

SWITCH AND SWITCH CIRCUIT

Technical Field

The present invention relates to switches and switch circuits and refers particularly, though not exclusively, to non-contact switches for data input, and a switch circuit for use with
5 such switches.

Background Art

Data input switches are used in many ways including, for example, keyboards for computers and electronic typewriters, domestic appliances, and industrial control equipment. Such switches are renowned for being susceptible to faulty operation due to
10 dust and/or water ingress. Furthermore, incorrect signals are frequently encountered when many keys are activated simultaneously, and sparking at switch contact points is a frequent occurrence. When dealing with the operation of computer keyboards, particularly by those who are able to operate at high speed, missing characters are a frequent occurrence of such high speed operation. Furthermore, the lifespan of the known key switches is limited by
15 the wear and tear of the contact point.

One form of a known data input switch is an electrical on/off switch using metallic contacts. The switch has a key cap, a plunger, a spring, a fixed plate and a movable plate. When the key cap is pressed, the plunger is moved downwards to force a contact on the moveable plate into contact with the fixed plate. This causes an "ON"
20 signal to be generated. Products such as electronic typewriters and computer keyboards use many of these switches. Scanning techniques are required to scan for the detection of the switch action. The known scanning technique often produces a wrong signal or what is known as a "ghost key" when three or more keys are pressed at the same time. It has been proposed to add diodes to the switch matrix to prevent the problem of ghost keys. This has
25 not found favour due to the very high cost involved.

A solution to the problems of the known electrical form of switch was a capacitive switch. This form of switch uses the principle of capacitance by adding a sponge and tin foil onto the printed circuit board at every touch pad, including the ground points. When a key is pressed, the change in capacitance gives rise to a signal. By using this construction, the
30 ghost key problem can be eliminated without the cost of diodes. However, the change in capacitance is minute. As an operator may have static electricity on their body and/or

clothing, that static electricity may also affect the capacitance to thus affect the operation of the keyboard. Therefore, signal errors are still possible. As such the capacitive switch was not stable. As a sponge hardens after contact with water, the switch was not considered to be water resistant as the effect of water was to significantly shorten the life of the switch.

5 Therefore, this form of switch did not obtain market acceptance and is no longer on the market.

This has lead to the development of what is known as the membrane pseudo-N-key switch. This form of switch used three layers of mylar sheets and silver foil as contacts for the switch signals. The switching principal is the same as for the electrical switch as described

10 above, but the printed circuit board is replaced by mylar sheets. However, the ghost key problem persisted and it was difficult to have diodes on the mylar sheets without incurring high cost. A standard was introduced that provided a keyboard which could be produced at the required cost but with a low standard of performance. Firmware was used to remove the ghost key. When three or more keys were pressed at the same time, the signal after the

15 third key stroke would be ignored and eliminated by the firmware. However, missing letters still occurred when the keys were pressed to fast due to speed of operation.

Brief disclosure of the invention

The invention provides a contactless switch having a cap, a stem, a core and a housing. The stem is adapted to be releasably attached to the cap. The core is attached to the stem

20 for movement therewith through an opening in a plate forming part of the housing. The opening is sized and shaped to allow for axial movement relative thereto by the stem, with the stem being biased upwardly relative to the housing by a biasing means, preferably a spring. The core is capable of inducing operational signals in a circuit panel to which the switch is to be attached.

25 Preferably the stem includes a body and a projection. The projection is a shaft which has a barbed lower end, with the core being mounted on the shaft. The plate may have protuberances extending upwardly therefrom at or adjacent the periphery of the opening to enable the stem to be mounted between the protuberances in the manner of a sliding fit. Preferably, the stem has a body of generally cuboid shape with a plurality of axially

30 directed edges each edge having for its full height a curved extension to engage the protuberances to provide correct operation.

Advantageously, the plate has a plurality of corner supports depending therefrom, with a base extending therebetween. The base has a passage therethrough, the passage being axially aligned with a portion of the opening so that the core can pass through the portion of the opening and into the passage upon operation of the switch.

