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PIANO KEYBOARD

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The present invention relates to the balancing of the keys and the placement of leads in a piano or similar action.

Heretofore leads have been placed as near the front ends of the keys as possible. This has resulted in the necessity of moving these leads through a given arc in the downward and upward motion of the key. By placing the leads in the keys according to this invention further toward the fulcrum of the keys this arc is diminished and therefore the downward and upward movement of the leads is proportionately diminished. This also reduces the amount of inertia and less effort is required to start the keys on their downward movement.

In the weighing or counter-balancing of keys in quality pianos two sizes of leads are used. In the final adjustment of weight of the keys the smaller lead is used. Heretofore the smaller leads have been mounted in the keys behind the larger leads or toward the fulcrum. According to this invention the positions of the smaller and larger leads are reversed wherein the smaller leads are placed outwardly from or in front of the larger leads to increase the effectiveness of the smaller leads and reduce the amount of weight toward the outer end of the keys and reduce the motion of the weight in the movement of the key.

Also it has heretofore been a principle to even out the touch of the keys throughout the keyboard, that is to add weight to each key so as to equalize the amount of pressure necessary to depress each key of the keyboard. This has also equalized the amount of rebound in each key. As the bass is the heaviest action and requires the most lead to overcome the weight of the hammers, the result obtained in the bass was the determining factor in weighing off the rest of the keyboard. It has been found by experiment and experience that the rapidity and force of the rebound of the key is quite as important for ease and flexibility of playing as ease of downward pressure. It is therefore a purpose of this invention to obtain a greater ease and flexibility of playing by graduating the weight of the keys from base to treble, especially in that portion of the keyboard from the middle to the treble, i. e., from about key 21 to key 88.

The main objects of the invention are to reduce the distance the weights or leads have to travel in the depression and rise of the keys and the inertia which has to be overcome in the movements of the keys, and to weigh off the keys proportionately to the quickness in action of their

respective hammers so that the playing of the piano may be accomplished with less fatigue and muscular effort and greater ease and facility be had in the playing. There is thus accomplished by the present invention greater speed in both fortissimo and pianissimo playing as the quick return of the keys admits the pianissimo notes to be made more staccato than in the old action above referred to, and less effort in playing as the muscular actions involved require expenditure of less energy in playing both precise pianissimos and in playing speedier and more precise fortissimos as compared with the present day action.

Another object of the invention is to provide a piano keyboard comprising a plurality of keys substantially eighty-eight in number divided in groups of bass, middle, treble and extreme treble, weighted members disposed within the shank of each of the keys, between the fulcrum and the free edge of the keys, the downward and upward weights of said groups being inversely proportional to each other, with the downward weight at the bass approximating fifty grams and the upward weight of the bass approximating twenty grams, and the downward weight of the extreme treble approximating forty-five grams and the upward weight of the extreme treble approximating twenty-seven grams, the weights of the intermediate, middle, and treble keys being proportionately ascending or descending.

With the foregoing and other objects in view, the invention will be more fully described hereinafter, and will be more particularly pointed out in the claims appended hereto.

In the drawing, wherein like symbols refer to like or corresponding parts throughout the several views,—

Figure 1 is a diagrammatic showing of the proportionate weighting or counter-balancing of the keys throughout the keyboard, the abscissa showing the approximate key weights in grams and the ordinates showing the relation of the various sections of the keyboard in respect of the weights;

Figure 2 is a side elevation, partly in section and partly broken away, of a key frame and keys with leads mounted in accordance with this invention, the keys being illustrated in normal or elevation position;

Figure 3 is a view embodying the lead mounting of the present invention wherein the larger lead is nearer the fulcrum or balance rail than the smaller lead to reduce the leverage action of the larger lead;

Figure 4 is a like view with the key depressed

and showing the small arc travel of the larger lead in the movement of the key; and

Figure 5 is a fragmentary horizontal section taken through a key showing one construction of lead mounting therein.

Referring now to the drawing, the present invention is applicable to different constructions of piano keys and piano actions, but for the purpose of illustration the invention is disclosed in Figures 2 to 5 of the drawing as applied to the piano key construction disclosed in my prior Patent No. 1,826,848, granted October 13, 1931.

