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Lehmann

[11] **3,845,683**

[45] **Nov. 5, 1974**

[54] **KEYBOARD FOR ELECTRONIC MUSICAL INSTRUMENT**

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[73] Assignee: **Pratt-Read Corporation,** Ivoryton, Conn.

[22] Filed: **Sept. 10, 1973**

[21] Appl. No.: **396,057**

Related U.S. Application Data

[63] Continuation of Ser. No. 301,895, Oct. 30, 1972, abandoned.

[52] **U.S. Cl.** **84/1.01,** 84/DIG. 7, 84/433

[51] **Int. Cl.** **G10h 1/00**

[58] **Field of Search** ..... 84/1.01, 423, 424, 430, 84/432–436, 439–441, 1.17, DIG. 7; 29/624, 29/625, 626

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Assistant Examiner—U. Weldon
Attorney, Agent, or Firm—Mueller, Aichele & Ptak

[57] **ABSTRACT**

A keyboard for a musical instrment includes a frame with keys pivotally mounted thereon, and a switch structure secured to the frame including individual switch contacts actuated by the keys. A circuit board is mounted on the frame and extends in a plane parallel to the keys, with a second right angle circuit board mounted thereon having resilient switch conductors extending generally parallel to the keys. An actuator for each key includes an insulator with openings through which the conductors extend. Fixed contacts in the form of bus bars are positioned to be selectively engaged by the resilient conductors to complete circuits from the circuit boards. A stop structure is provided for the keys including a resilient stop engaged when the keys are moved to the normal playing position. This movement of the key causes engagement of at least some of the switch conductors. The keys can be moved further to compress the resilient stop to provide a second touch action. Additional circuits may be established by the further movement of the keys. The stop structure can be in the form of a flat upwardly extending resilient strip which is engaged by a plurality of keys, and can have slits providing a separate portion for each key. Alternatively, a resilient tubular member can be provided for each key, to form the stop.

