



(51) International Patent Classification:
F24F 5/00 (2006.01)

(21) International Application Number:
PCT/EP2017/064381

(22) International Filing Date:
13 June 2017 (13.06.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
a 2016/08338 17 June 2016 (17.06.2016) TR

(71) Applicant: **ARCELIK ANONIM SIRKETI** [TR/TR]; E5
Ankara Asfalti Uzeri, Tuzla, 34950 ISTANBUL (TR).

(72) Inventors: **COBAN, Burak**; E5 Ankara Asfalti Uzeri, Tu-
zla, 34950 Istanbul (TR). **BALIOGLU, Onder**; E5 Ankara
Asfalti Uzeri, Tuzla, 34950 Istanbul (TR). **ERDEM, Fun-**

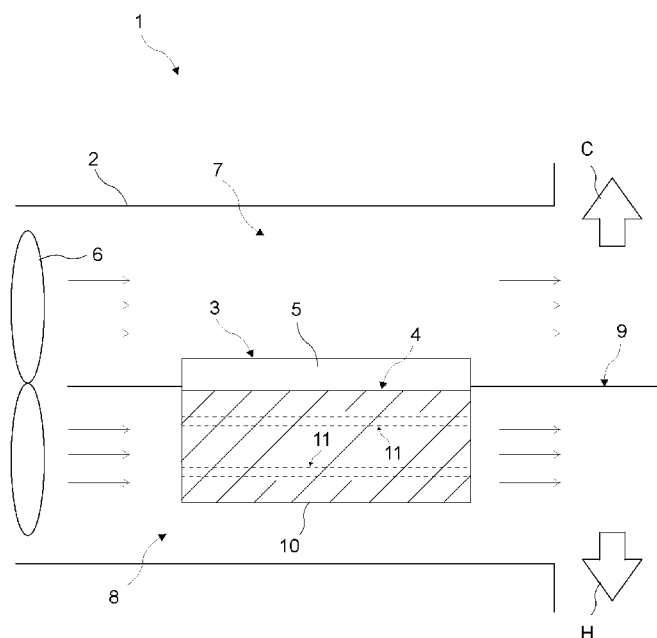
da; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR).
AKSOY, Adem; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Is-
tambul (TR). **KURULAR, Semih**; E5 Ankara Asfalti Uzeri,
Tuzla, 34950 Istanbul (TR).

(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, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, 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.

(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, ST, SZ, TZ,

(54) Title: PORTABLE AIR-CONDITIONING DEVICE COMPRISING THERMOELECTRIC MODULE

Figure 1



(57) Abstract: The invention relates to a portable air-conditioning device (1) comprising a body (2), at least one thermoelectric module (5) provided in the body (2) comprising a cold surface (3) cooling the air passing via thereof and a hot surface (4) warming the air passing via thereof, a fan (6) enabling the body (2) to receive the ambient air inside and to pass it through the thermoelectric module (5), a conditioned air duct (7) enabling the air delivered by the fan (6) to pass via the cold surface (3) and directs it to the environment outside the body (2), an exhaust air duct (8) enabling the air delivered by the fan (6) to pass via the hot surface (4) and directs it to the environment outside the body (2), and a separator (9) splitting the conditioned air duct (7) and the exhaust air duct (8) from each other.

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).

Published:

— *with international search report (Art. 21(3))*

Description

PORTABLE AIR-CONDITIONING DEVICE COMPRISING THERMOELECTRIC MODULE

- [0001] Present invention relates to a portable air-conditioning device that cools by means of a thermoelectric module, and that partially or fully stores residual heat by means of a phase changing material (PCM) package.
- [0002] In general, air-conditioning devices comprise an internal unit and an external unit, and the heat drawn from the internal unit during cooling is discharged to the outer environment by the external unit. In portable (transportable) air-conditioning devices, cooling is usually performed by discharging the heat drawn from the ambience to the outer environment by means of a vent which extends outdoors through an aperture opened on a window or a wall. However, the vent structure that enables heat to be discharged to the outer environment, restricts transportability of the air-conditioning device. In addition, many users do not prefer portable air-conditioners since an aperture suitably formed for the vent needs to be opened on a window or a wall, in order to obtain an efficient cooling performance by providing insulation between the ambience that requires cooling and the outer environment.
- [0003] With portable air-conditioning devices, cooling of the ambient air can be provided by using only a thermoelectric module or a group of thermoelectric modules. By means of passing an electric current determined according to requirements, through the thermoelectric module, heat difference is generated between two surfaces and consequently a hot surface and a cold surface is obtained. Ambient air is cooled by passing air via the cold surface of the thermoelectric module. Storage of residual heat by using phase change material (PCM) in portable air-conditioning devices with thermoelectric module is known. The thermal load generated on the hot surface of the thermoelectric module or modules which dissipates heat, can be stored by fully or partially transferring thereof to the phase change material (PCM), and thus the air-conditioning device is given the "portability" feature by suspending the need to discharge heat for a certain time, but there occurs a heat transfer problem between the hot

surface of the thermoelectric module which is the heated portion and the phase change material (PCM), and a difficulty of use.

[0004] US Patent Application No. US2015033764A1, relates to a thermoelectric air-conditioning device in which a thermoelectric module and a phase change material interact with each other.

[0005] The aim of the present invention is to provide a portable air-conditioning device in which cooling is obtained by means of a thermoelectric module and thermal energy drawn from the cooled environment and discharged outside is stored, and which allows ease of use.

