

# United States Patent

[11] **3,525,283**

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**[54] STRINGED KEYBOARD INSTRUMENT WITH  
ADHESIVE ACTUATOR  
13 Claims, 13 Drawing Figs.**

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[51]	Int. Cl.....	G10c 3/18, G10d 1/00
[50]	Field of Search.....	84/7, 8, 9, 173, 174, 199, 258, 320, 323

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**ABSTRACT:** A musical instrument of the stringed keyboard type wherein each individual string is vibrated by an action utilizing an adhesive effect. The vibrator normally rests on the string which adheres to it. When the vibrator is lifted, upon depression of the key, the string initially rises with the vibrator. When the pull of the string exceeds the adhesive pull, the string snaps away and is set into vibration. A sounding board is not employed, particularly formed and placed electromagnetic pick-ups being used instead, each pick-up being a coil of wire would around magnetic material and extending over five or six strings, the pick-ups being electrically connected in series. The vibrator may also provide a second vibration of the string. A rocking arrangement assures that all vibrators initially adhere to their strings with the same force.

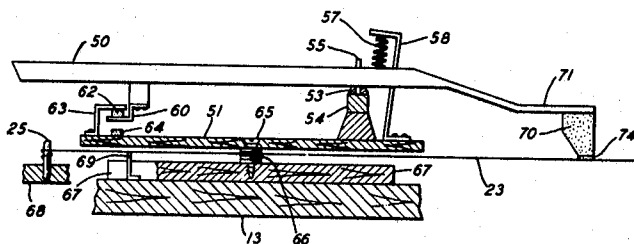


FIG. 1

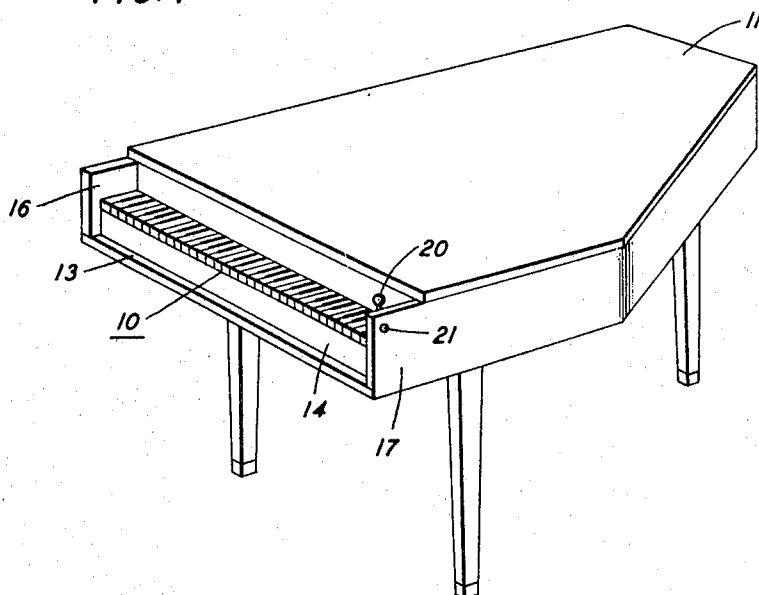
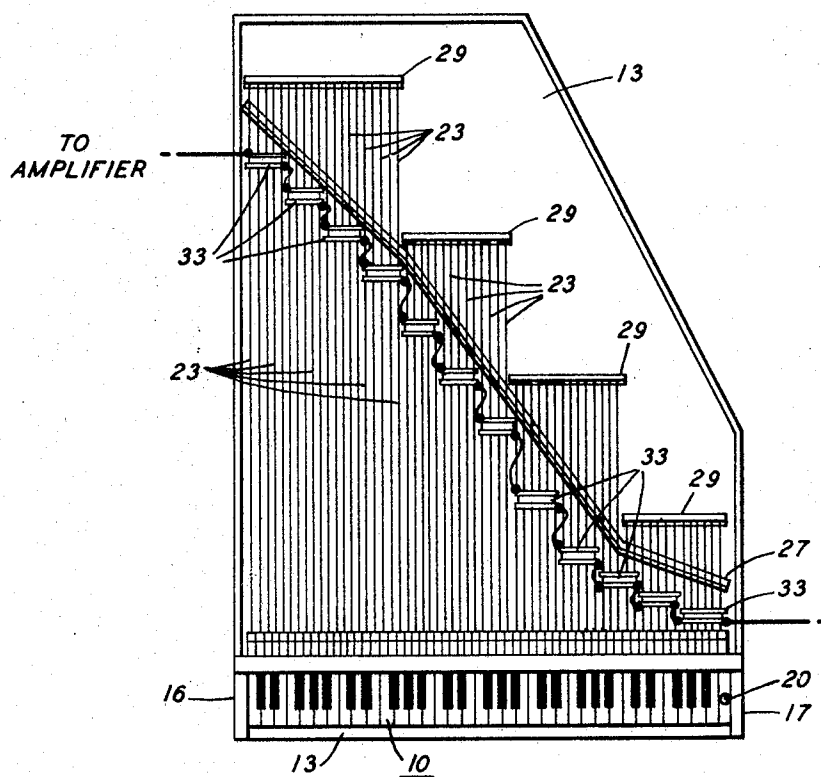


