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(54) Keyboard musical instrument featuring an electronic device for detecting the percussion mode of sound generating elements

(57) A keyboard musical instrument wherein, by means of a respective transmission mechanism (1), each key (2) strikes a corresponding sound generating element (19). The instrument presents a device (34) in turn presenting a number of sensors (40), each for generating a signal depending on the movement of a terminal actuating member (12) of each transmission mechanism (1), and an electronic musical note genera-

tor (35) employing as input signals the electric signals supplied by the sensors (40). In the event the instrument is a piano, the actuating member (12) whose movement is detected by the sensor is conveniently formed by a portion of the hammer (11) striking the piano strings (19).

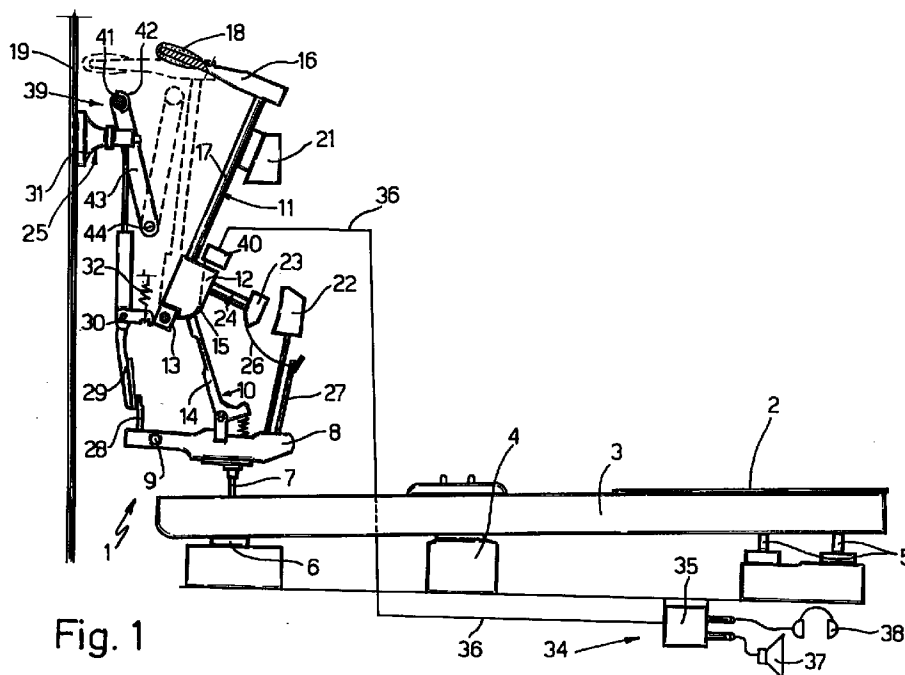


Fig. 1

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Description

The present invention relates to a keyboard musical instrument featuring an electronic device for detecting the percussion mode of sound generating elements of the instrument.

In particular, but not exclusively, the musical instrument to which the present invention relates is a piano.

As is known, one of the most important keyboard musical instruments is the so-called mechanical or acoustic piano, in which each key causes a hammer to strike one or more steel strings stretched on a frame. When struck, the strings produce a vibration, which in turn produces a corresponding musical note which is amplified by a sound box. The volume of the notes is modulated according to the pressure applied by the player to the keys, and which produces a predetermined operating speed, i.e. a predetermined movement, of the key. In particular, when light or strong pressure is applied, the key respectively produces a soft or loud sound.

Each key is connected to the respective hammer by a complex mechanism which varies according to the type of piano (grand or upright), but which in any case provides for a further movement of the hammer depending not only on the movement but also on the initial position of the key (at rest or in motion) and on other settings made, for example, using the pedals.

An accomplished pianist, therefore, does not simply press the key, but combines operation of the keys with the various settings, strikes the key repeatedly in rapid succession to produce a "trill", presses the key before it returns fully to the idle position to produce a "repeat" note, or presses a series of keys to produce a "slur".

Numerous instruments resembling the traditional mechanical piano are now produced, and by which sound is generated, not (or at least not only) by vibrating the strings, but with the aid of electronic devices, which are inserted inside a traditional piano or a simpler instrument simulating mechanical operation of the keys, or are set up externally and connected electrically to the instrument.

