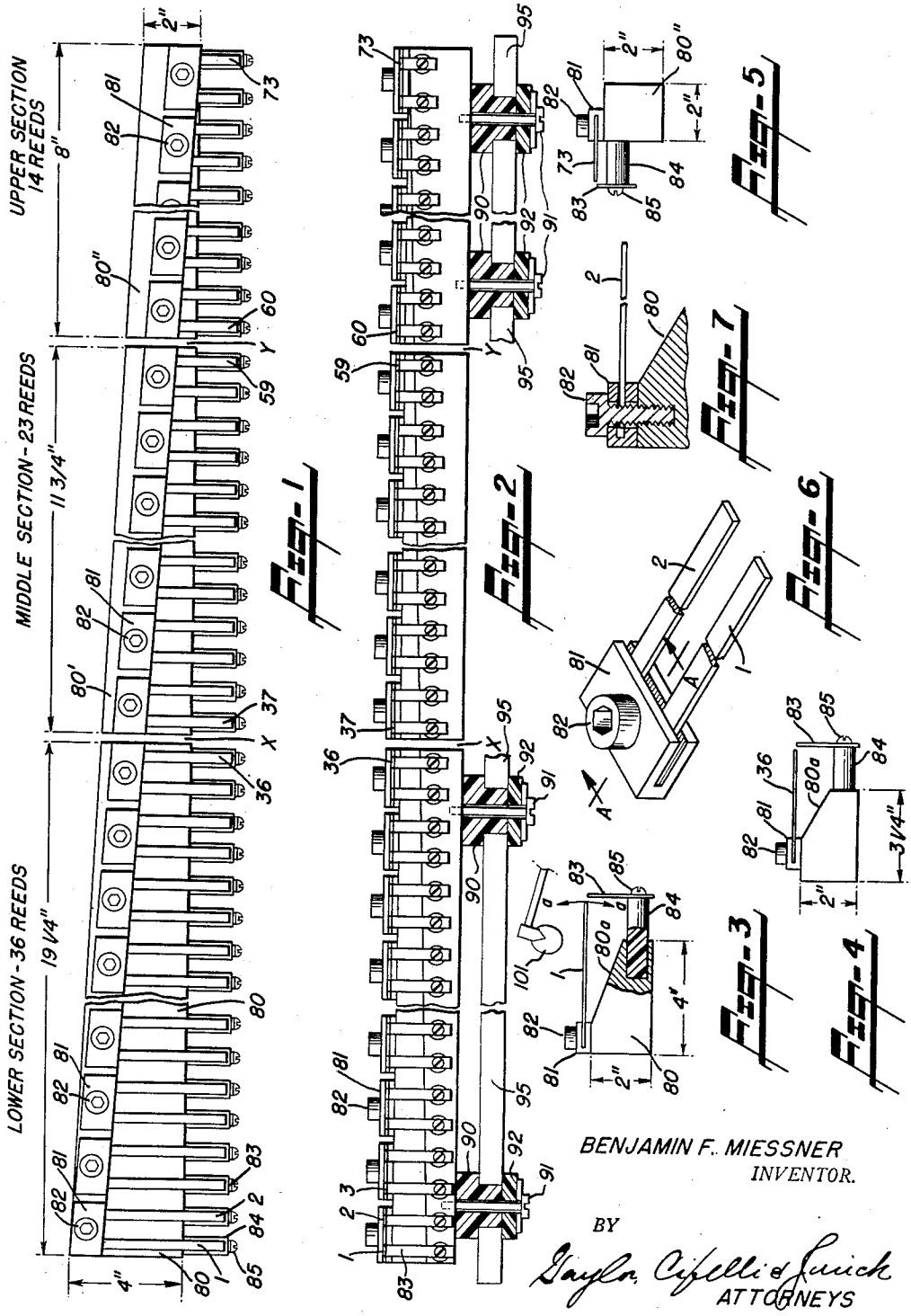
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MOUNTING ARRANGEMENT FOR VIBRATORY REEDS

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MOUNTING ARRANGEMENT FOR VIBRATORY REEDS

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This invention relates to electrical musical instruments and more particularly to a novel vibrator mounting base for instruments utilizing fixed-free vibratory reeds as tone-generators.

In electronic musical instruments employing vibratory reed tone-generators there exists the very real problem of preventing resonant absorption of the vibrational energy of certain specific reeds and minimizing absorption of such reed energy brought about by forced vibrations of the reed base, which vibrations are transmitted to the base by the reeds. In my copending United State patent application Serial No. 255,383, filed November 8, 1951, I discuss the problems involved and disclose a solution based upon the provision of a mounting base of such stiffness and structural shape that the lowest frequency of lateral and/or torsional vibrations of the base is well above that of the highest pitched, tone-generating reed. This solution, however, requires a rather massive base construction.