FIG. 2



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FIG. 3A

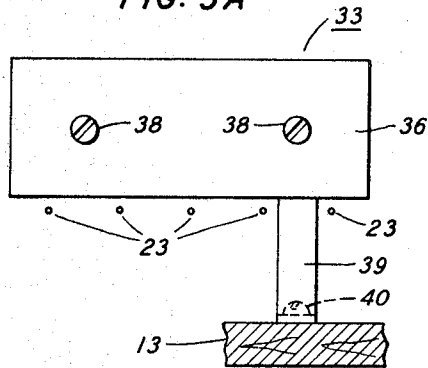


FIG. 3B

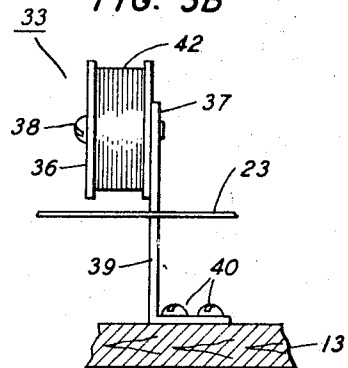


FIG. 4

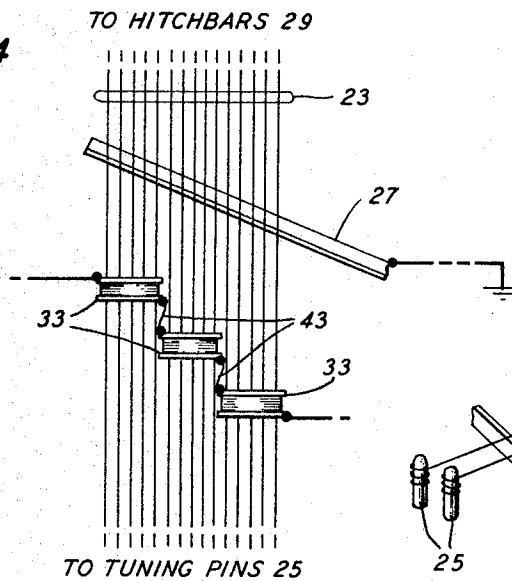


FIG. 5

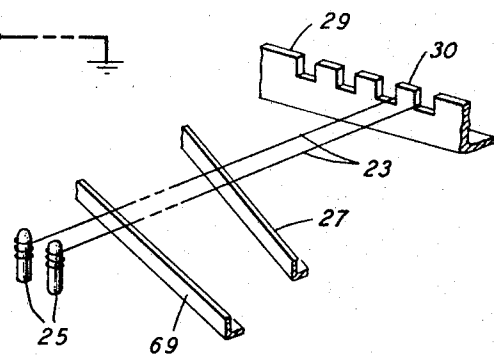
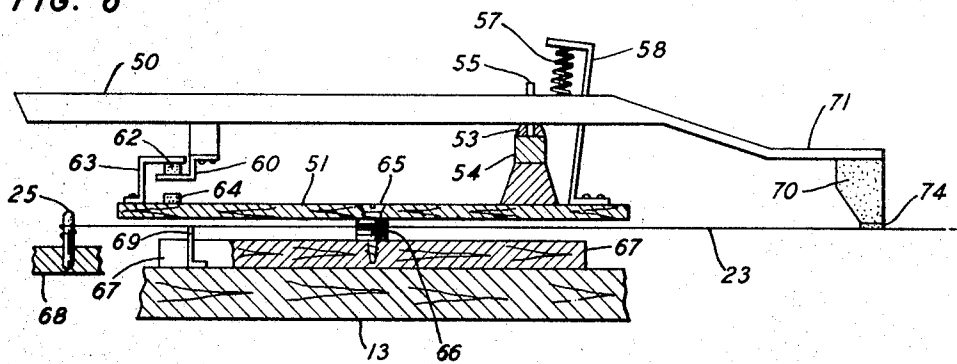
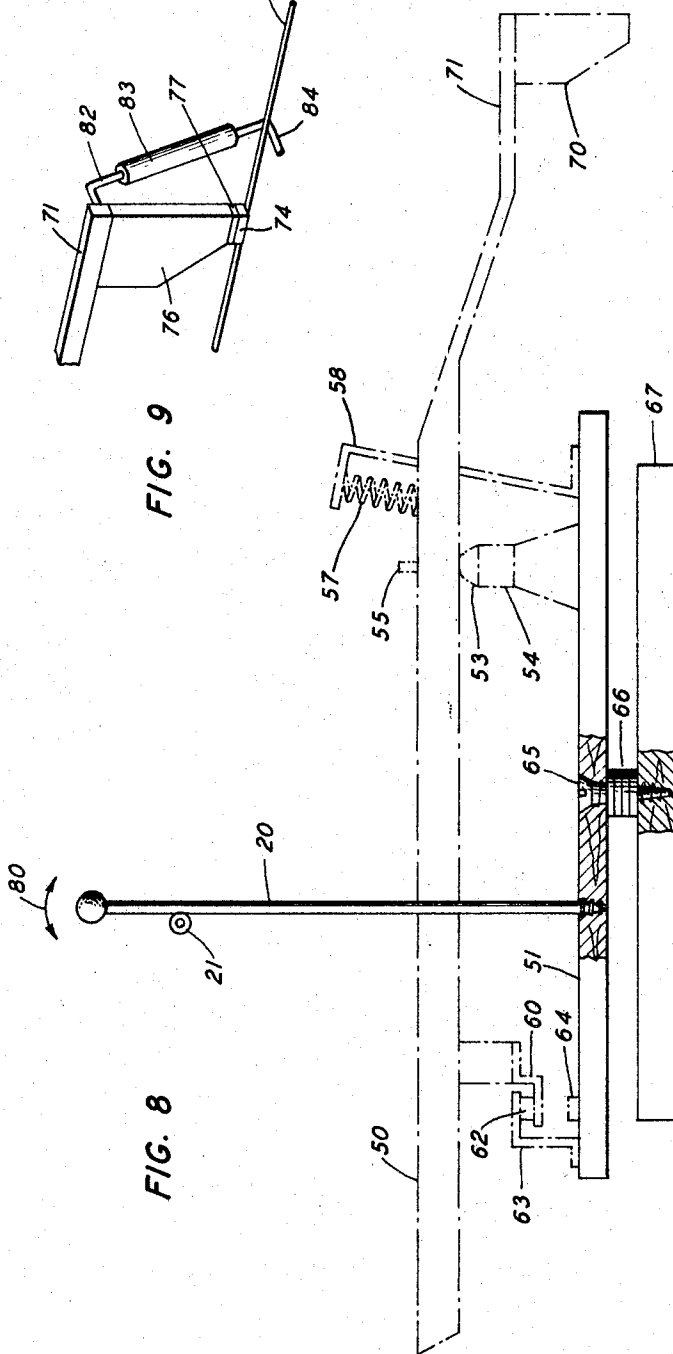
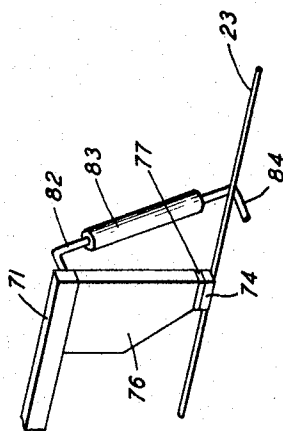
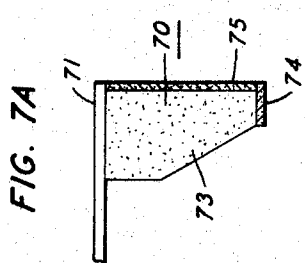
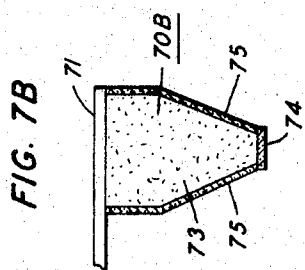
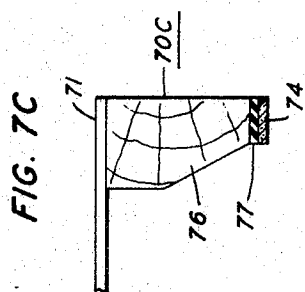
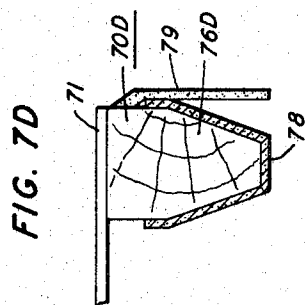


FIG. 6



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# STRINGED KEYBOARD INSTRUMENT WITH ADHESIVE ACTUATOR

## BACKGROUND OF THE INVENTION

In the development of stringed keyboard instruments different tonal effects have been obtained dependent on the manner of setting the strings into vibration. Thus in the harpsichord the strings are plucked by a plectrum whereas in a clavichord and a piano the strings are struck, as by hammers.

