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(71) Applicant: SAE MAGNETICS (H. K.) LTD. [CN/CN]; SAE Tower, 38-42 Kwai Fung Crescent, Kwai Chung N. T., Hong Kong (CN).

(72) Inventors: TAN, Binhua; Winnerway Industrial Area, Nancheng, Dongguan, Guangdong 510000 (CN). WU, Quansheng; Winnerway Industrial Area, Nancheng, Dongguan, Guangdong 510000 (CN). LUO, Zeliang; Winnerway Industrial Area, Nancheng, Dongguan, Guangdong 510000 (CN). FU, Yu; Winnerway Industrial Area, Nancheng, Dongguan, Guangdong 510000 (CN).

(74) Agent: CHINA PATENT AGENT (H. K.) LTD.; 22/F Great Eagle Centre, 23 Harbour Road, Wanchai, Hong Kong (CN).

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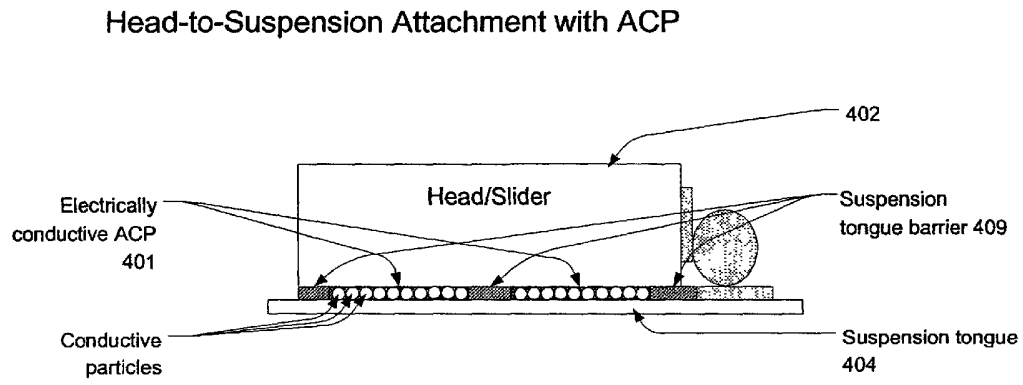
(54) Title: METHOD AND APPARATUS FOR THE PREVENTION OF ELECTROSTATIC DISCHARGE (ESD) BY A HARD DRIVE MAGNETIC HEAD INVOLVING THE UTILIZATION OF ANISOTROPIC CONDUCTIVE PASTE (ACP) IN THE SECUREMENT TO A HEAD-GIMBAL ASSEMBLY (HGA)



(57) Abstract: A system and method for the prevention of electrostatic discharge (ESD) by a hard drive magnetic head is disclosed. The magnetic head is secured to a head-gimbal assembly (HGA) by anisotropic conductive paste (ACP) to provide an improved electrostatic discharge path.

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METHOD AND APPARATUS FOR THE PREVENTION OF ELECTROSTATIC DISCHARGE (ESD) BY A HARD DRIVE MAGNETIC HEAD INVOLVING THE UTILIZATION OF ANISOTROPIC CONDUCTIVE PASTE (ACP) IN THE SECUREMENT TO A HEAD-GIMBAL ASSEMBLY (HGA)

Field of The Invention

The present invention relates to magnetic hard disk drives. More specifically, the present invention relates to a system and method for securement of a hard drive magnetic head to a head-gimbal assembly (HGA) to prevent electrostatic discharge (ESD) by the magnetic head.

Background Information

Figure 1 provides an illustration of a typical drive arm configuration as used in the art. A magnetic head 108 is utilized to read from and write to a magnetic hard disk.106. Voice-coil motors (VCM) 102 are used for controlling a hard drive's arm 104 motion across the magnetic hard disk 106.

Figure 2 provides an illustration of a head gimbal assembly (HGA) 204 and slider 202 as used in the art. Typically, a slider 202 (containing a read/write magnetic head; not shown) is utilized for maintaining a prescribed flying height above the disk surface 106 (See Figure 1). During flight over the disk, electrostatic charge accumulates on a head's surface. If the charge is not removed, an electrostatic discharge (ESD) may occur, damaging the magnetoresistive (MR) element. Electrically-conductive adhesives are used in the art to bond head to suspension, allowing static charge to be discharged from the head 202 to the suspension (HGA) 204.

