US00RE41017E

(19) **United States**

(12) **Reissued Patent**

Chiu et al.

(10) **Patent Number: US RE41,017 E**

(45) **Date of Reissued Patent: Dec. 1, 2009**

(54) **CIRCUIT LAYOUT ARRANGEMENT FOR KEY SWITCH SIGNAL RECOGNITION**

(76) Inventors: **Chui-Kuei Chiu**, No. 215, Sec. 1, Heng Shan St., Hang Shan Chuen, Heng Shan Shiang, Hsinchu Hsian (TW); **Yin-Chun Huang**, 6F, No. 72-11, Lane 531, Sec. 1, Kwangfu Road, Hsinchu City (TW)

(21) Appl. No.: **11/337,222**

(22) Filed: **Jan. 20, 2006**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **6,680,678**
Issued: **Jan. 20, 2004**
Appl. No.: **09/777,828**
Filed: **Feb. 7, 2001**

(51) **Int. Cl.**
H03K 17/94 (2006.01)

(52) **U.S. Cl.** ..... **341/22**; 341/26; 200/5 A; 400/477

(58) **Field of Classification Search** ..... 341/22, 341/26; 200/5 A; 400/472, 477
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,743,797 A * 7/1973 Hoffman ..... 200/1 R
4,518,951 A * 5/1985 Backes 341/26
4,567,469 A * 1/1986 Danish et al. 341/22
4,609,792 A * 9/1986 Levasseur ..... 200/5 A
4,673,933 A * 6/1987 Bauer 341/22
5,153,590 A * 10/1992 Charlier 341/31
5,534,860 A * 7/1996 Phillips et al. 341/22
5,831,556 A * 11/1998 Niot 341/26
5,900,829 A * 5/1999 Gardner et al. 341/26

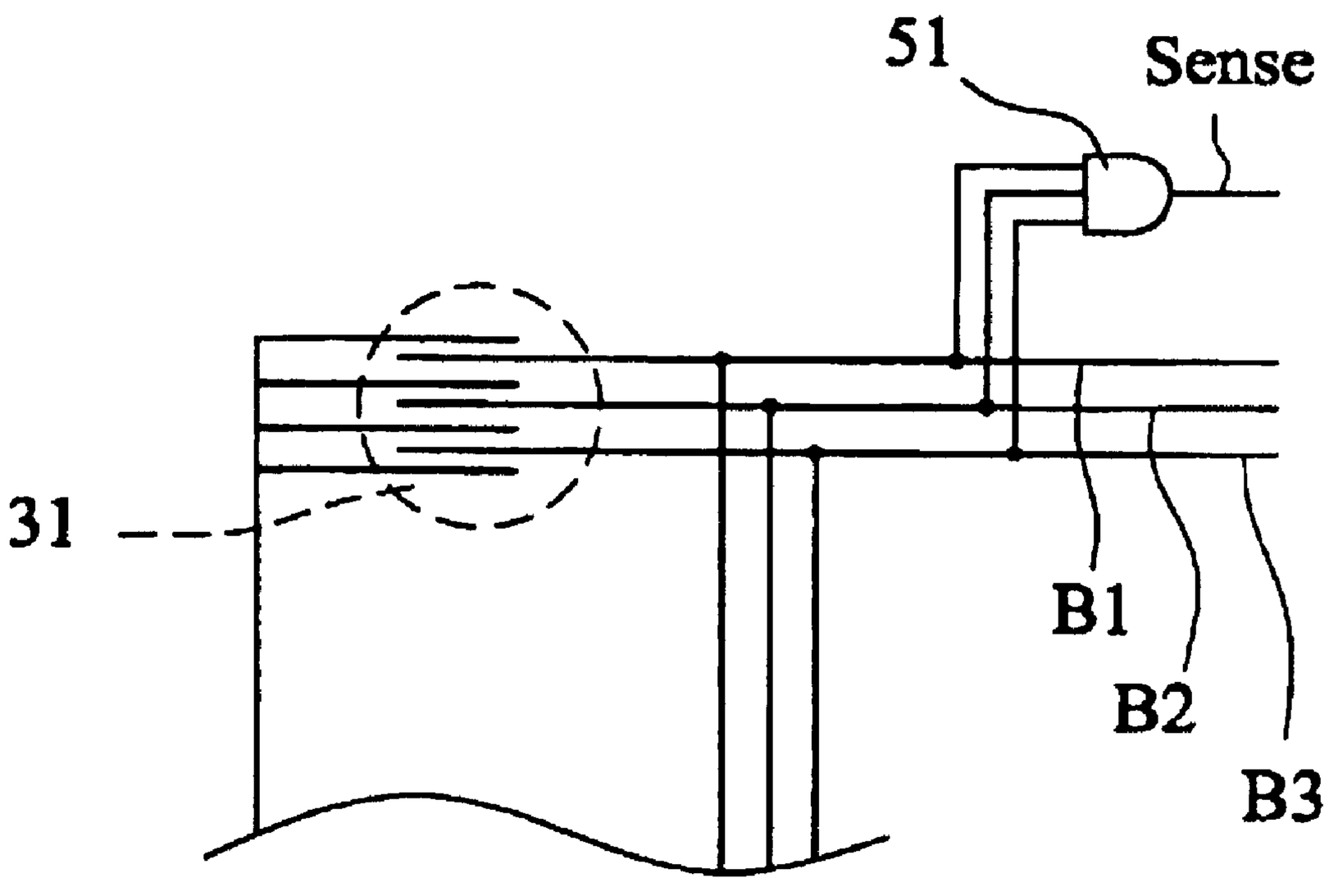
* cited by examiner

Primary Examiner—Timothy Edwards, Jr.
(74) *Attorney, Agent, or Firm*—Stolowitz Ford Cowger LLP

(57) **ABSTRACT**

A key switch signal recognition circuit including a plurality of key switch buttons, a plurality of key switch signal output lines, and a plurality of key switch button contact areas is disclosed. Each of the key switch contact areas includes a first wire set and a second wire set. The first wire set has at least one wire, and each wire of the first wire set has one end connected to a common line and an opposite end forming an open end. The second wire set has at least one wire respectively disposed in parallel to and electrically insulated from the wire of the first wire set. The wire of the second wire set is respectively connected to a key switch signal output line. When depressing one key switch button to touch the corresponding key switch button contact area, the electrically conductive element of the depressed key switch button electrically connects the first wire set and second wire set of the touched key switch contact area, causing the respective key switch signal output line to send a key switch signal corresponding to the depressed key switch button.