[0006] The portable air-conditioning device provided to achieve the aim of the present invention is disclosed in the claims.

[0007] In the portable (transportable) air-conditioning device of the present invention, the ambient air is cooled by means of a thermoelectric module which has a cold surface cooling the air passed via thereof and a hot surface warming the air passed via thereof. The portable air-conditioning device comprises a conditioned air duct that enables air to pass via the cold surface and directs it to the environment outside the body and an exhaust air duct that enables air to pass via the hot surface and directs it to the environment, and phase change material (PCM) packages obtained by packing PCM with high heat storage capacity in a container are placed detachably in the exhaust air duct. The heat dissipating from the hot surface of the thermoelectric module to the exhaust air duct is stored by transferring it to PCM packages by way of conduction and/or convection. The PCM packages are easily removed from the device after completing the efficient usage period for user's comfort, and are placed in a cooler/freezer device for regeneration.

[0008] The portable air-conditioning device provided to achieve the aim of the present invention is illustrated in the accompanying drawings, wherein:

[0009] Figure 1 is a schematic view of the portable air-conditioning device of the invention.

[0010] Figure 2 is a schematic view of the portable air-conditioning device in an embodiment of the invention.

[0011] Figure 3 is a schematic view of the portable air-conditioning device in

another embodiment of the invention.

[0012] Figure 4 is a schematic view of PCM packages placed perpendicularly to the hot surface of the thermoelectric module.

[0013] Figure 5 is a schematic view of PCM packages placed in a zigzag pattern and perpendicularly to the hot surface of the thermoelectric module.

[0014] Figure 6 is a schematic view of PCM packages placed in parallel with the hot surface of the thermoelectric module.

[0015] Figure 7 is a schematic view of PCM packages placed in a zigzag pattern and in parallel with the hot surface of the thermoelectric module.

[0016] Figure 8 is a schematic view of PCM packages placed between the hot surfaces of three thermoelectric modules.

[0017] Figure 9 is a schematic view of a portable air-conditioning device comprising a housing in which PCM packages are arranged.

[0018] The elements in the figures are numbered individually and the correspondence of the numbers are given hereinafter:

[0019] 1. Portable air-conditioning device

[0020] 2. Body

[0021] 3. Cold surface

[0022] 4. Hot surface

[0023] 5. Thermoelectric module

[0024] 6. Fan

[0025] 7. Conditioned air duct

[0026] 8. Exhaust air duct

[0027] 9. Separator

[0028] 10. PCM package

[0029] 11. Mini-channel

[0030] 12. Heat sink

[0031] 13. Inlet opening

[0032] 14. Outlet opening

[0033] 15. Housing

[0034] C: Conditioned air

[0035] H: Exhaust air

[0036] The portable air-conditioning device (1) comprises a body (2), at least one

thermoelectric module (5) provided in the body (2) comprising a cold surface (3) cooling the air passing via thereof and a hot surface (4) warming the air passing via thereof, a fan (6) enabling the body (2) to receive the ambient (the environment where the user is, that requires cooling) air inside and to pass it through the thermoelectric module (5), a conditioned air duct (7) enabling the air delivered by the fan (6) to pass via the cold surface (3) and directs it to the environment outside the body (2), an exhaust air duct (8) enabling the air delivered by the fan (6) to pass via the hot surface (4) and directs it to the environment outside the body (2), and a separator (9) that splits the conditioned air duct (7) and the exhaust air duct (8) from each other, and isolates the conditioned air (C) flow cooled by passing via the cold surface (3) and the exhaust air (H) flow warmed by passing via the hot surface (4).

- [0037] The portable air-conditioning device (1) of the invention comprises at least one phase change material (PCM) package (10) (PCM package (10), for short) obtained by packing phase change material (PCM) of high heat storage capacity in a container (not shown), placed detachably in the exhaust air duct (8), and storing heat dissipating from the hot surface (4) of the thermoelectric module (5) to the exhaust air duct (8) through heat transfer by way of conduction or convection.
- [0038] In the portable air-conditioning device (1), heat dissipates from the hot surface (4) of the thermoelectric module (5) to the exhaust air duct (8). Heat dissipating from the hot surface (4) is fully or partially transferred to the PCM packages (10) placed in the exhaust air duct (8), and PCM packages (10) are used to store residual heat. PCM packages (10) are placed detachably in the exhaust air duct (8). Heat is transferred from the hot surface (4) to the PCM packages (10) by way of conduction and/or convection. The PCM packages (10) are removed from the exhaust air duct (8) and placed in a cooler device after they store heat drawn from the hot surface (4), and they are thus regenerated to be reused in the portable air-conditioning device (1).
- [0039] In one embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) in such a way to have at least partially

surface-to-surface contact with the hot surface (4) of the thermoelectric module (5) (Figures 1 and 2). When the PCM packages (10) are in full contact with the hot surface (4) of the thermoelectric module, heat dissipating from the hot surface (4) of the thermoelectric module (5) is fully transferred to the PCM packages (10) by way of conduction (Figure 1). When the PCM packages (10) are in partial contact with the hot surface (4) of the thermoelectric module (5), a portion of the heat dissipating from the hot surface (4) is transferred to the PCM packages (10) by way of conduction, another portion is transferred by way of convection to the exhaust air duct (8) and partially from the exhaust air duct (8) to the PCM packages (10) (Figure 2).