As the size of slider/head elements reduces to provide for increasing areal density, the energy necessary to cause damage by an ESD reduces, causing the likelihood for ESD to increase and rendering current methods of ESD prevention obsolete. For example, electrostatic current traveling from head to suspension through electrically-conductive adhesive may experience a resistance of greater than 1000

ohms at a one-volt potential, which is too large to meet giant magnetoresistive (GMR) heads' requirements for ESD prevention.

Figure 3a-b illustrates a system for securing a head 302 to a suspension 304 (HGA) with an electrically conductive isotropic adhesive 307 as is used in the art. As seen in figure 3a, conductive isotropic adhesives 307, such as silver paste, contain conductive particles 311 (e.g., silver), which provide a pathway for electrostatic discharge from the head 302 to ground (suspension 304 / HGA).

As shown in Figure 3b, electrostatic (electrical) resistance is large for current passing through a typical isotropic adhesive 316 from head 312 to suspension 314 due to the distribution of conductive particles 320,322 within the head 312 and the isotropic adhesive 316. The head/slider 312 is typically made of Al_2O_3 319 and TiC 320 (together known as ALTIC). TiC 320 is electrically conductive, but Al_2O_3 319 is not. Silver epoxy, a typical isotropic conductive adhesive 316, is made of a binder resin 321 and silver powder 322. Silver powder 322 is electrically conductive, but binder resin is not. The internal distribution of these electrically conductive subparticles 320,322 causes the resistance problem. Although many TiC 320 particles may line up to provide an electrically conductive path toward the suspension 304, each TiC particle 320 terminating at the head 302/adhesive 306 interface has a low probability of being in physical contact with a particle of silver powder in the adhesive 306. Further, between each particle of silver 322 there is a this film of binder resin 321, which inhibits electrical current flow. Because of the small size of the silver particles 322, it can take several particles 322 to form an electrostatic discharge path, and thus, for each path there are several points in which the current must cross (highly resistive) binder resin 321, increasing the overall resistance across the isotropic adhesive.

It is therefore desirable to decrease head-to-suspension adhesive resistance to prevent electrostatic discharge (ESD) by the magnetic head as well as providing additional benefits.

Brief Description Of The Drawings

Figure 1 provides an illustration of a typical drive arm configuration as used in the art.

Figure 2 provides an illustration of a head gimbal assembly (HGA) and slider as used in the art.

Figure 3a-b illustrates a system for securing a head to a suspension with an electrically conductive isotropic adhesive as is used in the art.

Figure 4a-b provides an illustration describing the attachment of a magnetic head to a suspension with electrically conductive anisotropic conductive paste (ACP) under principles of the present invention.

Figure 5a-b illustrates ACP attachment of magnetic head to suspension with and without a suspension barrier under principles of the present invention.

Figure 6a-b illustrates the 'dual cure' process for ACP under principles of the present invention.

Detailed Description

Figure 4a-b provides an illustration describing the attachment of a magnetic head 402 to a suspension (HGA) 404 with electrically conductive anisotropic conductive paste (ACP) 401 under principles of the present invention. As is shown in figure 4a, in one embodiment a magnetic head 402 is secured to the suspension 404 by Ultraviolet ACP (ACP) 401. In an embodiment, a suspension barrier 409 is utilized to maintain proper directional orientation while the ACP is curing. The barrier 409 prevents the head 402 from tilting, etc. in relation to the suspension 404 while the adhesive 410 is still soft.

As is shown in figure 4b, in an embodiment the conductive particles 405 of the ACP 406 are much larger than the silver particles. In one embodiment, the conductive particles 405 are made of a polymer coated in gold. In an alternative embodiment, the particles 405 are made of a metal, such as nickel, etc., coated in gold. In one embodiment, the adhesive material in which the particles are suspended is Acrylate. In an alternative embodiment, the adhesive material is epoxy resin. The conductive particles 405 are large enough for each particle 405 to touch the head 402 and the suspension 404 simultaneously. Thus, the particles 405 must be at least as large in diameter as the depth of the tongue barrier 409. (See figure 4a). Because each conductive path through the ACP 406 is just through a single particle 405, resistance is greatly reduced.

