

United States Patent

Watson

[15] 3,648,279

[45] Mar. 7, 1972

[54] MULTIELECTRODE TRANSDUCER ELEMENT

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[73] Assignee: RCA Corporation

[22] Filed: May 14, 1970

[21] Appl. No.: 37,124

[52] U.S. Cl. 340/365, 340/345, 310/8.3

[51] Int. Cl. G08c 19/00

[58] Field of Search 340/365, 345, 337; 310/8, 8.3, 310/8.4, 8.6, 9.8; 179/105, 113, 125

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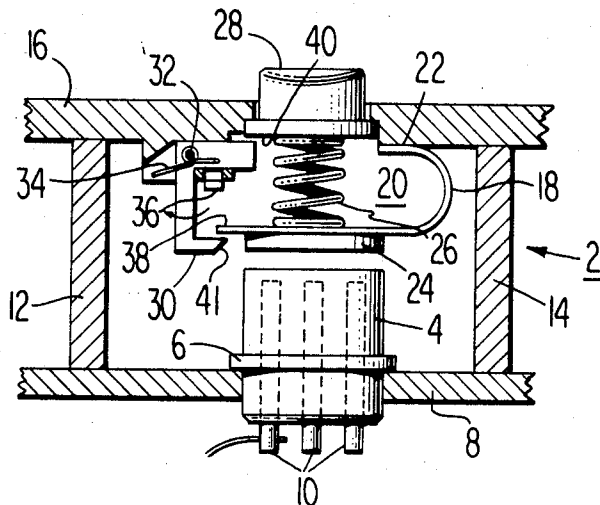
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[57] ABSTRACT

A transducer means suitable for use as the mechanical-to-electrical translating element of the key of a keyboard. It includes a plurality of electrodes embedded in a body of amorphous, piezoelectric material. When the key is actuated to strike the body, a voltage is induced at each electrode. The electrodes of the various keys may be connected in different ways to common buses to provide a coded output from the keyboard.

9 Claims, 8 Drawing Figures



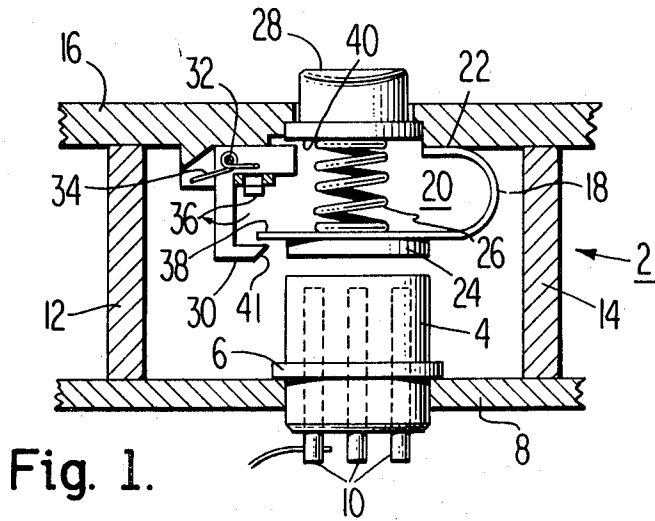


Fig. 1.

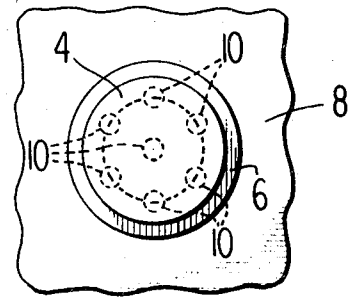


Fig. 2.

