United States Patent

Erbert et al.

[15] **3,651,732**

[45] **Mar. 28, 1972**

[54] PIANO ACTIONS

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[21] Appl. No.: **38,003**

[52] **U.S. Cl.** **84/240,** 84/236

[51] **Int. Cl.** **G10c 3/18**

[58] **Field of Search** 84/236–240, 242–243, 84/247–253

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Assistant Examiner—Lawrence R. Franklin
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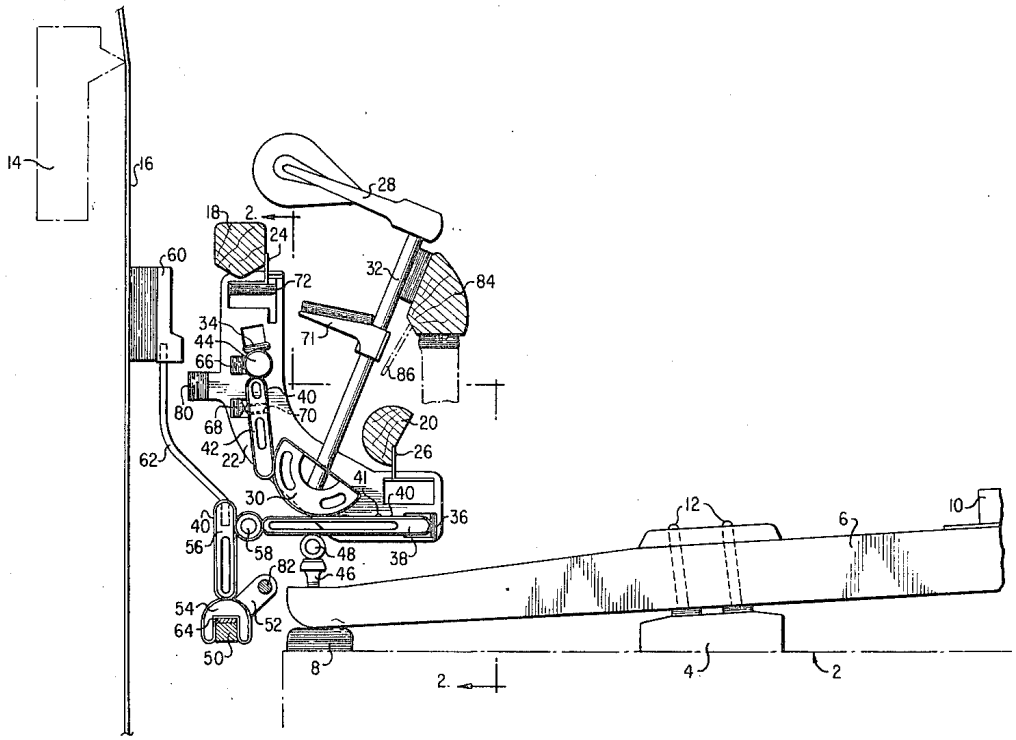
[57] **ABSTRACT**

A piano action for transmitting motion individually from a piano key to a hammer which strikes the corresponding string. The hammer is supported on a roller for swinging toward and away from the piano string. A guide bar supports the roller and a thin flexible band extending around the bar and the roller transmits motion from the key to the roller. The hammer, roller and guide bar are mounted on an individual frame which allows the piano action foe each string position to be installed and removed separately. The piano action also includes a toggle device which controls the operation of a backcheck and includes a damper for the string that is operated in coordination with the motion of the hammer.