Figure 5a-b illustrates ACP attachment of magnetic head 502 to suspension 504 with and without a suspension barrier 504 under principles of the present invention. In an embodiment, ACP 501 with large conductive particles 503 is utilized with a suspension barrier 509. As stated, in an embodiment the conductive particles 503 are larger than the suspension barrier 509 in depth (to enable particle 503 contact with head 502 and suspension 504 simultaneously).

As seen in figure 5b, in an alternative embodiment a suspension barrier 509 is not utilized. Because a suspension barrier is 15 to 25 micrometers (um) in depth, without a suspension barrier, the conductive particles 513 can be smaller than this when a barrier is not utilized (reduced bondline gap).

Figure 6a-b illustrates the 'dual cure' process for ACP 608 under principles of the present invention. As seen in figure 6a, in one embodiment, ultraviolet (UV) light 609 is directed upon the ACP 608 to cure the exposed surface of the ACP material 608. This is done to provide a preliminary cure, affixing the head 602 to the suspension 604, to maintain directional orientation of the head 602. In an alternate embodiment, a (non-conductive) UV adhesive (not shown), such as UV acrylate or UV epoxy, is utilized additionally for pre-tacking (to shorten the fixture time). As seen in figure 6b, in an embodiment the UV process is followed by a thermal cure (via a heater 611). In this, the ACP is fully cured, bringing its bond to full strength.

Although several embodiments are specifically illustrated and described herein, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is

1. A head system, comprising:

a head element coupled to a suspension element by an electrically conductive adhesive to prevent damage by electrostatic discharge (ESD) with said head element, wherein said adhesive is an anisotropic conductive paste (ACP).

2. The system of claim 1, wherein said head element is a hard drive magnetic head.

3. The system of claim 1, wherein said suspension element is a head-gimbal assembly (HGA).

4. The system of claim 3, wherein said suspension element is an HGA suspension tongue.

5. The system of claim 1, wherein said adhesive is a dual cure paste adhesive.

6. The system of claim 5, wherein a process for curing said adhesive includes ultraviolet (UV) treatment and thermal treatment.

7. The system of claim 6, wherein said UV treatment partially cures said adhesive to affix the head element to the suspension element in a proper location and with a proper directional orientation.

8. The system of claim 7, wherein said thermal treatment completes the adhesive cure process by strengthening said adhesive.

9. The system of claim 8, further comprising a barrier interposed between said head element and said suspension element.

10. The system of claim 9, wherein said barrier aids in sustaining said proper directional orientation of the head element with respect to the suspension element during the adhesive curing process.

11. A method for head attachment, comprising:

coupling a head element to a suspension element by an anisotropic conductive paste (ACP) to prevent damage by electrostatic discharge (ESD) with a head element.

