



(51) International Patent Classification:  
**H01L 23/367** (2006.01) **G06F 1/20** (2006.01)  
**H05K 7/20** (2006.01)

(21) International Application Number:  
PCT/CN2008/072288

(22) International Filing Date:  
8 September 2008 (08.09.2008)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): **ABB TECHNOLOGY LTD** [CH/CH]; Affolternstrasse 44, Zurich, CH-8050 (CH).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **TU, Zhanwei** [CN/CN]; No. 215, Unit 808, Qianpu Bei District 2 Li, Xiamen, Fujian 361000 (CN). **HU, Biao** [CN/CN]; Cheng Xi Village, Group 5, Fucheng Township, Funing County,

Yancheng, Jiangsu 224400 (CN). **LI, Chun** [CN/CN]; Unit 2-803, Building 1, Compound 8, Ming Tian Di Yi Cheng, No. 8 Liqing Road, Chaoyang District, Beijing 100107 (CN). **ZHU, Kuikui** [CN/CN]; Unit C6-2501, Qingqing Jia Yuan, Bujie Township, Shenzhen, Guangdong 518000 (CN).

(74) Agent: **UNITALEN ATTORNEYS AT LAW**; 7th Floor, Scitech Place, No.22, Jian Guo Men Wai Ave., Chao Yang District, Beijing 100004 (CN).

(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, 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, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[Continued on next page]

(54) Title: HEAT SINK

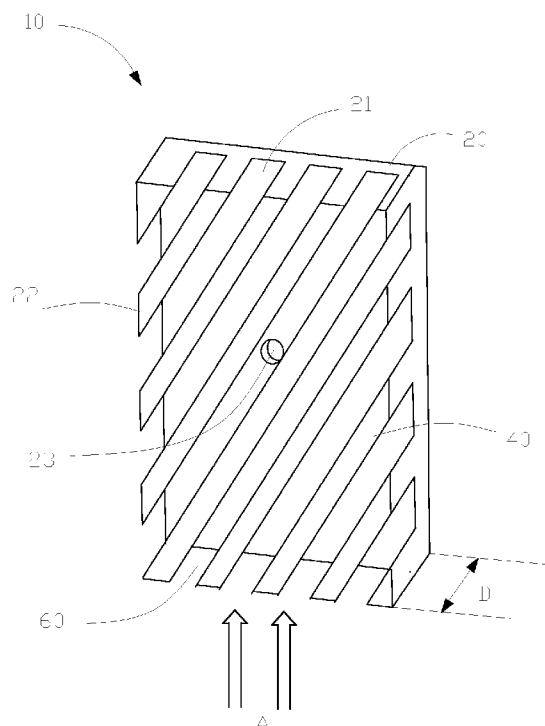


Fig. 1

(57) Abstract: A heat sink (10, 100) for dissipating heat from an electrical device comprises a base (20) having a generally flat top surface (21); a plurality of fins (40, 400) arranged on the top surface (21) of the base (20) such that a running direction of the fins (40, 400) is oblique to an in-flow (A) of heat flow; and a plurality of channels (60) defined between each two adjacent fins (40, 400).



**(84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, 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))*

## HEAT SINK

### FIELD OF THE INVENTION

[0001] The present invention relates to a heat sink for dissipating heat from an electrical device, such as a switch gear, a circuit breaker and a transform.

5

### BACKGROUND OF THE INVENTION

[0002] Electronic devices such as switchgears, circuit breakers and transforms often generate a large quantity of heat during the operation thereof. If the heat is not properly dissipated, the efficiency of the electronic devices will be lowered and the devices may be burned out. Therefore, a heat sink has become an indispensable part of modern electronic devices. Also, how to provide a high efficiency heat sink is always a hot topic in the field of electronic industry.