Referring now particularly to Figure 2, 15 designates a key frame, 16 the front rail provided with the usual felts 17 and upwardly projecting pins 18. The white key 19 and the black key 20 are disposed above the key frame 15 and have a rocking movement thereon in order to actuate the actions of the piano in the usual way. The piano actions are omitted from the drawing as they do not form any part of the present invention and they normally rest upon the rear portions of the keys so that the front portions of the keys are normally in elevated or leveling position. In accordance with the usual practice each key at its forward portion is provided with an aperture 21 which extends upwardly from the bottom of the key into the body thereof for the reception of the guide pin 18. The key frame 15 is provided with a balance rail 22 which extends across the frame for the support thereon of the upper and lower rows of white and black keys 19 and 20 for rocking movement from and to their elevated or normal position. The balance rail is provided with pins 23 which project upwardly from the key frame 15 and the balance rail 22 thereon. Each of the keys is provided with an opening 24 for the passage of its individual balance rail pin 23, and this opening extends from the passage of the key through key buttons 25 and 26 secured respectively to the lower and upper faces of the key.

In the upper key button 26 this opening is of elongated form extending lengthwise of the key, as shown by the dotted lines, to provide ample clearances for the rocking action of the key on the pin 23 and to accommodate felt pads or the like which are usually disposed about the pin to effect a gentle contact between the pin and the key.

The balance rail 22 is provided with a bearing 32 which is positioned in a recess 33 provided for the purpose in the balance rail 22, and in order to permit free and unobstructed rocking movement of the key upon the bearing body 32, the latter is cut away both at the front and the rear so as to have in general the form of a half round body. This bearing body may be of any suitable construction, such as disclosed in the prior patent above referred to, and which has a more or less resilient exterior surface to provide for the easy rocking action of the key. The rail pin 23 extends down through the central portion of this bearing body 32. The base or lower end of the bearing body is preferably of angular form so as to hold it against displacement and in proper line with the key which it supports.

As shown in Figures 2, 3, and 5, the heavier lead 38 is disposed in the key, such as 19, nearer the fulcrum or bearing 32 than the smaller or lighter weight 39. By placing the smaller leads in the keys outwardly from or in front of the larger leads the effectiveness of the leads is increased by reason of the fact that path of movement of the lighter leads is greater than the

heavier leads, and it is therefore easier to overcome inertia with less energy than when the heavier leads are placed in front of the smaller leads. It is therefore apparent that keys having leads placed according to this invention will be more responsive, and as the inertia is more readily overcome by pressure of a finger in a light manner, so the return weights will return the keys to normal more readily.

The larger lead 38 is thus disposed on a radius 40 relatively short as compared with the radius 41 of the smaller lead 39. When the key 19 is depressed its rebound or return is accelerated due to the reduction in the inertia set up by the relative positions of the heavier and lighter weights or leads 38 and 39. Furthermore, the positioning of the lighter lead 30 outwardly of the heavier lead 38 relative to the fulcrum or balance rail bearing 32, effects a greater result in the fine adjustment and sizing of the lead 39 so that greater accuracy may be obtained in the counter-balancing of the keys.

These leads 38 and 39 may be mounted in the body of the key or otherwise as is found convenient and necessary to the construction of a quality instrument. In Figure 5 the key body 19 is provided with a large bore or opening 42 which opens through one side of the key and in which may be inserted the large lead 38. Outwardly of the bore 42 is a second smaller bore 43 in which may be disposed the smaller lead 39.

The upward weight of my improved keys is for the bass 20—21; for the middle, 22—23; for the treble, 24—26, and for the extreme treble 27, the meaning of the upward weight being the amount of weight in grams the key will carry from the after touch to the normal level of the key.

To insure quick return of the keys when depressed to their normal leveling positions, and to thus reduce to a minimum the momentum set up in the leads by the depression of the keys, the leads are disposed in close proximity to the fulcrum or balance rail of the keys instead of in or upon the outer end portions of the keys adjacent the guide pins 18 as has heretofore been done.

This peculiar positioning of the weights, not only with respect to their distance from the fulcrum, but also with respect to their relative positions in each key, materially quickens the action of the returning of the keys to their normal leveling positions and also enables the more delicate counter-balancing of the keys than by the old structure of weight mounting. The touch of the keys may thus be made much lighter by the fine adjustment of the leads or weights so that playing will be rendered more accurate and easy with less fatigue of the player.

The invention also has to do with the proportioning of the weights throughout the keyboard from end to end thereof with respect to the lightness of the actions of the respective keys and the corresponding responsiveness to return to leveling position of the keys.