12. The method of claim 11, wherein said head element is a hard drive magnetic head.

13. The method of claim 12, wherein said suspension element is a head-gimbal assembly (HGA).

14. The method of claim 13, wherein said suspension element is an HGA suspension tongue.

15. The method of claim 11, wherein said adhesive is a dual cure paste adhesive.

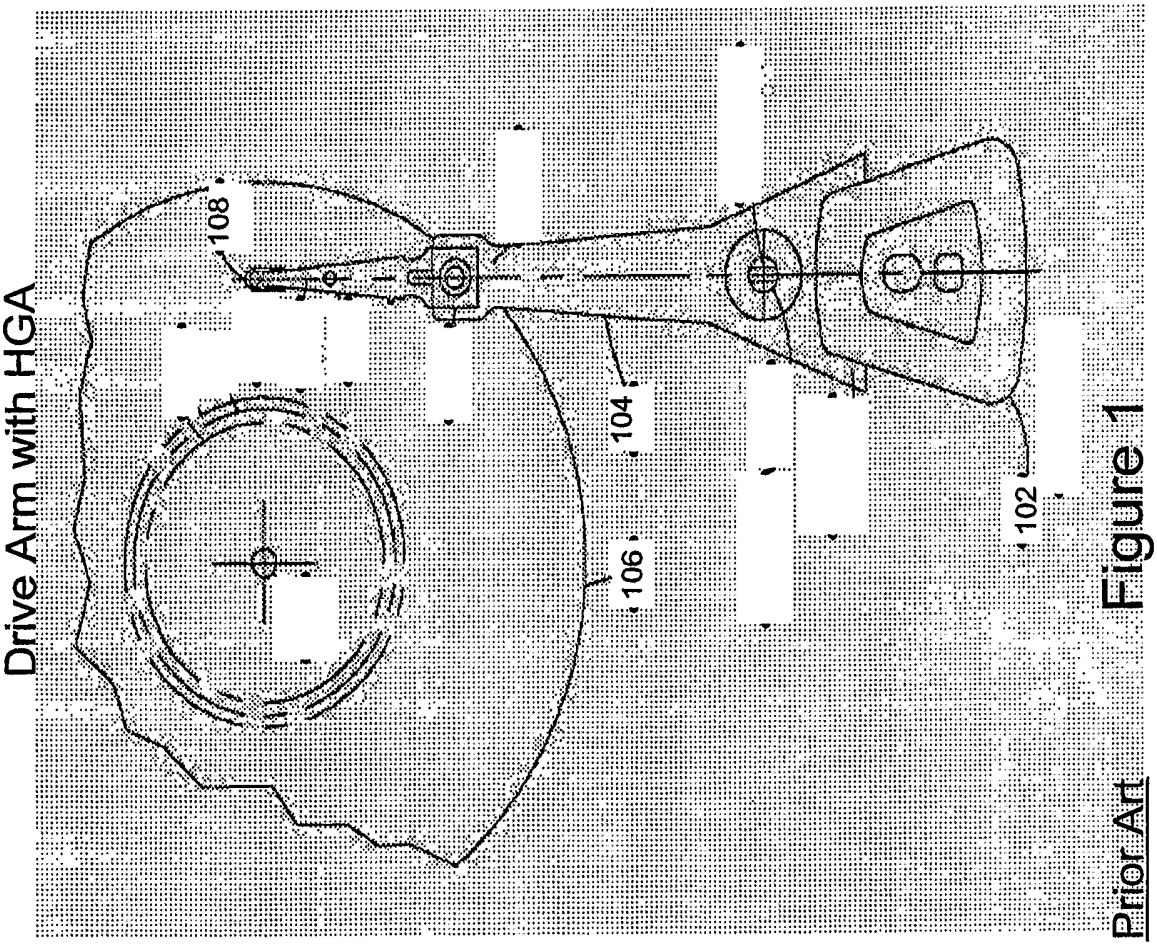
16. The method of claim 15, wherein a process for curing said adhesive includes ultraviolet (UV) treatment and thermal treatment.

17. The method of claim 16, wherein said UV treatment cures an exposed area of said adhesive to affix the head element to the suspension element in a proper location and with a proper directional orientation.

18. The method of claim 17, wherein said thermal treatment completes the adhesive cure process by strengthening said adhesive.

