(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 January 2017 (12.01.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/007353 A1

(51) International Patent Classification:
F24H 1/28 (2006.01) *F28F 1/40* (2006.01)
F24H 8/00 (2006.01) *F24H 9/00* (2006.01)
F28F 1/42 (2006.01)

(21) International Application Number:
PCT/PL2016/000072

(22) International Filing Date:
30 June 2016 (30.06.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
P.413025 5 July 2015 (05.07.2015) PL

(71) Applicant: **AIC SPÓŁKA AKCYJNA** [PL/PL]; ul. Rdestowa 41, 81-577 Gdynia (PL).

(72) Inventors: **SZCZEPAŃSKI, Krzysztof**; ul. Wigury 119, 83-110 Tczew (PL). **BERNACIAK, Maciej**; ul. Stefana Batorego 23/5, 81-365 Gdynia (PL).

(74) Agent: **POMIANEK, Grażyna**; Kancelaria Patentowo-Prawna Grażyna Pomianek, ul. Subisława 23C lok.7, 80-354 Gdańsk (PL).

(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, KR, 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, 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).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

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

(54) Title: CONDENSING HEAT EXCHANGER

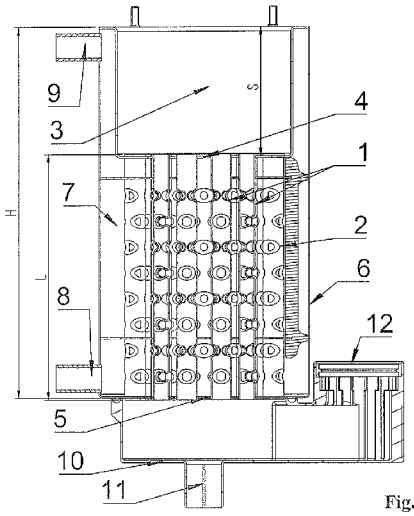


Fig.1

(57) Abstract: Condensing heat exchanger having in its upper part a combustion chamber equipped with a hole for a burner pipe, flue tubes mounted in a tube sheets, encircled by an outer shell, inside of which is created a chamber for the liquid being heated, and equipped with a heated liquid inlet port and outlet port, a condensate tank equipped with a condensate drain discharge and an exhaust outlet into the chimney, characterised in that the ratio of the length (L) of the flue tube (1) to its cross-sectional circumference washed by flue gas is between 2.5 and 6.5, while the flue tubes (1) have embossed pits (2) directed toward the centre of the tube (1), facing each other and forming a section in which the distance between the tips of the pits (2) inside the flue tube (1) is 1.0 mm at most.

WO 2017/007353 A1

Condensing heat exchanger

The invention relates to a condensing heat exchanger to be used in central heating systems and tap water systems.

There are known heat exchangers equipped with an assembly of tubular elements, with hot flue gases flowing through these elements, mounted between two tube sheets and placed in a chamber enclosed by an outer shell with heated water circulating in it, fed by an inlet port located in the lower part of the outer shell and received by a discharge port located in the upper part of the outer shell. In exchangers of this type, the combustion chamber is placed above the upper tube sheet, while below the lower tube sheet, the condensate drain pan is situated.

From patent description PL216290 B1, a heat exchanger is known that is equipped with an outer shell, inside of which there is an assembly of vertical tubular elements mounted at their both ends in tube sheets, and equipped with a gas combustion chamber located above the upper tube sheet, and equipped with walls, mounted crosswise the tubular elements, having holes with tubular elements running through them, and equipped with liquid inlet and outlet ports located in the side wall of the outer shell.

The aim of the invention is to reduce the resistance of flue gas flow through the heat exchanger.

This aim is achieved by selecting the optimum dimensional relationships between various elements of the heat exchanger, depending on the flue tube's cross sectional circumference washed by flue gas, while maintaining the condensing nature of the heat exchanger.

A condensing heat exchanger, having in its upper part a combustion chamber equipped with a hole for a burner pipe, flue tubes mounted

in a tube sheets, encircled by an outer shell, inside of which is created a chamber for the liquid being heated, and equipped with a heated liquid inlet port and outlet port, a condensate tank equipped with a condensate drain discharge and an exhaust outlet into the chimney, is characterised, according to the invention, in that the ratio of the length of the flue tube to its cross-sectional circumference washed by flue gas is between 2.5 and 6.5, and the flue tubes feature embossed pits formed along the length of the tube and pointing towards the centre of the tube, and said pits are positioned opposite each other, and two opposite pits mark out a section, where the distance between the lowest points in the pits measured inside the tube in the section is 1.0 mm at most.