Such devices provide for generating "soft" or "loud" sounds by means of a wide range of electronic techniques (all of which, however, involve detecting the pressure exerted on the key) so that the resulting sound resembles as closely as possible that produced by a similarly operated mechanical piano.

According to the known technique, such devices present sensors of various types (spring contacts, conductive rubber, optical, etc.) for determining the speed of respective keys, e.g. by measuring the time taken by the key to activate two sensors a given distance apart.

The above known devices present several drawbacks.

In particular, many of the characteristics of the notes generated by the strings of a traditional piano, and especially those produced by the skill of the pianist, cannot be determined on the basis of the operating speed of the

keys, so that the pianist must to some extent adapt his touch accordingly, and experiences a distinct difference from the piano keyboard to which he is accustomed.

Moreover, such devices, by detecting the movement of the keys, fail to provide for a satisfactory performance comparable with that obtainable from a traditional piano.

It is an object of the present invention to provide a keyboard musical instrument featuring a straightforward electronic device for detecting the percussion mode of sound generating elements, and designed to overcome the aforementioned drawbacks typically associated with known devices.

According to the present invention, there is provided a musical instrument comprising:

a keyboard in turn comprising a number of keys, each corresponding to a respective note, and each operated manually to effect a first movement determined by the player; and

a number of transmission mechanisms, each controlled by a respective key on said keyboard, and each presenting a terminal actuating member effecting a second movement dependent only partly on said first movement;

characterized in that it comprises an electronic device presenting a number of sensors, each for detecting the movement of a respective said terminal actuating member, and generating an electric signal depending on said second movement.

A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic side view of part of a keyboard musical instrument in accordance with the present invention;

Figure 2 shows a larger-scale detail of Figure 1.

Number 1 in Figure 1 indicates one of the percussion mechanisms of a known upright acoustic piano. Mechanism 1 is activated by a key 2 corresponding to a respective note, and which comprises the outward-facing arm of a rocker arm lever 3 pivoting on pivot 4, normally guided by members 5, and resting, when idle, on a fixed stop 6. The arm of lever 3 on the opposite side to key 2 activates a piston 7 forming part of mechanism 1, and which in turn controls a support 8 pivoting about axis 9.

By means of an escapement mechanism 10, support 8 activates a corresponding hammer indicated as a whole by 11. More specifically, hammer 11 comprises a cam portion, hereinafter referred to as core 12, pivoting on a pin 13, and a portion of which is covered by a wear-proof seal 15 (Figure 2) which is pushed by a vertical rod 14 of mechanism 10.

Hammer 11 also comprises a head or core 16, and a rod 17 connecting core 12 to head 16; and head 16 presents a hard-felt-covered tip 18 by which it strikes one or more steel strings 19 for acoustically generating the note corresponding to key 2. Rod 17 normally rests

against a supporting guide 21, as indicated by the continuous line in Figure 1.

When key 2 is pressed, piston 7 rotates support 8 of mechanism 10 about axis 9, and rod 14 provides core 12 with sufficient energy to rotate hammer 11 anticlockwise, with a so-called escapement movement, into the position shown by the dotted line in Figure 1. As can be seen, at least part of the movement of hammer 11 is effected independently of that of lever 3 of key 2. By means of felt 18, hammer 11 strikes the corresponding strings 19 to generate the relative note, and then bounces back into the idle position to allow strings 19 to vibrate freely.

The outer end of support 8 is fitted with a brake 22, which cooperates with the tip 23 of a counter-hammer 24 fitted to core 12, and which engages tip 23 during its return stroke to brake the oscillation of hammer 11. Counter-hammer 24 is connected by an elastic brace 26 to a hook 27 also fitted to support 8; which brace 26 permits hammer 11 to be operated repeatedly to produce a "trill", i.e. the same note repeated in rapid succession.

The inner end of support 8 is fitted with an appendix or spoon 28 for activating a vibration damping element 29 pivoting on a fixed pin 30. Element 29 terminates at the top with a pad 25 with a felt covering 31, and is normally pushed by a spring 32 so that felt 31 rests against and dampens the vibration of strings 19, as shown in Figure 1.