[0040] In another embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) further from the hot surface (4) in flow direction of the exhaust air (H). Thus the exhaust air (H) contacts first to the hot surface (4) and then to the PCM packages (10) (Figures 2 and 3).

[0041] In another embodiment of the invention, the portable air-conditioning device (1) comprise at least one mini-channel (11) extending in the PCM packages (10) in flow direction of the exhaust air (H), and enabling the heat transfer to improve by increasing contact surface area of the exhaust air (H) with the PCM packages (10) (Figures 1 and 9).

[0042] In another embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) in such a way to have no contact with the hot surface (4) of the thermoelectric module (5). Heat dissipating from the hot surface (4) is fully transferred to the exhaust air duct (8) and from the exhaust air duct (8) to the PCM packages (10) by way of convection. In this embodiment, the portable air-conditioning device (1) comprises a heat sink (12) extending from the hot surface (4) of the thermoelectric module (5) to the exhaust air duct (8), and accelerating heat transfer to the exhaust air (H) by way of convection (Figure 3).

[0043] In another embodiment of the invention, the PCM package (10) is shaped as a rectangular prism of a transversely or longitudinally rectangular cross-section allowing easy attachment and detachment thereof to the portable air-conditioning device (1), and said rectangular cross-section

comprises two short sides and two long sides.

- [0044] In one embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) consecutively and in a regular manner perpendicularly to the hot surface (4) in such a way that their short sides contact the hot surface (4) and their long sides contact each other (Figure 4).
- [0045] In another embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) with their long sides perpendicular to the hot surface (4) and in a zigzag pattern. Said zigzag arrangement enables accelerating the heat transfer by increasing the contact surface area of the exhaust air (H) with the PCM packages (10) (Figure 5).
- [0046] In another embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) in parallel with the hot surface (4), successively in a regular manner in such a way to have full contact with the hot surface (4) along the long side (Figure 6).
- [0047] In another embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) in a zigzag pattern with their long sides in parallel with the hot surface (4). Such zigzag arrangement enables accelerating the heat transfer by increasing the contact surface area of the exhaust air (H) with the PCM packages (10) (Figure 7).
- [0048] In another embodiment of the invention, the PCM packages (10) are placed in the exhaust air duct (8) perpendicularly to or in parallel with the hot surface (4) and spaced from each other in such a way to contact with their short sides or long sides to the hot surface (4) (Figure 8).
- [0049] In another embodiment of the invention, the air-conditioning device (1) comprises at least three thermoelectric modules forming a C-shape so as to partially surround the exhaust air duct (8), their hot surfaces (4) being arranged on the concave side of the C-shape, and PCM packages (10) placed between the hot surfaces (4).
- [0050] In an embodiment of the invention, the portable air-conditioning device (1) comprises at least one inlet opening (13) provided in the exhaust air duct (8), in which PCM packages (10) are placed, and enabling air directed by the fan (6) to contact with the PCM packages (10), and a housing (15)

having at least one outlet opening (14) which enables discharge of the air passing via the PCM packages (10).

[0051] In the portable air-conditioning device (1) of the invention, cooling is performed by thermoelectric module (5), and residual heat dissipating from the hot surface (4) of the thermoelectric module (5) is partially or fully stored in the detachable PCM packages (10).

Claims

1. A portable air-conditioning device (1), **comprising**, a body (2), at least one thermoelectric module (5) provided in the body (2) comprising a cold surface (3) cooling the air passing via thereof and a hot surface (4) warming the air passing via thereof, a fan (6) enabling the body (2) to receive the ambient air inside, and to pass it through the thermoelectric module (5), a conditioned air duct (7) enabling the air delivered by the fan (6) to pass via the cold surface (3) and directs it to the environment outside the body (2), an exhaust air duct (8) enabling the air delivered by the fan (6) to pass via the hot surface (4) and directs it to the environment outside the body (2), and a separator (9) splitting the conditioned air duct (7) and the exhaust air duct (8), **characterized by** at least one PCM package (10) placed detachably in the exhaust air duct (8), and storing heat dissipating from the hot surface (4) of the thermoelectric module (5) to the exhaust air duct (8) through heat transfer by way of conduction or convection.
2. The portable air-conditioning device (1) according to claim 1, **characterized by** PCM packages placed in the exhaust air duct (8) in such a way to have at least partial surface-to-surface contact with the hot surface (4) of the thermoelectric module (5).
3. The portable air-conditioning device (1) according to claims 1 or 2, **characterized by** PCM packages (10) placed in the exhaust air duct (8) in a such way to be further from the hot surface (4) in flow direction of the exhaust air (H).
4. The portable air-conditioning device (1) according to claim 1, **characterized by** at least one mini-channel (11) extending in the PCM packages (10) in flow direction of the exhaust air (H).
5. The portable air-conditioning device (1) according to claim 1, **characterized by** PCM packages placed in the exhaust air duct (8) in a such way to have no contact with the hot surface (4) of the thermoelectric module (5).
6. The portable air-conditioning device (1) according to claims 1 or 5, **characterized by** a heat sink (12) extending from the hot surface (4) of the thermoelectric module (5) to the exhaust air duct (8), and accelerating heat transfer to the exhaust air (H) by way of convection.