25 Claims, 13 Drawing Figures



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SHEET 1 OF 6

FIG. 1

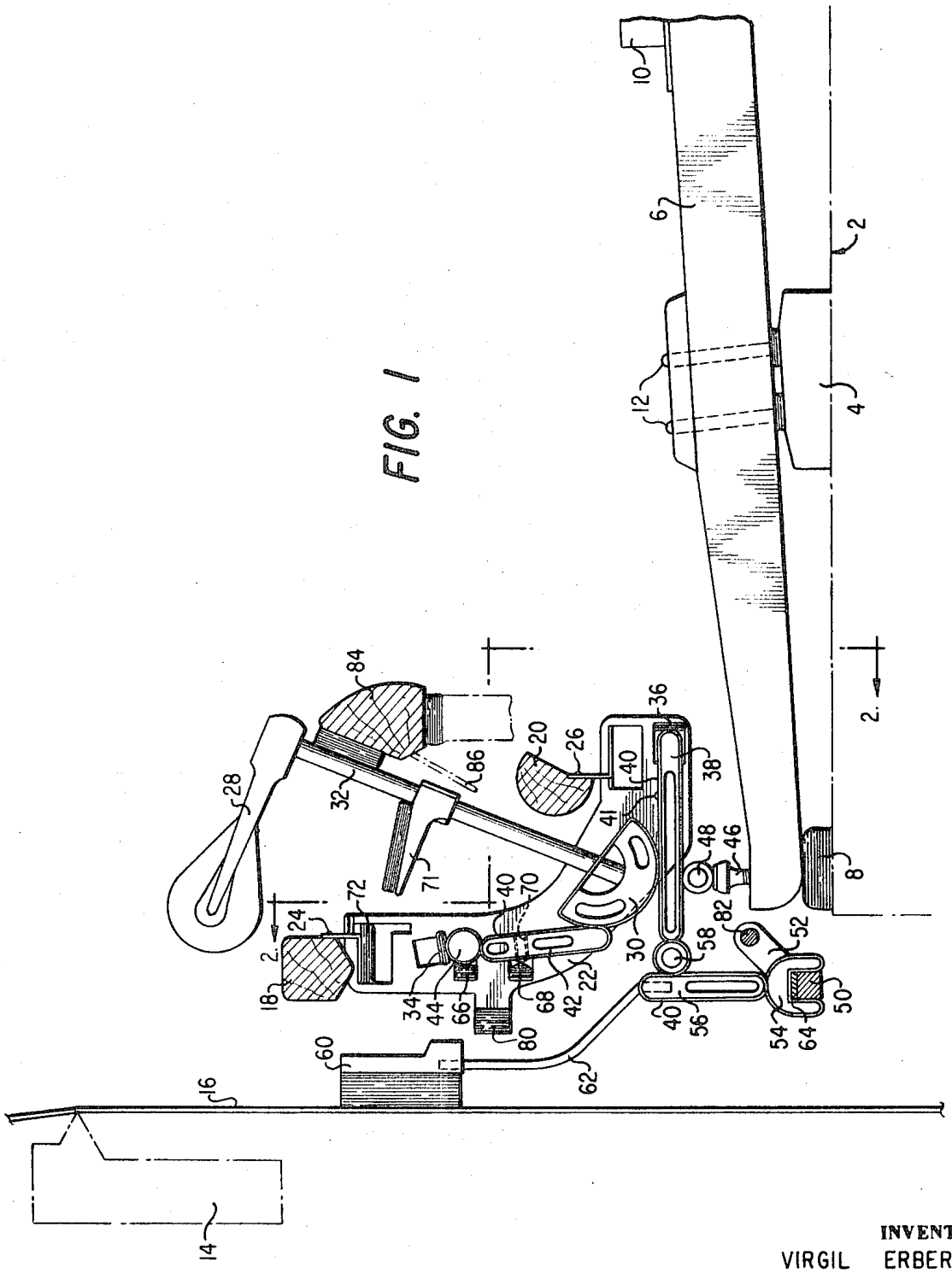

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FIG. 2

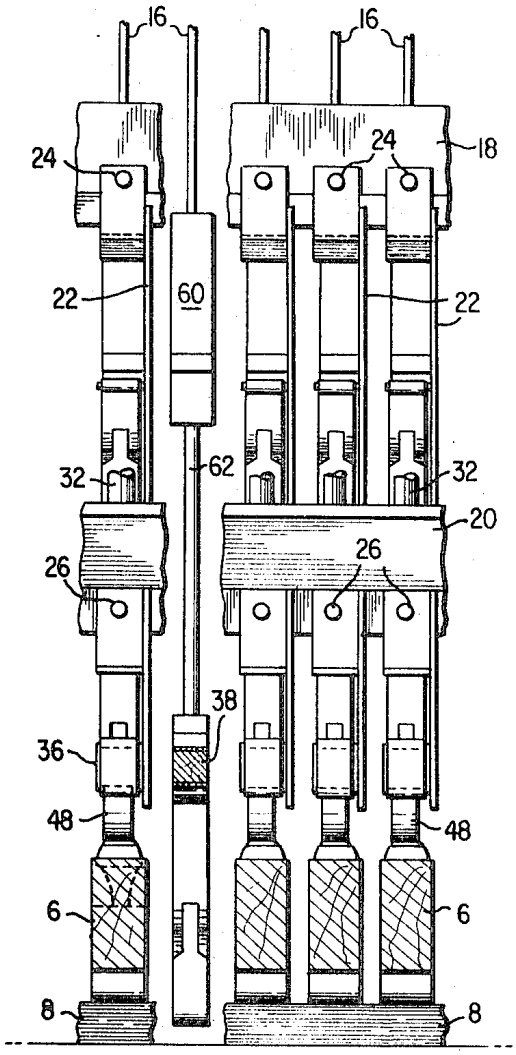

FIG. 9

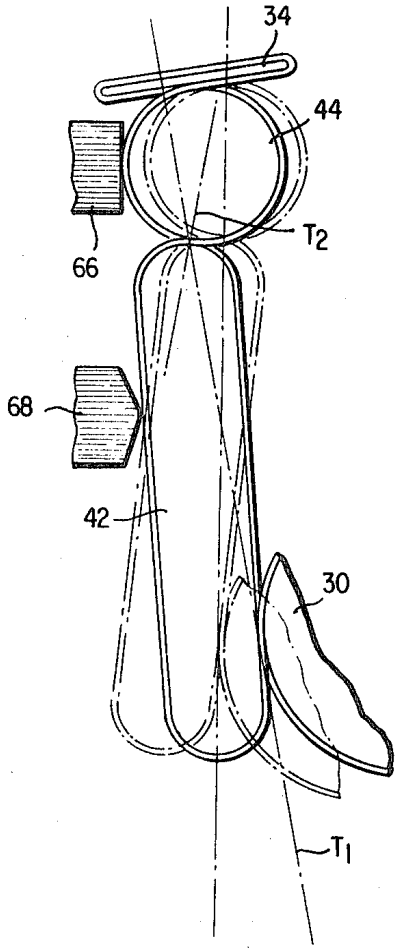

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FIG. 4

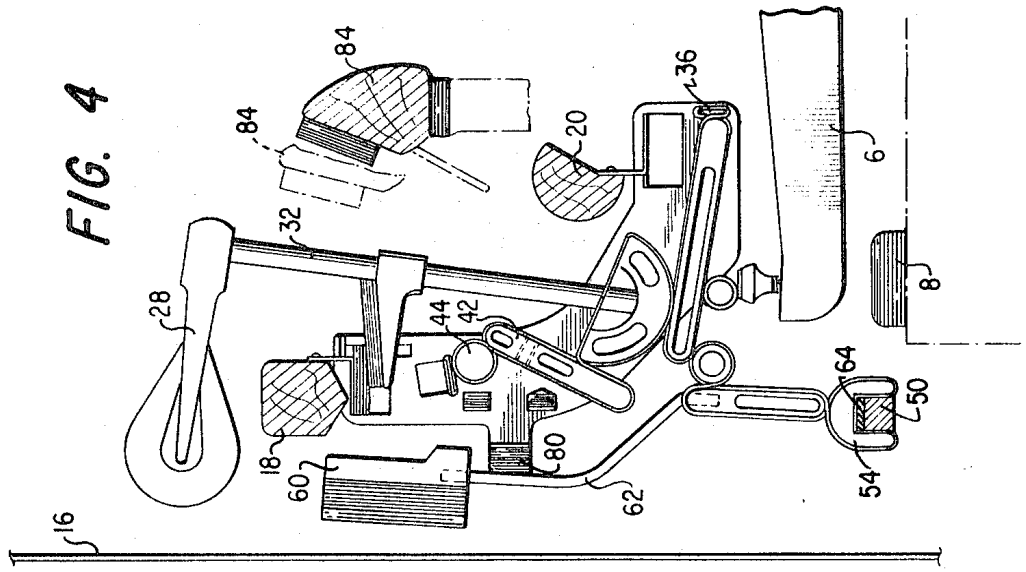
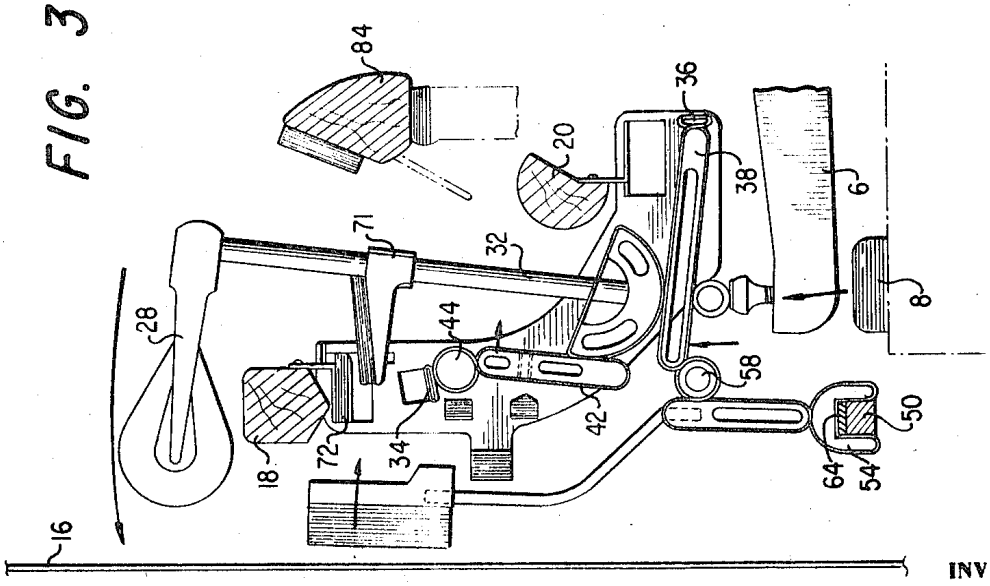


FIG. 3



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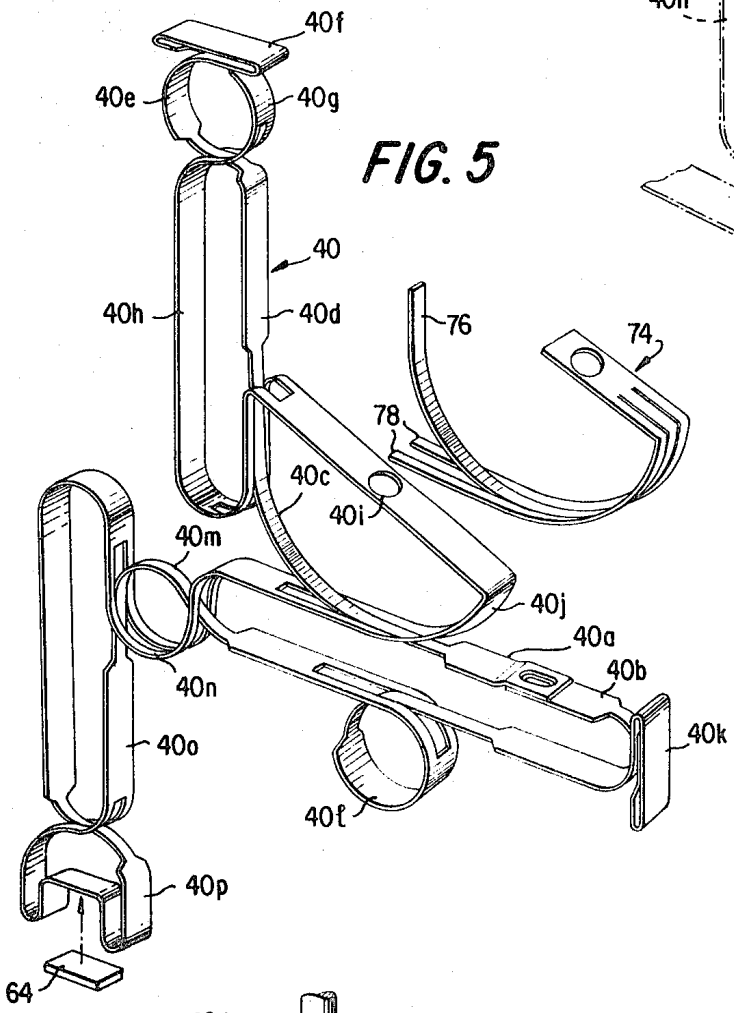

FIG. 5

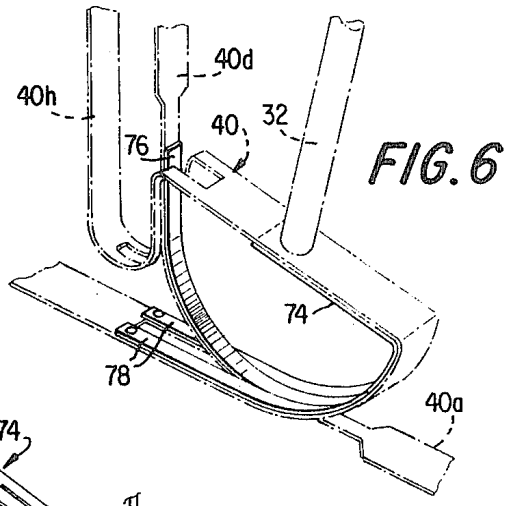

FIG. 6

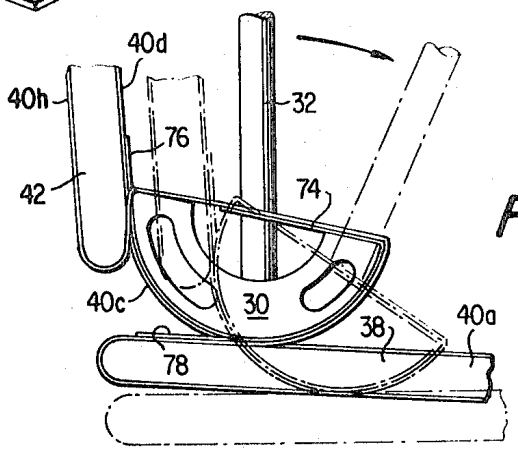

FIG. 7

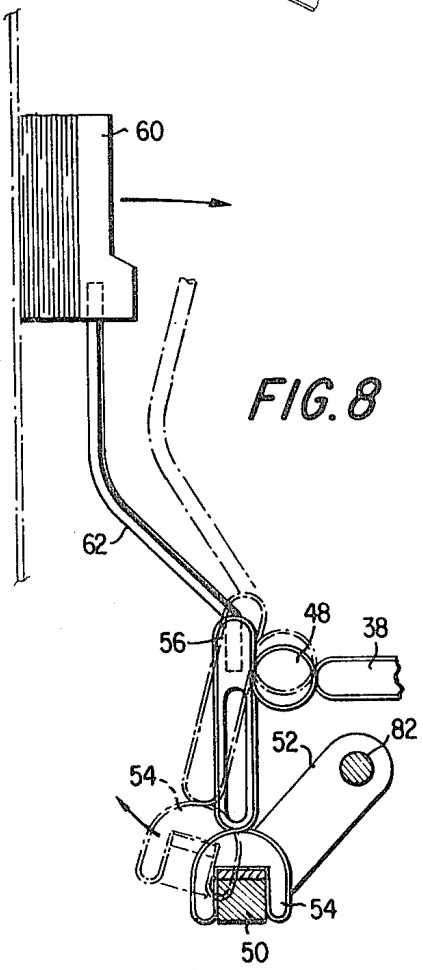

FIG. 8

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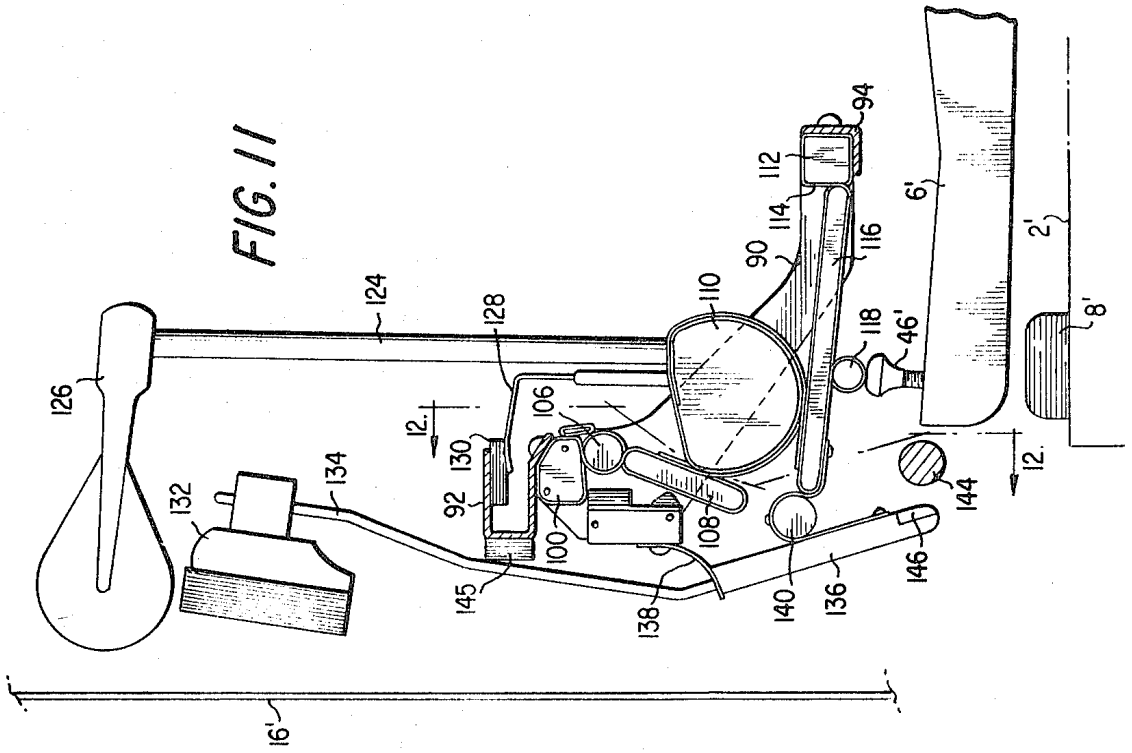

