

Aug. 11, 1970

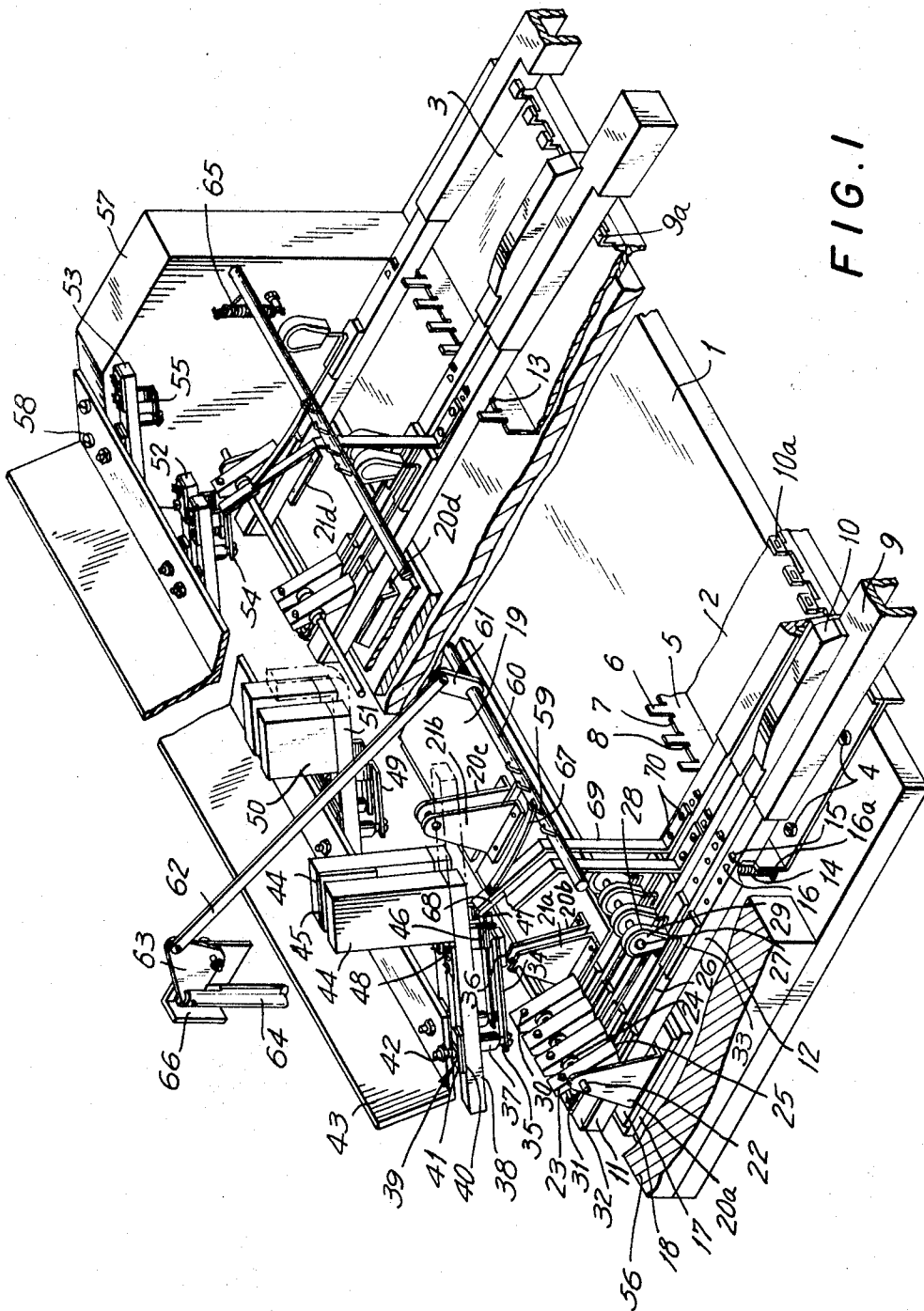
K. SCHERER ETAL

3,524,008

REED-TYPE MUSICAL INSTRUMENT WITH ELECTROMAGNETIC PICKUPS

Filed Aug. 13, 1968

3 Sheets-Sheet 1



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3 Sheets-Sheet 5

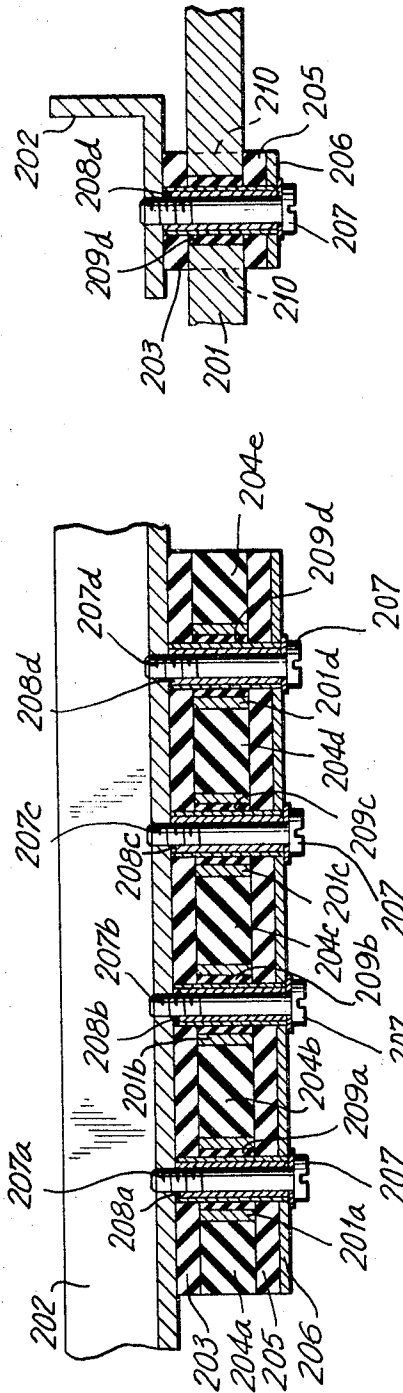


FIG. 4b

FIG. 4a

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REED-TYPE MUSICAL INSTRUMENT WITH ELECTROMAGNETIC PICKUPS

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Filed Aug. 13, 1968, Ser. No. 752,227

Claims priority, application Germany, Oct. 16, 1967, H 64,178

Int. Cl. G10d 13/00; G10h 3/04

U.S. Cl. 84-1.15

25 Claims

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide an electronic musical instrument of the above general type which does indeed make it possible to provide for impact vibration in such a way that not only will the desired tone be achieved but in addition this tone will not be accompanied by the disturbing undesirable impulse or noise which is unavoidably transmitted to the pick-up with conventional structures.

Also, it is an object of the present invention to provide a sound-generating structure which is so simple and compact that the required number of vibratory assemblies and hammer-actions coacting therewith can be easily accommodated in an instrument similar to a piano where the vibratory assemblies can be actuated in response to depression of keys of a keyboard.

In accordance with the invention the vibratory means with which a pick-up means coacts to convert the mechanical vibrations thereof into electrical waves is itself carried by an elongated bar means which has a mass substantially greater than the mass of the vibratory means. A support means is provided to carry a vibratory assembly which is formed by the bar means and vibratory means, this latter assembly vibrating about a predetermined nodal point. This support means which has a mass at least as great as the mass of the vibratory assembly is connected to the latter through an elastic means which while providing for support of the vibratory assembly on the support means nevertheless permits the entire vibratory assembly to vibrate freely with respect to the support means about the nodal point. With a construction of this type, particularly where the pick-up means is itself mounted on the bar means, the above-discussed disadvantage of the disturbing impulse which is primarily of low frequency and which necessarily accompanies the impact of the vibratory means as by a hammer action, is eliminated inasmuch as when a hammer-action strikes the vibratory means of the invention, this undesirable impulse is completely absorbed in the elastic connecting means between the bar means and support means so that this impact cannot result in transmission of any undesirable vibrations through the vibratory assembly to the pick-up.

Tests have shown that the separation of these undesirable vibrations is achieved in a particularly effective manner when the vibratory assembly is fixed at the nodal point to the elastic means. This nodal point about which the vibratory assembly vibrates is located, with the dimensions of the vibratory means and bar means which are used in a practical construction, at approximately 1/5 along the length of the elongated bar means which forms the carrier for the vibratory means, in the case where the vibratory means is fixed by a spacer approximately to the center of the elongated bar means with the end of the vibratory means, in the form of a reed, for example, which is distant from the spacer being free to vibrate. The elongated bar means will extend at both ends beyond the vibratory reed or the like, and the results of the invention are still achieved when that end of the bar means which extends freely beyond the vibratory end of the reed is shortened up to one-third of its length and where this mass which is thus eliminated from the longitudinal portion of the bar means is replaced instead by a metal block situated at the free end of the shortened bar means. Such a metal block must have approximately twice the mass of the part of the bar means which has been removed. Inasmuch as with a construction of this type, according to the invention, it is possible to situate in the bass region of the instrument, in particular, vibratory assemblies whose elongated bar means are much shorter than has hitherto been possible, the structure of the invention can be utilized without difficulty in regions such as in the bass tonal region of

ABSTRACT OF THE DISCLOSURE

A musical instrument which is electrically operated. The instrument includes a vibratory means which is adapted to be set into mechanical vibratory motion and an electrical pick-up means coacts with the vibratory means to convert the mechanical vibrations thereof into electrical waves. An elongated bar means which has a mass substantially greater than that of the vibratory means carries the latter, and the instrument further includes a support means which is stationary and has a mass at least as great as that of the vibratory assembly which is formed by the elongated bar means and vibratory means carried thereby. This latter vibratory assembly will vibrate about a given nodal point, and an elastic means which is situated substantially at this nodal point interconnects the vibratory assembly with the support means so that the latter will carry the vibratory assembly in a manner permitting the entire assembly to vibrate about the nodal point due to the elastic connecting means. In this way even if the vibratory means is set into vibration as a result of impact derived from a hammer-type of action, proper sounds will be produced.

BACKGROUND OF THE INVENTION

The present invention relates to electrical musical instruments.

In particular, the present invention relates to electro-mechanical vibration generators for musical instruments of the electronic type where a vibrator in the form of a rod, reed, or the like, is carried by a suitable carrier. This carrier has a relatively large mass as compared to that of the vibratory element, and the carrier is itself supported by a supporting structure. A pick-up coacts with the vibratory element so as to convert the mechanical vibrations into electrical vibrations or waves.