The present invention is directed to a more practicable solution of this general problem particularly with respect to a most significant and, in fact, tremendous reduction in the mass of the mounting base while, at the same time, eliminating the undesirably high damping rates of certain reeds brought about by frequency-selective absorption and dissipation of the reed's vibratory energy by the mounting base. I accomplish this by dividing the reed base into separate, isolated sections, each section having a lateral vibration frequency that is amply above the vibration frequency of the highest pitched reed carried by the particular base section. In a musical instrument having a pitch compass of 73 notes, from C=65.4 cycles per second to C=4,186 cycles per second, three such separate base sections are sufficient to achieve the desired results.

An object of this invention is the provision of a novel reed-mounting base for an electronic musical instrument and which base is of small size and minimum weight.

An object of this invention is the provision of a novel reed-mounting base made in a plurality of isolated sections, each section having a lowest lateral vibration frequency higher than the fundamental vibration frequency of the highest pitched reed associated with such base section.

An object of this invention is the provision of a mounting base for an electronic musical instrument employing vibratory reeds as the tone-generators said base having a flat bottom surface which gradually decreases in width from one end of the base to the other, a vertically-extending rear surface of substantially constant height throughout the length of the base, a flat top surface parallel to the said bottom surface said top surface having a gradually-varying width which has a minimum dimension at that end of the base which has a maximum bottom surface width, a front vertically-extending surface of gradually-varying height having a minimum dimension at that end of the base which has the maximum bottom surface

width, and a flat sloping surface joining the said flat top surface and the said front surface.

An object of this invention is the provision of an assembly for an electronic musical instrument said assembly comprising a plurality of separate, spaced base sections, a plurality of tuned reeds secured to the top of each base section and a plurality of conducting pick-ups carried by each base section, said pick-ups being capacitively coupled to the reeds.

These and other objects and advantages will become apparent from the following description when taken with the accompanying drawings. It will be understood 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 top view of a mounting base, tuned reed and pick-up assembly made in accordance with my invention;

Figure 2 is a front view of such assembly;

Figure 3 is an end view of the left-hand end of the lower section of the assembly;

Figure 4 is an end view of the right-hand end of the lower section of the assembly;

Figure 5 is an end view of the right-hand end of the upper section of the assembly;

Figure 6 is an isometric view, drawn to an enlarged scale, showing the dual reed-clamping lug; and

Figure 7 is a sectional view taken along the line A—A of Figure 6.

In stringed instruments, the output tone consists of many very nearly integrally related partial frequencies all of which are present in the string acting as a tone-generator which vibrates the sound board. However, in reed type tone-generators, which I employ for the production of complex output tones, the desired vibration partials above the fundamental (partial I) are produced by means of non-linear translating devices. If the reed vibrations are unduly damped, as by resonant vibrations of the supporting base, and which resonant vibrations are induced by the reeds, then all of the components of the output tones will also be unduly damped, that is, of short duration, after impulsive excitation. I have found that the mounting base does cause such selective reed-energy absorption. If one or more reeds, mounted on the base, have partial I vibration frequencies equal to, or very nearly equal to, the partial vibration frequency of the base, these reeds will have damping rates higher than those of other reeds (which are not so affected) with the net result that their output tones are impaired or ruined.

The above-mentioned tone ruination does not occur in instruments employing strings as the tone-generators or at least to no noticeable degree. The reason for this lies in the fact that if one or a few of the strings have their damping rates, for one or more of their partials, increased by resonant-dissipation elements of the string frame (or other attached parts of, say, a piano) such reasonantly vibrating elements will produce output tones at least with a fair degree of efficiency, since all such elements have sizable areas of air contact. Even if this resonant dissipation of one or a few string partials of one or more strings produced no appreciable direct sound there always remain numerous other partials of the string to produce the output tone, the total output tone energy being divided more or less equally among these many partials. Additionally, since these partial components of string tones are exactly, or very nearly, integrally related with one another in frequency, summation and difference tone components are generated in the listener's ear by the remaining output

tone partials, and their frequencies are those of all the partials of the string tone series. Thus, such missing, physical partials are restored subjectively in the ear and their actual absence or rapid damping in the string itself go unnoticed.