Preferably, the height of the combustion chamber corresponds, at most, to three times the dimension of cross-sectional circumference of the flue tube washed by flue gas.

Preferably, the height of the heat exchanger is six to eight times the dimension of cross-sectional circumference of the flue tube, washed by flue gas.

The proportions developed regarding the dimensions of the heat exchanger secure the condensing nature of the phenomena occurring in the heat exchanger while reducing the resistance of flue gas flow through the heat exchanger.

Further benefits and advantages of the present invention will become apparent after a careful reading of the detailed description with appropriate reference to the accompanying drawings.

In the drawings:

Fig. 1 shows the heat exchanger in an axial section;

Fig. 2 - the flue tube in an isometric view;

Figs. 3 and 4 - the flue tube in a side view;

Fig. 5 - the flue tube in a top view, Figs. 6 and 7 - the flue tube in an axial section;

Fig. 8 - the flue tube in a cross section.

A heat exchanger in the exemplary embodiment of the invention has, in its upper part, a combustion chamber 3 equipped with a hole for a burner pipe, flue tubes 1 mounted in tube sheets 4, 5, enclosed by an outer shell 6, inside of which a heated fluid chamber 7 is formed, and equipped with a heated fluid inlet port 8 and outlet port 9. The lower part of outer shell 6 has a condensate tank 10 mounted, equipped with a condensate discharge 11 and the exhaust outlet 12 into the chimney, as shown in Figure 1. Flue tubes 1 have embossed pits 2 directed towards the centre of tube 1. At a predefined height, the flue tube 1 has two embossed pits 2 facing each other and forming together a separate section, which is shown in Figs. 2 to 8. The distance between the tips of the pits in the flue tube in the section is 0.5 mm, and the ratio of flue tube 1 length L to its cross-sectional circumference washed by flue gas is 3.5. The adjoining sections of pits 2 are located along the flue tube at an angle of 90° one to another. The height H of the heat exchanger is seven times the dimension of the cross-sectional circumference of the flue tube washed by flue gas, and the height S of the combustion chamber is double the dimension of the cross-sectional circumference of the flue tube washed by flue gas.

In other variants of the embodiment described above, the distance between the tips of embossed pits 2 in the flue tube 1 in the section cannot be more than 1.0 mm, and the ratio of flue tube 1 length L to its cross-sectional circumference washed by flue gas is between 2.5 and 6.5.

In other variants of the embodiment described above, the height S of the combustion chamber 3 is at most three times the dimension of the

cross-sectional circumference of the flue tube 1 washed by flue gas, and the height H of the heat exchanger, including the height S of the combustion chamber 3 and the distance between tube sheets 4, 5 with flue tubes installed is six to eight times this dimension.

It was found that for a flue gas temperature of 1 450°C to 1 550°C, at the inlet to the flue tube and with a flow rate of 0.83 - 0.89 kg/h of flue gas in the tube (for natural gas, $CO_2 = 9\%$) and an initial temperature of 30°C and dT = 20 K of heated liquid, with a counterflow of 22 - 26 l/h for the flue tube, , the flue gas at a distance of 155 - 225 mm from the inlet to this tube reaches the dew point, and the pressure drop is not more than 375 Pa.

Claims

1. A condensing heat exchanger having in its upper part a combustion chamber equipped with a hole for a burner pipe, flue tubes mounted in the tube sheets, encircled by an outer shell, inside of which is created a chamber for the liquid being heated, and equipped with a heated liquid inlet port and outlet port, a condensate tank equipped with a condensate drain discharge and an exhaust outlet into the chimney, characterised in that the ratio of the length (L) of the flue tube (1) to its cross-sectional circumference washed by flue gas is between 2.5 and 6.5, and the flue tubes feature embossed pits (2) formed along the length of the tube (1) and pointing towards the centre of the tube (1), and said pits (2) are positioned opposite each other, and two opposite pits (2) mark out a section, where the distance between the lowest points in the pits (2) measured inside the tube (1) in the section is 1.0 mm at most.

2. The exchanger according to Claim 1, characterised in that the height (S) of the combustion chamber (3) corresponds, at most, to three times the dimension of the cross-sectional circumference of the flue tube (1), washed by flue gas.

3. The exchanger according to Claims 1 or 2, characterised in that the height (H) of the heat exchanger, covering the height (S) of the combustion chamber (3) and the distance between tube sheets (4, 5) with flue tubes (1) installed, is six to eight times the dimension of the cross-sectional circumference of flue tube (1), washed by flue gas.

