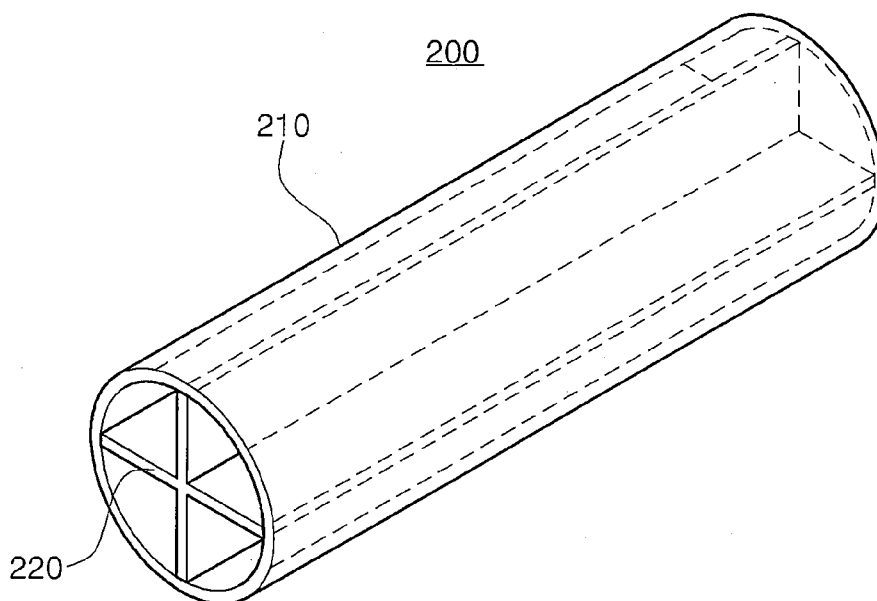




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- (74) Agent: **CHANG, Hoon**; Central Intellectual Property & Law, Korean Re Bldg. 5F, 68, Jong-ro 5-gil, Jongno-gu, Seoul 110-733 (KR).
- (81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, 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, IR, IS, JP, KE, KG, KN, KP, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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.
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(54) Title: INNER TUBE FOR SUBLIMATION PURIFICATION APPARATUS



(57) Abstract: The invention is related to an inner tube, especially an inner tube for collecting a purified material, used in an apparatus for sublimation-purification of OLED materials. The surface area or size of the conventional inner tube used for a sublimation-purification apparatus is limited to the surface area or size of an outer tube, and thus the amount of material obtained in one process is restrictive thereby. The present invention provides an inner tube for improving productivity of the purified material compared to the conventional inner tube.





UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, 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, KM, ML, MR, NE, SN, TD, TG).

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Description

Title of Invention: INNER TUBE FOR SUBLIMATION PURIFICATION APPARATUS

Technical Field

- [1] The present invention relate to a collecting body for collecting a sublimated organic material which is used in a sublimation purification apparatus of an organic material for an organic light emitting diode.

Background Art

- [2] Typically, materials used for an organic light-emitting diode (OLED) require purification. Purifying technology of the OLED materials is intended to extract only pure components required for electroluminescence from composite materials and to use the extracted components for thin film deposition. As the purifying technology of the OLED materials is improved, color purity and luminous efficiency are improved and the luminous lifetime of the OLED is prolonged. For the purpose of mass production of the OLED materials, the purifying technology for the OLED materials, which reduces the process time and improves purification efficiency, is essential.
- [3] A sublimation purification method of an organic material is disclosed in a thesis by H. J. Wagner. et al., Journal of Materials Science, 17, 2781, (1982). In this thesis, a glass tube with a length of approximately 1 meter is inserted into a copper tube for thermal conduction, and a source material to be purified to produce the OLED material are disposed within a region of one end of the glass tube. A heater surrounds the copper tube containing the source material, and an interior of the glass tube maintains a vacuum state. The heater heats the source material within the glass tube, and thereby the source material is sublimated. The glass tube is made to be a temperature gradient, and thereby the sublimated material is cooled and re-crystallized at the other end of the glass tube. Thereby, re-crystallized organic material is created within the region of the other end of the glass tube.
- [4] FIG. 1a illustrates a sublimation purification apparatus 100 for organic material according to the prior art. In the general sublimation purification apparatus 100, an inner tube 10 for containing a source material and an inner tube 20 for collecting a purified material are used to produce the organic material used for the organic light emitting diode. The inner tube 10 for containing a source material may have a boat shape to contain a source material 60 in a lower portion thereof. The inner tube 20 for collecting purified material is typically a tube of which the cross section is a circular shape or an elliptical shape. The inner tubes 10 and 20 are typically made of transparent materials, such as quartz, glass, and borosilicate glass, and may also be

made of metals.

- [5] There is an outer tube 30 as a chamber in which the sublimation purification process of the organic material is performed, and a heater 40 surrounds an outer surface of the outer tube 30. The outer tube 30 may be divided into a plurality of regions, in which each of the regions may be controlled at different temperatures by the heater 40.
- [6] For the sublimation purification process of the organic material, the inner tube 10 for containing source material, which contains the source material 60, and the empty inner tube 20 for collecting purified material are provided into an inside of the outer tube 30 (illustrated in FIG. 1b), and the heater 40 heats the source material 60. When the source material 60 is heated above the sublimation point, the source material is sublimated and thus is in a gas state. In this case, when an area of the outer tube provided with the inner tube 20 for collecting a purified material is heated by heater 40 below a sublimation point of a material to be obtained in the sublimation purification process, the purified material in the gas state is re-crystallized and is thus formed in a solid state in a form to surround an inner surface of the inner tube 20 for collecting a purified material. FIG. 1b illustrates a cross-sectional view of the inner tube 10 containing the source material 60 and the inner tube 20 containing the purified material 70.
- [7] In the purification apparatus according to the prior art, for the purpose of increasing a yield of the purified material, an outer diameter of the inner tube containing the purified material is close to an inner diameter of the outer tube to increase an area of an attached surface to which the purified material is attached. However, the above method has a limitation in that the size and area of the inner tube may not be larger than the size and area of the inside of the outer tube, and therefore there is a limitation in increasing the amount of purified material obtained in one process.
- [8] Therefore, Korean Patent No. 10-1160329 introduced area-increasing boards which are arranged in the inner tube for sublimation purification of an organic material. However, in connection with the area-increasing boards according to the prior art as disclosed in the above document, since the plurality of area-increasing boards are arranged in parallel, each of the plurality of area-increasing boards should be mounted in the inner tube one by one and then should be detached from the inner tube one by one. This results in inconvenience, since there is a need to accurately insert the area-increasing boards into a designated position of the inner tube. Therefore, the process time is increased, production costs are increased. In addition, a separate support portion for fixing the area-increasing board is required to fix the area-increasing board to the inner tube.

Disclosure of Invention

Technical Problem

- [9] The present invention proposes to solve the above problems of the inner tube for sublimation purification of an organic material according to the prior art and an embodiment of the present invention is directed to an inner tube including an assembly, in which an inner structure to increase an inner area of an inner tube may be mounted, the assembly may be integrally formed and thus the assembly may be attached and detached to and from the inner tube at a time, and the assembly may be mounted in the inner tube only by pushing the assembly into the inner tube without causing inconvenience to search for a designated position to fix the assembly to the inner tube one by one, thereby saving production time of the organic material and improving productivity thereof.

Solution to Problem

- [10] According to an exemplary embodiment of the present invention, there is provided a collecting body for collecting a sublimated organic material, including: a tube having an inner surface, wherein the sublimated organic material contacts the inner surface of the tube and is deposited thereon; and an assembly of a plurality of boards which are installed within the tube in a longitudinal direction of the tube for further providing the contact surface, wherein the plurality of boards are connected to each other, thereby forming a radial-symmetry shape around the center axis of the tube.
- [11] One end of each of the plurality of boards may contact the inner surface of the tube.
- [12] The plurality of boards may be four rectangular boards and the angles between each of the plurality of boards may be 90°.
- [13] The assembly of said four rectangular boards may be formed by combining two rectangle plates in a manner of a cross-halving joint.
- [14] The plurality of boards may be three rectangular boards and angles between each of the plurality of boards may be 120°.
- [15] Each of the plurality of boards may be separable from each other.
- [16] The collecting body may further include a pipe-shaped member which is formed along the axis of the tube and each of the plurality of boards may extend from an outer surface of the pipe-shaped member to the inner surface of the tube.
- [17] The plurality of boards may be made of quartz, glass, borosilicate glass, or metal.

Advantageous Effects of Invention

- [18] The present invention further comprises assembly, in comparison to the inner tube of the prior art, and thereby increases a yield of the purified material and a productivity of producing the organic materials for OLED.

Brief Description of Drawings

- [19] FIGS. 1a and 1b are diagrams illustrating a sublimation purification apparatus of an

organic material according to the prior art.

[20] FIGS. 2a to 2d are diagrams illustrating a collecting body for collecting a purified material according to one exemplary embodiment of the present invention.

[21] FIGS. 3a to 3c are diagrams illustrating a collecting body for collecting a purified material according to another exemplary embodiment of the present invention.

[22] FIGS. 4a to 4d are diagrams illustrating a collecting body for collecting a purified material according to other exemplary embodiment of the present invention.

Mode for the Invention

[23] Hereinafter, an inner tube for sublimation purification of an organic material according to an exemplary embodiment of the present invention will be described in more detail with reference to FIGS. 2a to 4d.

[24] FIG. 2a is a perspective view of a collecting body 200 for collecting a purified material in a sublimation purification apparatus of an organic material according to a first exemplary embodiment of the present invention. The collecting body 200 for collecting a purified material is configured to include a tube 210 of which the cross section is a circular shape and an assembly 220 which is mounted in the tube.

[25] A medium to agglomerate material molecules in a gas state is required so that a material sublimated in a gas state is re-crystallized in a sublimation purification process and thus deposited in a solid state. As described above, a sublimation purification apparatus according to the prior art uses only an inner surface of the tube 20 as a medium.

[26] However, according to the exemplary embodiment of the present invention, as illustrated in FIG. 2a, an assembly 220 is mounted in the tube 210. The assembly 220 is configured of a plurality of boards 220a, 220b, 220c, and 220d (see FIG. 2c), in which the plurality of boards 220a, 220b, 220c, and 220d are integrally combined with each other to form a cross shape. Therefore, as illustrated in FIG. 2b illustrating a cross-sectional view of FIG. 2a, both surfaces of the plurality of boards 220a, 220b, 220c, and 220d which are mounted in the tube 210 as well as the inner surface of the tube 210 may be the medium to re-crystallize the material molecules in the sublimated gas state. Therefore, the surface area on which the purified material is formed is expanded, and thus much more purified material may be obtained in the same period of time.

[27] When the sublimation purification process is completed, the purified materials are collected by taking the collecting body 200 for collecting purified material outside of the outer tube 30 and then raking out the purified materials 70 deposited in the tube 210 of the collecting body 200 for collecting purified material and the purified materials 70 deposited outside of the assembly 220. Preferably, the collecting body 200 for collecting a purified material according to the exemplary embodiment of the

present invention is configured to separate the assembly 220 from the tube 210.

Therefore, the purified materials deposited in the tube 210 and the assembly 220 may be more easily raked out and the collecting body 200 may be more easily cleaned.

[28] Further, according to the first exemplary embodiment of the present invention, as illustrated in FIG. 2c, the assembly 220 is designed as a cross structure. Therefore, at the time of mounting the assembly 200 in the tube 210 or separating from the tube 210, convenience to mount or separate the assembly in or from the tube 210 at a time may be secured. That is, even though the assembly 220 is configured of the plurality of boards 220a, 220b, 220c, and 220d, the assembly 220 configured of the plurality of boards 220a, 220b, 220c, and 220d may be mounted or separated at a time without causing inconvenience to mount or separate each of the boards 220a, 220b, 220c, and 220d one by one. Further, since the assembly 220 has a radial-symmetry, the assembly 220 may be disposed in the tube 210 only by pushing the assembly 220 into the tube 210 without searching for a separate designated position to fix the assembly 220 to the tube 210.

[29] Further, according to the exemplary embodiment of the present invention, as illustrated in FIGS. 2a and 2b, the width of an end surface of the assembly 220 is manufactured to meet an inner diameter of the tube 210 and thus ends of each of the plurality of boards 220a, 220b, 220c, and 220d of the assembly 220 contact an inner surface of the tube 210. Therefore, the assembly 220 may be fixed to the tube 210 without a separate support part for supporting the assembly 220 to the tube 210. However, the exemplary embodiment of the present invention is not limited to the foregoing; but alternatively, a support part for supporting the assembly 220 to the inside of the tube 210 may be further configured.

[30] The assembly 220 according to the exemplary embodiment of the present invention may also be a structure in which the plurality of boards 220a, 220b, 220c, and 220d formed in a cross shape may not be separated from each other since the plurality of boards 220a, 220b, 220c, and 220d are combined to each other or manufactured to be integrally molded. Alternatively, as illustrated in FIG. 2d to be described below, two boards 220e and 220f are assembled, the plurality of boards may be again separated into each of the boards later, the assembly 220 is assembled in a cross shape by combining four boards each other using a fastening part and may also be separated from each other later (not illustrated), and other various modifications and changes may be possible.

[31] Referring to FIG. 2d, each of the two rectangular boards 220e and 220f forming the assembly 220 includes grooves 221e and 221f in a longitudinal direction from one end to a center of the board. The cross shape may be implemented in such a manner that the groove 221f of one board is inserted into the groove 221e of another board to

intersect each other and then one of the grooves 221e and 221f of the boards is each combined with one of the boards 220e and 220f to support the other of the boards 220e and 220f to the other of the grooves 221e and 221f. The coupling scheme is usually referred to as a cross-halving joint. In this case, at the time of collecting the purified materials, it is easier to separate the two boards 220e and 220f of the assembly 220, rake out the purified materials, and clean the boards. However, the exemplary embodiment of the present invention is not limited to the foregoing and therefore the assembling may also be performed by including the support part or the fastening part (not illustrated) which may fix the two boards to each other and other various modifications and changes may be possible.

[32] FIG. 3a is a perspective view of a collecting body 300 for collecting a purified material in a sublimation purification apparatus of an organic material according to a second exemplary embodiment of the present invention which is a partial modification of the first exemplary embodiment of the present invention. Similar to the case of the first exemplary embodiment of the present invention, the collecting body 300 for collecting a purified material is configured to include a tube 310 of which the cross section is a circular shape and an assembly 320 which is mounted in the tube. As illustrated in FIG. 3b, the assembly 320 according to the second exemplary embodiment of the present invention is configured of three boards 320a, 320b, and 320c. Preferably, the three boards 320a, 320b, and 320c may each form an angle of 120° to one another. Similar to the case of the first exemplary embodiment of the present invention, the assembly 320 according to the second exemplary embodiment of the present invention may be mounted or separated in or from the tube 310 at a time, and even though a position to mount the assembly 320 in the tube 310 and to fix the assembly 320 is not separately prepared, the mounting is completed only by pushing the assembly 320 into the tube 310. FIG. 3c is a cross-sectional view of the collecting body 300 for collecting a purified material in which the purified materials 70 are deposited.

[33] FIG. 4a is a perspective view of a collecting body 400 for collecting a purified material in a sublimation purification apparatus of an organic material according to a third exemplary embodiment of the present invention which is a partial modification of the first exemplary embodiment of the present invention. Similar to the case of the first exemplary embodiment of the present invention, the collecting body 400 for collecting a purified material is configured to include a tube 410 and an assembly 420 which is mounted in the tube 410. As illustrated in FIG. 4b, the assembly 420 according to the third exemplary embodiment of the present invention includes a pipe-shaped member 420a formed along an axis in a longitudinal direction of the tube 410 and has a shape in which ends of each of the four boards 420b, 420c, 420d, and 420e are combined with an outer surface of the pipe-shaped member 420a to be radial toward an inner

surface of the tube 410. Preferably, the pipe-shaped member 420 and the tube 410 may be disposed on the same axis. FIG. 4c is a cross-sectional view of the collecting body 400 for collecting a purified material in which the purified materials 70 are deposited. As illustrated in FIG. 4d, the assembly 420 may be manufactured as an assembly type. The pipe-shaped member 420a is provided with four grooves 421b, 421c, 421d, and 421e and ends of the fourth board-shaped members 420b, 420c, 420d, and 420e are provided with convex parts 422b, 422c, 422d, and 422e to engage the grooves 421b, 421c, 421d, and 421e with the convex parts 422b, 422c, 422d, and 422e. In contrast to the one illustrated in FIG. 4d, the assembly may be manufactured by a method (not illustrated) of providing the four convex parts on the outer surface of the pipe-shaped member 420a and providing concave parts at the ends of the four boards 420b, the assembling may be done by putting the fastening part (not illustrated) between the pipe-shaped member 420a and the board-shaped members 420b, 420c, 420d, and 420e, and other several changes and modifications may be possible. Similar to the case of the first exemplary embodiment of the present invention, the assembly 420 according to the third exemplary embodiment of the present invention may also be mounted or separated in or from the tube 410 at a time and the assembly 420 may be mounted only by pushing the assembly 420 into the tube 410.

- [34] Herein, the tubes 210, 310, and 410 and the assembly 420 are described as the tube of which the cross section is a circular shape, but the exemplary embodiment of the present invention is not limited thereto, and therefore may also be a tube of which the cross section is an elliptic shape and other several changes and modifications are possible.
- [35] Meanwhile, the tubes 210, 310, and 410 and the assemblies 220, 320, and 420 of the inner tubes 200, 300, and 400 according to the exemplary embodiment of the present invention may be made of transparent materials such as quartz, glass, and borosilicate glass or metals.
- [36] According to the exemplary embodiments of the present invention, compared to the inner tube for sublimation purification of an organic material according to the prior art, the assembly is further provided to increase the yield of the organic material and compared to the inner tube for sublimation purification according to the prior art, the time to collect the purified material from the inner tube including the assembly is reduced which further increases productivity.
- [37] Hereinabove, the exemplary embodiments of the present invention are described. It will be appreciated by those skilled in the art that various modifications and alterations can be made without departing from the essential characteristics of the present invention. Accordingly, the embodiments disclosed in the present invention are used not to limit but to describe the spirit of the present invention. The scope of the present

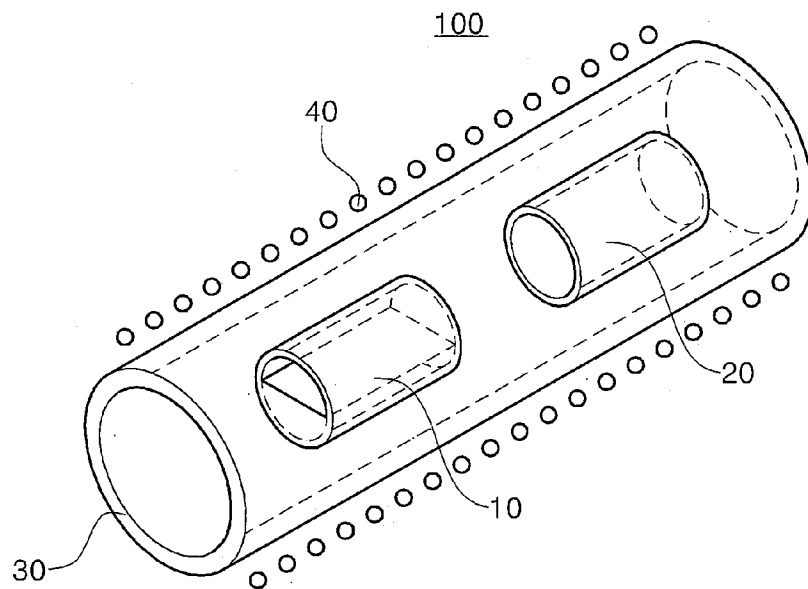
invention should be defined by the following claims rather than the above-mentioned description, and all technical spirits equivalent to the following claims should be interpreted as being included in the present invention.