12 Claims, 10 Drawing Figures

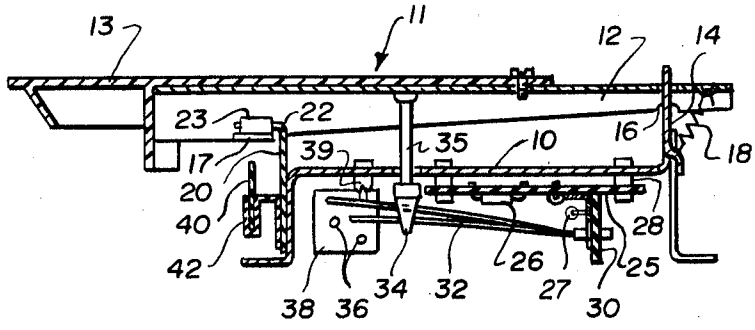


FIG. 1

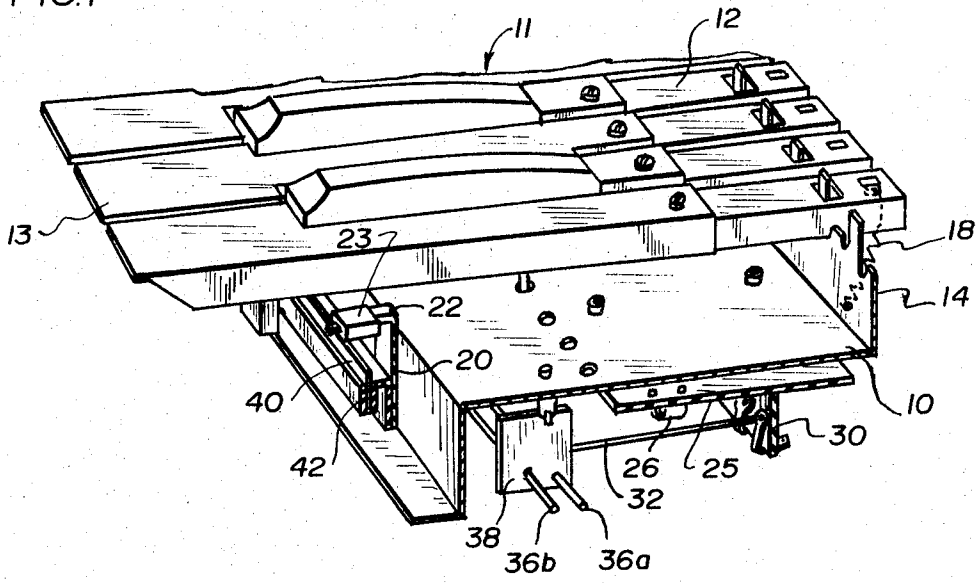


FIG. 2

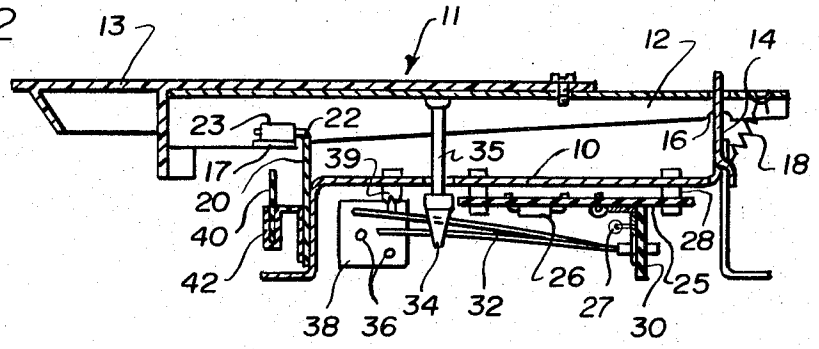


FIG. 3

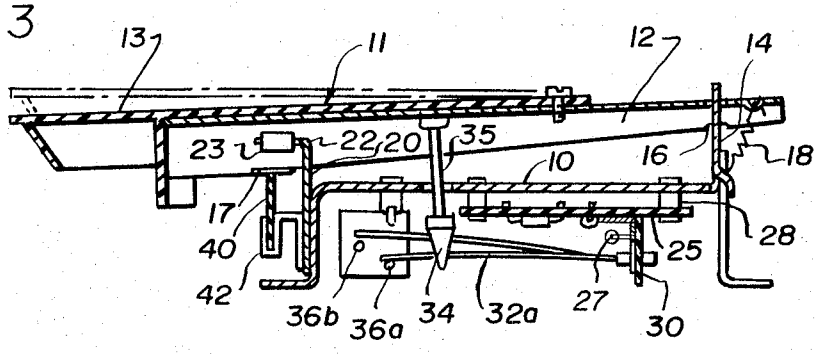


FIG.4

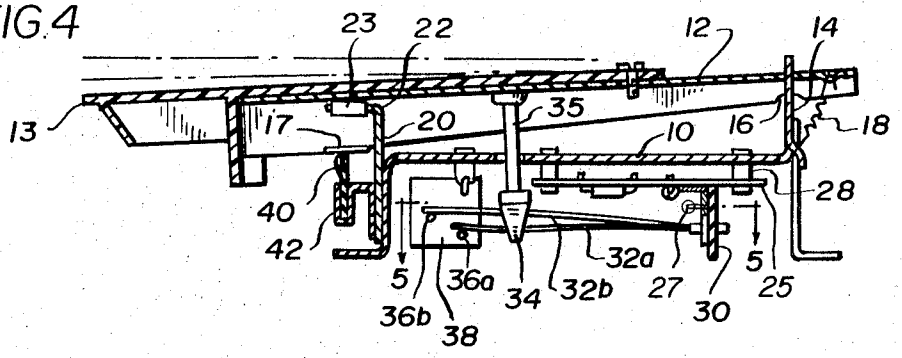


FIG.5

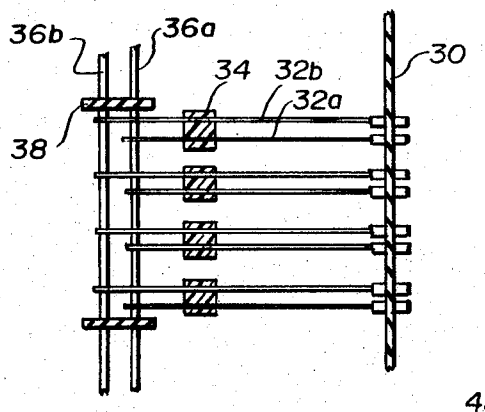


FIG.6

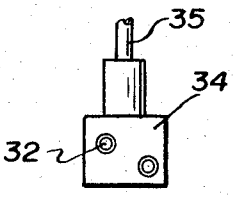


FIG.7

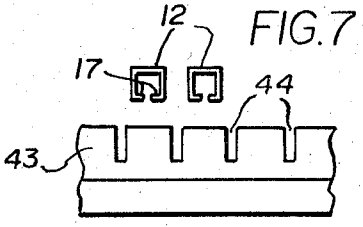


FIG.8

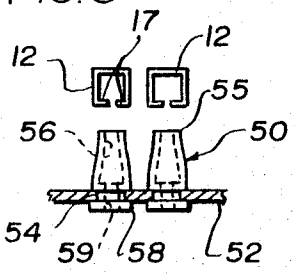


FIG.10

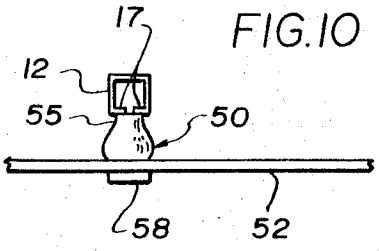
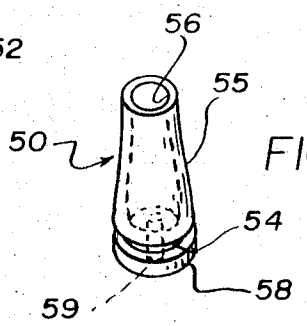


FIG.9



KEYBOARD FOR ELECTRONIC MUSICAL INSTRUMENT

This is a continuation, of application Ser. No. 301,895, filed Oct. 30, 1972 now abandoned.

BACKGROUND OF THE INVENTION

Electronic organs, pianos and other electrical musical instruments include keyboards with switches which are operated to activate tone generators, or to key signals therefrom, to selectively provide signals representing various musical notes. One such keyboard is described and claimed in U.S. Pat. No. 3,251,923, issued May 17, 1966 to F. M. Lund, and assigned to the assignee of the present invention. As the musical instrument art has developed, it is desired to provide keyboard assemblies with switches and circuits which are of simple and compact construction, and which can be used to provide musical effects not now available in small instruments.

It has also been desired to provide keyboards for electronic instruments, which may be electronic pianos, which have the same touch and response to the musician as that of standard piano key and action assemblies which have been available over many years. One such characteristic is second touch, which is produced in a piano key and action assembly when the coupling from the key to the hammer of the piano action is let off, with the key still being movable after the let off until a positive stop is reached. This is sometimes referred to as "after touch." This feel has not been present in keyboards for electronic musical instruments, wherein the key moves from a normal position to an operated position at which the key engages a stop.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved keyboard and switch assembly for an electronic musical instrument.

Another object of the invention is to provide a keyboard and switch assembly wherein circuit boards for electronic circuits are arranged with the keyboard and key switch structure in a compact assembly.

A further object of the invention is to provide a keyboard for an electrical musical instrument wherein the keys when operated provide a second touch feel to simulate the action of a piano key and action assembly.

A still further object of the invention is to provide a keyboard and key switch assembly wherein the keys have a second touch feel, and the switch structure provides a further contact engagement when the key moves beyond its normal actuated position.