4. A method of heat exchange in the exchanger according to Claims 1 to 3, characterised in that for a flue gas temperature of 1 450°C to 1 550°C, at the inlet to the flue tube (1) and with flow rate of 0.83 - 0.89 kg/h of flue gas in the flue tube (1) (for natural gas, $CO_2 = 9\%$) and

for an initial temperature of 30°C and dT = 20 K of heated liquid, with a counterflow of 22 - 26 l/h for the flue tube (1), , the flue gas at a distance of 155 - 225 mm from the inlet to this tube (1) reaches the dew point, and the pressure drop is not more than 375 Pa.

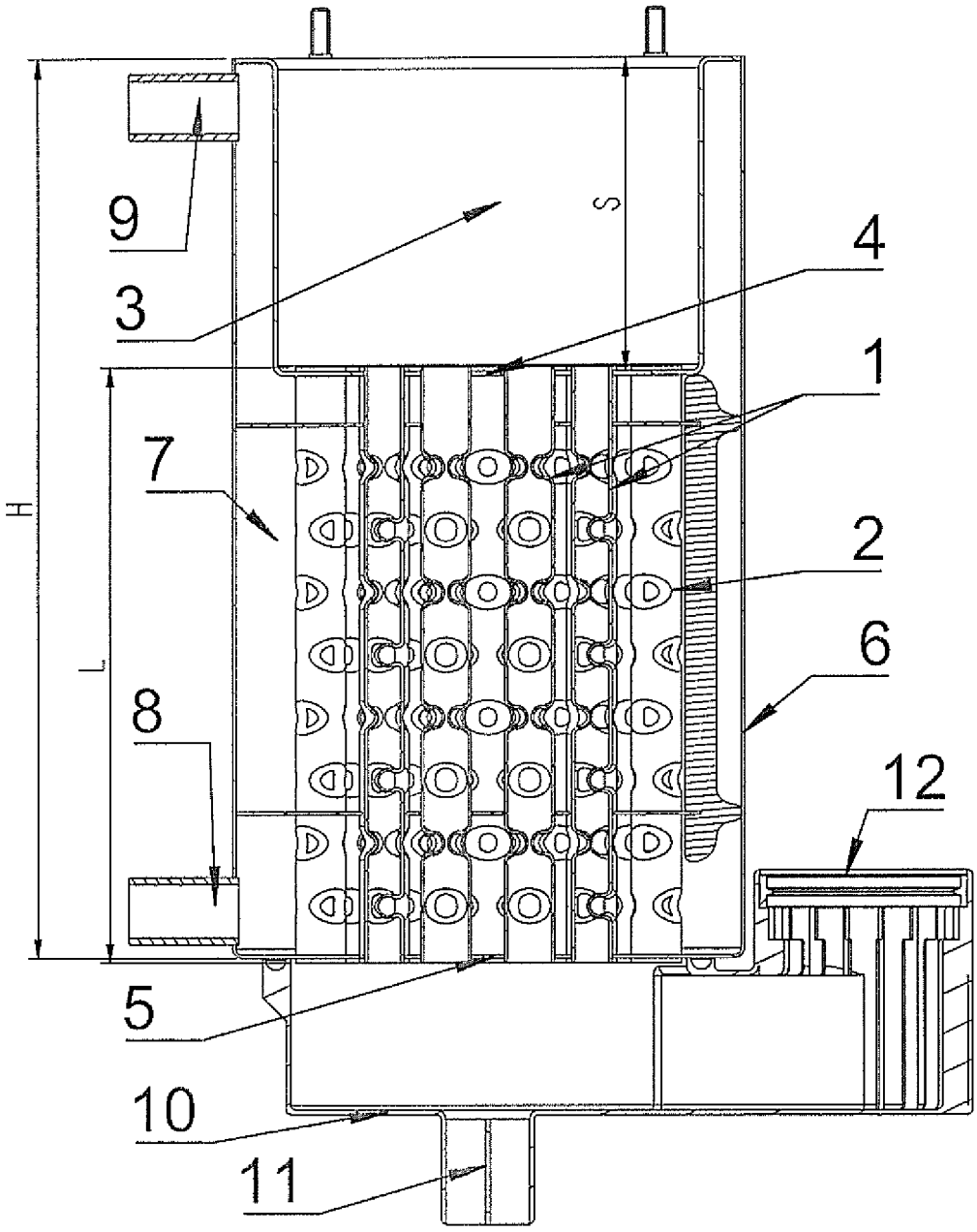


Fig.1

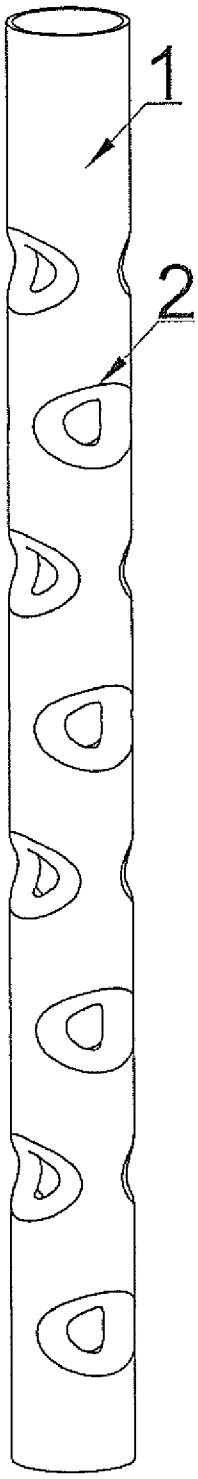


Fig.2

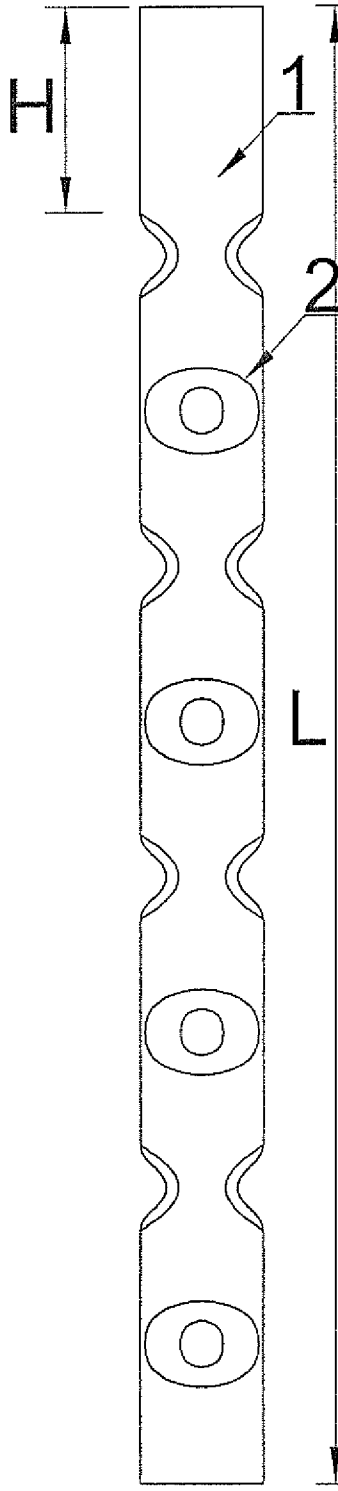


Fig.3

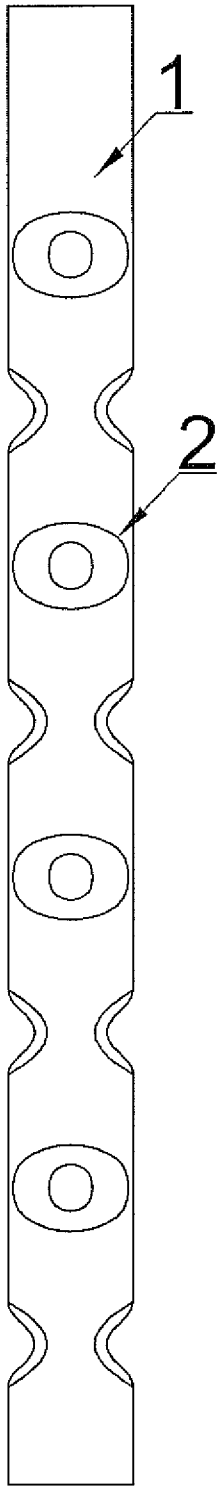


Fig.4

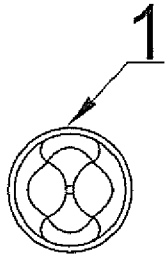