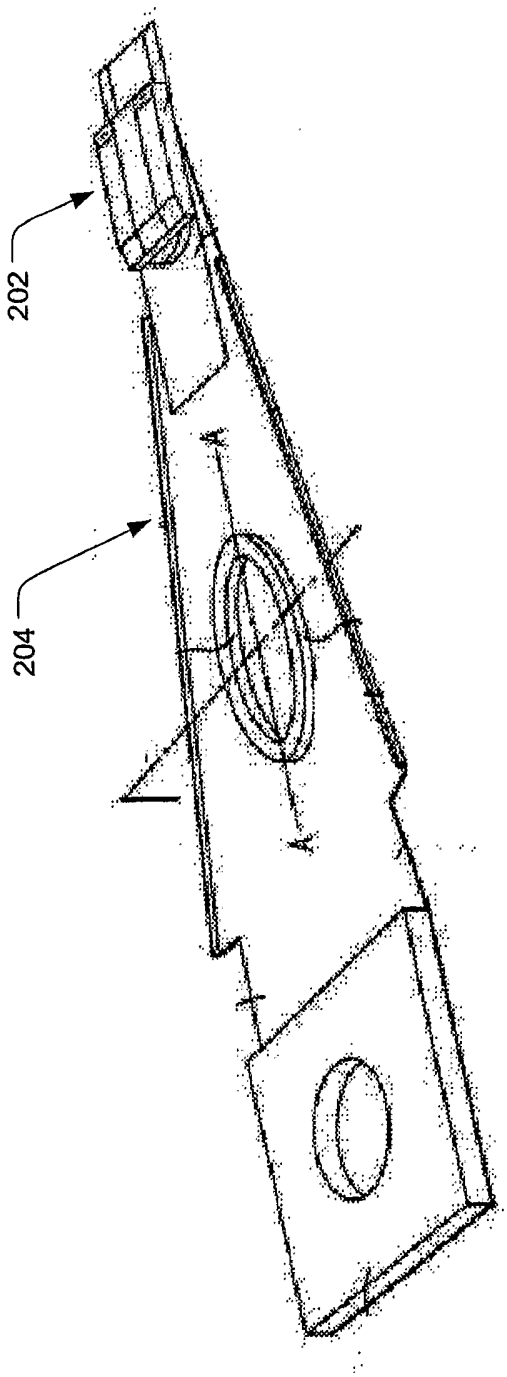
19. The method of claim 18, further comprising interposing a barrier between said head element and said suspension element.

20. The method of claim 19, wherein said barrier aids in sustaining said proper directional orientation of the head element with respect to the suspension element during the adhesive curing process.



