United States Patent

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[54] DAMPING MEANS FOR STRING PLATE

12 Claims, 7 Drawing Figs.

[52] U.S. Cl. 84/188, 84/216
[51] Int. Cl. G10c 3/08, G10c 3/00
[50] Field of Search 84/191, 189, 188, 234, 216, 1.24, 1.26, 255, 218, 184, 185, 187, 186; 165/69; 248/15

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Assistant Examiner—John F. Gonzales
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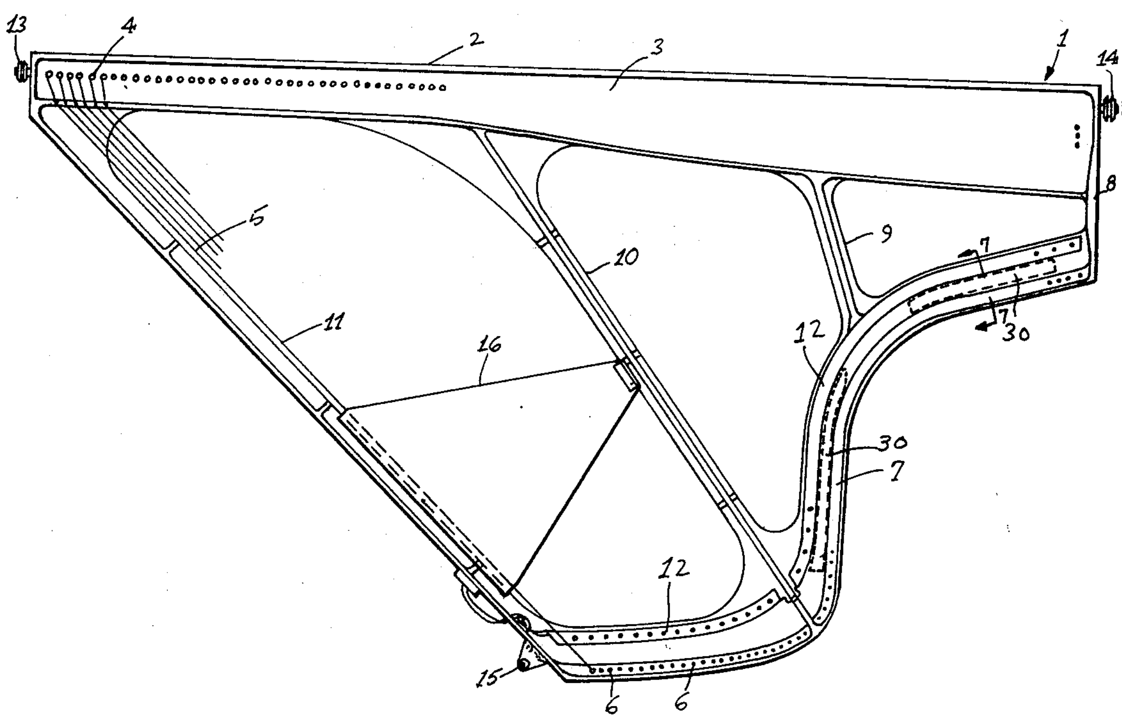
ABSTRACT: A simple, lightweight, and inexpensive damping device for damping out the undesirable ringing modes of shock-excited metal structures having connecting braces, such as the string plates of pianos and other stringed instruments, the damping device having opposing fittings containing damping masses in the form of lead bars positioned to contact the opposing bracing members, the metallic bars being cushioned in the fittings by a pliable material, such as dead rubber, the fittings being interconnected either by a metallic plate or by an axially adjustable connecting rod.



