

(19)



(11)

EP 2 878 907 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.06.2015 Bulletin 2015/23

(51) Int Cl.:
F28B 1/02 (2006.01) F28B 7/00 (2006.01)

(21) Application number: **13194842.4**

(22) Date of filing: **28.11.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME

(72) Inventor: **Lenherr, Hans-Ulrich**
5426 Lengnau AG (CH)

(74) Representative: **Alstom Technology Ltd**
CHTI Intellectual Property
Brown Boveri Strasse 7
5400 Baden (CH)

(71) Applicant: **ALSTOM Technology Ltd**
5400 Baden (CH)

(54) **Integrated condenser**

(57) This invention relates to a condenser for water/steam cycle, comprising a cooling water inlet (31), a cooling water outlet (33) and a cooling unit (32) disposed between the inlet and outlet, wherein the cooling unit comprises a first cooling chamber (34) to receive and cool steam from the water/steam cycle and a second cooling chamber (35) to receive and cool another cooling

circuit (70). With this integrated condenser of the present invention, no separate intercooler is needed and one common cooling water supply and return line can be applied. Thus the whole piping length can be reduced. Further, as no separate foundation and mounting are required, it is able to reduce the space and on-site installation process and thus reduce the overall cost.

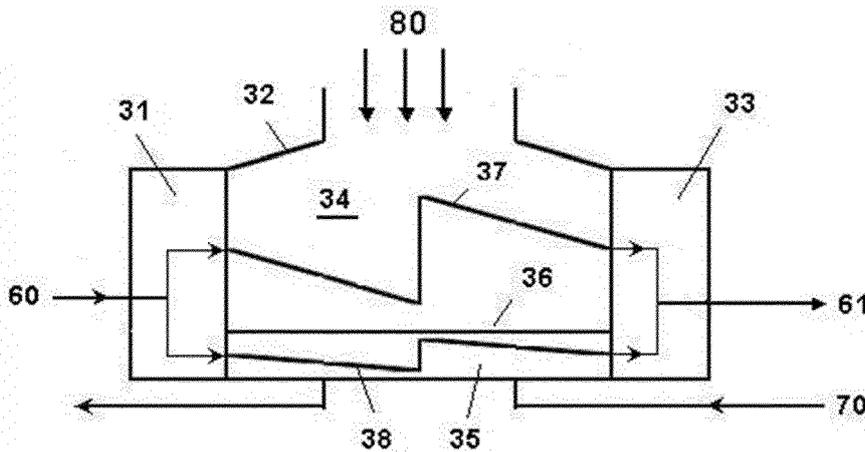


Fig.2

EP 2 878 907 A1

Description

Technical Field

[0001] The present invention relates to a condenser for water/steam cycle, in particular to an integrated condenser for water/steam cycle of a thermal power plant.

Background of the Invention

[0002] A water/steam cycle of a thermal power plant in general comprises, as shown in the schematic diagram of Fig. 1, a steam generator 10, a steam turbine 20, a condenser 30 and a feedwater pump 40. The steam generator 10, which may be a heat recovery steam generator (HRSG) of a combined cycle power plant (CCPP), generates steam by heating up feedwater, which is pumped to the steam generator 10 by means of the feedwater pump 40. The generated steam is used to drive the steam turbine 20, which may have high-pressure, intermediate pressure and low pressure stages. The steam, which leaves the steam turbine 20, is converted back into feedwater by means of the water cooled condenser 30 with its internal cooling water circuit. The configuration of a typical water cooled condenser 30 is well known in the prior art (see document US5018572A and WO2013117730). The condenser 30 comprises a plurality of tube bundles, through which the cooling water flows. The steam from the steam turbine 20 enters the condenser 30 and comes into close thermal contact with the tube bundles. As a result, the heat exchange was conducted between the steam and the cooling water in the tube bundles. The condensed steam is then collected in a hot well in the condenser, and then led to the feedwater pump 40.