10

[0003] Various heat sinks for dissipating the heat generated by the electronic devices have been proposed and examples can be found in U.S. Patent publication No. US2004141290 and U.S. Patent publication No. 2008144279. In U.S. Patent publication No. US2004141290, the heat sink includes a base and a plurality of fins provided on the surface of the base in parallel to each other, and a protrusion is provided on the surface of the base to dissipate more heat without increasing the height of the heat sink. In U.S. Patent publication No. 2008144279, the heat sink includes a base including a first base end face, a second base end face and a plurality of fins arranged on a surface of the base in parallel to each other, and distal ends of the fins are arranged on the surface of the base so that the distal ends of the fins outside a central area of the first base end face are located further from the first base end face than the distal ends of the fins located in the central area of the first base end face. With such configuration as described in U.S. Patent publication No. 2008144279, the velocity of air between fins is uniformed and thus heat dissipation performance can be improved.

15

20

25

### SUMMARY OF THE INVENTION

[0004] An object of the present invention is to provide a heat sink capable of efficiently dissipating heat from an electrical device.

[0005] According to an aspect of the present invention, a heat sink for dissipating heat from an electrical device includes a base having a generally flat top surface; a plurality of fins arranged on the top surface of the base such that a running direction of the fins is oblique to an in-flow direction of heat flow; and a plurality of channels defined between each two adjacent fins.

[0006] Further, the plurality of fins includes one set of fins in which all fins are oblique in a same direction with respect to the in-flow direction of heat flow .

[0007] Further, the plurality of fins includes a first set of fins and a second set of fins arranged on the top surface of the base side by side, and the fins in the first set of fins and the fins in the second set of fins extend vector components in opposite directions with respect to the in-flow direction of heat flow to form a plurality of pairs of inverted “V” shaped fins.

[0008] Further, the height of a portion of the base on which one single set of fins are arranged to be about 1.5 to 2.5 times of the width of that portion.

[0009] Further, the width of each channel in a direction perpendicular to a running direction of the channel is configured to be about 1.0 to 2.0 times of the thickness of each fin in a direction perpendicular to the running direction of the fins.

[0010] Further, the oblique angle at which the fins are oblique with respect to the in-flow direction of heat flow is in a range of  $30^{\circ}$  to  $45^{\circ}$  .

[0011] Further, the oblique angle at which the fins in the first set of fins are oblique with respect to the in-flow direction of heat flow is in a range of  $30^{\circ}$  to  $45^{\circ}$  , and the oblique angle at which the fins in the second set of fins are oblique with respect to the in-flow direction of heat flow is in a range of  $-30^{\circ}$  to  $-45^{\circ}$  .

[0012] According to the aspects of this invention, since the fins are oblique, the surface area of the fins, i.e., the area of dissipation, is larger than that in the case that the fins are parallel to the in-flow direction of heat flow and thus the heat transfer efficiency can be improved. Furthermore, with the oblique fins, when air flow through the channels, the thermodynamic effect can be improved and more efficient dissipation of the heat can be achieved. In particularly, in the case of the inverted “V” shaped fins, a convergent heat flow will be produced and thus a divergent heat flow can be creating such that the thermodynamic effect can be further improved and higher heat efficiency can be obtained.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The illustrated Figures are used to further explain the present invention and constitute a part of the application, and the schematic embodiments and the description thereof are used to construct the present invention and do not constitute the limit to the present invention. In the Figures:

[0014] Figure 1 is a perspective view of a heat sink according to an embodiment of the present invention;

[0015] Figures 2 is a plan view of the heat sink according the embodiment of the present invention;

[0016] Figures 3 is a perspective view of a heat sink according to another embodiment of the present invention; and

[0017] Figures 4 is a plan view of the heat sink according to another embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

[0018] The embodiments of the present invention will be explained in conjunction with accompanying figures in detailed.

[0019] Figures 1 and 2 show an embodiment of a heat sink 10 for dissipating heat from an electrical device of the present invention. Figure 1 is a perspective view of the heat sink 10 according to the embodiment. Figure 2 is a plan view of the heat sink 10 of according to the embodiment.

