

[54] CAPACITIVE KEYSWITCH

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[58] Field of Search 317/249 R;
200/DIG. 1, 159 R

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[57] ABSTRACT

A variable capacitance keyswitch is disclosed in which a differential capacitor is formed by two fixed plates and a moveable plate therebetween. Each plate is in the shape of the frustum of a cone. Depression of the pushkey varies the capacitance between each fixed plate and the moveable plate over a range of about one order of magnitude, or greater. In addition, depression of the pushkey provides a push-pull capacitance variation between fixed and moveable plates, achieving an electrical snap action effect useful in typical bistable flip-flop circuitry.

3 Claims, 2 Drawing Figures

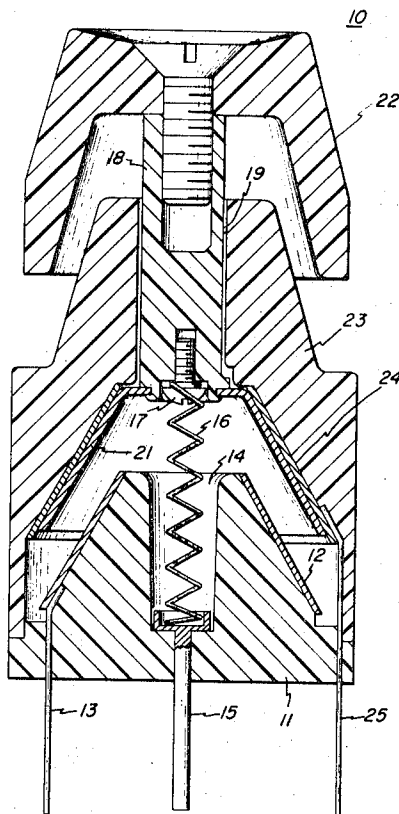


FIG. 1

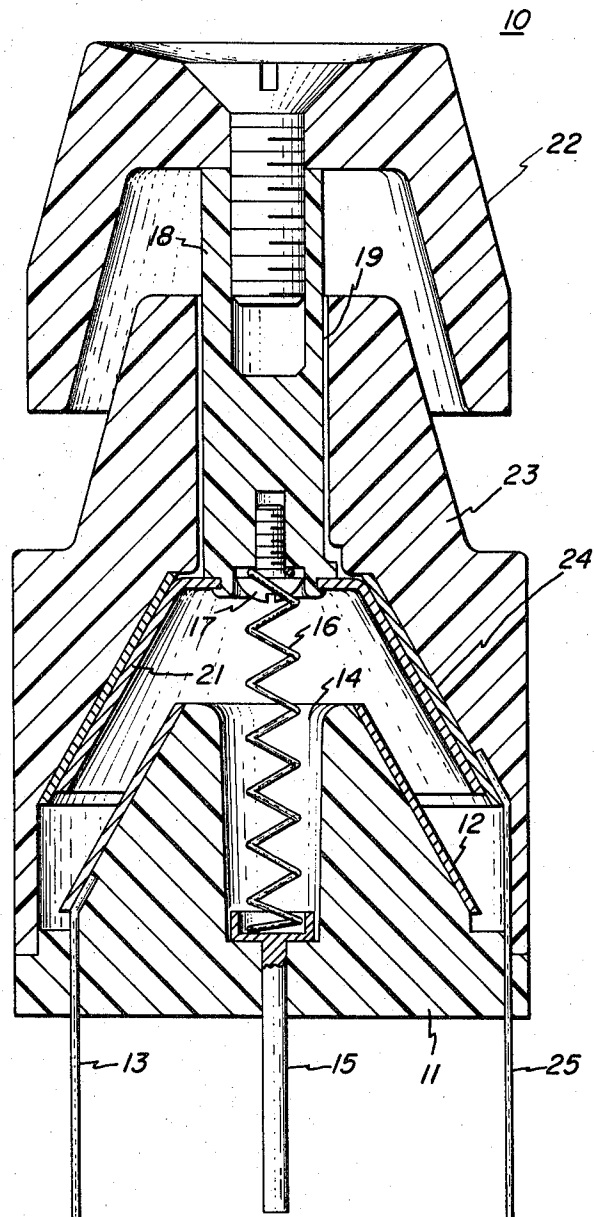
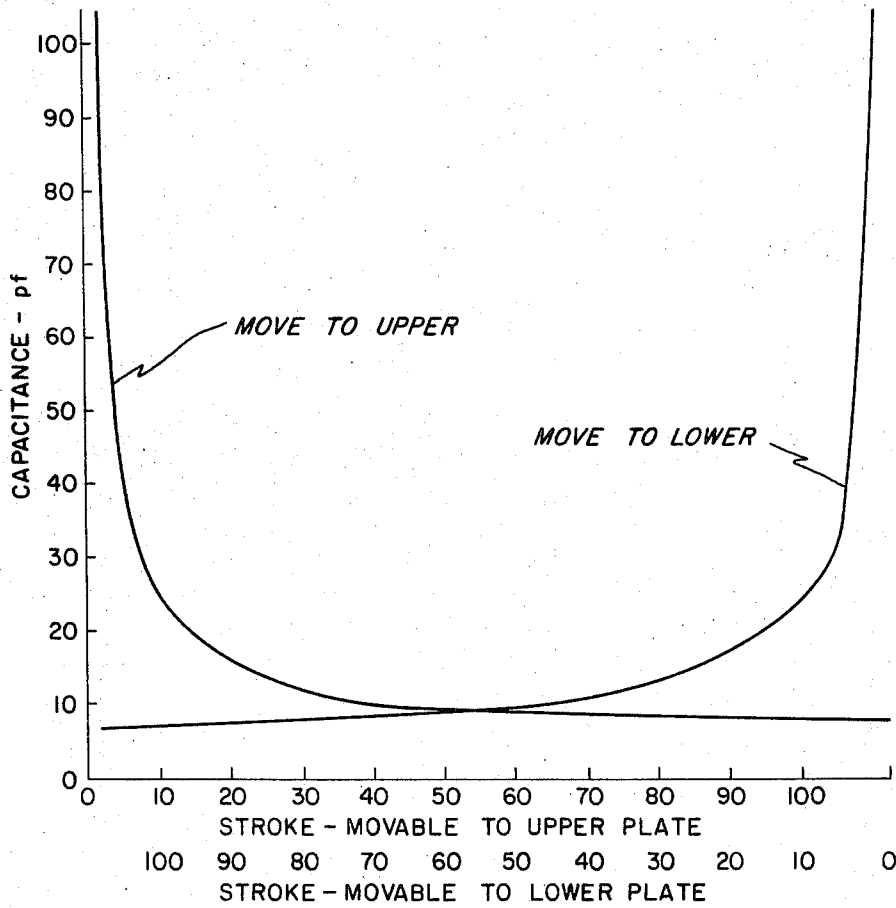


FIG. 2



CAPACITIVE KEYSWITCH

This invention relates to keyswitches and, in particular, to keyswitches exhibiting a variable capacitance.

Keyswitches are used in a wide variety of applications in the prior art, such as for control circuits, keyboards for typewriters, calculators, computers and the like. These switches may be classified according to the phenomenon relied upon to indicate activation: resistive, inductive or magnetic, and capacitive.

The resistive type generally comprises a pair of metal contacts that form either a normally open or a normally closed electrical path. A virtue of the resistance type of keyswitch is that the change in resistance between open and closed conditions is enormous and easily detected. Typically, for new contacts, the resistance may vary between a fraction of an ohm and virtually infinite resistance.

A problem exists with this type of switch, however, in that corrosion and deposits build up on the contact and points and wear on the points impair the performance of the keyswitch and limit its useful life, making it more difficult for sensing circuitry to distinguish between open and closed conditions.

In an attempt to avoid these problems, inductive and capacitive keyswitches have been developed in the prior art. The inductive or magnetic type of keyswitch is appreciably more complex than the resistive type and does not retain the advantage of readily distinguished conditions.

The capacitive types known to the prior art fall somewhere between the inductive and resistive types in terms of the balance between advantages and disadvantages. While simple in construction and immune to the problem of contact resistance, the capacitive keyswitches of the prior art do not have a large variation (one order of magnitude or greater) in capacitance upon actuation.

It is therefore an object of the present invention to provide a capacitive keyswitch having a large variation in capacitance upon activation.

