A keyboard is disclosed having a printed circuit board with arched contacts fastened thereto which may be deflected into contact with conductors on the printed circuit board. The arched contacts provide a snap-action when they are deflected by a key so that the user receives tactile feedback when electrical contact is made between the arched contact and the conductor on the printed circuit board. The key has a flat portion on its lower surface which is in contact with the arched conductor. On either side of the flat area are recessed areas which receive the arched conductor when it is deflected toward the printed circuit board through the application of force to the key by a user. The key is also provided with a protrusion which limits the travel of the key.

4 Claims, 4 Drawing Figures
KEYBOARD TYPE SWITCH WITH ROCKER TYPE KEY ACTUATOR

BACKGROUND OF THE INVENTION

A number of different kinds of prior art keyboards have provided tactile feedback to the user when a key is depressed. Certain of these prior art keyboards use snapping discs or arched strips supported on a printed circuit board for producing the tactile feedback as well as making electrical connection with another contact. In some of these prior art devices difficulties have been experienced both in obtaining reliable and repeatable contacts when the key is deflected and in obtaining reliable and repeatable tactile feedback. Some of these problems are due to asymmetrical buckling or deflection of the arched contact which may result if the deflecting force is not applied at the center of the arch. One prior art remedy for this difficulty has been the provision of protrusions from the printed circuit board that force the arched contact to buckle in the middle by preventing it from laying flat on the printed circuit board outside of the region of the contact on the circuit board. Such a device is described in a patent application entitled KEYBOARD HAVING SWITCHES WITH TACTILE FEEDBACK by William W. Mison, Clarence K. Studley, William J. West and Edward T. Liljenwall, Ser. No. 173,754 filed Aug. 23, 1971 and assigned to the assignee of the instant application.

A significant drawback of the aforementioned solution to the asymmetrical buckling problem is the difficulty of producing the protrusions in the printed circuit board. For high volume, low cost devices such as calculators it is unacceptably expensive to fasten protrusions to the circuit board by means such as gluing, screwing, etc. Protrusions have been formed in the past by dimpling the circuit board, however it is difficult to repeatably produce bumps or dimples having uniform size. In addition, dimpling the printed circuit board requires an extra operation in the manufacturing process and thus increases the cost of the keyboard.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a keyboard having tactile feedback using arched contacts with means for preventing asymmetrical buckling of the arched conductors when they are deflected.

According to the preferred embodiment of the present invention a keyboard of the aforementioned type is provided with a key configured to assure symmetrical buckling of the arched contact. The lower surface of the key, which deflects the arched contact, is provided with a substantially flat central portion which is in contact with the arched contact. On either side of the flat central portion there are recesses in the lower surface of the key. When the key deflects the arched contact, the contact buckles and the center contacts a conductor on the printed circuit board while the portions of the arched contact on either side of the center remain raised above the circuit board. The recessed portions in the lower surface of the key are approximately the same height above the printed circuit board as the two portions of the arched contact that remain raised when the contact has been deflected. Asymmetrical buckling occurs when one side of the arched contact starts to lay flat on the board as the strip is deflected, with the other side rising up higher above the board. This asymmetry is prevented when the higher portion of the contact comes in contact with one of the recessed portions of the key, forcing the contact back to a symmetrical configuration. Thus these recesses assure symmetrical buckling of the arched contact.

The key is also provided with an additional protrusion that contacts the circuit board to limit the deflection of the key. Limiting the deflection of the key before the flat central portion of the key has completely flattened the central portion of the arched contact reduces the stress in the arched contact and thus helps prolong the life of the arched contacts and thus the keyboard mechanism.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of a key and circuit board with arched contacts according to a preferred embodiment of the present invention.

FIG. 2 shows a cross-sectional view of a keyboard according to a preferred embodiment of the present invention.

FIG. 3 and FIG. 4 show additional cross-sectional views of the apparatus shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a circuit board 12 having a plurality of contacts thereon such as contacts 10a-10b. These contacts may be printed circuit board pads or traces that have been etched or plated and may be on one side only of circuit board 12 or may extend through to conductors on the other side of circuit board 12 via plated-through holes, for example. A plurality of arched contacts comprising arched conductive strips 14a through 14h is fastened to the circuit board 12, with one arched over each of the contacts 10. Various alternative embodiments of the arched strips and methods of mounting them to circuit board 12 are described in the aforementioned patent application, Ser. No. 173,754.