Fig.5

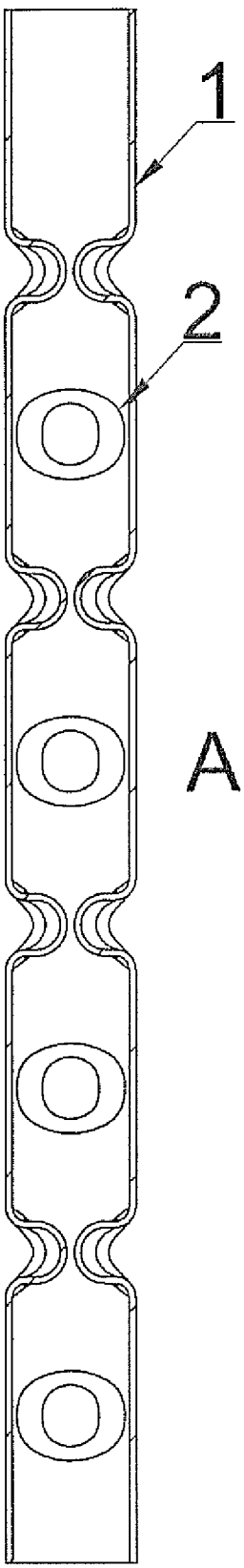


Fig.6

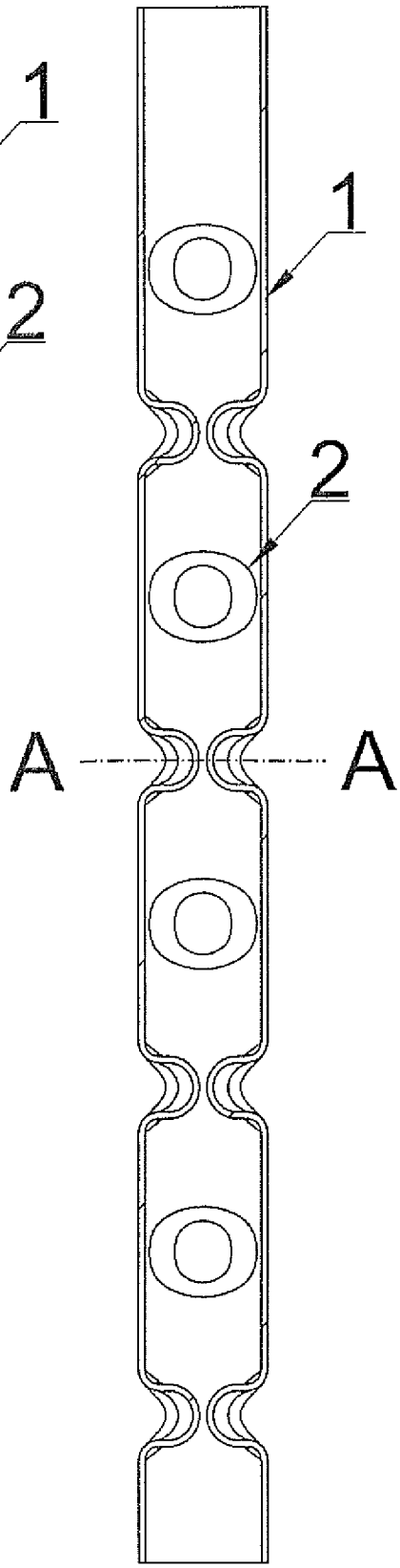


Fig.7

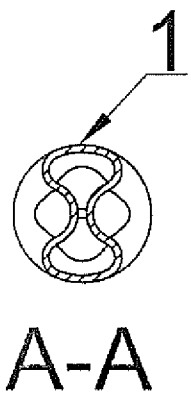


Fig.8

INTERNATIONAL SEARCH REPORT

International application No
PCT/PL2016/000072

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24H1/28 F24H8/00 F28F1/42 F28F1/40 F24H9/00
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)
F24H F28F

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.
Y	WO 2013/141728 A2 (AIC SPOLKA AKCYJNA [PL]) 26 September 2013 (2013-09-26) abstract; figure 1	1-4
Y	US 2008/029243 A1 (O'DONNELL MICHAEL J [US] ET AL) 7 February 2008 (2008-02-07) paragraphs [0009], [0035]; figures 3B,13,14	1-4
Y	US 2011/146594 A1 (SMELCER JIM C [US]) 23 June 2011 (2011-06-23) paragraphs [0060], [0064]; claim 1; figures 2,4,5,5a	1-4
Y	DE 24 08 886 A1 (BUDERUS EISENWERK) 4 September 1975 (1975-09-04) paragraphs [0002] - [0004], [0013]; figures 1,8	1-4

☐ 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	Date of mailing of the international search report
16 September 2016	04/10/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Degen, Marcello

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/PL2016/000072

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013141728 A2	26-09-2013	EP 2828587 A2	28-01-2015
		WO 2013141728 A2	26-09-2013
US 2008029243 A1	07-02-2008	US 2008029243 A1	07-02-2008
		US 2010258280 A1	14-10-2010
US 2011146594 A1	23-06-2011	US 2011146594 A1	23-06-2011
		WO 2011078910 A1	30-06-2011
DE 2408886 A1	04-09-1975	CS 175493 B2	31-05-1977
		DE 2408886 A1	04-09-1975
		DK 684274 A	20-10-1975