In practicing the invention, a musical instrument keyboard and switch assembly is provided including a frame having keys pivotally mounted thereon and a circuit board structure supported thereby. The circuit board structure includes a first board generally parallel to the frame, and a second board perpendicular to the first board and having resilient conductors extending therefrom which are moved by actuators coupled to the keys. The conductors are moved to engage bar conducting rods, or bus bars, to provide connections from the circuits on the circuit board to the bus bars which are connected on the music instrument circuitry. A resilient stop is engaged by the keys when they are moved to an operated position, with the resilient stop being

compressible to allow movement of the keys to a second position providing a second touch feel, as in a piano key and action assembly. The resilient conductors may cooperate with the actuators connected to the keys so that one or more connections are established when a key is moved to its normal operated position and an additional connection is established when the key is moved to the second position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing the keyboard and switch structure of the invention;

FIG. **2** is a cross-sectional view of the keyboard of FIG. **1**;

FIGS. **3** and **4** are cross-sectional views showing a key in different operated positions;

FIG. **5** is a view along line **5—5** of FIG. **4** and shows the switch conductors;

FIG. **6** shows the actuator for the switch conductors;

FIG. **7** shows a modification of the resilient stop structure of FIG. **1**; and

FIGS. **8, 9** and **10** illustrate a further embodiment of the resilient stop structure.

DETAILED DESCRIPTION

In FIG. **1** there is shown a perspective view of a section of a keyboard and switch structure in accordance with the invention. FIG. **2** is a cross-sectional view of this structure. A key frame or key bed **10** supports a plurality of keys **11** thereon, which are pivoted on an upturned portion **14** at the rear of the key bed **10.** The keys **11** have a metal channel **12** with a plastic cover **13** on the front thereof. The portion **14** has pivot portions which cooperate with V-shaped notches **16** (FIG. **2**) in the metal channels **12** of the keys. A spring **18** is connected to the portion **14** of the key bed and to the rear of each channel **12** to hold the front ends of the keys **11** upward. The keys and key frame may be generally like that shown and claimed in U.S. Pat. No. 3,251,923, referred to above.

Secured at the front of the key bed **10** is another upstanding portion **20** having individual stops **22** thereon. The stops have thereon a sleeve **23** of resilient material which is engaged by an inturned portion **17** on the channel **12** of each key, to limit the upward movement of the fronts of the keys. In FIG. **1**, the key associated with the first pivot portion and stop **22** has been removed so that these parts are more clearly shown.

Secured to the underside of the key bed **10** is a printed circuit board **25** having circuit components **26** thereon. The board **25** is supported on the key bed or frame **10** by insulating posts **28.** Secured to the board **25** and extending at right angles thereto is a second board **30** having additional circuits and components **27,** which may be connected to the circuits on the board **25.** Extending from the board **30** in a direction substantially parallel to the keys are elongated resilient conductors or rods **32.** These rods are connected to circuits on the board **30,** and extend through openings in actuators **34** which are secured to the keys. The actuators **34** are connected to studs **35** extending downwardly from the key channels **12.**

Fixed conducting rods **36,** which may be supported on insulators **38** which are secured to the key bed **10** by posts **39,** are engaged by the resilient conductors **32** when the keys **11** are operated. As the actuator **34**

moves downward it will move the conductors **32** downward into engagement with the transversely extending rods **36.** As the conductors **32** can slide freely within the openings of the actuator **34,** no tension is placed thereon, and the resilient conductors are capable of the large number of movements required of a switch for use with a musical instrument keyboard.

FIG. **3** is a cross-sectional view like FIG. **2,** except showing the key **11** in the actuated position. It will be noted that one of the conductors **32,** which is designated **32***a*, engages the cross rod **36***a* to provide a connection from a circuit on the printed circuit board **30** through the bus **36***a* to provide an operative circuit connection. As previously stated, the circuits on the circuit board **30** can be interconnected with circuits on circuit board **25,** to provide various circuit configurations as may be required. It will be noted that when the key **11** is depressed as shown in FIG. **3,** the extension **17** on the flange of the channel **12,** which limits the upward movement of the key as it engages stop **22,** engages an upstanding flat resilient member **40** to limit the downward movement of the key. The member **40** forms a wall which is supported in a channel like support **42** which is secured to the front of the key bed **10** along with the stop member **20.**