Reference is now made to Figures 1, 2, 3 and 5 which are top, front, left end and right end views, respectively, of a three-part mounting base made in accordance with this invention and including a plurality of tuned reeds and associated pick-ups. The illustrated assembly is designed for an instrument having 73 notes and each of the vibratory reeds 1, 2–73 is tuned to a specific note frequency. These reeds are secured to the top surface of the mounting base sections, in pairs, by means of dual reed-clamping lugs 81 and bolts 82 as will be described in more detail with specific reference to Figures 6 and 7. Associated with each reed is a pick-up element 83, made of suitable material, such as brass, the pick-ups being supported on insulators tubes 84 and secured in relatively fixed position by screws 85. Those skilled in this art will understand that the reeds and pick-ups are connected to a suitable translating system whereby capacity variations between the reeds and pick-ups, brought about by reed vibrations, are converted into corresponding electrical oscillations which are amplified and fed to an electro-acoustic device to produce audible tones. It may here be pointed out that the reeds may be set into vibration by key-actuated striker mechanisms, as indicated in Figure 3 by the respective hammer 101 associated with the reed 1, or other suitable means.

In order to eliminate the absorption of reed energy caused by forced or resonant vibrations of the mounting base, I divide the base into three, separate sections as indicated by the numerals 80, 80′, 80″, each section being made of a high grade of hard rolled aluminum plate such as that known as 24ST. Such alloy is light in weight and has a relatively low internal viscosity of vibration as indicated by its ability to sustain vibrations once it is excited. This low internal viscosity reduces to a low value any non-resonant vibratory absorption of reed energy such as many be set up in the base by reed vibrations. Furthermore, the masses of the separate base sections are very large compared to those of the individual reeds so that but little forced vibrations of the base sections will occur. Another material which may be used for the base sections is magnesium which has a density of 1.74, compared with 2.70 for the aluminum alloy, and which, therefore, affords further economies in weight.

As indicated in Figure 1, the upper base section 80″ is 8 inches long and 2 x 2 inches in cross-section at the right hand end. This section carries 14 reeds, specifically reeds 60 to 73, the latter having a vibration frequency of 4186 cycles per second. The middle base section 80′ has a length of 1134 inches and carries 23 reeds, specifically, reeds 37 to 59, the latter having a vibration frequency of 1864 cycles per second. The lower base section 80 is 19¼ inches long and carries 36 reeds, specifically, reeds 1 to 36, the latter having a vibration frequency of 523 cycles per second. It will be noted that the left hand end of the lower base section 80 has a height of 2 inches and a width of 4 inches (see Figure 3). Also, the top surface of this base section is flat, to accommodate the reed-clamping lugs 81, and the front face 80*a* slopes downwardly away from the lugs thereby providing a clearance area for unrestricted vibration of the largest reeds, as indicated by the arrows *a*—*a*. The front face 80*a* also slopes in a longitudinal direction, that is, the degree of slope decreases toward the right-hand end of the base section 80, as is shown in Figure 4 which is an end view of the right hand end of the lower base section 80 but reversed for direct comparison with Figure 3. As also will be apparent from a study of Figures 3 and 4, the height of the base section remains constant, 2 inches, but the width gradually decreases. Further, the top, flat surface of the base section increases in transverse width while the front edges of all the mounting lugs 81 coincide with the base edge that forms the line of demarcation between such top, flat surface and the sloping surface 80*a*. If we now consider the three base sections 80, 80′, 80″ longitudinally-aligned but separated by the small spaces X and Y, the following description of the gradual variation in the cross-sectional configuration of the base sections will be clear. The maximum base width, 4 inches, prevails at the left hand end of the lower base section 80 and this width dimension decreases gradually to 2 inches at the right hand end of the upper base section 80″. The top, flat surface of the base sections, upon which rest the reed-clamping lugs 81, varies from a minimum width at the left hand end of the lower base action 80 to a maximum width at the right hand end of the upper base section 80″, the minimum such width being equal to the length of the mounting lugs 81, as shown in Figure 3, and the maximum such width being 2 inches, as shown in Figure 5. Further, the sloping front surface 80*a* of the base sections has a maximum lateral width, and a maximum angular deviation from the plane of the reeds, at the left hand end of the base section 80. Such surface gradually decreases in lateral width, and angular deviation from the reed plane, toward the right hand end of the assembly and, in fact, disappears entirely at the right hand end of the upper base section 80″, as shown in the end view of Figure 5.

