



(43) International Publication Date
5 July 2012 (05.07.2012)

(10) International Publication Number
WO 2012/091734 A1

- (51) International Patent Classification:
H05K 7/00 (2006.01)
- (21) International Application Number:
PCT/US2011/002003
- (22) International Filing Date:
23 December 2011 (23.12.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
12/930,106 27 December 2010 (27.12.2010) US
- (71) Applicant (for all designated States except US): **TELE-COMMUNICATION SYSTEMS, INC.** [US/US]; 275 West Street, Suite 400, Annapolis, MD 21401 (US).
- (72) Inventor: **TRAN, Thanh**; 19951 Mariner Avenue, Bldg. 157, Torrance, CA 90503 (US).
- (74) Agent: **BOLLMAN, William H.**; Manelli Selter PLLC, 2000 M. Street, NW, 7th Floor, Washington, DC 20036 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: RUGGED SOLID STATE HARD DRIVE WITH SILICONE GEL DAMPING

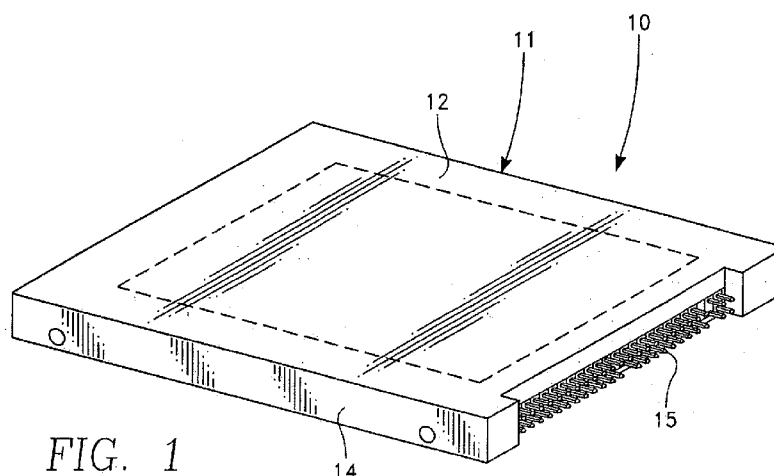


FIG. 1

(57) Abstract: A rugged hard drive includes a PC board mounted in an enclosure in a plane that is between, and parallel to two enclosure walls with the PC board being free to flex within the enclosure along an axis of the board when the hard drive is subjected to shock, or vibration, and with the enclosure including gaps, between the board and the inner surfaces of the enclosure, filled with silicone gel to cover electrical components on the board.

Rugged Solid State Hard Drive with Silicone Gel Damping

This invention comprises vibration-resistant, rugged hard drives that include a PC board (hereafter called a "PCB") mounted in an enclosure. The PCB is mounted within the enclosure in a plane that is between, and parallel to two walls of the enclosure. In some embodiments, the PCB may be mounted inside the enclosure at each end of the enclosure, leaving the PCB free to flex between these mountings. Between the PCB and each of the two walls are narrow air gaps that provide space for the PCB to move/flex when the hard drive is subjected to shock, vibration, oscillation or other periodic/apperiodic movement. The spacing between the PCB and the inner surface of the enclosure walls may be in the range of about 0.25 mm to about 2 mm. The volumes of the two gaps may be the same or different, and may be in the range of about 1.8 cubic inches to about 23 cubic inches.

To dampen the flexing of the PCB, to improve moisture protection for the PCB, and/or to improve heat conduction away from the PCB, the air gaps may be filled, wholly or partially, with a soft material such as silicone gel. Sufficient silicone gel is placed in the enclosure to cover the IC's and capacitors on the PCB.

In some embodiments, the PCB is made of FR4, and has a length, width and thickness in the ranges of about 2 inches to about 6 inches, of about 1.5 inches to about 4 inches, and of about 0.01 to about 0.12 inch, respectively. In some of these embodiments, the enclosure comprises two mating shallow halves. These halves include a substantially flat rectangular panel having four upstanding walls along each side of the panel, and attachment holes at the corners of the panel. One or both end walls of the

enclosure may include openings to receive connectors extending from the PCB.