With reference now to Figure 1 of the drawing, it will be observed that the keyboard is divided, generally into a base section or portion 45 which may comprise keys 1 to about 26, a middle section or portion 46 which extends from about key 27 to about key 54, a treble portion 47 which comprises approximately keys 55 to 71 and an extreme treble section or portion 48 composed of the remaining keys, such as 72 to 88. As the bass actions are the heaviest and slowest in moving, the keys thereof are counter-weighted to require a touch or downward pressure approximately 75

from 48 to 50 grams. Heretofore the keys of the entire keyboard have been counter-balanced or weighted to require an equal touch or downward pressure throughout the entire keyboard in accordance with the bass keys as the latter naturally require greater downward pressure than the keys in the other sections of the keyboard. The result is that the faster moving and quicker responsive keys in the middle, treble and extreme treble sections of the keyboard require the same pressure to depress them and consequently the momentum set up in the faster moving keys effects a retardation in the return of the keys to their leveling positions which is unresponsive to the quick action of the fingers, so that the keys do not follow up the fingers when raised with the rapidity necessary to position the keys and action in normal position for quickly repeated playing.

Referring now to Figure 1, the improvement of the present invention is diagrammatically illustrated wherein the abscissa 49 shows the various weights in grams required for the depression of the keys throughout the keyboard of the piano. The ordinates 50 show the relations between the various sections 45, 46, 47 and 48 of the keyboard with respect to their counter-balancing or weighing so that it will be seen that the bass section 45 which requires a heavier touch and is a slower action, is counter-balanced for approximately 50 to 51 grams touch. The middle section or portion of the keyboard 46 is counter-balanced to require a touch of but approximately 48 to 49 grams. The treble section 47 of the keyboard is counter-balanced by the leads to effect a touch of approximately 46 to 47 grams pressure while the extreme treble 48 of the keyboard is counter-balanced to require a touch of but approximately 45 grams pressure.

This weighing off of the different sections of the keyboard, or the proportioning of the sections of the keyboard relatively to their quickness of action, is accomplished by merely proportioning the size of the larger and smaller weights 38 and 39 for the respective keys in the sections. Of course a finer and more accurate adjustment of the weights may be made than as diagrammatically illustrated in Figure 1, as each successive key may be counter-balanced with a slight variation to decrease the required touch pressure successively from the base upward through the extreme treble. Of course any desired sections of the keyboard may be given any desired counter-balancing effect but the above described construction is found to materially increase the accuracy, ease and flexibility of playing of the piano.

The improved accelerated key action above described is found upon experimentation to be quicker than the old action by an average of at least 2 one-hundredths of a second (14 percent) for fortissimo playing, and by approximately 1 one-hundredth of a second (6 percent) for pianissimo playing. These differences were arrived at by high speed motion pictures and are based upon the time one complete cycle, or from the instant of the first touch of the finger to the key to the time when both key and hammer have returned to position for another touch.

This acceleration in the action of the keys and their hammers is due chiefly to the quicker return of the key and the hammer to its normal position. In pianissimo playing, the lag of the rising key behind the lifted finger averages two and one-half times ($2\frac{1}{2}$) greater in the present day old action as compared with the accelerated and improved action of this invention.

This acceleration in the key action provides greater precision in playing as the drop of the hammer away from the strings, in pianissimo playing averages two one-hundredths of a second faster according to this invention than in the prior action, which means that the pianissimo notes may be made more staccato.

There is also less effort and more ease and flexibility in playing by the present invention as the momentum of a key to produce a pianissimo tone averages fifteen percent (15%) more in the present structure than in the old action. The momentum with which the key returns to position as the finger is lifted also is greater by about the same percentage. This does not mean, however, that the energy required to be exerted by the player is greater. Instead, the consideration of the muscular actions involved indicates that this energy is less. Well-controlled pianissimo playing requires that two sets of arm and finger muscles work in antagonism with each other; one set to depress the finger, the opposing set to lift the finger and keep it from being depressed too much or with the wrong timing.

The quicker and more energetic return of the keys of the present invention as the fingers are lifted decrease the strain on the lifting muscles and the total effort required from the pianist.

These differences in momentum also indicate that playing of precise pianissimos will be easier on the improved accelerated action than on the old action for the reason that the force margin available for the necessary equilibrium between the two antagonistic sets of arm and finger muscles will be wider.