When support 8 is rotated anticlockwise by piston 7, spoon 28 detaches felt 31 slightly from strings 19, and keeps it in this position until key 2 is released. Depending on the time lapse between release and the next operation of key 2, "repeat" notes, "slurs" and other technical effects may be produced by the player. Moreover, the force with which each hammer 11 strikes strings 19 may be further adjusted by adjusting the position of guide 21 to move hammers 11 closer to strings 19. This is a known adjustment which, on a traditional piano, is made by operating the "loud" pedal.

The movement of hammer 11 therefore depends, not only on the movement of key 2 as operated by the player, but also on other characteristics including the type of piano, the volume provided for by the "loud" pedal, the repeat operating frequency of key 2, the time lapse between release and the next next operation of key 2, and, in general, the initial position of the hammer or key (at rest or in motion) when it is operated.

According to the present invention, the piano described above also comprises a device 34 for detecting the force with which strings 19 are struck, as described in detail below. More specifically, device 34 comprises an electronic musical note generator or synthesizer 35 controlled, via a number of electric connections 36, by a number of sensors 40, each relative to a respective hammer 11. In a manner not shown, synthesizer 35 may be connected selectively to a loudspeaker 37 or a headset 38, and presents known volume and tone control knobs.

To operate device 34 independently of the piano, e.g. to enable the player to practise in silence using headset 38, the piano also features a muting device 39, which is not essential as regards the present invention, and which comprises a bar 41 with a felt covering 42 and located between strings 19 and rods 17 of hammers 11.

Bar 41 is fitted to a pair of arms 43 pivoting on two pins 44, and is normally set to the Figure 1 position in which it does not affect the movement of hammers 11. Arms 43 may be controlled in any known manner to set bar 41 to the position shown by the dotted line in Figure 1, in which felt 42 of bar 41 arrests hammers 11 just before they strike strings 19, and so prevents strings 19 from producing the respective note.

According to the present invention, sensors 40 controlling synthesizer 35 provide for detecting the movement of hammer 11. More specifically, a respective sensor 40 is located at core 12 of each hammer 11, for determining the speed of core 12 during both the forward and return stroke of hammer 11.

Since it is the speed of hammer 11 that normally determines the characteristics of the note produced by strings 19, sensor 40 is therefore capable of causing synthesizer 35 to electronically generate the same note with the same characteristics determined by the speed of hammer 11, so that the player experiences the same response as on a traditional piano, between the pressure applied to the keys and the characteristics of the notes produced by synthesizer 35.

Each sensor 40 may comprise a pair of photo-switches 46 (Figure 2) located a given distance apart and for determining the passage of part, e.g. an edge, of core 12; and may advantageously comprise a capacitive, resistive or inductive transducer, or any other means for detecting the speed of a mechanical element.

The advantages of the control device according to the present invention will be clear from the foregoing description.

In particular, it provides for detecting the speed of the actual moving part on which the sound produced by the strings depends, as opposed to the movement of the key by which the above movement is produced, and as such for supplying the synthesizer with more accurate information concerning the volume desired by the player.

Moreover, it provides for achieving the same response as on a traditional piano, between the pressure applied by the player to the keys and the characteristics of the notes produced. Application of the present invention, in fact, has been found to provide for a much more faithful reproduction of the same performance on a traditional piano, particularly as regards "trills", "repeat" notes, "slurs", rapid repeat operation of the same key, and even operation of the "loud" pedal.

Clearly, changes may be made to the musical instrument incorporating device 34 as described and illustrated herein without, however, departing from the scope of the present invention.

For example, sensor 40 may be so located as to detect the speed of rod 17 or head 16 of hammer 11, as opposed to the speed of core 12.

Though, in the above application, device 34 (Figure 1) is incorporated in an upright piano with a muting system, it may of course be applied to any type of piano, e.g. a grand piano, or to any other type of musical instrument in which the movement of the part striking the sound generating element does not depend entirely on the movement of the key.