When mounted between the halves/walls of the enclosure, the PCB may extend near to, but not into contact with the inner surfaces of the enclosure's peripheral walls. The resulting gap at the perimeter of the PCB allows silicone gel to flow from one side of the PCB to the other side inside the enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate an example, or embodiment, of a vibration-resistant, rugged hard drives that include a PC board mounted in an enclosure, and include:

Figures 1 and 2, showing top and bottom perspective views of the drive;

Figure 3 shows an exploded perspective assembly view of the drive of Figures 1 and 2;

Figure 4 shows a top plan view of the PC board in the drive of Figures 1 and 2;

Figure 5 shows a side elevation view, taken in cross-section on line 5-5 of Figure 4, of the drive shown in Figures 1 and 2; and

Figure 6 shows an exploded detail view of encircled portion 6 in Figure 5.

DETAILED DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 show top and bottom perspective views of an exemplary, vibration-resistant, rugged, solid state hard drive with silicone gel damping 10. Enclosure 11 includes top panel 12 and bottom panel 13 attached to four-sided frame 14. Electrical connectors 15 protrude from one end of frame 14.

Figure 3 shows an exploded, assembly view of drive 10. PC board 18 is placed inside enclosure 11, and is held in place by fasteners such as fasteners 16 that seat in openings 17. PC board 18 includes attached integrated circuits and/or other electronics 19. See also Figure 4. Above and below PC board 18, and inside enclosure 11 is silicone gel 20, which dampens vibrations that drive 10 may suffer. The quantity of gel may be sufficient to fill 90% or more, and sometimes 95% or more of the volume within enclosure 11.

Board 18 lies in a plane that is between, and parallel to top panel 12 and bottom panel 13, and is free to flex within enclosure 11 along an axis of board 18 when drive 10 is subjected to shock, or vibration. Enclosure 11 includes gaps, between the panels 12/13 and the inner surfaces of enclosure 11, filled with silicone gel to cover components 19 on board 18.

Figure 4 also shows top panel attachment holes 32, openings 34 for flow of silicone gel 40 from one side of PCB board 18 to the other, drive mounting holes 34, PCB board mounting holes 36, and spaces 38 through which silicone gel may flow.

Figures 5 and 6 show silicone gel 40 inside enclosure 11, and also show the flow/passage 41 of gel 40 from one side to the other of PCB board 18.

The above-described embodiment of this invention is exemplary, and is not meant to limit the scope of the claims.