With known electronic musical instruments of this general type where mechanical vibrations of a string, rod, or reed are picked up, the only types which have proved to be of any great success in practice are those where the vibratory element is plucked in a manner similar to the strings of a harpsichord. Electronic musical instruments having reeds which are vibrated by impact, as through a suitable hammer action as known in conventional pianos, have not yet been satisfactorily constructed.

The primary reason why an impact type of vibration excitement has not been used in electronic instruments of this general type is that the reeds are carried by a support which with the reed, when it is struck, results in an accompanying impulse which cannot be eliminated and which is exceedingly disturbing to and detracts greatly from the quality of the sound which can be achieved. There are no known constructions where this highly undesirable impulse resulting from the impact of the hammer can be eliminated to such an extent that it is possible with electronic musical instruments to achieve from the impact-vibrated elements pure sounds similar to those of a piano.

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the instrument without requiring an undesirably large amount of space for the vibration generating structure. The same relationships can be achieved in the case where the elongated bar means, without being shortened, instead is angularly arranged in the vibratory plane of the vibratory assembly.

It is thus apparent that an important feature of the invention resides in the elastic means which interconnects the bar means of the vibratory assembly with the support means. This elastic means can take the form of a pad or layer of rubber or material having properties similar to rubber, or a different type of spring arrangement can be provided. It is particularly suitable when using a layer of rubber-like material to vulcanize or otherwise adhere this layer at its opposed surfaces on the one hand to the bar means and on the other hand to the support means. Thus, a plate which is fixed in this way to one face of the elastic layer can be connected through a suitable threaded fastener with the support means. Where a structure of this type is used, in accordance with the invention, it is possible in a simple way to bring about an exchange of an entire vibratory assembly so that it can be replaced for repair purposes, for example. This possibility of interchanging one vibratory assembly for another can be achieved in other ways as where part of the elastic connecting means is connected to the bar means and part to the support means, with these parts removably connected to each other. With a construction of this latter type it is possible to achieve the advantage of eliminating any stressing of the elastic material in tension by the weight of the bar means.

The simplest form of elastic connecting means as a spring is a construction where a metallic leaf spring is used, such as a curved leaf spring which has a pair of opposed ends connected to the bar means and which has an intermediate portion connected to the support means. In the event that a leaf spring assembly which is of greater yieldability is desired, then it is possible to use a pair of curved leaf springs connected to each other at their ends and respectively having their intermediate portions connected respectively to the bar means and the support means. As an alternative form, it is also possible to use a simple one-piece spring ring such as an endless circular spring cut from a thin-walled tube of bronze, for example, such a ring being connected at a pair of diametrically opposed portions with the bar means and support means, respectively.

With all of the above forms of the elastic connecting means, there is a fulfillment of the requirement that the bar means and support means be insulated from each other sufficiently with respect to the vibratory movement of the vibratory assembly, particularly in its vibratory plane, while at the same time a secure connection is achieved between the support means and the vibratory assembly. It may also be desirable to limit or eliminate the vibratory insulation under certain conditions as where the musical instrument is to be played in a special way or where the instrument is to be transported, by situating between the elongated bar means and the support means, or between the housing of the instrument and the bar means an additional more or less elastic structure, such as a suitable spring, rubber pad, or the like, which will be situated at a location preventing relative movement between the bar means and support means.

In carrying out the invention the vibratory means may take the form of an elongated vibratory reed connected at one end portion and at one side to the elongated bar means which extends parallel to the reed. In the event that the vibratory means is made up of a plurality of such reeds, then these reeds can be situated where they have the same or different tones in a spaced parallel relationship where they are located beside or over each other. Where the several reeds are to provide different tones and are to be actuated by different keys, it is possible to provide an exceedingly inexpensive construction

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with the present invention. The selection of the different vibratory elements of different tones on a single carrier structure should however be carried out in such a way that the tones are sufficiently different from each other to prevent an undesirable opposed coupling of the tones with respect to their frequency. Thus, by situating a plurality of such vibratory elements on a single carrier such as a suitable bar means it is possible to provide with the invention an exceedingly small number of vibratory assemblies which in fact are fewer than the number of keys of the instrument. If, however, there is for each key a vibratory assembly according to the invention each having different vibratory elements for different tones, then it is possible with this structure of the invention to achieve a musical instrument which presents musical possibilities incapable of being achieved heretofore.

Where the structure of the invention is designed, however, in such a way that the keys of the instrument and the hammer-actions actuated thereby and vibratory assemblies responding to the actions are distributed according to a conventional musical scale of tones, the several elongated bar means and vibratory means carried thereby are situated beside each other and carried by a common support means which extends primarily in a direction parallel to the keyboard with a group of the vibratory assemblies being carried by the common support means and fixed thereto by the elastic means of the invention. By providing bar means which are somewhat smaller than the distance between the keys, the structure of the musical instrument is rendered exceedingly simple and uncrowded with the possibility of combining with the hammer action damping means to engage the free ends of the vibratory elements to provide effects which are conventionally achieved by the pedal action of a piano. In another type of instrument, however, such as one where a multiplicity of tones are achieved through an electronic structure in which the vibratory means is automatically excited, it is of advantage to provide the electro-mechanical vibration generators with a support which is separate from and situated only over the housing of the device.