Measurements of internal friction indicate that this friction averages about 11 per cent less and is approximately 20 percent more uniform according to the present invention as compared with the old action, especially for the return of the key and hammer to normal position after a string is struck. Taken with the greater speed of this return noted above, this means that fortissimo playing should be substantially speedier and more precise by the present structure and with less effort and greater precision as compared with prior key actions.

It is obvious that various changes and modifications may be made in the details of construction and design of the above specifically described embodiment of this invention without departing from the spirit thereof, such changes and modifications being restricted only by the scope of the following claims:

What is claimed is:—

1. A piano key having a balance rail pin opening at a point intermediate the ends thereof, at least one relatively heavy weight secured to the key at a point closely adjacent said opening and positioned at a point spaced outwardly of the opening, and at least one lighter fine adjustment weight disposed at a point spaced outwardly of the heavier weight to obtain a low moment of inertia at the commencement of the depression and rebound of the key.
2. A piano key having a rail pin opening at a point intermediate the ends thereof, said key having a plurality of sockets therein disposed in spaced apart relation and extending outwardly of the pin opening, the innermost of said sockets being positioned closely adjacent said pin opening, and weights in said sockets, the innermost of said weights being relatively heavier than the next adjacent weight to obtain a low moment of

inertia at the commencement of the depression and rebound of the key.

3. A piano key having a rail pin opening at a point intermediate the ends thereof, said key
 5 having a plurality of recesses therein opening through a side of the key, the innermost of said
 recesses being positioned closely adjacent said pin opening, and weights in said recesses, the
 10 innermost of said weights being relatively heavier than the next adjacent weight to obtain a low
 moment of inertia at the commencement of the depression and rebound of the key.

4. A piano key having a rail pin opening intermediate the ends thereof and so positioned as to
 15 provide a long inner lever section and a relatively short outer section, and spaced apart weights in the short section, the innermost of said weights
 being disposed closely adjacent the pin opening and said innermost weight being relatively heavier
 20 than the next adjacent weight to obtain a low moment of inertia at the commencement of the
 depression and rebound of the key.

5. A piano key having a rail pin opening at a point intermediate the ends thereof, said key hav-
 25 ing a plurality of recesses therein opening through a side of the key, said recesses being disposed in
 alinement with the axial center thereof in substantially the transverse center of a vertical side
 of the key, and weights in said recesses, the
 30 innermost of said weights being relatively heavier than the next adjacent weight to obtain a low
 moment of inertia at the commencement of the depression and rebound of the key.

6. A piano key having means for obtaining a
 35 low moment of inertia at the commencement of the depression and rebound of the key, comprising
 an elongated key pivoted intermediate the ends thereof, a weight secured to the key closely adja-
 cent the pivotal point thereof, and a second weight
 40 lighter than the first weight secured to the key outwardly of the first weight.

7. In a piano having a plurality of keys, said keys being arranged in groups with the keys in

each group having like touch and rebound characteristics, and the touch and rebound characteristics of one group varying from the touch and rebound characteristics of an adjacent group where-
 5 by the touch and rebound characteristics of each group increases from the bass group to the treble
 group, each key having means for obtaining a low moment of inertia at the commencement of the depression and rebound of the key, compris-
 10 ing an elongated key pivoted intermediate the ends thereof, a weight secured to the key closely
 adjacent the pivotal point thereof, and a second weight lighter than the first weight secured to the key outwardly of the first weight.

8. In a piano having a plurality of keys, certain
 15 of said keys being arranged in a group whereby each key in the group will have a touch and rebound characteristic substantially equal to the touch and rebound characteristics of the other
 keys in the group, each key having means for
 20 obtaining a low moment of inertia at the commencement of the depression and rebound of the key, comprising an elongated key pivoted inter-
 mediate the ends thereof, a weight secured to the key closely adjacent the pivotal point thereof,
 25 and a second weight lighter than the first weight secured to the key outwardly of the first weight.

9. In a piano having a plurality of keys, said keys being arranged in groups with the keys in
 30 each group having like touch and rebound characteristics, and the rebound characteristic of an intermediate group being faster than the rebound characteristic of at least one adjacent group,
 each key having means for obtaining a low moment of inertia at the commencement of the
 35 depression and rebound of the key, comprising an elongated key pivoted intermediate the ends thereof, a weight secured to the key closely adja-
 cent the pivotal point thereof, and a second weight
 40 lighter than the first weight secured to the key outwardly of the first weight.

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