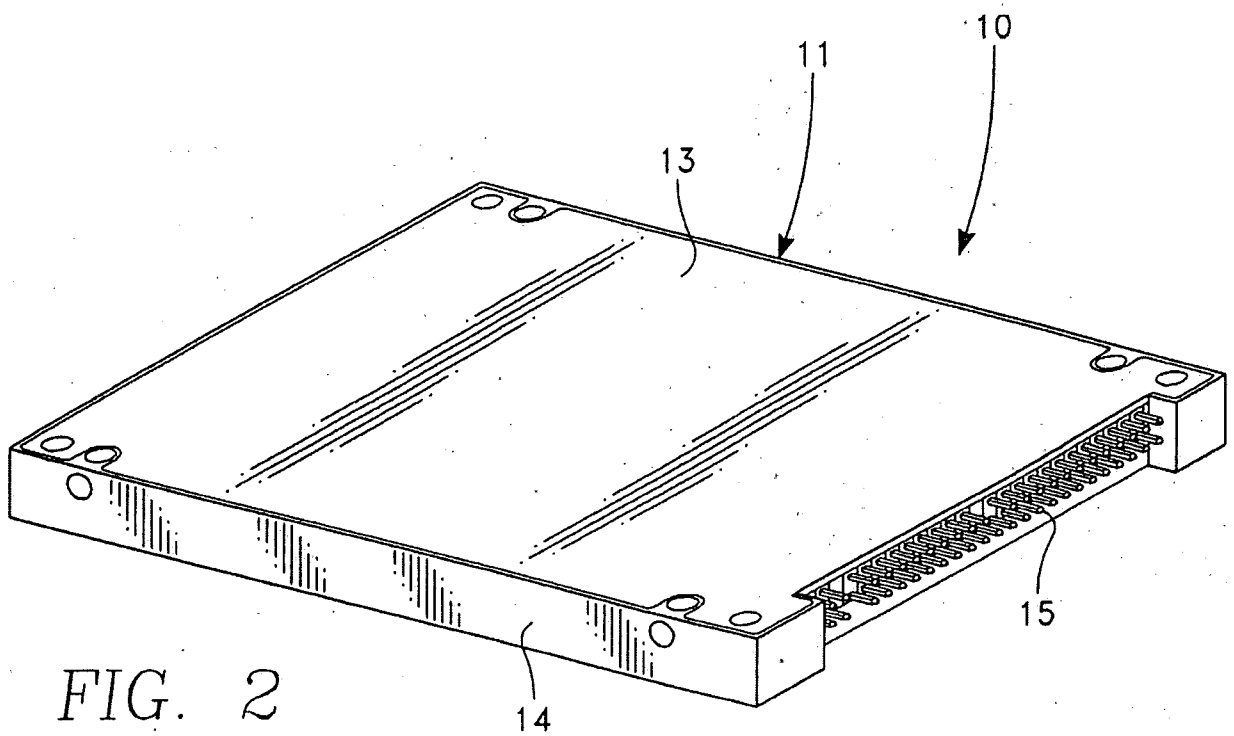
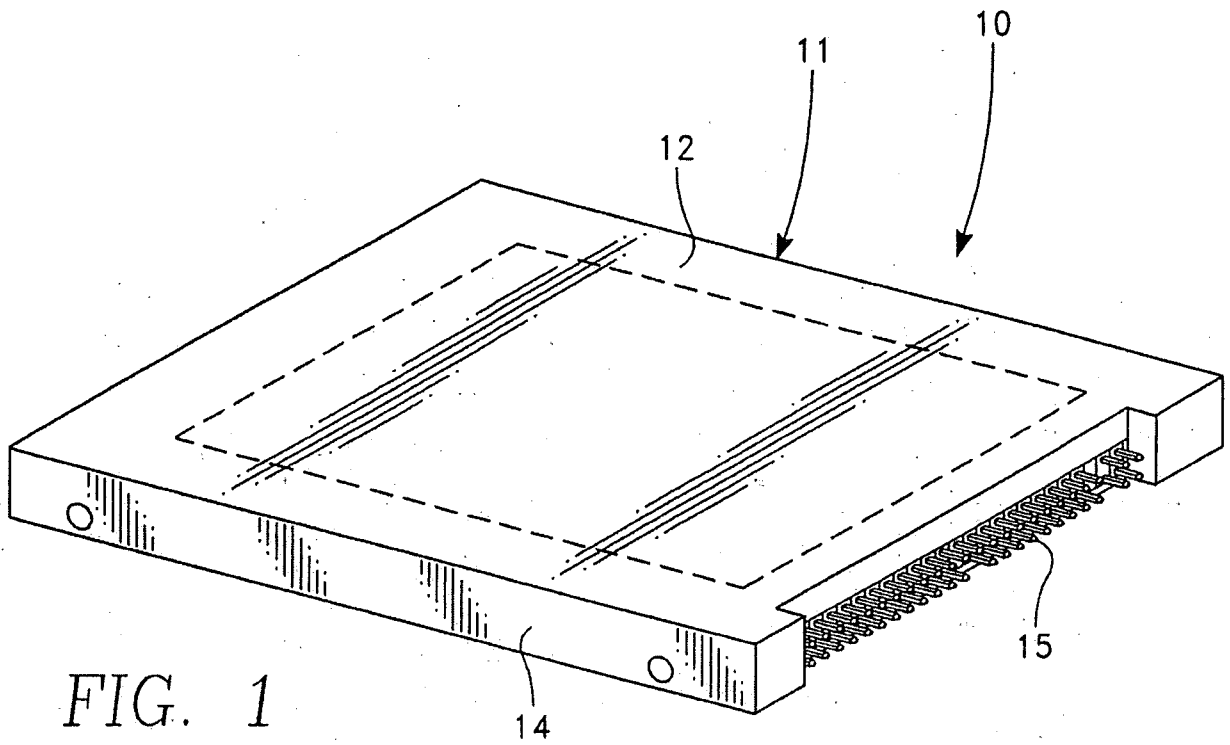
What is claimed is:

1. A rugged hard drive includes a PC board mounted in an enclosure in a plane that is between, and parallel to two walls of said enclosure, said PC board being free to flex within said enclosure along at least one axis of said PC board when said hard drive is subjected to shock, vibration, oscillation or other periodic/aperiodic movement, said enclosure including gaps between said PC board and the inner surfaces of said enclosure, said gaps including sufficient silicone gel to cover electrical components on said PC board.

