



(51) International Patent Classification:
F27B 21/06 (2006.01) *C22B 1/16* (2006.01)

(21) International Application Number:
PCT/FI2016/050785

(22) International Filing Date:
07 November 2016 (07.11.2016)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **OUTOTEC (FINLAND) OY** [FI/FI]; Rauha-
lanpuisto 9, 02230 Espoo (FI).

(72) Inventors: **KROGERUS, Helge**; Katariinankatu 10 B 21,
28100 Pori (FI). **MÄKELÄ, Pasi**; Kehäkukantie 7, 28430
Pori (FI). **KIVINEN, Visa**; Karhusuontie 9, 02810 Espoo
(FI).

(74) Agent: **PAPULA OY**; P.O. Box 981, 00101 Helsinki (FI).

(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, DJ, 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, KW,
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,

(54) Title: SINTERING EQUIPMENT, A PLANT FOR EXPLOITING DUST AND WASTE FROM IRON PRODUCTION AND
USE THEREOF

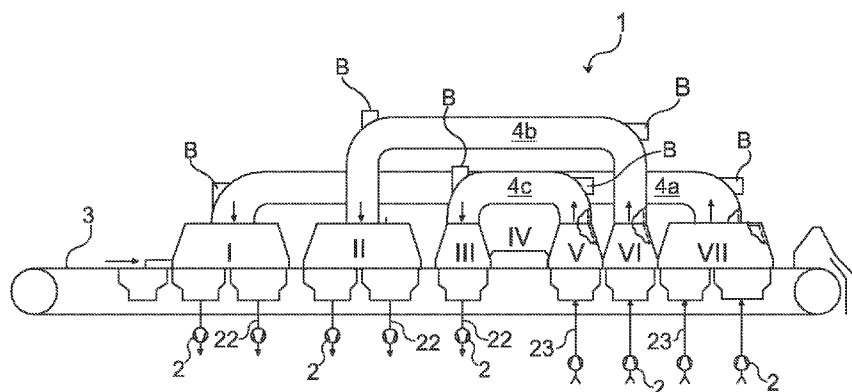


Fig. 2

(57) Abstract: The disclosure relates to sintering equipment for con- tinuous sintering of pelletized mineral material. The sintering
equipment comprisesa sintering furnace (1), comprising sequential process zones (I-VII), the tem- perature conditions in each process
zone being inde- pendently controllable; theprocesszones comprising at least one drying zone (I), at least one heating zone (II), at least
one sintering zone (III, IV) and at least one cooling zone (V, VI VII). The sintering equipment further comprises a gas-permeable
conveyor belt (3) for conveying the mineral material through the process zones (I-VII)andcirculation gas ducts (4a, 4b, 4c). The sintering
equipment is characterized in that thecirculation gas duct conducting gas to the at least one drying zone comprises at least oneburner
(B) for controlling the gas temperature in the at least one drying zone.The disclosure further relates to use of the sintering equipment
and to a plant.

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:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

Published:

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

SINTERING EQUIPMENT, A PLANT FOR EXPLOITING DUST AND WASTE FROM IRON PRODUCTION AND USE THEREOF

TECHNICAL FIELD

5 The invention relates to sintering equipment and to a plant for exploiting dusts and waste from iron production, as well as to the use thereof.

BACKGROUND

10 In connection with iron production, enormous amounts of different grades of dusts and waste material are produced both in metallurgical plants and at pellet loading and unloading stations. The inventors have thus recognized the need for an improved apparatus for utilizing dusts and waste material to enhance the process economy of such plants.

SUMMARY

20 The purpose of the present disclosure is to eliminate or at least reduce problems related to prior art. Specifically, it is the purpose of the current disclosure to provide a new type of sintering equipment and a plant for exploiting dusts and waste material from iron production.

25 The sintering equipment according to the present disclosure is characterized by what is presented in claim 1.

 The plant according to the present disclosure is characterized by what is presented in claim 12.

30 The use according to the current disclosure is characterized by what is presented in claim 19.

 In one aspect, sintering equipment for continuous sintering of pelletized mineral material is disclosed. The sintering equipment comprises a sinter-

35

ing furnace, comprising sequential process zones, the temperature conditions in each process zone being independently controllable; the process zones comprising at least one drying zone, at least one heating zone, at least one sintering zone and at least one cooling zone; a gas-permeable conveyor belt for conveying the mineral material through the process zones; a first circulation gas duct for conducting gas from at least one cooling zone to at least one drying zone; a second circulation gas duct for conducting gas from at least one cooling zone to at least one heating zone; and a third circulation gas duct for conducting gas from at least one cooling zone to at least one sintering zone. The sintering equipment is characterized in that the first circulation gas duct comprises at least one burner for controlling the gas temperature in the at least one drying zone.