It is another object of the present invention to provide a capacitive keyswitch having a readily detectable variation in capacitance upon activation.

It is another object of the present invention to provide a capacitive keyswitch having a push-pull capacitance variation characteristic.

The foregoing objects are achieved in the present invention wherein the capacitive keyswitch comprises three plates, each in the shape of the surface of the frustum of a cone. Two of the plates are fixed and one is moveable between the two fixed plates under the control of a pushkey, to which it is mechanically connected. In one position the moveable plate is nested with a first of the fixed plates. In the other position, the moveable plate is nested with the second fixed plate. The result is a differential capacitor in which an easily detected, push-pull type of variation in capacitance is provided. By virtue of the shape of the plates, a variation in capacitance of about one order of magnitude or greater is obtained.

A more complete understanding of the present invention can be obtained by considering the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates a preferred embodiment of the capacitive keyswitch in accordance with the present invention.

FIG. 2 illustrates the capacitance/stroke characteristics of a keyswitch in accordance with the present invention.

In FIG. 1, capacitive keyswitch 10 comprises a base 11 having a first capacitor plate 12 attached thereto. Lead 13 is attached to capacitor plate 12 and extends through an aperture in base 11. Base 11 further has a central hollowed out portion 14 at the bottom of which a second conductive lead 15 is inserted and extends through another aperture in the base. Resilient means 16, illustrated as a spring, is electrically conductive and is in both mechanical and electrical contact with conductor 15. The other end of resilient means 16 is attached by way of a screw or bolt 17 to actuating shaft 18. Actuating shaft 18 may be flatted or keyed as indicated by reference numeral 19 to prevent rotation thereof during actuation. Moveable plate 21 is attached to actuating shaft as for example by molding a lip around the inner edges of the moveable plate. Electrical connection to conductive resilient means 16 from moveable plate 21 can be made in a variety of ways. As for example, by utilizing a jumper wire or by fabricating the lower end of actuating shaft 18 from a conductive material which is then attached to actuating shaft 18 by bolt 17 or a suitable adhesive. The upper portion of actuating shaft 18 is attached to a key face 22 which provides an enlarged area for contact with the finger tips.

Cover means 23 surrounds actuating shaft 18 and moveable plate 21 and, together with base 11 to which it is attached, defines the volume within which plate 21 may move. Cover means 23 has an aperture for actuating shaft 18 which has a complementary shape to that of shaft 18. Attached to cover means 23 is a second fixed plate 24 to which is attached a conductive lead 25 which passes through a third aperture in base 11, thereby providing the third of the three leads to the capacitive keyswitch.

As illustrated in FIG. 1, the three plates of the variable capacitor are each shaped as the surface of a frustum of a cone which provides a larger surface area than could be obtained within the diameter of the keyswitch if the capacitor plates were flat or planar. This increases the capacitance of the keyswitch in accordance with the present invention. The change in capacitance exhibited by the keyswitch upon actuation is determined in part by the configuration of the capacitor plates and also by the amount of separation. This can be seen by inspection of FIG. 1 as moveable plate 21 is moved by depressing the pushkey. Capacitor plates 24 and 21 are not only separated but also moved relative to each other so that the area of overlap between the capacitor plates is reduced. This serves to further reduce the capacitance associated with plates 21 and 24 upon actuation. Similarly, as the pushkey is depressed, the capacitance associated with plates 12 and 21 increases because not only are the plates being moved closer together, but also because the area of overlap is increased as moveable plate 21 is lowered. Thus, by providing a non-planar shape for the capacitor plates, the moveable plate can nest with either of the fixed plates and have a larger area and hence higher capacitance in the nest condition than could be obtained with planar capacitor plates positioned very close to each other.

FIG. 2 illustrates the capacitance versus stroke characteristics of capacitive keyswitch 10. As can be seen from FIG. 2, with moveable plate 21 at its upper most position, a large capacitance is exhibited by plates 21 and 24. Also in this position a minimal capacitance is exhibited between plates 12 and 21. Conversely, in the fully depressed position, a minimal capacitance is exhibited between plates 21 and 24 whereas a maximum capacitance is associated with plates 12 and 21. This push-pull or see-saw type of capacitance variation is more easily detected than simply a change in capacitance. Further, however, the capacitive keyswitch in accordance with the present invention exhibits a very large variation in capacitance between the moveable plate and either one of the fixed plates so that the actuation of keyswitch 10 can be more easily detected by virtue of this characteristic alone.