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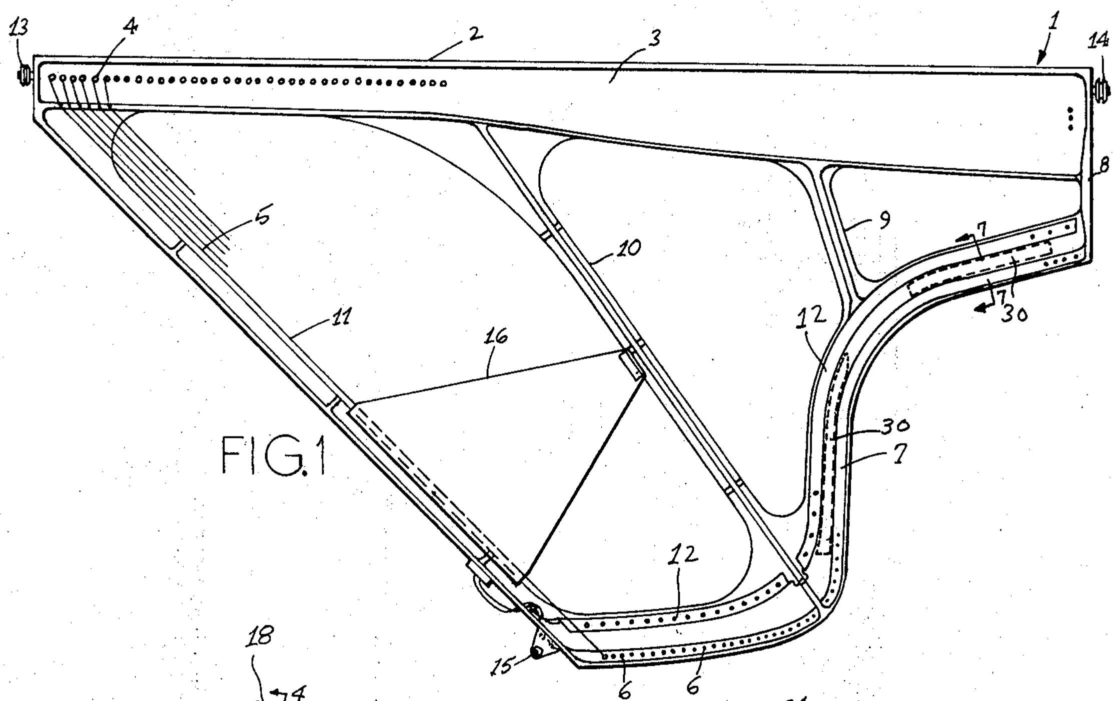

FIG.1

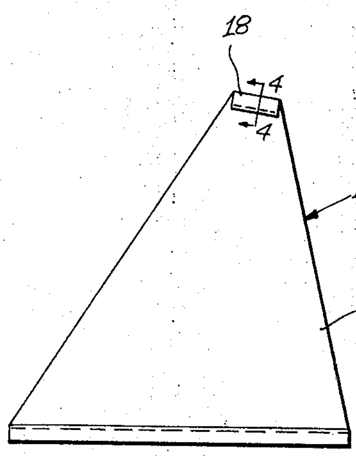

FIG. 2

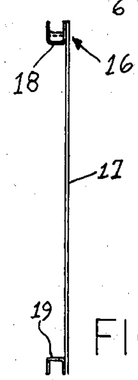

FIG. 3

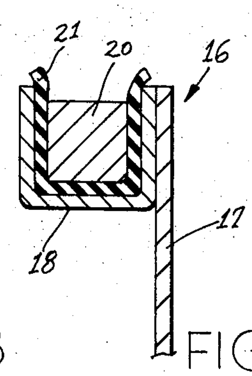

FIG.4

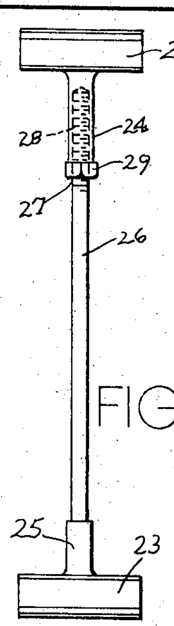

FIG.5

FIG.6

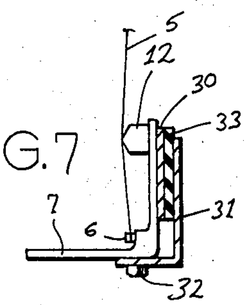

FIG.7

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DAMPING MEANS FOR STRING PLATE