The electro-mechanical vibration generator of the invention, whose advantages are particularly apparent in connection with a hammer-action, is nevertheless also capable of being used with a plucking type of action. Even with this latter type of action it is essential or at least desirable to avoid as much as possible impulses which accompany the excitation of the vibration but detract from the quality of the sound which can be achieved. With the present invention it is possible to eliminate such undesirable accompanying impulses to a very great degree so as to achieve a very high quality of sound.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary partly sectional perspective illustration of a musical instrument which includes features of the present invention;

FIG. 2 is a transverse sectional elevation of another embodiment of a musical instrument according to the invention;

FIG. 3 is a fragmentary schematic illustration of another type of elastic means for interconnecting a bar means and support means;

FIG. 4a is a fragmentary longitudinal sectional elevation showing still another form of elastic means for interconnecting a support means and bar means; and

FIG. 4b shows in a fragmentary section part of the structure of FIG. 4a in a plane taken transversely through the plane of FIG. 4a.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown therein a base plate 1 of the instrument, the lower right portion of the

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base plate 1 of FIG. 1 being directed toward the player of the instrument and carrying a profiled sheet metal supporting structure the left and right ends 2 and 3, respectively, of which are visible in FIG. 1 and fixed to the base plate 1 by way of the screws 4. This profiled sheet structure 2, 3 has a rear upstanding wall 5 provided with upwardly directed smaller projections 6 which are relatively narrow and which extend to an elevation substantially higher than the elevation of substantially wider projections 7 situated respectively between and alternating with the projections 6 and defining with the latter upwardly directed notches 8. The sheet structures 2, 3 has at its front edge known pads 10a on projections 9a which serve to guide the keys 9, 10 of the instrument. These keys have extensions 11, respectively which are of a hollow U-shaped cross section in the same way as the keys themselves and which have opposed side walls 12 which extend into the notches 8, the side walls 12 of the extensions 11 respectively having at their lower edges indentations 13 which receive the lower ends of the notches 8 so that a knife-blade type of rocking support is provided for the several keys and extensions thereof. In this way when the keys are depressed about the lower horizontal edges of the notches 8 the rear ends of the extensions 11 will move upwardly. The several narrow but higher projections 6 respectively extend through suitable openings 15 formed in the top walls of the extensions 11 for limiting the extent of turning of the keys and their extensions. The several keys are held on their knife-edge supports by way of tensioned springs 14 respectively connected to the keys and openings 16 thereof and to the wall 5 at rearwardly directed brackets 16a which are connected thereto.

At the rear end of the base plate 1 which is directed away from the player of the instrument there is an elongated mounting board 17 which extends throughout the entire length of the keyboard and on which mounting brackets 18, 19 are situated, these brackets including a plurality of upwardly directed bearing walls 20a-20d and 21a-21d. These elements are arranged in a manner shown in FIG. 1 for the purpose of supporting the shaft 22 which serves to support for rotary movement the cams 23 of the hammer actions illustrated. The several cams 23 are respectively situated over the extensions 11 of the several keys. Suitable spacers 24 are situated between the cams 23 to locate them at proper distances from each other, these spacers 24 being made of plastic or felt. The supporting of the cams 23 on the shaft 22 takes place in a manner known in the piano art with the use of suitable bushing and the like. The cams 23 respectively have suitably profiled camming surfaces which respectively carry the hammer shafts 26 at one end of the latter, these shafts 26 respectively carrying distant from the cams 23 the hammers 29 which are provided with the weights 27 and covered with felt liners 28. At the other ends of the camming surfaces, the cams 223 carry, in threaded bores 30, adjustable stops 31.

Thus, when a selected key, such as a key 9 is depressed, then the extension 11 thereof is raised behind the pivotal supporting structure 5, 13 so that the sliding camming surface 25 of the coating cam or hammer butt 23 of the action rolls on the layer 32 of felt or similar material which is fastened to the extension 11 in such a way that the hammer 29 is displaced from the location where the hammer shaft 26 engages the strip 33 which is also made of felt or a similar material about the shaft 22 upwardly toward the rear section of a vibratory means in the form of a reed 34 at the region 35 where the reed is fixed by a spacer 37 to an elongated bar means 38. Thus, as a result of the impulse derived from the depression of the key 9, the upwardly thrown hammer can swing to strike the vibratory element 34, this swinging of the hammer being limited by engagement of the stop 31 with the upwardly raised rear end portion of the extension 11, which is to say with the layer 32 thereon, and then the hammer will be retracted back down to its rest position

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from the vibratory element 34. This principle of operation has been known in the impact actions of pianos since the beginning of the construction thereof and does not form in itself any part of the invention. The short description thereof presented above is provided only in connection with the structure of the invention described below.

