is lowered from 174 C. P. S. to 84.5 C. P. S.; the frequency of partial II is lowered from 1090 to 990 C. P. S., and that

of partial III is lowered from 3060 to 2500 C. P. S. Attention is directed to the significant separation between partials II and I by the application of the load device; specifically the ratio has been increased from

$$\frac{1090}{174}=6.27 \text{ to } \frac{990}{84.5}=11.7$$

By applying a load device of proper weight the frequency ratio between the reed vibration partials II and I can be established at a desired value and such ratio can be such that the vibration frequencies of these partials are musically consonant.

In order not to alter significantly the flexure and damping characteristic of the reed by the addition of the load member, such member should contact the reed surface a minimum amount in the longitudinal direction of the reed. This is accomplished by rounding the inner edges of the load member **16** at the point of contact with the reed, as shown in Figure 6.

While a gripping type load device, as shown in Figures 5–7, is satisfactory for most reeds, it may be well to provide additional anchoring means especially for reeds having very low fundamental vibration frequencies. This, of course, can be achieved by soldering or welding the load member directly to the reed.

A modification of the load member is shown in Figure 8 which is a transverse, sectional view similar to Figure 7. Here the load member **17** comprises a substantially flat plate provided with apertures **18** that are connected by a slot having a width that is 1 or 2 thousandths of an inch less than the thickness of the reed **12**. The member can be forced over the end of the reed and will remain in place by friction. One advantage of this particular construction is the fact that the load is balanced about the reed's axis and, therefore, will not alter the normal vibration plane of the reed.

An alternative construction for this purpose is illustrated in Figure 9 wherein the loading member **20** is secured to the reed by the set screw **21**. In this case, one side of the load member is of sufficient thickness to accommodate the set screw whereas the other side is rounded to reduce the mutual contact area between the load and the reed, as has been explained with reference to Figure 6.

Those skilled in this art will understand that a series, or scale of reeds for the lower few octaves of a piano will include reeds of progressively-varying length and load mass. Additionally, such scale of reeds may also employ reeds of variable thickness, all to the end that the necessary vibration frequencies are provided for.

So far as I am aware it is new in this art to provide a fixed-free vibratory reed so loaded as to separate the partials I and II, in frequency, so that the vibration ratio of

$$\frac{\text{partial II}}{\text{partial I}}$$

is greater than 6.27, the normal value.

Having now described my invention in detail in accordance with the patent statutes, various changes and modifications will suggest themselves to those skilled in this art, and it is intended that such changes and modifications shall fall within the spirit and scope of the invention as recited in the following claims.

I claim:

1. In combination with a vibratory reed of substantially rectangular cross-section, a loading member secured to the reed and comprising a plate provided with a pair of spaced apertures and a slot extending from one to the other of said apertures, said slot conforming to the cross-section of and being traversed by the reed.

2. A vibrator arrangement for an electronic musical instrument of the piano type, comprising a fixed-free vibratory reed whose free vibrations include first and second partials of which the frequency ratio of the second to the

first is normally non-integral, and means for changing said ratio to a greater and integral one comprising supplementary mass secure with respect to and vibratable with the reed and localized substantially wholly at the nodal point of the second-partial vibration of the reed, said supplementary mass comprising a plate provided with a pair of spaced apertures and a slot extending from one to the other of said apertures, said slot corresponding to the cross-section of the reed.

References Cited in the file of this patent

UNITED STATES PATENTS

756,952	Gale	Apr. 12, 1904
1,269,511	Roberge	June 11, 1918
1,545,251	Gent	July 7, 1925
2,413,062	Miessner	Dec. 24, 1946
2,581,963	Langloys	Jan. 8, 1952
2,599,135	Seybold	June 3, 1952