

[54] **SOLID STATE SWITCH CONSTRUCTION**

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[58] Field of Search..... **335/229; 197/98; 179/901 C; 340/365 L, 347**

[56] **References Cited**

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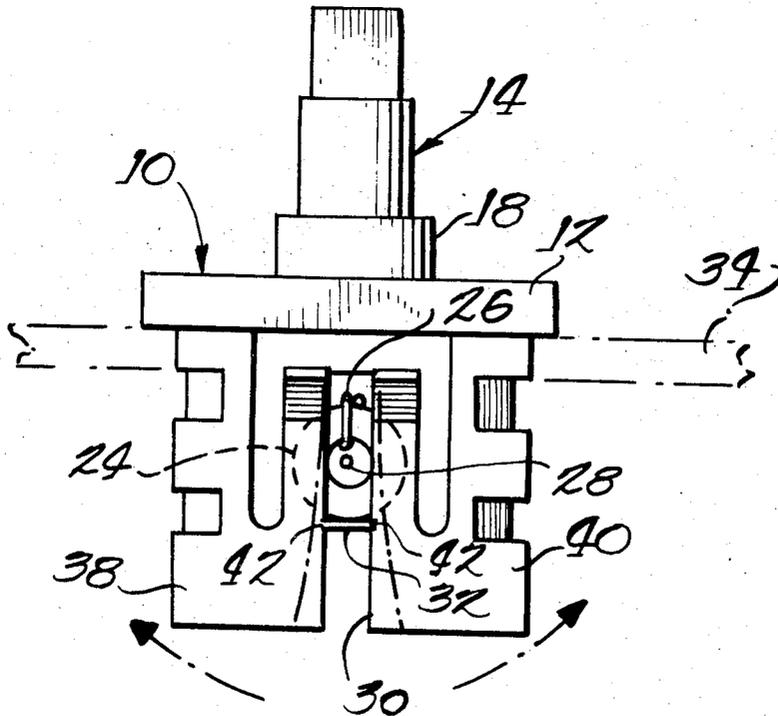
