# United States Patent

[11] 3,559,526


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[21] Appl. No. **761,099**
[22] Filed **Sept. 20, 1968**
[45] Patented **Feb. 2, 1971**
[32] Priority **Sept. 25, 1967**
[33] **France**
[31] **122,069/67**


[54] **MUSICAL INSTRUMENTS, ESPECIALLY OF THE PERCUSSION TYPE**
**18 Claims, 11 Drawing Figs.**


[52] **U.S. Cl.** ..... **84/434,** 84/236, 84/423, 84/433, 84/440
[51] **Int. Cl.** ..... **G10c 3/16**
[50] **Field of Search** ..... 84/433-—438, 236, 423, 430, 437, 451, 440, 240



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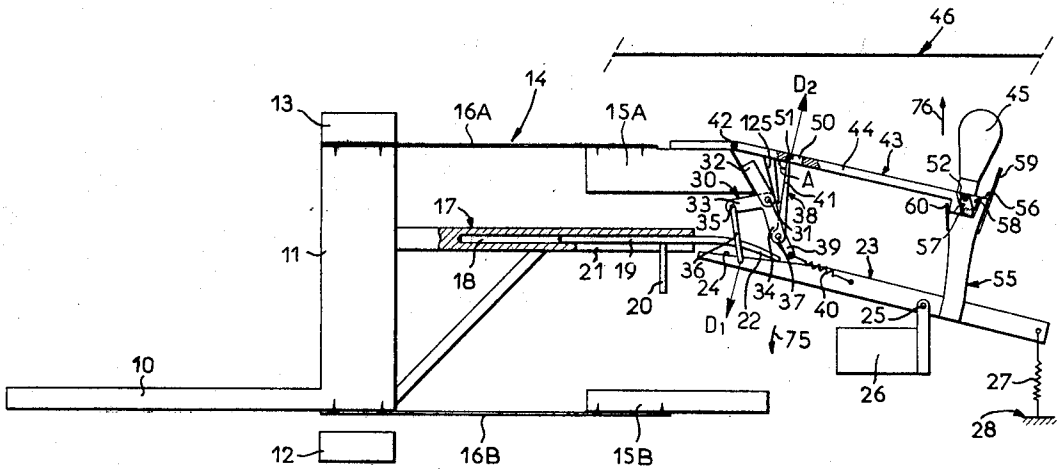
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**ABSTRACT:** In application of the invention to a keyboard musical instrument such as a piano, the key is guided by a deformable parallelogram linkage, so that during its actuated displacement, the key remains parallel to its original orientation; between each key and the associated hammer is interposed a transmission which, when the key is depressed, gives the hammer an accelerated movement with respect to the movement of depression of the said key; the release of the transmission for the free return of the hammer after striking, is effected after the full depression of the key during the sole inertia movement of the hammer towards the wire; the effect of the soft pedal is obtained by continuous modification of the active length of an intermediate lever of the transmission.

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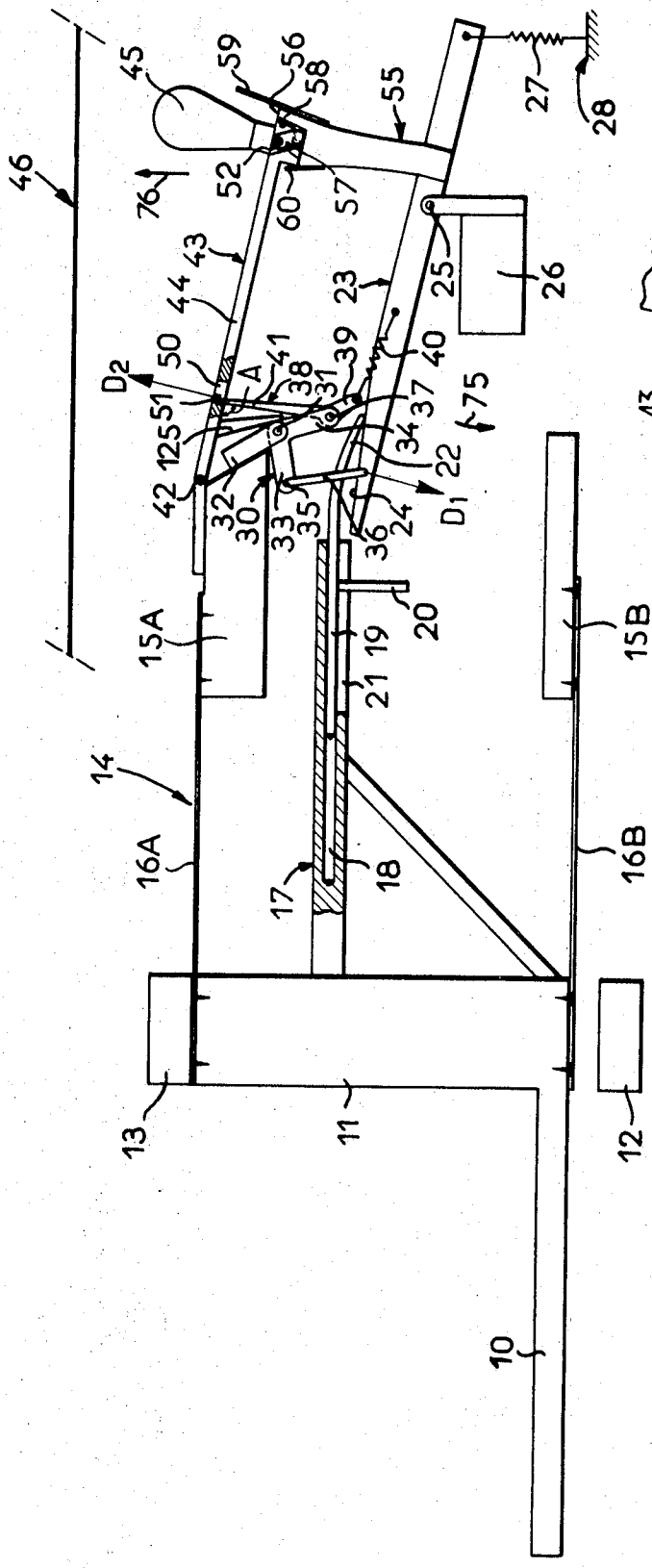