- [38] [Description of Reference Numerals]
- [39] 200, 300, 400: Collecting body for Purified material
- [40] 210, 310, 410: Tube
- [41] 220, 320, 420: Assembly

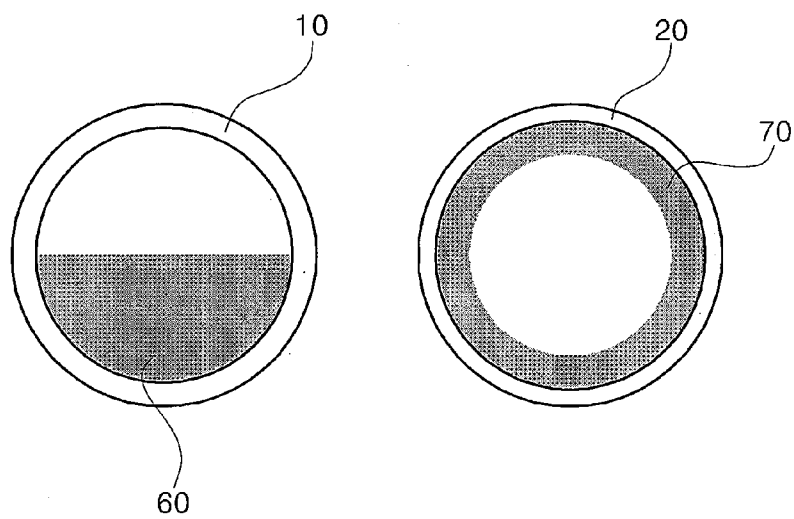
Claims

- [Claim 1] A collecting body for collecting a sublimated organic material, comprising:
a tube having an inner surface, wherein the sublimated organic material contacts the inner surface of the tube and is deposited thereon; and
an assembly of a plurality of boards which are installed within the tube in a longitudinal direction of the tube for further providing the contact surface, wherein the plurality of boards are connected to each other, thereby forming a radial-symmetry shape around center axis of the tube.
- [Claim 2] The collecting body according to claim 1, wherein one end of each of the plurality of boards contacts the inner surface of the tube.
- [Claim 3] The collecting body according to claim 1, wherein the plurality of boards are four rectangle boards, and wherein the angles between each of the plurality of boards are 90°.
- [Claim 4] The collecting body according to claim 3, wherein the assembly of said four rectangle boards is formed by combining two rectangle plates in a manner of a cross-halving joint.
- [Claim 5] The collecting body according to claim 1, wherein the plurality of boards are three rectangle boards, and wherein angles between each of the plurality of boards are 120°.
- [Claim 6] The collecting body according to claim 1, wherein the each of the plurality of boards is separable from each other.
- [Claim 7] The collecting body according to claim 1,
wherein the collecting body further comprises a pipe-shaped member which is formed along the axis of the tube, and
wherein each of the plurality of boards extends from an outer surface of the pipe-shaped member to the inner surface of the tube.
- [Claim 8] The collecting body according to claim 1, wherein the plurality of boards are made of quartz, glass, borosilicate glass, or metal.

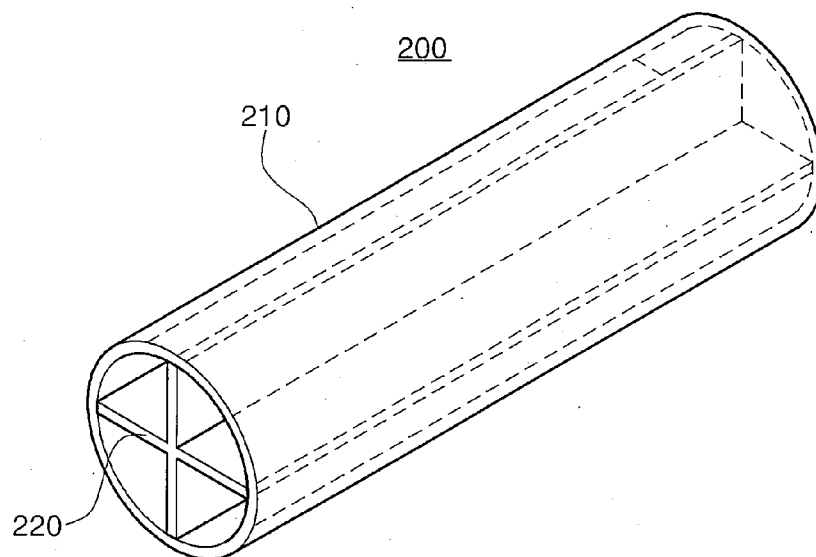
[Fig. 1a]



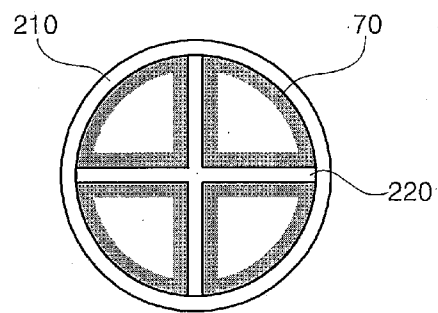
[Fig. 1b]