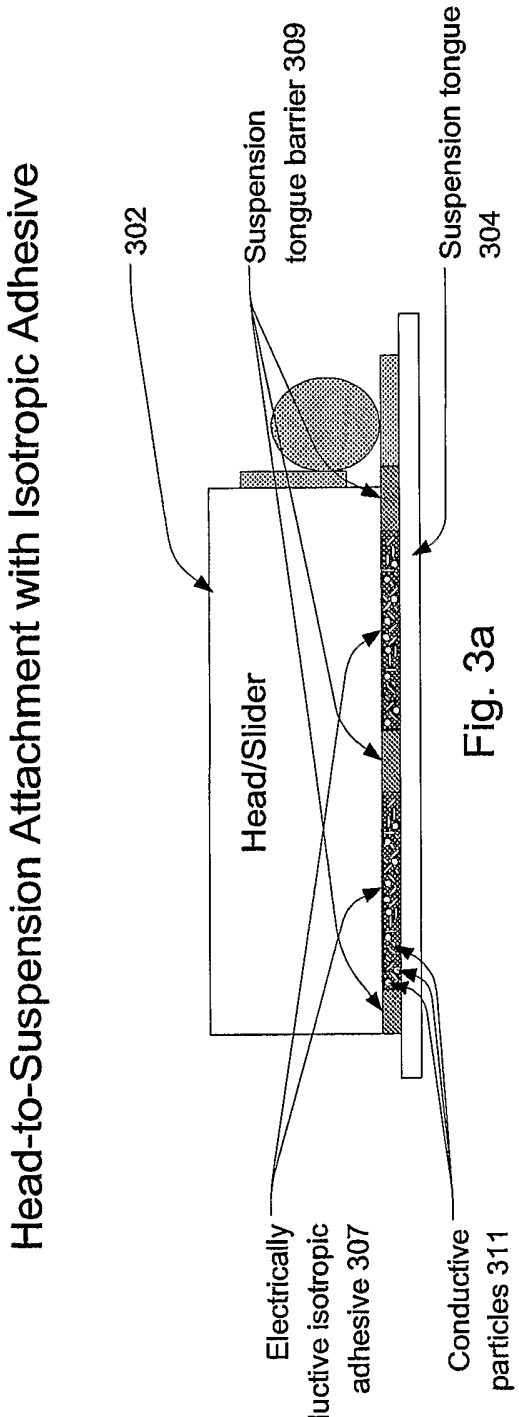
Prior Art Figure 1

HGA with Slider



Prior Art

Figure 2



PRIOR ART

Figure 3a-b

Head-to-Suspension Attachment with ACP

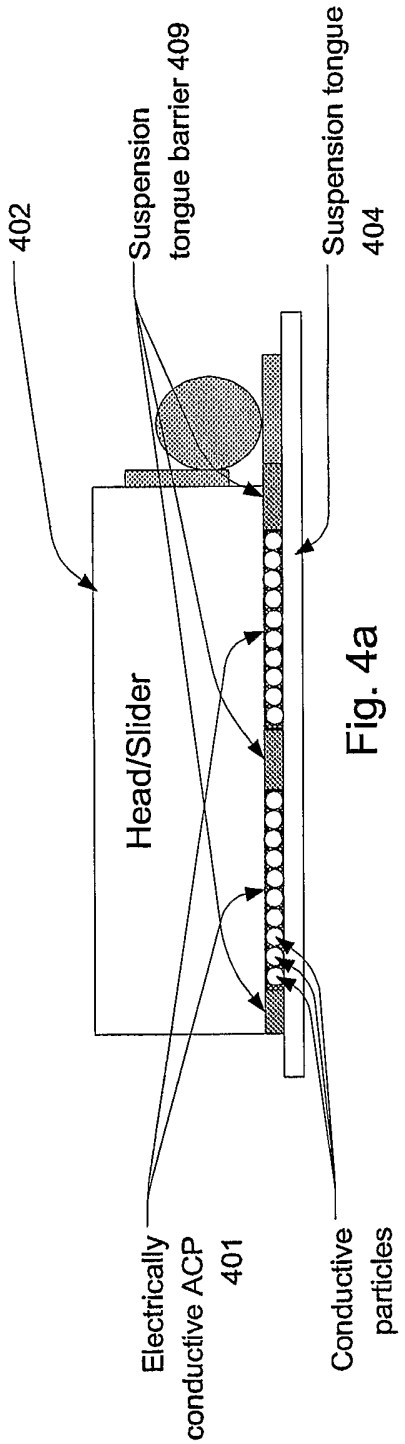


Fig. 4a

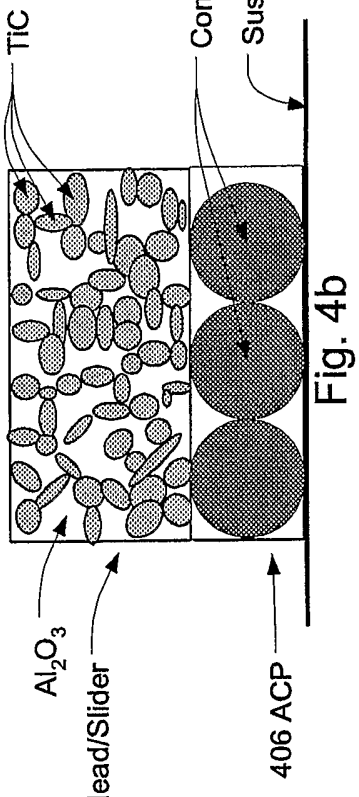


Fig. 4b

Figure 4a-b

Head-to-Suspension Attachment with and without Barrier

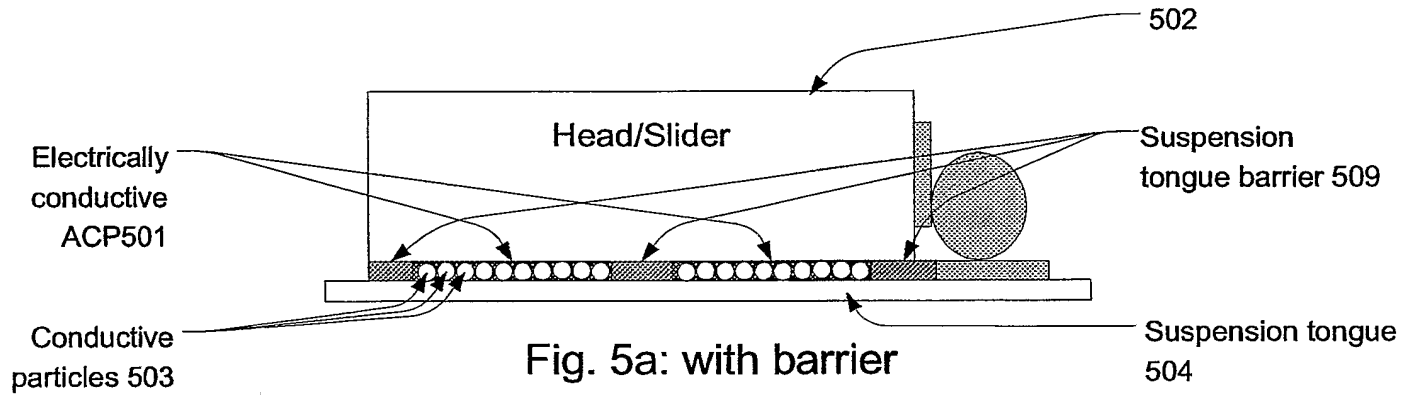


Fig. 5a: with barrier

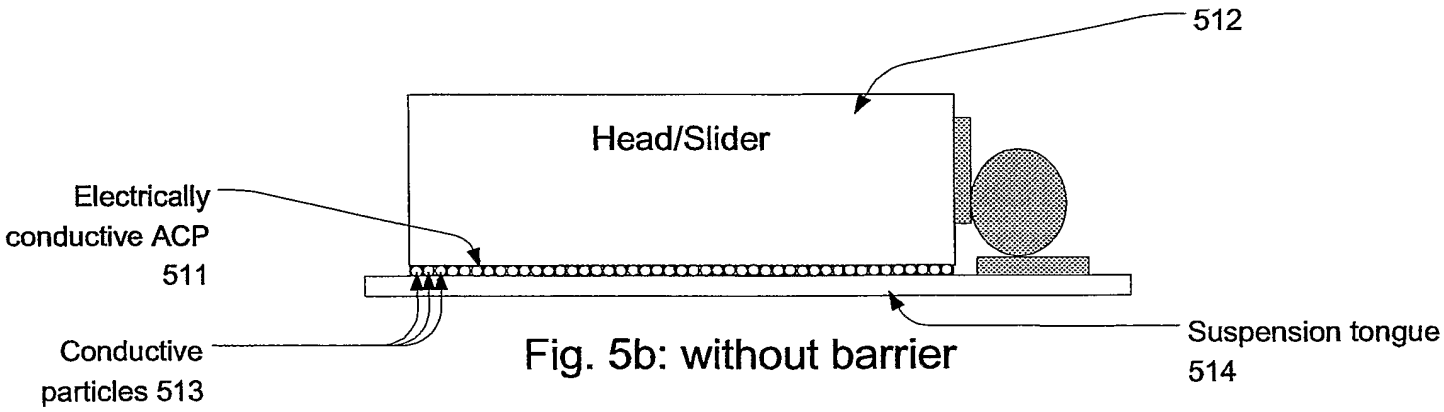


Fig. 5b: without barrier

Figure 5a-b

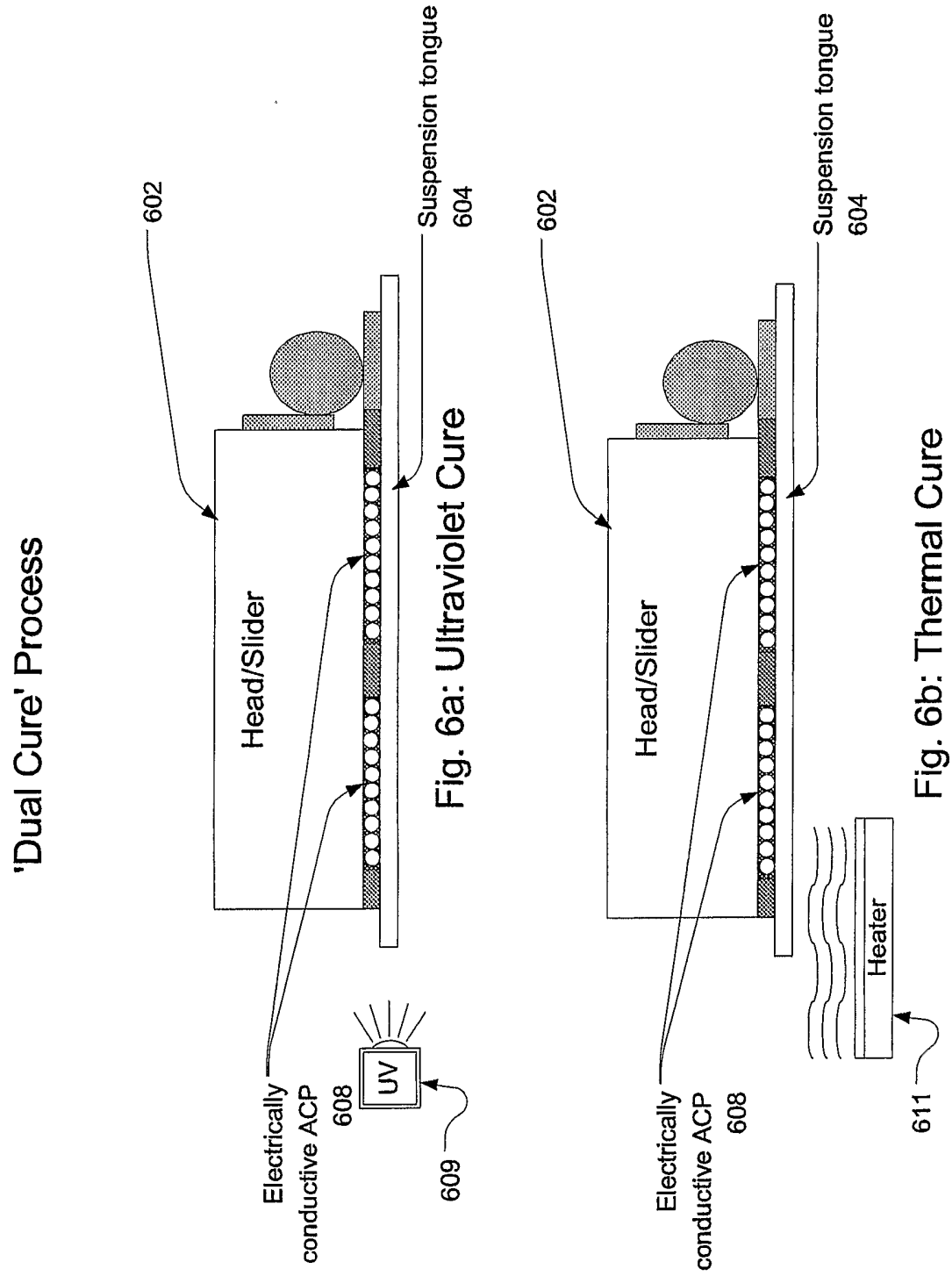

'Dual Cure' Process
602
Head/Slider
Suspension tongue
604
Electrically
conductive ACP
608
UV
609
Fig. 6a: Ultraviolet Cure
602
Head/Slider
Suspension tongue
604
Electrically
conductive ACP
608
Heater
611
Fig. 6b: Thermal Cure

Figure 6a-b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN02/00042

A. CLASSIFICATION OF SUBJECT MATTER

IPC [7] G11B5/40

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 [7] G11B

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

CN

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US-A-6034851(Read Rite Corp) 07.Mar.2000 (07.03.2000) See the whole document	1-20
A	US-A-5654850(Applied Magnetics Corp)05.Aug.1997 (05.08.1997) See the whole document	1-20

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

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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/CN 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, 100088, China Facsimile No. 86-10-62019451	Authorized officer ZHANG, Jing 张景之 Telephone No. 86-10-62093810

INTERNATIONAL SEARCH REPORT Information on patent family members			International application No. PCT/CN02/00042
Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-6034851	07.Mar.2000	None	
US-A-5654850	05. Agu.1997	US-A-5336550 US-A-5939133	09.Agu.1994 17.Aug.1999

Form PCT/ISA /210 (patent family annex) (July 1998)