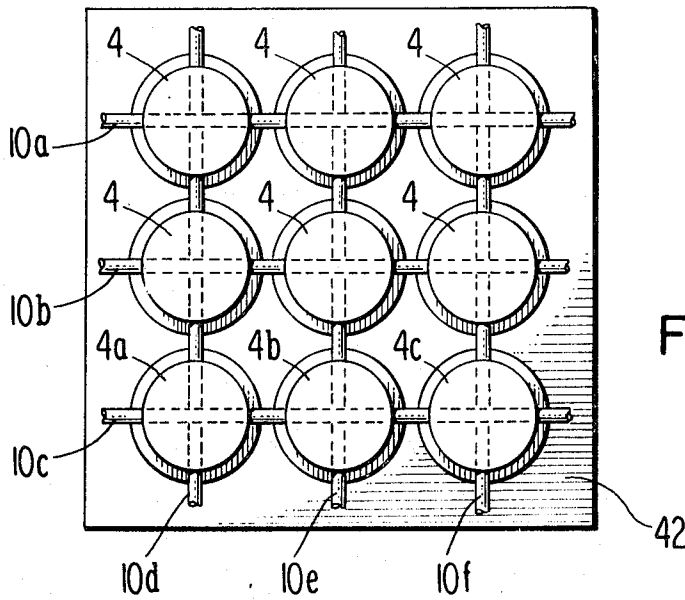


Fig. 3b.

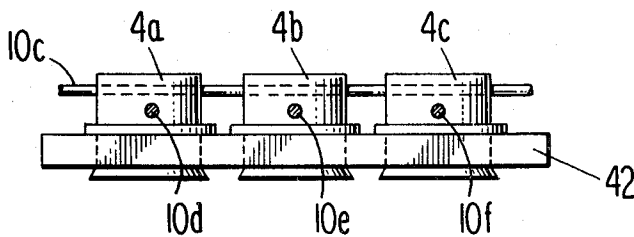


Fig. 3a.

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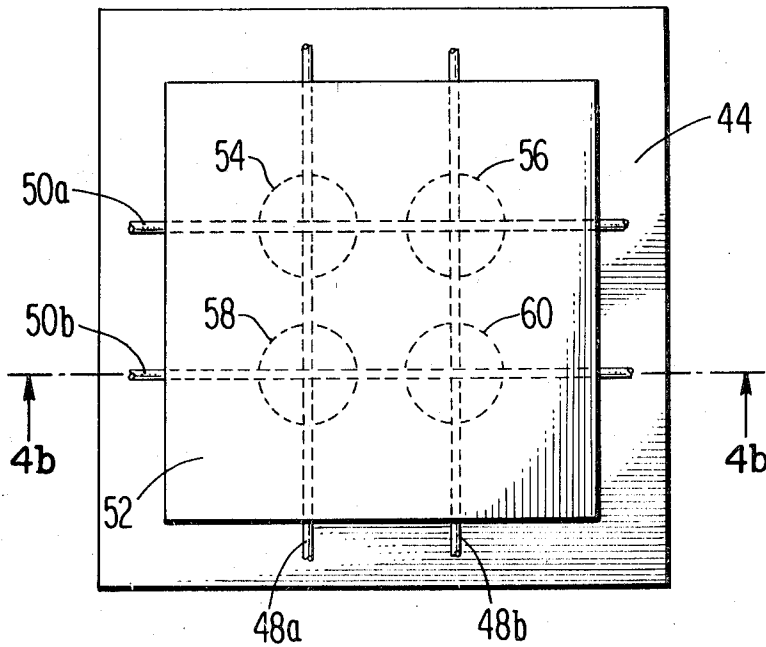


Fig. 4a.

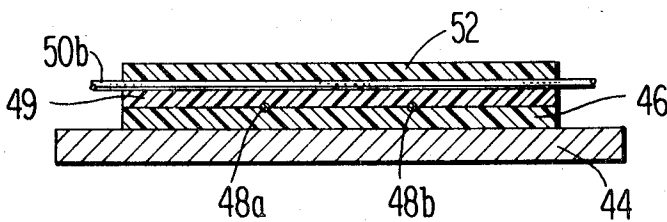


Fig. 4b.