25 Claims, 5 Drawing Sheets



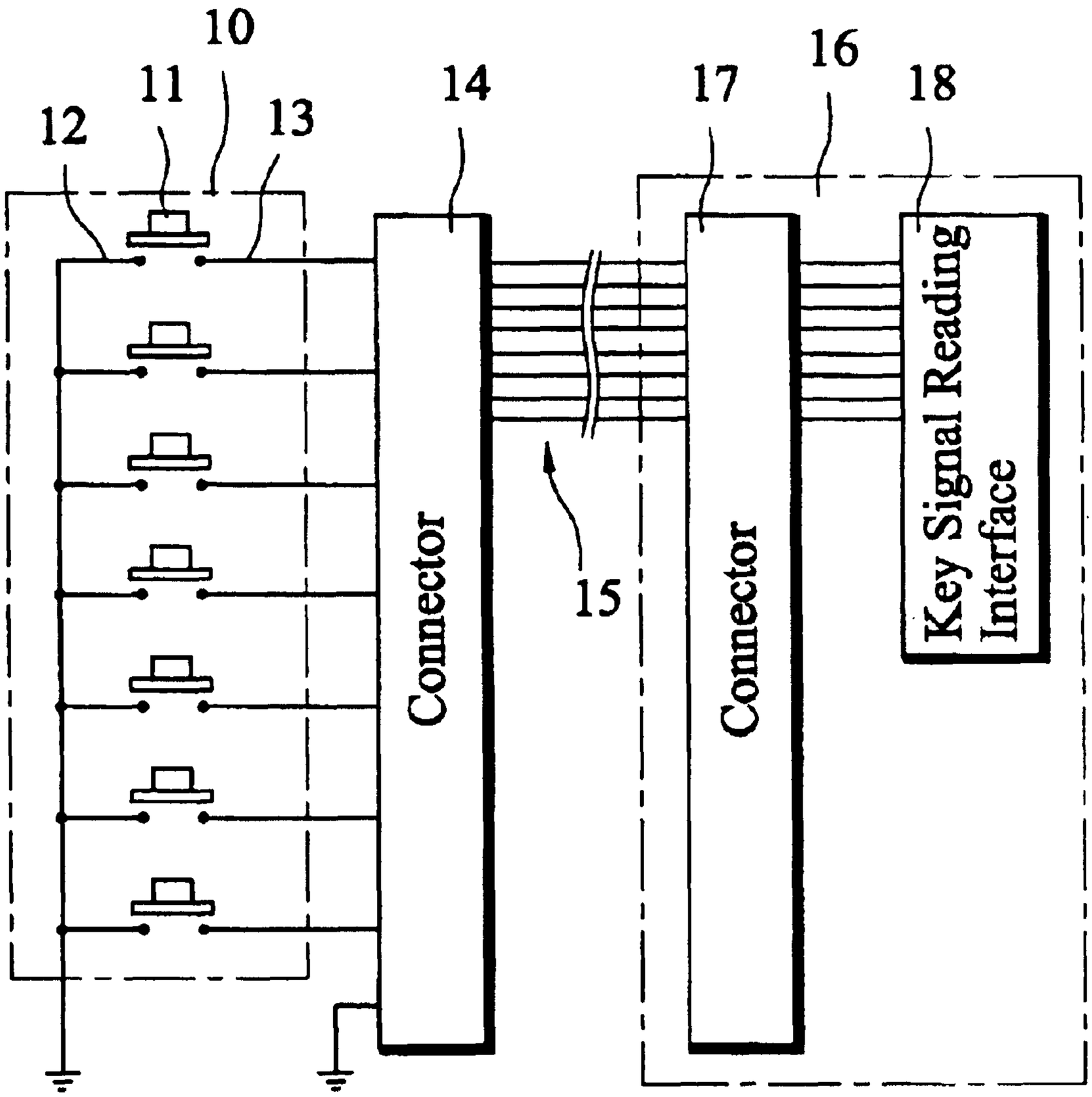


FIG. 1 (Prior Art)

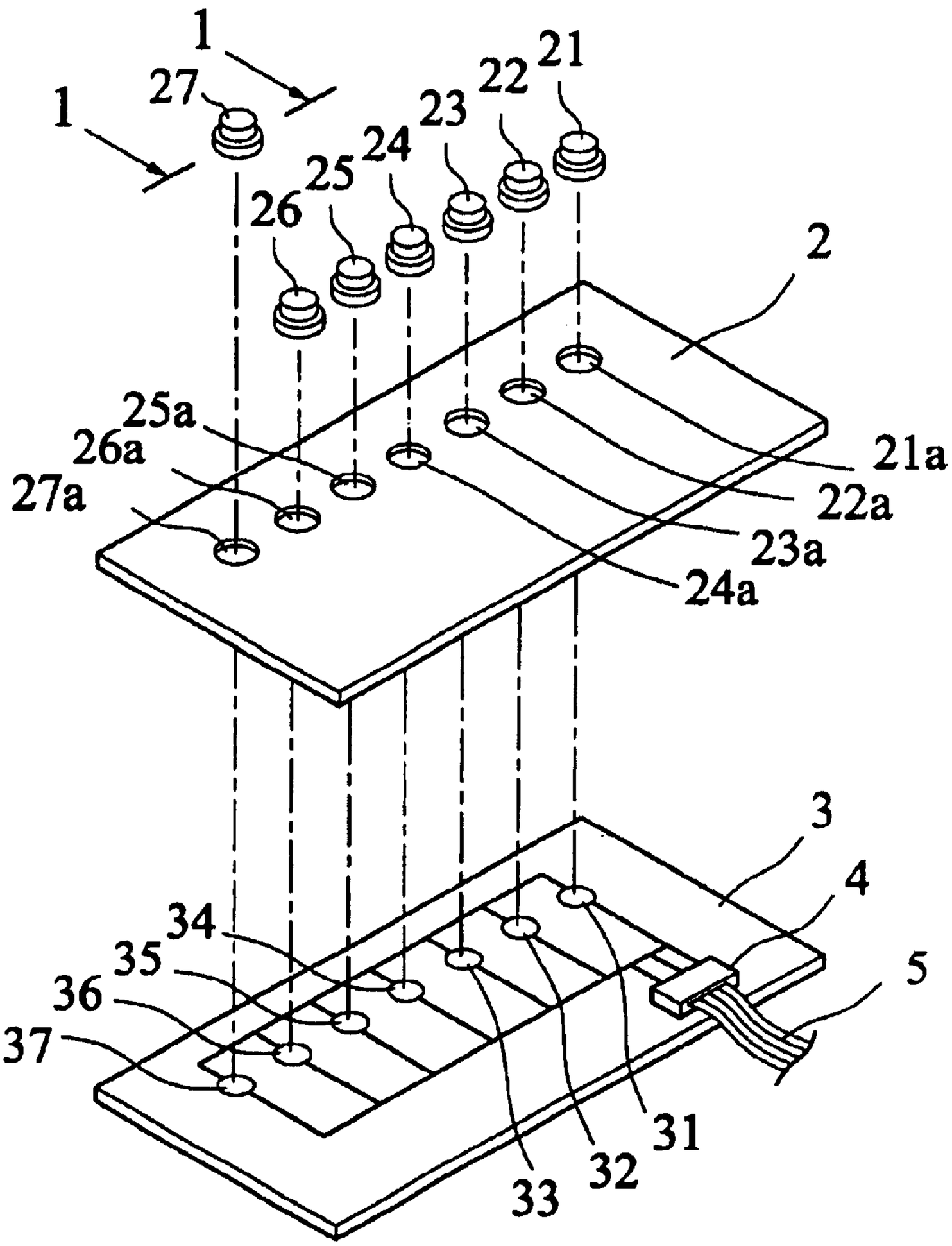

1
1
27
21
22
23
24
25
26
2
21a
22a
23a
24a
25a
26a
27a
3
4
5
31
32
33
34
35
36
37

FIG.2

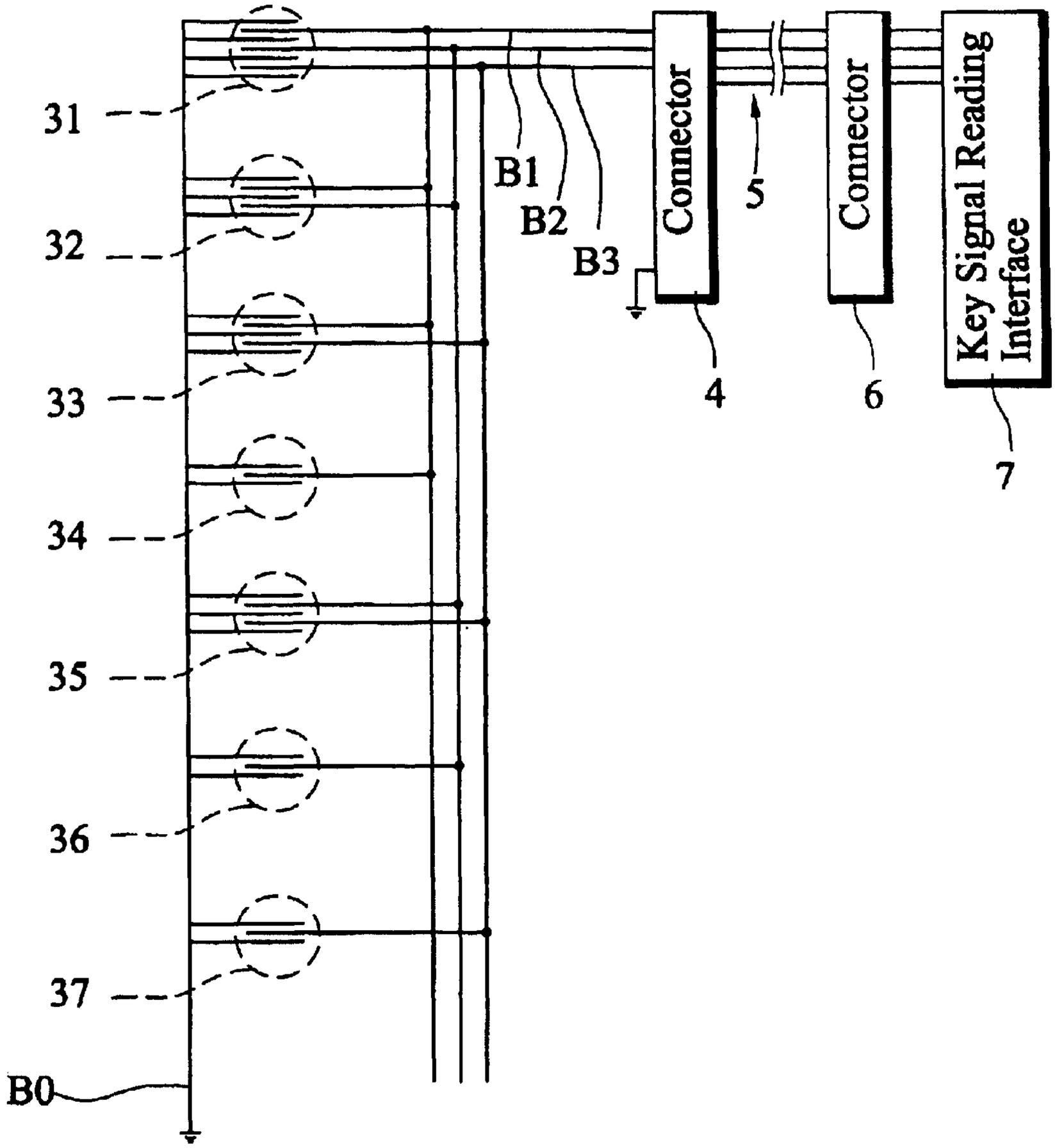

31
32
33
34
35
36
37
B0
B1
B2
B3
Connector
4
5
Connector
6
Key Signal Reading Interface
7

FIG.3

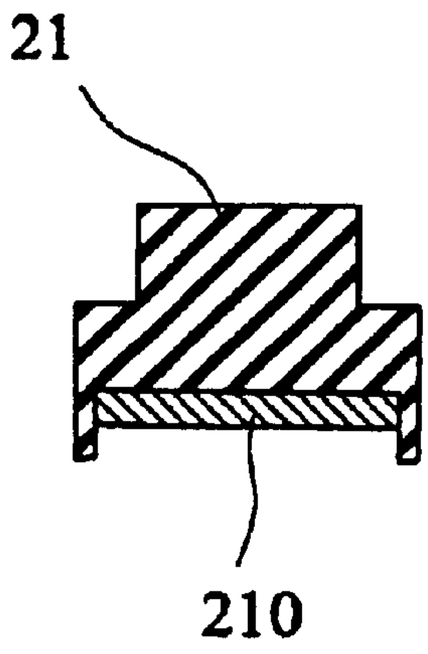


FIG.4

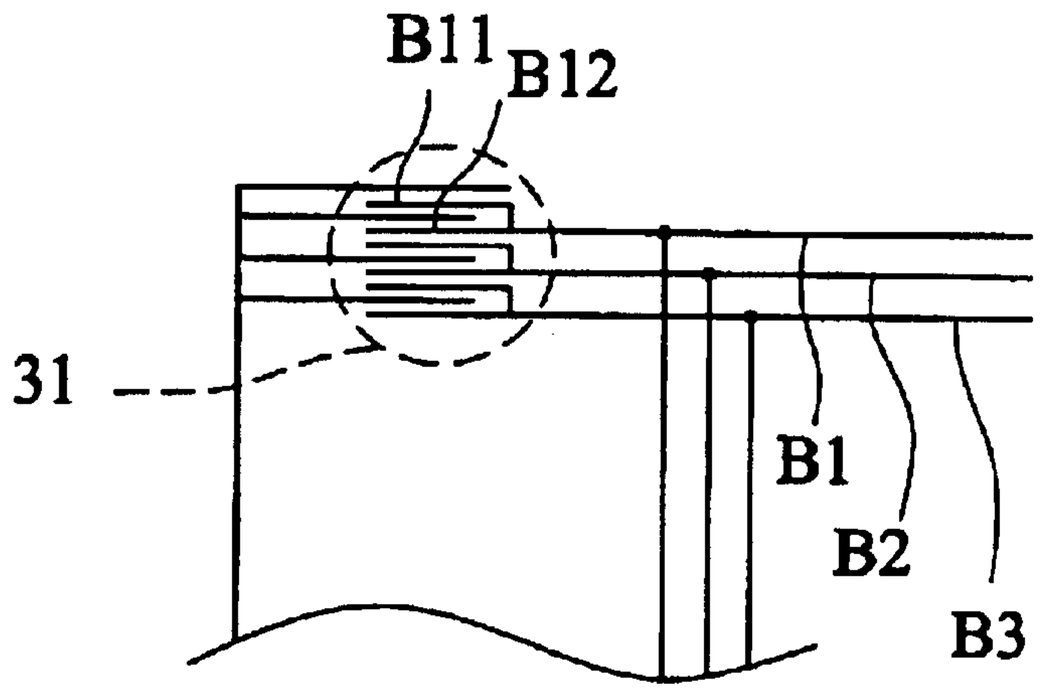


FIG.5

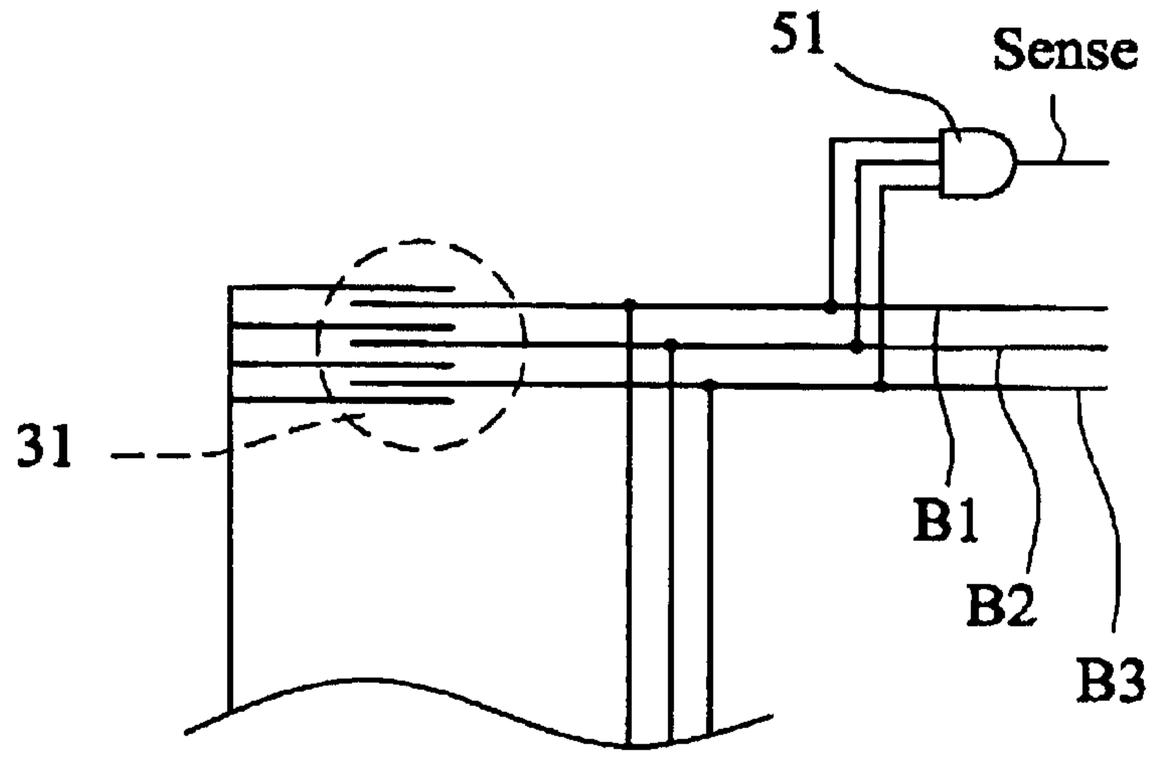

51
Sense
31
B1
B2
B3

FIG.6

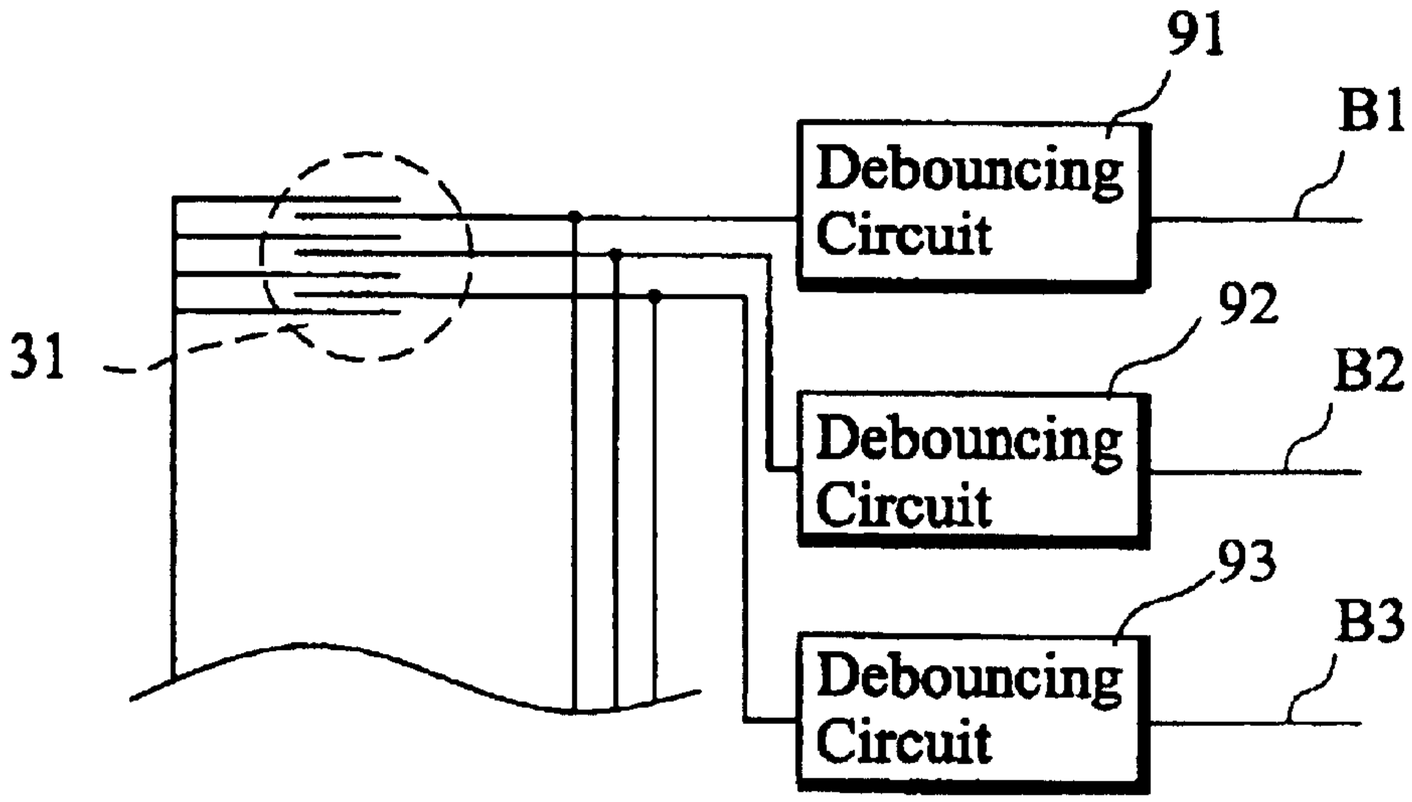

91
B1
Debouncing Circuit
92
B2
Debouncing Circuit
93
B3
Debouncing Circuit
31

FIG.7

CIRCUIT LAYOUT ARRANGEMENT FOR KEY SWITCH SIGNAL RECOGNITION

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a key switch signal recognition circuit, and more particularly to a simple circuit layout of key switch signal recognition circuit.

2. Description of the Prior Art

Key switch circuits are intensively used in office automation equipment, industrial instrument, electric and electronic consumers products, and electric home appliances to serve as input interface means between the user and the machine. According to the conventional key switch circuit designs, one key switch button is matched with one circuit loop. The key switch buttons can be switches, micro switches, and membrane switches.

FIG. **1** shows a prior art switch button type key switch signal recognition circuit including a number of key switches. According to this design, a number of key switch contact areas may be arranged on a substrate **10** such as a printed circuit board, and a number of key switch buttons **11** are suspended above the key switch contact area. Each key switch contact area is generally formed of two corresponding copper foil wires **12** and **13**. One copper foil wire **12** is connected to a common point, such as a grounding terminal or a power source terminal. The other copper foil wire **13** is connected to a first connector **14**. The pins of the first connector **14** are respectively connected through a cable **15** to a second connector **17** mounted on a circuit board **16**. The second connector **17** of the circuit board **16** is further connected to a key switch signal reading interface **18** or a key switch signal processing circuit. According to this conventional key switch circuit design, a number of independent circuit loops are needed to transmit click signal from the key switch buttons, the cable **15** must have a number of wires, and the connectors **14** and **17** each must have a number of pins and one grounding wire. Further, when the numbers of the key switch button are changed, the model of the connector, the number of wires of the cable, and the number of pins of the key switch signal reading interface must be relatively changed.

In some key switch circuit designs, an encoder is used to achieve the object of using a limited number of wires to recognize a number of key switch buttons. However, the use of the encoder greatly increases the cost of the key switch circuit. Therefore, these conventional key switch circuit designs do not satisfy current market requirements. For example, in the design of a key switch circuit for a scanner, the factors of ease of use, highly expandability, less number of component parts, and lost cost must be taken into account.

Therefore, it is desirable to provide an improved key switch signal recognition circuit to mitigate and/or obviate the aforementioned problems.

SUMMARY OF THE INVENTION

Accordingly, the primary object of the present invention is to provide a key switch signal recognition circuit, which uses the architecture of a circuit layout to achieve accurate signal recognition of a number of key switch buttons, so that the number of key switch contact wires, the number of wires of the cable, and the number of pins of the related connector can be minimized.

It is another object of the present invention to provide a key switch signal recognition circuit, which uses a limited number of wires to achieve signal recognition of a number of key switch buttons. No signal encoder is required.

The present invention will be apparent to those skilled in the art by reading the following description of preferred embodiments thereof, with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a circuit diagram of a key switch signal recognition circuit according to the prior art;

FIG. **2** is an exploded view of a key switch signal recognition circuit according to the present invention;

FIG. **3** shows a circuit layout in accordance with a first embodiment of the present invention;

FIG. **4** is a cross sectional view of the key switch button taken along line **1**—**1** of FIG. **2**;

FIG. **5** is a circuit layout of a second embodiment of the present invention;

FIG. **6** is a circuit layout of a third embodiment of the present invention, showing the key switch signal output lines respectively connected to an input of an AND gate; and

FIG. **7** is a circuit layout of a fourth embodiment of the present invention showing each of the key switch signal output lines is further connected with a debouncing circuit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **2** is an exploded view of the key switch signal recognition circuit of the present invention. FIG. **3** shows the circuit layout in accordance with the first embodiment of the present invention. As illustrated, the key switch signal recognition circuit comprises for example seven key switch buttons **21**~**27**, and three **[**keys witch**]** *key switch* signal output lines B**1**~B**3**.

Each key switch button is provided with an electrically conductive *element*. FIG. **4** is a cross sectional view of the key switch button, taken along line **1**—**1** of FIG. **2**, showing that an electrically conductive element **210** is mounted at the bottom side of the key switch button **21**. The electrically conductive element **210** is preferably made of electrically conductive rubber.

During installation, the key switch buttons **21**~**27** are mounted in respective through holes **21**a~**27**a arranged on a frame **2** corresponding to respective contact areas **31**~**37** arranged on a substrate **3** below the frame **2**. A connector **4** is mounted on the substrate **3**, having a set of pins respectively connected to the key switch signal output lines B**1**~B**3**.

When clicking either of the key switch buttons **21**~**27**, the corresponding contact area of the substrate **3** is triggered to output a signal to the corresponding pin of the connector **4** through the key switch signal output line B**1**~B**3**.

According to the present design, each contact area of the substrate comprises a first wire set and a second wire set. The first wire set comprises at least one wire. Each wire of the first wire set has one end connected to a common line. The other end of each wire of the first wire set is an open end. The second wire set comprises at least one wire respectively disposed in parallel to and electrically insulated from the at least one wire of the first wire set. The other end of

each wire of the second wire set is respectively connected to an assigned bit line, which is selected subject to a bit encoding mode. The bit-encoding mode can be known BCD code or any suitable encoding format.

Therefore, when depressing one key switch button to touch the corresponding contact area, the respective electrically conductive element electrically connects the first wire set and second wire set of the touched contact area, causing the respective key switch signal output line to send a key switch signal corresponding to the depressed key switch button.

As illustrated in FIG. **3**, the wires of the first wire set (left-sided wires) of the first contact area **31** are connected to a common line B**0**. The second wire set (the right-sided wires) of the first contact area **31** includes three wires respectively connected to key switch signal output lines B**1**, B**2** and B**3**. The right side of the first wire set of the first contact area **31** is an open side. The left side of the second wire set of the first contact area **31** is also an open side. The wires of the first wire set of the first contact area **31** are disposed in parallel to and electrically insulated from the wires of the second wire set of the first contact area **31**.