7. The portable air-conditioning device (1) according to claim 1, **characterized by** PCM packages (10) shaped as rectangular prisms having a rectangular cross-section and comprising two short sides and two long sides.
8. The portable air-conditioning device (1) according to claims 1 or 7, **characterized by** PCM packages (10) placed in the exhaust air duct (8) consecutively and in a regular manner perpendicularly to the hot surface (4) in such a way that their short sides contact the hot surface (4) and their long sides contact each other.
9. The portable air-conditioning device (1) according to claims 1 or 7, **characterized by** PCM packages (10) placed in the exhaust air duct (8) with their long sides perpendicular to the hot surface (4) and in a zigzag pattern.
10. 10- The portable air-conditioning device (1) according to claims 1 or 7, **characterized by** PCM packages (10) placed in the exhaust air duct (8) successively in parallel with the hot surface (4) in such a way to have full contact with the hot surface (4) along a long side.
11. The portable air-conditioning device (1) according to claims 1 or 7, **characterized by** PCM packages (10) placed in the exhaust air duct (8) with their long sides in parallel with the hot surface (4) and in a zigzag pattern.
12. The portable air-conditioning device (1) according to claims 1 or 7, **characterized by** PCM packages (10) placed in the exhaust air duct (8) perpendicularly to or in parallel with the hot surface (4) and spaced from each other in such a way to contact with their short sides or long sides to the hot surface (4)
13. The portable air-conditioning device (1) according to claim 1, **characterized by** at least three thermoelectric modules (5) forming a C-shape so as to partially surround the exhaust air duct (8), their hot surfaces (4) being arranged on the concave side of the C-shape, and by PCM packages (10) placed between the hot surfaces (4).
14. The portable air-conditioning device (1) according to claim 1, **characterized by** at least one inlet opening (13) provided in the exhaust air duct (8), in which PCM packages (10) are placed, and enabling air directed by the fan (6) to contact with the PCM packages (10), and a housing (15) having at least one outlet opening (14) which enables discharge of the air passing via the PCM

packages (10).