The illustrated vibratory means 34 shown at the left of FIG. 1 is in the form of a reed loaded at its freely vibrating end by way of a head member 36 and held at its opposed end 35 by a spacer 37 in the form of a sleeve through which a screw extends for fixing the rear end of the vibratory means 34 to the elongated bar means 38 to which this latter screw is connected. In this way the elongated bar means 38 and the vibratory means 34 extend parallel to and are spaced from each other with a suitable spring washer or the like interposed in a known way at the connection between the reed 34 and bar 38. This elongated bar means 38, which thus carries the vibratory means 34 and forms a vibratory assembly therewith, is in turn connected through an elastic means with a support means 41-43. In this example of the invention the elastic means takes the form of an elastic layer 40 of rubber or a material having elastic properties similar to rubber, this layer 40 being glued or vulcanized directly to the surface of the bar 38 which is directed away from the reed 34. The opposed surface of the layer 40 is glued or vulcanized to the plate 41 which together with the plate 40 forms the assembly 39. A screw 42 forms a threaded fastener for interconnecting the plate 41 with the angle bar 43 of the support means, and the screw 42 carries a suitable nut and washer assembly by means of which the plate 41 is fixed to the angle member 43. The mass of the support means 41-43 is at least as great as the mass of the vibratory assembly 34, 38, and the mass of the bar means 38 is substantially greater than the mass of the vibratory means 34. Thus, the metallic angle member 43 has the screw 42 fixed thereto and incapable of rotating with respect thereto as for example through the use of suitable lock washers, and in this way the vibratory assembly 34, 38 is prevented from rotating about the axis of the screw 42 with respect to the angle member 43. The particular vibratory assembly 34, 38 illustrated at the left portion of FIG. 1 is situated in the lower, base region of the tonal scale and thus has a relatively large vibratory mass as is conventional with low tones. Because of the required mass for the vibratory assembly at this region of the instrument, it is essential for the elongated bar means 38 to have a substantial length extending from the part of the bar 38 which is situated beneath the angle member 43. However, the requirement of a substantial length of bar 38 extending forwardly beyond the angle member 43 is avoided with the structure of the invention by providing instead of a bar which would have a length as indicated by the dotted line extension of FIG. 1 a shorter bar 38 which carries in place of the eliminated forward portion thereof shown in dotted lines an additional weight 44 of approximately double the mass of the eliminated portion. Inasmuch as the additional weight 44 because of its relatively great height might possibly vibrate about the longitudinal axis of the bar 38, a pad 45 is provided on one side of each additional weight 44.

The inductive sound pick-up 46 is situated beside the free vibratory end of the reed 34 and is in the form of a downwardly extending ferromagnetic strip of sheet metal forming a pole shoe surrounded by and carrying a winding 47 and curved or bent so as to extend to the region of the adjoining side edge of the reed 34 in such a way that the distance between the lower edge of the ferromagnetic strip and the side edge of the reed 34 is as small as possible. The ferromagnetic strip is directly fixed to the elongated bar means 38 by way of a connecting plate 48. Instead of an inductive pick-up, it is also possible to use a capacitive pick-up the metal strip of which can be in the form of a strip of any desired metal and must only be mounted opposite the reed in an

insulated manner. The connection of an inductive or capacitive sound pick-up, the means for initially magnetizing or providing the electric potential, and the further electrical connections to an amplifier and loudspeaker are not described and shown since such features are well known. A particular production of sound can be achieved when the sound pick-up is simultaneously both inductive and capacitive and the electric potential of the electrode together with the potential of the winding are mixed in such a way that the mixing ratio is adjustable and the polarization of the potential is reversible.

At a further region of the keyboard, which adjoins the part thereof which produces the deepest tones, there are vibratory reeds 49 which have a vibratory mass which is not as great as that of the reeds 34. Therefore, a smaller additional weight 50 is required for the bar means 51 of these vibratory assemblies, the weights 51 being of a lesser height and thus of a smaller mass than the weights 44. This construction is provided under the condition where the elongated bar means 51 without any additional weight would not have to be quite as long as the bar means 38. In the same way additional bar means 552 without any additional weights and bar means 53 of shorter lengths than the effective length of the bars 38 are provided in the regions of the instrument which produce the higher tones inasmuch as the vibratory masses of the reeds 54 or 55 of these vibratory assemblies are even smaller. As is indicated in dotted lines at the front end of the bar 51, it is possible instead of using an additional weight 50, to bend the carrier bar so that in order to save space its front region is angled upwardly. The bar carries 51-53 are respectively connected through identical elastic means with the support means 43, this elastic connecting means corresponding to that described above in connection with the bar means 38. The angle member 43 is in the form of a suitably profiled elongated metal member extending across the rear of the entire structure and connected to the lateral end blocks 56 and 57 by way of screws 58. These lateral end blocks 56 and 57 which are carried by the base plate 1 serve also to support for rotary movement a shaft 60 of a damping assembly, this shaft 60 carrying the plurality of pins 59. The shaft 60 is connected by the lever 61 with a link 62 which is in turn connected with a lever 63 pivotally carried by a bracket 66 and connected to the top end of a tube 64 whose bottom end is connected to a pedal-actuated mechanism known in the art. The shaft 60 can thus be turned in opposition to a spring 65 which retracts the damping assembly to its rest position. The several pins 59 are respectively connected to the ends of bands 67 of leather or similar material, so that when the shaft 60 is turned in opposition to the spring 65 damping pads 68 together with the springy carrier brackets 69 therefor made of sheet metal are displaced from the free ends of the vibratory reeds. Thus, with this construction it is possible to maintain the vibratory movement of the reeds even after the keys are released. This same effect is achieved upon actuation of a given key. Thus, the carrier 69 of each damping pad 68 is connected by screws 70 with an extension 11 of a given key, so that whenever a given key is depressed the individual damping pad 68 which is connected thereto is individually raised from the reed which is to be set into vibration.