[0003] The cooling water through the condenser 30 comes from the main cooling water stream 60. As shown in Fig. 1, a branch of the main cooling water stream 60 enters the condenser 30 for cooling the steam. In the meantime, another branch of the main cooling water stream 60 enters an intercooler 50 to conduct heat exchange with another cooling circuit 70. Typically, the cooling circuit 70 uses the closed cooling water (CCW) therein to cool another unit such as the gas turbine generator, gas turbine lube oil system, and the like. The closed cooling water is demineralized water treated with chemicals so as to prevent corrosion. Therefore, the units are not directly cooled by the main cooling water but by the closed cooling water. Then the cooling circuit 70 taking the heat from the units is cooled by the main cooling water in the intercooler 50.

[0004] Fig. 1 schematically shows the conventional arrangement of the cooling system in a thermal power plant. As described above, the water cooled condenser 30 and the closed cooling water intercooler 50 are two separate components while they share the same main cooling water stream 60 as the cooling media source. However, such arrangement of the cooling system raises an issue. That is, due to the separate arrangement of the condens-

er 30 and the intercooler 50, cleaning system and piping need to be disposed dublicately for the condenser and the intercooler, and separate foundations for the condenser and the intercooler are required. This takes up a lot of space. In the meantime, the duplicated arrangement also causes higher cost.

Summary of the Invention

[0005] It is therefore an object of the present invention to avoid the drawbacks of the current arrangement of the cooling system and provide an integrated condenser, which could achieve the same cooling effect while save the space and cost as well as simplify the on-site installation process.

[0006] According to one embodiment of the present invention, a condenser for water/steam cycle is provided, comprising a cooling water inlet, a cooling water outlet and a cooling unit disposed between the inlet and outlet, wherein the cooling unit comprises a first cooling chamber to receive and cool steam from the water/steam cycle and a second cooling chamber to receive and cool another cooling circuit.

[0007] According to another one embodiment of the present invention, the cooling water inlet receives main cooling water and delivers it respectively to the first cooling chamber and the second cooling chamber, the cooling water outlet receives the returned main cooling water and delivers it out of the condenser.

[0008] According to another one embodiment of the present invention, the first cooling chamber comprises a plurality of first pipes to convey cooling water from the cooling water inlet to the cooling water outlet and conduct heat exchange with the steam, the second cooling chamber comprises a plurality of second pipes to convey cooling water from the cooling water inlet to the cooling water outlet and conduct heat exchange with said another cooling circuit.

[0009] With the integrated condenser of the present invention, no separate intercooler is needed and one common cooling water supply and return line can be applied. Thus the whole piping length can be reduced. Further, as no separate foundation and mounting are required, it is able to reduce the space and on-site installation process and thus reduce the overall cost. Besides, as the intercooler is integrated into the condenser as the second cooling chamber, the whole equipment shall be delivered and maintained by one supplier, which also reduce the cost and outage time for service.

[0010] According to another one embodiment of the present invention, the returned main cooling water comprises a first cooling water return line on the downstream of the first cooling chamber and a second cooling water return line on the downstream of the second cooling chamber, wherein a control valve is disposed in the first cooling water return line or the second cooling water return line. The control valves can also be disposed in both the first cooling water return line and the second cooling

water return line.

[0011] According to another one embodiment of the present invention, the main cooling water is split into a first cooling water supply line on the upstream of the first cooling chamber and a second cooling water supply line on the upstream of the second cooling chamber, wherein a control valve is disposed in the first cooling water supply line or the second cooling water supply line.

[0012] The another cooling circuit mentioned above is used to cool another unit in a thermal power plant such as the gas turbine generator or steam turbine generator, gas turbine or steam turbine lube oil system, feedwater pump and the like.

[0013] With the control valve disposed in the cooling water supply line or return line, it is able to keep the cooling circuit in an expected temperature level, so as to assure a correct cooling on said another unit to be cooled by the cooling circuit.

Brief Description of the Drawings

[0014] The objects, advantages and other features of the present invention will become more apparent upon reading of the following non-restrictive description of preferred embodiments thereof, given for the purpose of exemplification only, with reference to the accompany drawing, through which similar reference numerals may be used to refer to similar elements, and in which:

- Fig. 1 shows a schematic view of a water/steam cycle of a thermal power plant in prior art;
- Fig. 2 shows a schematic view of the first embodiment of the invention;
- Fig. 3 shows a schematic view of the second embodiment of the invention;
- Fig. 4 shows a schematic view of the third embodiment of the invention.

Detailed Description of Different Embodiments of the Invention

[0015] Fig. 2 shows a schematic view of the condenser according to the first embodiment of the invention. As described in the above section, this condenser 30 is arranged in a water/steam cycle of a thermal power plant in general. The condenser 30 comprises a cooling water inlet 31, a cooling water outlet 33 and a cooling unit 32 disposed between the cooling water inlet and outlet. The cooling water inlet and outlet can be a waterbox as known in the prior art. The cooling unit 32 comprises a first cooling chamber 34 and a second cooling chamber 35 separated by a partition wall 36.

[0016] The cooling water inlet 31 receives the main cooling water 60 as the cooling media source from outside and delivers it into the first cooling chamber 34 and

second cooling chamber 35. The first cooling chamber 34 includes a plurality of first pipes 37 to convey a portion of the main cooling water from the cooling water inlet 31. The first pipes 37 are in form of a plurality of tube bundles arranged in parallel. As shown in Fig. 2, the steam 80 from the water/steam cycle is fed into the first cooling chamber 34 and comes into close thermal contact with the cooling water flowing through the first pipes 37. The cooling water in the first pipes 37 after taking the heat from the steam flows to the cooling water outlet 33. The second cooling chamber 35 includes a plurality of second pipes 38. The second pipes 38 can also be in form of a plurality of tube bundles, which conveys another portion of the main cooling water 60 from the cooling water inlet 31. The second cooling chamber 35 receives the water to be cooled from another cooling circuit 70. As mentioned in the previous section, the cooling circuit 70 is used to cool another unit in a thermal power plant, such as the gas turbine generator or steam turbine generator, gas turbine or steam turbine lube oil system, feedwater pump and the like. The cooling circuit 70 normally contains demineralized water treated with chemicals so as to prevent corrosion. It takes the heat from another unit and then is fed into the second cooling chamber 35. The heat exchange is conducted in the second cooling chamber 35 between the demineralized water from the cooling circuit 70 and the cooling water flowing through the second pipes 38. As shown in Fig. 2, the flow direction of the cooling circuit 70 is preferably opposite to the cooling water flow direction in the second pipes 38 so as to perform a better heat exchange effect. The cooling water in the second pipes 38 upon taking the heat then flows to the cooling water outlet 33.

[0017] In the conventional arrangement of the cooling system as mentioned in the previous section, a separate intercooler is used to cool the cooling circuit 70. In the above embodiment of present invention, the second cooling chamber 35 performs as the intercooler, which is integrated into the condenser 30. As a result, no additional foundation and mounting are required for the intercooler, which saves space and makes the on-site installation process simpler.

[0018] Fig. 3 shows a schematic view of the condenser according to the second embodiment of the invention. The main configuration is similar to that in Fig. 2. The main cooling water after flowing through the first cooling chamber 34 and the second cooling chamber 35 returns to the cooling water outlet 33. This returned main cooling water comprises a first cooling water return line 43 on the downstream of the first cooling chamber 34 and a second cooling water return line 44 on the downstream of the second cooling chamber 35. The cooling water outlet 33 is divided into two compartments, which respectively receive the first cooling water return line 43 and the second cooling water return line 44. A control valve 46 is disposed in the second cooling water return line 44. After the control valve 46, the first cooling water return line 43 and second cooling water return line 44 are joined

to one stream of the returned main cooling water 61.

[0019] As mentioned before, the cooling circuit 70 is used to cool another unit in a thermal power plant, such as the gas turbine generator or steam turbine generator, gas turbine or steam turbine lube oil system. Such unit requires a more precise control on the target cooling temperature. Therefore, the cooling water temperature in the cooling circuit 70 has to be precisely controlled to assure a correct cooling on said unit. To achieve this target, the control valve 46 is arranged to control the flow rate of the main cooling water through the second cooling chamber 35, and thus to control the heat exchange between the cooling water in the second pipes 38 and the cooling water in the cooling circuit 70. As a result, the temperature of the cooling water in the cooling circuit 70 can be kept on an expected temperature level.

[0020] Alternatively, the control valve 46 is disposed in the first cooling water return line 43 to control the distribution of the flow rate for the main cooling water 60. For example, the control valve 46 can reduce the cooling water flow rate through the first cooling chamber 34 and as a result increase the flow rate to the second cooling chamber 35. Further, it is also possible to arrange two control valves in both the first and second cooling water return line. This may provide better flexibility and operability on the temperature control of the cooling circuit 70.

[0021] Fig. 4 shows a schematic view of the condenser according to the third embodiment of the invention. The main cooling water 60 is split into a first cooling water supply line 41 on the upstream of the first cooling chamber 34 and a second cooling water supply line 42 on the upstream of the second cooling chamber 35. A control valve 45 is disposed in the second cooling water supply line 42. The cooling water inlet 31 is divided into two compartments, which respectively receive the main cooling water from the first cooling water supply line and the second cooling water supply line, and deliver it into the first cooling chamber 34 and the second cooling chamber 35 separately. Same as the second embodiment, the control valve 45 is used to control the flow rate of the cooling water flowing through the second pipes 38, so as to indirectly control the cooling temperature of the cooling circuit 70. Alternatively, the control valve 45 is disposed in the first cooling water supply line 41.

[0022] Although in the second and third embodiment, the control valve is disposed either on the upstream or the downstream of the second cooling chamber, it can be also arranged on both the upstream and downstream of the first and/or second cooling chamber depending on the actual requirement. When two valves are arranged on both the upstream and downstream of the cooling chamber, it is preferred that a control valve is arranged on the downstream of the cooling chamber, and a shutoff valve is arranged on the upstream of the cooling chamber.

[0023] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not

limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

List of Reference Numerals

15	[0024]	
10		steam generator
20		steam turbine
30		condenser
20	31	cooling water inlet
	32	cooling unit
	33	cooling water outlet
	34	first cooling chamber
	35	second cooling chamber
25	36	partition wall
	37	first pipe
	38	second pipe
	40	feedwater pump
	41	first cooling water supply line
30	42	second cooling water supply line
	43	first cooling water return line
	44	second cooling water return line
	45, 46	control valve
	50	intercooler
35	60	main cooling water
	61	returned main cooling water
	70	cooling circuit
	80	steam

40

Claims

1. A condenser for water/steam cycle, comprising a cooling water inlet (31), a cooling water outlet (33) and a cooling unit (32) disposed between the inlet and outlet, wherein the cooling unit comprises a first cooling chamber (34) to receive and cool steam from the water/steam cycle, **characterized in that** the cooling unit further comprise a second cooling chamber (35) to receive and cool another cooling circuit (70).
2. The condenser according to claim 1, **characterized in that**, the cooling water inlet (31) receives main cooling water (60) and delivers it respectively to the first cooling chamber (34) and the second cooling chamber (35), the cooling water outlet (33) receives the returned main cooling water and delivers it out

55

of the condenser.

- 3. The condenser according to claim 2, **characterized in that**, the returned main cooling water comprises a first cooling water return line (43) on the downstream of the first cooling chamber (34) and a second cooling water return line (44) on the downstream of the second cooling chamber (35), wherein a control valve (46) is disposed in the first cooling water return line or the second cooling water return line.

5
10

- 4. The condenser according to claim 3, **characterized in that**, the control valves (46) are disposed in both the first cooling water return line and the second cooling water return line.

15

- 5. The condenser according to any of claims 2 to 4, **characterized in that**, the main cooling water (60) is split into a first cooling water supply line (41) on the upstream of the first cooling chamber (34) and a second cooling water supply line (42) on the upstream of the second cooling chamber (35), wherein a control valve (45) is disposed in the first cooling water supply line or the second cooling water supply line.

20
25

- 6. The condenser according to any one of the above claims, **characterized in that**, the first cooling chamber (34) comprises a plurality of first pipes (37) to convey cooling water from the cooling water inlet (31) to the cooling water outlet (33) and conduct heat exchange with the steam, the second cooling chamber (35) comprises a plurality of second pipes (38) to convey cooling water from the cooling water inlet (31) to the cooling water outlet (33) and conduct heat exchange with said another cooling circuit (70).

30
35

- 7. The condenser according to any one of the above claims, **characterized in that**, said another cooling circuit (70) is used to cool another unit in a thermal power plant such as the gas turbine generator or steam turbine generator, gas turbine or steam turbine lube oil system, and feedwater pump.

40
45
50
55

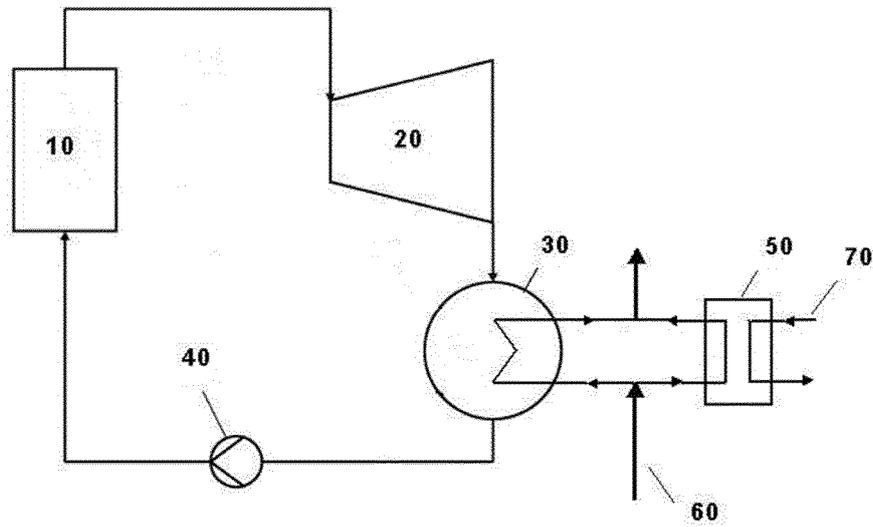


Fig.1

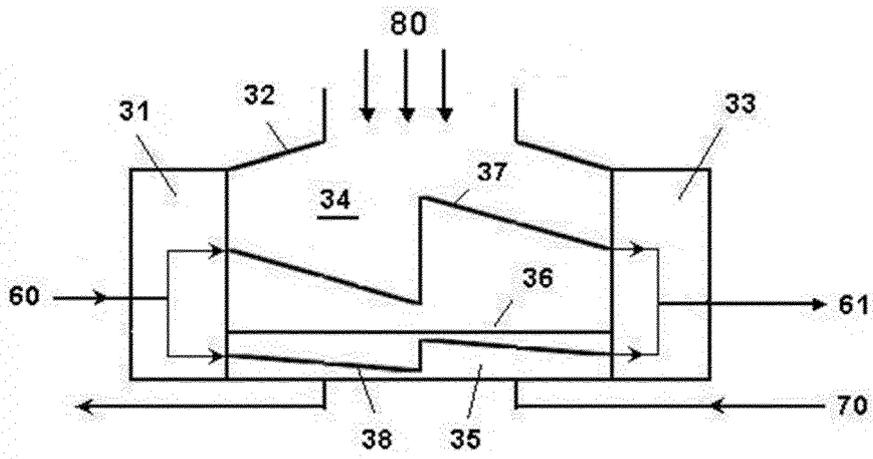


Fig.2

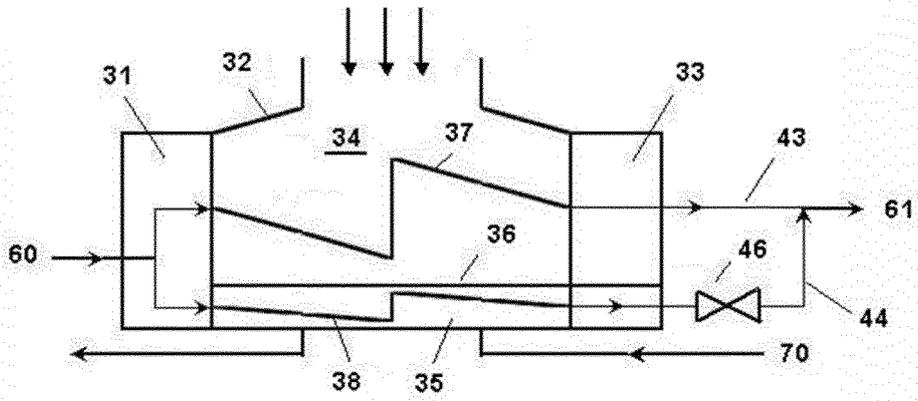


Fig.3

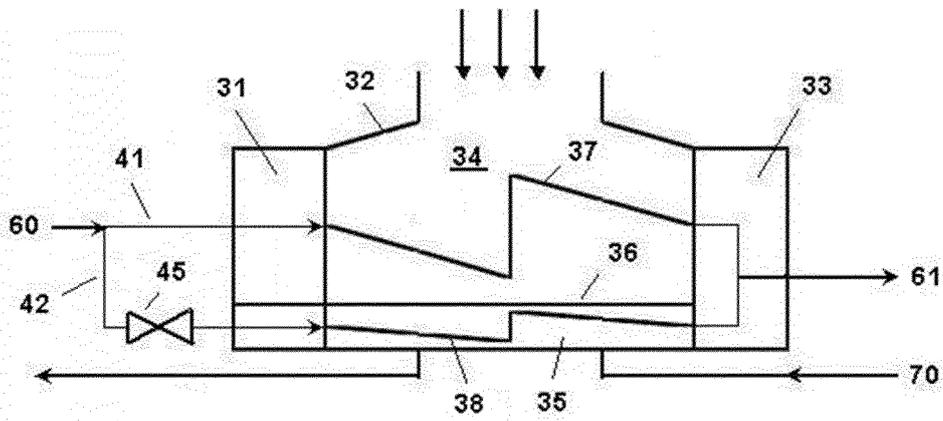


Fig.4



EUROPEAN SEARCH REPORT

Application Number
EP 13 19 4842

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 174 672 A2 (ALSTOM SWITZERLAND LTD [CH]) 23 January 2002 (2002-01-23)	1,2,6,7	INV. F28B1/02 F28B7/00
Y	* figure 4 *	3-5	
Y	----- US 2010/229553 A1 (SMITH GORDON RAYMOND [US]) 16 September 2010 (2010-09-16) * figure 1 * -----	3-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		1 April 2014	Vassoille, Bruno
CATEGORY OF CITED DOCUMENTS		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	
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			

1
EPO FORM 1503 03 82 (P04C01)

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

EP 13 19 4842

5

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.

01-04-2014

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1174672 A2	23-01-2002	DE 10031789 A1	28-02-2002
		EP 1174672 A2	23-01-2002
		US 2002005276 A1	17-01-2002

US 2010229553 A1	16-09-2010	CN 101900494 A	01-12-2010
		EP 2423458 A2	29-02-2012
		JP 2010216475 A	30-09-2010
		US 2010229553 A1	16-09-2010

15

20

25

30

35

40

45

50

55

EPO FORM P/0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5018572 A [0002]
- WO 2013117730 A [0002]