FIG.1

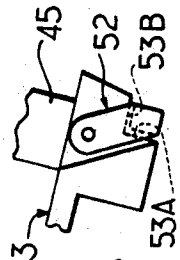



FIG.1A

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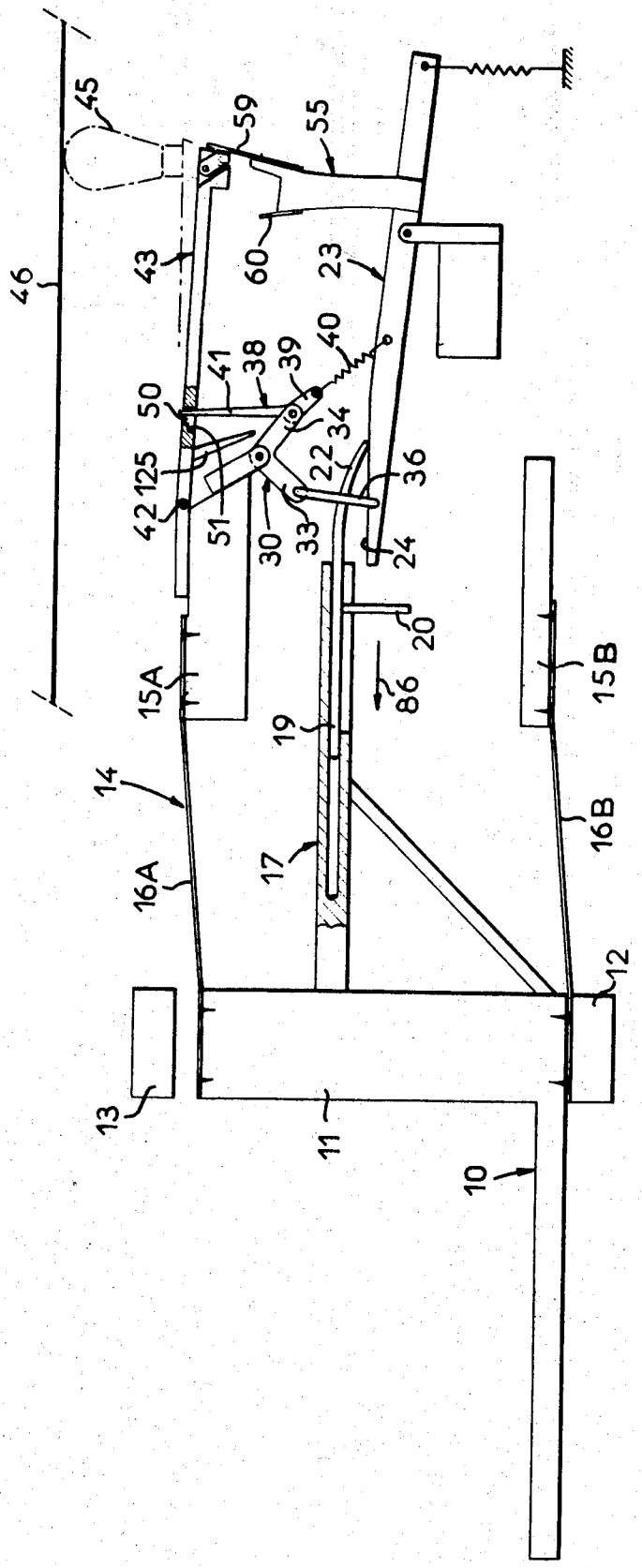



FIG. 2

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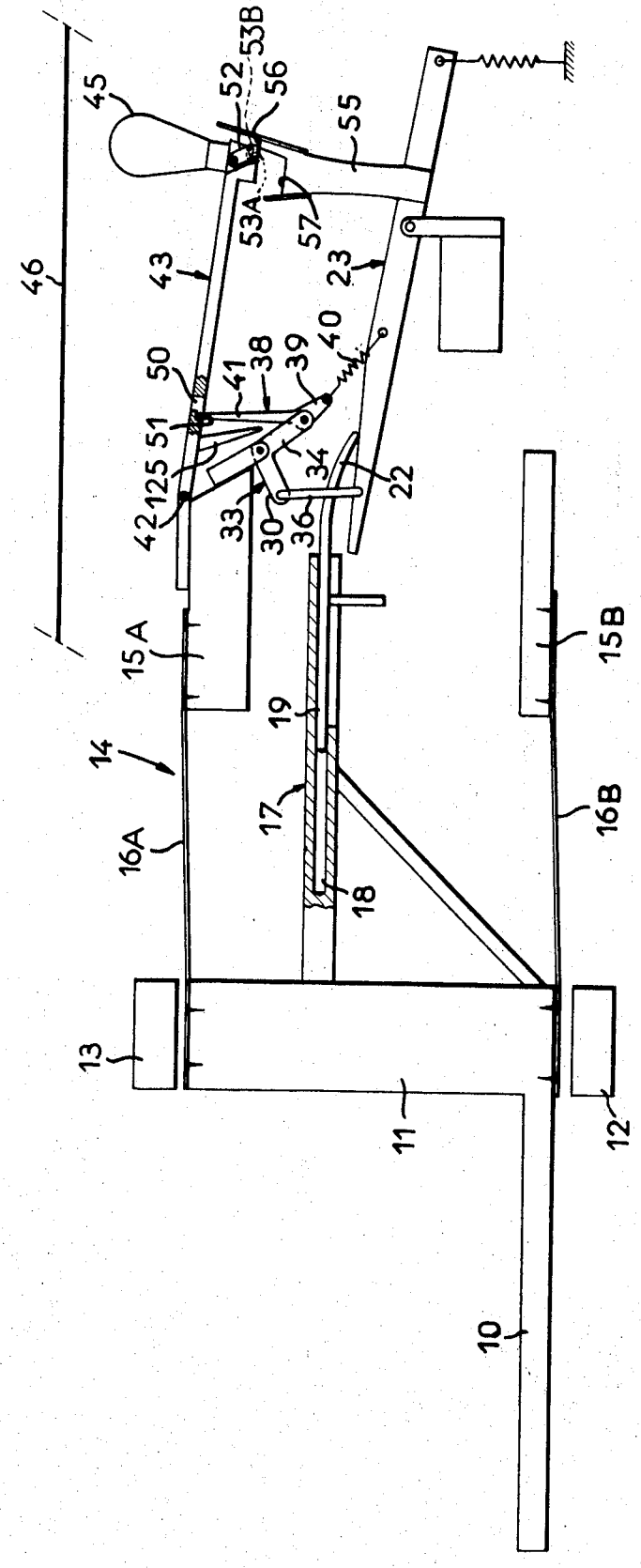