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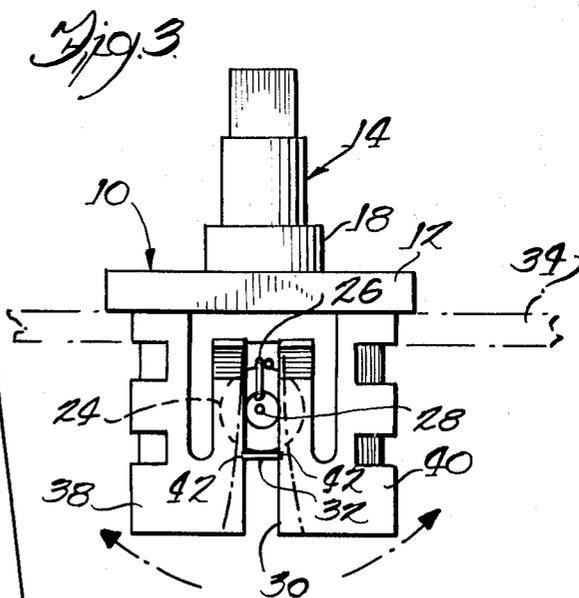
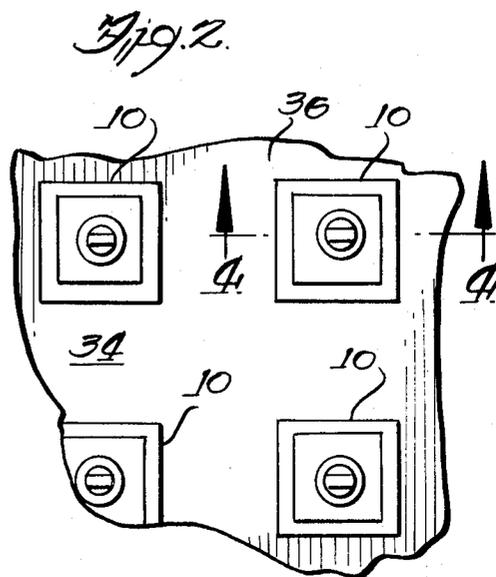
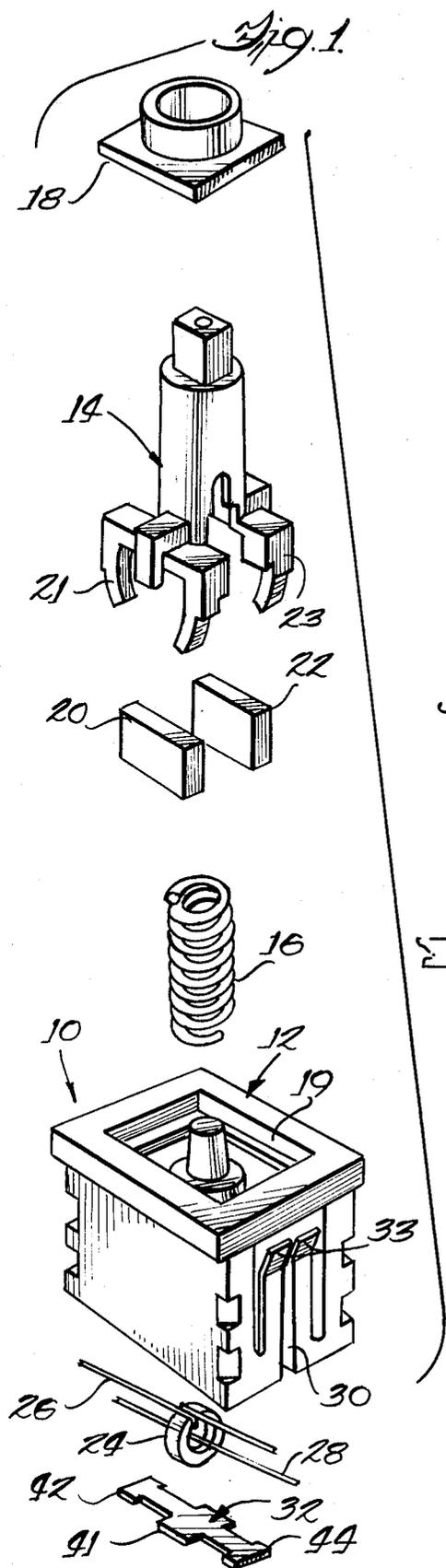
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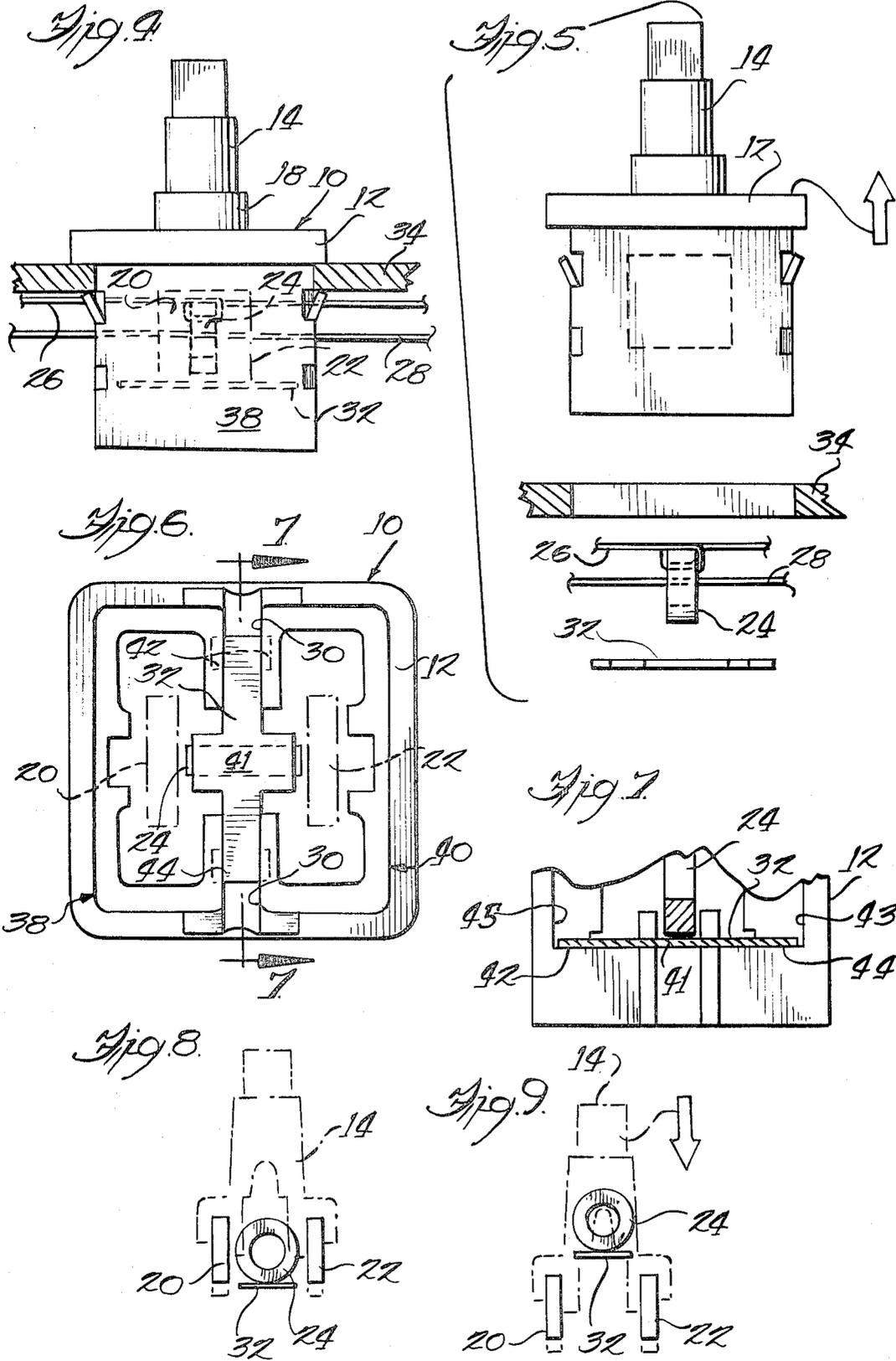
[57] **ABSTRACT**