The harpsichord has a particularly pleasing sound but traditional harpsichords suffer from several problems. One is the requirement for constant adjustment and maintenance of the individual plectrums to assure the proper plucking action of the string. A second problem has been the relatively complex arrangements necessary to obtain a large volume of sound.

Harpsichords are particularly affected by changes in temperature and humidity. Since only a small area of the string is plucked by the plectrum, the physical relationships between the string and the plectrum must be maintained with great accuracy, thereby requiring the constant adjustments of the plectrum.

In a piano the hammer strikes on a large area of the string so that adjustments are not necessary in the key action to compensate for changes in the physical spacing between the hammer and the strings. However, the striking of a string by a hammer does not give a sound at all similar to a harpsichord sound, due mainly to the damping effect of the hammer initially resting on the string when it is struck.

It is an object of my invention to provide an instrument having a sound similar to a harpsichord but not requiring a plucking action.

However, in the development of my invention I discovered that the sound is sufficiently different from a harpsichord that I can characterize my instrument as an entirely new type of stringed keyboard musical instrument.

It is another object of my invention to provide a stringed keyboard instrument which does not require a sounding board.

## SUMMARY OF THE INVENTION

In one specific illustrative embodiment of my invention a stringed keyboard instrument is provided in which the strings are set into vibration by a vibrator member which normally rests on the individual string. The vibrator member includes, as the body thereof a coating or layer on the body, a resilient portion and then an outer coating of adhesive or other material to which the string will adhere.

When the individual key is struck, the vibrator member is lifted. The tonal attack in embodiments of my invention is slightly delayed because the sound is not immediately initiated. Instead the string, due to its adhering to the vibrator member because of the adhesive nature of the outer surface of the member, initially is lifted by the member. It is lifted, however, against the inherent tension of the string, which is tuned between a tuning pin and hitch post or pin, as is known in the art. As the vibrator element is lifted, the string's tension will finally become sufficient to overcome the adhesive forces and the string snaps free, thereby being set into vibration.

It is to be noted that in accordance with my invention the string is not pretensioned, it is not plucked, nor hit. The adhesive may be over a relatively large surface of the string, when considered relative to a harpsichord plectrum, and so long as the vibrator element can rest on the string in the normal or non-played position, slight dimensional changes due to changes in temperature or humidity will have no effect, unlike traditional harpsichords.

The resilient portion of the vibrator member also serves to dampen the vibration of the string when the key is released as the vibrator member returns, by gravity or spring action, to rest on the string. Accordingly, the resilient portion, which may be a rubber pad or liner, should not be too small or the vibrator member will strike the string too hard when it returns to its rest position and thus, instead of dampening the string,

might actually set up new vibrations. At the same time the resilient portion should not be so soft or large as to stretch when the vibrator member is raised.

It is to be noted that unlike most prior mechanisms or actions for setting a string into vibration, my arrangement is not a mechanical action requiring a striking, whether for a hammer effect or for plucking, but instead a vibrator member in accordance with my invention relies on an adhesion effect whereby the string sticks or adheres to the vibrator member and is lifted thereby from an untensioned rest position.

I have found that key actions in accordance with my invention may be made very compact and have the additional advantage therefore of requiring less room. However, the major advantages of my invention are the attainment of the sound, which can best be described as somewhat rounder and less bright than a harpsichord, and the freedom from the continual adjustments that the harpsichord plectrum requires.

This sound is, however, also dependent on the mechanism employed for responding to the vibrations of the strings in order to produce the musical notes. Traditionally in keyboard instruments of this type, this has been accomplished by a sounding board. It is also known to use microphones and individual magnetic pick-ups for each wire or string of the instrument. In accordance with another aspect of my invention a particular type of electromagnetic pick-up is employed, the positioning of the pick-ups determining the quality of the sound of the instrument. Specifically, in this specific embodiment I employ a pair of magnetic flux plates having a magnetic plastic material positioned therebetween. A coil of wire is wound around the magnetic material. This pick-up thus defied extends over a plurality of strings, such as five or six, and a group of pick-ups are electrically connected in series to suitable amplifying equipment.

When the instrument is originally assembled I have found it desirable individually to position the pick-ups by ear in order to attain the tonal quality I desire.