Figure 1

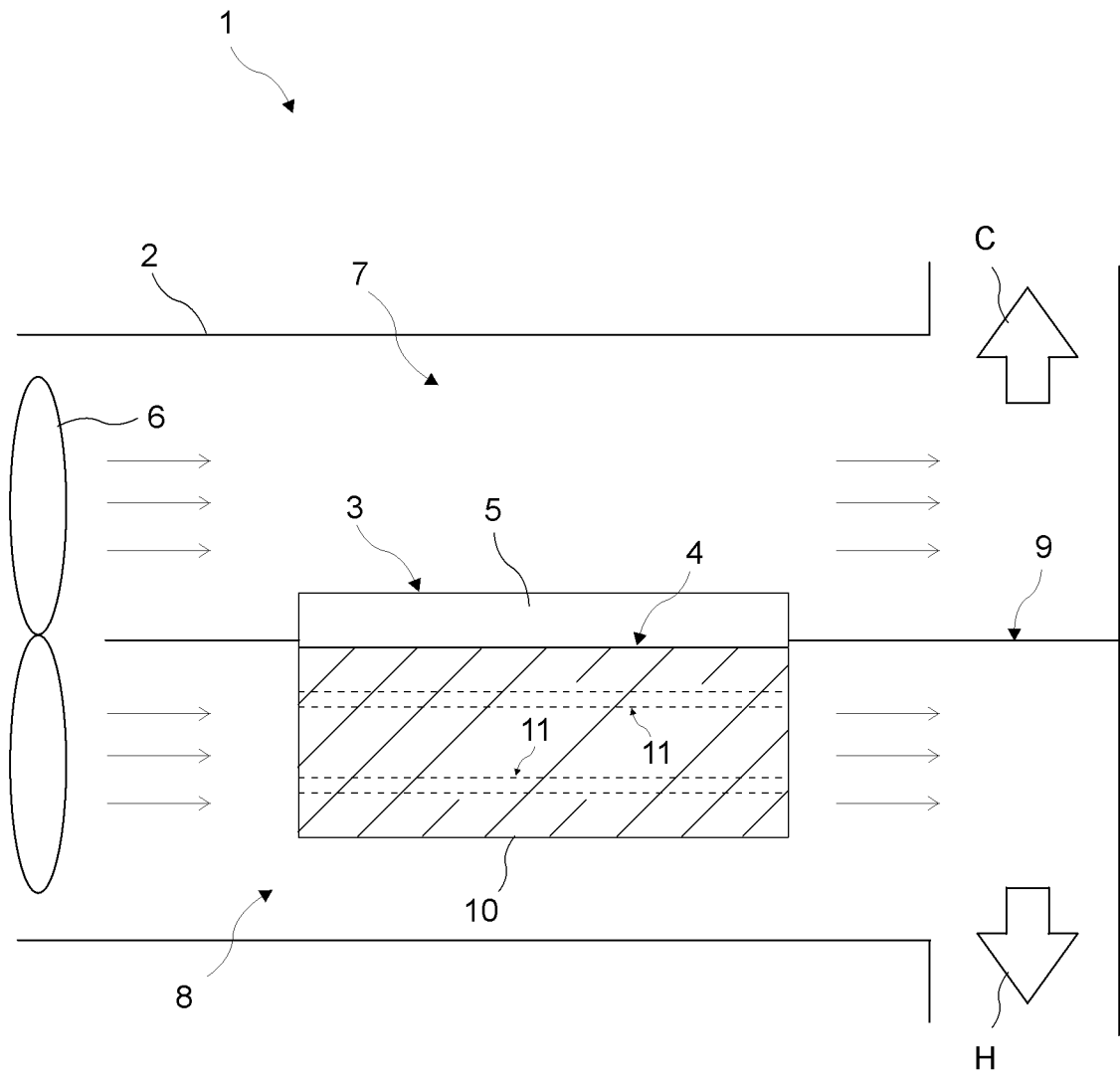


Figure 2

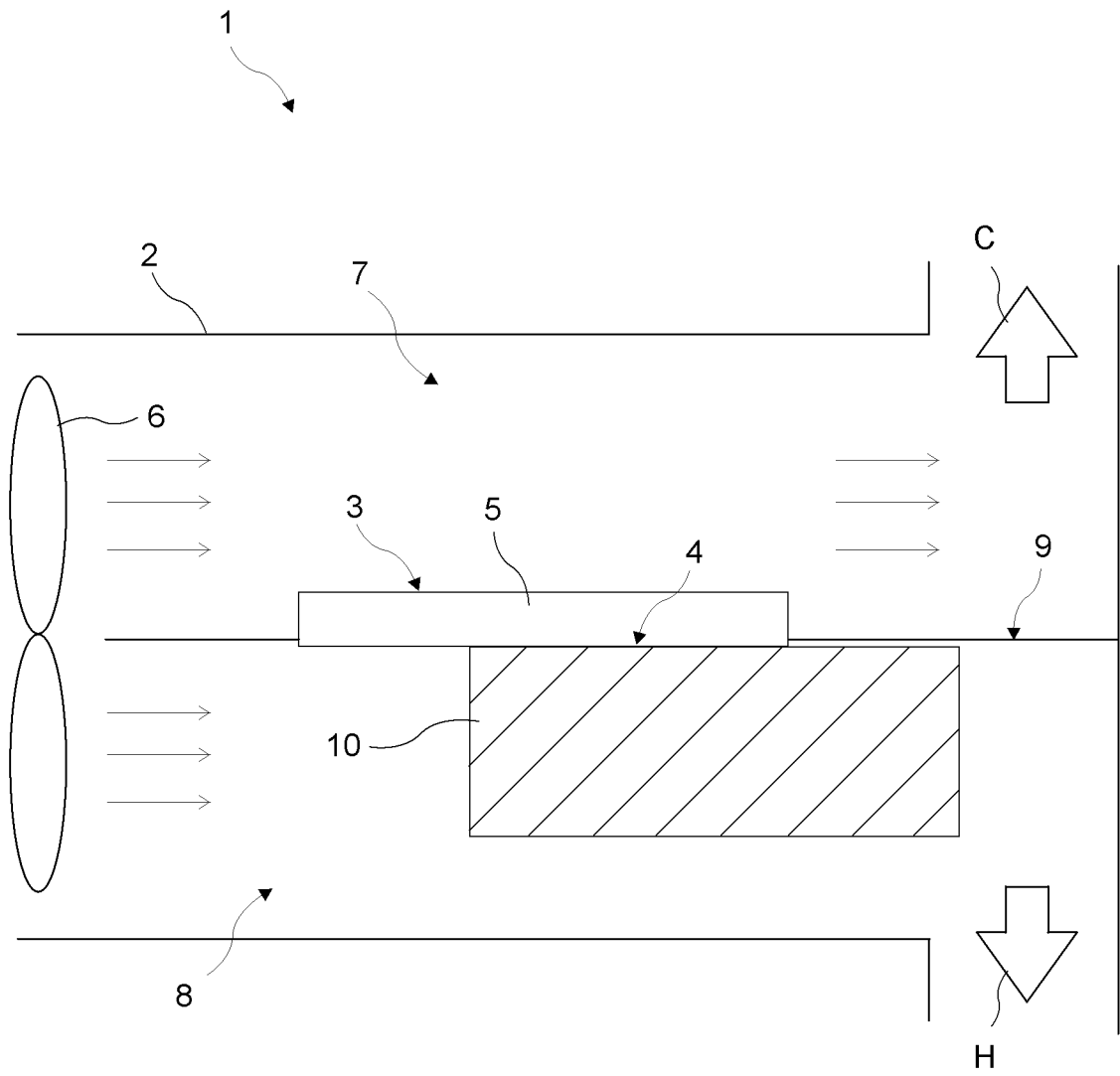


Figure 3

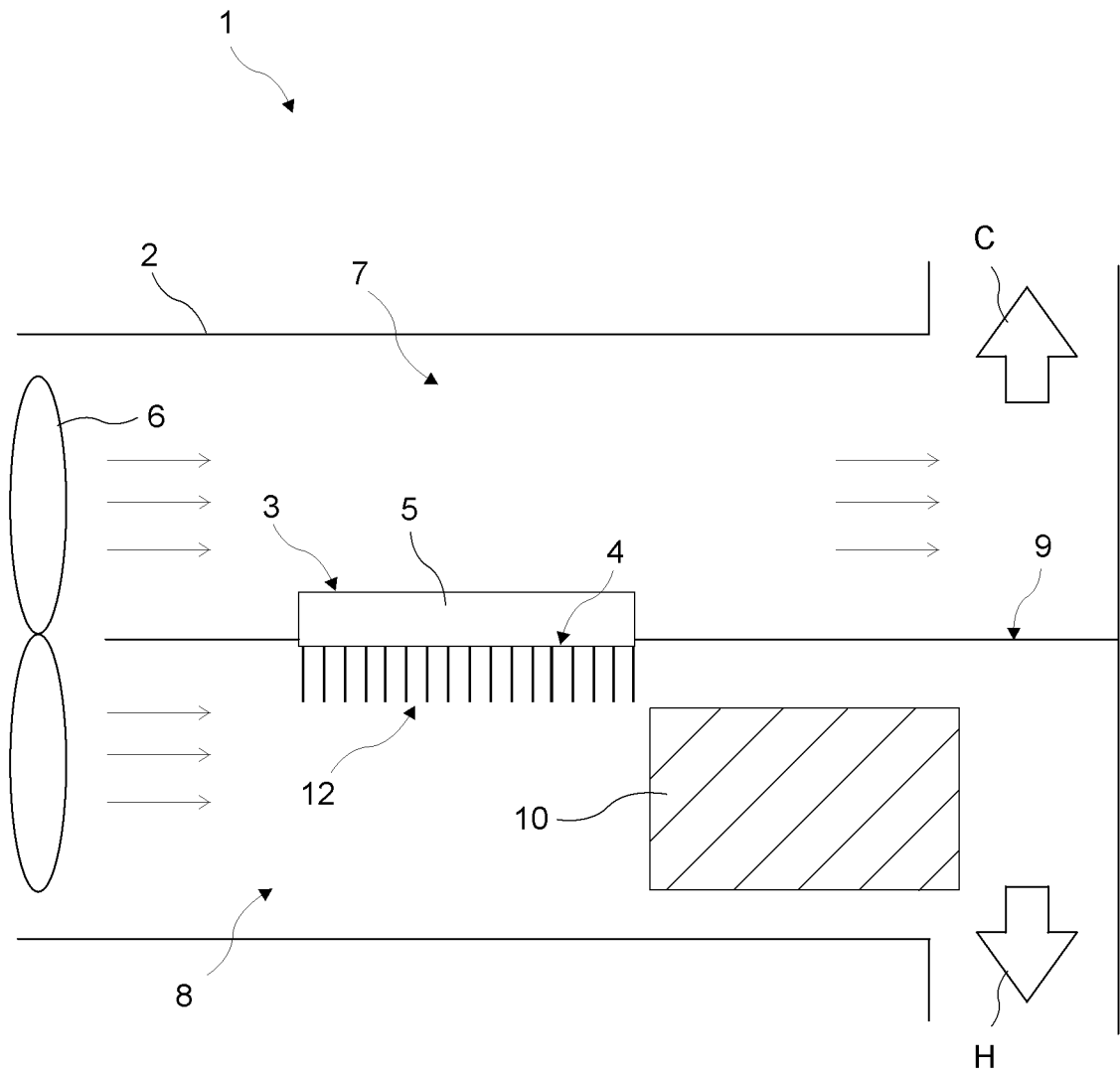


Figure 4

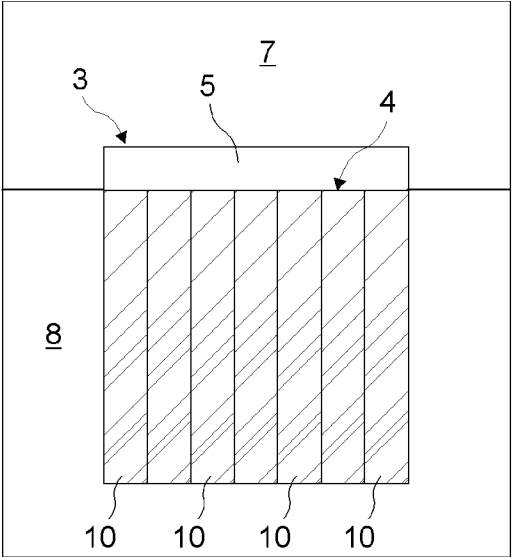


Figure 5

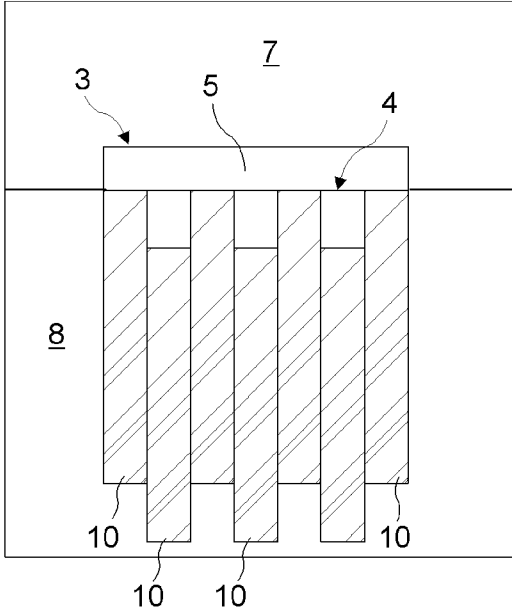


Figure 6

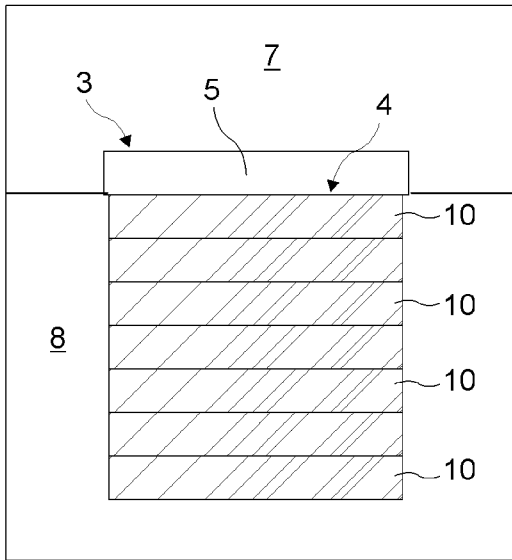