A solid state switch construction employing a saturable magnetic core switch. The switch has a keystone of magnetic material to change the magnetic property of the saturable magnetic core to effect switching of the signal information by transformer coupling. The keystone has a pair of legs extending on opposite sides of the magnetic core with two permanent magnets secured thereto. When the keystone is not depressed the magnets are located adjacent opposite sides of the core so that the magnetic flux path is formed through the magnetic core, the keystone, and the two permanent magnets to thereby saturate the magnetic core and prevent transformer coupling. When the keystone is depressed, the permanent magnets are moved away from the magnetic core to unsaturate it and variations in the magnetic field effect witching of signal information. The magnetic core is readily removable from the key construction without electrically disconnecting the leads from the circuitry to which they are connected should a malfunction of the switch body or keystone occur. The magnetic core is firmly but removably held within the switch body by a metal clip.

9 Claims, 9 Drawing Figures







SOLID STATE SWITCH CONSTRUCTION**BACKGROUND OF THE INVENTION**

This invention relates generally to a solid state switch construction, and more particularly to a switch construction suitable for use in keyboards utilized for feeding information into data processing equipment.

Keyboards are well known for use with data processing equipment to feed in signal information corresponding to some particular code. Such keyboards may take many forms, they being either provided with electronic switches or mechanical switch components. One well known type of keyboard comprises a plurality of electric switch contacts mechanically operated by depressing a keystem. The keystem may have a coded top face with a letter or number or the like. These devices suffer many disadvantages in that they are subject to wear and the contacts tend to cause high resistance due to arcing or oxidization thereof. Also, atmospheric conditions may cause unreliable switching of these components due to dirt that may enter the keyboard.

More recently, solid state switches have been developed for such keyboards and have generally overcome the above disadvantages of mechanically actuated electrical switch contacts. One form of solid state switch comprises a permanent magnet and a core associated therewith. The permanent magnet, or the core, is fastened to a keystem or actuating member to move the core and magnet relative to one another. The core is generally provided with a drive winding wire and a sense wire threaded therethrough. An AC signal is applied to the drive winding. When the switch actuator is in the undepressed condition, the permanent magnets are positioned on each side of the core and the effective impedance is relatively low and no transformer coupling can take place between the drive wire and the sense wire. When the actuator is depressed, however, the permanent magnets move away from the core to unsaturate the core and substantially increase the AC impedance and effect transformer coupling between the drive wire and the sense wire. While this type of switch construction overcomes the disadvantages of prior keyboards for data processing equipment, it still suffers mechanical failure of the switch body and the magnetic cores within the switch body are not readily replaceable or interchangeable without actually unwiring or disconnecting the wires from the circuitry to which they are connected.