In accordance with another aspect of my invention the key action mechanisms are not mounted from the bed of the instrument but instead are mounted from a separate key bed board or plate which is mounted at each end from the actual bed of the instrument by single screws or rods. An oversize washer surrounds the screw and is positioned between the instrument bed and this key bed. The washers allow the key bed to rock forward and backward slightly. A rocking rod provides a handle for the player to rock the key bed slightly. This serves the purpose of lifting all the adhesive vibrators off the strings at once and thereby prevents differences in effect of the adhesives of the vibrators. These differences, which I have found to be particularly prevalent with the higher notes, arise after the instrument has not been played for a time and the vibrators have been resting in their normal position on the strings.

In accordance with one embodiment of my invention a vibrator also provides a secondary striking of the string. The adhesive vibrator, as described above, normally rests on the string and provides the vibration of the string. However, extending from the vibrator is a support for a flexible or rubber rod which itself extends down beside the string. At the bottom of this rod and extending under the string is a striker member.

The flexible rod is so dimensioned that when the key is struck and the vibrator lifted in turn to lift, by the adhesion effects of my invention, the string, and thus set the string in vibration, the striker will not come into contact with the string. However, if the key is struck sharply, then the vibrator in moving suddenly will, in effect, snap the flexible rod and, after the string is first set into vibration by the adhesion effect of the vibrator, in accordance with my invention, the striker will be thrown against the under side of the string. Accordingly, a second vibration of the string occurs of different timbre.

## DRAWING

These and various other objects and advantages of my invention may be better understood from consideration of the following detailed description, together with the accompanying drawing, in which:

FIG. 1 is a top perspective view of a musical instrument in accordance with my invention;

FIG. 2 is a top view of the instrument of FIG. 1 with the lid of the instrument removed;

FIGS. 3A and 3B are views of the magnetic pick-up employed in the embodiment of FIG. 1;

FIG. 4 is a partial schematic drawing depicting the grounding of the instrument strings and the serial connection of the pick-ups of the embodiment of FIG. 1;

FIG. 5 is a representation of a single wire of the instrument of FIG. 1, the wire extending between two tuning pins and a hitch bar;

FIG. 6 is a side view of a single one of the key actions of the embodiment of FIG. 1;

FIGS. 7A, 7B, 7C, and 7D are representations of vibrators in accordance with specific different embodiments of my invention and all employable in the musical instrument of FIG. 1;

FIG. 8 is a side view of the rockable key bed together with the rocker rod, as employed in the embodiment of FIG. 1; and

FIG. 9 is an enlarged representation of a single wire and associated actuator employable in the musical instrument of FIG. 1 and in accordance with another illustrative embodiment of my invention.

## DETAILED DESCRIPTION

Turning now to the drawing, FIG. 1 depicts a musical instrument in accordance with my invention having a single manual or keyboard 10. The instrument is depicted with the lid 11 down and the first lid flap which extends over the keyboard 10 and the second lid flap which closes the instrument in front of the keyboard removed. The keyboard 10 is positioned higher above the bottom 13 of the instrument than is usual for keyboard instruments. This is because in this embodiment the keys are positioned above the springs, as best seen in FIG. 6, and the tuning pins are mounted beneath the keyboard 10 behind a tuning pin strip 14 which may be readily removed to allow access to the tuning pins.

The keyboard 10 extends between two sides or cheeks 16, 17. A rocking rod 20 is positioned adjacent the cheek 17 and is held in one of two positions by a bolt or pin 21 extending through the cheek 17. The rocking rod 20 and its function are further explained below with reference to FIG. 8.

Inside the instrument, in accordance with this specific embodiment, are the individual strings 23, as seen in the top view of the instrument depicted in FIG. 2, wherein the lid 11 has been removed. As seen in FIG. 5 each string 23 extends from a tuning pin 25, which is positioned beneath the keyboard 10, across a bridge 69, seen in FIG. 6, and the bridge 27 and around a hitch post 30 of the hitch bar 29 back over the bridges 27 and 69 to an adjacent tuning pin 25. Accordingly, two adjacent notes are defined by the single wire; however, I have found that the two separate strings or portions of this wire defining the two notes can be individually tuned without affecting the neighboring note also defined by the same wire even though the strings are under relatively low tension.

While hitch posts 30 have been depicted in the hitch bar 29, the same result may be attained merely by drilling adjacent holes in the hitch bar and threading the wire through the two holes for the two strings 23.

