

Dec. 26, 1939.

L. HAMMOND

2,184,424

ELECTRICAL MUSICAL INSTRUMENT

Filed June 28, 1938

2 Sheets-Sheet 1

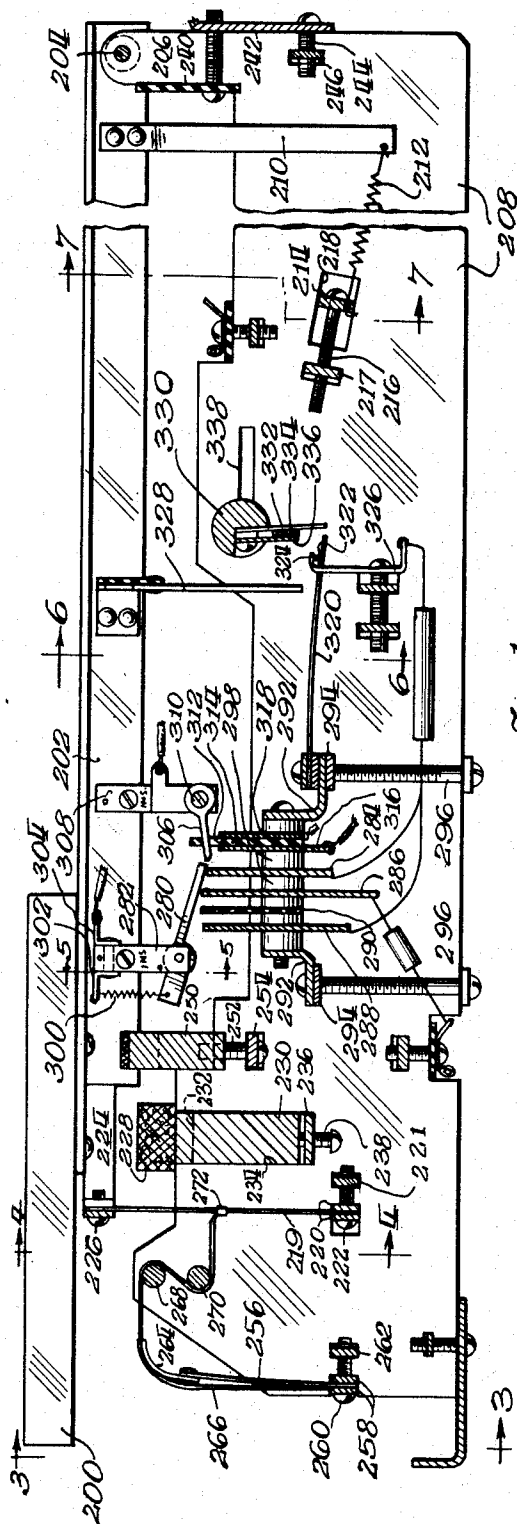


Fig. 1

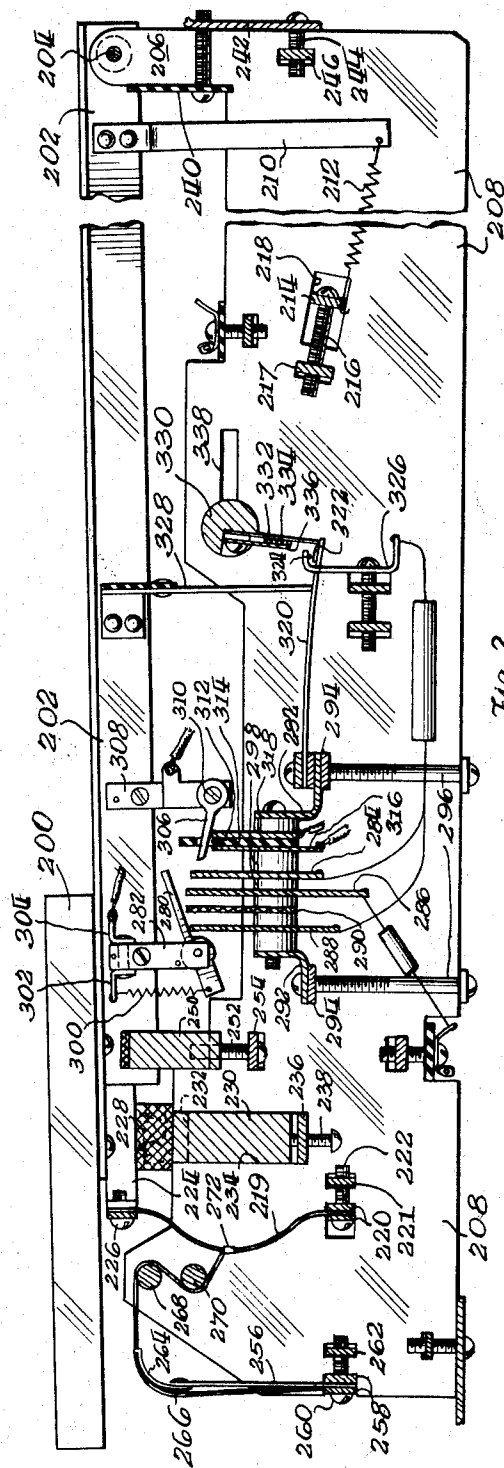


Fig. 2

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2 Sheets-Sheet 2

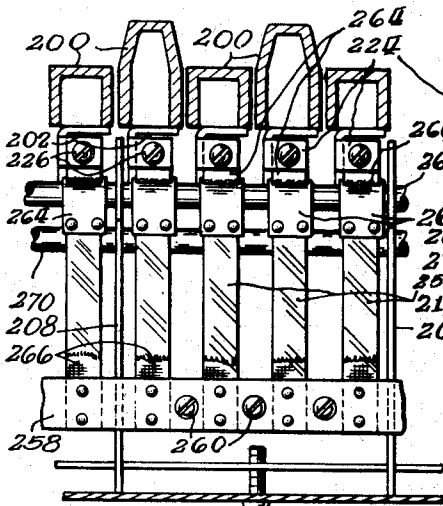


Fig. 3

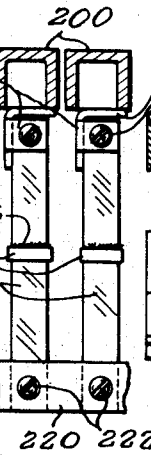


Fig. 4

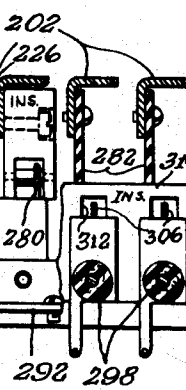


Fig. 5

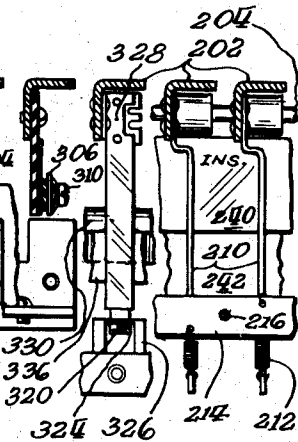


Fig. 6

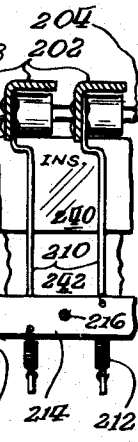


Fig. 7

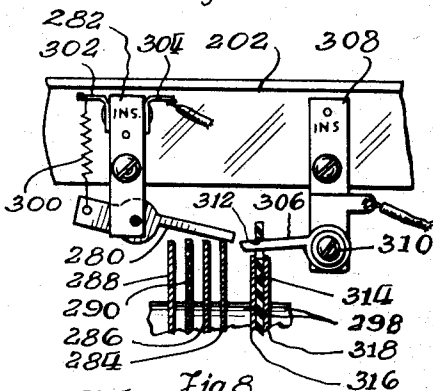


Fig. 8

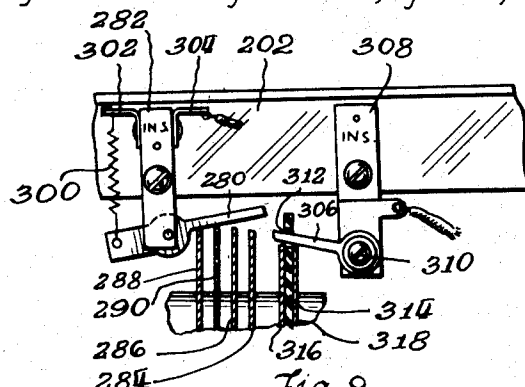


Fig. 9

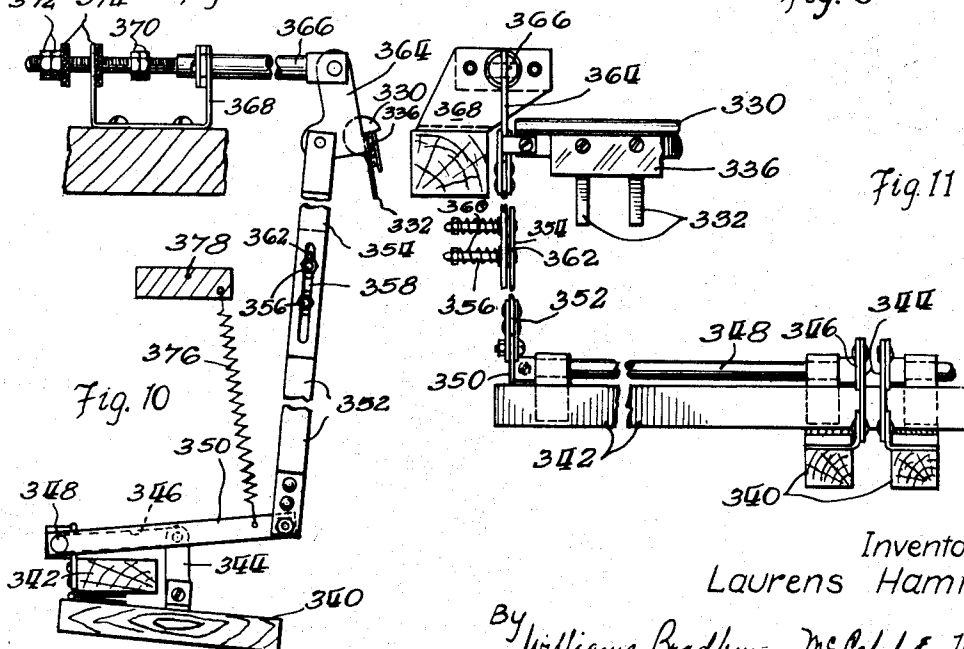


Fig. 10

Fig. 11

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UNITED STATES PATENT OFFICE

2,184,424

ELECTRICAL MUSICAL INSTRUMENT

Laurens Hammond, Chicago, Ill.

Application June 28, 1938, Serial No. 216,336

12 Claims. (Cl. 84-423)

My invention relates generally to electrical musical instruments, and more particularly to key actions for instruments of this kind.

It is an object of my invention to provide an improved key action for electrical musical instruments in which the keys have an improved touch, are capable of being very rapidly actuated, and in which rebound of the key at the end of its return stroke is eliminated.

A further object is to provide a key action for musical instruments which may be economically manufactured, which will be durable, and in which the keys will respond faithfully to the touch of the player.

Other objects will appear from the following description, reference being had to the accompanying drawings in which:

Figure 1 is a transverse sectional view of the keyboard showing the key in its normal position;

Figure 2 is a view similar to Fig. 1, showing the key depressed;

Figure 3 is a front elevational view of the key action;

Figures 4, 5, 6 and 7 are sectional views taken on the lines 4-4, 5-5, 6-6 and 7-7 respectively;

Figure 8 is an enlarged fragmentary sectional view of the key switch shown in normal position;

Figure 9 is a view similar to Figure 8 showing the key switch parts in the positions assumed upon full depression of the key;

Figure 10 is a side elevation of the sustaining pedal mechanism; and,

Figure 11 is a front elevational view of the sustaining pedal mechanism.

The key action disclosed herein is particularly adapted for use with electrical musical instruments of the type disclosed in my co-pending application Serial No. 199,613, filed April 2, 1938, which matured into Patent No. 2,126,464 on August 9, 1938, although many of the features thereof may be incorporated in keyboards for musical instruments of various other kinds.