SUMMARY OF THE INVENTION

Therefore, it is an object of this invention to provide an improved solid state key construction wherein the magnetic core within the switch body is readily removable without disconnecting or removing the wires wound or threaded through the cores and a new switch body and actuating mechanism is easily connected to the existing magnetic core while it remains connected to the keyboard.

Another object of this invention is to provide an improved solid state switch construction wherein the switch body is readily mounted into large keyboard assemblies for data processing equipment and wherein replacement of defective switches is easily accomplished without unwiring the wires that are through the magnetic core within the switch body.

Another object of this invention is to provide a solid state switch construction which is inexpensive to manufacture and wherein interchangeability of components is readily accomplished.

The solid state switch construction of this invention is an improvement over application Ser. No. 879,220 filed on Nov. 24, 1969, now U.S. Pat. No. 3,638,221 which is assigned to the assignee of the present application. As disclosed in this application a relatively large number of switches are mounted in a housing to form a keyboard for data processing equipment. Such keyboards are commonly used to feed information into the electronic circuitry of computers. Such computers require pulse signal information at rapid rates and over long periods of time to do the necessary manipulation of the data and produce the desired result. Therefore, keyboard switches are actuated substantially continuously over long periods of time and are often in need of repair. One type of failure is that of the switch body components, they being the actuating mechanism itself or the arms carrying the permanent magnets within the switch body. Since there is no movement of the magnetic core or the wires passed therethrough, failure of this component is indeed rare. Therefore, replacement of a defective switch requires only that the switch body or actuating mechanism be removed and a new switch body and actuating mechanism positioned about the existing magnetic core.

Briefly, the solid state switch construction of this invention includes a magnetic core which is relatively loosely received within the switch body and firmly but removably held therein by a small metal clip. The switch body is then inserted through a wall of a keyboard for mounting the same in a conventional manner and the wires passing through the magnetic core is wired into the computer circuitry. Should failure occur of the switch body components, the switch body components can be removed from the keyboard housing without unwiring of the windings passing through the magnetic core. To remove the switch body from the keyboard housing, it is necessary to gain access to the underside of the keyboard. This will allow removal of the small metal clip within the switch body and allow the switch body to be pulled upwardly off of the top wall of the keyboard housing and from about the magnetic core which remains in place with its connected wires within the keyboard housing. A new switch body is then inserted through the keyboard over the magnetic coil and the small metal clip is then inserted into the new switch body to assemble the switch body and magnetic core.

A further improvement of the switch construction of this invention is that the retaining clip is of paramagnetic material and functions to provide a magnetic shunt between the permanent magnets to further substantially aid in unsaturating the magnetic core so that AC signal coupling can occur between the drive and sense wires about and through the core which may act as a transformer coupled device.

Other objects, features and advantages will become more fully apparent from the following detailed description when taken in conjunction with the accompanying drawings wherein like reference numerals throughout the various views of the drawings are intended to designate similar elements or components.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of a solid state key switch constructed in accordance with the principles of this invention;

FIG. 2 is a plan view of a portion of a keyboard illustrating four key switches extending upwardly therefrom to be actuated for applying signals to a data processing machine;

FIG. 3 is an elevational end view of the solid state switch extending through the top wall of the keyboard housing and which shows, in phantom lines, the flexure of the switch body to remove a retaining clip for disassembling a magnetic core member from the switch body;

FIG. 4 is an elevational side view of the solid state switch extending through the top wall of a keyboard housing showing the magnetic core member having the wires thereof extending outwardly for connection into a circuit;

FIG. 5 is a view showing the switch body removed from the keyboard and disassembled from the magnetic core which remains beneath the top wall of the keyboard housing;

FIG. 6 is an enlarged bottom view of the switch construction of FIG. 1 showing the relative placement of the retainer clip and magnetic core;

FIG. 7 is a sectional view taken along line 7-7 of FIG. 6; and

FIGS. 8 and 9 illustrate the relative position of the permanent magnets within the switch body relative to the magnetic core for saturating and unsaturating the core to effect a switching action.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring now to FIG. 1, there is seen an exploded view of a solid state switch constructed in accordance with the principles of this invention and is designated generally by reference numeral 10. The solid state switch 10 is formed of a switch body 12 into which is inserted a keystem 14 over a coil spring 16 which resiliently urges the keystem 14 upwardly in a deactivated condition when assembled. The keystem 14 is confined at the upper end by a top wall member 18 which is secured within a recess 19 of the key body 12 by ultrasonically welding or other suitable means.

