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(54) Title: IMPROVED TAMPER PROOF SAFETY CIRCUIT

(57) Abstract

An electronic device (100) includes electrical circuitry (130), a housing (105) in which the electronic circuitry (130) is situated, a cover (110) for enclosing the electrical circuitry (130) within the housing (105), and a tamper proof safety circuit (120) coupled to the electrical circuitry (130) for rendering the electronic device (100) inoperable when the housing (105) and cover (110) are disassembled.
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Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.
IMPROVED TAMPER PROOF SAFETY CIRCUIT

Technical Field
This invention relates in general to electronic devices, and more specifically to electronic devices that include safety circuits.

Background of the Invention
Current market demands for small, lightweight electronic devices, such as cellular telephones, have required that batteries for such devices also become smaller and lighter in weight. As a result, many battery packaging designs have incorporated the use of extremely thin packaging in the form of covers, housings, and integral cover/labels that can be removed or peeled open without difficulty. Though the packaging of a battery is sometimes destroyed upon disassembly, the battery can still remain electrically functional with its active circuitry fully exposed. This represents a significant safety risk, especially when an opened battery contains lithium cells or high energy super capacitors.

Thus, what is needed is an improved tamper proof safety circuit for use in electronic devices such as batteries.

Brief Description of the Drawings
FIG. 1 is an exploded view of an electronic device that includes a tamper proof safety circuit according to the present invention.

FIG. 2 is a top view of a flexible substrate that incorporates the tamper proof safety circuit of FIG. 1 according to the present invention.

FIG. 3 is a top view of the flexible substrate of FIG. 2 after the electronic device of FIG. 1 has been impermissibly opened.

Detailed Description of the Preferred Embodiment
While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawing figures, in which like reference numerals are carried forward.

FIG. 1 is an exploded view of an electronic device 100, such as a primary battery pack or a secondary battery pack, a cellular telephone, or a selective call receiver, that includes a tamper proof safety circuit 120
rendering the device 100 inoperable in the event of unauthorized disassembly. The electronic device 100 includes a housing 105 and a cover 110 which are held together, such as by ultrasonic welding, heat seal processes, adhesive bonding, rivets, or mechanical latches, to enclose electrical circuitry 130 of the electronic device 100. When the device 100 comprises a battery, at least one battery cell 115 is included. The electrical circuitry 130 can be coupled to the cell 115 by a flexible substrate 125 to which the circuitry 130 is mounted in a conventional manner.

According to the present invention, the tamper proof safety circuit 120, which is preferably an integral part of the flexible substrate 125, permits normal operation of the electronic device 100 as long as the cover 110 and the housing 105 remain sealed together. However, upon unauthorized removal of the cover 110 from the housing 105, the tamper proof safety circuit 120 is torn from the flexible substrate 125 to inactivate the electronic device 100. As a result, disassembly of the device 100 conveniently prevents situations in which exposed, potentially unsafe circuitry remains active, thereby minimizing the likelihood of harm to the user in the event of device tampering.

The operation of the tamper proof safety circuit 120 can be better understood by referring to FIG. 2, which is top view of the flexible substrate 125. As shown, the substrate 125 includes metallization 135 which electrically couples the circuitry 130 to the battery cell 115 (FIG. 1) via the safety circuit 120. Preferably, the safety circuit 120 includes a metallized portion 210 that extends into an area of the substrate 125 that is partially surrounded by a cutout 205 in the flexible substrate 125. In other words, portions of the flexible substrate 125 surrounding the metallized portion 210 have been removed to form a moveable flap that is connected to other regions of the substrate 125 at only a single end 220. According to the present invention, the moveable flap adheres to the cover 110 (FIG. 1) when the device 100 is assembled. This could be done, for instance, by coating a top surface of the flap with an adhesive 215 that sticks to the cover 100, by riveting the flap to the cover 100, or by providing a mechanical clasp (not shown) on the cover 100 to grasp the flap once the device 100 is assembled.

According to the present invention, unauthorized removal of the cover 110 from the housing 105 will pull up the flap of the flexible substrate 125 and rip the tamper proof safety circuit 120 from the substrate 125, as shown in FIG. 3. Once the tamper proof safety circuit 120 has been torn from
the substrate 125 by tampering, the metallized portion 210 (FIG. 2) that previously connected the battery cell 115 (FIG. 1) to the electrical circuitry 130 will no longer be present to provide the electrical connection, leaving a hole 305 torn in the flexible substrate 125. As a result, tampering advantageously renders the electronic device 100 inoperable, preventing situations in which the user could be harmed by exposed, active circuitry.

Preferably, the electronic device 100 is able to be opened by an authorized repairperson without tearing the tamper proof safety circuit 120 from the flexible substrate 125. By way of example, returning to FIG. 2, the device 100 could be opened by removing the cover 110 in the direction indicated by the arrow 230 and disengaging the flap from the cover 110. In the case where adhesive 215 is used to hold the flap to the cover 110, this could be done by inserting a device (not shown) to hold the flap down while the cover 110 is peeled from the adhesive coated flap. When other coupling devices are used, other methods, such as removal of a rivet, could be used to disengage the flap from the cover 110.