FIG.3

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FIG. 4

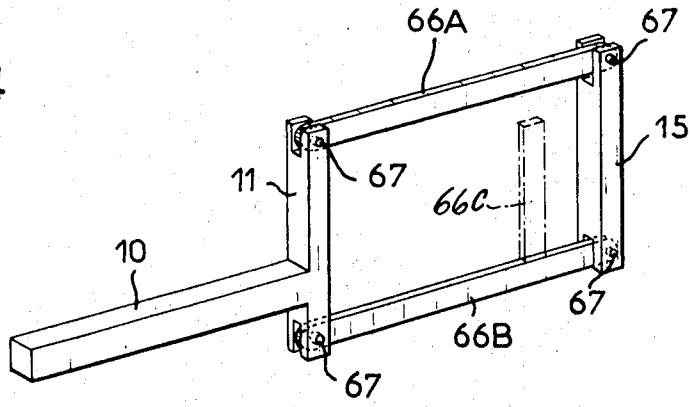



FIG. 5

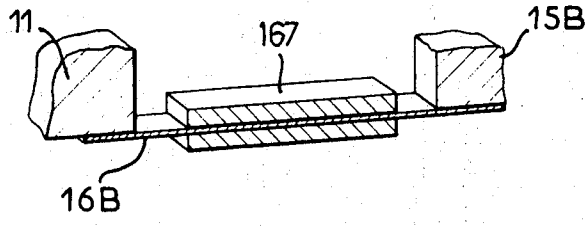



FIG. 6

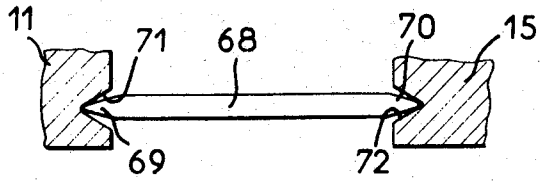
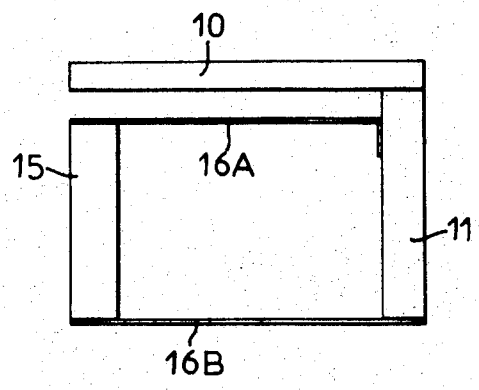



FIG. 7




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FIG.9

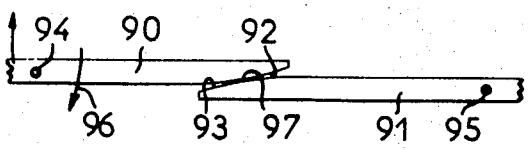



FIG.8

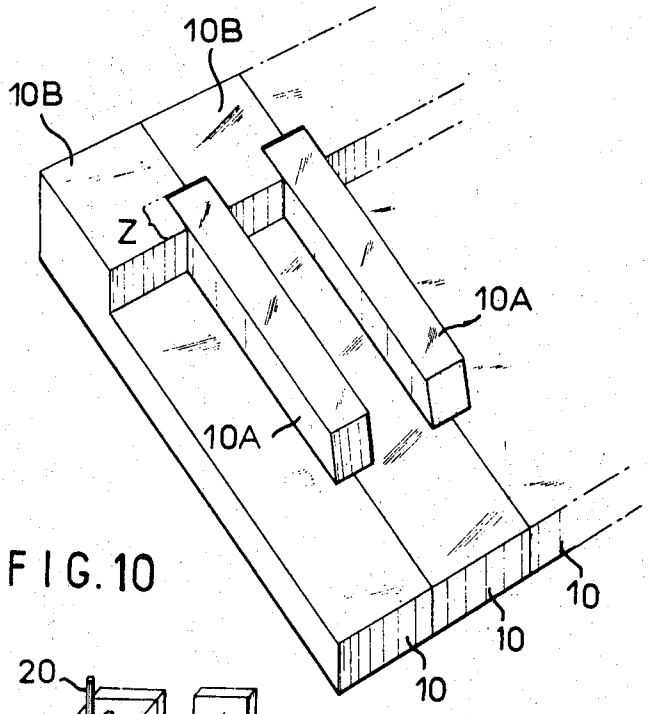
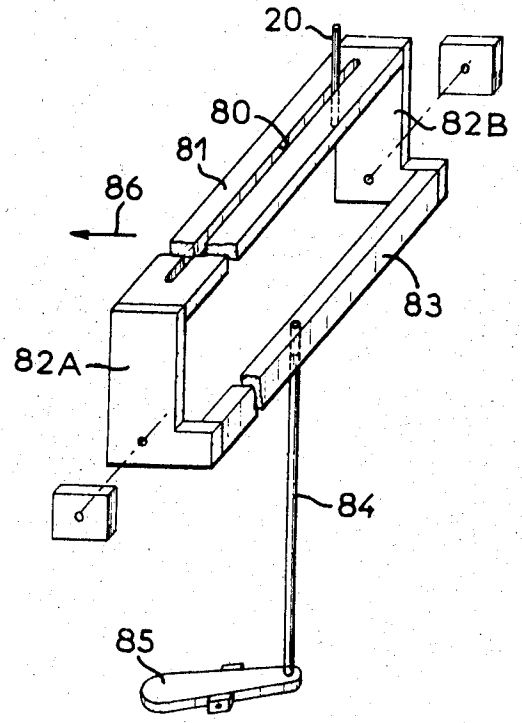