Turning again to FIG. 2, it will be noted that I do not provide any sounding board in my instrument, as is usual in keyboard instruments. Instead the tones initiated by my unique key action, as described below particularly with reference to FIG. 6, are detected by electromagnetic transducers and applied to amplification equipment, not shown. Specifically, in accordance with an aspect of my invention, I

provide a plurality of individual transducers 33 each of which is positioned, as best seen in FIG. 3, over a number of strings 23. I have found that the tone of the instrument is dependent upon the positioning of these transducers 33 along the strings 23 and that each should be advantageously placed relative to the bridge 27 dependent upon the nature of the harmonic for the specific type of tone I desire. Thus in accordance with an aspect of my invention I provide that each transducer 33 extends across five or six strings. Further, overlapping of the transducers 33 so that two adjacent transducers both are energized by the same string may occur. In this specific embodiment wherein the manual 10 has 61 keys I provide twelve transducers 33 with each extending over five strings 23 except for the first transducer responsive to the highest notes, which first transducer extends over six strings.

Each transducer or magnetic pick-up 33 advantageously comprises a magnetic material, such as a magnetic plastic, capable of providing the desired magnetic field, mounted between two steel flux direction plates 36, 37, and held together as a unit by screws 38. The unit itself is supported by a support bracket 39 from the bottom 13 of the instrument, to which it is attached as by screws 40; alternatively the units may be hung from a support rail above the strings.

A plurality of turns of wire 42, such as only twenty-five turns, are wrapped around the magnetic material and between the plates 36, 37 to define the coil winding. These windings 42 are connected in series, as by wires 43, and the series connected coils are in turn connected to an amplifier. While in the embodiment of FIG. 2 I have shown all the coils 42 connected in series to a single amplifier, I have also found it advantageous to split the coils 42 into two sections, for the higher and lower notes, and have each connected to separate amplification equipment and speakers.

Further, as seen in FIG. 4, I have found it advantageous to connect the bridge 27 to the electrical ground of the amplifier so that the strings 23 themselves define an electrical ground grid.

The particular key action in accordance with my invention which gives my instrument its unique tonal qualities is depicted in FIG. 6 which shows a single key 50 supported from a key bed for pivoting, as is usual with keyed instruments. Specifically the key pivots on a curved pivot rail 53 mounted on a fulcrum or pivot bar 54, a pivot or fulcrum pin 55 extending up from the bar 54 through an enlarged slot in the key 50, as is known in the art. A positive return of the key 50 is provided by a pressure spring 57 positioned between the key 50 and a bracket 58 secured to the key bed.

The travel of the key in pivoting around the pin 55 is limited by a limit finger 60 supported beneath the key and traveling between a first felt pad 64 on the key bed 51 and a second felt pad 62 on a stop bracket 63 mounted on the key bed 51.

It is to be noted that, in accordance with an aspect of my invention, the key bed 51 is not rigidly affixed to the bottom 13 of the instrument but is itself slightly movable. Specifically it is connected at its ends adjacent the cheeks 16, 17 by a screw 65 extending through an enlarged washer 66 to two key bed mounting blocks 67 which are themselves rigidly affixed to the bottom 13 at each end of the keyboard, the one side block 67 being shown broken away to show the position of a bridge 69 mounted on the bed 13.

The strings 23 extend from the tuning pin 25 in the tuning pin block 68, beneath the keys as discussed above, over the nut or second bridge 69 and between the key bed mounting side blocks 67 and the key bed 51.

In accordance with my invention the string is neither plucked, as in a harpsichord, nor struck by a hammer, as in a piano, or a bar, as in a clavichord; instead I provide a unique action for setting the strings into vibration. This action as well as the other aspects of my invention gives my keyboard instrument its unusual tone. Specifically as seen in FIG. 6 in the normal position before a key 50 is played there is resting on the string 23 a vibrator 70 which serves both to set the string 23 into vibration when the key is depressed and also to damp the vibration when the key is released.

The vibrator 70, which is secured to the end 71 of the key 50, may take any of many specific shapes and forms, exemplary embodiments of which are depicted in FIGS. 7A, 7B, 7C, and 7D. Each of these embodiments has in common that the vibrator have an outer surface capable of sufficiently adhering to the string 23 to lift the string. The vibrator also provides a sufficient softness, either by the member carrying the adhesive material or by a separate member, to damp the vibration without causing additional sound. In each instance the length of the portion of the vibrator 70 along the wire may be only of the order of  $\frac{1}{4}$  to  $\frac{3}{8}$  of an inch.

In FIG. 7A the vibrator 70, which is the one depicted in FIG. 6, comprises a section of sponge rubber 73 on the lower portion of which is coated a thin layer of an adhesive 74. Stiffness is provided by painting the long side of the vibrator with a lacquer, glue, or other material 75 which upon drying stiffens the soft sponge rubber. The layer of adhesive may be quite thin, as of only of the order of  $\frac{1}{16}$  to  $\frac{1}{32}$  of an inch.