[0020] As shown in Figures 1 and 2, the heat sink 10 for dissipating heat from an electrical device such as a switch gear, a circuit breaker or a transformer (not shown) includes a base 20 having a generally flat top surface 21 and a lateral side 22, a plurality of fins 40 arranged on the top surface 21 of the base 20 such that a running direction of the fins 40 is oblique to an in-flow direction A of heat flow. , and a plurality of channels 60 defined between each two adjacent fins 40. The in-flow direction A is a direction in which the heat flow outside of the heat sink 10 flow in the channels 60 at the inlets 61

of the channels 60, which can be determined by a convectional heat flow or a forced heat flow forced by a fan (not shown). In the case that the heat sink is in a vertical state, the convectional heat flow is always vertically directed. In the case that the heat flow is forced by the fan, the forced heat flow can be directed in any direction depending on the arrangement of the fan. For example, in this embodiment, the in-flow direction A is a vertically downward direction forced by the fan and therefore the plurality of fins 40 arranged on the top surface 21 of the base 20 in such a matter as to be oblique also with respect to the lateral side 22 of the heat sink 10.

[0021] In this embodiment, the base 20 has a substantially rectangular shape. At least one hole 23 (in this embodiment, one) is provided in the base 20 so as to assemble the heat sink 10 on the electrical device. For example, the heat sink 10 is assembled on the electrical device by using screws (not shown) through the hole 23 of the base 20 and holes (not shown) provided in the electrical device. Although in this embodiment the base is substantially rectangular shape and the heat sink is attached to the electrical device by screws, it would of course be possible to adapt any other suitable shape base and any other suitable attaching method as desired.

[0022] The plurality of fins 40 form one set of fins in which all fins are oblique in a same direction with respect to the in-flow direction A of heat flow in particular to the lateral side 22. In view of air flow, it is advantageous to arrange the fins to be parallel to each other. For the purpose of efficiently dissipating heat, it is advantageous to design the dimensions of the base 20, the fins 40 and the channel 60 in the following manner. For the sake of convenient, in this embodiment, the up-down direction in the paper which is here also the direction along the lateral side 22 is defined as the height direction of the base 20. The left-right direction in the paper which is in this embodiment also the direction along the side of the base 20 perpendicular to the lateral side 22 is defined as the width direction of the base 20. The height H of a portion of the base 20 on which the fins 40 are arranged are about 1.5 to 2.5 times of the width W of that portion. The width S of each channel 60 in a direction perpendicular to a running direction of the channel 60 is configured to be about 1.0 to 2.0 times of the thickness T of each fin 40 in a direction perpendicular to the running direction of the fins 40. The oblique angle  $\alpha$  at which the fins are oblique with respect to the in-flow direction A of heat flow or the lateral side 22 is in a range of  $30^\circ$  to  $45^\circ$ .

[0023] Figures 3 and 4 show another embodiment of a heat sink 100 for dissipating

heat from an electrical device of the present invention. Figure 3 is a perspective view of the heat sink 100 of the embodiment. Figure 4 is a plan view of the heat sink 100 of the embodiment. For the sake of clarity, in Figures 3 and 4, the same members as those in the embodiment described above are denoted by the same reference numerals, and description thereof is omitted.

[0024] As shown in Figures 3 and 4, the heat sink 100 includes a plurality of fins 400 consisting of two sets of fins, i.e., the first set of fins 410 and the second set of fins 420. Specifically, the first set of fins 410 and the second set of fins 420 are arranged on the top surface 21 of the base 20 side by side and the fins in the first set of fins 410 and the fins in the second set of fins 420 extend vector components in opposite directions with respect to the in-flow direction A of heat flow to form a plurality of pairs of inverted “V” shaped fins or a plurality of pairs of inverted “V” shaped channels.

[0025] In view of air flow, it is advantageous to arrange the fins in one and the same set of fins to be parallel to each other. For the purpose of efficiently dissipating heat, it is advantageous to design the dimensions of the base 20, the fins 400 and the channel 60 in the following manner. For the sake of convenient, in this embodiment, the up-down direction in the paper which is in that embodiment parallel to the direction along the lateral side 22 is defined as the height direction of the base 20. The left-right direction which is in that embodiment parallel to the direction along the side of the base 20 perpendicular to the lateral side 22 is defined as the width direction of the base 20. The height H of a portion of the base 20 on which a single set of fins 410, 420 are arranged are about 1.5 to 2.5 times of the width W of that portion. The width S of each channel 60 in a direction perpendicular to a running direction of the channel 60 is configured to be about 1.0 to 2.0 times of the thickness T of each fin in a direction perpendicular to the running direction of the fins. The oblique angle  $\alpha$  at which the first set of fins 410 are oblique with respect to the in-flow direction A of heat flow or in this embodiment also with respect to the lateral side 22 is in a range of  $30^{\circ}$  to  $45^{\circ}$ . The oblique angle  $\beta$  at which the second set of fins 420 are oblique with respect to the in-flow direction A of heat flow or in this embodiment also with respect to the lateral side 22 is in a range of  $-30^{\circ}$  to  $-45^{\circ}$ .