FIG.10




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# MUSICAL INSTRUMENTS, ESPECIALLY OF THE PERCUSSION TYPE

## BACKGROUND OF THE INVENTION

The present invention relates generally to musical instruments comprising a keyboard with keys, and is more particularly directed to instruments of the percussion type, that is to say instruments such as the piano, for which, with each key of the keyboard there is associated a hammer pivotally mounted between a rest or waiting position and a striking position of a musical device which, in the particular case of the piano, is a wire or a set of wires. To this end, between each key and the associated hammer there is interposed an appropriate transmission mechanism for driving the hammer from its position of rest to its striking position when the key itself is depressed from a high position of rest to a low striking position. All the known instruments of this type have a certain number of disadvantages and inadequacies.

In present-day pianos, and generally speaking in all keyboard instruments such as instruments sold under the commercial name of CLAVIOLINE, harmoniums or the like, each key is carried by a simple lever articulated on the frame of the instrument. This results in a variable hardness of "touch," depending on the position of the finger on the key, this hardness increasing when the finger is moved from the front part towards the rear part of the key, that is to say as the finger approaches the articulation point or pivot of the key.

This drawback is particularly marked with short instruments such as upright pianos, in which lack of space limits the length which it is possible to give to the key-carrier levers.

In present-day pianos, the transmission mechanism interposed between a key and its associated hammer is such that the movement relation which it introduces between a depression movement of the key and the corresponding angular movement of the hammer, is substantially linear. Now, as is well known, in order to launch a weight, in the present case that of the hammer, with a constant force, there must be impressed on the hammer an accelerated and nonuniform movement. From the linear coupling ensured by the transmission mechanisms employed at the present time, there results therefore for a performer, a particular hardness when striking a key, followed by a poor control of the hammer which, impelled too rapidly at the start, is subsequently less sensitive to the action of the key.

In addition, various arrangements are provided in present-day pianos, to comply with particular requirements.

In the first place, the transmission mechanism between a key and its associated hammer is of the so-called double-release type, so as to permit the hammer to return freely, after a stroke, from its striking to an intermediate position, between the striking position and the position of rest. In this intermediate position, the coupling between the key and the hammer is interrupted and is only reestablished when the key, during its return from its low striking position to its high rest position, reaches a level which, during the depression, corresponds to the intermediate position at which the hammer is waiting. This arrangement makes it possible to reactuate the hammer immediately before the complete return of the key to its high position of rest, thereby facilitating the execution of repeated notes.

In present-day pianos, this "escape" of the hammer with respect to its propulsion mechanism is effected during the depression of the key, by abutment and sliding of a member known as a "release finger." This results in an additional discontinuity in the hardness of the touch which is particularly troublesome during the execution of soft shades of expression.

Furthermore, in addition to the "loud pedal" which has the function of cutting out the action of dampers which stop the vibration of the wire or wires of a note when the corresponding key has returned to its high position of rest, present-day pianos are provided with a "soft pedal," the purpose of which is to permit of a reduction of the sound intensity emitted when striking a key.



According to a first known arrangement, the "soft pedal" effect is obtained by laterally displacing all the hammers, so that they only strike one or two wires of the one, two or three wires which compose each note. This arrangement has a twofold disadvantage: on the one hand, the effect obtained is not uniform over the whole register, since the bass notes in particular, which only have one wire, are not affected, and on the other hand, the effect obtained is much more a hardening of the timbre than a reduction of the sound intensity emitted, since the power of the hammers is not modified in any way.

In accordance with a second known arrangement, the effect of the "soft pedal" is obtained by modifying the position of rest of the hammers so as to reduce the possible striking travel of the said hammers. This arrangement is more effective than that previously described, but the resulting introduction of a play between the hammers and their propulsion mechanisms causes a discontinuity in the hardness of touch of the keyboard, which gives the player an annoying sensation of floppiness at the beginning of the travel of the keys.

## SUMMARY OF THE INVENTION

The present invention has for its object a number of improvements which enable the above-mentioned drawbacks to be overcome.

One object of the invention is to provide a keyboard musical instrument in which a key may be struck at any point along its length, without the behavior or the "sensitivity" of the key being thereby modified.

A further object is to provide an improved key and hammer action which facilitates the execution of certain chords or successions of notes, and in particular of the chromatic glissendo which brings into play successions of alternate black and white keys.

Another object which relates more particularly to percussion instruments, consists of the provision, between the key and the hammer, of a so-called accelerating transmission, adapted to give the hammer an accelerated striking movement when a uniform depression movement is applied to the corresponding key.

Another object is to provide a key and hammer action in which the release of the hammer is effected, not during the course of depression of the corresponding key, but after the latter has reached its low striking position.

A further object is to obtain the "soft-pedal" effect by a continuously variable means.

These and other objects according to the invention are achieved especially by the associated of each key of the keyboard of the instrument with a deformable parallelogram linkage such that, during the course of its movements, the key remains parallel to itself; by the arrangement between each key and an associated hammer of an accelerating transmission; by the inclusion in this transmission of a release means adapted to permit the free return of the hammer after striking, after complete depression of the key, and during the inertial movement alone of the hammer towards the guardrest; by the arrangement of a "soft-pedal" means adapted to obtain, simultaneously for all the keys of the keyboard, a continuous modification of the movement ratio obtained by the accelerating transmissions respectively associated with the said keys.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in elevation of a guiding device for a key and a transmission mechanism interposed between the said key and an associated hammer;

FIG. 1A is an enlarged fragmentary view of hammer-support structure in FIG. 1;

FIGS. 2 and 3 are views similar to FIG. 1, for different positions of parts, to illustrate operation of the mechanism;

FIGS. 4 to 7 are detail view illustrating various alternative forms of the guiding device for a key;

FIG. 8 is a perspective view of a portion of a keyboard according to the invention;

FIG. 9 is a diagrammatic view of an alternative form of construction of the accelerating transmission; and