For each of the notes there is a key 200, preferably of molded plastic composition and of the general character disclosed and claimed in my Patent No. 2,117,002 granted May 10, 1938. The keys 200 are suitably secured to key bars 202 which are pivoted upon a rod 204, the latter being suitably secured in the keyboard assembly and being supported adjacent each group of keys by the upwardly projecting portions 206 of frame plates 208. There is riveted to each of the key bars 202 adjacent its rearward end, an offset downwardly extending arm 210, to the lower end

of which one end of a tension spring 212 is secured. The other end of the tension spring 212 is anchored to a bar 214 extending lengthwise of the keyboard and secured in adjusted position by adjusting screws 216 threaded in a bar 217. By adjusting the screws 216 the bar 214 may be moved forwardly or rearwardly in slots 218 formed in the frame plates 208, and thereby vary the tension upon the springs 212. The bar 214 may extend the full length of the keyboard or may be made in sections, for example, extending throughout the length of one octave of the keyboard. By adjusting the positions of the bars 214, the keys may be adjusted for any desired tension or "touch".

Upward movement of the key is limited by a thin metallic strip 219 which is preferably of thin spring steel so as to be very flexible. The lower end of the strip 219 is anchored between a pair of clamping strips 220 which are secured to a bar 221 by screws 222. The bars 220 and 221 preferably extend the full length of the keyboard and the lower ends of the strips 219 are preferably perforated to receive the clamping screws 222. The upper end of the strip 219 is secured to an extension 224 of the key bar 202 by means of a screw 226.

Downward movement of the key is limited by a strip 228 of felt or the like, which is mounted upon a bar 230 which extends lengthwise of the key bar and is provided with slots 232, which engage the plates 208 and hold them in properly spaced relation. It will be understood that each of the plates is provided with a rectangular opening 234 of sufficient size to receive the bar 230 and that the latter, after being inserted through these openings in a plurality of the frame plates 208, is raised so as to have its slots 232 engage the frame plate. Thereafter strip 236 is inserted beneath the bar 230 and screws 238 threaded in the locking strip 236 are turned upwardly so as rigidly to clamp the bar 230 in position.

The rearward ends of the frame plates are held in spaced relation by a strip 240 of insulating material, the lower edge of which is slotted to receive the frame plates, and the upper edge of which is slotted to receive the webs of the key bars 202, the strip 240 thus maintains both the ends of the frame plates 208 and the key bars 202 in properly spaced relation. The insulating strip 240 is clamped to a member 242, which latter member is also clamped to the frame plates by screws 244 threaded in anchoring strips 246 which extend lengthwise of the keyboard

through suitable apertures formed in the frame plates.

The forward ends of the key bars 202 are guided for oscillatory movement and held against lateral movement by a comb member 250 which is clamped to the frame plates 208 by means of screws 252 extending through an anchoring bar 254.

A leaf spring 256, one for each key, has its lower end rigidly clamped between bars 258 held by screws 260 threaded in an anchoring strip 262, and at its upper end carries an arcuate bracket 264. A flexible fabric ribbon 266, which has one end clamped by means of the screw 250 and 15 clamping bars 258, extends upwardly to be guided in the bracket 264 and is wrapped partially around snubber rods 268 and 270. The other end of the ribbon 266 is secured to the approximate center of the flexible strip 219 by means of a clip 272. The spring 256 is of such tension and the ribbon 266 is of such length, that the center of the strip 219 is normally slightly to the left (Fig. 1) of dead center position.

When the key is depressed, the strip flexes to the bowed position in which it is shown in Figure 2, and the leaf spring 256 flexes toward the left so as to take up the resultant slack in the ribbon 266. Upon the return stroke of the key, under the influence of its spring 212, the flexible metallic strip 219 is of course straightened by the tension placed thereon, but such action is resisted by the friction between the ribbon 266 and the snubber rods 268, 270. It will be understood that during the initial portion of the upward stroke of the key, the tension on the ribbon 266 is very slight since the leaf spring 256 is substantially in its normally unflexed position, but as the strip 219 assumes a more straightened position, the tension on the ribbon 266 increases, and as a result, the amount of friction between the snubber rods 268 and 270 and the ribbon 266 increases at a geometric rate. The energy returned to the key bar 202 by the contraction of the spring 212 is thus dissipated at a rapidly increasing rate as the key bar approaches its normal upper position.

The parts are so proportioned that the key (including the parts moving therewith), will have its kinetic energy substantially completely dissipated by the time the key reaches its uppermost position, and there will therefore be no rebound of the key. Instead, the key will return to its normal position as rapidly as is feasible, but its motion will be decelerated at a rapid rate as it approaches its normal position. With this construction the performer may play much more rapidly than is possible on the conventional type keyboard. The key bar 202 is preferably made of a light aluminum alloy and as previously indicated, the key itself is of a hollow boxlike construction made of a molded plastic. The other parts carried by the key bar are likewise made as light as possible so that the rotary moment of inertia of the key about its pivot 204 is kept at a minimum compatible with the necessary strength of the parts. Thus, the amount of energy required to depress the key is much less than is commonly found in piano keyboards, and therefore the action of the keys is unbelievably light and rapid.