[0026] In use, the heat sink 10, 100 is attached to the electrical product, e.g., by using screws through the holes 23 of the base 20 and holes (not shown) provided in the electrical device. The air flows through the channels 60. Since the fins 40, 400 are

oblique, the surface area of the fins, i.e., the area of dissipation, is larger than that in the case that the fins are parallel to the in-flow direction A of heat flow and thus the heat transfer efficiency can be improved. Furthermore, with the oblique fins, when air flows through the channels 60, the thermodynamic effect can be improved and more efficient dissipation of the heat can be achieved. In particularly, in the case of the inverted “V” shaped fins, a convergent heat flow will be produced and thus a divergent heat flow can be creating such that the thermodynamic effect can be further improved and high heat transfer efficiency can be obtained.

[0027] The above-discussed embodiments are only used to explain and describe the principle of the present invention. It can be appreciated that the present invention is not limited to the described embodiments. For those skilled in the art, various modifications and variations may be made without departing from the spirit and scope of the present invention. For example, three or more sets of fins with oblique fins may be arranged on the base. These modification and variation will be covered within the protection scope of the present invention. Therefore, the protection scope of the present invention will be defined by the claims.

## CLAIMS

What is claimed is:

1. A heat sink (10, 100) for dissipating heat from an electrical device comprising:

5 a base (20) having a generally flat top surface (21);

a plurality of fins (40, 400) arranged on the top surface (21) of the base (20) such that a running direction of the fins (40, 400) is oblique to an in-flow direction (A) of heat flow; and a plurality of channels (60) defined between each two adjacent fins (40, 400).

10 2. The heat sink according to Claim 1, wherein the plurality of fins (40) comprise one set of fins in which all fins are oblique in a same direction with respect to the in-flow direction (A) of heat flow.

3. The heat sink according to Claim 1, wherein the plurality of fins (400) comprise a first set of fins (410) and a second set of fins (420) arranged on the top surface (21) of the base (20) side by side, the fins in the first set of fins (410) and the fins in the second set of fins (420) extend vector components in opposite directions with respect to the in-flow direction (A) of heat flow to form a plurality of pairs of inverted “V” shaped fins.

4. The heat sink according to any one of Claims 1 to 3, wherein the height (H) of a portion of the base (20) on which one single set of fins (40, 410, 420) are arranged to be about 1.5 to 2.5 times of the width (W) of that portion.

5. The heat sink according to any one of Claims 1 to 3, wherein the width (S) of each channel (60) in a direction perpendicular to a running direction of the channel (60) is configured to be about 1.0 to 2.0 times of the thickness (T) of each fin (40) in a direction perpendicular to the running direction of the fins (40, 400).

6. The heat sink according to Claims 1 or 2, wherein the oblique angle ( $\alpha$ ) at which the fins (40) are oblique with respect to the in-flow direction (A) of heat flow is in a range of  $30^\circ$  to  $45^\circ$ .

7. The heat sink according to Claims 1 or 3, wherein the oblique angle ( $\alpha$ ) at which the fins in the first set of fins (410) are oblique with respect to the in-flow direction (A) of heat flow is in a range of  $30^\circ$  to  $45^\circ$ , and the oblique angle ( $\beta$ ) at which the fins in

the second set of fins (420) are oblique with respect to the in-flow direction (A) of heat flow is in a range of  $-30^{\circ}$  to  $-45^{\circ}$  .

8. The heat sink according to any one of Claims 1 to 3, wherein the base (20) has a substantially rectangular shape.

5 9. The heat sink according to any one of Claims 1 to 3, wherein at least one hole (23) is provided in the base (20) for assembling the heat sink (10) on the electrical device.