FIG. 10 is a perspective view of the operating mechanism for a "soft-pedal" control of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the form of embodiment chosen and shown in FIGS. 1 to 3, which concern, by way of example, the application of the invention to a grand piano, any key 10 of the keyboard of this piano is carried by a small pillar 11 mounted for axial displacement between two fixed stops, a lower stop 12 and an upper stop 13. For guiding its movements, the pillar 11 forms one of the sides, known as the driving side, of a deformable parallelogram linkage 14, the opposite side of which is formed by the frame, shown as two fixed members 15A, 15B. The pillar 11 is coupled to the members 15A and 15B by oscillating guiding arms 16A, 16B respectively. According to the form of embodiment shown, the guiding arms 16A and 16B are single flexible blades. As shown, and preferably, the effective spans or lengths of the flexible blades 16A, 16B are the same and are substantially the same as the effective spans or lengths of the fixed link (15A, 15B) and of the movable line (pillar 11); the range of movement of the movable link 11 is constrained by stops (12, 13) to be small compared to the effective spans of all links, and throughout the range of movement of the pillar link 11, all corner angles of the parallelogram remain substantially 90°.

the pillar 11 also carries a rigid finger 17 parallel to the key 10. This finger is hollowed by an axial bore 18, in which a rod 19 is slidably mounted. For preventing its rotation and driving its sliding movement, which will be detailed later, the rod 19 has a heel 20 engaged in a slot 21 formed longitudinally in the finger 17, at the lower portion of its axial bore 18. The rod 19 has a curved head 22, supported against a lever 23, known as the intermediate lever, on a flat supporting surface 24 of this latter. This intermediate lever 23 is pivoted at 25 on a fixed member 26 and is subjected to the action of a return spring 27, which in turn is coupled at 28 to the frame of the instrument.

An angle lever or bell crank 30, known as the acceleration lever, is pivoted by its elbow at 31 on an extension 32 of the fixed member 15A; the bell crank 30 comprises a driven arm 33 and a driving arm 34. A driving rod or link 36 pivoted to the driven arm 33 connects bell crank 30 to the intermediate lever 23. The length of the driven arm 33 between its pivots 31 and 35 is small as compared with that of the intermediate lever 23 between its pivot 25 and its connection to the rod 36.

The driving arm 34 pivotally carries at 37 an angle lever or bell crank 38, known as the driving-and-release lever or finger, comprising, on each side of its point of connection to the acceleration lever 30, a return arm 39 (connected by a spring 40 to the intermediate lever 23), and a driving-and-release arm 41.

The hammer assembly 43 for key 10 is pivoted at 42 to the frame member 15A. The hammer assembly comprises an arm 44 and a felt-padded head 45 and is movable about pivot 42 in the direction for head 45 to strike one or more wires, shown diagrammatically by a heavy line 46 in FIGS. 1 to 3. Means, not detailed, permit head 45 to be advantageously fixed at a selected height or offset above arm 44. In its central portion, the arm 44 has a release opening 50 having along one of its edges a notch 51 known as the release notch, positioned for engagement by the free extremity of arm 41 of the driving-and-release lever 38.

On the free extremity of arm 44, and below head 45, is pivoted a lever 52 known as the takeup lever. As can be more clearly seen from FIG. 1A, the small angular movement of this lever, which can take the form of a stirrup engaged to arm 44 (thereby defining a lower terminal edge of arm 44), is limited in each direction by two supporting surfaces 53A and 53B of arm 44. The stirrup 52 extends oblique with respect to the arm 44.

Facing the arm 41 of the driving and release lever 38, the hammer arm 44 carries an oblique arm or abutment 125.

Facing the free extremity of the hammer assembly 43, the intermediate lever 23 carries an upstanding arm 55, the free extremity of which has two successive notches, namely an upper notch 56, known as the takeup notch and a lower or rest notch 57; an inclined surface 58 provides the offset between notches 56 and 57. On the outer side of notch 56, arm 55 carries a projection of braking strip 59 and similarly, on the outer limit of notch 57, arm 55 carries another projection or braking strip 60.

As will have been understood, the intermediate lever 23 forms a driving member for the acceleration lever 30; and the direction of movement of this driving member, or driving direction, perpendicular to the longitudinal axis of the lever 23, has been shown diagrammatically by an arrow D1 in FIG. 1; similarly, the hammer arm 44 forms a receiving member for the acceleration lever 30, and the direction of movement, or receiving direction, perpendicular to the longitudinal axis of arm 44 has been shown diagrammatically by an arrow D2 in FIG. 1.

When the mechanism is in the waiting or rest position, as shown in FIG. 1, the key 10 is in its high position; the pillar 11 is in abutment against the upper stop 13; the driven arm 33 of the acceleration lever 30 forms with the lever 23 an angle which is zero or near zero (and which will become a greater acute angle as lever 30 is rocked counterclockwise); arm 39 of the driving-and-release lever 38 forms with the spring 40 an upwardly facing obtuse and very open angle; arm 41 of this lever 38 is engaged in the driving notch 51 of the hammer assembly 43 and forms, with the alignment of notch 51 and pivot 42, an angle A substantially equal to 90°; the alignment 51—42 also forms with arm 34 of lever 30, an angle equal to or slightly less than 90°; in the direction toward the free end of the hammer 43; the takeup lever 52 is supported against the face 53A of the hammer and the latter rests by its extremity on the lower notch 57 of arm 55 of the intermediate lever 23.

In practice, as can be seen from FIG. 1, the link 36 and the finger 41 of the lever 38 are approximately and respectively parallel, in the initial or at rest position, to the driving and receiving directions D1 and D2.

When the key 10 is depressed, it is displaced to the low or striking position, as shown in FIG. 2. During the course of this downward movement, the finger 17 (including its rod 19) causes the intermediate lever 23 to pivot in the direction of the arrow 75 of FIG. 1. If the depression of the key is approximately uniform, the rotation of the intermediate lever 23, which is substantially proportional to the depression of the key, is also approximately uniform and this is true for the downward movement, namely X, which results for the driving link 36 to lever 30, the angular movement of link 36 being negligible and involving substantially equal downward movements of its extremities. As the length of the intermediate lever 23 is great, or in any case considerably greater than that, namely R, of the driven arm 33, between the pivots 31 and 35, rotation of lever 23 is negligible with respect to that of the driven arm 33 (and, therefore, of bell crank or lever 30), and is approximately equal to arc sin X/R; taking into account the initial conditions specified above, rotation of the driven arm 33 of lever 30 is accelerated with respect to the downward movement X of the driving link 36, and therefore with respect to the depression of the key 10.

During the course of the rotation of the bell crank or acceleration lever 30, arm 41 of the driving and release lever or finger 38, being engaged at notch 51, drives the hammer assembly 43, causing it to rotate in the direction of the arrow 76 of FIG. 1 (i.e., counterclockwise about its pivot 42). As long as arm 34 of lever 30 does not exceed a limiting position in which it is parallel to the alignment 51—42, the resulting hammer movement is one of acceleration, tracking that which has been described for the acceleration lever 30, which, as has been seen, is in turn accelerated with respect to the depressed movement of key 10. As the driving and receiving directions D1 and D2 are only slightly variable (i.e., are substantially opposed), the effects of these two accelerations are additive, and the result is a substantial acceleration of hammer head 45 with respect to key 10.

The total acceleration obtained is increasingly great as the final position of arm **33** of lever **30** approaches its limiting position, namely a position of alignment with link **36**, since the initial position of driving arm **38** is always close to its limit, namely substantially perpendicular to the alignment **42—51**. In practice, care is taken not to permit the arm **33** to work too near to its final limiting position, since such a relationship produces excessive acceleration of the hammer and excessive longitudinal force on the driving link **36** and arm **33**.

It is important to note that during the course of the movement of acceleration lever **30**, the driven arm **33** of the latter sweeps out an angle equal to or less than 90° between an initial or at rest position which, in the limit, is perpendicular to the driving direction **D1** and a final or actuated position which, in the limit, is parallel to this direction **D1** or in alignment therewith. Similarly, during the course of this movement, the driving arm **34** sweeps out an angle equal to or less than 90° between an initial position which, in the limit, is parallel to the receiving direction **D2** and a final position which, in the limit, is perpendicular to the said direction **D2**.

It will be understood that choice of the angle between arms of the bell crank or lever **30** will depend on the relative angle between the driving direction **D1** and the receiving direction **D2**; since in the form disclosed, directions **D1** and **D2** are substantially opposite, the bellcrank arm angle is substantially 90°.

During the course of rotation of lever **30** to lift the driving-and-release lever **38**, the obtuse angle formed between arm **39** and the return spring **40** becomes reversed, whereupon lever **38** is urged in the direction for which its arm **41** tends to escape from the driving notch **51** of the hammer **43**. As long as key **10** is being driven down, arm **41** is maintained in frictional engagement with the notch **51**, but when key drive ceases, the reversed spring action disengages arm **41** from notch **51** (see FIG. **2**), as will be more fully explained.

When key **10** reaches its bottom striking position (abutment **12**), the hammer head **45** is close to its actual striking position but is in fact slightly short of this position. It is, thus, freely and by simple inertia (momentum) that the hammer assembly **43** strikes the wire or wires **40**. During the course of this free travel, friction contact is interrupted between notch **51** and arm **41**; at the same time, abutment arm **125** of the hammer assembly **43** comes into striking contact with arm **41**. Lever **38** then pivots towards the release opening **50**, aided by the action of return spring **40**, so that when the hammer assembly **43**, after striking the wire or wires **46**, retracts by rebound (aided, as by a return spring, not shown, or by gravity, in the example shown), the hammer notch **51** escapes from arm **41** of lever **38** to pass instead into the opening **50** adjacent notch **51** (see FIG. **2**). The hammer assembly **43** then returns to an arrested position in which it is supported by friction on the braking strip **59**, it being understood that, during the downward movement of key **10**, the braking strip **59** followed the counterclockwise movement of member **55** towards hammer pivot **42**. The elastic damping effect of strip **59** prevents further rebounding of the hammer. In FIG. **2**, the braked position of the hammer has been shown in full lines, and the striking position of the hammer is shown in phantom.

It should be observed that the escape of lever **38** takes place after key **10** has reached its low or striking position.

During the striking action of the hammer, the takeup lever **52** remains withdrawn under the hammer **45** head supported against the surface **53A**, and does not engage the notch **56**.

If key **10** is now permitted to return to its high position of rest, by the action of spring **27**, the braking strip **59** moves away from and releases the hammer assembly **43**, which continues to drop until its takeup lever **52** is supported by the takeup notch **56** of arm **55**. From this moment, and if upward movement of the key **10** continues, takeup lever **52** pivots while supported on the notch **56**, transferring its abutment from surface **53A** to surface **53B** to retain the hammer assembly **43** in the position shown in FIG. **3**, known as the intermediate position, while the remainder of the mechanism tends to return gradually to its initial position. During the course of this return movement, the obtuse angle of arm **39** of lever **38** with the associated return spring **40** reverses again to resume its initial orientation, so that arm **41** of lever **38** (as it moves down) may return to engage the hammer notch **51**, just before notch **56** withdraws under the takeup lever **52** and liberates the latter.

The driving coupling between key **10** and the hammer assembly **43** is thus restored at a position of this key, shown (by clearance with stop **12**) in FIG. **3**, intermediate between its low striking position and its high rest position. It is thus possible by depressing key **10** to strike the wire or wires **41** again before the key has returned to its high position. It is also possible to permit key **10** to return to its high rest position (FIG. **1**) by the action of spring **27**. The final drop of the hammer onto the notch surface **57** is damped by the flexible braking strip **60** which rubs against the end or heel portion of the hammer arm **43**.

In accordance with the invention, the "soft-pedal" effect is obtained by continuous reduction of the ratio of movement between the key **10** and the hammer **43**; in practice, following the example shown, this reduction is obtained by modifying the active length of the intermediate lever **23** (i.e., operative radial distance) between pivot **25** and the point of engagement with rod **19**, that is to say, by displacing rod **19** inside the finger **17**. This displacement modifies the rest position of the intermediate lever **23** and therefore that of the hammer assembly **43**, without modifying the striking position of the hammer; in fact, the arrangement according to the invention is such that for the striking position of lever **23** (see FIG. **2**), the supporting surface **24** of this latter, on which the head **22** of the rod **19** bears, is preferably parallel to finger **17** and therefore to the sliding axis of rod **19**.