Figure 7

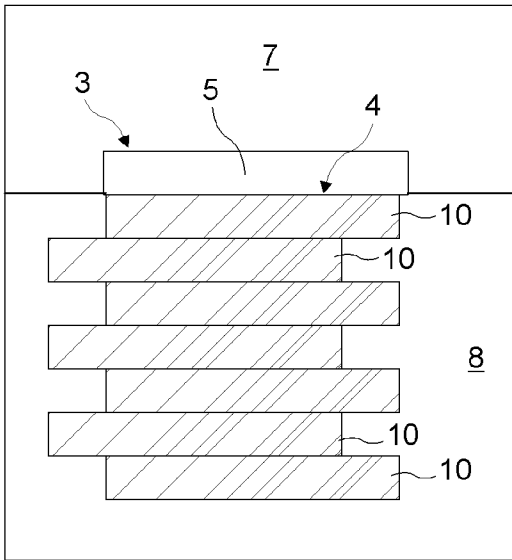


Figure 8

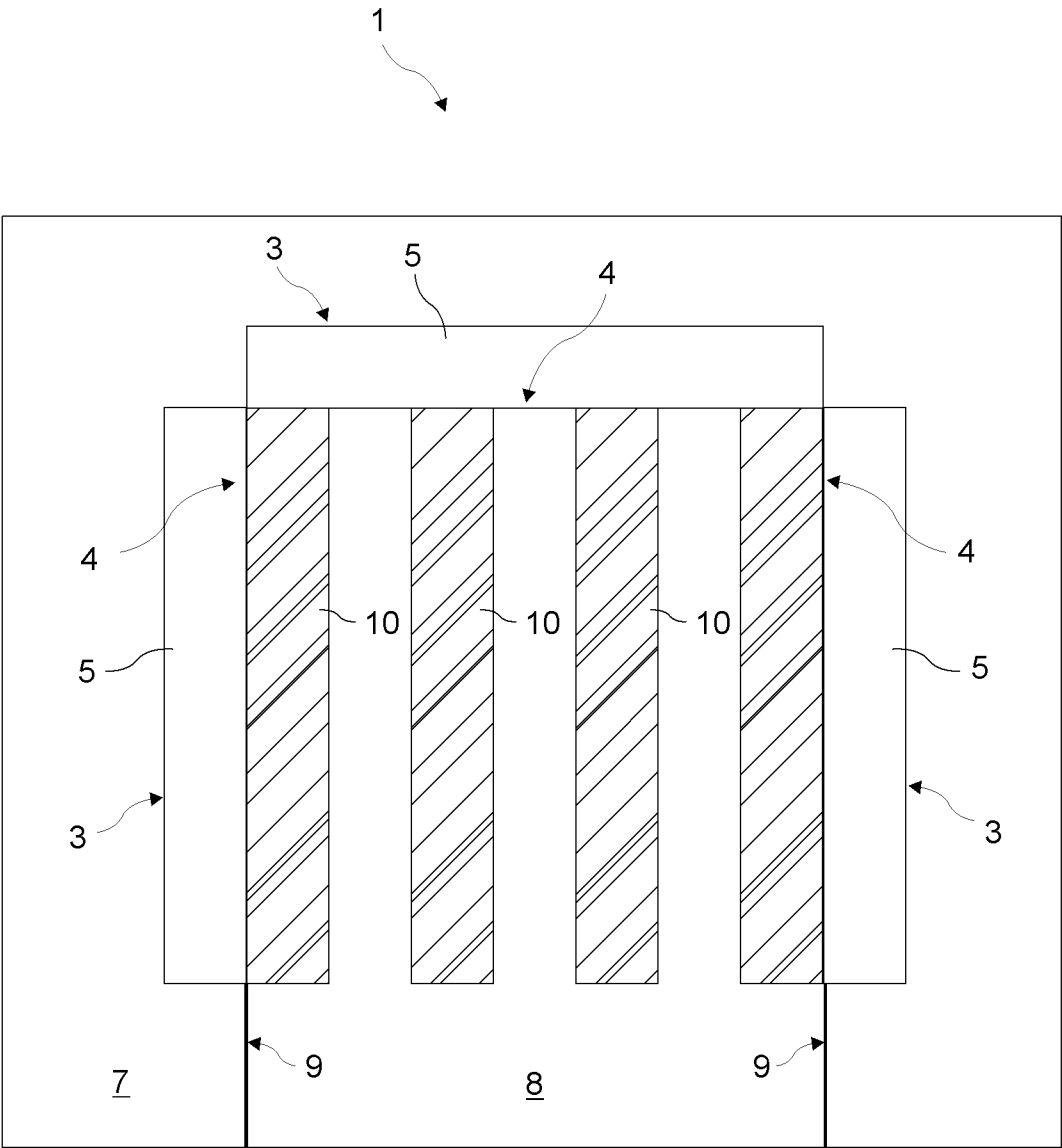
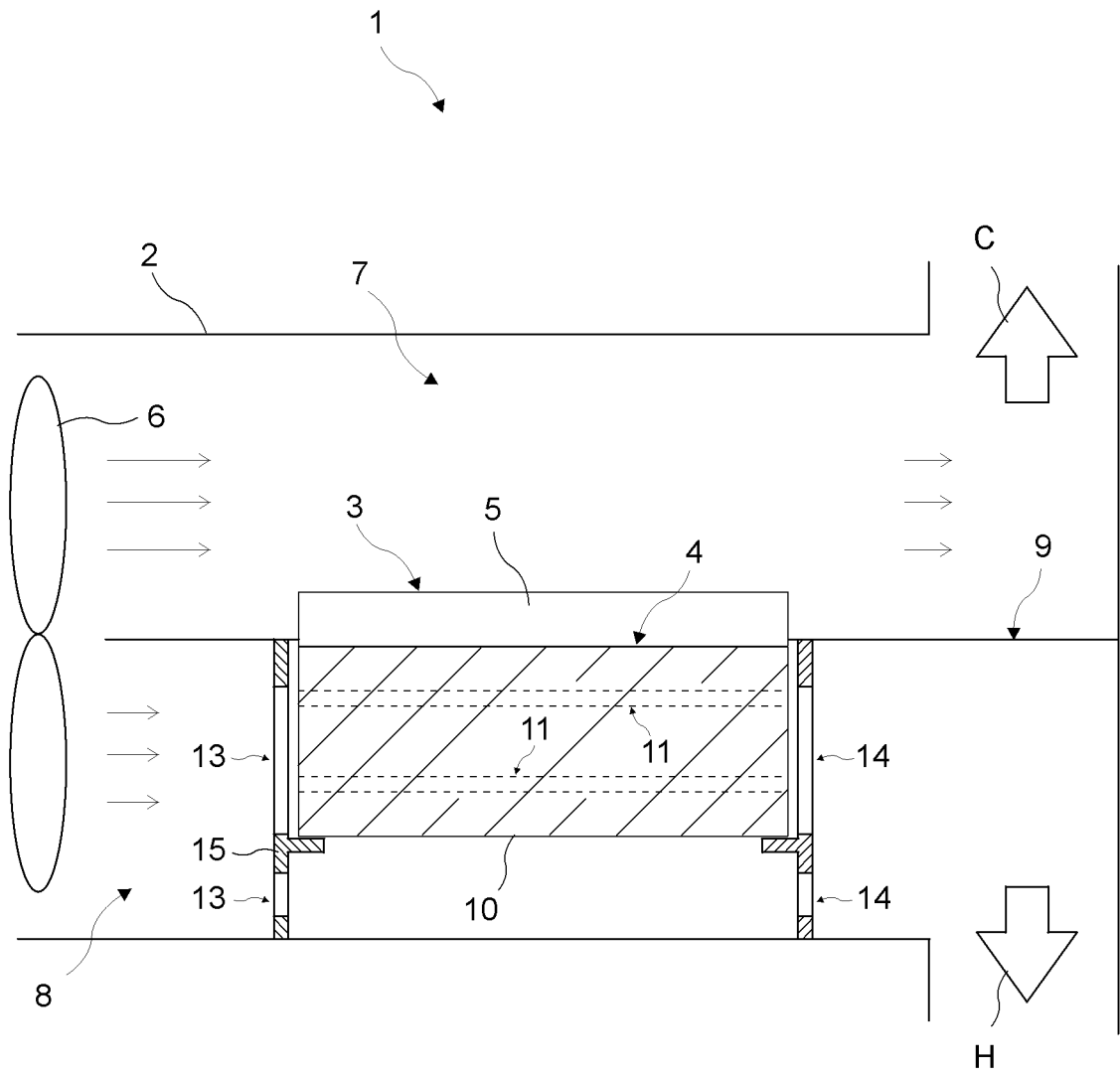