A pair of permanent magnets 20 and 22 are firmly held by spaced apart legs 21 and 23, respectively, of the keystem 14 and are movable therewith. The magnets 20 and 22 may be insert molded in the keystem. Mounted within the switch body 12, from the underside thereof, is a magnetic core member 24 having a drive wire 26 and sense wire 28 extending therefrom and through recesses 30 formed in the end walls of the switch body.

Most advantageously, the magnetic core 24 is firmly but removably held within the switch body by a removable clip 32 which frictionally engages the interior side walls of the switch body when assembled. Upon removal of the clip 32 the entire switch body structure can be removed from the magnetic core 24 and its associated wires 26 and 28 without necessitating disconnecting of the leads from the electric circuitry to which they are connected.

Referring now to FIG. 2, a fragmentary portion of a top wall 34 of a keyboard 36 is shown with four solid state switches, each designated by reference numeral 10. The switches 10 may be part of a switch matrix in a ten-by-ten, or any other suitable XY configuration, and may include indicia caps secured to the top of the keystem 14 so that letters or numbers may be displayed.

FIG. 3 illustrates the switch 10 secured to the top wall 34 and further illustrates the side flexure of leg portions 38 and 40 in diametrically opposed directions, as shown by the broken line, to allow simple removal of the clip 32 from within the recess 30. Once the clip 32 is removed, the holding tabs 33, FIG. 1, are squeezed together to remove the switch body 12 upwardly and the magnetic core 24 can be dislodged from its position within the switch body 12 without requiring the disconnection of the wires 26 and 28 from the circuits. This is best shown in FIGS. 4 and 5. The switch 10 is shown in FIG. 4 with the magnetic core 24 located between the permanent magnets 20 and 22 within the switch body 12 and with the magnetic core 24 held firmly therein by the removable clip 32. The wires 26 and 28 extend outwardly of the switch body 12 through the recesses 30, as best seen in FIGS. 1 and 3. FIG. 5 shows the switch body 12, together with its keystem 14 and other associated components, completely removed from the top wall 34 of the keyboard so that the magnetic core 24 and its associated wires 26 and 28 remain below the keyboard wall 34 in continuous electrical connection with its associated circuitry. Therefore, none of the electrical circuitry of the data processing equipment is disturbed, and little or no down time will be experienced.

Referring to FIG. 6, the bottom view of the switch 10 is shown and the leg portions 38 and 40 of the switch body 12 are shown as being hollow to receive the permanent magnets 20 and 22 movable therein. The magnetic core 24 is located centrally within the switch body 12 and engages an enlarged portion 41 of the clip 32 which is substantially in the middle of the clip. Outwardly extending gripping end portions 42 and 44 are formed on the clip 32 to dig into the material of the switch body and thereby be firmly held in place. This is best illustrated in FIG. 3 which shows the gripping end portions 42 slightly embedded in the material of the switch body. Therefore, outward flexure of the leg portions 38 and 40, as shown in FIG. 3, will facilitate removal of the clip 32 for removing the magnetic core. In the alternative the gripping end portions 42 and 44 may engage recesses 43 and 45, respectively, formed within the switch body as shown in FIG. 7. In this case the clip 32 is held in position by being confined at its lower end by the recesses and confined at its upper end by the presence of the core member 24.

FIGS. 8 and 9 illustrate the operating condition of the keystem 14 relative to the magnetic core 24. In FIG. 8 the keystem is in a deactivated up position and the permanent magnets 20 and 22 are positioned immediately adjacent the magnetic core 24 to completely saturate the magnetic material thereof. The retaining clip 32 has little or no effect on diverting magnetic flux from passing through the magnetic core 24. However, upon actuation of the keystem 14 as shown in FIG. 9, the permanent magnets 20 and 22 are moved

downwardly and the magnetic core 24 is substantially freed of all magnetic flux and AC coupling can take place to cause a switching action.