In an embodiment, the first circulation gas duct comprises one burner. In an embodiment, the first circulation gas duct comprises two burners. In one embodiment of the sintering equipment, each circulation gas duct comprising at least one burner comprises two burners. It is possible that a circulation gas duct comprises more than two burners. For example, the number of the burners may be three. In such embodiments, the third burner may be positioned in the middle of the length of the circulation gas duct. Alternatively, the number of the burners may be four. In such embodiments, the third and fourth burner could be positioned so that the distance between the burners is the same or approximately the same. Further, embodiments may be envisaged in the number of the burners is five. In such embodiments, burners may be placed in the circulation gas duct at regular intervals.

In one embodiment of the sintering equipment, each circulation gas duct comprises at least one burner for controlling the gas temperature in the process

zone to which the gas circulation gas duct conducts gas.

The presence of burners in the first circulation gas duct allows the temperature of the at least one drying zone to be regulated, so that even challenging pellet material may be successfully dried.

Additional regulation may be provided by dividing the at least one drying zone into two or more compartments. The lower exhaust gas ducts leading away from the at least one drying zone may be equipped with a blower. Typically there is one blower in each lower exhaust gas duct. However, not all lower exhaust gas ducts are necessarily equipped with a blower. If the at least one drying zone is divided into two or more compartments, each compartment may have its own lower exhaust gas duct. Each of the lower exhaust gas ducts may have its own blower.

In one embodiment of the sintering equipment, blowers are arranged below the drying zone for regulating gas flow and/or gas distribution in the drying zone. The blowers in the current sintering equipment are typically independently controllable. This allows the regulation of gas flow in each zone, or compartment, connected to a blower. Without limiting the current disclosure to any specific theory, the division of gas flow in different compartments might affect the thermal exchange reactions of the pellet material and gas. This, again, allows the regulation of the temperature gradient within a process zone, and therefore, allows the optimization of the process within a process zone.

The at least one burner may be positioned in various directions relative to the flow of the gas in the circulation gas duct. In some embodiments, the direction of the flame might be perpendicular to that of the gas flow. Alternatively, the flame may be directed along the direction of gas flow. In many embodiments,

the angle of the flame relative to the direction of the gas flow is less than 90 °C, i.e. approaching the direction of gas flow. It may, for example be 20° or 30° or 45°. The orientation of each burner relative to the gas flow may be individually selected. Thus variable angles may be present in a given circulation gas duct.

In one embodiment of the sintering equipment, the sintering furnace comprises three cooling zones (V, VI, VII). The cooling zones may be termed first cooling zone (V), second cooling zone (VI) and third cooling zone (VII) in the order that the sintered pellets are conveyed through the zones. Thus, a first circulation gas duct conducts gas from the third cooling zone (VII) to at least one drying zone (I). A second circulation gas duct conducts gas from the second cooling zone (VI) to at least one heating zone (II). A third circulation gas duct conducts gas from the first cooling zone to at least one sintering zone (III).

20

In one embodiment of the sintering equipment, the temperature of the gas conducted into the drying zone is regulated to be 200-250 °C, preferably 220-230 °C by the at least one burner in the third circulation gas duct.

25

In one embodiment of the sintering equipment, the drying zone comprises two compartments.

In one embodiment of the sintering equipment, temperature of the heating gas conducted into the heating zone is regulated to be 1,100-1,230 °C, preferably 1,150-1,180 °C by the at least one burner in the second circulation gas duct.

30

In one embodiment of the sintering equipment, temperature of the gas conducted into the sintering zone is regulated to be 1,150-1,300 °C, preferably 1,200-1,250 °C by the at least one burner in the first circulation gas duct.

35

In one embodiment of the sintering equipment, product bed temperature at the end of the sintering zone is 1,220-1,410 °C, preferably 1,270-1,390 °C. The product bed temperature may be different from the gas temperature. In addition to the gas temperature, the composition of the pellets affects the product bed temperature, as heating of the pellets may trigger various reactions in the pellet material. These reactions may be exothermic or they may be endothermic, or there may be both. Therefore, the temperature of the product bed is an independent parameter that can be followed when optimizing the sintering equipment according to the current disclosure.

In one embodiment of the sintering equipment, exhaust gas from the sintering equipment is cleaned to remove detrimental substances.

In one aspect, a plant for exploiting dusts and waste materials from iron production is disclosed. The plant comprises a pelletizing feed production station for mixing dusts, waste materials and binding agent for producing pelletizing feed; a pelletizing apparatus for pelletizing the pelletizing feed to produce green pellets; the sintering equipment according to the present disclosure for producing sintered pellets; and optionally a smelting furnace, such as a blast furnace, or an electric furnace, for smelting the sintered pellets. The smelting furnace may be constructed to be a part of the plant according to the current disclosure. Alternatively, the plant may be used for producing sintered pellets, and they can be smelted at another location.

In one embodiment, the plant further comprises a device for adding pellet fines from a direct reduction process into the pelletizing feed.

In one embodiment, the plant further comprises a device for adding mill scale from a rolling mill into the pelletizing feed.