If more stiffness is desired, the vibrator 70B of FIG. 7B may be employed wherein the sponge rubber 73 is differently shaped and the lacquer coating 75 is painted on both sides.

In both the embodiments of FIGS. 7A and 7B the adhesive may be of a rubber cement or any other adhesive which retains its tackiness and never hardens; many such adhesives are well known today and are used for a variety of purposes, such as for weather stripping. The adhesive serves to lift the string 23 against its natural tension. The string lifts until the tension in the string overcomes the pull of the adhesive, at which point the string releases and vibrates. It is to be pointed out that the string is specifically not pretensioned by the vibrator 70 resting on it or forcing it down. Instead the vibrator merely rests on the string, adhering to it while in its normal unstressed position due to the tackiness of the adhesive layer 74. I have found that different adhesives will cause the resulting notes to be different timbres.

The sponge rubber 73 serves to soften the damping of the string when the key is released and the vibrator 70 returns to rest on the still vibrating string.

In the embodiment of FIG. 7C the body 76 of the vibrator 70C is of a solid material, such as wood, and there are positioned on the bottom surface of the body member 76 a first layer comprising a rubber pad 77 and a second layer 74 of adhesive. The adhesive 74 serves, as discussed just above, to seize by adhesion of "stickiness" the string 23 and lift it to set it into vibration. The rubber pad 77 serves in place of the sponge rubber body 73 to soften the damping of the string. The rubber pad may be several times larger than the adhesive layer, as of the order of  $\frac{1}{2}$  of an inch thick, depending on the particular material employed. However, care must be taken in determining the thickness of the pad 77. If the pad is too thick, then the pad itself will tend to stretch when the vibrator is lifted by the depression of the key, thereby preventing the immediate attack or lifting of the string 23 by the adhesive layer. However, if the rubber pad is too thin, then when the vibrator 70 is returned to the string 23 to dampen it, it will strike the string too hard and act as a hammer inducing an additional vibration.

In each of the embodiments of FIGS. 7A, 7B, and 7C the adhesion action of the vibrator in accordance with my invention was a surface effect because of the tackiness or adhesive quality of the material employed. There are however materials which will remain sufficiently soft during use to allow the string to sink into the material and be enveloped thereby. The embodiment of FIG. 7D depicts such a vibrator 70D wherein the body 76D is again of wood. In this embodiment a material 78 is coated over the bottom and advantageously partly up the sides of the body member 76, the material 78 being of the group, including caulking compound, which will allow the string to sink into the coating and adhere thereto. Because of this effect the string is again lifted to be set into vibration by the adhesion action, in accordance with this aspect of my invention. I have found, however, that it is desirable with this embodiment to provide a separate damping member, such as a felt finger 79 secured to the body 76D.

As noted above a rocking rod 20 is visible adjacent the cheek 17 in FIG. 1. The purpose and functioning of that bar will now be discussed with reference to FIG. 8. As can there be seen the rod 20 is screwed into or otherwise rigidly affixed to the key bed 51. This bed 51 is capable of a slight rocking action when the rod 20 is moved, as indicated by the arrows 80, to either side of the bolt or pin 21 affixed through the cheek 17. The end of the pin 21 is directly adjacent the rod 20 and the rod has enough lateral flexibility that it can be placed to either side of the pin 21.

The bed 51 is mounted by two screws 65 at either end of the bed to the two key bed mounting side blocks 67 which are in turn rigidly held by the bottom 13. An over size washer 66 allows the screw 65 to move slightly thereby allowing the bed 51 to rock or pivot slightly. The rocking movement may be so slight that the handle of the rod 20 will itself only move about a quarter or a half an inch, that is, from one side of the pin 21 to the other.

Because the attack in my invention is dependent upon the adhering qualities of the vibrator 70 which, when the key is not depressed, sits on the string 23, I have found that when the instrument is not in use there is a tendency for the strings to stick to the vibrators more than is desired during the playing of the instrument and that the degree of adhesion may not be even for all vibrators and strings. Accordingly before playing my instrument it is desirable that all vibrators be simultaneously removed from the strings. This may be done by moving the rod 20 to the front of the pin 21 (away from the position depicted in FIG. 8), which causes the whole key bed 51 to rock slightly, lifting all actions away from the strings. The rod may be moved just before the instrument is played, or the instrument, when not being played, may be left with the rod in this position so that the vibrators are lifted out of contact with the strings at this time.