Structurally, a capacitive keyswitch in accordance with the present invention can be manufactured in a variety of ways from a number of materials. For example, base 11, cover 23, and key face 22 are preferably made of a plastic material. Suitable plastic materials are those that are moldable, have a high dielectric strength and have long wear characteristics. One plastic found suitable is Delrin AF Plastic as sold by E. I. Du Pont de Nemours and Company. This plastic material, in addition to being moldable, having dielectric strength and good wearability, also contains a small amount of Teflon which provides lubricity between the moving parts. Other suitable plastics may be used, for example Nylon.

The metal parts of the capacitive keyswitch can be any metallic material. Brass, aluminum, or steel are common examples.

As a specific example of the capacitive key-switch formed in accordance with the present invention, a keyswitch may be made of Delrin AF Plastic having hard anodized aluminum capacitor plates, a steel wire spring, and copper conductors. The keyswitch should be shaped to fit the standard three-quarter inch center-to-center keyboard spacing, have a height of slightly more than one and one-quarter inches and a stroke of approximately one-eighth of an inch. Such a keyswitch exhibits a capacitance change of from 5 to greater than 50 picofarads during the activation thereof.

The hard anodized coating upon moveable plate 21 is used for purposes of wear resistance and not necessarily for any dielectric properties. If desired, moveable plate 21 and/or fixed plates 12 and 24 can be suitably coated with a dielectric material. However, since the capacitive keyswitch of the present invention is most likely to be used in conjunction with transistor circuitry, which is tolerant of a short circuited capacitor, insulating coatings are not necessary. However, the capacitive keyswitch of the present invention can readily accommodate tube-type circuits and other circuits that are not tolerant of short circuited capacitors simply by including a suitable dielectric layer over the moveable plate and/or the fixed plates.

As is apparent from the foregoing description, a capacitive keyswitch in accordance with the present invention achieves the constructional simplicity of the resistive type of keyswitch without the problem of contact resistance variations. Further, a large variation in capacitance is obtained by virtue of the configuration

and mechanical relation of the plates. Also, a push-pull variation is obtained that is readily detected and provides an electrical snap action effect useful in typical bistable flip-flop circuitry.

Having thus described the invention, it will be obvious to those of skill in the art that various modifications can be made within the spirit and scope of the present invention. For example, the capacitive key-switch as illustrated in FIG. 1 has a differential capacitance characteristic. A suitable capacitive keyswitch in accordance with the present invention need only have one fixed and one moveable plate. In this embodiment, an improvement is still obtained over keyswitches of the prior art in that the keyswitch in accordance with the present invention provides a substantially larger variation in capacitance upon actuation. The keyswitch illustrated in FIG. 1 is analogous to a momentary contact switch of the resistive type in that the capacitor is restored to its initial condition by resilient means 16 upon release of the pushkey. Capacitive keyswitch 10 may also be actuated analogous to a single pole double throw switch.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A variable capacitance keyswitch comprising:

first and second fixed plates;

a moveable plate;

said fixed and moveable plates having a non-planar shape and nesting one in the other when the plates exhibit a high capacitance; and

actuating means, mechanically coupled to said moveable plate, for differentially varying the capacitance between said moveable plate and said first and second fixed plates.

2. A variable capacitance keyswitch as set forth in claim 1 wherein said plates are in the shape of the surface of the frustum of a cone.

3. A variable capacitance keyswitch comprising:

a first fixed plate;

a second fixed plate;

a moveable plate positioned between said first and second fixed plates;

said first, second and moveable plate being in the shape of the frustum of a cone and capable of nesting one within the other;

shaft means connected to said moveable plate for nesting said moveable plate with either of said first or second fixed plates;

first and second electrical conductors connected to said first and second fixed plates respectively;

base means having three apertures and having said first fixed plate attached thereto;

cover means having the second fixed plate attached thereto and an aperture through which said shaft means moves;

said base means and said cover means defining a volume in which said moveable plate moves; and

electrically conductive resilient means connected to said moveable plate and connected to a third electrical conductor; said first, second and third electrical conductors passing through said three apertures.

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