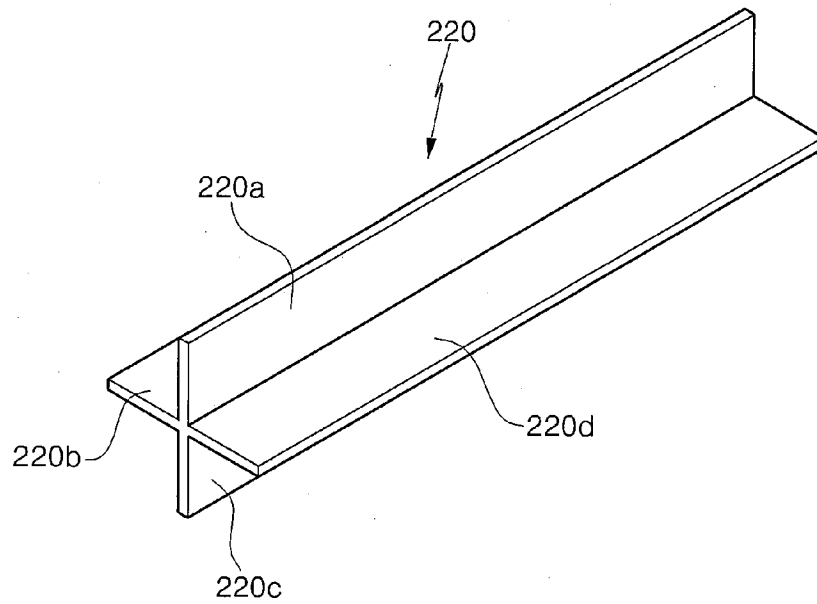
[Fig. 2a]



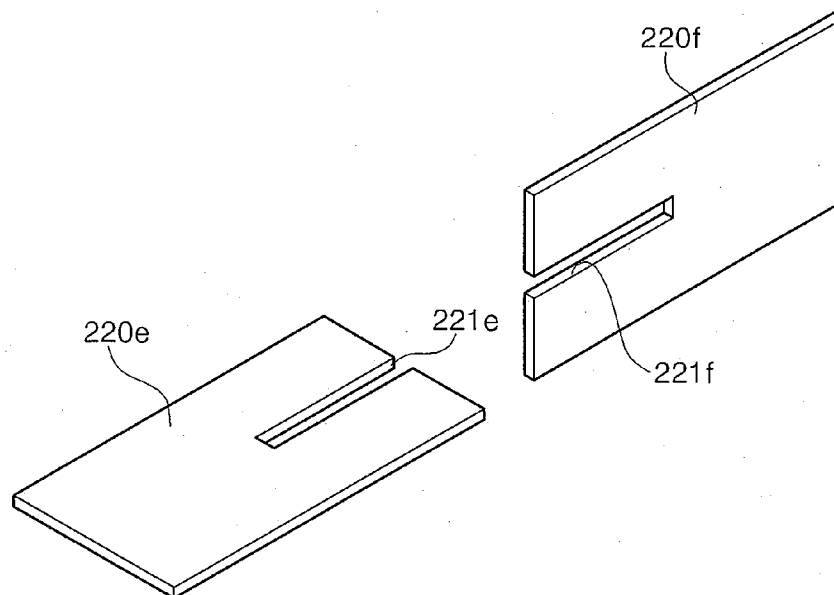
[Fig. 2b]



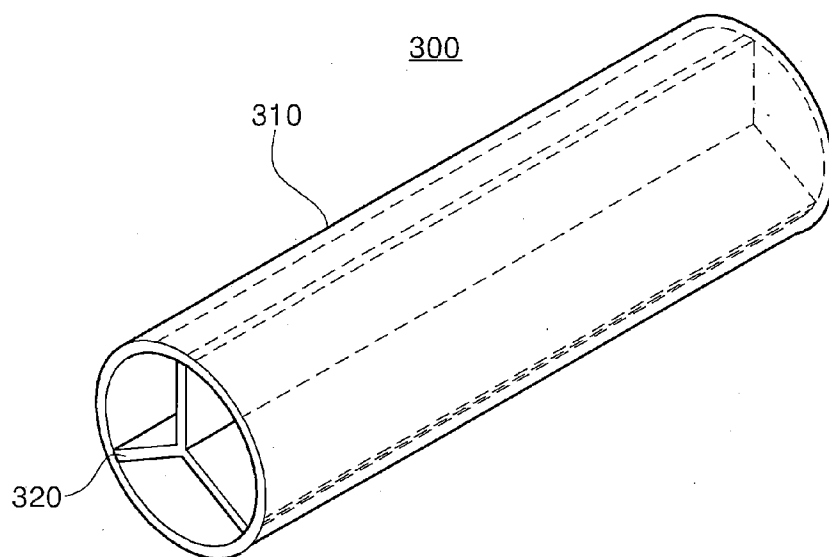
[Fig. 2c]



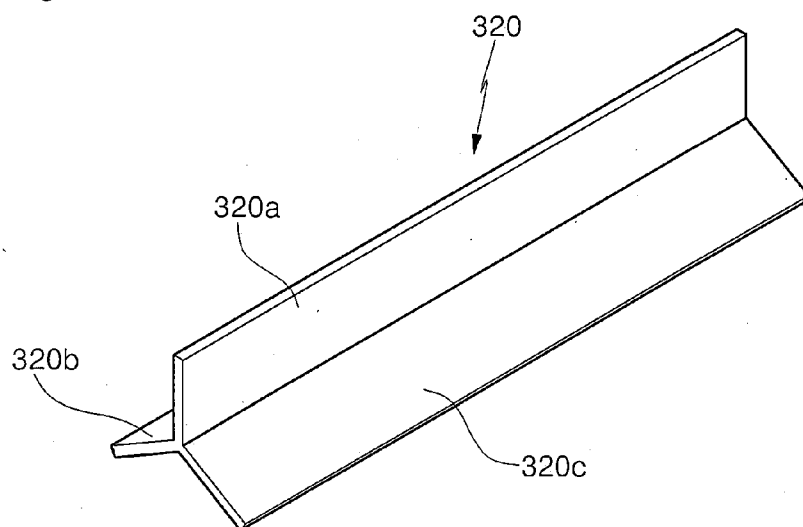
[Fig. 2d]



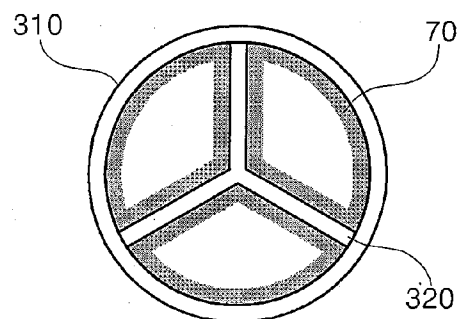
[Fig. 3a]



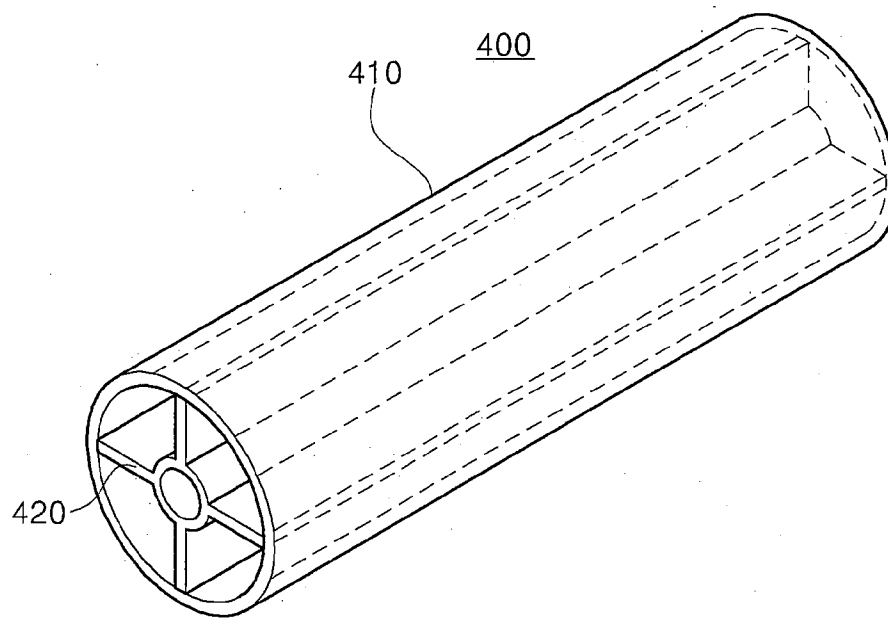
[Fig. 3b]



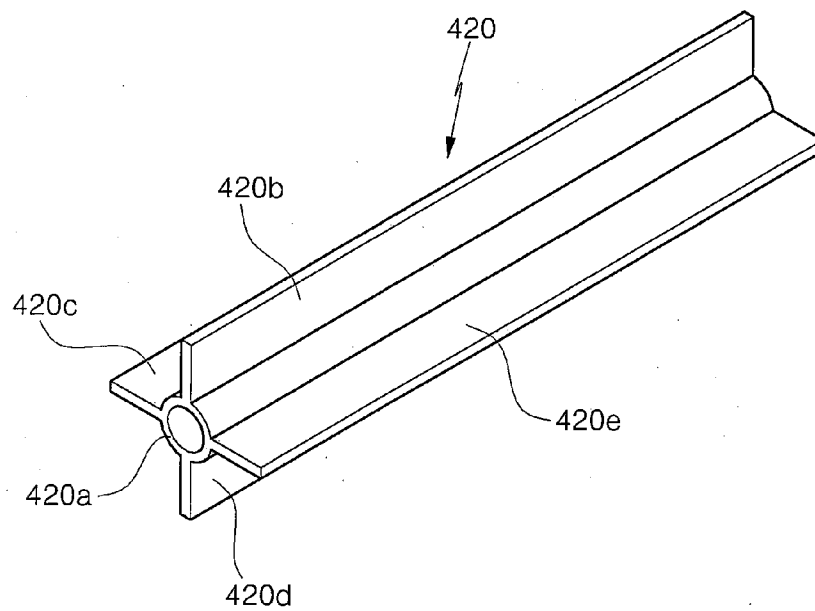
[Fig. 3c]