As more fully disclosed in my aforesaid co-pending application Serial No. 199,613, the depression of a key functions merely to operate certain switches in a predetermined sequence. While the mechanical features of the key action

may be employed in various types of instruments, the action is particularly suited for electrical musical instruments where the main function of the key is to operate switches.

In the embodiment of the invention disclosed herein, the key carries two switch members and an actuator for a third switch. A switch arm 280 is pivotally mounted on a bracket 282 of insulating material which is secured to the key bar 202. The rearwardly projecting portion of the switch arm 280 is adapted to cooperate with contacts 284, 286 and 288, and is adapted to have its motion in part controlled by an insulated bar 290. The contacts 284, 286 and 288 and the insulated bar 290 are suitably mounted upon a pair of brackets 292 which are secured to strips 294 extending longitudinally of the keyboard and which are anchored in position by screws 296. The mounting is such that the contacts 284, 286 and 288 are separated from each other by insulating bushings 298.

The rearwardly extending portion of the switch arm 280 is normally held in engagement with the contact 284 by a tension spring 300 which is anchored to a lug 302 which together with a soldering lug 304 is riveted to the insulating bracket 282. The spring 300 also serves as a means for conducting current to the switch arm 280. As the key is depressed, the switch arm 280 successively engages the contact 286, the insulated bar 290 and the contact 288, the switch arm being caused to rock over the contacts 284, 286 and 288 and insulated bar 290 due to their different elevations. Upon release of the key, the switch arm engages these members in a reverse order.

A repeat switch arm 306 is carried by an insulating bracket 308 which is secured to the key bar 202, the arm 306 being mounted for rotation about its pivot screw 310, there being friction applied to the arm, as by a spring washer. This friction is sufficiently great that the forces of gravity and momentum will not move the switch arm. The switch arm 306 projects through an opening 312 formed in a strip 314 of insulating material and is adapted during its downward stroke to engage the upper edge of the contact bar 316. Shortly prior to the completion of the downward stroke, the switch arm 306 engages a reset bar 318 which is shown in Figs. 2 and 9, and the contact between the switch arm and contact bar 316 is thus broken prior to the completion of the downstroke of the key. During the upstroke of the key the switch arm 306 does not make contact, and prior to the completion of the upstroke engages the upper edge of the opening 312 in the insulating bar 314, and thus is repositioned so that upon the next downward stroke of the key, it will engage the contact bar 316.

The third switch which is operated by the key comprises a leaf spring 320 which is secured to the chassis in a suitable manner and at its free end carries a contact 322 which is engageable with a contact 324 carried on a lug 326 which, as shown in Fig. 6, is apertured to receive the leaf spring 320. The contacts 322, 324 are adapted to be separated shortly prior to the completion of the downward stroke of the key by the engagement of an actuator 328 with the leaf spring 320.

If it is desired to maintain the contacts 322, 324 separated after the key has been released, this result may be accomplished by depression of the sustaining pedal which, as hereinafter described, serves to rotate a shaft 330 clockwise

(Figs. 1 and 2) through an angle of approximately 15 degrees. The shaft 330 has a plurality of short leaf spring latches 332 secured thereto, one adjacent the end of each of the leaf springs 320. If the shaft 330 is rotated clockwise from the position in which it is shown in Fig. 1 to the position in which it is shown in Fig. 2, while a key is being held depressed, the spring latch 332 will position itself above the end of leaf spring 320 and thus prevent closure of the contacts 322, 324 when the key is released. If, however, the key associated with a particular spring latch 332 has not been depressed, the spring latch will abut against the extreme tip of the leaf spring 320 and bend as the shaft 330 is rotated clockwise and the spring latch will thus not have any effect upon the switch 322, 324. However, should a key be depressed while the shaft 330 is in the position shown in Fig. 2 (sustaining pedal depressed), the associated leaf spring 320 will be flexed downwardly and the spring latch 332 will immediately snap into position above the end portion of the leaf spring thereby preventing the closing of contacts 322, 324 when the key is subsequently released. To limit the forward flexure of the spring latches 332 and to reduce the noise resultant from the operation of these spring latches, the latches are arranged normally to press against a felt pad 334, which is carried by a metallic strip 336 secured to the shaft 330. The shaft 330 extends through the frame plates 208 and may have its bearings therein, or other suitable bearings may be provided. In order to permit the insertion of the shaft assembly in the frame plate assembly, each of the frame plates is provided with a generally keyhole shaped slot 338.

A suitable means for rotating the shaft 330 is diagrammatically shown in Figs. 10 and 11 and comprises a pair of pedals 340 which are hinged to a fixed frame member 342. Each of the sustaining pedals is connected by means of a link 344 and arm 346 with a shaft 348 mounted for oscillation in suitable bearings carried by the frame member 342. An arm 350 is secured to the end of the shaft 348 and is pivotally connected to a link 352 which has a frictional lost motion connection with a link 354, the lost motion connection being provided by a pair of bolts 356 which extend through an elongated slot 358 formed in the link 354 and which carry compression springs 360 which serve to press the links 352 and 354 against friction washers 362. A bell crank bracket 364 is secured to the end of shaft 330, the link 354 being pivotally connected to one arm of the bracket while a rod 366 is pivotally connected to the other arm of the bracket. The rod 366 is guided for sliding movement in the U-shaped bracket 368, and is threaded to receive adjustable stop nuts 370 and 372 which are adapted to limit the extent of angular movement of the shaft 330, suitable felt washers 374 being provided to eliminate noise. The shaft 330 is normally held in the position in which it is shown in Figure 1 by a suitable spring herein illustrated as a tension spring 376, one end of which is connected to the free end of the arm 350 and the other end of which is anchored to a fixed member 378.

As shown in Figure 11, there are preferably two sustaining pedals provided for the complete instrument, one controlling the notes of the bass register and the other controlling the notes of the treble register. When two sustaining pedals are thus provided the shaft 330 will be made in

two independently movable sections, each operated by one of the sustaining pedals.

The keyboard will be operated in the usual manner, except that the player will find that the keyboard responds so rapidly that trills and arpeggio passages may be executed with much greater facility than is possible on standard piano and organ keyboards. Furthermore, the touch is so light that the finger may very easily be slid up and down the keyboard to play chromatic scales with great rapidity.

The ribbon 266 with the parts associated therewith has been found to be a very practical and simple means for eliminating rebound of the key while at the same time permitting the key to return to its normal position in the shortest possible time. It will be understood that to secure the greatest possible speed of action of the key with the least required application of energy in the depressing of the key, it is desirable that the key, key bar and parts carried thereby be as light as possible, that the key return spring be sufficiently powerful to return the key to normal position at a speed substantially equaling the speed at which the highly skilled musician can withdraw his finger from the key, and in addition, that the key be retarded as it approaches its normal position on the return stroke in a manner to prevent rebound of the key as it strikes the stop which limits its upward movement. In other words, to make the return stroke of the key as rapid as possible, it must first be rapidly accelerated by the return spring and then must be rapidly decelerated by the snubbing means.

All of these desirable characteristics are present in the key action disclosed herein.

It will be understood that the flexible metallic strip 219 functions in a manner similar to a toggle linkage and that such linkage, or other equivalent linkage, can be utilized to actuate the snubber. It is of course desirable that the snubber be so connected with the key bar that its effectiveness in applying a retarding force to the key increases rapidly as the key approaches its normal position. The snubbing force which is applied, however, must be carefully balanced against the force applied by the spring 212 so that the key will not be stopped before it reaches its normal position.

While I have shown and described a preferred form of my invention, it will be apparent to those skilled in the art that numerous variations and modifications may be made without departing from the basic principles of the invention. I therefore desire, by the following claims, to include within the scope of my invention all such equivalent or similar constructions whereby substantially the same results may be obtained by substantially the same means, or means equivalent to the structure disclosed herein.

I claim:

1. In a keyboard instrument, the combination of a depressible key, resilient means for resisting depression of said key and for restoring said key to normal position, a flexible metallic strip for limiting return movement of said key, said strip being adapted to flex outwardly upon depression of said key, a flexible band having one end secured to the mid-portion of said flexible strip, a spring exerting tension upon the other end of said band, and means for applying to said band intermediate its ends, a frictional retarding force of value determined by the extent to which said band is tensioned.