2. The drive of claim 1 wherein said enclosure includes a peripheral gap between the inner surfaces of said enclosure and said PC board of sufficient size to permit said silicone gel to flow from one side of said PC board to the other side of said PC board.

3. The drive of claim 1 wherein said silicone gel occupies more than about 90% of the volume inside said enclosure.

4. The drive of claim 2 wherein said silicone gel occupies more than about 90% of the volume inside said enclosure.



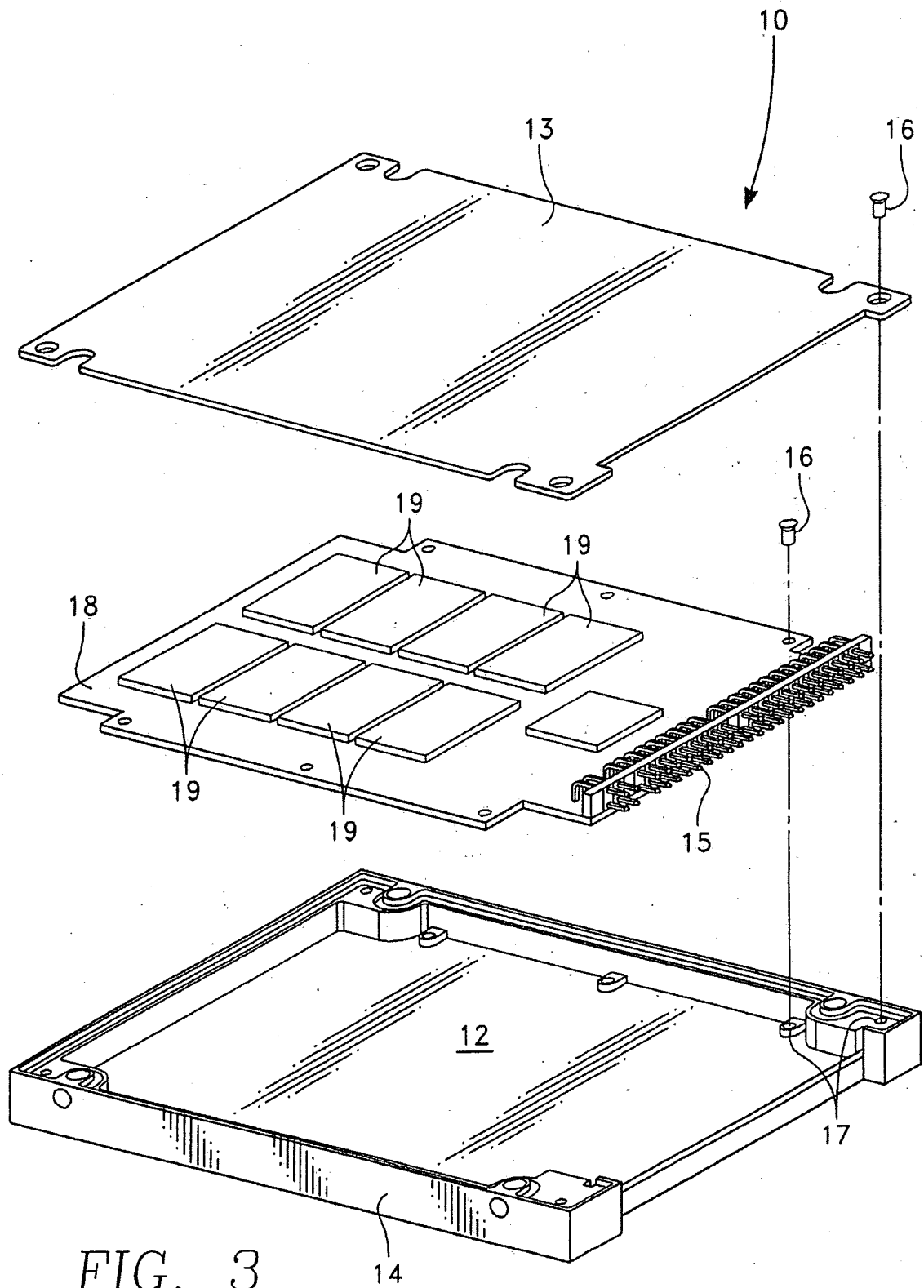
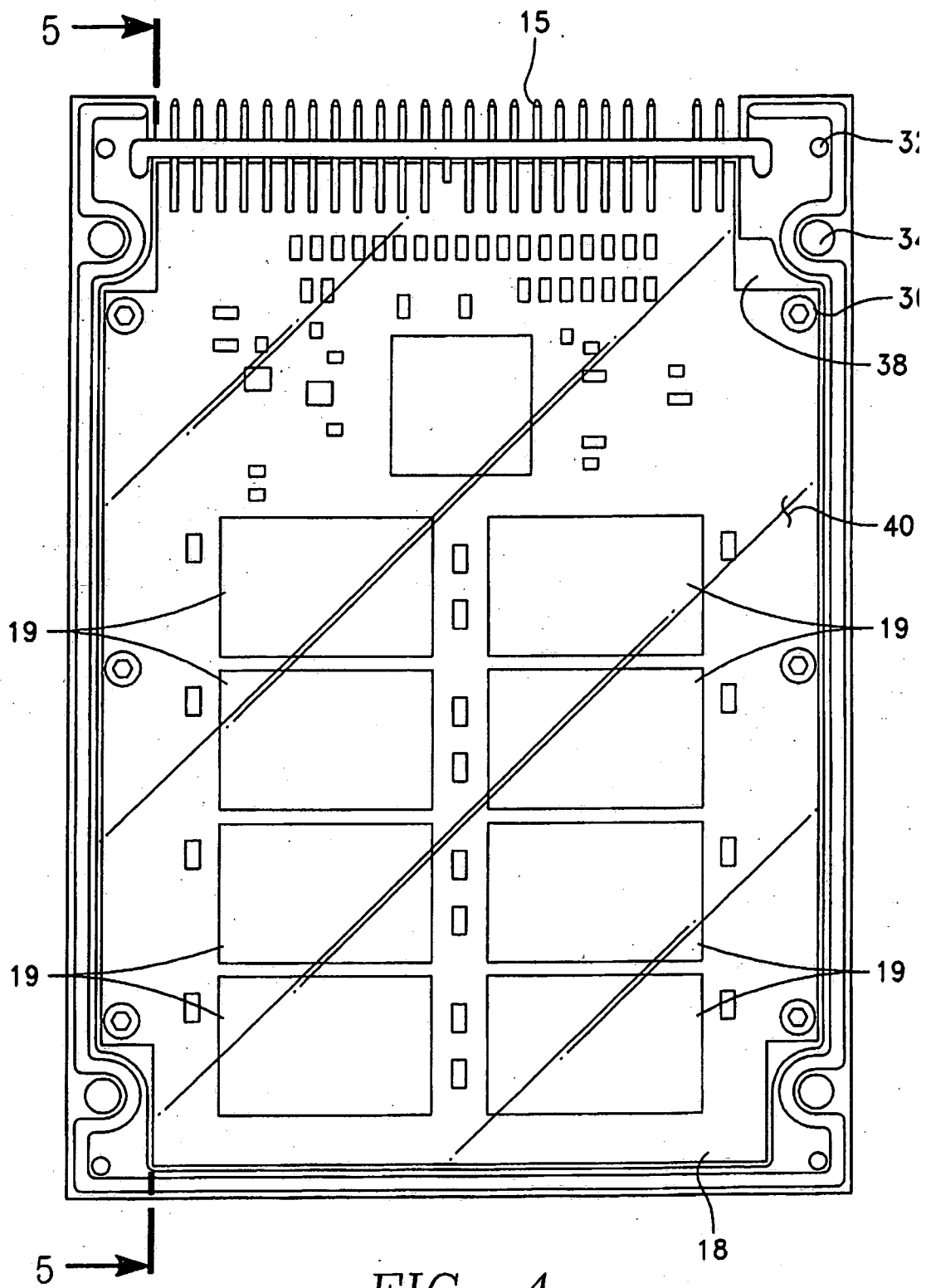