Most advantageously, the retaining clip 32 is constructed of paramagnetic material and now acts as a magnetic shunt between the permanent magnets 20 and 22 and the magnetic core 24 further to insure the switching action. Any stray magnetic flux which would tend to enter the magnetic core 24 will be shunted by the metal clip 32. This feature helps to create a more finite switching position or condition of the solid state switching device as the keystem 14 is moved downward. That is, the keystem 14 moves downward to a definite position whereupon magnetic flux is quickly diverted from the magnetic core 24 and fast switching is accomplished by instantaneous transformer coupling between the drive and sense wires 26 and 28.

What has been described is a simple and efficient solid state switching device which can be completely mechanically connected and electrically connected to a keyboard structure and whereupon any failure of a switch component will allow complete mechanical removal of the switch body without necessitating disconnecting or unsoldering of the leads connected in circuit within the keyboard arrangement. Therefore, variations and modifications of this invention may be effected without departing from the spirit and scope of the novel concepts disclosed and claimed herein.

The invention is claimed as follows:

1. In a solid state switch construction the combination including, a switch body having a recess, a core of magnetic material positioned within said recess, at least two winding means passing through said core to have the ends thereof electrically connected in a circuit when said switch body is mounted to a keyboard, movably mounted permanent magnet means positioned within said switch body closely adjacent said core to saturate said core when in one position and to be moved away from said core to unsaturate the same when in another position, and clip means removably secured to said switch body over said recess firmly but removably to hold said core within said recess and to allow removal of said core from said switch body without disconnecting said winding means from the circuit to which it is connected when said switch body is removed from the keyboard.

2. The solid state switch construction of claim 1 wherein said clip means is formed of paramagnetic material, and said permanent magnet means moves adjacent said clip means when moved away from said core to facilitate unsaturating of said core by providing a magnetic shunt path between said permanent magnet means and around said core.

3. The solid state switch construction of claim 1 wherein said core of magnetic material is circular in

configuration.

4. The solid state switch construction of claim 1 wherein said clip means is formed of a flat piece of paramagnetic material having outwardly extending gripping end portions thereof to be embedded into the switch body in said recess, and removal of said clip means is accomplished by flexure of the switch body to additionally open said recess.

5. A keyboard switch comprising, a saturable magnetic core, a depressable keystem having first and second legs extending on opposite sides of said core, first and second permanent magnets mounted on said first and second legs, respectively, each permanent magnet being mounted on its corresponding leg intermediate the leg and said magnetic core, said permanent magnets being positioned on said legs to be opposite said core when the keystem is not depressed, whereby a flux path is established from one said magnet to the other said magnet, and through said core to saturate the same, said keystem carrying said permanent magnets out of saturating relation with said core when said keystem is actuated, and clip means removably engaged with said magnetic core to hold said magnetic core within said keyboard switch and to allow removal of said magnetic core without disconnecting the core from its associated electronic circuitry.

6. A keyboard comprising, a plurality of keyboard switches each having an active and an inactive state and including, a saturable magnetic core having a closed loop magnetic flux path, a movable keystem having leg portions on opposite sides of said magnetic core, first and second permanent magnets secured to said legs and movable with said keystem to saturate said core when said switch is in one of said states with the flux passing through said magnetic core and to unsaturate said magnetic core when the switch is in the other of said states, coupling winding means positioned about said core to be connected in circuit with associated circuitry, and clip means removably holding said magnetic core and its associated windings into the keyboard switch to allow removal of the keyboard switch from said magnetic core and its associated windings without necessitating disconnecting of the windings from its circuitry.

7. The keyboard of claim 6 wherein said clip means is formed of a flat piece of paramagnetic material to form a magnetic shunt path with said core to divert the magnetic flux from said permanent magnets when said switch is in its active state.

8. The keyboard of claim 6 wherein said magnetic core is circular in configuration.

9. The keyboard of claim 6 wherein said clip means is formed of a flat piece of material having outwardly extending end portions to be engaged into recesses formed in the switch body.

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