If rod **19** is actuated by sliding towards the left of FIG. **1**, the at rest position of intermediate lever **23** pivots in the direction of the arrow **75**, and in consequence the hammer assembly pivots in the direction of the arrow **76**. The new at rest position of the hammer will therefore be nearer to the striking position than the previous position. The possible travel of the hammer and its speed relative to that of the key being then reduced, it will strike the wire **46** with a lower power, other conditions being equal; in consequence, the sound intensity will be reduced, which is of course the effect desired.

The sliding movement of rod **19** can, for example, be effected by a device of the type shown in FIG. **10**. The heel **20** of the rod **19** is engaged in the slot **80** of a comb **81** common to all or to at least a plurality of adjacent heels **20**. This comb is carried by two like end-plates or bell cranks **82A**, **82B** pivotally carried by the frame of the instrument, and the end-plates **82A**, **82B** conjointly carry a cross member **83** which, in turn, is connected by a rod **84** to the "soft-pedal" **85**. When the "soft-pedal" is depressed, the comb **81** rocks in the direction of the arrow **86** and drives the heels **20** in the direction, as explained above, corresponding as desired to a reduction of the sound intensity emitted when striking a note.

FIGS. **4** to **7** illustrate various alternative forms relative to the deformable parallelogram guiding device for key **10**.

According to the alternative form shown in FIG. **4**, the oscillating guiding arms of this parallelogram are rigid links **66A**, **66B**, connected at their extremities by pivots **67**, on the one hand on the driving side **11** of the parallelogram and on the other hand to the fixed or frame-based side **15** thereof.

The alternative shown in FIG. **5** concerns the case in which, as previously (FIG. **1**) these guiding arms are flexible blades which have the advantage of eliminating the causes of wear and maladjustment of the parallelogram which they form. These flexible blades must of course be sufficiently rigid to be able to withstand longitudinal compression forces, that is to say should be resistant to buckling. Now, due to the direction of action of the finger on key **10**, the weight of this key and the inertia and restoring force of the mechanism which it drives, the upper oscillating blade **16A** (not shown in FIG. **5**) always works in tension, while the lower oscillating blade **16B** always

works in compression. Under these conditions, it can be advantageous to associate with the blade **16B** a rigid sheath or stiffening means **167** arranged in the central portion of the blade, as shown diagrammatically in FIG. **5**.

In the alternative form of FIG. **6**, the lower oscillating arm may be a rigid blade **68**, having its pointed extremities **69**, **70** supported in the bottom of grooves **71**, **72** formed respectively in the driving side **11** of the deformable parallelogram and in the fixed side **15** of this latter. Up to this point, it has been assumed that key **10** was fixed to a flank of the driving side **11** opposite to that on which the oscillating guiding arms **16A**, **16B** are fixed. According to the alternative construction shown in FIG. **7**, which is particularly suitable for keyboard instruments of small dimensions, key **10** is arranged on the same side as the guiding arms with respect to the driving side **11** of the parallelogram. For example, as shown, key **10** is arranged above this parallelogram. An intermediate position of the key on the driving side, extending on each side beyond this latter, is also possible. In this case, each oscillating arm is capable of working in tension or in compression, depending on the striking position of the finger on the key. The free space between the oscillating arms **16A**, **16B** can be employed for the reception of various members of the instrument and especially for the reception of members appropriate to each key or note. If this space remains unused, it can be reduced by bringing the oscillating arms **16A**, **16B** closer to each other within the limits of the longitudinal forces which the arms are capable of withstanding without deformation.

FIG. **8** illustrates by way of example a fresh possibility of arrangement of the keyboard, permitted by the method of guiding utilized according to the invention for the white keys **10** of this keyboard, together with the associated black keys **10A**. Each key **10** has at its rear portion a section **10B** which, raised above the remainder of the white key considered, is level with the adjacent black keys **10A** and is engaged between these latter. The keyboard is thus provided advantageously with a zone Z in which the black and white keys have the same level and the same width, this zone being particularly adapted for the execution of the chromatic glissando.

According to an alternative form (not shown), the rear portions **10B** of the white keys have a zone, behind the black keys, which is raised with respect to the black keys.

FIG. **9** relates to an alternative form of accelerating transmission. Two arms **90**, **91** are mounted in contact with each other by two cylindrical surfaces of appropriate divergent profiles **92**, **93** respectively, at least one of the surfaces being convex, while the other is convex, concave or flat. In the example shown, the surfaces **92**, **93** are both convex. The arms **90**, **91** are rotatably mounted on pivots **94**, **95** respectively, parallel to the generator lines of the surfaces **92**, **93** and at a distance from these latter.

When the arm **90** pivots about its axis **94** in the direction of the arrow **96**, the contact generator **97** of the two arms moves away from the pivot **94** and approaches the pivot **95**, and the rotation of the arm **91** is thus accelerated following the relative curvature of the surfaces **92**, **93**.

According to an alternative construction (not shown), one of the arms **90**, **91** is guided in a parallel translation movement instead of being pivoted. In the same way, by displacement of the contact generator line, the movement of one lever towards the other communicates an accelerated movement.

The transmission mechanism according to the invention which has been described and shown, by way of example, with reference to grand pianos, can readily be adapted to upright pianos, for example by conversion of the vertical movement of a key to a horizontal movement for the driving side of the associated deformable parallelogram.