A key 16 has a key top 18 on which may be placed descriptive legends for identifying the function performed by the key and also has a pivot portion 20 for supporting the key. On the front edge of the key is a protrusion 22 which, as will later be described, limits the downward travel of the key and the bottom of the key has a protrusion 24 which interacts with arched strips 14. As shown in FIG. 2 key 16 rests on arched strip 14a when it is in its undeflected position, since the arched strip acts as a return spring as well as a contact. Key 16 has a substantially flat central portion 26 that rests on the approximate center of arched strip 14 and on either side of this central portion there are recesses 28a and 28b. When force is applied to key 16, the center of arched strip 14a is deflected toward contact 10a on circuit board 12 as shown in FIG. 3. As the arched strip is deflected, the center buckles or snaps through giving a tactile signal to the user to indicate that contact has been made. The flat central portion 26 helps accentuate the snapping acting of the arched strip since the strip is in contact with the center of portion 26 when the deflection starts and with the edges of portion 26 after the strip buckles.

Because the arched strip is longer than the portion of circuit board 12 between the points where the strip is fastened to the circuit board, some lateral portions of the arched strip must remain above the circuit board when the central portion is in contact with conductor 10a. Those lateral portions that are above the circuit
board fit into recesses 28a and 28b when the key is depressed. If these recesses are made substantially the same height as the height of lateral portions 30a and 30b of strip 14a, then the arched strip must buckle symmetrically since the recesses will constrain lateral portions 30a and 30b to be approximately the same height. If the arched strip starts to buckle asymmetrically, with lateral portion 30a rising higher than lateral portion 30b, then lateral portion 30a will be lowered in height as key 16 is pushed down toward the circuit board, forcing the strip to buckle symmetrically. By forcing the strip to buckle symmetrically, contact between the strip and conductor 10a is assured and a more repeatable tactile signal is also assured.

FIG. 4 shows a side view of the key shown in FIG. 3, illustrating how protrusion 22 limits the travel of key 16. As can be seen from FIG. 3, the separation between portion 26 of the key and conductor 10a is greater than the thickness of strip 14a when the key is depressed. Reliable contact can be made between strip 14a and conductor 10a without having strip 14a flattened completely by the key, and by maintaining the distance between portion 26 and conductor 10a greater than the thickness of strip 14a, stress levels in strip 14a can be reduced. This reduction of stress levels helps prolong the life of the strip and ultimately of the keyboard. FIG. 4 also shows a journal 32 in which pivot portion 20 rotates when the key is deflected. Journal 32 is fastened to a cover 34 which serves as the top cover of the keyboard. Circuit board 12 may be fastened to the cover by conventional means such as screws, gluing, etc. A dust cover comprising, for example, a thin plastic membrane may be provided between the keys and the arched strips 14 in order to protect the switch contacts from contamination without affecting the operation of the device described above.

We claim:

1. A key switch comprising:
   a substrate;
   a first conductor supported on a first side of the substrate;
   a second conductor supported by the substrate and symmetrically arched over the first conductor;
   a key for deflecting the second conductor into contact with the first conductor upon the application of force to the key, the lower surface of the key resting on the arched conductor when no force is being applied to the key, the lower surface of the key having a substantially flat central portion and recessed portions on either side of the central portion for preventing the second conductor from buckling asymmetrically when it is deflected by the key, the recessed portions having a depth substantially equal to the height of the buckled second conductor above the central portion when the second conductor is deflected; and
   means connected to the substrate for supporting and guiding the key.

2. A key switch as in claim 1 wherein the lower surface of the key includes a protrusion for limiting the travel of the key to a distance less than the undeflected separation of the first and second conductors.

3. A key switch as in claim 2 wherein the substrate is a printed circuit board, the first conductor is a printed circuit trace on the printed circuit board, and the second conductor is an arched conductive strip supported by and in contact printed circuit traces on the printed circuit board.

4. A key switch as in claim 1 wherein the means for supporting and guiding the key includes a journal in which the key is rotatably mounted.

* * * * *
UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,916,135
DATED : October 28, 1975
INVENTOR(S) : Thomas E. Holden and Thomas A. Hender

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

Column 2, line 28, "10a-10b" should read -- 10a-10h --;
line 59, "acting" should read -- action --;
Column 4, line 31, after "contact" insert -- with --.

Signed and Sealed this

seventeenth Day of February 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks