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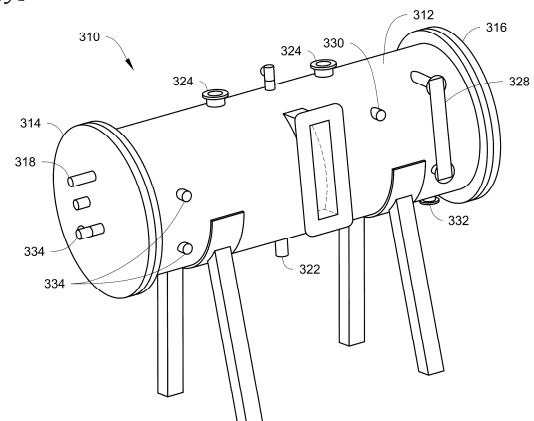
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(54) **STEAM GENERATION UNIT USING A HEAT EXCHANGER**

(57) A steam generation unit includes a heat exchanger that has a shell, end plates for receiving a process fluid in a volume defined by the shell and the end plates, and channels for a working fluid. The shell and the channels define at least a first heat exchange zone, a second heat exchange zone, and a third heat exchange zone each having a respective pass of the channels for preheating the process fluid, for boiling the process fluid, and for superheating the process fluid, respectively. The process fluid is heated sequentially from the first to the second to the third heat exchange zone. A heating, ventilation, air conditioning, and refrigeration (HVACR) system includes a refrigerant circuit with a compressor, a steam generation unit, an expander, and an evaporator fluidly connected.

Fig. 3A



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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2023/143887 A1 (SHEAFFER BRYSON LEE [US]) 11 May 2023 (2023-05-11) * paragraphs [0024] - [0042]; figures 6,7 *	1-15	INV. F22B1/16 F22B1/02 F22B1/18 F22B15/00 F22B29/02 F22D1/00 F22G3/00 F25B39/02 F28D1/02
A	----- CN 114 111 113 A (TAILING INT CO LTD) 1 March 2022 (2022-03-01) * paragraphs [0292] - [0295]; figure 15 *	1-15	F22B1/18 F22B15/00 F22B29/02 F22D1/00 F22G3/00 F25B39/02 F28D1/02
A	----- US 2023/288106 A1 (GALLANT ERICA L [US] ET AL.) 14 September 2023 (2023-09-14) * the whole document *	1-15	ADD. F22D1/20 F22G1/00
A	----- CN 106 482 549 A (GREE ELECTRIC APPLIANCES INC ZHUHAI) 8 March 2017 (2017-03-08) * the whole document *	1-15	
A	----- CN 104 395 687 A (DAIKIN APPLIED AMERICAS INC) 4 March 2015 (2015-03-04) * the whole document *	1-15	
A	----- EP 4 030 119 A1 (JOHNSON CONTROLS DENMARK APS [DK]) 20 July 2022 (2022-07-20) * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F22B F22D F22G F25B F28D F28B
A	----- CN 103 946 658 A (CARRIER CORP) 23 July 2014 (2014-07-23) * the whole document *	1-15	
A	----- CN 118 687 143 A (DONGFANG BOILER GROUP CO LTD OF DONGFANG ELECTRIC CORP ET AL.) 24 September 2024 (2024-09-24) * the whole document *	1-15	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 September 2026	Examiner Röberg, Andreas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 26 16 7555

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-09-2026

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2023143887 A1	11-05-2023	CN 115398162 A	25-11-2022
		EP 4111109 A1	04-01-2023
		KR 20220146592 A	01-11-2022
		US 2023143887 A1	11-05-2023
		US 20250257921 A1	14-08-2025
		WO 2021174110 A1	02-09-2021

CN 114111113 A	01-03-2022	CN 113383200 A	10-09-2021
		CN 114111113 A	01-03-2022
		CN 117515934 A	06-02-2024
		EP 3659838 A1	03-06-2020
		EP 3887181 A2	06-10-2021
		EP 4644803 A2	05-11-2025
		US 2021285693 A1	16-09-2021
		US 2021396436 A1	23-12-2021
		WO 2020113152 A2	04-06-2020

US 2023288106 A1	14-09-2023	CN 219810065 U	10-10-2023
		EP 4220040 A1	02-08-2023
		US 2023288106 A1	14-09-2023

CN 106482549 A	08-03-2017	NONE	

CN 104395687 A	04-03-2015	CN 104395687 A	04-03-2015
		EP 2841867 A1	04-03-2015
		ES 2593403 T3	09-12-2016
		HK 1205246 A1	11-12-2015
		JP 6378670 B2	22-08-2018
		JP 2015518132 A	25-06-2015
		US 2013277020 A1	24-10-2013
		US 2018112924 A1	26-04-2018
		WO 2013162761 A1	31-10-2013

EP 4030119 A1	20-07-2022	EP 4030119 A1	20-07-2022
		US 2022228781 A1	21-07-2022

CN 103946658 A	23-07-2014	CN 103946658 A	23-07-2014
		EP 2780650 A1	24-09-2014
		US 2014311721 A1	23-10-2014
		WO 2013074749 A1	23-05-2013

CN 118687143 A	24-09-2024	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82