FIG. 11

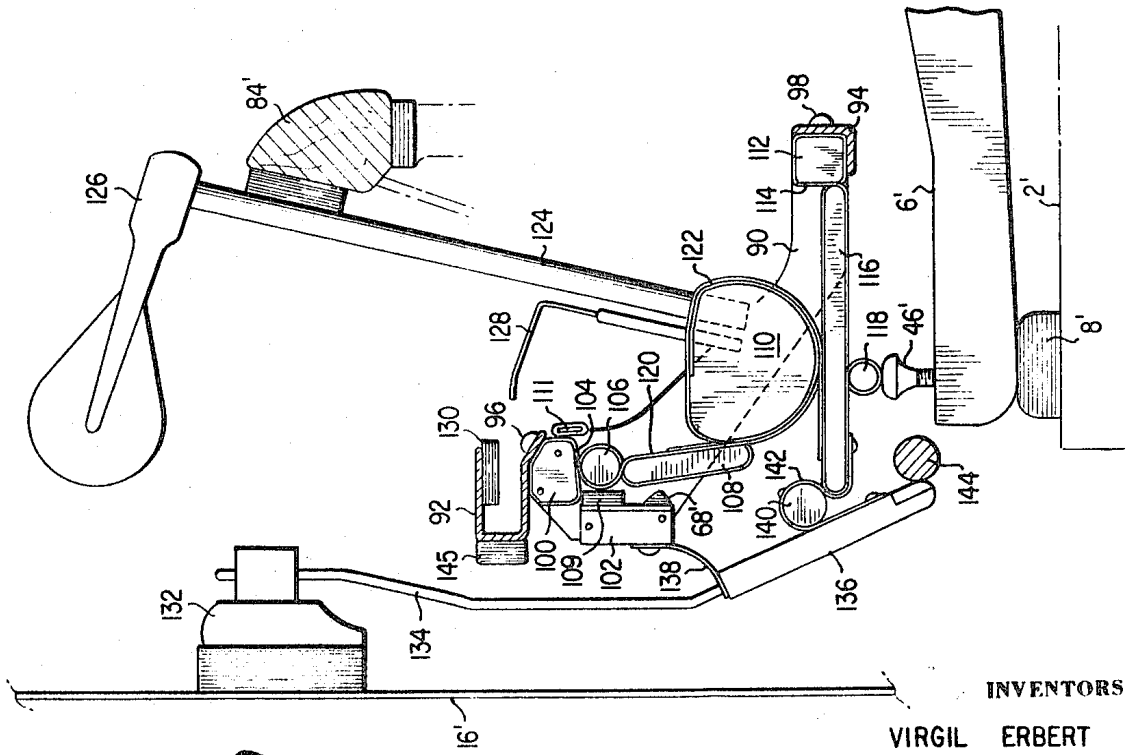

FIG. 10

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FIG. 13

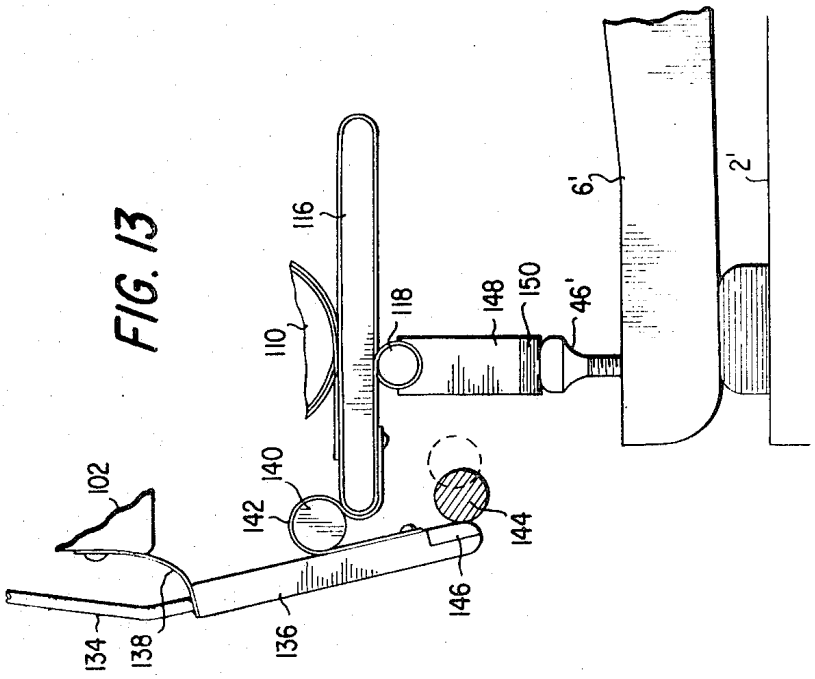
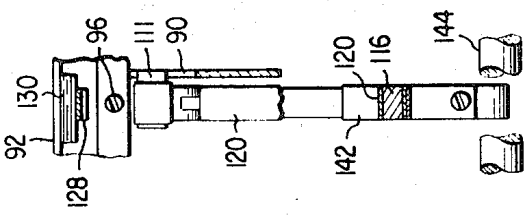


FIG. 12



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PIANO ACTIONS

BACKGROUND OF THE INVENTION

This invention relates to key operated percussion devices, and more particularly to piano actions for transmitting motion from a key to a movable hammer.

In a conventional piano, the piano action transmits motion from a key to a hammer, causing the hammer to swing toward the corresponding string and after striking the string, a backcheck in the piano action prevents rebound of the hammer beyond a certain distance. The piano action also includes a damper which moves away from the string just before the hammer strikes the string. The components of the piano action are duplicated for each key along the keyboard. It is customary to manufacture a component individually and then to assemble the component by hand on the main rail of the piano. After assembly, the piano action for each note is adjusted, as necessary.

Conventional piano actions have a large number of components, and these components are cushioned by individual felts adhesively bounded on appropriate surfaces of the piano action, and in some piano actions, felts are installed in pivoted joints to reduce the noise of the action to a minimum. In view of the large number of components, including the felts, and the complexity of the piano actions, the cost of manufacturing and assembling these components is relatively high.

In order to gain acceptance of improved piano actions, it is necessary to maintain the functional characteristics of present piano actions. Conventional piano actions require a certain minimum kinetic energy to be imparted to the hammer by the key in order to cause the hammer to strike the string. The hammer must be disconnected from the key immediately before striking the string in order to allow an unincumbered rebound of the hammer on the first vibration cycle of the string. The damper must remain in contact with the string until immediately before the hammer strikes, in order to keep the string from vibrating sympathetically with other strings which may already be vibrating. Another requirement is that after striking the string, the hammer's rebound kinetic energy must be immediately absorbed in a noiseless way, in order to be ready for a succeeding strike. Continued depression of the key keeps the damper withdrawn to allow the string to vibrate. All of the strings can be allowed to vibrate simultaneously by pressing the sustain pedal which overrides the damper action on all keys. Depression of the soft pedal decreases the kinetic energy imparted to the hammer by any key that is struck while the pedal is depressed.

SUMMARY OF THE INVENTION

In view of the difficulties in manufacturing conventional piano actions, it is an object of this invention to provide an improved piano action.

Another object of this invention is to provide a piano action having fewer parts which are easily manufactured and assembled in the piano action.

Another object of this invention is to provide a piano action which requires a minimum of force for operation and is resistant to wear.

These objects are accomplished in accordance with a preferred embodiment of the invention by a piano action in which the hammer projects outwardly from a roller and is movable toward and away from the string as the roller rolls along a guide surface. Motion of the piano key is transmitted to the guide surface, which produces a corresponding rolling motion of the roller. A thin flexible band interconnects the roller and the guide surface to hold these parts together while allowing relative rolling motion. A backcheck operates in response to the displacement of the guide surface for temporarily holding the hammer as it rebounds after striking the string. A damper is also operated in response to the motion of the guide surface and is displaced from the string immediately before the hammer strikes the string. The damper is also capable of being operated independently of the hammer motion when the sustain pedal is depressed.

DETAILED DESCRIPTION OF THE DRAWINGS

Several preferred embodiments of the invention are illustrated in the accompanying drawings, in which:

FIG. 1 is a side elevational view, partially in cross section, showing a piano action in accordance with one embodiment of this invention;

FIG. 2 is an enlarged cross-sectional view of the piano action along the line 2—2 in FIG. 1;

FIG. 3 is a cross-sectional view of the piano action as in FIG. 1, but showing the hammer moving toward the string;

FIG. 4 is a cross-sectional view of the piano action as in FIG. 1, but with the hammer in checked position and while the key remains depressed;

FIG. 5 is a perspective view, partially schematic, showing the flexible band arrangement;

FIG. 6 is a perspective detail view of the hammer roller spring and the band;

FIG. 7 is a detail side elevational view showing the relative motion of the hammer roller and associated components;

FIG. 8 is a side elevational detail view of the damper mechanism;

FIG. 9 is a schematic view of the toggle components;

FIG. 10 is a side elevational view, partially in cross section, showing a piano action in accordance with another preferred embodiment of this invention;

FIG. 11 is a cross-sectional view of the piano action as in FIG. 10, but with the hammer in checked position and while the key remains depressed;

FIG. 12 is a cross-sectional view of the piano action along the line 12—12 in FIG. 11; and

FIG. 13 is a side elevational view of the piano action as in FIG. 10, but showing a modified connection between the key lever and the drive lever.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A conventional piano has a keybed on which a plurality of key levers are arranged in side-by-side relation. Each key lever has a key at one end and is connected at the opposite end with the piano action.