- 5 The invention also provides a circuit panel for use with at least one switch, the circuit panel including a single layer mylar sheet having at least one aperture therethrough, there being one aperture for each switch. The aperture is axially aligned with the passage when the switch is fitted. The sheet has a printed circuit layer on at least one of an upper and lower surface of the sheet, including a scan line and a return line adjacent the aperture.
- 10 The printed circuit may be on the upper and lower surfaces with the scan line being on one surface and the return line on the other surface. Preferably, the printed circuit is covered by a water-proof and dust-proof layer.

- The invention also provides a switch circuit which includes central processing unit and a key matrix, a multiplexer to determine the source of a return signal, a latch circuit to read
- 15 and remove any return signal after it is read, and an input/output connector to cause the keys to be scanned via the scan line. There may also be a variable resistor to enable the ON/OFF point of the switches to be controlled by an operator, and a make/break (ON/OFF) point control circuit after the multiplexer.

Description of drawing figures

- 20 In order that the invention can be properly understood there shall now be described by way of non-limitative example only at least one mode of carrying-out the present invention, the description being with reference to the accompanying illustrative drawings in which:

Figure 1 is an exploded perspective view of a switch incorporating the principal features of the present invention;

- 25 Figure 2 is a schematic illustration of the operation of the switch of Figure 1;

Figure 3 as an enlarged vertical cross-sectional view of the switch of Figures 1 and 2 when assembled and ready for operation;

Figure 4 is a vertical cross-section corresponding to that of Figure 3 but at time of operation of the switch;

Figure 5 is an example of a signal capturing circuit for use with the switch of the present invention;

Figure 6 is a block diagram of the circuit for the switch circuit of the present invention;

Figure 7 is a detailed block diagram of the circuit for the make/break (ON/OFF) point of
5 the present invention;

Figure 8 is an exploded perspective view corresponding to Figure 1 of a second form of switch of the present invention; and

Figure 9 is an exploded perspective view corresponding to Figures 1 and 8 of a third form of switch of the present invention.

10 Mode for carrying-out the invention

To refer to the drawings there is shown a switch generally designated as 10 and which has a key cap 12, a stem 14, core 16, spring 18 and housing 20.

The cap 12 is generally of known construction and operation. The stem 14 has a main body 22. The body 22 has a top 24, on which is located an upwardly projecting cross-
15 shaped projection 26. The purpose of cross 26 is to engage with cap 12 so that cap 12 is correctly located both axially and in orientation relative to stem 14.

The body 22 also has side walls 28 which are generally planar. The side walls 28 depend from top 24. Joining the side walls 28 are a front face 30 and a rear face 32 so that the general appearance of the body 22 is somewhat cubic. Front 30 has a cut-out portion 34 at
20 its lower end. Where each side-wall 28 joins to the front 30 and rear 32, and arcuate, axially-directed projection is provided for the full height of body 22 so as to enable a proper fit of stem 14 within housing 20 in such a way that the stem 14 can move axially relative to housing 20, and for the friction to be minimised. Extending outwardly from side wall 28 is an inverted "L" shaped shaft base 40 and a shaft 42 having barbed head 44 at its
25 lower end.

Core 16 is generally of cylindrical construction and is solid with a bore 46 therethrough along the longitudinal axis of core 16. In this way core 16 can be passed over barbed head 44 of shaft 42 such that core 16 locates on shaft 42 between head 44 and shaft base 40. It is preferable that the diameter of bore 46 is slightly larger than the diameter of shaft 42, but

less than the diameters of head 44 and shaft base 40. In this way core 16 is accurately located on shaft 42 and thus accurately located relative to stem 14.

Spring 18 is a compression spring and is located on an axially and downwardly projecting spindle 48 depending from top 24.

- 5 The housing 20 has a central plate 50 which is adapted to be located in a panel 52. The plate 50 is generally square and has a central opening 54 having a semi-circular portion 56 through which is adapted to pass the core 16. The central opening 54 is sized and shaped to enable the stem 14 to pass therethrough. Protuberances 58 extend upwardly from plate 50 so as to receive therebetween the stem 14 in the manner of a sliding fit.
- 10 Extending downwardly from plate 50 are corner supports 60 which hold the base 62 of housing 20. Spring 18 is adapted to be located on base 62, as is clear from Figures 3 and 4. Base 62 has an opening 64 which aligns with portion 56 so that core 16 can pass through opening 64.