The resilient stop **40** may be made of a material which can be flexed to permit further movement of a key which engages this stop, as shown in FIG. **4.** In FIG. **4** the normal unoperated position of the key is shown by dot-dash lines, and the operated position at which the extension **17** on the key channel **12** engages stop **40** is shown by dashed lines, both of these positions being above the position shown in FIG. **4.** In the position shown in FIG. **4,** the key channel **12** is moved downwardly until the web of the channel **12** engages the resilient stop **23,** which forms a limit to downward movement. As the key moves from the position shown in FIG. **3** to the position shown in FIG. **4,** the actuator **34** moves the flexible conductors **32** further down so that the conductor **32***b* engages the rod **36***b*. The conductor **32***a* will still be held in engagement with the rod **36***a*, but will be flexed to a greater extent. It will therefore be apparent that a further connection can be established from the printed circuit board **30** through the conductor **32***b* to the bus **36***b* when the key is depressed to the position shown in FIG. **4.**

FIGS. **5** and **6** show the structure of the resilient conductors **32** and the conducting rods **36,** and the supports and actuators therefor. As previously stated, the conductors **32** can slide within the openings in actuators **34** so that there is no tension on the conductors **32.**

In FIG. **7** there is shown a modified construction of stop member **40,** which is identified as **43.** In the construction, slits **44** are provided in the member **43** intermediate the portions engaged by the individual keys. As previously stated, the extensions **17** on the key channels **12** will engage the upper edge of the resilient stop member **40.** By providing slits between the portions engaged by the individual keys, the wall portion under each key can flex independently of the portions under adjacent keys. This does not cause the deflection of the portion under an adjacent key when one key is depressed. Accordingly, each key reaches the stop at the same position, whether or not adjacent keys are operated. The desired resistance to further movement can be obtained by selecting the material for the member **43.** A material which has been found to be suitable is neoprene.

FIGS. **8, 9** and **10** show a second embodiment of the stop structure wherein an individual stop is provided for each key. As shown in FIG. **8,** a tubular resilient member **50** is provided directly under the extensions **17** of the channel **12** of each key. These resilient members are mounted on a support **52** which may be secured to the key frame **10,** in the same manner that the support **42** is secured thereto as illustrated in FIG. **2.** The tubular member **50** is shown in FIGS. **8** and **9,** and has a reduced portion **54** which fits into an opening in the support **52,** with shoulders on either side so that the member **50** is held in place on the support **52.** The upper wall portion **55** of the member **50** is of tubular configuration having an opening **56** therein, so that the member can be compressed to be inserted up through the opening in the support **52.** The bottom end **58** may be of larger diameter than the top portion **55,** and may have an opening **59** therein if desired which joins with the opening **56** to increase the resilience and facilitate the insertion of the member **50** in the support **52.**

In FIG. **10** the resilient stop **50** is shown in the compressed position which takes place during the second touch movement. The material from which the tubular member **50** is made can have the required resiliency to provide a significant stop action when the portion **17** of the key channel **12** engages the same, and to be compressible when a further force is applied thereto. A suitable material for this use is neoprene. When the resilient member **50** is compressed, the key will continue to move downwardly until the top of the channel **12** engages the resilient sleeve **23,** as described in connection with FIG. **4.**

The embodiment of the stop members shown in FIGS. **8, 9** and **10** can be used in place of the resilient member **40** and the support **42** in the structure shown in FIGS. **1** to **4.**

The keyboard for a musical instrument which has been described is suitable for use in many electrical musical instruments, such as electric organs and pianos. The circuit board and switch construction provides flexibility for different connection arrangements which may be desired. The resilient stop structure provides a second touch, or after touch, characteristic so that the feel to the musician is very similar to that of a piano which has an action with hammers for striking strings. The keyboard and switch structure is relatively simple and can be economically produced, and at the same time provides the characteristics desired.

