MAGNETIC SURFACE CONTACTS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 15/181,307, filed Jun. 13, 2016, which claims priority under 35 USC 119(e) to U.S. Provisional Patent Application No. 62/235,326 filed on Sep. 30, 2015, and entitled "MAGNETIC SURFACE CONTACTS," the disclosures of which are incorporated by reference in their entirety and for all purposes.

FIELD

The described embodiments relate generally to a connector for an accessory device capable of exchanging power and data with an electronic device. In particular, the connector includes recessed contacts that are magnetically actuated by magnets associated with contacts of the electronic device.

BACKGROUND

In an effort to progressively improve the functionality of a portable electronic device, new ways of configuring an accessory device are desirable. A variety of accessory devices are available that can augment the functionality of host electronic devices such as tablet computers, smart phones, laptop computers, etc. These accessory devices often include electronic circuitry and one or more embedded batteries that power the electronic circuitry. In many such devices the batteries can be charged by connecting an appropriate cable to a charging port. Such ports and the contacts positioned therein can be susceptible to damage, etc. Consequently, an accessory device with more robust and/or protected charging contacts is desirable.

SUMMARY

This disclosure describes various embodiments that relate to a magnetic accessory connector having magnetically actuated electrical contacts.

A magnetically actuated connector is disclosed and includes a floating contact having an exterior portion formed of electrically conductive material and an interior portion including a magnet. The magnetically actuated connector also includes a flexible circuit that includes a flexible attachment feature. The flexible attachment feature is electrically coupled to the floating contact and configured to accommodate movement of the floating contact between a first position and a second position.

An accessory device is disclosed and includes the following: a device housing; and a magnetically actuated connector arranged along an exterior surface of the device housing. The magnetically actuated connector includes a floating contact having an exterior portion formed of electrically conductive material and an interior portion that includes a magnet. The magnetically actuated connector also includes a flexible circuit having a flexible attachment feature that is soldered to the floating contact and configured to accommodate movement of the floating contact between a first position and a second position.

Another accessory device is disclosed and includes the following: a device housing; and a magnetically actuated connector arranged along an exterior surface of the device housing. The magnetically actuated connector includes an electrical contact having an exterior portion formed of electrically conductive material and an interior portion that includes a magnet. The magnetically actuated connector also includes an electrically conductive pathway electrically coupling the electrical contact to circuitry of the accessory device. The electrically conductive pathway is configured to accommodate movement of the electrical contact between a first position and a second position.

Other aspects and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the described embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. **1** shows various portable electronic devices suitable for use with embodiments disclosed herein;

FIGS. **2**A-**2**B show exploded views of a connector configured to be built into an accessory device;

FIG. **3**A shows how floating contacts are assembled together from an electrical contact, a magnet and a magnetic shunt;

FIG. **3**B shows the floating contacts assembled and attachment features of a flexible printed circuit board;

FIG. **3**C shows a view of the floating contacts soldered to the solder pads arranged on attachment features of the flexible printed circuit board;

FIG. **3**D shows a cross-sectional view of a floating contact coupled with a DC shield by way of a flexible PCB in accordance with section line A-A;

FIG. **3**E shows a cross-sectional view of another floating contact coupled with a DC shield by way of a flexible PCB in accordance with section line B-B; and

FIGS. **4**A-**4**B show recessed and engaged positions of a connector;

FIGS. **5**A-**5**B show a variety of pogo pins configured to electrically couple with another electrical contact;

FIG. **6**A shows a cross-sectional side view of a pogo pin having an integrated movable magnet;

FIG. **6**B depicts a pogo pin that differs slightly from the pogo pin depicted in FIG. **6**A in that the rear housing component utilizes a press-fit feature to couple with the front housing component;

FIG. **6**C depicts how an electrical contact can be depressed slightly into the front opening of a housing component on account of a force being exerted on the electrical contact;

FIGS. **7**A-**7**B show first and second positions of an electrical connector **700** utilizing pogo pins similar to those described in FIGS. **5**A-**5**B;

FIG. **7**C shows an electrical connector utilizing magnetic pogo pins similar to the pins depicted in FIGS. **6**A-**6**C;

FIGS. **8**A-**8**B show cross-sectional views of magnetic ball style pogo pins;

FIGS. **9**A-**9**B show top views of a magnetic electrical connector;

FIGS. **9**C-**9**D show cross-sectional side views of the electrical connector depicted in FIGS. **9**A-**9**B;

FIGS. **10**A-**10**B show an alternative electrical connector design; and

FIGS. **11**A-**11**B show multiple views of another magnetic connector having a pill-shaped protrusion.