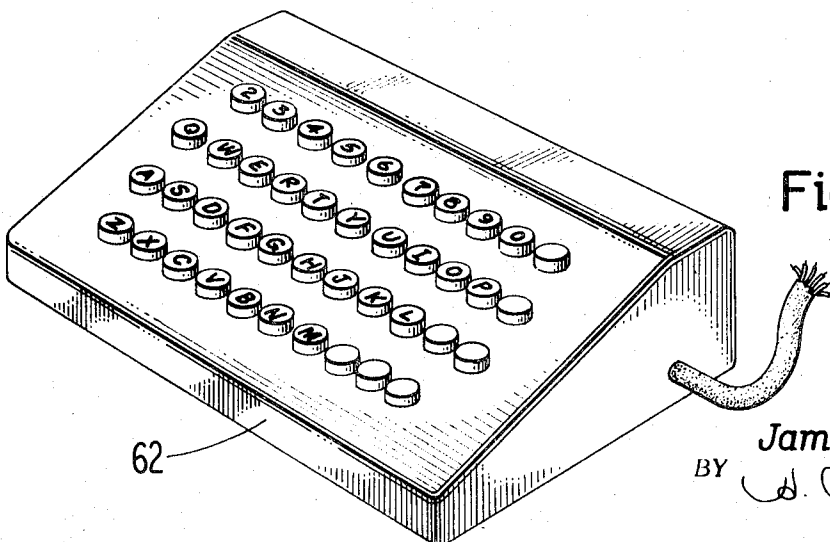


Fig. 5.

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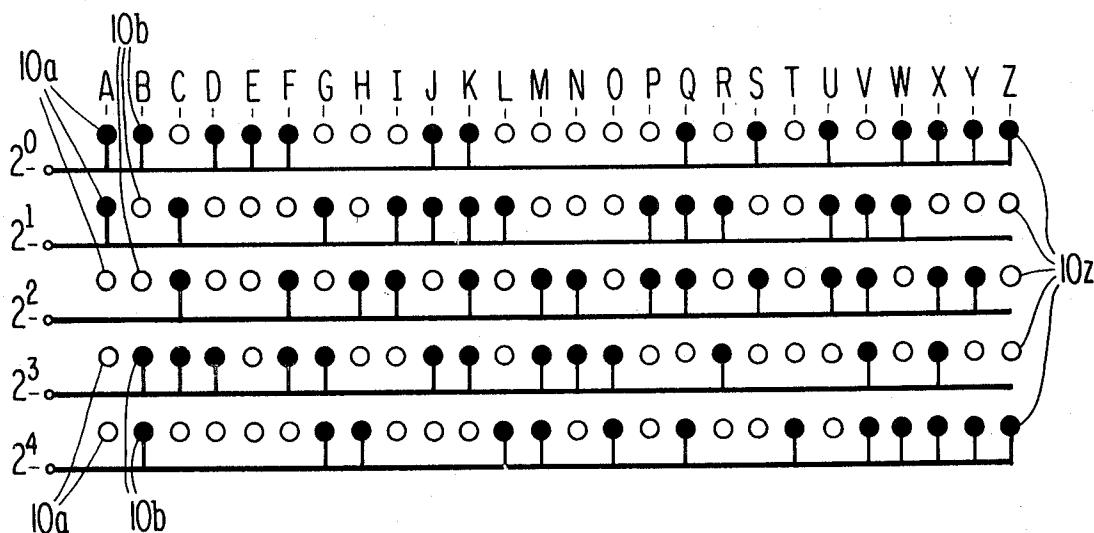


Fig. 6.

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MULTIELECTRODE TRANSDUCER ELEMENT

BACKGROUND OF THE INVENTION

There are a number of keyboards on the market, each of which have their own advantages and disadvantages. These keyboards may operate on an electrical, magnetic, photoelectric, piezoelectric, or any number of other principles.

The advantage of a keyboard transducer operating on the piezoelectric effect is that no external power is needed to generate a signal. The crystal itself directly translates the mechanical energy employed to strike the key to electrical energy—the electrical output signal. Unfortunately, however, the piezoelectric crystals proposed up to present time for use in a keyboard are very delicate and the amplitude of signal they produce is critically dependent on the plane along which they are cut. In addition, a high degree of skill is required properly to cut the crystal and even so there is a considerable amount of "breakage." All of this makes such crystals relatively expensive.

Crystals which have the proper "axis" of cut are suitable for keyboard transducers, but, because of their delicate nature, are subject to catastrophic failure if overstressed. This in turn requires careful initial alignment of the keyboard assembly, to prevent overstressing and this too increases the expense of the keyboard.