Having in mind the above-described configurations of the base sections, it can be shown mathematically and experimentally that if the base sections are made of 24ST aluminum alloy, the lowest vibration frequency of the upper base section 80″ is 6650 cycles per second which is amply above the 4,186 cycles per second vibration frequency of the highest-pitched reed 73 carried by this base section. Similarly, the lowest vibration frequency of the middle base section 80′ is 3,100 C. P. S. which is well above the 1864 C. P. S. frequency of its highest-pitched reed 59, and that of the lower base section 80 is 1000 C. P. S. which is well above the 523 C. P. S. frequency of its highest-pitched reed 36. The specified vibration frequencies of the three base sections have been calculated by using the length and the minimum width and thickness dimensions for the separate base sections. Actually, the vibration frequencies of the base sections will vary from point to point, (since the frequency varies directly as the base dimensions taken in the plane of the vibrations being considered) and the base section frequency will, therefore, increase toward the position of the lower-pitched reeds. The loading and stiffening effect of the reed-clamping lugs, clamping screws and the pick-up assemblies have not have taken into consideration in my computations as these are considered to have frequency-determining effects of a second order of magnitude.

For mounting base materials having a very high "Q," corresponding to very low internal losses, (such as, for example, high quality steel with a hardness of about 50C, Rockwell, bell-metal alloys, etc.,) it is possible to reduce the cross-sectional dimensions of the base sections and allow their lowest vibration frequencies to approach very closely (that is within say 5 or 10 cycles) the vibration frequency of the highest-pitched reed carried by the particular base section without appreciable resonant energy absorption.

The vibration forces set up in the base sections, in the plane of the reeds, have twice the frequency of the reeds since there is a small component of reed motion which is parallel to the reed axis and this develops two impulses for each cycle of reed oscillation. Due to the fact, then, that the effective frequency of the horizontal forces, developed by the reeds on the base, is actually double that of the reed, and that the base frequency for this vibration mode is also higher than that of the vertical vibration mode, there is no possibility of resonant base vibrations in such horizontal mode. Also, since the lowest vibration frequency for torsional and longitudinal vibrations of bars having ordinary dimensions are always much higher than those of transverse vibrations, such torsional

and longitudinal vibrations cause no concern in the matter of reed-energy absorption.

In actual practice, I prefer to support the individual base sections on a highly-elastic cushion such as air-inflated elastic envelops, foam rubber pads, felt, etc., but maintaining a positive separation between adjacent base sections. Thus in Figure 2 I show each of the bases **80** **80''** (a similar illustration as to base **80'** being omitted only for simplification of the drawing) resting on rubber or other elastic pads **90** which are typically of T-shaped cross-section and of which the lower portion passes through the single common support **95**, the bases being held in place on the pads by headed studs **91** screwed upwardly through the pads into the bases—a rubber or other elastic washer **92** intervening between the head of each stud and the bottom of the common support **95** in order that the vibrational decoupling of the bases (from the common support and thus from each other) provided by the pads **90** will not be defeated. Whether each base section is supported only at each end, or rests entirely upon such pads, is not of particular consequence. Alternatively, the base sections may be suspended by elastic, non-viscous and non-resonant supports.

Reference is now made to Figures 6 and 7 for a description of the illustrated reed-clamping lugs. Each lug **81** comprises a metal block having a lateral slot cut in one side, as shown, such slot having a width about 0.005 to .010 inch greater than the thickness of the associated reeds 1 and 2. The bolts **82** passes through a transverse, clearance hole in the metal block. When the bolt **82** is threaded into a hole in the mounting base, such as the base **80** shown in the sectional view of Figure 7, the pressure of the bolt head forces the upper portion of the block toward the reed and since the slot in the block is wider than the reed thickness the outer edge of such upper block portion will establish substantially a line contact with the reed. As the bolt pressure is increased more and more of the upper block portion will contact the reed surface but the greatest reed-clamping pressure will always be exerted by the front edge of the upper block portion. Such construction, therefore, results in a simple, positive, dual-reed clamp and one providing a sharp line of demarcation between the fixed end and vibratory portion of each reed. I prefer to make the reed-clamping blocks of hard, spring-tempered material to prevent a rounding-off of the clamp edges with reed vibration and to prevent indentation of the clamp by the hard reeds due to the pressure of the clamping screw. Other types of reed-clamping arrangements may, of course, be used with my reed-mounting base.

Having described my invention it is apparent that I provide a support system for a large number of reeds, having a wide range of vibration frequencies, without loss of reed-vibration energy through resonant or forced vibration absorption by the support system. Such a support system for vibratory reeds may be used for other than musical instrument purposes as, for example, tuned reed frequency meters, audio spectrum analysers, etc., where minimization of reed vibrational energy losses by their mounting support is important. Those skilled in this art will not find it difficult to make various changes and modifications in the illustrated construction without thereby deviating from the spirit and scope of my invention as set forth in the following claims.