The above-described structure shown in FIG. 1, including the base plate 1 and the end blocks 56 and 57 can either be introduced as a separate unit into the housing of an electronic musical instrument, or part of the housing thereof may be formed by the components 1, 56, 57. Within the housing of the instrument it is also advantageous to locate the amplifier and loudspeaker, although the latter arrangement is not essential since it is possible, if desired, to use a special amplifier or a special loudspeaker in certain cases.

Instead of a single elongated metal angle member 43

to form the substantially rigid supporting structure, it is also possible to use a plurality of such components distributed along the rear of the instrument and each carrying a predetermined group of vibratory assemblies so that such a given group can be separated from the housing as a complete unit for repair purposes while the same group with its common support can be interchanged with a properly operating unit if desired.

Referring now to FIG. 2, there is shown therein the upper part of an electronic musical instrument having the electro-mechanical vibration generator of the invention, this structure being shown in section in FIG. 2. The housing of this structure includes the keyboard base plate 101, the front cover strip 102, the front housing wall 103, the base plate 104, the rear housing wall 105, the hinge-carrying strip 106 which carries the hinge 107, the cover 108 connected to the hinge 107 so as to be swingable, and the front cover plate 109 which is connected to the hinged top wall 108 to be swingable therewith between a pair of lateral side walls of which only the right side wall 110 is visible in FIG. 2. The keyboard is made up of white keys 111 and black keys 112 which are supported for swinging movement about a shaft 114 in a known way, this shaft being carried by the supporting sheet structure 113, and the extensions 115 of U-shaped section are situated with suitable spacers 116 therebetween on the shaft 114 with a tensioned spring which is not illustrated connected between each extension 115 and the supporting sheet structure 113 to yieldably hold each key in its operating position ready to be depressed by the operator. The profiled sheet metal 113 is carried by a board 117 which is in turn mounted upon the base plate 101 of the keyboard. The ends of the keyboard are closed by side walls of which the right side wall 118 is visible in FIG. 2. At the rear end of each key extension 115 there is a lever 119 which is fixed to the rear end of each extension 115 and which carries at its lower region a damping strip 120 of felt or the like engaged by the sliding cam profile 121 of the hammer cam 122. Thus, upon depression of a selected key, the lever 119 will swing about the shaft 114 in a clockwise direction with the camming profile 121 sliding and rolling along the strip 120, while the cam 122 turns about its supporting shaft 123 in a counter-clockwise direction, as viewed in FIG. 2, in opposition to the retracting force of the tension spring 127 which is connected to and extends between a rod 126 carried by a supporting block 125 and a pin 124 carried by the cam 122. As was the case with the action of FIG. 1, the end position of the hammer cam is adjusted by way of the adjustable stop structure 131. The hammer includes the hammer shaft 128 fixed to and extending from the cam 121 and carrying the hammer 130 which is covered by the felt strip 129 or the like. As was indicated above such actions are well known in the art. The supporting block 125 is carried with other unillustrated supporting blocks on a bearing plate 132 which is fixed to the base plate 104 of the housing.

The vibratory assembly of the invention which is shown in FIG. 2 also includes an elongated vibratory reed 134 having a head 133 at its free vibratory end while at its lower end it is connected by a spacer assembly 135 with the elongated bar means 137, the spacer assembly including the threaded fastener 136 which is threaded into a suitable bore of the bar 137 for mounting the reed 134 thereon. This bar 137 carries at its top end the additional weight 138 which functions in the same way as the additional weight 44 of FIG. 1. The additional weight 138a illustrated in dotted lines in FIG. 2 is part of a vibratory assembly which achieves lower tones than the assembly shown in FIG. 2 so that a larger vibratory mass is provided. In all cases, however, the vibratory mass of the elongated bar means is greater than the mass of the vibratory means 134. For producing tones higher than that which will be achieved with the structure shown in FIG. 2, the bar means will have smaller additional weights or will

have no additional weights while at the uppermost tones the bars will become gradually of a shorter length, as shown by the dotted line 139. The angle member 140 which forms the support means for this embodiment is carried by spacer blocks on the base plate 104, and only the right spacer block 141 is visible in FIG. 2.

In the embodiment of FIG. 2 the elastic means of the invention which interconnects the vibratory assembly 134, 137 with the support means 140 takes the form of a leaf spring structure which is situated between the bar 137 and the upstanding wall 142 of the angle member 140. In this case the elastic means is formed from a pair of leaf springs 144 and 145 which are curved in the manner illustrated in FIG. 2 and joined at their outer free ends to form a spring support similar to that which is used to support wagons. A threaded fastener 146 serves to connect the leaf spring 144 at an intermediate portion thereof to the bar 137 while a threaded fastener 147 serves to connect the leaf spring 145 at an intermediate portion thereof to the wall 142. Suitable lock washers can be combined with these fasteners to prevent turning thereof and to maintain the structure in assembled condition. The bar 137 also serves to carry the inductive sound pick-up 148 which has the pole shoe of flat profile carrying the winding.

In the rest position of the keyboard, the top vibratory end of the reed 134 is engaged by the damping pad 150 glued or otherwise fastened to the springy metal band or feeler 149 which is fixedly carried by the upper end of the lever 119. Therefore, when a key is depressed the damping pad 150 will be raised away from the vibratory reed 134 simultaneously with the actuation of the hammer action to impart vibratory movement to the reed 134 by impact therewith. The pedal mechanism which is not illustrated in detail in FIG. 2 serves when actuated to rotate a shaft 151 which has a plurality of pins 152 fixed thereto, and these pins are connected by pull elements indicated in a dot-dash line in FIG. 2, with the springy pad supports 149 so as to raise the latter and maintain the damping pads 150 out of engagement with the reeds when the pedal is actuated.

The manner in which the structure of the invention operates is more clearly apparent from FIG. 2 than from FIG. 1 because of the larger number of details which are included in FIG. 1. It is possible to see from FIG. 2 that when the vibratory element 134 is set into vibration, because of the connection between the reed 134 and the bar 137 a vibratory motion is created where the amplitude of the vibrations of the reed 134 and the bar 137 are substantially different because of the mass relationship therebetween and also the vibrations are carried out in phase opposition. This relationship between the reed 134 and the bar 137 of substantially larger mass corresponds fully to the known methods for coupling mechanical or electrical vibratory structures. The pair of components, which is to say the reed 134 and the bar 137 thus form a vibratory assembly where the elements 132 and 137 are simultaneously deflected in opposed directions so that there will be located between these components, below the spacer 135, the nodal point about which the vibratory assembly vibrates. One of the important features of the invention resides in connecting the entire vibratory assembly 134-137 at the location of this nodal point by way of the elastic means to the support means, so that as a result practically no energy is dissipated at the connection of the vibratory assembly to the elastic means, resulting in this way in vibrations of low frequency, each taking a relatively large period of time, in a manner which cannot be achieved with other types of rod or reed vibrators.

The upper part of FIG. 2 shows an elongated bar 154 of rectangular cross section, in dotted lines, formed with notches for receiving the top end of the bar 137 and the additional weight 138 connected thereto, this bar 154 being made, for example, of a foam plastic of the type used in modern packages for transporting delicate articles. This

element 154 is carried by the cover 108 between the latter and the bars 137 with the added weights 138 thereof to engage the bars 137 and prevent movement thereof during transportation or when the instrument is not used, so that it is possible to achieve in this way a mechanical protection against damaging of the components 137 and 138 which have a certain weight and which might possibly be damaged during transportation or during long periods when the instrument is not used.

As is indicated in FIG. 3, the elastic means may also be composed of a single simple curved leaf spring 155 connected at an intermediate portion to the support means 140 and at its free ends 156 and 157 to the bar means 137. The center of the leaf spring 155 is connected to the support 140 by way of a threaded fastener which with suitable lock washers or the like is prevented from rotation. In this way the spring 155 is also prevented from turning about the axis of the screw fastener with respect to the support means 140. The simple initially curved leaf spring 155 must, as is clear, in order to achieve an operation which will correspond to that achieved with the pair of springs of the spring means 143, be made of a spring material which is of lesser thickness and/or width.

In FIG. 4a, there is fragmentarily illustrated in section the connection between a group of electromechanical vibratory assemblies of the invention, FIG. 4a being a longitudinal section taken along the support means formed by the metallic angle member 202. FIG. 4b shows the structure in a transverse section as compared to FIG. 4a. FIGS. 4a and 4b in particular illustrate another embodiment of the elastic means which interconnects the bar means of the several vibratory assemblies with the support means. The elastic means of this embodiment includes portions respectively connected to the plurality of bar means and portions connected to the support means, these portions being separable from each other so that a releasable connection is provided. Each bar means 201a-201d, simply designated as 201 in FIG. 4b, is surrounded at all four sides by interposed layers of rubber or material similar to rubber, the rubber layers which form the elastic means all having approximately the same thickness. Thus, located directly next to the elongated support means 202, along the underside of the bottom wall thereof, is an elongated strip 203 of rubber or rubber-like material, and along the lower surface of this strip 203 are the several elongated bar means 201a-201d with the intermediate spacer blocks 204a-204e of rubber or rubber-like material interposed therebetween. At the lower surfaces of the bars and spacers is a second elongated strip 205 of rubber or similar material, and finally the lower surface of the strip 205 is engaged by a covering plate 206 of metal, the entire assembly being held together by way of the screws 207a-207d. These screws have threaded portions received in threaded bores of the lower wall of the angle member 202, with suitable washers and the like being provided to prevent rotary movement of the screws once they are in their final positions. The several screws 207a-207d respectively extend through spacer sleeves 208a-208d, these sleeves providing a precisely predetermined pressure for the rubber intermediate layers. In order to provide an insulation between the vibrations of bars 201a-201d with respect to the substantially rigid spacer sleeves 208a-208d, so that the connection between the support means 202 and the bar means 201a-201d can be elastic in accordance with the invention, the spacer sleeves 208a-208d which are made of metal are respectively surrounded by rubber sleeves 209a-209d which, for the purpose of increasing the extent of insulation of the vibrations, are provided with inner diameters greater than the outer diameters of the spacer sleeves 208a-208d.

