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⑫ # EUROPEAN PATENT APPLICATION

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(54) **Electronic sound generating instrument.**

(57) An electronic sound generating instrument utilizes digital techniques (20) to sense how hard any one of a plurality of operating members (14) on a keyboard is depressed. The instrument generates a desired or particular sound such as a musical note, with a desired parameter, such as volume, corresponding to how hard an operating member (14) was depressed.

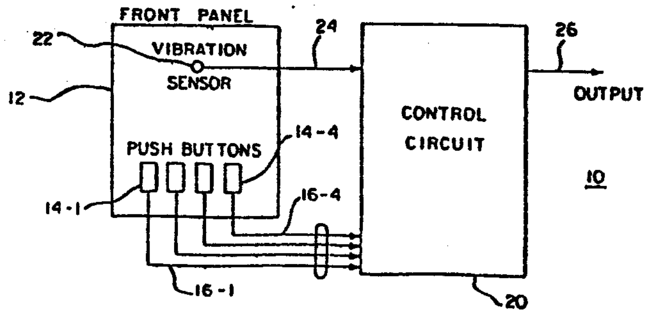

FIG.—1

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ELECTRONIC SOUND GENERATING INSTRUMENT

The present invention relates to an electronic sound generating instrument.

Electronic musical instruments such as keyboard type instruments have long been known for generating musical sounds corresponding to actuation of one or more keys on the keyboard. The desired note or sound corresponds to depression of a particular key and the loudness or other parameter of the sound corresponds in some fashion to how hard the particular key was depressed.

In instruments known as polyphonic type instruments, several sounds can be created simultaneously. With polyphonic keyboard type instruments, it is desirable to detect how hard each push button or key was actuated or depressed in order to generate a musical sound or tone having a specific volume level or other parameter corresponding to how hard the respective key or button was depressed.

In one approach, the prior art provides two switches per button or key, which are sequenced such that by measuring the time between switch closures, the button velocity can be determined. This approach requires accurate physical switch sequencing and fast scanning times.

A second approach in the prior art is where each button or key is provided with an analog pressure sensor. The key or button that is struck measures pressure. Continuous pressure can also be used to modulate the desired sound. This second approach requires analog multiplexing equipment and expensive push buttons. A further problem with the second approach is the wear and tear on the push buttons.

A third approach is where an individual vibration sensor is provided for each key or button. In this third approach, the button directly strikes a vibration sensor. As with the second approach described above, this requires expensive buttons, and an analog multiplexer. Also, crosstalk between buttons can degrade performance.

A fourth approach is in monophonic equipment, where only one sound is played at a time. With only one sound generated at one time, only one button is actually used. The problem with this approach is generation of only one sound (as contrasted with polyphonic equipment) and in addition, crosstalk can be a detrimental factor.

According to this invention there is provided an electronic sound generating instrument, characterised by a plurality of operating members; interface means responsive to actuation of any one of said operating members for generating a first control signal representative of a particular sound to be generated; vibration sensor means responsive to the actuation of any one of said operating members for generating a second control signal representative of how hard that one of said operating members was actuated; and processor means responsive to said first and second control signals for generating a third control signal representative of the particular sound to be generated and a specified parameter of said particular sound.

The specified parameter can be volume, pitch, timbre, attack time, modulation or the like.

This invention will now be described by way of example with reference to the drawings, in which:-

Figure 1 is a block diagram of a touch sensitive electronic musical or sound generating instrument according to the present invention;

Figure 2 is a more detailed block diagram of the instrument illustrated in Figure 1:

Figure 3 is a block diagram illustrating the vibration sensing means of the instrument of Figures 1 and 2;

Figure 4 is a diagram illustrating waveforms in the means of Figure 3; and

Figure 5 is a schematic diagram of vibration sensing means for use in an instrument according to the present invention.