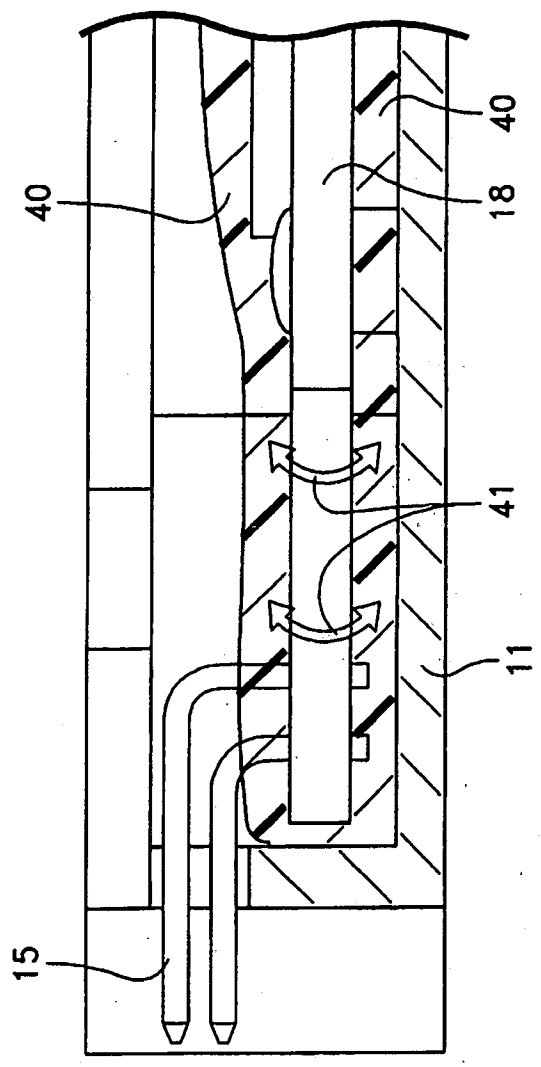
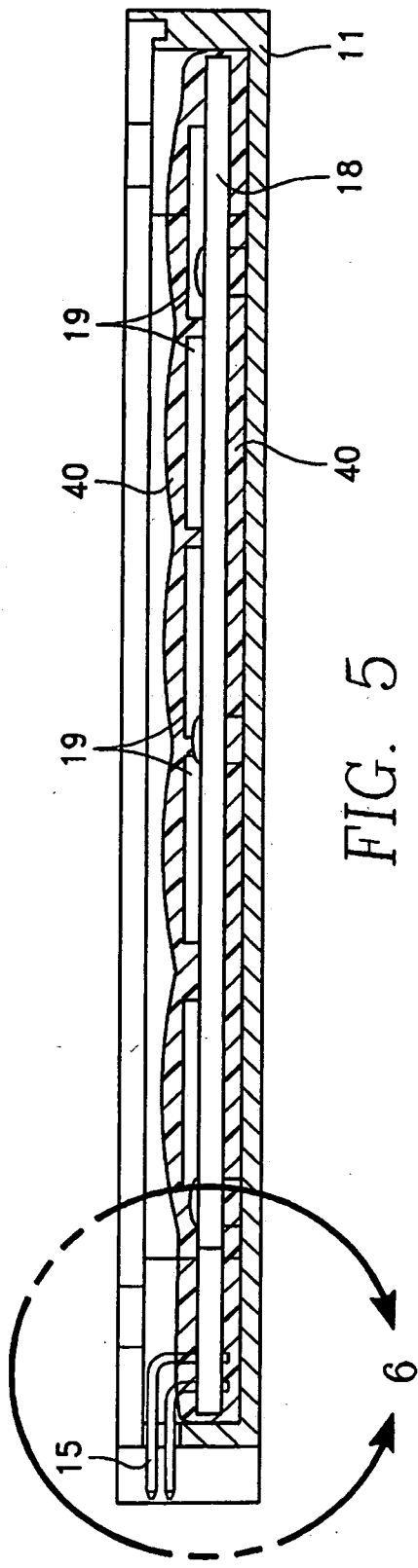


FIG. 3





INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2011/002003

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H05K 7/00 (2012.01)

USPC - 361/679.36

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)

IPC(8) - G06F 1/16, H05K 5/00, H05K 7/00 (2012.01)

USPC - 361/679.31, 361/679.34, 361/679.36

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

MicroPatent, Google Patents, and ACM

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0057849 A1 (TWOGOOD et al) 17 March 2005 (17.03.2005) entire document	1-4
Y	US 5,623,191 A (WIELOCH) 22 April 1997 (22.04.1997) entire document	1-4
Y	US 5,428,190 A (STOPPERAN) 27 June 1995 (27.06.1995) entire document	1-4
A	US 7,719,828 B2 (BROWN et al) 18 May 2010 (18.05.2010) entire document	1-4
A	US 5,430,607 A (SMITH) 04 July 1995 (04.07.1995) entire document	1-4

☐ Further documents are listed in the continuation of Box C.


* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 April 2012

Date of mailing of the international search report

01 MAY 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774