BACKGROUND OF THE INVENTION

The string supporting frame members of early conventional pianos were made almost entirely of wood, a material which has considerable internal damping. During the last century or so the frame structure was reinforced with iron more and more until the iron became a complete plate structure on which the strings were stretched. However, wood was retained both for the sound radiating member (the soundboard) and as a part of the tension supporting structure, in the form of back posts, case rim, and the case itself. During this evolution of structure the duration of the piano tones tended to increase because the vibrating strings were terminated at one end by rigid metal, the other end being terminated at a woden bridge connected to the wooden sounding board. The wood damped the vibration of the string plate by contact, the plate being fixedly secured to the wooden supporting structure. The timbre of the tones also receives a distinctive contribution from the damped modes of plate vibration.

Where it is desired to control the output of a piano or similar instrument electronically, by both amplification an attenuation, it is necessary to eliminate the direct radiation means consisting of the bridge and soundboard employed in a conventional instrument. It has also been found highly desirable to shock mount the string plate relative to the case of the instrument so that vibrations will not travel through the plate into the case from which tone can be radiated into the air. Such shock or cushion mounting of the string plate relative to the case is also desirable because shock noises in the case, such as from keys striking the keyboard and from pedals making impact on the bottom of the case, would otherwise be transmitted into the string plate where the vibration transducers for the strings are located, thereby producing tonal interference.

However, when the string plate is shock mounted or otherwise isolate from the case structure, there is no longer any substantial a mount of wood in contact with the cast iron string plate, and the plate tends to ring much longer than usual at its many natural modes of vibration after each shock excitation of the strings by the hammers. Such protracted vibration poses a particular problem for notes played in the treble end of the piano scale where the felt hammers strike the strings in close proximity to the termination points of their vibrating segments. In other words, the hammers strike extremely close to the portion of the spring plate supporting the ends of the tuned segments and hence the source of the shock is in close proximity to the plate.

Excessive duration of plate vibration is detrimental to the tone of the instrument. While it would be possible to eliminate effectively the shock excitation of the plate by adding damping at the termination of the strings upon the plate, such expedient would have the disastrous effect of shortening the tone duration of the excited string to a point where the tone produced by the string would be wholly unacceptable.

Accordingly, a principal object in the instant invention is the provision of a solution to the problem of string plate vibration damping which is not only effective from an acoustical standpoint, but which from a mechanical standpoint embodies damping means which are simple, easy to install, light in weight, and also inexpensive to produce.

RESUME OF THE INVENTION

In accordance with the invention, it has been found that the most objectionable undamped plate vibrating components of the piano tone lie at the lower frequencies. These components are most apparent when the higher notes are played. This is due to the fact that the higher pitched string tones are not effective in masking low frequency plate noise. It was also found that the plate vibration amplitudes are greatest in the portion of the plate supporting the string terminations and in the bracing members extending across the relatively open spaces of the plate in which the hammers and dampers operate, with the most undesirable plate vibration modes most prominent in the two longest bracing members in the bass and tenor sections of the plate.

In accordance with the invention, it has been found that the undesirable protracted vibrations of the string plate can be effectively eliminated by utilizing a damping structure which extends between the aforementioned bracing members, each such bracing member being utilized as an effective means for applying a damping force upon the other. In other words, the damping means is effectively wedged between the adjacent members and hence acts to exert a damping effect upon each brace with a steady force. Preferably, a damping mass comprising a relatively rigid bar of damping material, such as lead, will be held in contact with one or both of the plate bracing members, with a sheet of mechanically pliable but dead material, such as dead rubber, sandwiched between the damping masses and the body or intermediate portion of the damping structure which effectively produces the wedging action.

In one embodiment of the invention the damping structure comprises a plate having U-shaped channels along its opposite edges positioned to mount the damping masses for contact with the bracing members of the string plate. By making the channels slightly nonparallel to each other a wedging action can be obtained easily with a plate of fixed length. In another embodiment of the invention the opposing damping masses are interconnected by an axially adjustable threaded rod which acts, when extended in place, as a holding means to force the damping masses into positive contact with the corresponding plate braces. This is particularly useful when the braces are parallel. In still another embodiment, particularly suited for damping piano plate vibration near the string terminations, the damping material is held against the plate in back of or near the string terminations, with a thin piece of softer material, such as felt or dead rubber, interposed between the plate and bar or between the bar and the holding means.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a string plate for an electropiano incorporating two types of damping means in accordance with the instant invention.

FIG. 2 is an enlarged front elevational view of one of the damping means shown in FIG. 1.

FIG. 3 is an end elevational view of the damping means of FIG. 2.

FIG. 4 is an enlarged vertical sectional view taken along the line 4–4 of FIG. 2 illustrating one of the U-shaped fittings, which contains a lead bar and a dead rubber pad between the fitting and the bar.

FIG. 5 is a side elevational view of a modification of the damping means of FIG. 2 wherein the U-shaped fittings are mounted on the opposite ends of a rod and are axially adjustable relative to each other.

FIG. 6 is an end elevational view of the modification shown in FIG. 5.

FIG. 7 is an enlarged vertical sectional view taken along the line 7–7 of FIG. 1 illustrating a damping means particularly suited for damping plate vibration near the string terminations.

THE PREFERRED EMBODIMENTS

Referring first to FIG. 1 of the drawing, the spring plate 1 is of the type used in an electropiano, although at the outset it is to be understood that the specific construction of the string plate and the specific instrument with which it is to be used do not constitute limitations on the invention. In a typical string plate construction, the entire plate is cast from a material such as gray iron and comprises a frame portion 2 which mounts a pin block 3 in which the tuning pins 4 are received, the strings 5 extending between the tuning pins and a series of hitch pins 6 mounted on the curved portion 7 of the string plate. Bracing members 8, 9, 10 and 11 extend between the frame portions 2 and 7, the braces serving as strengthening and rigidifying members. In an electropiano, the strings contact transducer means 12 mechanically coupled to the strings for transmitting sounds generated by the strings to suitable amplifying means which reproduces the sounds electrically through a loudspeaker system or the like. Were the instrument of the mechano-acoustic type, the transducer means and the amplifying and reproducing system would be replaced by a soundboard and bridge means arranged to contact the strings.

In the embodiment illustrated, the string frame is adapted to be shock mounted at its opposite ends to a supporting case or the like by means of shock-resistant fittings 13 and 14 which incorporate a resilient cushioning material, the curved portion 7 of the frame also being provided with a shock-resistant fitting 15 which serves to stabilize the string plate relative to the supporting case. In a mechano-acoustical piano, the string plate would normally be secured directly to a supporting frame forming a part of the instrument case.

In accordance with the invention, protracted vibration of plate bracing members 10 and 11 is effectively damped by means of the damping structure 16 which, as illustrated in FIG. 1, extends between the bracing members 10 and 11 where it is lightly wedged in place. In the arrangement illustrated, the damping structure 16 extends from between the bracing members 10 and 11 where the least desirable vibration modes are encountered in the particular plate under consideration.

As seen in FIGS. 2, 3 and 4, the damping structure 16 comprises a metallic plate 17 which may conveniently comprise a steel plate having U-shaped metallic channels 18 and 19 welded to the opposite edges thereof with the channels opening outwardly away from each other. As best seen in FIG. 4, each of the channels is fitted with an elongated rectangular bar 20 formed preferably of lead, though steel strips may be employed but the advantage is not as great. The damping bars 20 are held in place in the channels 18 and 19 by means of an interposed layer of a flexible sheet material, such as dead rubber, although other mechanically pliable but dead materials may be sandwiched between the damping bar and the U-shaped channels.

The braces 10 and 11 are not truly parallel, but rather converge slightly as they extend from the frame portion to the curved frame portion 7. This slight convergence permits the damping structure to be readily wedged in place between the adjoining bracing members with each of the damping bars 20 held securely and firmly in contact with the bracing member to which it is juxtaposed. The plate 17 acts to effectively constitute each of the bracing members as a means for applying a positive damping force against the other bracing member. The damping forces are, however, exerted against the damping bars 20 which are in direct contact with the bracing members and hence the vibration power transfer from the braces to the damping mass is highly efficient as is the damping material 21 in inhibiting vibration power transfer between the damping bars and the supporting channels and plate. The damping masses are thus effectively held against the vibrating structure with a steady force transmitted through a soft, dead cushioning material, the arrangement serving to effectively damp out the undesirable ringing modes of the plate structure.

In addition to damping the plate ring so that it is not an objectionable form of reverberation, it has been found that the damping structure additionally gives the "knock" portion of the tone of an electropiano a much more natural pianolike sound than damping devices heretofore employed. To explain, in a conventional mechano-acoustical piano, shock noise generated in the damped plate when the strings are struck by the felt hammers becomes an integral part of the tone generated and hence a part of the normal tone to which the listener is accustomed. An electropiano is more sensitive to external noise and vibrations, so it is normally desirable to damp such extraneous vibrations by minimizing the physical interconnection between the piano action and the vibrating string system, which comprises the strings and string plate. However, if all of the effects of tonal shock excitation are completely removed, the instrument loses its natural pianolike tone quality. Damping means in accordance with the instant invention have been found to produce an effective balance in which the "knock" portion of the tone is effectively maintained at a natural level.

The configuration of the damping structure does not constitute a limitation on the invention, although a generally triangular plate with a short damping segment on one brace and with a much longer damping segment on the other brace is preferred for damping the vibrations of plate bracing members, such as members 10 and 11. In an exemplary embodiment, of the invention, the channel 18 and the damping mass 20 contained therein may have a length of 1 ¾ inch as compared to a length of 12 inches for the channel member 19 and its damping mass. The advantage of such an arrangement is that the angle between the converging bracing members between which the damping structure is inserted does not have to be matched as precisely as would be the case were both of the damping segments of the longer length. In addition, the triangular configuration of the plate makes the device more economical without adversely affecting the ability of the structure to effectively damp the undesirable plate vibrations.

The mass of the rectangular bars 20 will be chosen in accordance with the magnitude of vibration which takes place in the respective bracing members being damped. In a typical construction, the bars 20 have been formed from a noncorroding grade of substantially pure lead (99.9 percent) each having a cross-sectional dimension of one-fourth inch × three-eighths inch.

Instead of a damping structure embodying a metallic plate, such as the plate 17, one or more damping devices of the type illustrated in FIGS. 5 and 6 may be employed. As seen therein, the damping device comprises an opposing pair of channel members 22 and 23 having centrally disposed neck portions 24 and 25, respectively. As before, lead bars 20 will be inserted in the channel members 22 and 23, the bars being separated from the channel members by interposed layers 21 of dead rubber or felt, for example. An elongated rod 26 has a threaded end 27 adapted to be freely received in a bore 28 in the neck 24. An adjustment nut 29 is in threaded engagement with the threads 27 and is adapted to abut against the distal end of the neck 24. The opposite end of the rod 26 is fixedly secured to the neck 25 of channel 23.

With the arrangement just described, the damping device may be inserted between the bracing members to be damped, whereupon by tightening the adjustment nut 29 the damping bars in the respective channel members will be forced into contact with the bracing members. It should be pointed out, however, that care must be taken to avoid tightening of the adjustment nut to a point where the dead rubber material 21 is too severely compressed since some of the vibration damping effectiveness will be lost. This is also true of the embodiment of the invention illustrated in FIGS. 2 through 4. Pressing the device downwardly with moderate force will secure it between the braces, giving optimum damping. If excessive force is used, or if the device is pounded into place, the connection can become too rigid and the damping effect is lessened.