I claim:

1. In a keyboard for a musical instrument including a frame structure and a plurality of elongated keys pivotally mounted on said frame structure, the combination including:

a first circuit board secured to the frame structure and extending generally parallel to the plane of the keys, said first circuit board having first and second ends and including circuit components and conductors thereon,

a second circuit board secured to said first circuit board adjacent said first end thereof and extending at substantially a right angle thereto, said second circuit board including circuit components thereon and conductors thereon connected to said conductors on said first circuit board,

elongated resilient conductor means individually associated with the keys supported on said second circuit board and extending therefrom in the direction from said first end to said second end of said first circuit board and generally parallel to the keys and having a portion extending beyond said second end of said first circuit board, said resilient conductor means being connected to said conductors on said second circuit board,

actuator means individually secured to the keys and extending perpendicular therefrom, said actuator means being coupled to said extending portion of said resilient conductor means for moving the same in response to movement of the keys, and

fixed contact means secured to the frame structure and positioned to be selectively engaged by said resilient conductor means in accordance with the movement of said actuator means, whereby actuation of one of the keys provides a connection from a circuit on said first circuit board through said second circuit board and said resilient conductor means to said fixed contact means.

2. The structure of claim **1** further including resilient stop means positioned to be engaged by a key upon movement of the key to a first position, said stop means being responsive to a predetermined pressure on the key to permit movement thereof through said first position to a second position.

3. The structure of claim **2** wherein said conductor means includes first and second elongated conductors associated with at least one key, and first and second fixed contacts positioned to be engaged by said first and second conductors, respectively, with said first conductor engaging said first contact in response to movement of the key to said first position, and said second conductor engaging said second contact in response to movement of the key to said second position.

4. In a keyboard structure for an electrical muscial instrument including a frame structure, a plurality of keys pivotally mounted on the frame structure, and electric switch means coupled to the keys for actuation thereby, the combination including;

stop means on each of said keys,

a resilient member positioned to be engaged by said stop means upon movement of a key to a first position to actuate the switch means coupled thereto, and

means for supporting said resilient member on the frame structure,

said resilient member having a wall extending generally in the direction of movement of said stop means and providing resistance to further movement of the key upon engagement by the key, said wall being formed of material which flexes to permit further movement of the key through said first position to a second position in response to a predetermined pressure applied thereto by the key.

5. The structure of claim **4** wherein said resilient member is formed by a flat strip of resilient material extending generally perpendicular to the keys, and adapted to be engaged by said stop portions of a plurality of keys.

6. The structure of claim **5** wherein said flat strip of material has slits cut therein to form individual wall portions engaged by said stop portions of individual keys.

7. The structure of claim **4** wherein said resilient member is a tubular member having a shape to be compressed.

8. The structure of claim **7** wherein said supporting means has a plurality of openings aligned with the keys, and including a tubular resilient member for each key having a reduced portion mounted within an opening in said supporting means.

9. The structure of claim **4** including further stop means supported on the frame structure and adapted to engage the key to limit said further movement thereof.

10. The structure of claim **4** wherein said resilient member is formed of neoprene.

11. A keyboard structure in accordance with claim **4** further including, a first circuit board secured to the frame structure and extending generally parallel to the plane of the keys, said first circuit board including components and conductors thereon, a second circuit board secured to said first circuit board and extending at substantially a right angle thereto, said second circuit board including components and conductors thereon with said conductors on said second circuit board being connected to said conductors on said first circuit board, elongated resilient conductors supported on said second circuit board and connected to the conductors thereon and individually coupled to the keys, and fixed contact means cooperating with said resilient conductor means to form electric switch means operated by said keys.

12. In a keyboard structure for an electrical musical instrument including a frame structure, a plurality of keys pivotally mounted on the frame structure, and electric switch means coupled to the keys for actuation thereby, the combination including;

stop means on each of said keys,

resilient means positioned to be engaged by said stop means upon movement of a key to a first position to actuate the switch means coupled thereto, and

means for supporting said resilient means on the frame structure,

said resilient means forming a wall extending generally in the direction of movement of said stop means and engaged thereby as the key moves to said first position, said resilient means having a portion providing resistance to further movement of the key beyond said first position which flexes to permit further movement of the key through said first position to a second position in response to a predetermined pressure applied thereto by the key.

* * * * *