The wires of the first wire set (left-sided wires) of the second contact area **32** are connected to the aforesaid common line B**0**. The second wire set (the right-sided wires) of the second contact area **32** includes two wires respectively connected to the first**[**,**]** *and* second **[**and third key**]** switch signal output lines B**1** and B**2**. The wires of the first wire set of the second contact area **32** are disposed in parallel to and electrically insulated from the wires of the second wire set of the second contact area **32**.

The wires of the first wire set (left-sided wires) of the third contact area **33** are connected to the aforesaid common line B**0**. The second wire set (the right-sided wires) of the third contact area **33** includes two wires respectively connected to the first and third key switch signal output lines B**1** and B**3**. The wires of the first wire set of the third contact area **33** are disposed in parallel to and electrically insulated from the wires of the second wire set of the third contact area **33**.

The wires of the first wire set (left-sided wires) of the fourth contact area **34** are connected to the aforesaid common line B**0**. The second wire set (the right-sided wires) of the fourth contact areas **34** includes one wire connected to the first key switch signal output line B**1**. The wires of the first wire set of the fourth contact area **34** are disposed in parallel to and electrically insulated from the wires of the second wire set of the fourth contact area **34**.

The wires of the first wire set (left-sided wires) of the fifth contact area **35** are connected to the aforesaid common line B**0**. The second wire set (the right-sided wires) of the fifth contact area **35** includes two wires respectively connected to the second and third key switch signal output lines B**2** and B**3**. The wires of the first wire set of the fifth contact area **35** are disposed in parallel to and electrically insulated from the wires of the second wire set of the fifth contact area **35**.

The wires of the first wire set (left-sided wires) of the sixth contact area **36** are connected to the aforesaid common line B**0**. The second wire set (the right-sided wires) of the sixth contact area **36** includes one wire connected to the second key switch signal output line B**2**. The wires of the first wire set of the sixth contact area **36** are disposed in parallel to and electrically insulated from the wires of the second wire set of the sixth contact area **36**.

The wires of the first wire set (left-sided wires) of the seventh contact area **37** are connected to the aforesaid common line B**0**. The second wire set (the right-sided wires) of the seventh contact area **37** includes one wire connected to the third key switch signal output lines B**3**. The wires of the first wire set of the seventh contact area **37** are disposed in parallel to and electrically insulated from the wires of the second wire set of the seventh contact area **37**.

Subject to the aforesaid circuit layout, a bit definition table illustrating the relation between the key switch buttons and the bit codes for the key switch signal recognition is obtained as shown in TABLE 1:

TABLE 1

	Bit definition		
Key switch	B1-bit	B2-bit	B3-bit
7	0	0	0
6	0	0	1
5	0	1	0
4	0	1	1
3	1	0	0
2	1	0	1
1	1	1	0

It is noted that the present invention requires only three bit lines (key switch signal output lines B**1**, B**2**, B**3**) for recognizing signals from the seven key switch buttons **21**~**27** without the use of any encoding circuit or encoder.

In actual practice, the key switch signal output lines B**1**, B**2** and B**3** are connected to the respective pins of the connector **4**, and the connector **4** is connected to a cable **5**. According to the preferred embodiment of the present invention, the cable **5** comprises three signal lines and one grounding line. A second connector **6** is used to connect the cable **5** to a circuit board or signal-reading interface **7**.

FIG. **5** shows a second embodiment of the present invention. According to this embodiment, the wires of the first wire set (left-sided wires) of the first contact area **31** are connected to the common line B**0**, the three wires of the second wire set (right-sided wires) of the first contact area **31** each has one end respectively connected to the first, second and third key switch signal output lines B**1**, B**2** and B**3** and an opposite end terminating in two parallel end portions B**11** and B**12** disposed in parallel to and electrically insulated from the wires of the first set of the first contact area **31**.

FIG. **6** shows a third embodiment of the present invention. According to this embodiment, the first, second and third key switch signal output lines B**1**, B**2** and B**3** are respectively connected to the signal input end of a respective AND gate **51**. The AND gate **51** is induced to output a triggering signal Sense to the key switch signal reading circuit (not shown) when the corresponding key switch signal output line B**1**, B**2** or B**3** is logically high.

FIG. **7** shows a fourth embodiment of the present invention. According to this embodiment, the first, second and third key switch signal output lines B**1**, B**2** and B**3** are respectively connected to respective debouncing circuits **91**, **92** and **93** capable of preventing the respective key switch signal output line to output an unusable signal at the initial stage when the respective key switch button is depressed.

Although the present invention has been described with reference to the preferred embodiments, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from the scope of the present invention which is intended to be defined by the appended claims.

What is claimed is:

1. A key switch signal recognition circuit comprising:

a plurality of key switch buttons, said key switch buttons each provided with an electrically conductive element;

a plurality of key switch key signal output lines;

an AND gate having an output and a plurality of inputs respectively connected to said plurality of key switch key signal output lines; and

a plurality of contact areas arranged on a substrate corresponding to said key switch buttons, said contact areas each comprising a first wire set and a second wire set, said first wire set comprising at least one wire having one end connected to a common line and an opposite end forming an open end, said second wire set comprising at least one wire respectively disposed in parallel to and electrically insulated from the wire of said first wire set, the wire of said second wire set being respectively connected to the key switch signal output line which is selected subject to a predetermined bit encoding mode;

when one of said key switch buttons is depressed to touch the corresponding contact area, the electrically conductive element of the depressed key switch button electrically connects the first wire set and second wire set of the touched contact area, causing the respective key switch signal output line to send a key switch signal corresponding to the depressed key switch button, said output of said **[**And**]** *AND* gate outputting a triggering signal responsive to the key switch signal output line of a corresponding contact area is at a logically high level.