Where the embodiment of the FIGS. 5 and 6 is employed, it has been found that two such devices located symmetrically along the length of the bracing members provides more effective damping in that the second device will damp vibration modes missed by the first. Where the damping masses are interconnected by a solid plate, such as the plate 17 shown in FIG. 2, the necessity for multiplicity of damping devices is normally eliminated. It is to be understood, however, that the number of damping devices employed in a given instrument does not constitute a limitation on the invention, nor does their specific location with respect to the various braces making up the plate structure. Rather, as now should be evident, the instant invention provides an effective means for holding a damping mass against a vibrating structure with a steady force transmitted to the damping mass through a soft, highly damped material.

The embodiment of FIG. 7 applies the principles of the invention to a different portion of the plate 1, namely, the curved portion 7 of the plate nearest the string terminations where transduction occurs. Thus one or more damping bars 30 may be mounted on the back of the middle and treble sections of the curved frame portion 7, at or near the string terminations at transducer means 12. Each of the damping bars will be of lead, although steel and brass have also been used, the bars resting against the plate frame and secured in place by a clamp member 31. Secured to the plate by adjustment bolts or the like 32, the clamps being slotted to adjustably receive the bolts. A dead rubber or felt strip 33 is preferably interposed between the bar and the clamp. Alternatively, the strip 33 may be inserted between the bar and the frame. In either event, the metallic damping mass will serve to effectively dampen undesirable plate vibration in the curved areas of the plate.

Modifications may be made in the invention without departing from its spirit and purpose, and several such modifications have already been set forth. It will be evident, for example, that where the damping device extends between a spaced apart pair of plate members, situations may arise where a damping mass is not required for each of the plate members, in which event one end of the mounting body may simply engage the adjoining plate member, preferably with the interposition of a strip of felt, dead rubber or the like between the end of the mounting body and the adjoining plate member.

We claim:

1. A vibration damping device for damping piano plate vibration, said device comprising a metallic damping mass, mounting means for urging said damping mass against a portion of the piano plate to be damped, and a layer of a flexible damping material interposed between said metallic damping mass and said mounting means, said mounting means comprising a clamp member secured to said plate and adapted to urge said metallic damping mass against an adjoining portion of said plate.

2. A vibration damping device adapted to be engaged between a pair of spaced apart members forming a part of a structure to be damped, said vibration damping device comprising a body part of a length to extend between the said spaced apart members, damping mass mounting means on secured least one end of said body including a damping mass secured to each of said mounting means, including a layer of a flexible damping material interposed between each said damping mass and said mounting means, a surface of each said damping mass being exposed for direct contact with one of the said spaced apart members.

3. The damping device claimed in claim 2 wherein said body part comprises a metallic plate.

4. The damping device claimed in claim 3 wherein said plate is of generally triangular configuration.

5. The damping device claimed in claim 2 wherein said damping masses each comprises a rectangular metallic bar.

6. The damping device claimed in claim 5 wherein said mounting means comprises channel-shape members in which said metallic bars are received, said flexible damping material being sandwiched between said channel-shape members and said bars.

7. The damping device claimed in claim 2 wherein said body part comprises a metallic rod.

8. The damping device claimed in claim 7 including adjustment means for effectively varying the length of said rod.

9. The damping device claimed in claim 8 wherein said adjustment means includes an adjustment nut in threaded engagement with one end of said rod, and a hollow neck portion on one of said damping mass mounting means, said hollow neck portion surrounding the threaded end of said rod and seated against said adjustment nut.

10. A vibration damping device for a string plate having a pair of spaced apart members forming a part of said plate, said device comprising an elongated body member of a length to extend between said spaced apart members having an oppositely directed pair of channel-shaped members at its opposite ends, a metallic damping mass secured in each of said channel members and positioned to contact one of said spaced apart members, and a layer of a pliable damping material interposed between said damping mass and said channel-shaped mounting members.

11. The device claimed in claim 10 wherein said damping masses are of unequal length.

12. The damping device claimed in claim 11 wherein said elongated body comprises a metallic plate of generally triangular configuration.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,564,963 Dated February 23, 1971

Inventor(s) Daniel W. Martin and John L. Stein

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 1, cancel "secured" and insert - at -; same line, cancel "including" and insert - part, -.

Signed and sealed this 22nd day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents