(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 789 722 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.03.2021 Bulletin 2021/10

(21) Application number: **19195102.9**

(22) Date of filing: **03.09.2019**

(51) Int Cl.:
F28G 1/02 *(2006.01)* ***F28G 9/00*** *(2006.01)*
F28G 1/16 *(2006.01)* ***B01D 53/88*** *(2006.01)*

(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
Designated Validation States:
KH MA MD TN

(71) Applicant: **Yara International ASA**
0277 Oslo (NO)

(72) Inventors:
- **KURKA, Wolfgang**
  73431 Aalen (DE)
- **MADL, Florian**
  1220 Vienna (AT)
- **ZOBL, Adi**
  1120 Vienna (AT)

(74) Representative: **De Clercq & Partners**
Edgard Gevaertdreef 10a
9830 Sint-Martens-Latem (BE)

(54) RECIPROCATING RAKE TYPE SOOT BLOWER SYSTEM

(57) The present disclosure relates to a reciprocating rake type soot blower system, which is arranged to be installed above a catalyst of a DeNOx-system, the catalyst being provided with an upper surface and with one or more catalyst channels, wherein the soot blower system is arranged to clean upper surface of the catalyst, wherein the system comprises at least one blowing rake that is provided with at least one transverse tube that is provided with a nozzle row having a multitude of nozzles that are arranged to blow a soot blowing medium onto the upper surface of the catalyst, and a brushing system comprising one or more rows of brushes lined on at least one side of each of the nozzle rows that are arranged to move over the upper surface of the catalyst and to swipe the dust into the one or more catalyst channels. The present disclosure furthermore relates to a thermal power plant comprising such a system.

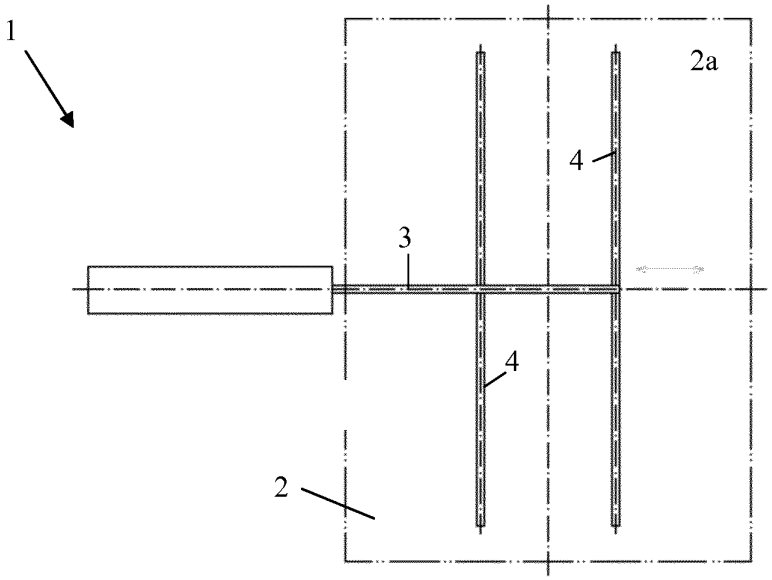

FIG. 1

EP 3 789 722 A1

Description

Technical field

[0001] The present disclosure relates to the field of cleaning devices for DeNOx-systems at flue gas temperatures lower than 700°C. The present disclosure more in particular relates to rake (type) soot blowers.

Background

[0002] In thermal power plants such as boilers, a flue gas is produced as a result of combustion of fuels, waste materials and the like. During the combustion process, soot is produced. In thermal power plants having a DeNOx-system that is provided with one or more catalysts and that is arranged to reduce the emission rates of nitrogen oxides produced during combustion, dust is deposited on the catalyst during normal operation of the catalyst fouling the catalyst.

[0003] Known reciprocating rake (type) soot blowers are equipped with a blowing rake that is provided with at least one transverse tube that in its turn is provided with at least one nozzle row having a multitude of nozzles that are arranged to blow a soot blowing medium onto the catalyst. The soot blowing medium usually is water, steam or air. During a blowing process, the blowing rake continues to move axially into the flue gas path. On reaching the front-side end position, the direction of movement changes and the blowing rake returns to a rest position.

[0004] In US 6,170,117, a multiple rake soot blower is described wherein the soot blower reciprocates over an area to clean an entire surface using a minimum of space for the soot blower stroke. An internal valving manifold and a plurality of bushings inside of a plenum isolate the rakes from each other and operate one rake at a time. This maintains the required soot blowing media pressure at the nozzles of each of the rakes. The internal valving manifold may either be reciprocated or rotated to select the desired rake.

[0005] The disadvantage of such systems however is that during the cleaning operation, a lot of pressurized air is consumed and there is no guarantee that the catalyst is sufficiently cleaned.

[0006] In JPH06281127, a soot-blowing device is described for removing soot, slugs and the like which are adhered to a heat transfer surface. A soot blower is arranged in a heat-exchanger which uses gas outside of pipes, under a condition in which a rake arm is inserted in a gap in a bundle of heat pipes being arranged in multiple layers. When a rotating shaft rotates by the operation of a driving device, the rake arm rotates accompanying with the rotation of the rotating shaft. When the bundle of the heat pipes has a rectangular cross section by a soot sweeping device which is provided on the rake arm, soot in a circle drawn by the rake arm is swept away. Soot at four corners, which cannot be swept by the soot sweeping device, i.e., the soot at dead angles, is swept away by a fluid which is jetted from an injection nozzle provided at the tip of the rake arm. Therefore, a cleaning of the heat pipes can be performed by the single soot blowing device. Such a soot blowing device is however not applicable to clean the upper surface of a catalyst.

[0007] It is consequently a goal of the rake type soot blower according to the present disclosure that is suited to clean the upper surface of a catalyst of a DeNOx system, which consumes less pressurized air to clean the catalyst and furthermore ensures that the catalyst stays as clean as possible during operation.

Summary

[0008] According to a first aspect of the present application, a reciprocating rake type soot blower system is disclosed, that is arranged to be installed above a catalyst of a DeNOx-system, the catalyst being provided with an upper surface and being provided with one or more catalyst channels, wherein the soot blower system is arranged to clean the upper surface of the catalyst, wherein the blower system comprises

- at least one blowing rake that is provided with at least one transverse tube that is provided with a nozzle row having a multitude of nozzles that are arranged to blow a soot blowing medium onto the upper surface of the catalyst; and
- a brushing system comprising one or more rows of brushes lined or lined up on at least one side of each of the nozzle rows and that are arranged to move over the upper surface of the catalyst and to swipe the dust into the one or more catalyst channels. Stated differently, the brushing system comprises one or more rows of brushes located adjacent to and in parallel with at least one side of each of the nozzle rows.

[0009] This system takes care that the consumption of pressurized air to clean the upper surface of the catalyst is reduced and ensures that the catalyst stays as clean as possible during operation.

[0010] In a more particular embodiment of a system according to the present disclosure, a row of brushes is lined at each side of each of the nozzle rows. This provides in an efficient cleaning of the upper surface of the catalyst.

[0011] In a possible embodiment of a system according to the present disclosure, the distance between the brushes and the upper catalyst layer is between 0 and 20 mm. The distance typically is around 0 mm, or in other words the brushes touch the upper catalyst layer. In this way, the soot particles are effectively liberated from the upper catalyst layer.

[0012] In an optional embodiment of a system according to the present disclosure, the one or more rakes are arranged to move periodically over the upper layer of the catalyst.

[0013] More in particular, the movement of the one or more rakes over the upper layer of the catalyst is initiated every 5 to 120 minutes.

[0014] In a possible embodiment of a system according to the present disclosure, each of the brushes are attached to the respective transverse tube such that the distance between the brushes and the upper layer of the catalyst is manually adjustable. This allows a flexible adaptation of the distance between the brushes and the upper catalyst layer depending on the dust behaviour.

[0015] In an optional embodiment of a system according to the present disclosure, the system comprises between 1 to 4 rakes. The more rakes, the shorter the moving distance of the system and consequently the length of the drive, which moves the rakes forwards and backwards, outside the flue gas duct. It needs however to be taken into account that the number of rakes increases the air consumption.

[0016] In a particular embodiment of a system according to the present disclosure, each rake comprises 1 to 3 transverse tubes with a nozzle row. The amount of nozzles rows is designed in that way that the stream of soot blowing medium is covering the complete length of the rake.

[0017] In a specific embodiment of a system according to the present disclosure, each nozzle row has a length of between 500 mm and 4 000 mm, and each of the brushes that are lined with the respective nozzle row have a corresponding transverse length of between 500 mm and 4 000 mm. The brushes must cover the complete length of the rake. The bypassing of dust particles around the brushes and the nozzles needs to be minimized.

[0018] In a possible embodiment of a system according to the present disclosure, the brushes comprise a multitude of wires having a downward length of 20 mm to 300 mm. This length allows that the wires of the brushes are flexible enough to ben around bigger obstacles such as bigger dust particles that cannot pass through the catalyst channels or that needs to pass over constructive parts such as bolts or nuts that are used to fixed the catalyst that lies beneath the brushes.

[0019] In a specific embodiment of a system according to the present disclosure, the brushes comprise a multitude of stainless steel wires having a diameter of between 0.1 mm and 2.5 mm. These stainless steel wires are easily bendable in case an obstacle that needs to be swept away is too hard, in this way avoiding damage to the catalyst.

[0020] In a possible embodiment of a system according to the present disclosure, the soot blowing medium is superheated steam or heated compressed air. In power plants, it is common to use superheated steam. In plants where no steam is available, heated compressed air is commonly used.

[0021] According to another aspect of the present disclosure, a thermal power plant provided with a reciprocating rake type soot blower system according to the present disclosure as described above is disclosed.

[0022] In a particular embodiment of a thermal power plant according to the present disclosure, the catalyst is provided with a catalyst channel which is arranged to collect the dust that is swiped by the reciprocating rake type soot blower system and wherein the plant is arranged to suspend the dust out of the catalyst channel into the flue gas which is responsible for taking the dust with it to the outside.

Description of the figures

[0023]

FIG. 1 shows a top view of a reciprocating rake type soot blower system according to the present disclosure,

FIG. 2 shows a side view of the system according to the present disclosure as shown in FIG. 1,

FIG. 3 shows a front view of the system according to the present disclosure as shown in FIG. 1.

Detailed description

[0024] An exemplary embodiment of a reciprocating rake type soot blower system (1) according to the present disclosure as shown in FIGs. 1 to 3 is arranged to be installed above a catalyst of a DeNOx-system of a thermal power plant or of a burning (combustion) industrial application such as a cement clinker kiln, a lime furnace, a solid fuel (biomass, coal) fired boiler, a waste to energy incinerator. The catalyst is more in particular installed before the de-dusting unit through which dust concentrations up to 120 g/Nm^3 or higher can occur.

[0025] As can be seen in FIG. 2, this catalyst (2) comprises an upper surface (2a) and a plurality of catalyst channels (2b). The reciprocating rake type soot blower system (1) is arranged to clean the upper surface (2a) of the catalyst (2).

[0026] The system (1) according to the present disclosure comprises at least one blowing rake (3) that is provided with at least one transverse tube (4) that is provided with at least one nozzle row (5) having a multitude of nozzles (5a) (see FIG. 3) that are arranged to blow a soot blowing medium (5b) onto the upper surface (2a) of the catalyst (2). The one or more transverse tubes (4) are arranged to pass soot blowing medium through it. The multitude of nozzles (5a) are more in particular arranged at the underside of the transverse tube(s) (4) or in other words are facing the upper surface (2a) of the catalyst (2).

[0027] As can be seen in FIG. 1 and 2, the system (1) further comprises a brushing system (6) comprising one or more rows of brushes (6a) lined on at least one side of each of the nozzle rows (5) and that are arranged to move over the upper layer (2a) of the catalyst (2) and to swipe the dust into the channels (2b) of the catalyst (2). Stated differently, the system (1) further comprises a brushing system (6) comprising one or more rows of brushes (6a) located adjacent to and in parallel with at

least one side of each of the nozzle rows (5) and that are arranged to move over the upper layer (2a) of the catalyst (2) and to swipe the dust into the channels (2b) of the catalyst (2). More in particular, and as can be seen in FIG. 3, the exemplary embodiment according to the present disclosure comprises two rows of brushes (5a) of which one is lined on one or each side of each of the nozzle rows. It is remarked that is also possible to provide only one row of brushes (5a) at only one side of the nozzle rows (not shown in the figures).

[0028] The brushes (6a) are more in particular attached to their respective transverse tube (4) such that the distance between the brushes (6a) and the upper surface (2a) of the catalyst (2) is manually adjustable. The brushes (6a) are more in particular welded on a bended steel sheet which is then screwed on the respective transverse tube (4).

[0029] The dust that is collected into the one or more catalyst channels (2b) is suspended in the flue gas and transported with the flue gas to the outside air.

[0030] The reciprocating rake type blower system according to the present disclosure can comprise between 1 and 4 rakes (3). Each rake can comprise between 1 and 3 transverse tubes (4) with a nozzle row. As can be seen in FIGs. 1 and 2, the exemplary embodiment of a system according to the present disclosure comprises one rake (3) that is provided with two transverse tubes (4) with a nozzle row comprising a multitude of nozzles (5a) that are arranged to blow the soot blowing medium onto the upper surface (2a) of the catalyst (2). In case the thermal power plant uses steam, the soot blowing medium is typically superheated steam. In case no steam is applied, the soot blowing medium typically is heated compressed air.

[0031] The one or more rakes (3) are arranged to move periodically over the upper catalyst layer (2a). More in particular, the movement of the one or more rakes over the upper layer of the catalyst is initiated every 5 to 120 minutes.

[0032] Each of the nozzle rows (5) has a length of between 500 mm and 4 000 mm, and each of the brushes (6a) that are lined with the respective nozzle row (5) have a corresponding transverse length of between 500 mm and 4 000 mm.

[0033] The brushes (6a) comprise a multitude of wires typically having a downward length of 20 mm to 300 mm. The brushes (6a) typically comprise a multitude of stainless steel wires having a diameter of between 0.1 mm and 2.5 mm.

[0034] The distance between the brushes (6a) and the upper catalyst layer (2a) is typically between 0 and 20 mm, and more in particular 0 mm meaning that the brushes (6a) touch the upper catalyst layer (2a).

Claims

1. A reciprocating rake type soot blower system, which is arranged to be installed above a catalyst of a DeNOx-system, the catalyst being provided with an upper surface and with one or more catalyst channels, wherein the soot blower system is arranged to clean the upper surface of the catalyst, **CHARACTERIZED IN THAT** the system comprises

- at least one blowing rake that is provided with at least one transverse tube that is provided with a nozzle row having a multitude of nozzles that are arranged to blow a soot blowing medium onto the upper surface of the catalyst;
- a brushing system comprising one or more rows of brushes lined on at least one side of each of the nozzle rows and that are arranged to move over the upper layer of the catalyst and to swipe the dust into the one or more catalyst channels.

2. A reciprocating rake type soot blower system according to claim 1, wherein a row of brushes is lined on each side of each of the nozzle rows.

3. A reciprocating rake type soot blower system according to claim 1 or 2, wherein the distance between the brushes and the upper catalyst layer is between 0 and 20 mm.

4. A reciprocating rake type soot blower system according to claim 3, wherein the distance between the brushes and the upper catalyst layer is around 0 mm.

5. A reciprocating rake type soot blower system according to any one of claims 1 to 4, wherein the one or more rakes are arranged to move periodically over the upper layer of the catalyst.

6. A reciprocating rake type soot blower system according to claim 5, wherein the movement of the one or more rakes over the upper layer of the catalyst is initiated every 5 to 120 minutes.

7. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein each of the brushes are attached to the respective transverse tube such that the distance between the brushes and the upper layer of the catalyst is manually adjustable.

8. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein the system comprises between 1 to 4 rakes.

9. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein each rake comprises 1 to 3 transverse tubes with a nozzle row.

10. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein each nozzle row has a length of between 500 mm and 4 000 mm, and each of the brushes that are lined with the respective nozzle row have a corresponding transverse length of between 500 mm and 4 000 mm.

11. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein the brushes comprise a multitude of wires having a downward length of 20 mm to 300 mm.

12. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein the brushes comprise a multitude of stainless steel wires having a diameter of between 0.1 mm and 2.5 mm.

13. A reciprocating rake type soot blower system according to any one of the preceding claims, wherein the soot blowing medium is superheated steam or heated compressed air.

14. A thermal power plant or a burning industrial application provided with a reciprocating rake type soot blower system according to anyone of the preceding claims.

15. A thermal power plant or a burning industrial application according to claim 14, wherein the catalyst is provided with at least one catalyst channel which is arranged to collect the dust that is swiped by the reciprocating rake type soot blower system and wherein the plant is arranged to suspend the dust out of the catalyst channel into the flue gas which is responsible for taking the dust with it to the outside.

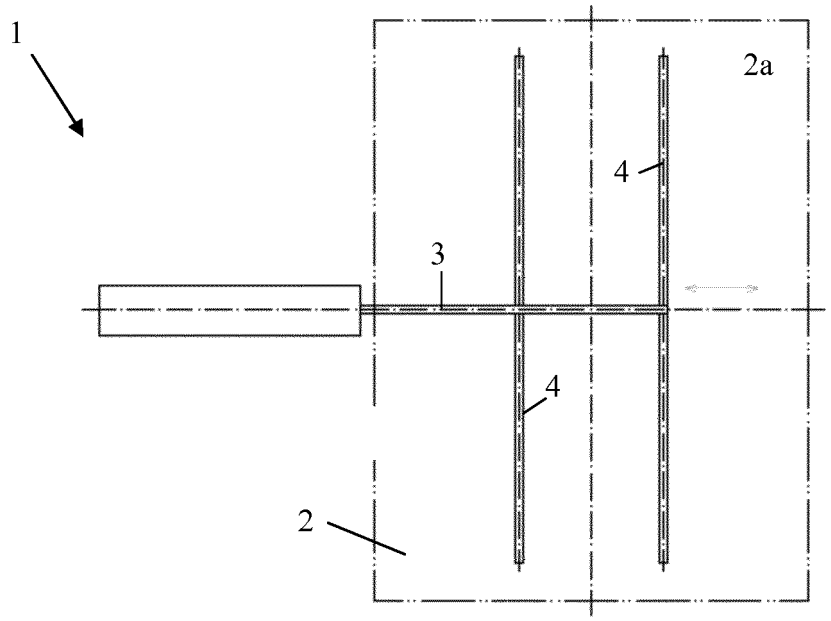

FIG. 1

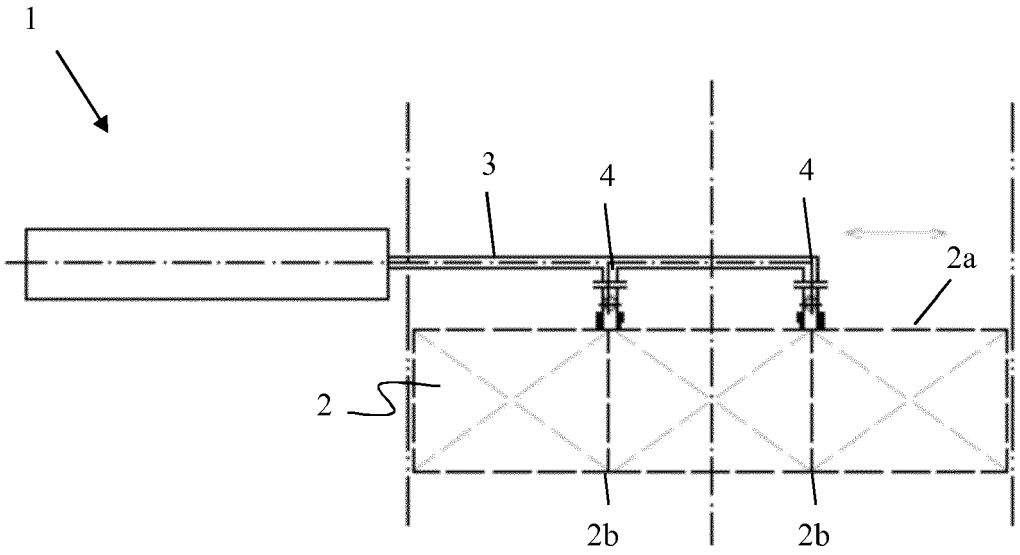

FIG. 2

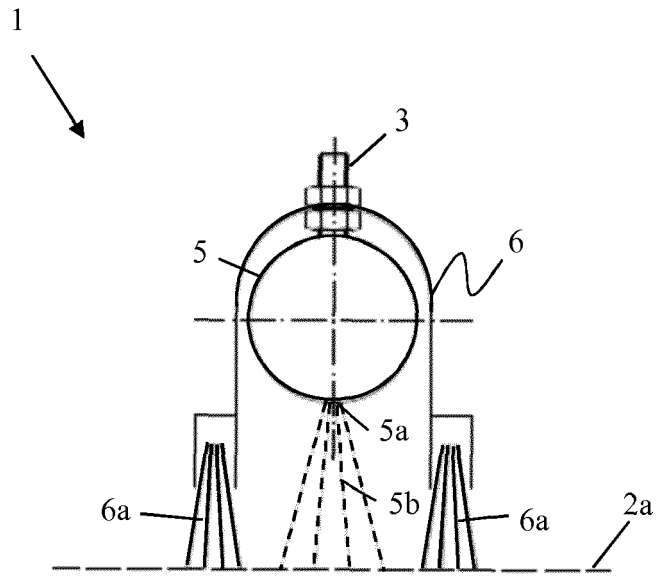

FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 19 5102

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	CN 202 893 190 U (JIANGSU CNBM ENVIRONMENTAL PROT RES INST CO LTD ET AL.) 24 April 2013 (2013-04-24) * paragraph [0001] - paragraph [0015]; figures 1,2 *	1	INV. F28G1/02 F28G9/00 F28G1/16 B01D53/88
A	JP H06 281127 A (EBARA INFILCO) 7 October 1994 (1994-10-07) * paragraph [0001] - paragraph [0038]; figures 1-7 *	1	
A,D	US 6 170 117 B1 (BATT PAUL J [US]) 9 January 2001 (2001-01-09) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F28G
F28F
F23J
B01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 February 2020	Theis, Gilbert

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 19 5102

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.

03-02-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 202893190 U	24-04-2013	NONE	
JP H06281127 A	07-10-1994	JP H081296 B2	10-01-1996
		JP H06281127 A	07-10-1994
US 6170117 B1	09-01-2001	AU 2039701 A	30-05-2001
		TW 455669 B	21-09-2001
		US 6170117 B1	09-01-2001
		WO 0136892 A1	25-05-2001

EPO FORM P0459

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 6170117 B **[0004]**