Referring to FIG. 1, a conventional keybed 2 is illustrated schematically. The keybed has a balance rail 4 which serves as a fulcrum for reach key lever 6. A pad 8 extends across the keybed under each lever for supporting the lever when the keyboard end is raised. A portion of the key 10 is shown in FIG. 1. The key lever 6 is held against longitudinal movement relative to the balance rail 4 by a pair of pins 12, which allow removal of the key lever 6 merely by lifting the key lever off of the pins 12.

A string frame 14 supports the strings 16 in an upright position. The strings 16 are spaced apart across the length of the string frame 14 at locations corresponding to each of the key levers 6. An upper rail 18 and a lower rail 20 extend along the length of the string frame 14 and at each key lever location, a mounting plate 22 is secured on the upper rail 18 by a screw 24 and on the lower rail 20 by a screw 26.

At each key lever location, a hammer 28 is mounted for swinging movement on a hammer roller 30 by means of a hammer shaft 32. The hammer roller 30 is supported on the mounting plate 22 by a system of levers, rollers, and a thin flexible band, which are connected with the mounting plate 22 at an upper guide 34 and a lower guide 36. The guides 34 and 36 are preferably in the form of tabs bent outwardly from the mounting plate 22 and have substantially flat guide surfaces. A drive bar 38 is hingedly connected with the guide 36 by a thin flexible band 40. The drive bar has a substantially flat surface adjacent the surface of the roller 30. The band 40 passes between the surface of the drive bar 38 and the rolling surface of the roller 30. A release bar 42 is also positioned adjacent the hammer roller 30 and has a substantially flat guide surface adjacent the rolling surface of the roller 30. The band 40 also passes between the surface of the release bar 42 and the rolling surface of the roller 30. A release roller 44 is posi-

tioned between the guide 34 and the end of the release bar 42. The band 40 is tensioned to hold the various components together, while allowing the components to roll relative to each other, and the band 40 is secured on the guide 34.

The end of the key lever 6 has a peg 46 for transmitting motion from the key lever to the piano action. A drive roller 48 is interposed between the peg 46 and the drive bar 38. The band 40 passes between the guide bar 38 and the roller 48 and urges the roller against the drive bar. A damper bar 50 extends along the key bed 2 in front of the strings 16 and has a lever 52 which is connected with the sustain pedal of the piano, so that when the pedal is depressed, the lever 52 rotates in a counterclockwise direction as viewed in FIG. 8. A damper coupling 54 is secured on the bar 50 and a damper shank 56 extends upwardly from the damper coupling 54. A damper roller 58 is interposed between the side of the damper shank 56 and the curved end of the drive bar 38. The damper coupling 54, the damper shank 56 and the damper roller 58 are held together for relative rolling motion by the band 40. A damper head 60 is supported from the upper end of the damper shank 56 by a rod 62. The band is clamped against the interior surface of the coupling 54 by a spacer 64 which is gripped by grooves in the coupling.

A single band interconnects and supports the various components of the piano action, as shown schematically in FIG. 5. The opposite ends 40*a* and 40*b* of the band are secured to the upper surface of the drive bar 38 by means of a screw 41, after applying tension in the band. The portion 40*c* of the band extends across the curved surface of the roller 30 and is connected with the portion 40*d* on the surface of the release bar 42. The portion 40*e* extends around the roller 42 and extends along the lower surface of the guide 34. The portion 40*f* of the band is looped over the guide 34 and may be secured against slippage by applying a suitable fastener between the guide 34 and the band 40. A portion 40*g* extends around the periphery of the release roller 44 and the band also is looped around the release bar 42 with the portion 40*h* being on the outer surface of the release bar. The band is also looped around the hammer roller and has a hole 40*i* through which the hammer shaft 32 extends. A portion 40*j* extends around the curved surface of the hammer roller 30 and along the upper surface of the drive bar 38. The portion 40*k* is looped over the guide 36 and extends along the lower surface of the drive bar 38. A portion 40*l* of the band is looped around the drive roll 48. The damper roll 58 is retained between portions 40*m* and 40*n* of the band and the portion 40*o* extends around the damper shank 56. The portion 40*p* is also looped around the damper coupling 54 and clamped in the coupling 54 by the spacer 64.

As shown in FIG. 5, the adjacent components of the piano action roll on the surfaces of the band 40, while the band tension maintains the components in engagement with each other. Since there is no relative sliding between components and the band, the piano action has virtually no frictional drag and the parts are not subjected to wear. Also, if any dirt particles should be present on the band or component surfaces, the components merely roll over the particles and there is no interference with the action.

The upward displacement of the peg 46 by depressing the opposite end of the key lever 6 transmits motion through the drive roll 48 to the drive bar 38, thereby swinging the drive bar about its right end, as viewed in FIG. 1. The release bar 42 cannot move upwardly when the drive bar begins to swing upwardly because the upper end of the release bar engages the release roller 44. Thus, the hammer roller pivots about the intersection of the band at the surface of the release bar, but since the band prevents slippage between the surface of the drive bar 38 and the rolling surface of the roller 30, the roller 30 must also pivot at the intersection of the band between the roller 30 and the drive bar 38. As a result, the upward force transmitted by the drive roller 48 is exerted on the hammer roller 30, from which it is transmitted to the release bar 42 in a direction at substantially right angles to the direction of swinging of the drive bar 38. This movement is shown in FIG. 7 with the initial positions of the components shown in phantom lines in FIG. 7 while the final positions of the components is shown in full lines in FIG. 7. It can be seen that the left end of the drive bar 38 moves upwardly, while the lower end of the release bar 42 swings toward the left. It should also be noted that the center of the roller 30 follows a path that is approximately a straight line extending at about 45° to the line of motion of the peg 46. This upward movement of the hammer roller 30 is necessary for operation of the backcheck feature, as will explained below.

In order to decouple the motion of the roller 30 from the motion of the key lever 6, a toggle device is provided. The toggle includes the release bar 42 and the release roller 44 which rolls along the surface of the guide 34. The release roller 44 bears against a cushioned stop 66 on the mounting plate 22 and another stop 68 is provided adjacent the release bar 42. The bar has an adjustment screw 70 which extends through the bar and the end of the screw pushes against the inside of the band, which in turn engages the stop 68. The band 40 has a corresponding slot to expose the slotted end of the screw 70. By turning the screw, the the distance between the release bar and the stop can be adjusted.

When the release bar 42 and the roller 44 are in the position shown in full lines in FIG. 9, the upward force on the roller 30 is transmitted through the band to urge the bar 42 upwardly against the roller 44 along the axis T_1. Since the roller 44 rolls on the surface 34, the reaction force on the end of the bar 42 is applied along the axis T_2. As a result, the roller 44 is urged to roll toward the left where it engages the stop 66. As the key lever 6 moves upwardly, however, the hammer roller 30 progressively swings the lower end of the bar 42 about the stop 68, while continuing to exert an upward force on the bar. When the bar reaches the position shown in full lines in FIGS. 3 and 9, the axes T_1 and T_2 coincide and the roller 44 is not urged by the force of the roller 30 to move in either direction. However, displacement of the roller 30 toward the left, as viewed in FIG. 9, immediately causes the mutual support between the end of the bar and the roller 44 to become unstable, and the roller rolls toward the right, carrying the bar 42 with it. The upper end of the bar 42 swings in the direction of the arrow in FIG. 3, thereby relieving the resistance previously provided by the bar against the roller 30, and the roller freely rolls along the surface of the drive bar 38. The motion of the hammer roller 30 allows the hammer 28 to strike the string 16 and to rebound freely.

The backcheck feature includes a hammer check 71 which extends outwardly from the shaft 32. A checkpad 72 is supported on a bracket extending outwardly from the mounting plate 22 in position to engage a corresponding felt pad on the hammer check 71 when the hammer 28 rebounds from the string 16. As shown in FIG. 3 in full lines, the hammer check 71 passes under the pad 72 before the bar 42 has released the roller, and in moving from the position shown in full lines to the position shown in phantom lines in FIG. 9. At the time the toggle lever 42 releases, the end of the drive bar 38 is not at its extreme upward position, but is able to swing upwardly a distance sufficient to bring the hammer check 71 into engagement with the pad 72 as the hammer 28 rebounds from the string 16. Upward movement of the drive bar 38 is limited by stops under the key lever 6. As long as the key remains depressed, the end of the drive lever 38 is elevated and maintains the hammer check 71 in engagement with the pad 72, as shown in FIG. 4. As soon as the key is released, the roller 48 and the drive bar 38 drop downwardly to the position shown in FIG. 1, thereby moving the hammer check 70 away from the pad 72 and allowing the hammer to swing back to the position shown in FIG. 1. The instantaneous pivot axis for the hammer shaft 32 is at the intersection of the band between the roller 30 and the drive bar 38, so that the hammer 28 has a greater effective length, than it would, if the hammer had a fixed pivot. Therefore, it is possible to shorten the actual length of the hammer shaft 32 to reduce the overall height of the piano action without adversely affecting the quality of performance.

As shown in FIGS. 5, 6 and 7, a leaf spring 74 is provided for returning the release bar 42 from the position shown in FIG. 4 to the position shown in FIG. 1. The leaf spring has a tongue 76 which is wrapped on the outer surface of the roller 30 and extends between the band portion 40*d* and the surface of the roller 30. As shown in FIG. 6, the tongue 76 extends upwardly along the band portion 40*d*. Since the band 40 is maintained in tension, spring force in the tongue 76 is ineffective to rotate the lever when the roller 30 is in the position shown in full lines in FIG. 7. As the roller rolls back to the position shown in dotted lines in FIG. 7, the end of the tongue 76 is progressively uncovered. The length of the tongue between its free end and the intersection of the band portions 40 between the lever 42 and the roller 30 applies a counterclockwise torque on the lever 42 about the band intersection, the force of the return spring 76 is sufficient to cause the lever to pivot and to bring the roller 44 back to the position shown in FIG. 1. This resetting of the release lever occurs while the hammer shaft 32 is moving away from the backcheck pads.

The leaf spring 74 also includes a pair of tongues 78 which overlie the band 40 at the movable end of the drive bar 38. The tongues 78 continually urge the roller 30 to rotate in a clockwise direction as viewed in FIG. 7.

The damper 60 is pulled away from the string 16 immediately before the hammer 28 strikes the string. This is accomplished by the arrangement of the roller 58 and the cured end of the drive bar 38. As shown by comparing FIGS. 1 and 3, during the initial upward movement of the end of the bar 38, the roller 58 is displaced only a short distance toward the right as it rolls across the end of the bar. As soon as the bar 38 swings upwardly from the position shown in FIG. 3, however, the roller 58 accelerates because the slope at the end of the bar increases in the direction of movement of the roller 58 as the roller approaches the lower surface of the bar 38. Thus, the damper head 60 quickly moves away from the string 16 as the hammer 28 approaches the string 16. A stop 80 is provided on the mounting plate 22 to limit movement of the rod 62.

The damper for each key position can also be operated by means of the sustain pedal. A shaft 82 is rotated by means of a link connected with the sustain pedal (not shown) and the arm 52 is secured on the shaft 82 for swinging the damper bar 50 in the direction of the arrow in FIG. 8. The roller 48 allows the damper shank 56 to pivot from the position shown in full lines in FIG. 8 to the position shown in phantom lines in FIG. 8. When the damper of all of the strings is displaced by the sustain pedal, the roller 58 still allows relative motion of the drive bar 38 independent of the position of the damper shank 56 and does not interfere with the action.

In order to soften the percussion of the hammer 28, a conventional loudness rail 84 extends across the piano actions and is operated by means of a lever 86 connected with the loudness pedal so that in a conventional manner the loudness rail 84 can be displaced to the position shown in phantom lines in FIG. 4. In this position, the hammer shaft 32 does not swing through as great an arc as when the loudness rail 84 is retracted to the position shown in full lines in FIG. 4. Thus the kinetic energy imparted by the key lever is reduced.

In operation, when the piano action is initially in the position shown in FIG. 1, depressing lifts the drive rolls 48 and causes the hammer roller 30 to rotate in a counterclockwise direction as the roller moves upwardly along an inclined path. When the hammer 28 approaches the string 16, the roller 58 draws the damper head 60 away from the string (FIG. 3). The toggle releases the hammer, preferably at about one-eighth inch before the hammer strikes the string, and the hammer rebounds until the backcheck pad 72 engages the hammer check 71, preferably with the hammer spaced about five-eighths of an inch away from the string (FIG. 4). As soon as the key is released, the bias provided by the leaf spring 74 urges the hammer roller to rotate in a clockwise direction as the hammer check drops away from the pad 72. During the return travel of the hammer roller 30, the release lever 42 is reset by the tongue 76 and the end of the drive bar 38 pushes the damper head 60 against the string through the roller 58 and the shank 56. The action is then returned to the position shown in FIG. 1 and is ready for striking the string again when the key is depressed.

Since the hammer roller and associated components are mounted on the plate 22, the action for each key position can easily be removed for repair or replacement and this unitary arrangement also facilitates initial assembly of the piano. The hammer 28, hammer roller 30, release lever 42, roller 44, the drive bar 38, the drive roller 48, the damper shank 56, damper roller 58 and coupling 54 all can be assembled together with the band on the mounting plate 22 and installed merely by fastening the screws 24 and 26 to the upper and lower rails 18 and 20 and applying the damper coupling over the sustain bar 50. The key lever 6 is then installed by inserting the end of the lever between the roller 48 and the pad 8 and then swinging the lever down so that the pins 12 project through the sockets in the lever. The position of the toggle can be adjusted after assembly by turning the adjustment screw 70 which is accessible through the slot in the band 40. Other adjustments can easily be made by bending the brackets on the mounting plate to change slightly the position of the components. The rod 62 for the damper can also be bent, if necessary. Another preferred embodiment of the invention is illustrated in FIGS. 10 to 13. Referring to FIG. 10, the keybed 2′ supports a key lever 6′ for swinging movement about a fulcrum. When the key is depressed at the outer end of the lever, the inner end of the lever in which a peg 46′ is mounted swings upwardly to actuate the piano action for the selected note. A pad 8′ under the end of the key lever 6′ cushions the decent of the lever 6′.

The piano action for each note is mounted as a modular unit on a mounting plate 90. An elongated channel extends across the length of the string frame and is supported in fixed relation to the keybed 2′. An angle bar 94 extends across the string frame parallel to the channel 92 and is supported in fixed relation to the keybed 2′. The mounting plate 90 is secured to the upper rail 92 and the lower rail 94 by screws 96 and 98, respectively. The mounting plate 90 has mounted blocks 100 and 102 which are riveted to the mounting plate 90. The block 100 forms a guide surface 104 for a release roller 106. A cushion strip 109 limits movement of the roller along the surface 104 in one direction and a tab is bent outwardly from the mounting plate 90 to form a stop 111 limiting movement of the roller 106 in the opposite direction. The stop 111 preferably is covered with a resilient material to absorb energy when engaged by the roller 106.

A release bar 108 extends between the release roller 106 and a hammer roller 110, corresponding to the release bar 42 and hammer roller 30 of the embodiment illustrated in FIG. 1. A bracket 112 extends in overlapping spaced relation with the mounting plate 90 and one side of the bracket 112 forms a guide surface 114 for a drive bar 116, corresponding to the drive bar 38 in the embodiment of FIG. 1. A drive roller 118 is positioned between the drive bar 116 and the peg 46′ on the key lever. A single elongated thin flexible band encircles the release roller 106, the release bar 108, the hammer roll 110, the drive bar 116, and the drive roller 118 in the same manner as the corresponding portions of the band 40 supports the corresponding elements, as shown in FIG. 5. The band 120 is looped around the side of the block 100 that forms the guide surface 104 in the same manner as the band portion 40f is secured on the upper guide 34. Similarly, the band 120 is looped around the side of the block 112 which forms the guide surface 114 in the same manner as the portion 40*k* of the band is looped over the lower guide 36 in the embodiment of FIG. 1.

The hammer roller 110 has a leaf spring 122 applied over the band 120. The leaf spring 122 has substantially the same shape as the spring 74 shown in FIGS. 5 and 6, and performs substantially the same function. A hammer shaft 124 is supported at its lower end in a socket formed in the hammer roller 110. The upper end of the shaft 124 supports a conventional

hammer 126. A hammer check 128 is secured in a socket in the hammer roller 110 adjacent the hammer shaft 124. The hammer check extends forwardly in position to engage a felt pad 130 on the upper rail 92 as the hammer 126 rebounds away from the string 16', thus the hammer checks holds the hammer at a short distance away from the string as long as the key is depressed. When the key is released, the hammer checks moves away from the pad 130, allowing the leaf spring 122 to return the hammer to the position shown in FIG. 10.

The damper 132 is supported on a rod 134 that is mounted at its lower end in a damper bar 136. A leaf spring 138 is secured at one end on the block 102 and at the opposite end on the damper bar 136. A damper roller 140 is interposed between the damper bar 136 and the drive bar 116. A thin flexible band 142 is secured at one end on the lower surface of the bar 116 and is wrapped around the roller 140 and secured on the damper bar 136. The leaf spring 138 is resiliently flexed, as shown in FIG. 10, urging the damper bar 136 downwardly and toward the end of the drive bar 116. This imposes sufficient tension in the band 142 to retain the roller 140, and to hold the damper 132 against the string 16'. In addition, the roller is fixed to the band by means of pins.

The damper moves away from the string immediately before the hammer 126 strikes the string. As shown in FIG. 11, as the drive bar 116 swings upwardly, in response to upward movement of the key lever, motion is transmitted to the roller 140 against the force of the leaf spring 138. The roller 140 is displaced toward the left, causing the damper bar 136 to rotate in a clockwise direction, as viewed in FIG. 11, about the lower end of the spring 138. This motion is transmitted through the rod 134 to the damper 132, causing the damper to swing away from the string 16' until it engages a pad 144 on the upper rail 92. When the key lever 6' is released, the drive bar 116 swings downwardly to the position shown in FIG. 10, and the force of the spring 138 urges the roller 140 to roll in a clockwise direction, thereby returning to the position shown in FIG. 10 with the damper 132 in engagement with the string 16'.

It is also necessary to provide for holding the damper 132 of all of the note positions simultaneously away from the corresponding strings. This is accomplished in the embodiment of FIG. 11 by a movable bar that extends parallel to the upper and lower rails 92 and 94. The bar 144 is connected with the foot pedal of the piano so that upon depression of the foot pedal, the bar 144 moves from the position shown in FIG. 10 toward the left where it engages a padded surface 146 on the damper bar 136. Although the drive bar 116 remains in the position shown in FIG. 10, the movement of the sustain bar 144 causes the damper bar 136 to swing about the end of the spring 138 to displace the damper 132 away from the strings 16'.

In operation, when the key is depressed, the key lever 6' swings upwardly toward the position shown in FIG. 11. This motion of the key lever is transmitted through the peg 46' and through the drive roller 118 to the drive bar 116, causing the drive bar to swing in a clockwise direction about the side 114 of the block 112. As the drive bar 116 swings upwardly, the hammer roller 110 rolls in a counterclockwise direction along the surface of the bar 116, while at the same time moving diagonally upward. The force of the key lever 6' is transmitted through the hammer roller 110 to the release bar 108, as the bar pivots about the release roller 106, in the same manner as the release bar 42 pivots about the release roller 44. Ultimately, the release bar 108 engages the stop 68' on the block 102 and the roller 106 is released for movement toward the stop 110. At the same time, the damper 132 has been displaced away from the string by motion of the roller 140 by the drive bar 116.

After striking the string 16', the hammer rebounds freely as a result of the release action of release bar 120 and roller 106, until the backcheck 128 engages the pad 130 to hold the hammer against further movement away from the string and to absorb the rebound energy of the hammer. As soon as the key is released, the end of the lever 6' returns to the position shown in FIG. 10 and the backcheck 128 moves away from the pad 130 to allow the hammer to move against the loudness rail 84', as shown in FIG. 10. An extension of spring 122 bears against bar 108 urging it and the release roller 106 against stops 108 and 68. At the same time, the drive bar 116 returns the damper 132 into engagement with the string 16' and the hammer 136 is ready to strike the string again.

In a modified form of the embodiment of FIG. 10, the height of the hammer 126 over the keybed' can be increased by increasing the length of the hammer shaft 124 and by inserting an extension 148 between the peg 46' and the drive roller 118. The extension 148 has a socket which grips the drive roll 118 to hold the extension on the roller. A felt pad 150 is provided on the extension 148 in position to engage the peg 46'. As the lever 6' moves upwardly, the forces are transmitted through the extension to swing the drive bar 116 in the same manner as described with respect to the form of this embodiment illustrated in FIG. 11.

FIG. 13 also illustrates the action of the sustain bar 144 in displacing the damper 132 of each note position away from the string. The sustain bar is displaced by the pedal from the position shown in dotted lines in FIG. 13 to the position shown in full lines, thereby swinging the lower end of the damper bar 136 about the release spring 138. The force of the spring 138 maintains the bar in engagement with the sustain bar 144.

The band 40 of the embodiment shown in FIG. 1 and the bands 120 and 142 of the embodiment shown in FIG. 10 may be formed of any thin flexible material which has sufficient strength and tension to sustain the forces transmitted through the band. Suitable materials for the band include thin sheet metal, such as beryllium-copper alloys and stainless steel, flexible tapes made of glass fibers impregnated with synthetic resins, such as polytetrafluorol ethylene, Mylar, or other plastic tapes and cloth tapes.

The piano action of this invention allows each key position to be assembled as a modular unit and then installed in the piano. It is not necessary to manufacture different sizes and shapes of parts for each key position. Another important advantage of the apparatus of this invention is that the components are primarily formed of simple shapes that are easy to manufacture by extruding, molding or milling. The rollers, for example, may be cut from rods and the various levers may be molded of plastic. Dimensions of the parts are not particularly critical. The most critical dimensions can be confined to the band which can be manufactured to close tolerances by conventional chemical etching techniques. The assembly of this invention provides a piano action in which the keyboard touch or feel is substantially identical with that of conventional piano actions. There is essentially no wear on the components, except for the felts, and the components should not be adversely affected by changes in climate.

While this invention has been illustrated and described in a preferred embodiment, it is recognized that variations and changes may be made therein without departing from the invention set forth in the claims.

What is claimed is:

1. A piano action comprising:
a roller having a rolling surface;
a hammer fixed on said roller;
mounting means;
guide means including a pair of guide bars mounted for swinging movement on said mounting means, said guide bars each having a guide surface;
means restricting said roller to rolling along said guide surfaces;
a piano key;
drive means interconnecting said piano key with one of said guide bars for swinging said one guide bar;
whereby in response to said swinging of said guide bar the roller rolls along said guide surfaces and said hammer moves to strike a piano string.

2. The piano action according to claim 1 wherein said drive means includes band means between said roller and said guide

means, said band means being secured against longitudinal slippage relative to said roller surface while allowing said roller to roll relative to said guide surfaces, said band means urging said roller toward said guide means.

3. The piano action according to claim 1 including means mounting a backcheck pad at a fixed location, and a hammer check on said hammer, said guide means including means for maintaining said hammer check spaced from said backcheck pad while said hammer moves in the direction of a piano string and for moving said hammer check into engagement with said backcheck pad upon swinging said hammer in the opposite direction.

4. The piano action according to claim 3 wherein one of said guide bars is movable toward and away from said backcheck pad, said roller swinging said hammer in the direction of said string in response to displacement of said guide bars whereby the displacement of the guide bars causes the hammer check to engage the backcheck pad as the hammer rebounds.

5. The piano action according to claim 1 including damper means for engaging a piano string and damping vibration, and means for disengaging said damper means from a piano string in response to said roller swinging said hammer in the direction of a piano string.

6. The piano action according to claim 1 wherein said mounting means includes a mounting plate, said drive means including a band, said guide bars being pivotally supported on said mounting plate by said band and said roller being supported on said guide bars by said band, whereby the components of the piano action may be assembled on the mounting plate before being installed in the piano.

7. The piano action according to claim 1 including means urging said hammer to swing away from said piano string, and including means for rendering said urging means ineffective when said hammer is in the proximity of a piano string, whereby the hammer swings freely when striking and rebounding from the piano string.

8. A piano action comprising:

mounting means;

guide means including a pair of guide levers mounted for swinging movement on said mounting means, said guide levers each having a guide surface;

a roller having a rolling surface;

thin band means extending along said guide surface of each of said levers and extending along said rolling surface, said band means being supported in tension to cause said roller surface to bear against said guide surfaces of both levers while restricting said roller to roll along said guide surfaces without slippage between said surfaces;

a piano key;

drive means interconnecting said key and one of said levers for swinging said one lever in response to depressing movement of said key;

a hammer;

motion transmitting means between said roller and said hammer for displacing said hammer toward a piano string in proportion to the extent of rolling of said roller in one direction along said guide surface of the respective levers, whereby the motion of the key is transmitted to the hammer through said roller.

9. The piano action according to claim 8 wherein said guide surface of each lever is substantially straight, said rolling surface of said roller bearing on said surfaces of the respective levers at first and second locations spaced apart circumferentially of said rolling surface, said locations being arranged to apply torque tending to roll said roller in said one direction along said guide surface of the respective levers in response to depressing movement of said key.

10. The piano action according to claim 9, including a resiliently flexible spring element, said spring element being secured on said roller and extending along said rolling surface on one side of said first location and extending along said guide surface of one of said levers on the opposite side of said first location, whereby the portion of said spring element on said rolling surface is biased toward said guide surface and urges said roller to roll along said guide surface in a direction opposite to said one direction.

11. The piano action according to claim 9 wherein said band means extends across said first and second locations on said rolling surface, the spacing along said rolling surface between said first and second locations remaining substantially constant during rolling motion of said roller along said guide surfaces.

12. The piano action according to claim 8 wherein said band means includes a band portion encircling said roller and extending along said guide surface of each lever in opposite directions from the respective locations at which said roller bears against said guide surface, said band portion being secured against longitudinal movement relative to said guide surface and said rolling surface, whereby said band portion causes said roller to bear against said guide surface while restricting said roller to roll along the guide surface without slippage.

13. A piano action comprising:

a roller having a roller surface;

a first guide lever having a first guide surface;

a second guide lever having a second guide surface;

means for connecting said second guide lever with a piano key for movement of said second lever in response to movement of said key;

a hammer;

means for mounting said hammer on said roller for movement toward and away from a piano string in response to rolling of said roller means along said first and second guide surfaces;

mounting means, said guide levers being movably mounted on said mounting means;

a thin flexible band extending along said first and second guide surfaces and along said rolling surface, said band restricting displacement of said first and second guide surfaces away from said rolling surfaces while allowing rolling of said roller means along said surfaces, said first and second guide surfaces being in closest proximity to said rolling surface at bearing locations spaced circumferentially along said rolling surface, and

means for holding portions of said band in tension along said guide surfaces, whereby displacement of said second guide surface by a piano key lever results in rolling said roller means along said second guide surface and thereby causing said hammer to strike a piano string.

14. The piano action according to claim 13 wherein said mounting means includes hinges between said mounting means and said guide levers, said hinges includes portions of said band supporting said levers for hinged movement, said hinges being positioned at hinge locations spaced from said roller surface.

15. The piano action according to claim 13 including a release roller between said first lever and one of said hinge locations, and including fulcrum means fixed relative to said hinge locations, said fulcrum means being on the opposite side of said first lever from said rolling surface and being spaced a shorter distance from said release roller than is the closest bearing location between said first guide surface and said roller surface, whereby rolling of said roller surface along said first and second guide surfaces swings said first lever about said fulcrum means and displaces said release roller, thereby allowing the hammer roller means to roll freely along said guide surface.

16. The piano action according to claim 15 including spring means for urging said first lever to pivot about said rolling surface upon displacement of said point of close proximity away from said release roller, whereby the first lever is returned from a release position to a holding position.

17. The piano action according to claim 15 wherein said means for holding includes a first mounting surface at said first lever hinge location, said band being secured on said first

mounting surface and encircling said release roller and said first lever to allow rolling of said roller relative to said mounting surface and said lever.

18. The piano action according to claim 17 wherein said means for holding includes a second mounting surface at said second lever hinge location, said band being secured on said second mounting surface and encircling said second lever to allow swinging of said second lever relative to said second mounting surface, said first and second mounting surfaces being provided on a continuous mounting plate extending between said first and second locations.

19. A piano action comprising:

mounting means;

a first lever hingedly mounted on said mounting means at a first hinge location;

a second lever hingedly mounted on said mounting means at a second hinge location; said first and second levers each having a longitudinal guide surface, said levers being arranged for swinging about their respective hinge locations to positions wherein the guide surface of said first lever extends at substantially right angles to the guide surface of said second lever;

a main roller having a roller surface bearing on both of the respective guide surfaces of said levers;

traction means preventing relative sliding between said rolling surface and said guide surfaces, said traction means including means for maintaining said rolling surface in bearing relation with both of said guide surfaces during swinging movement of said levers;

a piano key;

drive means connecting said second lever with said piano key for swinging said second lever in one direction about said second hinge location by depressing said key, and for swinging said second lever in the opposite direction while said key raises from a depressed position;

a hammer;

motion transmitting means between said main roller and said hammer for displacing said hammer toward a piano string in response to rotation of said roller in one direction relative to said guide surface of said second lever and away from the piano string in response to rotation of said roller in the opposite direction.

20. The piano action according to claim 19 wherein said levers are hingedly mounted for swinging about substantially parallel axes, said rolling surface being substantially cylindrical and having a central axis extending substantially parallel to said lever axes.

21. The piano action according to claim 20 wherein said motion transmitting includes an arm fixed on said main roller, said hammer being spaced from said rolling surface and being fixed on said arm, a hammer check secured on said roller adjacent said arm, means mounting a check pad at a fixed location adjacent said first lever hinge location, said pad being arranged to be engaged by said check upon rebound from said string while said key is depressed, whereby release of said key allows said second lever to swing in a direction opposite to said one direction and thereby to disengage said check from said pad, allowing said roller to return to its retracted position.

22. The piano action according to claim 20 wherein traction means includes a thin, flexible band extending continuously along said guide surfaces of said first and second levers and looped around said main roller and said release roller, said band forming the sole means supporting said main roller from movement from said retracted position to said extended position.

23. The piano action according to claim 20 wherein said mounting means includes a cam surface, said cam surface extending transversely of said first lever guide surface and being spaced from said first lever, a release roller interposed between said first lever and said cam surface, said first hinge location being between said release roller and said first lever, and including a stop positioned adjacent said cam surface for engagement by said release roller and a fulcrum in engagement with said first lever on the side thereof opposite said main roller, said main roller being capable of rolling along the respective guide surfaces from a retracted position in which the rolling surface bears on the respective guide surfaces at a position remote from said first hinge location and close to said second hinge location to an extended position in which the rolling surface bears on the respective guide surfaces at locations close to said first hinge location and remote from said second hinge location, said fulcrum pivoting said first lever on movement of said main roller from the retracted position toward the extended position.

24. The piano action according to claim 23 wherein the bearing location between said main roller and said first lever is aligned with said first hinge location along an axis intersecting said cam surface between the point of engagement of said release roller and said cam surface and the point of engagement between said release roller and said stop, whereby said first lever applies torque through said traction means for rotating said roller while said second lever swings in said one direction, until said first lever pivots about said fulcrum sufficiently to cause said first lever to roll said release roller along said cam surface.

25. The piano action according to claim 24 including a spring element on said main roller, said spring element extending along said rolling surface and along said guide surface of said first lever, said spring element being arranged to urge said first lever to displace said release roller along said cam surface into engagement with said stop as said main roller returns to said retracted position.

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