2. In a keyboard instrument, the combination

of a depressible key, means for storing energy imparted to said key upon depression thereof and for returning a portion of the energy to said key to return the latter to normal position, and means
5 for dissipating excess energy stored in said energy storing means during the return movement of said key, whereby said key will be substantially devoid of kinetic energy as it closely approaches its normal position.

10 3. In a keyboard instrument, the combination of a depressible key, means to resist depression of said key and to return said key to normal position, a flexible stop element for limiting
15 return movement of said key, said element flexing during depression of said key, and a resiliently biased friction element connected to said flexible element resisting return of said flexible element to normal position with a rapidly increasing
20 force as said flexible element approaches its normal position.

4. A key action comprising, a depressible key, resilient means to resist depression of said key and to return said key to normal position, frictional means for dissipating the energy stored
25 in said resilient means in excess of that required to return said key to normal position, said frictional means applying a rapidly increasing retarding frictional force to said key as said key approaches its normal position.

30 5. In a keyboard for musical instruments, the combination of a depressible key, resilient means to resist depression of said key and to return said key to normal position when it has been depressed, and means for retarding return movement
35 of said key as it approaches its normal position, said retarding means frictionally applying a rapidly increasing retarding force as said means approaches its normal position, whereby
40 the excess energy stored in said resilient means is dissipated prior to the return of said key to its normal position.

6. In a keyboard for musical instruments, the combination of a depressible key, resilient means
45 for resisting depression of said key and for returning it to normal position, and frictional means means opposing return movement of said key with a force increasing rapidly as said key approaches normal position.

7. In a keyboard musical instrument, the combination of a depressible key, resilient means to
50 return said key to normal position, a flexible element for limiting upward movement of said key, a ribbon secured to a mid-portion of said flexible element, resilient means exerting a pull upon
55 said ribbon when said flexible element is flexed upon depression of said key, and frictional means for applying a restraining force preventing movement of said ribbon, said frictional means
60 applying an increased force as the tension of said flexible element is increased.

8. In a keyboard for musical instruments, the combination of a depressible key, resilient means
65 to resist depression of said key and to return the depressed key to normal position, and means to limit the return stroke of the key, said means

comprising a snubber acting to apply to said key a retarding force of increasing value as the key approaches its normal position.

9. In a keyboard for musical instruments, the combination of a depressible key, resilient means
5 for resisting depression of said key and for returning the depressed key to normal position, mechanism freely actuated by said key upon the downward stroke thereof and effective upon the
10 return stroke of the key to apply a progressively increasing retarding force to said key, whereby said key will be decelerated at an increasing rate
15 as it approaches its normal position.

10. In a keyboard for musical instruments, the combination of a depressible key, resilient
15 means to resist depression of said key and to return said key from depressed to normal position, a pivoted switch arm, a plurality of contact making elements positioned at different elevations
20 beneath said arm with the end elements lower than an intermediate element whereby said arm will rock over said contact elements successively to make and break electrical contacts
25 therewith as the key is depressed, and resilient means acting upon said switch arm to cause it to rock over said contact elements in a reverse
30 sequence during the return stroke of the key.

11. In a keyboard for electrical musical instruments, the combination of a depressible key,
30 means resisting depression of said key and operable to move the key from depressed position to its normal position, a pivoted switch arm carried by said key, frictional means to resist pivotal movement of said switch arm, a switch contact adapted to be engaged by said switch arm,
35 stop means engageable with said switch arm to position the latter for engagement with said switch contact during the downward stroke of the key, and means engaged by said switch arm
40 to move it to a position out of contact with said switch contact prior to the completion of the downward stroke of the key.

12. In a keyboard for musical instruments, the combination of a depressible key, resilient means
45 to resist depression of said key and to return said key from depressed to normal position, a pivoted switch arm movable between two extreme positions, a plurality of contact making elements located adjacent said arm and at different distances
50 from said arm when the latter is in a position intermediate its extreme positions, the outer of said contact elements being more remote from said contact arm when the latter is in its
55 said intermediate position than an intermediate one of said contact elements, and resilient means to swing said contact arm to one of its extreme positions when said key is in normal position, whereby said contact arm will successively make and break electrical contacts with
60 said contact elements upon depression of said key and will make and break electrical contacts with said contact elements in a reverse order upon return movement of said key.

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