



(51) International Patent Classification:

F27B 1/18 (2006.01) *C21B 7/22* (2006.01)
F27D 17/00 (2006.01) *F27D 7/00* (2006.01)
C21B 7/00 (2006.01)

(21) International Application Number:

PCT/EP2012/065375

(22) International Filing Date:

6 August 2012 (06.08.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

91 855 18 August 2011 (18.08.2011) LU

(71) Applicant (for all designated States except US): **PAUL WURTH S.A.** [LU/LU]; 32, rue d'Alsace, L-1122 Luxembourg (LU).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **THILLEN, Guy** [LU/LU]; 136 route de Gilsdorf, L-9234 Diekirch (LU).
HAUSEMER, Lionel [LU/LU]; 4a, rue d'Itzig, L-5231 Sandweiler (LU).(74) Agents: **LAMBERT, Romain** et al.; Office Freylinger S.A., 234, Route d'Arlon, P.O. Box 48, L-8001 Strassen (LU).

(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, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, 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.

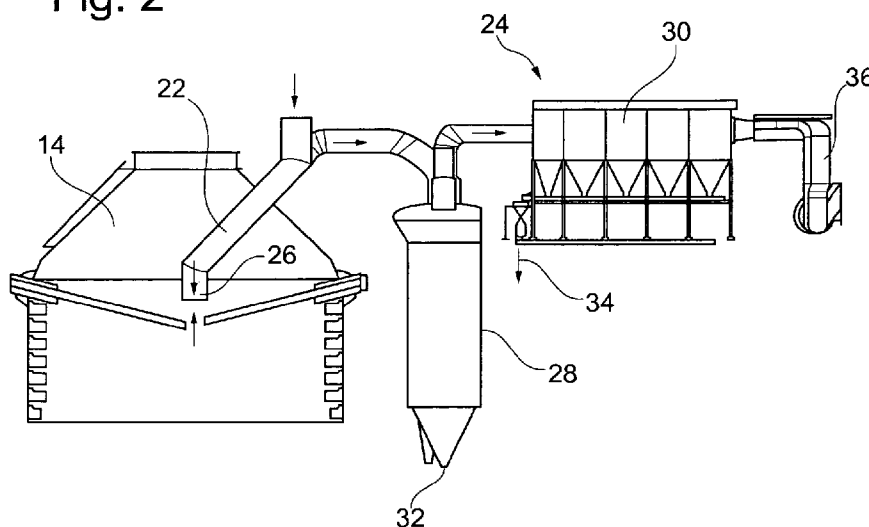
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, 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, ML, MR, NE, SN, TD, TG).

Published:

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

(54) Title: BLAST FURNACE INSTALLATION

Fig. 2



(57) Abstract: A blast furnace installation comprises a blast furnace (10), a gas cleaning unit and lateral top gas extraction tubes connected between an upper topcone (14) of the blast furnace (10) and the gas cleaning unit. According to an aspect of the present invention, the blast furnace installation further comprises a central gas uptake conduit (22) with an uptake opening (26) arranged in the vicinity of a vertical axis of the blast furnace in an upper portion of the blast furnace (10) for extracting gas from an axial region of the blast furnace (10); and an auxiliary gas cleaning unit (24) connected to the central gas uptake conduit (22) for cleaning gas extracted via the central gas uptake conduit (22).

BLAST FURNACE INSTALLATION

Technical Field

[0001] The present invention generally relates to a blast furnace installation, in particular comprising blast furnace and a gas extraction unit connected to a gas cleaning unit.

Background Art

[0002] Blast furnace gas, also referred to as top gas, is a by-product of blast furnace operation that is generated when the iron ore is reduced with coke to metallic iron. The top gas, which is mostly composed of nitrogen, carbon dioxide and carbon monoxide, is commonly used as a fuel within the steel works. It may however also be used in external installations such as boilers and power plants. As the top gas generally has a rather low heating value, it may be mixed with a richer gas, e.g. natural gas or coke oven gas, before combustion. The top gas is generally also fed through a gas cleaning unit before it is used further. In such a conventional gas cleaning unit, particulate matter, such as blast furnace dust, is generally removed from the top gas to provide a cleaner gas for combustion.

[0003] Top gas however also contains some undesired contaminants, such as recirculating elements such as zinc and alkalis, which may have a negative influence on the blast furnace operation. The introduction of such undesired contaminants into the burden cycle may be unavoidable, such as when the contaminants are naturally found in the charged raw materials.

[0004] It is generally accepted that in order to minimize the amount of contaminants in the top gas, the charge material is carefully chosen not to exceed a predetermined amount of such contaminants. In the case of zinc, for example, it is generally accepted that Zn input must be limited to about 120 – 160 g/tHM, although operations with higher Zn loads of up to 1 kg/tHM have been reported in the past in Luxemburg and Lorraine with the use of Minett ore.

[0005] Such a limitation on the ZN load in the charge material is necessary as too high a Zn concentration in the burden may lead to dramatic problems in the blast furnace. A complex re-circulating Zn flow between Zn vapours and metallic

Zn condensate is present in the blast furnace: as the burden descends in the blast furnace shaft, Zn oxides start to be reduced. Once in a metallic state, Zn evaporates in zones with a sufficiently high temperature. As soon as Zn vapours come into contact with a colder surface, Zn starts to condensate and deposits on the cold surface.

[0006] If Zn vapours are not eliminated, Zn scaffolds can start to build up in the blast furnace wall region. Experience shows, that this Zn scaffolding areas are usually in the upper shaft and throat as temperatures are lower in these regions.

[0007] In order to avoid this scaffolding phenomenon, it is nowadays common practice on most modern blast furnaces to operate with an intensive centre flow with high centre gas temperatures and velocities. Indeed, high centre gas temperatures ($>400^{\circ}\text{C}$ – 1000°C) permit to avoid any condensation of the Zn in the furnace itself.