Thus, adaptation of the mechanism shown in FIG. **1** to an upright piano is effected by fixing finger **17**, not to the pillar **11**, but vertically on the lower oscillating arm **16B** on the side of the member **15B**. This oscillating arm is rigid according to any one of the forms of construction described above with reference to FIGS. **4**, **5** and **6**, such a finger (corresponding to **17** in FIG. **1**) being suggested at **66c** in FIG. **4**. This oscillating arm thus forms with the finger **17** (**66c**) a square which transmits the downward movement of the key. With respect to the wires, which are vertical in an upright piano, the remainder of the mechanism occupies the same position as that shown in FIG. **1**. Thus, rod **19** is engaged vertically in finger **17**, its heel **20** being directed horizontally towards the keyboard. The finger **17** and rod **19** are in this case guided in rotation instead of being guided in parallel movement; this modifies slightly the conditions of operation but not the principle of the system. The dampers which, in the upright piano, are located on the same side as the hammers with respect to the wires, can be actuated directly by taking-off the movement from the finger **17** or from the lever **23**.

In the present description, no mention has been made of the various adjustment devices which may be rendered necessary by the wear of parts in frictional contact and the degree of precision of manufacture. These adjustments mainly concern the supporting surface of lever **23**, notch **51** and finger **125** of the hammer, and also the position of flexible blade **59** on arm **55**. Also, no mention has been made of the nature of the friction or contact surfaces. These problems can be resolved by following the techniques usually employed in the art.

It will of course be understood that the present invention is not limited to the forms of embodiment described and shown, but includes all alternative forms of construction or combination of their various parts.

I claim:

**1**. A keyboard musical instrument comprising a frame, a series of keys forming a horizontal keyboard, like independent suspensions for mounting each of said keys, each of said suspensions being referenced to said frame and independently guiding each key for substantially purely vertical and non-rotating displacement, sound-producing action mechanism carried by said frame and including a separate hammer and fixed-pivot lever for each of said keys, and a separate transmission connection from each key into actuating relation with the lever associated with each hammer, said connection including elongated horizontally extending parts carried by each key and each lever in partially overlapping vertical registration, contact means carried by one of said parts for engagement with the other of said parts and horizontally adjustably positionable to determine selection of the operative lever radius for key actuation thereof, and selectively operable means simultaneously engaging the corresponding adjustably positionable parts associated with a plurality of keys for selecting in unison the operative lever.

**2**. A keyboard musical instrument comprising a frame and a series of keys forming a keyboard, and like independent suspensions for mounting each of said keys; each suspension comprising a deformable parallelogram linkage for which one side link is fixed to said frame, a movable side link in opposed and spaced relation to said fixed side link and carrying one of said keys, and spaced parallel third and fourth links connecting correspondingly spaced locations of said fixed and movable links, whereby said key is constrained to maintain its orientation to said linkage throughout a range of displacement of said movable side link with respect to said frame; sound-producing action mechanism carried by said frame; and means including a driving member secured to and carried by one of said second, third and fourth links and connected in actuating relation with said action mechanism.

**3**. An instrument according to claim **2**, in which said driving arm is rigidly carried by said movable link and extends substantially at 90° to the elongation axis of said movable link.

**4**. An instrument according to claim **2**, in which said driving arm is rigidly carried by one of said third and fourth links at a location between connection thereof to said fixed and movable links and extends at substantially 90° to the link by which it is carried.

**5**. An instrument according to claim **2**, in which said action mechanism includes a hammer.

6. An instrument according to claim 2, in which at least one of said third and fourth links is a blade extending between two pointed extremities, said fixed and movable side links having corresponding opposed grooves within which the respective extremities of said blade are received and supported.

7. An instrument according to claim 2, in which said third and fourth links are each flexible blades clamped at their respective ends to said fixed and movable links.

8. An instrument according to claim 7, in which at least one of said third and fourth links includes stiffening means intermediate the clamped locations thereof.

9. A musical instrument as claimed in claim 2, in which said action mechanism comprises in association with each key, a hammer mounted pivotally between a position of rest and a striking position, a transmission interposed between said key and said hammer, said transmission comprising a fixedly pivoted acceleration lever having a driven arm and a driving arm on each side of the pivot of a fixedly pivoted intermediate lever, a driving link connecting said intermediate lever to said driven arm, said intermediate lever being movable between a position of rest and a striking position, elastic restoring means urging said intermediate lever to its rest position, a supporting surface on said intermediate lever and positioned to receive driving actuation by said driving member.

10. A musical instrument as claimed in claim 9, comprising a soft pedal, in which each of said driving members comprises axially extendable telescoping elements one of which is carried by said movable link and the other of which extends into driving engagement with said supporting surface, said supporting surface of said intermediate lever being substantially parallel to said telescoping elements, and an axially shifting actuating connection from said "soft-pedal" to said other telescoping element.

11. A musical instrument as claimed in claim 10, in which said actuating connection includes a comb coextensive with the keyboard and in which each of said other telescoping elements is provided transversely with a heel in tracking engagement with said comb.

12. A musical instrument according to claim 2, in which said keyboard comprises a first plurality of keys longer than but partially longitudinally overlapping a second plurality of keys and in interlaced relation therewith, the keys of said first plurality including a first elongated portion that is depressed below the level of adjacent parts of the keys of said second plurality, and the keys of said first plurality including a second elongated portion that is raised to the level of adjacent parts of the keys of said second plurality.

13. A musical instrument according to claim 12, in which said first plurality of keys corresponds to the conventional white keys of a standard keyboard array and said second plurality of keys corresponds to the conventional black keys of such an array; whereby each white key is provided, between adjacent black keys, with a raised portion level with said black keys.

14. A musical instrument according to claim 13, in which said raised portion comprises an extension spreading behind the black keys and level with said black keys, offering a striking surface located at a level at least equal to the level of the striking surface of said black keys.

15. An instrument according to claim 2, and including frame-based stop means for limiting the range of displacement of said movable link, the range of said displacement between stop-limited positions being small compared to the length of said third and fourth links between their connection to said fixed and movable links.

16. An instrument according to claim 15, in which the corner angles of said linkage are substantially $\pi$°for the range of movable-link displacement between stop-limited positions thereof, said one key being rigidly carried by said movable link and extending at substantially 90° from the elongation axis of said movable link.

17. An instrument according to claim 15, in which said one key is rigidly carried by said movable link.

18. An instrument according to claim 17, in which the rigid connection of said key to said movable link is such as to position said key in overstanding substantial registration with said parallelogram linkage and in clearance therewith throughout the range of key-operated actuation of said sound-producing action mechanism.