Another disadvantage in keyboard applications of the crystals discussed above is that the number of connections which can be made to each crystal is limited. Such connections must be made to the faces of the crystal and, as a practical matter, the faces are so small that in most cases, only two such connections per crystal are possible. As a result, the translation of the electrical signal or signals produced when a crystal is struck to the larger number of signals required to represent a character, requires relatively complex (and therefore expensive) coding circuits.

Another characteristic of such crystals is that they generally produce multiple signals (a ringing oscillation) in response to a single mechanical stimulus. As only a single oscillation is of interest in keyboard applications, circuits, such as gate circuits, are needed to suppress, say, all oscillations following the first one.

An object of this invention is to provide new and improved piezoelectric devices which are sturdy, relatively inexpensive, and are capable of translating a mechanical stimulus to a relatively large group of concurrent signals.

Another object of this invention is to provide a new and improved keyboard employing piezoelectric transducers.

SUMMARY OF THE INVENTION

An element of the type which in response to being mechanically struck induces a voltage change in an electrode mechanically coupled therein. A plurality of such electrodes are mechanically coupled in the element, and means are included for striking the element for concurrently producing a plurality of signals, one at each electrode.

A keyboard according to the invention includes a plurality of such elements interconnected in different ways to a common output bus and each responsive to a different key.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, partially in section, of a keyboard element embodying the invention;

FIG. 2 is a top view of the keyboard element illustrated in FIG. 1;

FIG. 3a is a side view of another keyboard element configuration embodying the invention;

FIG. 3b is a top view of the keyboard element of FIG. 3a;

FIG. 4a is a top view of yet another keyboard element configuration embodying the invention;

FIG. 4b is a section of the keyboard element of FIG. 4a taken along the lines 4b;

FIG. 5 is a diagram of a standard keyboard which may be used in the practice of the invention; and

FIG. 6 is a schematic diagram illustrating how the Baudot Code may be obtained from a keyboard formed from the keyboard elements illustrated in FIG. 1.

DETAILED DESCRIPTION

FIG. 1 illustrates a device 2 which is useful, for example, as a keyboard element. The body 4 of the device is formed of an amorphous material which exhibits piezoelectric characteristics. Some typical materials which are especially suitable include plastics such as polytetrafluoroethylene. Flange 6 is mechanically pressed into the body 4 and in turn is secured in a baseplate member 8. A plurality of conducting electrodes 10, which, for example, may be formed of copper or any other good conductor of electricity, are embedded in the body 4. The electrodes 10 may be secured in place in apertures in the body 4 by threads, flanges, or knurling, etc. Alternatively, the electrodes may be mechanically coupled to the body 4 in other ways well known in the art.

Supporting members 12 and 14 are attached to baseplate member 8, for example, by screws (not shown), and also to a member 16. A flat spring 18 of a key 20 is secured to point 22 of member 16 by means of screws (not shown) or spot welding. Flat spring 18 is also secured to a striking or impacting means 24 and to one end of a coil spring 26 which form part of the key 20. The other end of the spring 26 is attached to the key top 28. A latch 30 is pivotally mounted to member 16 by means of a pin 32. Latch 30 is biased into the position shown by means of a spring 34. A retaining element 36 is attached to member 16 to prevent latch 30 from traveling any further than the element 36.

The application of a force to the key top 28 compresses coil spring 26, forcing the end 38 of flat spring 18 against latch 30 where flat spring 18 is stopped, since there is not enough force to overcome the tension in spring 34, which would cause latch 30 to pivot in the direction of the arrow. Spring 26, however, continues to be depressed thereby storing energy. When the bottom edge 40 of key top 28 engages latch 30, the latch pivots in the direction shown, releasing the end 38 of flat spring 18. Latch 30 continues to travel until stopped by retaining member 36. The energy stored in coil spring 26 is sufficient to overcome the bias of flat spring 18 causing striking means 24 to impact the upper surface of body 4 inducing a voltage in each of the electrodes 10.

Since the coefficients of elasticity of springs 18 and 26 are fixed, as is the length of travel of key top 28 until it engages latch 30, the same amount of energy is stored in spring 26 prior to latch 30 being engaged, independent of the force applied to the key top. The magnitude of the force applied to body 4, therefore, is substantially the same for each depression of the key, regardless of the force applied to the key top.

When the force applied to the key top is removed, latch 30 returns to its rest position due to the tension of spring 34. The upward bias of spring 18 returns striking element 24 to its rest position. In the event latch 30 returns prior to the return of spring 18, the end 38 of the spring 18 slides over the angled surface 41 of the latch to the rest position.

If the electrodes 10 are embedded to equal depths, voltages of essentially equal magnitude are induced in each of the electrodes 10. The closer the electrodes 10 are situated to the impact surface of the element 4, the greater the magnitude of the induced voltage, and conversely the greater the distance the electrodes are from the impact surface, the lesser the magnitude of the voltage induced. The signal is taken from the interior of element 4, rather than externally as is done with a piezoelectric crystal.

FIG. 2 is a top view of the element 4 in which seven electrodes 10 are embedded. A greater or lesser number of electrodes may be utilized depending on the needs of the particular user. Since the element 4 is formed of a plastic, it is very durable and can withstand great stress. This results in a long operational life and minimal failure.

For each striking or impacting of the element 4, there is but one signal generated at each electrode which obviates the need for external gates. As was mentioned earlier, prior art keyboard devices operating on the piezoelectric effect require gates to block unwanted ringing signals.

The application of only a minimal force such as the tapping of the impact surface of the element 4 with one's finger, results in a signal of 2 volts at each of the electrodes 10. On the other hand, even a vigorous striking of the baseplate member 8 results in no voltage at any of the electrodes 10 so long as the body 4 is not struck by the impacting means 24. Thus, a keyboard unit employing a plurality of elements such as shown in FIGS. 1 and 2 is rugged and relatively insensitive to vibration.

The design chosen for the key 20 is but one of many that may be used in the practice of the invention. Even if a design is chosen in which the impacting or striking means applies forces of varying magnitude to the body 4, for different forces applied to the keytop, the magnitude of the induced voltages in the electrodes 10 does not vary to an extent sufficient to degrade operation.

Also, it is to be noted that the body 4 and electrodes 10 may be fabricated in ways other than shown in FIGS. 1 and 2, which are within the teachings of the invention. For example, consider FIGS. 3a and 3b in which a plurality of bodies 4 are embedded in a baseplate member 42. FIG. 3a is a side view of the bodies and FIG. 3b is a view looking downward on the impact surfaces of the bodies. The electrodes 10 run substantially parallel to the impact surface of the body 4 whereas in FIGS. 1 and 2 the electrodes ran substantially perpendicular to the impact surface.

It may be seen (FIG. 3a) that the electrode 10c is situated nearer the impact surface of the bodies 4 than are the electrodes 10d, 10e, and 10f. If the electrodes are of the same size, a voltage of a greater magnitude is induced in electrode 10c than in 10d when body 4a is impacted. If it is desired that the voltage induced in each electrode, in this arrangement, be the same, the surface area of the electrodes 10d-f could be made greater than the surface area of the electrode 10c. A greater or lesser number of electrodes may be passed through the bodies 4, depending upon the needs of the particular user.

FIG. 4 illustrates yet another way in which the bodies and electrodes may be fabricated in a laminated form. A baseplate member 44 (FIG. 4b) has a first sheet of plastic 46, of the type used for the bodies 4 earlier described, secured to its surface by means of cementing, bonding, etc. A plurality of conductors 48, which may be flat or of circular cross section, is then placed on top of the sheet 46. A second sheet of plastic 49 is placed over the conductors 48 and secured to sheet 46. A plurality of conductors 50 is placed on top of sheet 49 substantially perpendicular to the direction at which the conductors 48 were placed. A third sheet of plastic 52 is placed over the conductors 50 and secured to the sheet 49.

FIG. 4a illustrates the laminated structure looking downward on the impact surface of the structure. The dotted circles 54, 56, 58 and 60 define the areas at which the striking or impacting means of a key would strike the structure. For example, if the area defined by circle 54 were impacted, a voltage would be induced in conductors 48a and 50a. It is to be understood that a greater or lesser number of conductors and sheets of plastic may be utilized in the practice of the invention.