For disposable electronic devices 100 that are not intended to be repaired, a repair method may not be necessary. In this situation, cutouts could be formed in the flexible substrate 125 on both sides of the attached region 220 of the tamper proof safety circuit 120 so that removal of the cover 110 in the direction 230 also causes the tamper proof safety circuit 120 to be lifted away and torn from the substrate 125.

In summary, the electronic device described above includes a tamper proof safety circuit integrally formed into a flexible substrate of the device. The tamper proof safety circuit is formed by surrounding certain metallized portions of the electronic circuitry with cutouts in the flexible substrate to form a flap. The flap is attached to the cover of the electronic device when assembled so that, when the cover is impermissibly removed, the flap is lifted away from the flexible substrate to tear the tamper proof safety circuit from the device, rendering the device inoperable. The likelihood of harm to the user from electrically active, exposed circuitry is therefore minimized.

It will be appreciated by now that there has been provided an improved tamper proof safety circuit for electronic devices.

What is claimed is:
Claims

1. An electronic device, comprising:
   - electrical circuitry;
   - a housing in which the electrical circuitry is situated;
   - a cover for enclosing the electrical circuitry within the housing;
   - and
   - a tamper proof safety circuit coupled to the electrical circuitry for rendering the electronic device inoperable when the housing and cover are disassembled.

2. The electronic device of claim 1, further comprising a flexible substrate on which the electrical circuitry is mounted, wherein the tamper proof safety circuit is formed on the flexible substrate.

3. The electronic device of claim 2, wherein the tamper proof safety circuit comprises a metallized portion of the flexible substrate and a cutout in the flexible substrate that partially surrounds the metallized portion.

4. The electronic device of claim 3, further comprising attaching means for attaching the tamper proof safety circuit to the cover when the electronic device is assembled, wherein removal of the cover tears the tamper proof safety circuit from the flexible substrate.

5. The electronic device of claim 4, wherein the attaching means comprises an adhesive coated on a top surface of the tamper proof safety circuit.

6. The electronic device of claim 4, wherein the electronic device is a primary battery pack.

7. The electronic device of claim 4, wherein the electronic device is a secondary battery pack.

8. The electronic device of claim 4, further comprising a battery cell coupled to the electrical circuitry by the flexible substrate.
9. A battery pack, comprising:
   electrical circuitry;
   a housing in which the electrical circuitry is situated;
   a cover for enclosing the electrical circuitry within the housing;
   and
   a tamper proof safety circuit coupled to the electrical circuitry
   for rendering the battery pack inoperable when the housing and cover are
   disassembled.

10. The battery pack of claim 9, further comprising a flexible substrate
    on which the electrical circuitry is mounted, wherein the tamper proof
    safety circuit is formed on the flexible substrate.

11. The battery pack of claim 10, wherein the tamper proof safety
    circuit comprises a metallized portion of the flexible substrate and a cutout
    in the flexible substrate that partially surrounds the metallized portion.

12. The battery pack of claim 11, further comprising attaching means
    for attaching the tamper proof safety circuit to the cover when the battery
    pack is assembled, wherein removal of the cover tears the tamper proof
    safety circuit from the flexible substrate.

13. The battery pack of claim 12, wherein the attaching means
    comprises an adhesive coated on a top surface of the tamper proof safety
    circuit.

14. The battery pack of claim 12, further comprising a battery cell
    coupled to the electrical circuitry by the flexible substrate.
15. A battery pack, comprising:
   at least one battery cell;
   electrical circuitry coupled to the at least one battery cell;
   a flexible substrate on which the electrical circuitry is mounted
   and by which the electrical circuitry is coupled to the at least one battery cell;
   a housing in which the electronic circuitry, the at least one battery cell, and the flexible substrate are situated;
   a cover for enclosing the electrical circuitry, the at least one battery cell, and the flexible substrate within the housing; and
   a tamper proof safety circuit formed onto the flexible substrate
   so that unauthorized removal of the cover tears metallization from the flexible substrate to render the battery pack inoperable when the housing and cover are disassembled.

16. The battery pack of claim 15, wherein the tamper proof safety circuit comprises a metallized portion of the flexible substrate and a cutout in the flexible substrate that partially surrounds the metallized portion.

17. The battery pack of claim 16, further comprising attaching means for attaching the tamper proof safety circuit to the cover when the battery pack is assembled.

18. The battery pack of claim 17, wherein the attaching means comprises an adhesive coated on a top surface of the tamper proof safety circuit.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/13741

A. CLASSIFICATION OF SUBJECT MATTER
IPCl(6) : H02J 7/00
US CL : Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 307/150; 340/573; 439/116; 379/38, 39

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search
13 AUGUST 1998

Date of mailing of the international search report
20 OCT 1998

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Form PCT/ISA/210 (second sheet) (July 1992)*
A. CLASSIFICATION OF SUBJECT MATTER:
US CL:
307/150; 340/573; 439/116