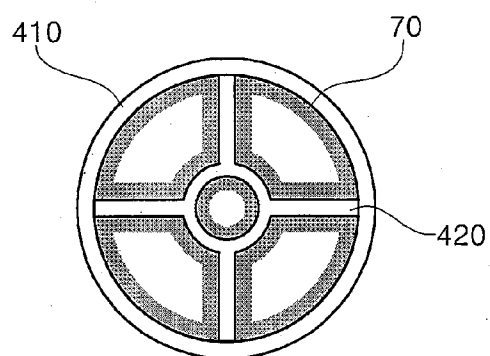
[Fig. 4a]



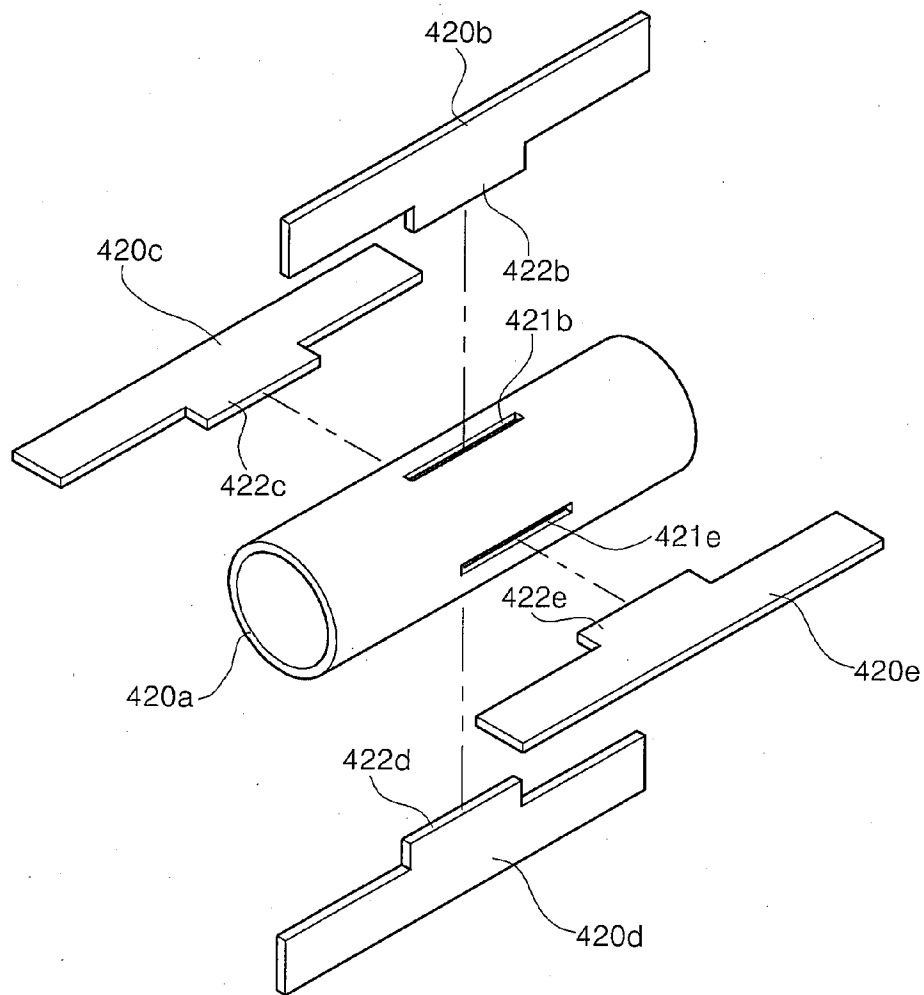
[Fig. 4b]



[Fig. 4c]



[Fig. 4d]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2014/001363**A. CLASSIFICATION OF SUBJECT MATTER****B01D 7/00 (2006.01) B01D 9/00 (2006.01)**

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)

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)

WPI & EPODOC: IC/CC: B01D7/-, B01D9/-, C07B63/- & keywords (sublimation, tube, board, radius, symmetrical, glass and similar words); Espacenet & Google Patents: keywords (sublimation, OLED, organic light emitting diode, organic, sublimation, tube, pipe, conduit, channel, duct, board, sheet, panel, frame, radius, central, symmetrical, similar, regular, glass, quartz, borosilicate, metal); Auspat & Espacenet: Applicant search on "ROHM AND HASS ELECTRONIC MATERIALS KOREA LTD."

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

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

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
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Date of the actual completion of the international search 22 May 2014		Date of mailing of the international search report 22 May 2014	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au Facsimile No.: +61 2 6283 7999		Authorised officer Hatinder Sharma AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262256151	

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/KR2014/001363
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7611548 B2 (JANG et al.) 03 November 2009 abstract; col 1, lines 6-9; col 2, line 55 to col 3, line 26; col 5, line 35 to col 6, line 2; col 7, lines 11-67; figs. 1-7	1-8
A	KR 10-1129449 B1 (SSIESEUEISSOIRA CO. LTD.) 26 March 2012 abstract; pages 1-2; pages 5-10; figs. 1a, 1c, 2a, 2b	1-8
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INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/KR2014/001363	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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