10. The heat sink according to any one of Claims 1 to 3, wherein the fins in each set of fins (40, 410, 420) are parallel to each other.

10 11. The heat sink according to any one of the preceding Claims, wherein the heat sink comprises a lateral side (22);

a plurality of fins (40, 400) arranged on the top surface (21) of the base (20) such that a running direction of the fins (40, 400) is oblique to the lateral side (22).

15 12. The heat sink according to Claim 11, wherein the direction along the lateral side (22) is defined as the height direction of the base (20) and the direction along the side of the base (20) perpendicular to the lateral side (22) is defined as the width direction of the base (20), the height (H) of a portion of the base (20) on which the set of fins (40, 410, 420) are arranged to be about 1.5 to 2.5 times of the width (W) of that portion.

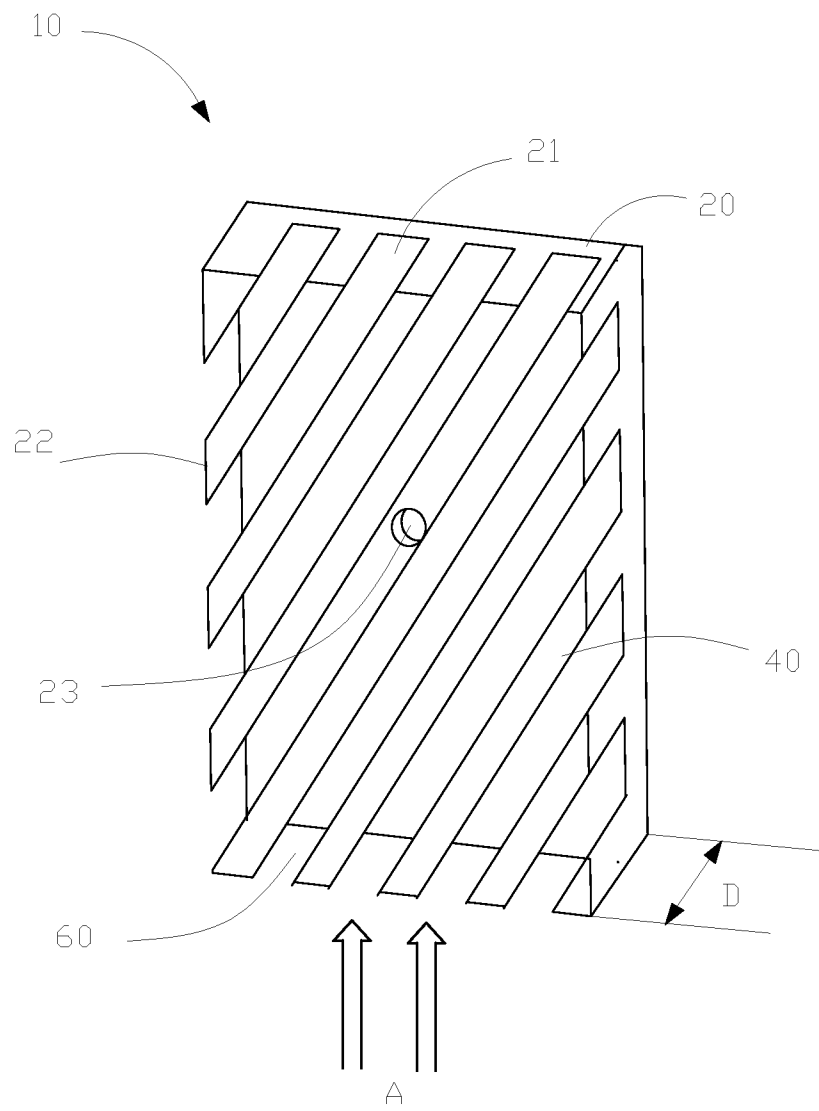


Fig. 1

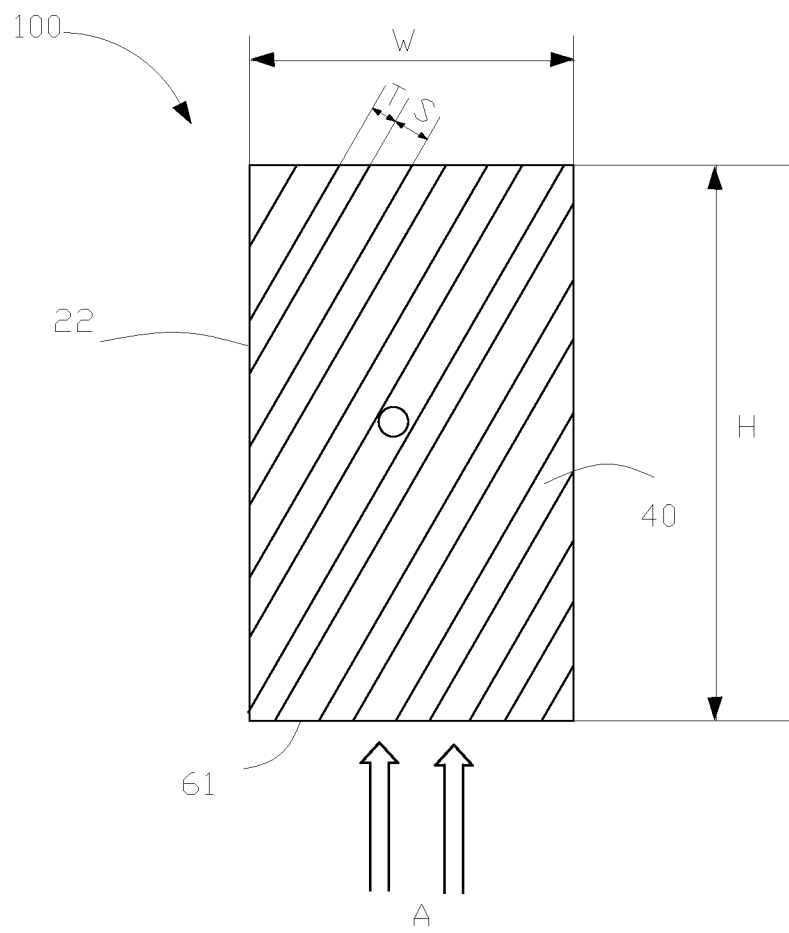


Fig. 2

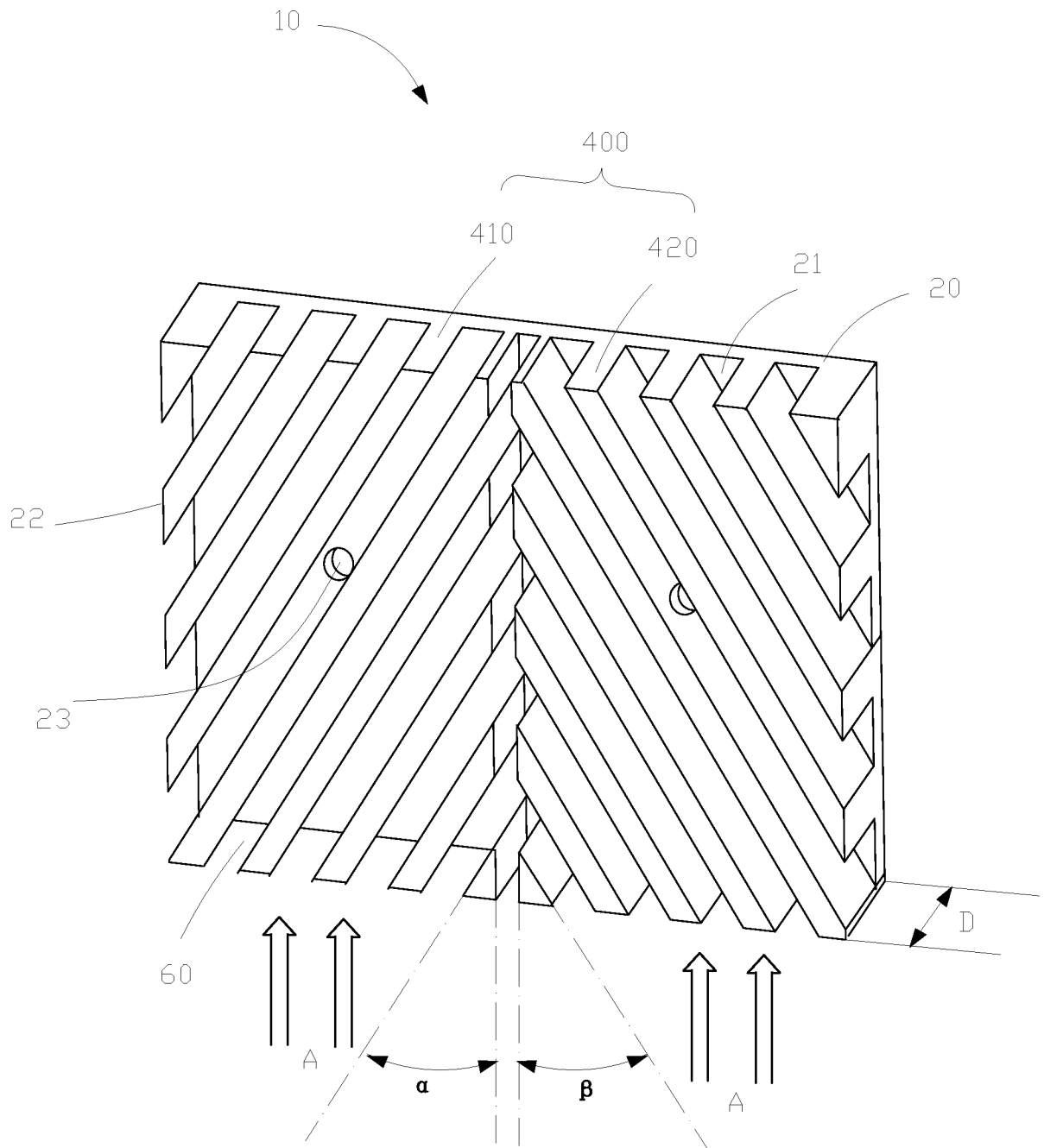


Fig. 3

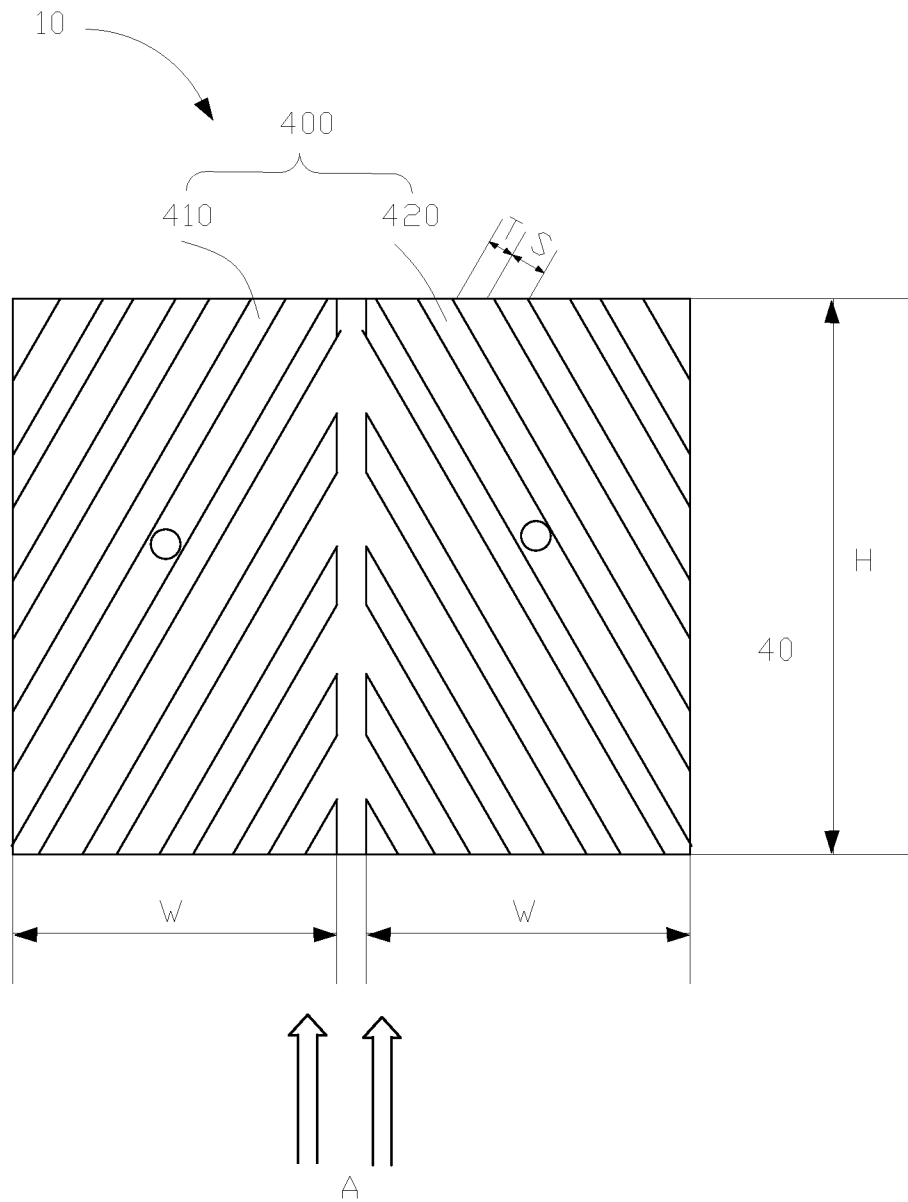


Fig. 4

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/072288

## A. CLASSIFICATION OF SUBJECT MATTER

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)

IPC: H01L23/-, G06F1/20, H05K7/20

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)

CPRS,CNKI, ISI, WPI, PAJ, EPODOC: fin, heat sink, direction, angle, base, oblique, inclined, tilt, slope, slant