I claim:

1. A mounting base for a plurality of tuned, vibratory reeds which constitute the tone-generators of an electronic musical instrument; said base comprising an elongated, unitary, metal member having five mono-planar surfaces as follows: a bottom surface which gradually varies in width from a maximum value at the left end of the member to a minimum value at the right end, a rear surface substantially normal to the base surface and having a substantially constant width throughout the length of the member, a top surface substantially

normal to the rear surface and which gradually varies in width from a minimum value at the left end of the member to a maximum value at the right end, a front surface which gradually varies in width from a minimum value at the right end, and a sloping surface joining the top and front surfaces, said sloping surface gradually varying in width from a maximum value at the left end of the member to a minimum value of the right end.

2. The mounting base recited in claim 1, in combination with a plurality of tuned reeds disposed in a plane parallel to that of the base top surface, reed-clamping members securing the reeds to the top surface of the base, a plurality of insulating members extending from the front surface of the base, and capacitive pick-ups secured to the insulating members, said pick-ups having ends spaced from the free ends of the reeds.

3. The invention as recited in claim 2, wherein each reed-clamping device serves to secure two adjacently-disposed reeds and comprises a rectangular metal block secured to the top surface of the mounting base by a bolt passing through a transverse hole in the block and threaded into a cooperating hole in the mounting base, said block having a longitudinal slot intersecting the transverse hole and said slot accommodating the ends of two reeds one on each side of said bolt.

4. In an electronic piano wherein each output tone is produced principally through the translation of electric oscillations consisting of a series of harmonically related components from the fundamental-frequency vibration of a respective reed, the combination of a plurality of reeds respectively tuned to the frequencies of a musical scale, base means for the reeds subdivided into a plurality of longitudinally successive bases of each of which the length is the major dimension and from along each of which a respective series of the reeds extends laterally, and means vibrationally interposed between the several bases for decoupling them from each other, each of the bases having a lowest natural frequency of transverse vibration higher than the fundamental of the highest-frequency reed extending therefrom.

5. In an electronic piano wherein each output tone is produced principally through the translation of electric oscillations consisting of a series of harmonically related components from the fundamental-frequency vibration of a respective reed, the combination of a plurality of reeds respectively tuned to the frequencies of a musical scale and selectively vibratable in a given direction, base means for the reeds subdivided into a plurality of longitudinally successive bases of each of which the length is the major dimension and from along each of which a respective series of the reeds extends laterally, a transverse dimension of each of said bases being generally parallel with said direction of vibration of the reeds, and means vibrationally interposed between the several bases for decoupling them from each other, each of the bases having a lowest natural frequency of vibration in said transverse dimension higher than the fundamental of the highest-frequency reed extending therefrom.

6. The invention according to claim 5, wherein each of the bases has a lowest natural frequency of vibration in any mode other than vibration in said transverse dimension higher than its said lowest natural frequency of vibration in that dimension.

7. In an electronic piano wherein each output tone is produced principally through the translation of electric oscillations consisting of a series of harmonically related components from the fundamental-frequency vibration of a respective reed, the combination of a plurality of reeds respectively tuned to the frequencies of a musical scale, base means for the reeds subdivided into a plurality of longitudinally successive bases of each of which the length is the major dimension and from along each of which a respective series of the reeds extends laterally, and means vibrationally interposed between the several bases for decoupling them from each other, the bases having respective lowest natural frequencies of trans-

verse vibration the lowest of which is within the range of said scale but each base having a lowest natural frequency of transverse vibration higher than the fundamental of the highest-frequency reed extending therefrom.

8. In an electronic piano wherein each output tone is produced principally through the translation of electric oscillations consisting of a series of harmonically related components from the fundamental-frequency vibration of a respective reed, the combination of a plurality of reeds respectively tuned to the frequencies of a musical scale, base means for the reeds subdivided into a plurality of longitudinally successive bases of each of which the length is the major dimension and from along each of which a respective series of the reeds extends laterally, and means vibrationally interposed between the several bases for decoupling them from each other, said base means having the overall length and the various cross-sectional measurements of an integral bar of similar material characterized by a lowest natural frequency of

transverse vibration within the range of said scale but each base having a lowest natural frequency of transverse vibration higher than the fundamental of the highest-frequency reed extending therefrom.

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