[0008] The collected top gas, which contains the Zn vapours, is extracted from the blast furnace and fed through a conventional gas cleaning unit. Most of the Zn will condensate on the surface of the fine particles which can be retrieved from the extracted top gas e.g. in the form of wet scrubber sludge, such sludge thus containing a fair amount of Zn. In a lower extent part of the Zn is found in the dust collected at a primary stage of the conventional gas cleaning unit. . The sludge may however also contain a non-negligible amount of residual iron and it may be of advantage to further use the sludge to extract the remaining iron. However, due to the high concentration of Zn in the sludge, the latter cannot be fed back into the blast furnace, as the blast furnace cannot eliminate Zn. Indeed, feeding the sludge back into the blast furnace would continuously increase the amount of Zn in the system, which would further accentuate the problem of Zn scaffolding.

[0009] Thus, the sludge from the wet scrubber is generally considered as an unusable waste product with all its associated problems.

[0010] The recycling of the sludge is however not impossible. Indeed, a method for treating sludge from iron-and-steelworks has been disclosed in EP 1 797 207, wherein the sludge is treated in a multiple hearth furnace and Fe

and Zn are very efficiently recovered. The only downfall of this recycling method is that a recycling plant with a multiple hearth furnace is relatively expensive.

Technical Problem

[0011] It is thus an object of the present invention to provide a blast furnace installation with an alternative means for recovering zinc contaminants in the top gas. This object is achieved by a blast furnace installation as claimed in claim 1.

General Description of the Invention

[0012] A blast furnace installation comprises a blast furnace with a charging system arranged centrally above the furnace shaft and connected at the top of an upper top cone of the furnace for feeding charge material into the furnace, a conventional gas cleaning unit, and lateral top gas extraction uptakes connected between the top cone, laterally with respect to the charging system, and the gas cleaning unit. According to an aspect of the present invention, the blast furnace installation further comprises a central gas uptake conduit having a lower uptake opening arranged in the vicinity of a vertical axis of the blast furnace, in an upper portion of the blast furnace for extracting gas from an axial region of the blast furnace; and an auxiliary gas cleaning unit connected to the central gas uptake conduit for cleaning gas extracted via the central gas uptake conduit.

[0013] In addition to the conventional lateral top gas extraction uptakes, which are arranged at a distance from the vertical axis of the blast furnace, the present invention provides a central gas uptake conduit. Whereas, the conventional lateral top gas extraction uptakes extract gas from a lateral region of the blast furnace, the central gas uptake conduit extracts gas from an axial region of the blast furnace, thus allowing a more selective extraction of gas from the furnace.

[0014] Particularly, said auxiliary gas cleaning unit is a gas cleaning unit dedicated to treating zinc or zinc containing components contained in said gas extracted via said central gas uptake conduit.

[0015] Preferably, the uptake opening of the central gas uptake conduit is arranged in the top cone or throat region of the blast furnace, preferably at the

level of the base of the top cone, that is below the openings of the lateral top gas extraction uptakes.

[0016] The extraction of gas from an axial upper region of the blast furnace allows extracting gas with high Zn concentration. Indeed, it has been found that the Zn concentration in top gas is highest in this axial upper region, due to the fact that there are the zones of higher gas velocities and higher gas temperatures.

[0017] A dedicated gas extraction in the axial region of the blast furnace thus permits the extraction of a gas much richer in Zn than an average top gas through the traditional lateral top gas extraction uptakes would be.

[0018] The Zn rich gas collected through the central gas uptake conduit is then fed through an auxiliary gas cleaning unit, which is preferably specifically adapted to collect Zn rich dust or sludge.

[0019] When compared to a traditional gas cleaning unit, the auxiliary gas cleaning unit is fed with a gas richer in Zn and thus produces dry flue dust or sludge that is also expected to be richer in Zn. Such an "enriched" sludge is a product with an added value as it can easier be exploited in a dedicated recycling unit or sold to a specialized company.

[0020] By enabling an improved extraction of Zn from the blast furnace, it is possible to raise the limit of Zn load in the charge material. Indeed, it is even possible to feed Zn rich sludge back into the blast furnace and thus extract the residual iron in the dust or sludge.

[0021] It should also be noted that the central gas uptake conduit and the auxiliary gas cleaning unit allow the recycling of Zn rich by products at reduced cost when compared to recycling plants with multiple hearth furnaces.

[0022] According to a preferred embodiment, the blast furnace is provided with a central gas uptake conduit that is arranged and formed so as to serve as centre material feeding pipe, which is connected to a material hopper and to the auxiliary gas cleaning unit. Indeed, such a centre material feeding pipe is in some blast furnace installations used to feed further charge material, generally coke, into the blast furnace.

[0023] In case of an existing blast furnace installation, which is already provided with a centre material feeding pipe, such an installation may thus be easily adapted for use with the present invention. Indeed, the existing centre material feeding pipe may be used as central gas uptake conduit and additionally be connected to an auxiliary gas cleaning unit.

[0024] It is also worth noting that such a centre material feeding pipe / central gas uptake conduit would be self-cleaning. Indeed, any Zn deposits on the inner walls of the pipe would be abraded while coke or any other charge material is fed through the pipe.

[0025] According to another preferred embodiment, the blast furnace is provided with a central gas uptake conduit that is arranged and formed within or on a probe reaching into the blast furnace. Such a probe may e.g. be an above burden probe or an in burden probe.

[0026] It should also be noted that the uptake opening of the central gas uptake conduit may be arranged above the burden level within the blast furnace. Alternatively, it may be arranged below the burden level within the blast furnace.

[0027] A primary stage of the auxiliary gas cleaning unit may comprise a cyclone for removing gross particles from the extracted gas. It has been found that Zn generally tends to condensate to the finer particles. The gross particles removed from the extracted gas thus generally have low concentration of Zn. Such gross particles may therefore be more easily recycled, e.g. by feeding them back into the blast furnace.

[0028] A second stage of the auxiliary gas cleaning unit may comprise a dry gas cleaning unit, e.g. an electrobag filter, downstream of the cyclone for removing flue dust from the extracted gas. As the Zn generally tends to stick to the finer particles, such flue dust would be particularly rich in Zn. The use of electrobag filters has the advantage that the flue dust remains dry and therefore uses less volume than wet sludge would do.

[0029] The second stage of the auxiliary gas cleaning unit may also comprise a scrubber downstream of the cyclone for removing sludge from the extracted gas. For the same reasons explained above the removed sludge is rich in Zn.

[0030] Alternatively the auxiliary gas cleaning unit may comprise a venturi ejector for the removal of fine particles from the extracted gas. Such a venturi ejector, which comprises the injection of water, allows separating Zn rich dust from the gas by using the phenomenon of different exit velocities of the gas and the water. The fine dust particles are then removed as sludge..

[0031] Furthermore, the ejector permits to drive the gas back to the blast furnace. According to an embodiment of the invention, the installation further comprises a return conduit between the auxiliary gas cleaning unit and the blast furnace for feeding cleaned gas back into the blast furnace. The cleaned gas, which has been stripped of its high Zn content, may thus be fed back into the blast furnace.

[0032] The cyclone may be connected to the return conduit for feeding back gross particles removed by the cyclone into the return conduit for introduction into the blast furnace. Gross particles, which are poor in Zn may therefore be fed back into the blast furnace and the residual iron therein may be extracted. In this configuration, the gross particles and gas are entrained by a second ejector placed below the cyclone.

[0033] According to an embodiment of the invention, the installation may further comprise a recirculation conduit between the dry gas cleaning unit and the central gas uptake conduit for feeding flue dust removed by the dry gas cleaning unit back into central gas uptake conduit. Re-circulation of cold flue dust containing fine Zn particles into the central gas uptake conduit upstream of the cyclone, scrubber or dry gas cleaning unit allows for hot Zn extracted from the blast furnace to condensate on the recirculated colder flue dust, thereby increasing further the Zn concentration of the particles.

[0034] According to a further embodiment of the invention, a combustion chamber is arranged in the central gas uptake conduit for heating the extracted gas fed to the auxiliary gas cleaning unit. Such a combustion chamber allows re-evaporation of the Zn deposited on the bigger particles and a quick oxidation of the Zn to ZnO, which may then be easier to separate as dust in the off-gas. This combustion can also avoid a condensation of the Zn on the inner face of the pipes.

[0035] It should be noted that, although the present application generally mentions zinc (Zn), this is understood to encompass zinc-containing molecules such as e.g. zinc oxide (ZnO).

Brief Description of the Drawings

[0036] Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a cross-section through a traditional blast furnace;

Fig. 2 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a first embodiment of the invention;

Fig. 3 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a second embodiment of the invention;

Fig. 4 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a third embodiment of the invention;

Fig. 5 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a fourth embodiment of the invention;

Fig. 6 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a fifth embodiment of the invention;

Fig. 7 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a sixth embodiment of the invention;

Fig. 8 is a cross-section through a portion of a blast furnace installation with an auxiliary gas cleaning unit according to a seventh embodiment of the invention;

Description of Preferred Embodiments

[0037] A blast furnace installation comprises a blast furnace 10, as shown in Fig.1, with a furnace shaft 12, which has in an upper region a furnace top cone 14 through which charge material is fed into the furnace shaft 12. Laterally in the roof

16 of the blast furnace top cone, openings are arranged for the connection of top gas extraction uptakes 18 leading top gas from the blast furnace to a conventional gas cleaning unit (not shown). A charging system 20 is arranged centrally above the furnace shaft 12 for feeding charge material into the blast furnace 10. Due to the central arrangement of the charging installation 20, the top gas extraction uptakes 18 are arranged off-centre in the roof 16 of the blast furnace. Although the charging system 20 shown in Fig.1 is of the bell-less top type, it should be noted that other installations, such as e.g. two- or three-bell systems, are equally possible and within the scope of the present invention.

[0038] Fig.2 shows the top cone 14 of a blast furnace with a central gas uptake conduit 22 and an auxiliary gas cleaning unit 24. The central gas uptake conduit 22 has an uptake opening 26 arranged centrally at the base of the top cone 14 on the axis of the blast furnace 10. The central gas uptake conduit 22 is configured as a centre material feeding pipe connected to a material hopper (not shown) for feeding an additional charge material into the blast furnace in addition to the charge material fed from the charging system 20. The central gas uptake conduit 22 is further connected to the auxiliary gas cleaning unit 24, which comprises a cyclone 28 and a dry gas cleaning unit 30 in the form of an electrobag filter. In the cyclone 28, gross particles are removed from the extracted gas via a gross particle exit 32. Such gross particles have low concentration of Zn. In the dry gas cleaning unit 30, flue dust is removed from the extracted gas via dust exit 34. Such flue dust has high Zn concentration. The remainder of the extracted gas may be fed via feed pipe 36 to another installation (not shown) for further use.

[0039] Fig.3 shows the top cone 14 of a blast furnace with a central gas uptake conduit 22 and another auxiliary gas cleaning unit 24. The auxiliary gas cleaning unit 24 of Fig.3 comprises a scrubber 38 for removing sludge from the extracted gas via sludge exit 40. Such sludge has high Zn concentration.

[0040] Fig.4 shows the top cone 14 of a blast furnace with a central gas uptake conduit 22 and another auxiliary gas cleaning unit 24. The auxiliary gas cleaning unit 24 of Fig.4 comprises a venturi ejector 42 for removing sludge from the extracted gas via sludge exit 44. Such sludge has high Zn concentration. The auxiliary gas cleaning unit 24 of Fig.4 further shows a return conduit 46 for feeding cleaned gas back into the throat 14 of the blast furnace.

[0041] Fig.5 shows the top cone 14 of a blast furnace with a central gas uptake conduit 22 and another auxiliary gas cleaning unit 24. The auxiliary gas cleaning unit 24 of Fig.5 comprises a cyclone 28 for removing gross particles from the extracted gas via the gross particle exit 32 and a venturi ejector 42 for removing sludge from the extracted gas via sludge exit 44. Furthermore, this auxiliary gas cleaning unit 24 also comprises a return conduit 46 for feeding cleaned gas back into the throat 14 of the blast furnace. The gross particle exit 32 is connected to the return conduit 46 and feeds gross particles having low Zn concentration into the cleaned gas, which is fed back into the throat 14 of the blast furnace. A further venturi ejector 48 is provided in the return conduit 46 for entraining the gross particles.

[0042] Fig.6 shows the top cone 14 of a blast furnace with a central gas uptake conduit 22 and another auxiliary gas cleaning unit 24. The auxiliary gas cleaning unit 24 of Fig.6 comprises a cyclone 28 for removing gross particles from the extracted gas via a gross particle exit 32 and a dry gas cleaning unit 30 for removing flue dust from the extracted gas via dust exit 34. A recirculation conduit 50 is connected between the dust exit 34 and the central gas uptake conduit 22 for feeding the removed flue dust, which is high in Zn concentration, into the central gas uptake conduit 22 upstream of the cyclone 28. The flue dust is thereby further coated with Zn and forms bigger dust particles.

[0043] Fig.7 shows the top cone 14 of a blast furnace with another central gas uptake conduit 22 and an auxiliary gas cleaning unit 24. The central gas uptake conduit 22 of Fig.7 is formed within an above burden probe 52 and has its uptake opening 26 arranged centrally in the furnace throat 14 in the vicinity of the axis of the blast furnace 10. The central gas uptake conduit 22 is connected to an auxiliary gas cleaning unit 24 as shown in Fig.3.

[0044] Fig.8 shows the top cone 14 of a blast furnace with a central gas uptake conduit 22 and an auxiliary gas cleaning unit 24 as generally shown in Fig.2. According to Fig.8, a combustion chamber 54 is provided in the central gas uptake conduit 22. Such a combustion chamber 54 is arranged for heating the extracted gas, thereby allowing oxidation of the Zn to ZnO, which is easier to separate.

[0045] It should be noted that, although many different combinations have been shown in Figures 2 to 8, these combinations are not exhaustive, indeed many other combinations are possible and well within the scope of the present invention.

Legend of Reference Numbers:

10	blast furnace	34	dust exit
12	furnace shaft	36	feed pipe
14	furnace top cone	38	scrubber
16	roof	40	sludge exit
18	conventional top gas extraction uptakes	42	venturi ejector
20	charging system	44	sludge exit
22	central gas uptake conduit	46	return conduit
24	auxiliary gas cleaning unit	48	further venturi ejector
26	uptake opening	50	recirculation conduit
28	cyclone	52	above burden probe
30	dry gas cleaning unit	54	combustion chamber
32	gross particle exit		

Claims

1. A blast furnace installation comprising a blast furnace, a gas cleaning unit and lateral top gas extraction uptakes connected between an upper topcone of said blast furnace and said gas cleaning unit
characterized by
a central gas uptake conduit, said central gas uptake conduit having an uptake opening arranged in the vicinity of a vertical axis of the blast furnace, in an upper portion of said blast furnace for extracting gas from an axial region of said blast furnace; and
an auxiliary gas cleaning unit connected to said central gas uptake conduit for cleaning gas extracted via said central gas uptake conduit.
2. The installation according to claim 1, wherein said auxiliary gas cleaning unit is a gas cleaning unit dedicated to treating zinc or zinc containing components contained in said gas extracted via said central gas uptake conduit.
3. The installation according to claim 1 or 2, wherein said uptake opening of said central gas uptake conduit is arranged in the top cone or a throat region of said blast furnace.
4. The installation according to any of claims 1 to 3, wherein said uptake opening of said central gas uptake conduit is arranged at the level of the base of the top cone. .
5. The installation according to any of claims 1 to 4, wherein said central gas uptake conduit is formed by a centre material feeding pipe, said centre material feeding pipe being connected to a material hopper and to said auxiliary gas cleaning unit.
6. The installation according to any of claims 1 to 4, wherein said central gas uptake conduit is within or on a probe reaching into said blast furnace.

7. The installation according to any of claims 1 to 6, wherein said uptake opening of said central gas uptake conduit is arranged above a level of burden within said blast furnace.
8. The installation according to any of claims 1 to 6, wherein said uptake opening of said central gas uptake conduit is arranged below a level of burden within said blast furnace.
9. The installation according to any of claims 1 to 8, wherein said auxiliary gas cleaning unit comprises a cyclone for removing gross particles from said extracted gas.
10. The installation according to claim 9, wherein said auxiliary gas cleaning unit comprises a dry gas cleaning unit downstream of said cyclone for removing flue dust from said extracted gas.
11. The installation according to claim 9, wherein said auxiliary gas cleaning unit comprises a scrubber downstream of said cyclone for removing sludge from said extracted gas.
12. The installation according to any of claims 1 to 10, wherein said auxiliary gas cleaning unit comprises a venturi ejector for removing sludge from said extracted gas.
13. The installation according to any of claims 1 to 12, wherein said installation further comprises a return conduit between said auxiliary gas cleaning unit and said blast furnace for feeding cleaned gas back into said blast furnace.
14. The installation according to claims 9 and 13, wherein said cyclone is connected to said return conduit for feeding gross particles removed by said cyclone into said return conduit for introduction into said blast furnace.
15. The installation according to any of claims 10 to 14, wherein said installation further comprises a recirculation conduit between said dry gas cleaning unit

and said central gas uptake conduit for feeding flue dust removed by said dry gas cleaning unit back into central gas uptake conduit.

16. The installation according to any of claims 1 to 15, wherein said installation further comprises a combustion chamber arranged in said central gas uptake conduit for heating said extracted gas fed to said auxiliary gas cleaning unit.

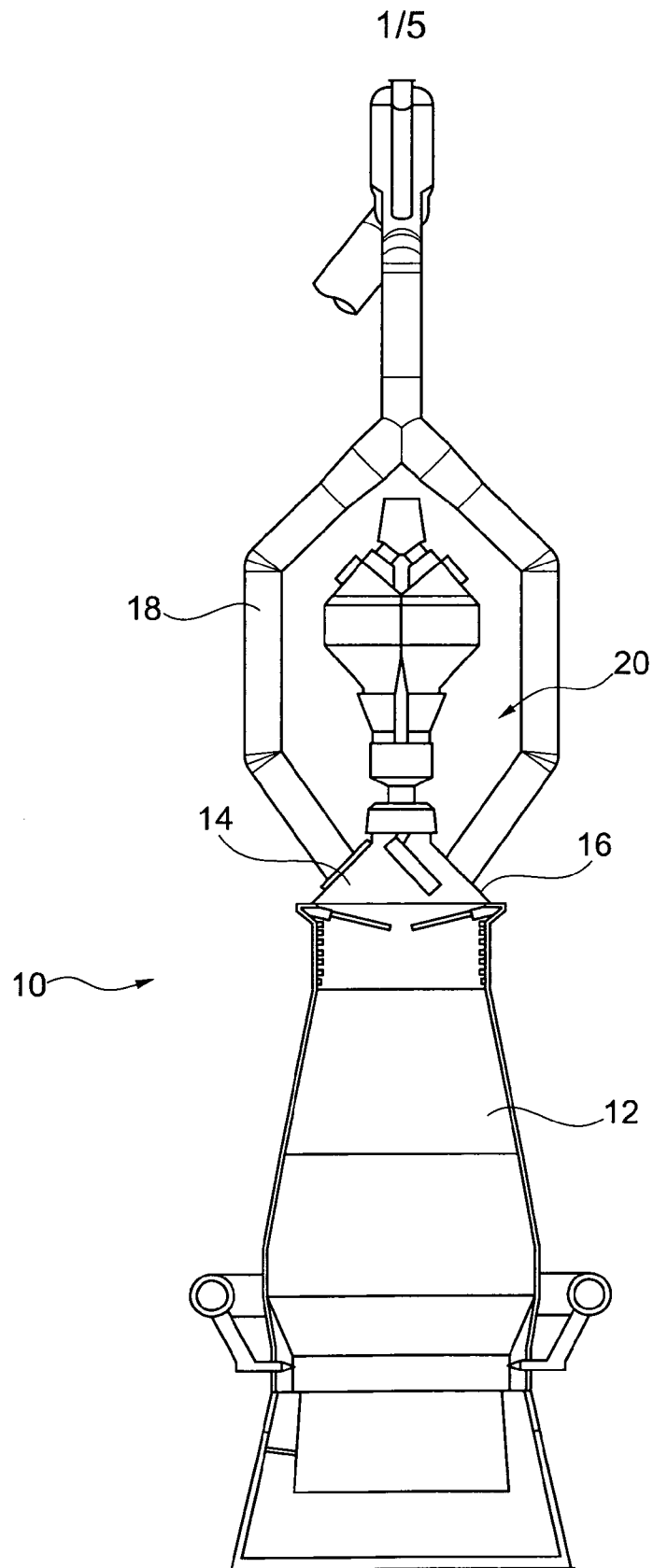


Fig. 1

2/5

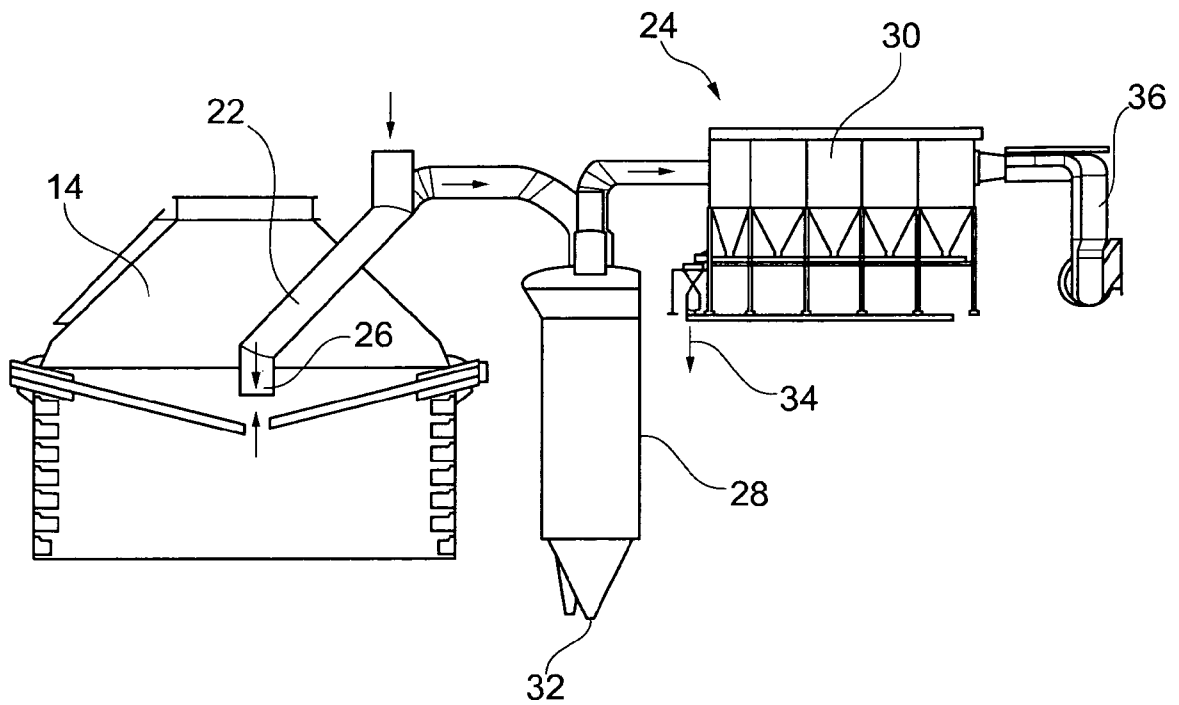


Fig. 2

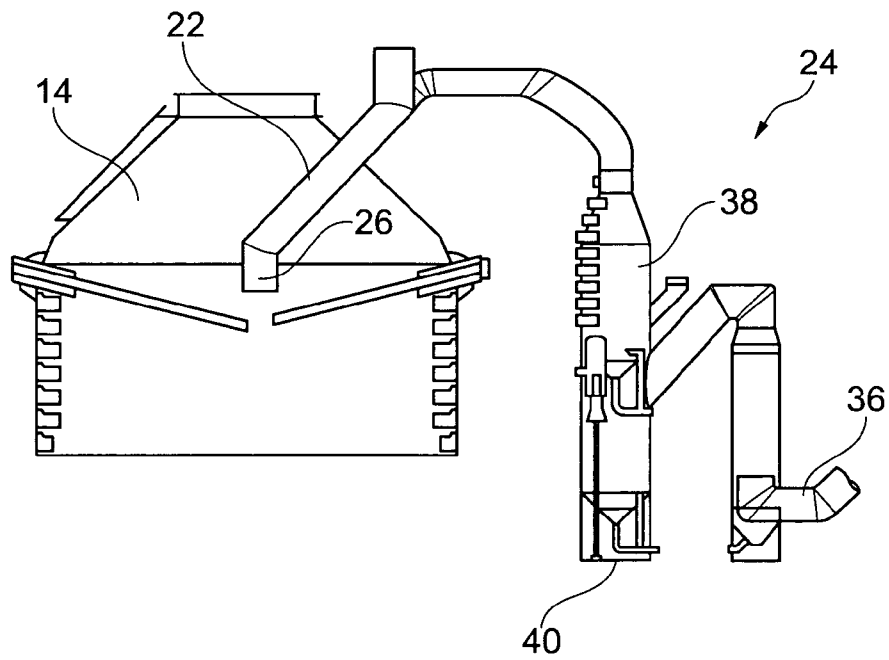


Fig. 3

3/5

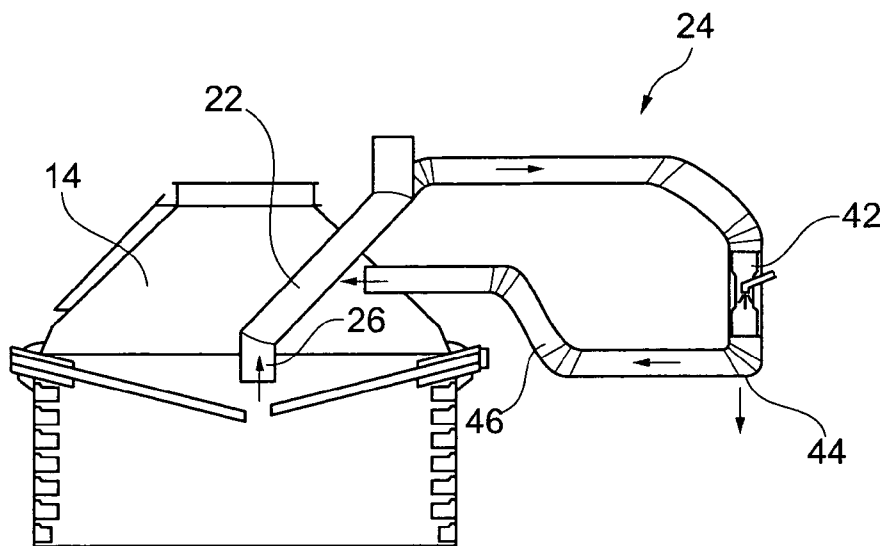


Fig. 4

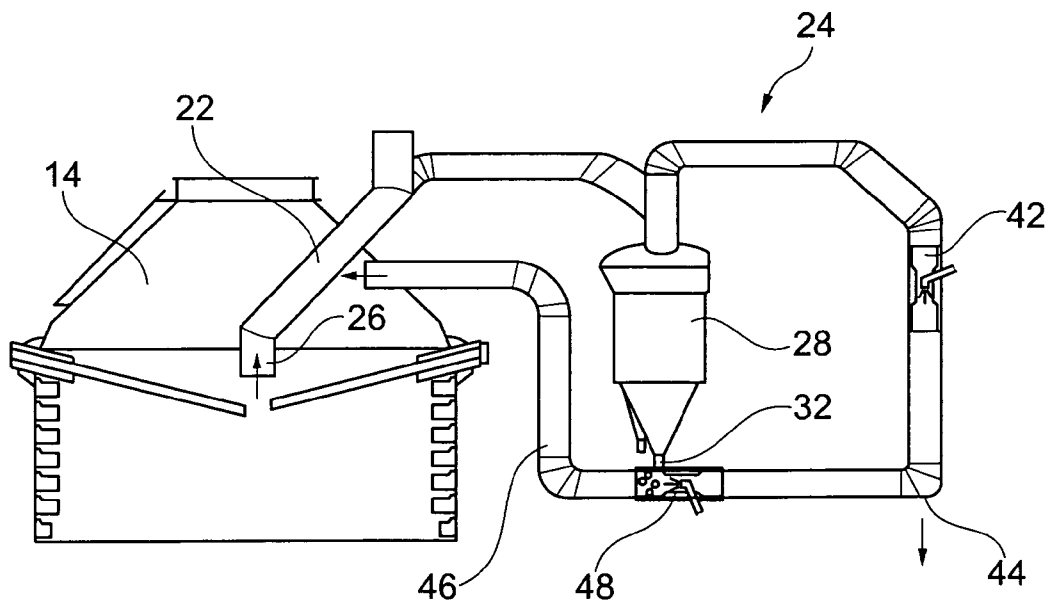


Fig. 5

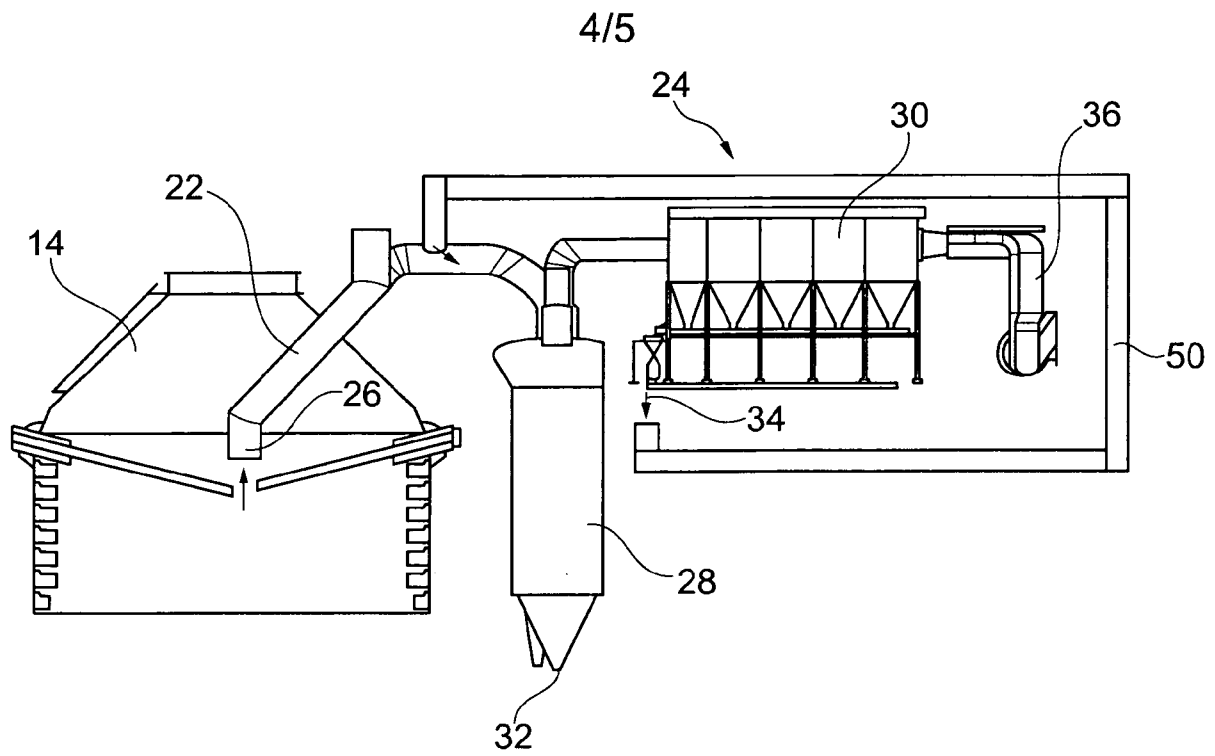


Fig. 6

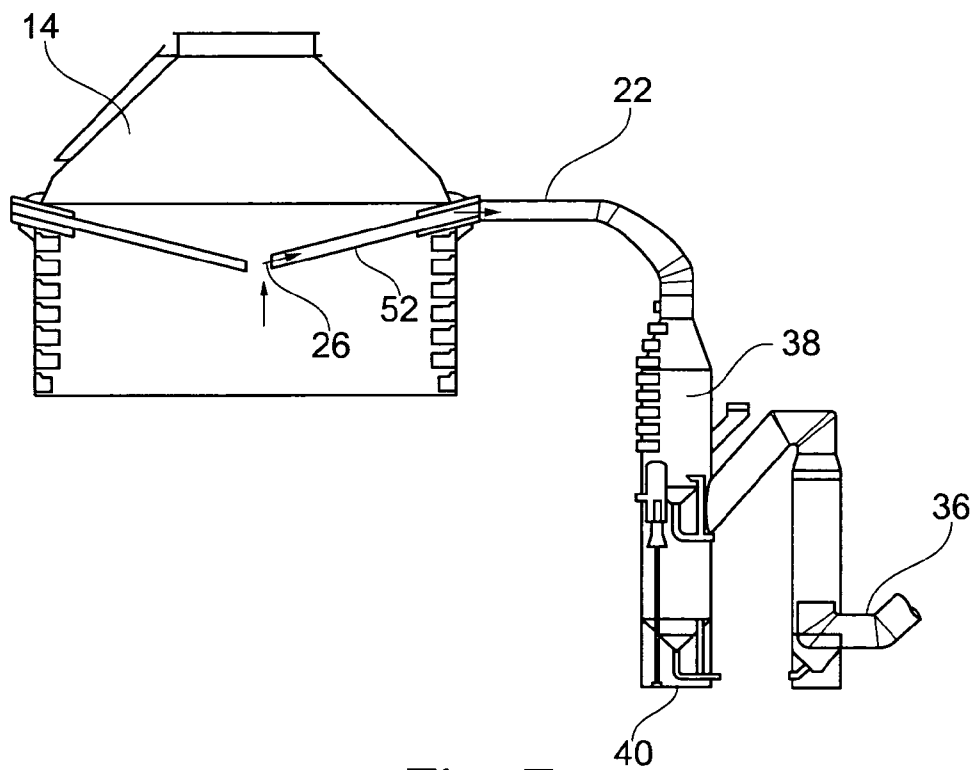


Fig. 7

5/5

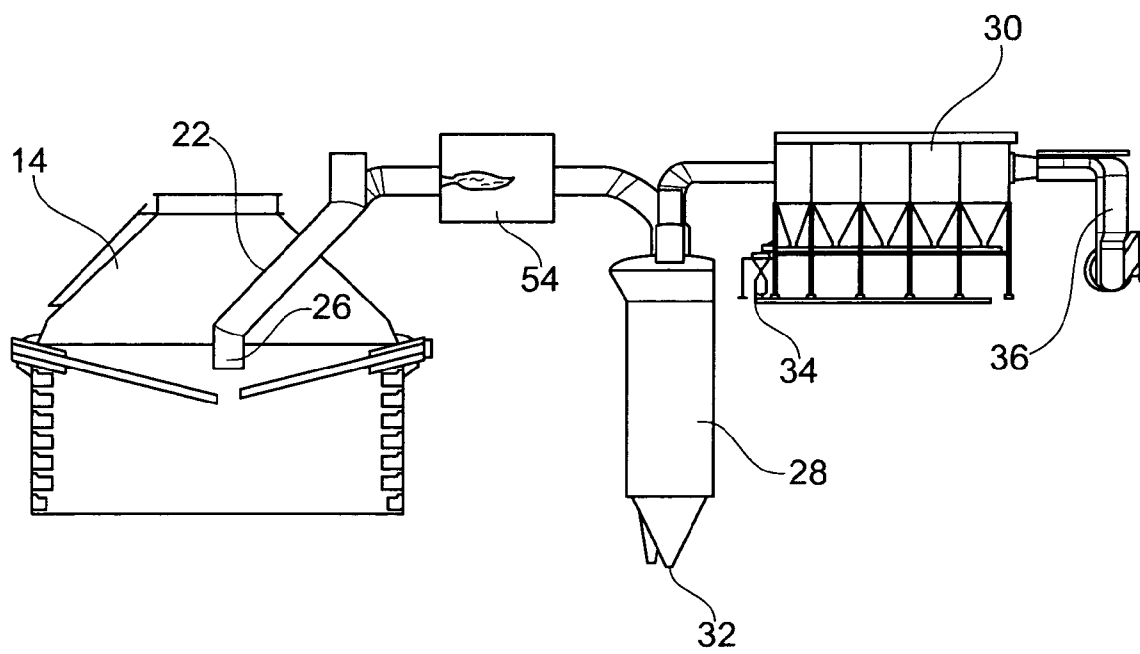


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/065375

A. CLASSIFICATION OF SUBJECT MATTER INV. F27B1/18 F27D17/00 C21B7/00 C21B7/22 F27D7/00 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) F27B F27D C21B 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 <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>JP 49 044909 A (CO. JAPAN) 27 April 1974 (1974-04-27) figure 1</td> <td>1</td> </tr> <tr> <td>X</td> <td>----- THEODOR W NIESS ET AL: "The Bischoff top gas process for relined blast furnaces", IRON AND STEEL ENGINEER,, vol. 61, no. 1, 1 January 1984 (1984-01-01), pages 47-52, XP001409344, figure 1</td> <td>1</td> </tr> <tr> <td>A</td> <td>----- JP 2002 115827 A (NIPPON STEEL CORP) 19 April 2002 (2002-04-19) the whole document ----- -/-</td> <td>1-16</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	JP 49 044909 A (CO. JAPAN) 27 April 1974 (1974-04-27) figure 1	1	X	----- THEODOR W NIESS ET AL: "The Bischoff top gas process for relined blast furnaces", IRON AND STEEL ENGINEER,, vol. 61, no. 1, 1 January 1984 (1984-01-01), pages 47-52, XP001409344, figure 1	1	A	----- JP 2002 115827 A (NIPPON STEEL CORP) 19 April 2002 (2002-04-19) the whole document ----- -/-	1-16
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.												
X	JP 49 044909 A (CO. JAPAN) 27 April 1974 (1974-04-27) figure 1	1												
X	----- THEODOR W NIESS ET AL: "The Bischoff top gas process for relined blast furnaces", IRON AND STEEL ENGINEER,, vol. 61, no. 1, 1 January 1984 (1984-01-01), pages 47-52, XP001409344, figure 1	1												
A	----- JP 2002 115827 A (NIPPON STEEL CORP) 19 April 2002 (2002-04-19) the whole document ----- -/-	1-16												
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.														
* Special categories of cited documents : <table> <tr> <td> "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 </td> <td> "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 </td> </tr> </table>			"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										
"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												
26 October 2012		06/11/2012												
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 Gavriliu, Alexandru												

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/065375

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 43 24 699 A1 (FEUSTEL HANS ULRICH DIPL ING [DE]; MALLON JOACHIM DIPL PHYS [DE]; SCHA) 26 January 1995 (1995-01-26) the whole document -----	1-16
A	KR 2001 0064156 A (PO HANG IRON & STEEL [KR]) 9 July 2001 (2001-07-09) abstract; figure 1 -----	1-16
A	DD 299 917 A7 (SBKW KEULAHUETTE KRAUSCHWITZ V [DE]) 14 May 1992 (1992-05-14) the whole document -----	1
A	US 4 152 123 A (HEGEMANN KARL-RUDOLF [DE] ET AL) 1 May 1979 (1979-05-01) the whole document -----	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/065375

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 49044909	A	27-04-1974	NONE
JP 2002115827	A	19-04-2002	NONE
DE 4324699	A1	26-01-1995	NONE
KR 20010064156	A	09-07-2001	NONE
DD 299917	A7	14-05-1992	NONE
US 4152123	A	01-05-1979	DE 2756106 A1 21-06-1979 US 4152123 A 01-05-1979