Referring now to Figure 1, a block diagram of a touch sensitive electronic instrument is depicted. The instrument 10 could be utilized for musical or any other sound generating instrument, such as a polyphonic keyboard type instrument, an electronic organ, electronic drum sound instruments, or any other sound generating instrument. In one application, the present invention provides the capability of sensing a plurality of keys or push buttons which are depressed and producing a distinct sound, pitch, timbre, attack time or the like. For purposes of discussion it will be assumed that the invention is utilized to provide a parameter representative of a sound to be generated and the desired volume of the sound.

In Figure 1, the instrument 10 includes a front panel 12 in a typical fashion. The front panel 12 provides for a plurality of push buttons or keys, as illustrated by push buttons 14-1 through 14-4.

Each push button 14 has a corresponding lead 16, such as lead 16-1 for push button 14-1. The signals on combined leads 16 constitute first control signals which are input to control circuit 20, the details of which will be described in conjunction with Figure 2.

In Figure 1, the front panel 12 includes a common vibration sensor 22, which generates a signal on lead 24 for input to control circuit 22. Vibration sensor 22 is provided to determine how hard any one of the push buttons 14 is actuated or depressed. Vibration sensor 22 provides a corresponding second control signal on lead 24 which is representative of how hard any one of the push buttons 14 has in fact been depressed or actuated.

Control circuit 20 is responsive to the first and second signals on leads 16 and 24, and provides on lead 26 an output signal which is representative of the particular sound to be generated (such as a musical note) and in addition, corresponds to the specific or desired volume of the particular sound. This specified volume corresponds to how hard any one of the push buttons 14 was in fact actuated. Of course, the desired parameter, could be the pitch, timbre, or other desired parameter, as described above.

In a preferred embodiment of this invention, the vibration sensor is utilized to detect how hard a push button is depressed. The sensor 22 is used to set an amplitude (or other) parameter of sound generated in response to the depression of a push button 14.

If two of the buttons 14-1 through 14-4 are depressed simultaneously, it is presumed for purposes of operation that the button pushed hardest is the specified or desired output volume for the respective sounds to be generated.

Referring now to Figure 2, a more detailed diagram of the instrument depicted in Figure 1 is illustrated. In Figure 2, the push buttons 14 are shown connected to a button interface circuit 32. The purpose of button interface circuit 32 is to provide a control signal on lead 40. The control signal on lead 40 could be a parallel format signal where each push button 14 is scanned by a microprocessor, such as processor 44.

Actuation of any one of the plurality of push buttons 14 will result in button interface 32 being responsive thereto in order to generate a first control signal on lead 40 which is representative of a particular sound to be generated (such as a musical note or the like).

In Figure 2, the vibration sensor 22 provides an analog signal on lead 24 for input to amplitude detector 34. In one embodiment, the vibration sensor 22 includes a conventional piezo electric crystal assembly. Amplitude detector 34 provides another signal on lead 38 which is representative of the peak amplitude corresponding to how had a respective one of the buttons 14 was depressed. This signal on lead 38 is converted by analog to digital converter (A/D) 36, which generates a digital signal 42 which is representative of how hard a particular one of the push buttons was depressed or actuated. In one embodiment, processor 44 is scanning the push buttons 14 and will detect when any one of the push buttons is actuated. Hence, the digital signal 42 corresponds to the first signal 40.

The signals 40, 42 are input to processor 44 (typically a Z-80 microprocessor), which is responsive to the first and second control signals for generating a third control signal on lead 26, which is representative of, for example, the particular sound to be generated, including the specified volume of the particular sound. The specified volume corresponds to how hard any one of the particular push buttons 14 of Figures 1 and 2 was in fact actuated or depressed.

The instrument in Figure 2 also incldues a sound generator 30, which could be connected to a suitable speaker of sufficient audio fidelity and which is responsive to the signal on lead 26 for generating an audio output 50. The output 50 from sound generator 30 could also be the actual audio sound being generated by sound generator 30 at the desired volume level, corresponding to how hard the specified push button 14 of Figures 1 and 2 was depressed or actuated.

The output signal on lead 26 from processor 44 could also be an analog signal for connection to sound generator 30, in which case the audio speaker will be connected directly to the processor 44.

Referring to Figure 3, a more detailed block diagram of the amplitude detector circuit of Figure 2 is depicted. The amplitude detector 34 is responsive to a signal on lead 24 from the vibration sensor. Figure 4A depicts the level of the signal on lead 24 which is input to rectifier 52 of Figure 3.

Figure 4B illustrates the rectified signal from rectifer 52, which is input to peak detect circuit 54, which detects the peak amplitude of the signal on lead 24. This peak signal is illustrated in Figure 4C and corresponds to how hard a particular push button or key of Figures 1 and 2 was in fact depressed or actuated.

As can be seen in Figures 3 and 4, the vibration sensor and amplitude detector illustrate that hitting a particular button harder causes a larger amplitude vibration and hence, higher signal levels. This is sensed to provide a reliable indication of how hard a particular key or push button 14 has been depressed.

Figure 5 depicts a schematic diagram illustrating the details of the vibration sensor of Figure 1. The drawing of Figure 5 includes a conventional quad operational amplifier (IC2) and a CMOS analog switch (IC1).

The preferred embodiment provides for digital scanning to sense actuation or depression of a plurality of push buttons with a signal vibration sensor. This provides for a wide dynamic range with low cost in terms of componenets. With a digital implementation, a long lifetime is expected.

Another improvement over the prior art is that with this implementation, crosstalk problems are eliminated. The present invention is capable of slow scanning or proportional scanning of the push buttons to provide a reliable indication of the sound to be generated and, in addition, the volume desired for the respective sound.

The instrument of the present invention can be monophonic or polyphonic. Even if two buttons are hit simultaneously with different hardness, an acceptable compromise is available. It is considered in a preferred embodiment that when two buttons are hit simultaneously with different hardness, each button is considered to have been hit equally hard. As indicated, this is an acceptable compromise, especially if the instrument is a sequencer.

CLAIMS

1. An electronic sound generating instrument, characterised by a plurality of operating members (14); interface means (32) responsive to actuation of any one of said operating members (14) for generating a first control signal (16) representative of a particular sound to be generated; vibration sensor means (22) responsive to the actuation of any one of said operating members (14) for generating a second control signal (24) representative of how hard that one of said operating members (14) was actuated; and processor means (20) responsive to said first and second control signals (16, 24) for generating a third control signal (26) representative of the particular sound to be generated and a specified parameter of said particular sound.

2. An instrument as claimed in Claim 1, characterised by sound generator means (30) responsive to said third control signal (26) for generating the particular sound with said specified parameter.

3. An instrument as claimed in Claim 1 or Claim 2, characterised in that said vibration sensor means (22) includes an amplitude detector (34) for detecting how hard any one of said operating members (14) was actuated, said amplitude detector (34) generating said second control signal.

4. An instrument as claimed in any preceding claim, characterised in that said specified parameter is volume.

5. An instrument as claimed in any one of Claims 1 to 3, characterised in that said specified parameter is timbre.

6. An instrument as claimed in any one of Claims 1 to 3, characterised in that said specified parameter is attack time.

7. An instrument as claimed in any one of Claims 1 to 3, characterised in that said specified parameter is pitch.

8. An instrument as claimed in any one of Claims 1 to 3, characterised in that said specified parameter is modulation.

9. An instrument as claimed in any preceding claim, characterised in that said processor means functions digitally.

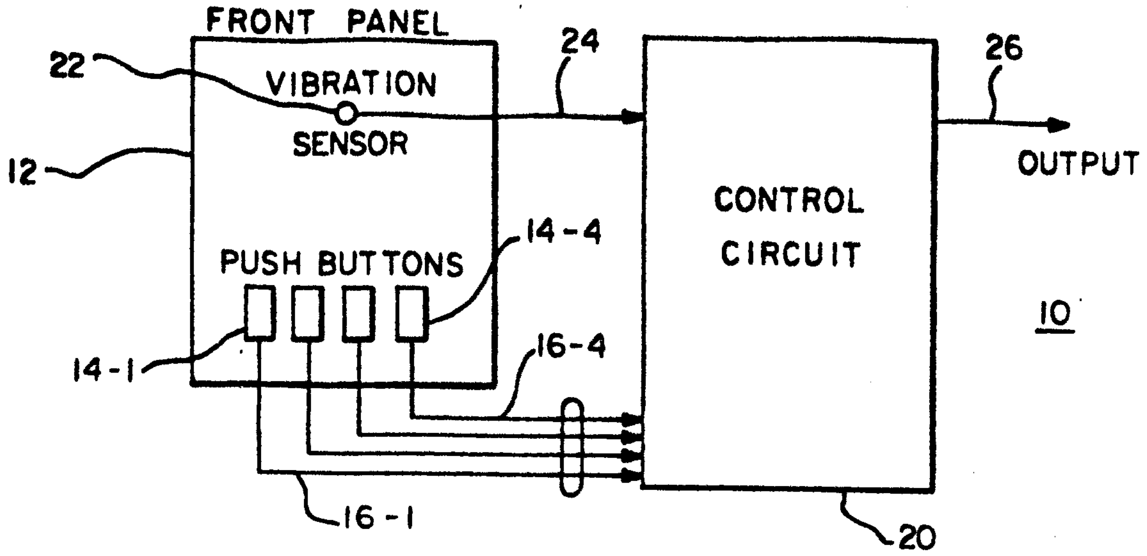


FIG. — 1

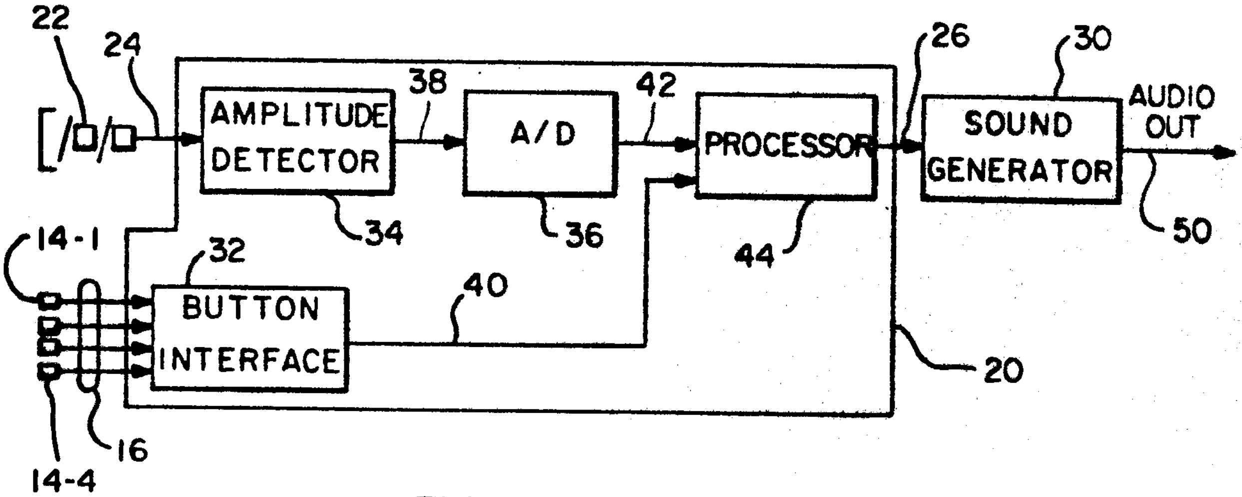


FIG. — 2

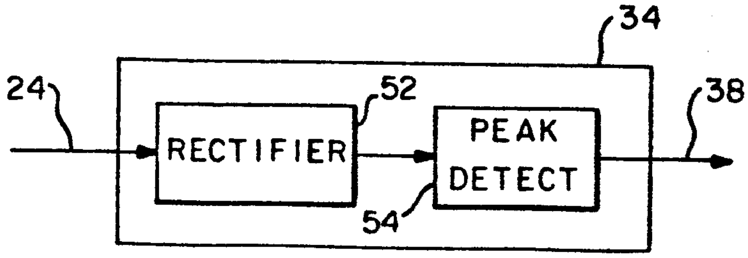
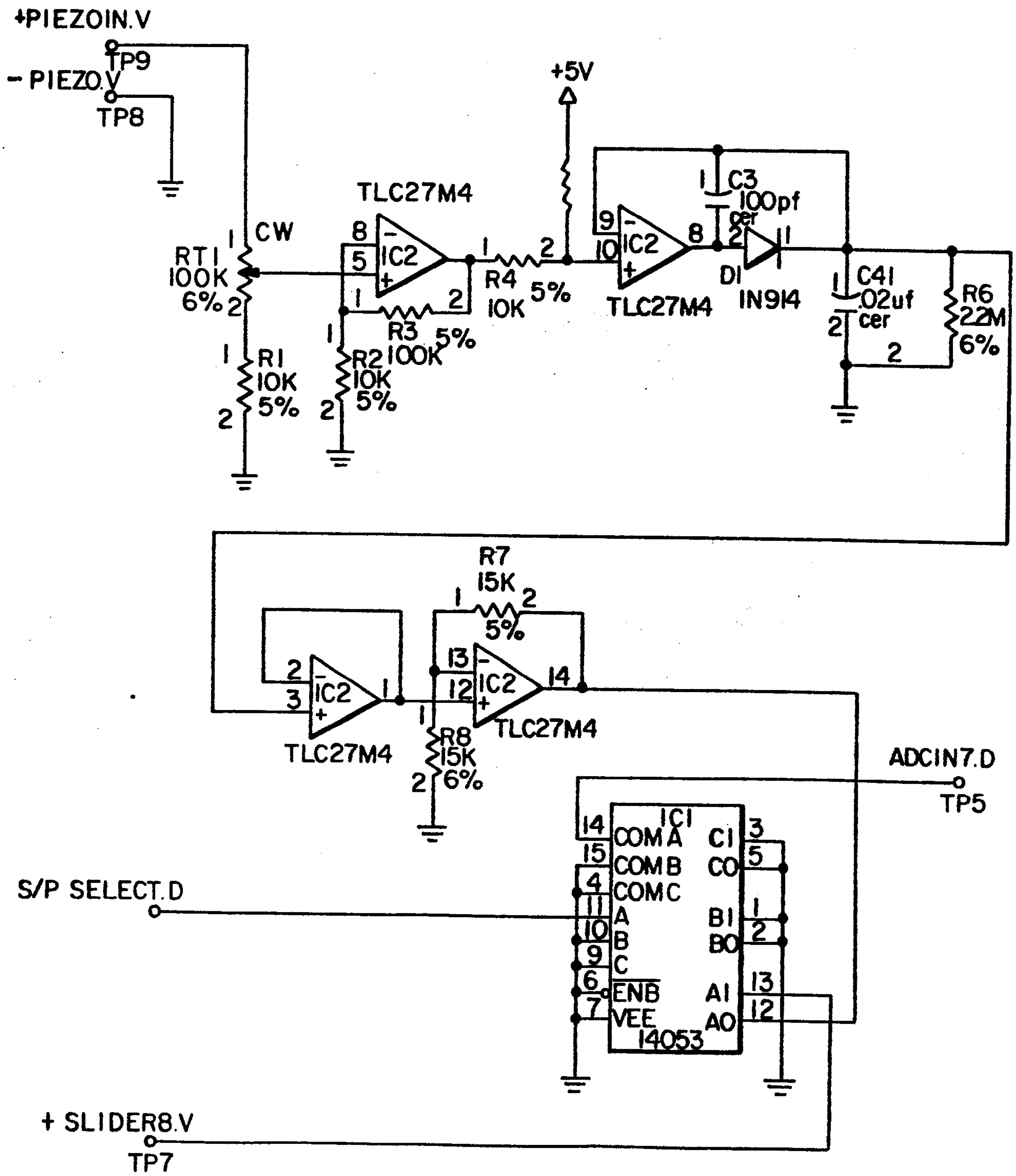


FIG. — 3

A B C

FIG. — 4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-PIEZO.V
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+5V
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TP7

FIG.—5