In a modification of my attack mechanism, as depicted in FIG. 9, I have provided a double acting key, controllable by the force with which the player attacks the note. The vibrator there depicted is the vibrator 70C of FIG. 7C including a wooden body portion 76 and the outer adhesive layer 74 and inner rubber layer 77. Also extending from the key end 71 is a pin 82 extending out from the side of the end 71 and then at an angle down toward the string 23. Attached to pin 82 is a rubber rod 83 extending down at an angle towards the side of the string 23. A metal striker 84 is in turn attached to the lower end of the rubber rod 83 and normally positioned below and at right angles to the string 23.

When the key 50 is depressed normally, or softly, and the vibrator lifts the string 23 and sets it into vibration due to the adhesive action, in accordance with my invention, as described above, the striker 84 is lifted up towards but not against the string 23. However, if the key 50 is hit hard or suddenly by the player, the vibrator is lifted up suddenly. This sudden movement is sufficient to cause the rubber rod 83 to snap upwards slightly, causing the striker 84 to hit the under side of the string 23 and give a secondary attack on the note produced by the string.

In both instances the string is damped when the player releases the key and lets the vibrator return to rest on the string.

While the above-described embodiment depicts only a single manual instrument, it is obvious that multiple manuals may be provided. Thus a second manual can be provided in which the keys are below the strings and a linkage provided to place the vibrators, employing the adhesion effect in accordance with my invention, above the strings. Similarly a second key block can be placed above the second keyboard and within the main part of the instrument, as is usual in harpsichords and pianos, rather than below a keyboard, as described above.

If a third manual is desired its tuning block can be placed at the other end of the strings, where the hitch bar is shown in the above-described embodiment.

Further, while a separate bridge bar and hitch bar are depicted, they may be both incorporated in a single member and

the bridge bar itself serve as the hitch bar, since no pins are required and the wire is just extended through and around the hitch post to allow two adjacent strings to be defined by a single wire.

Further while damping or felt pads have not been depicted, they may be placed on the strings between the bridge and the hitch bar and advantageously just adjacent the bridge, as is known in the art.

While specific illustrative embodiments of my invention have been depicted and described, it is to be understood that they are merely illustrative of the application of the principles of my invention and that various modifications and other arrangements may be devised without departing from the spirit and the scope of my invention. I have found that in playing the embodiment described one can feel the strings because of the direct coupling provided in which, at rest the string is directly attached to the key by the adhesion of the string to the vibrator 70.

I claim:

1. In a musical instrument, a vibratory string under tension and means for setting said string into vibration, said means including a member resting on said string and to which said string adheres, at least a portion of said member being resilient, and means for raising said member whereby said string is concurrently raised therewith by the adhesion of said string to said member and then is released and set into vibration.

2. In a musical instrument, the combination in accordance with claim 1 wherein said member is of a solid material having a layer of resilient material and a layer of adhesive thereon, said adhesive being in contact with said string.

3. In a musical instrument, the combination in accordance with claim 1 wherein said member is of a resilient material having a coating of adhesive between it and said string.

4. In a musical instrument, the combination in accordance with claim 1 wherein said member is of a solid material having a coating thereon of a soft resilient material into which said string sinks so as to be enveloped thereby when said member is resting on said string.

5. In a musical instrument, the combination in accordance

with claim 1 wherein said means for raising said member and lifting said string comprises key action means.

6. In a musical instrument, the combination in accordance with claim 5 further comprising means for rocking said key action means so as to remove said member from said string.

7. In a musical instrument, the combination in accordance with claim 1 further comprising a striker below said string and flexible means attaching said striker to said member.

8. In a musical instrument, the combination in accordance with claim 7 wherein said means for raising said member and lifting said string comprises key action means, said striker being positioned below said string so as not to contact said string on normal striking of said key action means but sharp striking of said key action means causing said flexible means to bend and cause said striker to strike said string.

9. A musical instrument comprising a plurality of strings, individual action means for setting said strings into vibration, and keyboard means for operating said action means, each said action means comprising a member resting on one of said strings and having a resilient portion and said string adhering to said member when said member is resting on said string.

10. A musical instrument in accordance with claim 9 wherein said member includes an adhesive coating to which said string adheres.

11. A musical instrument in accordance with claim 9 wherein said member is of solid material and has a coating of a soft resilient material into which said string sinks so as to be enveloped thereby.

12. A musical instrument in accordance with claim 9 further comprising a key bed means supporting said action means on said key bed, and means for rocking said key bed so as simultaneously to remove all said members from said strings.

13. A musical instrument in accordance with claim 9 wherein at least certain of said action means further include a striker below said string and flexible means attaching said striker to said member, the length of said flexible means being such that said striker does not strike said string unless said keyboard means is played sharply enough to cause said flexible member to flex and throw said striker against the under side of said string.

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