By providing the intermediate blocks 204a-204e with a length, indicated by dotted lines 210 in FIG. 4b, approximately equal to the width of the strips 203 and 205, so that these components 204a-204e are not too small, then the assembly of FIGS. 4a and 4b forming the elastic

means of this embodiment will also function to prevent lateral swinging of the plurality of elongated bar means toward or away from each other in the event that the connection is provided, as shown in FIGS. 4a and 4b, only through a single screw. It will be noted that with this construction upon removal of only one of the fastening screws 207a-207d, the bar means 201a-201d previously fastened thereby to the elastic means can be very simply removed from the assembly with the elastic sleeve 209a of the elastic means being removed with the bar means while the remainder of the elastic means is maintained connected to the support means 202 and the rest of the bar means.

What is claimed is:

1. In a musical instrument, vibratory means, pick-up means coacting with said vibratory means for converting mechanical vibrations thereof into electrical waves, elongated bar means carrying said vibratory means and forming therewith a vibratory assembly which vibrates about a given nodal point, said bar means having a mass which is substantially greater than said vibratory means, support means having a mass at least as great as that of said vibratory assembly, and elastic means connecting said vibratory assembly approximately at said nodal point thereof to said support means to be supported thereby.

2. The combination of claim 1 and wherein said pick-up means is carried by said bar means.

3. The combination of claim 1 and wherein said vibratory means is of an elongated configuration and extends substantially parallel to said bar means, with said bar means being situated on one side of said vibratory means.

4. The combination of claim 3 and wherein said vibratory means includes a plurality of elongated vibratory elements carried by said bar means.

5. The combination of claim 4 and wherein said plurality of vibratory means will provide different tones when vibrated.

6. The combination of claim 5 and wherein said vibratory elements are reeds.

7. The combination of claim 6 and wherein said reed elements are parallel to each other.

8. The combination of claim 7 and wherein said reed elements are fixed at a common location to said bar means and have free ends located distant from said location.

9. The combination of claim 1 and wherein said elastic means includes a layer of an elastic material having properties similar to that of rubber, said layer adhering at one face to said bar means and at an opposed face to said support means.

10. The combination of claim 1 and wherein said elastic means includes portions respectively connected with said support means and said bar means and said portions being removably connected to each other, so that said bar means can be disconnected from said support means with one portion of said elastic means remaining connected to said bar means and the other portion thereof remaining connected to said supporting means.

11. The combination of claim 9 and wherein said support means includes a plate fixedly adhered to said layer, said support means including a substantially stationary rigid member, and a threaded fastener fixing said plate to said substantially rigid member.

12. The combination of claim 1 and wherein said elastic means includes a metallic leaf spring.

13. The combination of claim 12, said elastic means being in the form of an elongated leaf spring which has a pair of opposed ends connected to one of said pair of means and which has an intermediate portion connected to the other of said pair of means,

14. The combination of claim 12 and wherein said leaf spring includes a pair of curved leaf spring members joined to each other at free opposed ends thereof and respectively having intermediate portions connected respectively to said support means and said bar means.

15. The combination of claim 12 and wherein said leaf spring is in the form of a one-piece ring.

16. The combination of claim 1 and wherein said vibratory assembly vibrates in a predetermined plane, and said elongated bar means having a pair of portions extending angularly with respect to each other in said plane.

17. The combination of claim 16 and wherein one of said portions of said bar means which extends angularly with respect to the other forms an additional weight located at one end of said bar means for increasing the mass thereof.

18. The combination of claim 1 and wherein a protective means engages a free end of said bar means distant from said support means to protect the vibratory assembly as when it is transported, for example.

19. The combination of claim 1 and wherein a plurality of said vibratory assemblies are carried by a common support means.

20. The combination of claim 1 and wherein the musical instrument is similar to a piano, damping means engaging an end of said vibratory means in a rest position of the latter, key means for actuating said vibratory means while displacing said damping means to a location spaced from said vibratory means to release the latter for vibratory movement, and pedal means also coacting with said damping means for displacing the latter from said vibratory means at the will of the operator.

21. The combination of claim 20 and wherein an arresting means is situated between said bar means and support means for arresting movement of said bar means with respect to said support means.

22. The combination of claim 1 and wherein a housing accommodates said vibratory means, and said support means being separate from but connected to said housing.

23. The combination of claim 1 and wherein a key-actuated action means includes a hammer assembly for setting said vibratory means into vibratory movement by impact of said hammer assembly with said vibratory means.

24. The combination of claim 1 and wherein said vibratory means is in the form of an elongated vibratory reed, said elongated bar means being in the form of an elongated substantially rigid bar which is longer than and spaced from and parallel to said reed, situated at one side thereof and extending beyond opposed ends thereof, and a spacer fixed to said bar and to said reed at the region of one end thereof so that said reed can vibrate at an end thereof distant from said spacer.

25. The combination of claim 24 and wherein said elastic means is situated at a side of said bar means which is opposite and directed away from said reed.

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