The musical instrument may even comprise only the keyboard and relative percussion mechanisms, with no sound generating elements, i.e. may be a "hybrid" instrument featuring a traditional mechanical and an electronic sound generating section, in which case, sensor 40 would be so located as to determine the speed of a control element with the same movement as core 12 in Figure 1.

Claims

1. A musical instrument comprising:
 - a keyboard in turn comprising a number of keys (2), each corresponding to a respective note, and each operated manually to effect a first movement determined by the player; and
 - a number of transmission mechanisms (1), each controlled by a respective key (2) on said keyboard, and each presenting a terminal actuating member (12) effecting a second movement dependent only partly on said first movement;
 - characterized in that it comprises an electronic device (34) presenting a number of sensors (40), each for detecting the movement of a respective said terminal actuating member (12), and generating an electric signal depending on said second movement.
2. An instrument as claimed in Claim 1, characterized in that said device (34) comprises an electronic musical note generator (35) employing as input signals the electric signals generated by said sensors (40).
3. An instrument as claimed in Claim 1 or 2, characterized in that each said sensor (40) comprises a pair of photoswitches (46) a given distance apart and facing a respective said terminal actuating member (12).
4. An instrument as claimed in Claim 1 or 2, characterized in that each said sensor (40) comprises a capacitive, resistive or inductive transducer.
5. An instrument as claimed in any one of the foregoing Claims, characterized in that it comprises a guide (21) for establishing the rest position of said terminal actuating member (12) of each said transmission mechanism (1), and for affecting said second movement in such a manner as to affect the volume of the notes.
6. An instrument as claimed in any one of the foregoing Claims, characterized in that it comprises means (41) for damping the percussion speed of said terminal actuating member (12) of each said transmission mechanism (1), and for affecting said second movement in such a manner as to produce a "muting" effect.
7. An instrument as claimed in any one of the foregoing Claims, characterized in that said second movement comprises a component depending on the operating frequency of the corresponding key (2) on said keyboard.
8. An instrument as claimed in one of the foregoing Claims, characterized in that said second movement comprises a component depending on the speed at which the corresponding key (2) on said keyboard is released after being operated.
9. An instrument as claimed in one of the foregoing Claims, characterized in that each of said transmission mechanisms (1) comprises a member (14) activated by the corresponding key (2) on said keyboard, and which pushes said terminal actuating member (12) in such a manner that at least part of the movement of said terminal actuating member (12) is effected independently of that of said key (2).
10. An instrument as claimed in any one of the foregoing Claims, characterized in that each said terminal actuating member (12) comprises a cam portion (12) of a hammer (11); said hammer (11) also comprising a head (16) for striking at least one corresponding string (19), and a rod (17) connecting said cam portion (12) to said head (16); and each said sensor (40) detecting the traveling speed of said cam portion (12) during both the forward and return stroke of said hammer (11).
11. An instrument as claimed in Claim 10, characterized in that a brake member (22) provides for braking the return stroke of said hammer (11), and is connected to the hammer (11) by a brace (26) permitting repeat operation of the corresponding key (2) in rapid succession.
12. An instrument as claimed in Claim 10 or 11, characterized in that it comprises a muting device (39) which may be set to arrest the stroke of said hammers (11) shortly before the respective head (16) engages the corresponding said string (19).
13. An instrument as claimed in one of the foregoing Claims from 9 to 12, characterized in that it com-

prises individual means (31) for damping the sound produced by said strings (19).