The switch is adapted to be used in conjunction with a mylar sheet or membrane 66 which
15 has an aperture 68 therethrough again aligned with opening 64 and portion 56 so that core 16 can pass through aperture 68. An aperture 68 is provided for each switch 10. Only a single mylar sheet is required and it has a printed silver paste or metallic layer 70 thereon, which preferably is provided with an insulating coating, to provide the necessary electric circuits.

- 20 Intersected silver-foil circuits are provided to form a plurality of cross-inductive nodes. For each switch 10, there is provided a scan line 72 rather than the hitherto known system of a single scan line for all switches. By using a scan line 72 for each switch the cause of missing characters is eliminated. Each scan line 72 can be created using multiplexing techniques to reduce the number of physical lines. When a user presses a single key 10 by
25 pressure in the axially downwardly direction on cap 12, stem 14 and cap 12 will move axially downwardly against the action of spring 18 so that core 16 passes through portion 56, opening 64 and thus aperture 68. As there is a current flowing through the scan line 72, the induced field due to the movement of core 16 will cause a signal to be generated in return line 74. This signal can then be processed in the manner described below.

When an individual key 10 is released by a finger being removed from cap 12, the stem 14 can move axially upwardly. This causes core 16 to again move relative to opening 68 to provide the appropriate signal to turn that particular circuit OFF.

To now refer in particular to figure 6, which is a block diagram illustrating the inter-connection of the relevant circuit elements, there is provided a key matrix 11 which includes the panel 52, the mylar sheet 66, switches 10, and all appropriate circuitry and connections. Therefore, any signal induced in the return line 74 will be passed to the analogue multiplexer 13. The multiplexer 13 selects the appropriate return source, after amplification by a signal amplifier 15. A debounce control circuit 17 eliminates grey area voltages or unstable noise signals. This improves sensitivity and eliminates noise interference. A make/break (on/off) point control circuitry is read due to there being a variable resistor 21 to adjust the setting to enable an operator to have control over the sensitivity of the operation of the switch, if an individual switch 10 is being used, or for all such switches 10 on a keyboard. This is then passed to the central processing unit ("CPU") 23, which controls all operations.

An in/out connector 25 is used for the scanning of the keys 10 by the scan line 72. Additional circuits illustrated include a resonator circuit 27, indicator display circuit 29, current control structure 31, and signal trigger structure 35. A decoder 37 is provided between the CPU 23 and the key matrix 11; and a feed back circuit 39 is provided to a latch structure 33 so that the latch structure 33 can read and remove the signal after it is read.

The operation principal is quite stable. In view of the technology available in semiconductor design, it is possible to incorporate the entire circuitry of figure 6 into an Applications Specific Integrated Circuit to enable the cost of that component to be significantly reduced.

It is preferable that the mylar sheet 66 has the scan line 72 and return line 74 on different sides. This means a layer 70 may be required for the upper and lower surfaces of sheet 66. It is preferable that both be provided with an appropriate dust-proof and water-proof coating. In that way there will be no interference between scan line 72 and return line 74.

By virtue of the nature of operation of switch 10, there are no contacts. Therefore, a long life would be expected for the switch 10. A life of up to ten times that presently available

may be able to be achieved. With mylar sheet 66 being provided with a layer 70 on each side, and each layer having a water-proof and dust-proof coating, the switch 10 is effectively water proof and dust proof. A splash or spill of water or other liquid should not cause inoperation. By virtue of there being a scan line 72 for each switch 10, by using
5 multiplex techniques, it is a true N-key system and the problem of ghost keys should be eliminated, as should be the problem of missing letters. By having the variable resistor 21, there is an adjustable ON-OFF point. The scan circuit 72 preferably terminates at one point and uses the same resistor to "pull-high". When the scan is at "pull-low" a stable current will pass through the resistor to scan A or scan B from the same source. Scan A
10 and scan B are open collect and thus will not affect the current flow. The upper and lower limits of the signal can be set to determine the signal triggering point for the read-enable ON/OFF point travel. Preferably, the key signal is locked for processing by the CPU 23 to reduce the possibility of interference from noise, spikes and other spurious signals.

The core 16 may be made of any suitable material. Preferably, it is a non-ferrite material
15 such as, for example, carbon.

To now refer to figures 8 and 9, there are shown variations of the embodiment of figures 1 to 7. That in figure 8 uses a different spring 76 so that the switch 10 can operate as a tactile key switch.

For the embodiment of figure 9, which is a variation of that of figures 1 to 7, a metal plate
20 78 is added. The plate 78 is attached to protuberances 58 to provide a "click" sound and/or feel to a user when the switch 10 is operated.

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative
25 aspects of the invention.

It will also be understood that where the term "comprises" or its grammatical variants, is employed herein, it is equivalent to the term "includes" and is not to be taken as excluding the presence of other elements or features.

Whilst there has been described in the foregoing descriptions preferred constructions of a
30 switch and switch circuitry in accordance with the principal features of the present invention, it will be understood by those skilled in the art that many variations or

modifications in details of design of construction may be made without departing from the essential features of the present invention.

The claims defining the invention are as follows:

1. A contactless switch including:
a cap,
a stem adapted to be releasably attached to the cap,
5 a core attached to the stem for movement therewith,
a housing having a plate with an opening therethrough,
the opening being sized and shaped to allow for axial movement relative thereto by the stem,
the stem being biased upwardly relative to the housing by a biasing means,
10 the core being capable of inducing operational signals in a circuit panel to which the switch is to be attached.
2. A switch as claimed in claim 1, wherein the stem includes a body having a shaft base projecting therefrom, and a shaft having a socket and a barbed lower end, the core being mounted on the shaft.
- 15 3. A switch as claimed in claim 1 or claim 2, wherein the plate has protuberances extending upwardly therefrom at or adjacent the periphery of the opening, the stem being mounted between the protuberances in the manner of a sliding fit.
4. A switch as claimed in claim 3, wherein the stem has a body of generally cuboid shape, the body having a plurality of axially directed edges each edge having for its
20 full height a curved extension to engage the protuberances to provide correct operation.
5. A switch as claimed in any one of claims 1 to 4, wherein the plate has a plurality of corner supports depending therefrom, the corner supports having extending therebetween a base; the base having a passage therethrough, the passage being
25 axially aligned with a portion of the opening.
6. A switch as claimed in claim 5, wherein the core passes through the portion of the opening and into the passage upon operation of the switch.
7. A switch as claimed in any one of claims 1 to 7 wherein the biasing means is a spring.



8. A switch as claimed in claim 3 or claim 4, wherein a metal plate is attached to the protuberances to provide a click sound and/or feel when the switch is operated.
9. A switch as claimed in claim 7, wherein the spring is a compression spring.
10. A switch as claimed in claim 7, wherein the spring is arranged to enable the switch to operate as a tactile key switch.
11. A switch as claimed in any one of claims 1 to 10, wherein the core is cylindrically shaped, and is of a carbon material.
12. A circuit panel for use with at least one switch as claimed in any one of claims 1 to 11, including a single layer mylar sheet having at least one aperture therethrough, there being one aperture for each switch, the aperture being axially aligned with the passage when the switch is fitted; the sheet having a printed circuit layer on at least one of an upper and lower surface of the sheet, the printed circuit layer including a scan line and a return line adjacent the aperture.
13. A circuit panel as claimed in claim 12, wherein the sheet has the printed circuit on the upper and lower surfaces, the scan line being on one surface and the return line on the other surface.
14. A circuit panel as claimed in claim 12 or claim 13, wherein the printed circuit is covered by a water-proof and dust-proof layer.
15. A circuit panel as claimed in any one of claims 12 to 14, wherein the aperture is adapted to receive therein the core of the switch when fitted.
16. A switch circuit including a central processing unit and a key matrix, the key matrix including a circuit panel as claimed in any one of claims 12 to 15 when fitted with a plurality of switches as claimed in any one of claims 1 to 11, a multiplexer to determine the source of a return signal, a latch circuit to read and remove any return signal after it is read, and an input output connector to cause the keys to be scanned via the scan line.
17. A switch circuit as claimed in claim 16, wherein there is included a variable resistor to enable the ON/OFF point of the switches to be controlled by an operator, the circuit further including a make/break (ON/OFF) point control circuit after the multiplexer.