2. The key switch signal recognition circuit of claim **1**, wherein said bit encoding mode is a BCD encoding format.

3. The key switch signal recognition circuit of claim **1**, wherein said key switch signal output lines comprises a grounding wire.

4. The key switch signal recognition circuit of claim **1**, wherein the open end of the wire of the first wire set and the second wire set is terminated into two parallel end portions.

5. The key switch signal recognition circuit of claim **1**, wherein the key switch signal output lines are further respectively connected to a debouncing circuit.

6. An apparatus comprising:

two or more key switch buttons;

two or more key switch signal output lines;

an AND gate having an output and a plurality of inputs respectively connected to said two or more key switch signal output lines; and

two or more contact areas corresponding to said two or more key switch buttons, said contact areas connected to at least one of said two or more key switch signal output lines, and configured to cause at least one of said two or more key switch signal output lines to send a key switch signal in response to a depressed corresponding key switch button, wherein at least one of said two or more contact areas is connected to only one of said two or more output lines, wherein at least one of said two or more contact areas is connected to two or more of said two or more output lines, and

wherein said AND gate is configured to output a triggering signal if the key switch signal output line of a corresponding contact area is at a logically high level.

7. The apparatus of claim 6, wherein said two or more key switch buttons are greater in number than said two or more key switch signal output lines.

8. The apparatus of claim 6, wherein said two or more key switch buttons comprise an electrically conductive element, said electrically conductive element configured to electrically connect a first wire set and a second wire set of at least one of said two or more contact areas if one of said two or more key switch buttons is depressed, said first wire set comprising at least one wire having one end connected to a common line and an opposite end forming an open end, and said second wire set connected to at least one of said two or more key switch signal output lines.

9. The apparatus of claim 8, wherein said first wire set and said second wire set of said at least one of said two or more contact areas are connected to said two or more key switch signal output lines according to a predetermined bit encoding mode.

10. The apparatus of claim 9, wherein said bit encoding mode comprises a BCD encoding format.

11. The apparatus of claim 6, wherein said two or more key switch signal output lines comprise a grounding wire.

12. The apparatus of claim 6, wherein said two or more contact areas are arranged on a substrate, said two or more contact areas comprising a first wire set and a second wire set, said first wire set comprising at least one wire having one end connected to a common line and an opposite end forming an open end, said second wire set comprising at least one wire respectively disposed in parallel to and electrically insulated from the wire of said first wire set, the wire of said second wire set being respectively connected to at least one of said two or more key switch signal output lines.

13. The apparatus of claim 12, wherein the open end of the wire of the first wire set and the second wire set is terminated into two parallel end portions.

14. The apparatus of claim 6, wherein said two or more key switch signal output lines are connected to a debouncing circuit.

15. A method comprising:

causing at least one of two or more key switch signal output lines to send a key switch signal in response to a depressed corresponding key switch button, wherein at least one of two or more contact areas corresponding to said two or more key switch buttons is connected to only one of said two or more key switch signal output lines, and wherein at least one of said two or more contact areas is connected to two or more key switch signal output lines;

receiving said key switch signal via at least one of two or more inputs of an AND gate connected to said two or more key switch signal output lines; and

outputting a triggering signal at least via an output of said AND gate if the key switch signal output line is at a logically high level.

16. The method of claim 15, wherein said key switch signal is sent at least via said two or more key switch signal output lines, and wherein said two or more key switch buttons are greater in number than said two or more key switch signal output lines.

17. A method of claim 15, further comprising processing said key switch signal of said two or more key switch signal output lines at least via a bit encoding mode.

18. The method of claim 17, wherein said bit encoding mode comprises a BCD encoding format.

19. The method of claim 15, further comprising touching a contact area corresponding to at least one of said two or more key switch buttons if at least one of said two or more key switch buttons is depressed to cause at least one of two or more key switch signal output lines to send said key switch signal.

20. The method of claim 15, further comprising processing said key switch signal of said two or more key switch signal output lines at least via a debouncing circuit.

21. The key switch signal recognition circuit of claim 1, wherein at least one of said plurality of contact areas is connected to the key switch signal output line by only one wire of said second wire set, and wherein at least one of said plurality of contact areas is connected to the key switch signal output line by two or more wires of said second wire set.

22. An apparatus comprising:

key switch signal output line means for sending a key switch signal;

key switch button means for switching said key switch signal output line means;

an AND gate means having an output and a plurality of inputs respectively for connecting to said key switch signal output line means; and

contact area means corresponding to said key switch button means, said contact area means connected to at least one of said key switch signal output line means, and said contact area means configured to cause at least one of said key switch signal output line means to send a key switch signal in response to a depressed corresponding key switch button means, wherein at

least one of said contact area means is connected to only one of said key switch signal output line means, wherein at least one of said contact area means is connected to two or more of said key switch signal output line means, and

wherein said AND gate means is further configured to output a triggering signal if the key switch signal output line means of a corresponding contact area means is at a logically high level.

23. The apparatus of claim 22, further comprising means for processing said key switch signal of said two or more key switch signal output lines at least via a bit encoding mode.

24. The apparatus of claim 23, wherein said bit encoding mode comprises a BCD encoding format.

25. The apparatus of claim 22, further comprising means for processing said key switch signal of said key switch signal output line means to prevent the respective key switch signal output line means to output an unstable signal.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : RE 41,017 E
APPLICATION NO. : 11/337222
DATED : December 1, 2009
INVENTOR(S) : Chiu et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

At column 6, line 54, please replace "A method of" with --The method of--.

Signed and Sealed this

Nineteenth Day of October, 2010

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office