Consider now the case in which a complete keyboard 62 (FIG. 5), for example, a standard typewriter keyboard, is formed by one of the above-described methods. Such a keyboard is extremely useful in that it is self-encoding.

Refer now to FIG. 6. By way of example only, the letters of the alphabet are shown as being the symbols indicative of certain of the keys. It is understood, however, that any symbol grouping may be used.

The arrangement in FIG. 6 illustrates how certain electrodes of each keyboard element are connected to a plurality of output terminals for generating a different code for each

key which is depressed. In this case, a five-bit code such as a Baudot Code is employed so that each element has five electrodes. However, any other code using a different number of bits may be employed in which case there would be a greater (or fewer) number of electrodes per element, as needed.

In FIG. 6, the five circles 10a directly under the letter A represent the electrodes which are mechanically coupled to the body 4 for the A key. The remaining keys are illustrated in similar fashion. The convention is adopted that an electrode represented by a clear circle (and that does not have a line connected to an output terminal) represents a binary 0 in the code and an electrode represented by a black circle (and connected by a line to an output terminal) represents a binary 1 in the code, when the key is depressed. For example, key A has the 2⁰ and 2¹ output terminals representing a 1 and the 2²-2⁴ representing a 0 when key A is depressed. The codes for the remaining keys are easily determined by referring to the remaining electrode connections.

The output terminals 2⁰-2⁴ may be connected to any sensing device or computer which acts upon the information generated by the keyboard. Since the information comes from the keyboard in coded form, there is no encoding or gating device needed between the keyboard and the computer.

What is claimed is:

1. In combination:

an element of the type which in response to being mechanically struck induces a voltage change in a metal electrode substantially imbedded therein;
a plurality of metal electrodes substantially imbedded in said element; and
means for striking said element for concurrently producing a plurality of signals, one at each electrode.

2. In combination:

an element of the type which in response to being mechanically struck produces equal voltages in metal electrodes substantial portions of which are imbedded to equal depths therein;
a plurality of metal electrodes substantially imbedded in said element; and
means for impacting said element for concurrently producing a plurality of signals, one at each such electrode.

3. In combination:

a plastic, not easily fracturable element of the type which in response to being mechanically struck induces a voltage change in an electrode mechanically coupled to said element;
a plurality of electrodes mechanically coupled to said element; and
means for striking said element for concurrently producing a plurality of voltages, one at each such electrode.

4. The combination claimed in claim 3, said element being made of material of the type which produces equal voltages, relative to a reference point, in electrodes mechanically coupled to equal depths.

5. The combination claimed in claim 3, said element comprising polytetrafluoroethylene.

6. A keyboard comprising, in combination:

a plurality of plastic, not easily fracturable elements of the type which in response to being mechanically struck induce a voltage change in an electrode mechanically coupled therein;
a plurality of electrodes mechanically coupled to each of said elements;
means for selectively striking said elements; and
decoder means coupled to said electrodes and responsive to the voltages induced therein, for producing a unique signal code for each element.

7. A keyboard comprising in combination:

a plurality of elements of the type which in response to being mechanically struck induce a voltage change in an electrode substantially imbedded therein;
a plurality of electrodes substantially imbedded in each of said elements;
means for selectively striking said elements;

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a plurality of output terminals; and
means for connecting electrodes of said elements in different ways to said output terminals for producing at said output terminals a different code for each element struck.
8. A keyboard comprising in combination:
a plurality of plastic, not easily fracturable elements of the type which in response to being mechanically struck induce a voltage change in an electrode substantially imbedded therein;
a plurality of electrodes substantially imbedded within said elements;
a plurality of keys, there being one key mechanically

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aligned with each one of said elements such that when a key is depressed the element mechanically aligned with the key is struck;
means for selectively depressing said keys;
a plurality of output terminals; and
means for connecting certain electrodes of said elements in different ways to said output terminals for producing at said output terminals a different code for each key depressed.
9. The combination as claimed in claim 8 wherein said elements comprise polytetrafluoroethylene.

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