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                        | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2004/0246676 A1 (HEWLETT-PACKARD DEVELOPMENT COMPANY (US))<br>09 Dec. 2004 (09.12.2004) paragraphs [0024]-[0036] of description, and figures 2A and 2B | 1-12                  |
| A         | US 2002/0170702 A1 (ANDO ELECTRIC CO. LTD. (US)) 21 Nov. 2002 (21.12.2002)<br>paragraphs [0014]-[0021] of description, and figure 1                       | 1-12                  |
| A         | JP 2002-162188 A (NIPPONDENSO CO. LTD. (JP)) 07 Jun. 2002 (07.06.2002)<br>paragraphs [0007]-[0010] of description                                         | 1-12                  |

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

☒ See patent family annex.

|                                                                                                                                                                          |                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * Special categories of cited documents:                                                                                                                                 | “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                                              |
| “A” document defining the general state of the art which is not considered to be of particular relevance                                                                 | “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                                                                     |
| “E” earlier application or patent but published on or after the international filing date                                                                                | “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 |
| “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) | “&” document member of the same patent family                                                                                                                                                                                                    |
| “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                                                                   |                                                                                                                                                                                                                                                  |

|                                                                                                                                                                                                              |                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Date of the actual completion of the international search<br>14 May 2009 (14.05.2009)                                                                                                                        | Date of mailing of the international search report<br><b>11 Jun. 2009 (11.06.2009)</b> |
| Name and mailing address of the ISA/CN<br>The State Intellectual Property Office, the P.R.China<br>6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China<br>100088<br>Facsimile No. 86-10-62019451 | Authorized officer<br><b>FANG Hualong</b><br>Telephone No. (86-10)62411551             |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
PCT/CN2008/072288

| Patent Documents referred<br>in the Report | Publication Date | Patent Family    | Publication Date |
|--------------------------------------------|------------------|------------------|------------------|
| US 2004/0246676 A1                         | 09.12.2004       | US 7079390 B2    | 18.07.2006       |
| US 2002/0170702 A1                         | 21.11.2002       | KR 20020087885 A | 23.12.2002       |
|                                            |                  | JP 2002343912 A  | 29.11.2002       |
| JP 2002-162188 A                           | 07.06.2002       | NONE             |                  |

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/072288

## A. CLASSIFICATION OF SUBJECT MATTER

H01L 23/367 (2006.01) i

H05K 7/20 (2006.01) i

G06F 1/20 (2006.01) i