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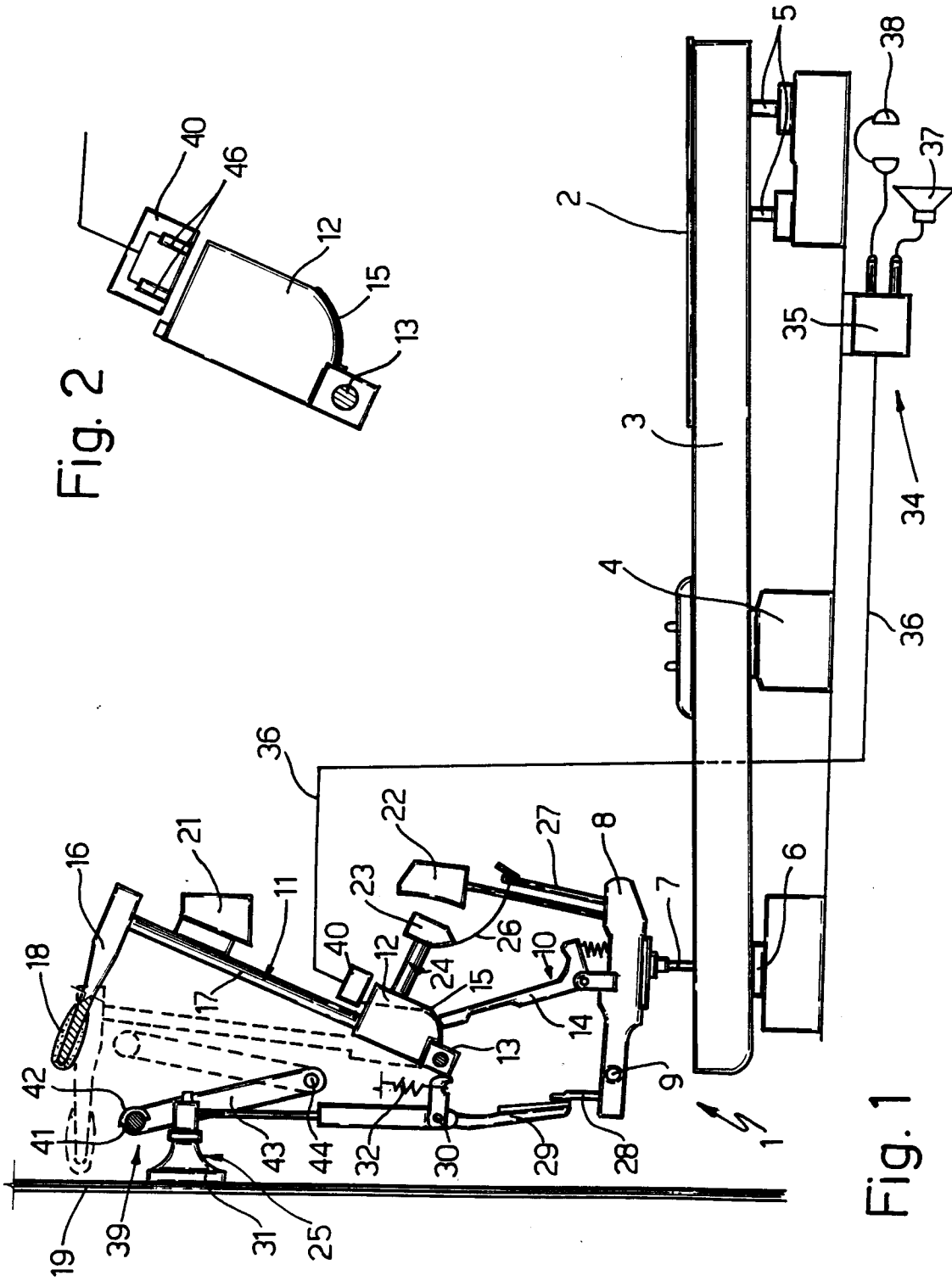
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EUROPEAN SEARCH REPORT

Application Number
EP 96 10 0226

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-5 164 532 (ISHII JUN ET AL) 17 November 1992 * column 1, line 22 - line 48 * * column 5, line 15 - column 6, line 18 * * column 8, line 35 - column 9, line 14; figures 1,3,8 *	1-3,5,7,9-11,13	G10H1/34
X	EP-A-0 573 963 (YAMAHA CORP) 15 December 1993 * page 5, line 10 - line 17 * * page 11, line 36 - page 12, line 20 * * page 15, line 14 - page 16, column 1; figures 1,10,20 *	1-3,5-7,9-13	
A	EP-A-0 206 284 (MONTE CHARLES) 30 December 1986 * page 5, line 9 - line 27 * * page 7, line 22 - page 10, line 1; figure 2 *	1,2,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			G10H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 April 1996	Examiner Pulluard, R
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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