Figure 9



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/064381

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24F5/00
ADD.

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)
F24F F25B F28D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 901 572 A (PEIFFER LARRY [US] ET AL) 11 May 1999 (1999-05-11) column 5, line 1 - column 9, line 5; figures 2,3 -----	1-14
X	WO 2013/130424 A1 (DOUBLE COOL LTD [IL]; KLEIN DAVID [IL]) 6 September 2013 (2013-09-06) cited in the application pages 2-4; claim 1; figure 2 -----	1,2,6
X	JP 2004 319658 A (NIPPON BUROAA KK) 11 November 2004 (2004-11-11) the whole document -----	1,2
X	US 2012/152511 A1 (CHANG CHIEN-LUNG [TW] ET AL) 21 June 2012 (2012-06-21) the whole document ----- -/-	1,2



Further documents are listed in the continuation of Box C.



See patent family annex.

* 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

1 September 2017

Date of mailing of the international search report

08/09/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Lienhard, Dominique

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/064381

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/111008 A1 (SHEETAK INC [US]; GHOSHAL UTTAM [US]; GUHA AYAN [US]; BORAK JAMES [US]) 11 September 2009 (2009-09-11) page 14, line 11 - page 16, line 6; figure 7 page 20, line 35 - page 37, line 15; figures 27,28 -----	1,2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/064381

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5901572	A	11-05-1999	NONE
WO 2013130424	A1	06-09-2013	US 2015033764 A1 05-02-2015 WO 2013130424 A1 06-09-2013
JP 2004319658	A	11-11-2004	JP 3979531 B2 19-09-2007 JP 2004319658 A 11-11-2004
US 2012152511	A1	21-06-2012	NONE
WO 2009111008	A1	11-09-2009	CN 101965490 A 02-02-2011 CN 103398494 A 20-11-2013 US 2011016886 A1 27-01-2011 WO 2009111008 A1 11-09-2009