5 In one embodiment, the plant further comprises a device for adding finely divided sludgy dusts from a direct reduction process into the pelletizing feed.

10 In one embodiment, the plant further comprises a device for adding finely divided dry dusts separated by a bag filter from the exhaust gas of an electric arc furnace into the pelletizing feed.

In one embodiment, the plant further comprises a device for adding underflow of pellets feed to sintering into the pelletizing feed.

15 In one embodiment, the plant further comprises a device for milling coarse raw materials to a desired fineness before adding to the pelletizing feed.

20 In one aspect, use of the sintering equipment according to the current disclosure for the production of sintered pellets is disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

25 The accompanying drawings, which are included to provide a further understanding of the invention and constitute a part of this specification, illustrate embodiments of the invention and together with the description help to explain the principles of the invention. In the drawings:

30 Fig. 1 is a schematic presentation of a plant according to the present disclosure.

Fig. 2 is a schematic presentation of sintering furnace according to the present disclosure.

35

DETAILED DESCRIPTION OF THE INVENTION

Large amounts of different grades of iron-bearing dusts and wastes are available globally. Therefore, it would be economically sensible to convert these dusts and waste materials to a suitable
5 form in which they can be charged into a blast furnace or an electric furnace, depending on the contamination level of the dusts.

The disclosure relates to producing a pelletizing feed from a mixture of dusts, waste materials and binding agent and pelletizing the feed to
10 produce green pellets. Green pellets are sintered in a steel belt sintering furnace which comprises one or more zones for drying, heating, sintering and cooling of the pellets. The sintered pellets are charged into
15 a blast furnace or an electric furnace.

According to the present disclosure, iron-bearing sintered pellets can be produced using a steel belt sintering furnace. The raw material can be milled, if necessary, and fed in a certain grain size
20 to a pelletizing unit before sintering. The need for milling depends on the composition of the starting materials, as the efficiency of the pelletizing process depends on the size distribution of the particles to be pelleted. Another aspect that affects the function-
25 ing of the pelletizing, is the proportion of easily and poorly pelletizable material. High grade green pellets and sintered pellets can be produced. Sintered pellets are hard and abrasion-resistant and their reducibility is high due to their highly porous struc-
30 ture. Exhaust gas from the sintering equipment can be cleaned by generally used pro-sustainable methods depending on the content of harmful components in the gas.

Dusts and waste material from iron production
35 can be used as raw material in the sintering equipment and plant according to the present disclosure. Such dusts and waste material comprise, for instance, pel-

let fines from direct reduction process, mill scale from a rolling mill, sludgy dusts from a direct reduction process, dry dusts from a bag filter and pellet underflow.

5 By pellet fines is herein meant pellets and pellet fragments under 6 mm diameter. By pellet underflow, on the other hand, is herein meant sintered pellets that are too small to be used in a furnace. Thus, pellet underflow has already been sintered. In this
10 respect, it differs from other materials described in the current disclosure.

By mill scale is herein meant scale from a rolling mill. It is typically a waste or side product of steel making. Mill scale may contain magnetite,
15 wüstite and metallic iron, can be used in the present sintering equipment and plant.

By sludgy dusts is herein meant finely divided dusts, also referred to as sludge, from the cleaning systems of a direct reduction process. Sludgy
20 dusts originally contain moisture, although they may be dried before actual utilization in the current systems. Sludgy dusts may contain detrimental substances.

By dry dusts is herein meant dusts separated by a bag filter from exhaust gas of an electric arc
25 furnace. This material is also referred to as baghouse dust. Also dry dusts may contain detrimental substances.

The above-mentioned detrimental substances can include, for instance, compounds of alkali metals,
30 zinc, chlorine and fluorine.

In figures 1 and 2, the components of the plant 5 and the sintering furnace 1, respectively, are drawn schematically. All design details are omitted
35 for clarity.

FIGURE 1

In the plant 5 according to the present disclosure, dusts and waste material are mixed in a pelletizing feed production station 6 to produce a pelletizing feed 14 for use in manufacturing of sintered pellets 16, which can be charged into a smelting furnace 8, such as a blast furnace or an electric furnace.

The concept was tested by grinding coarse raw materials in a mill to reach a pelletizing fineness, except for mill scale 19, which is partly metallic material. The mixtures to be examined were prepared so that the amount of normal pellet raw material was 50-70 w-% and the amount of mill scale 19 varied between 10 and 20 w-% of the mixture. The amount of dried sludgy dust 20 was varied between 20 and 30 w-% of the mixture and the amount of dry dusts 21 was varied between 1 and 10 w-% of the mixture. Bentonite, organic binder, or a mixture thereof was used as a binding agent in pelletizing. The amount of binding agent was kept low, between 0.1 and 1.0 w-%.

In the embodiment of fig. 1, the pelletizing feed production station comprises a device 9 for adding underflow of pellet feed 17 into the pelletizing feed 14. The embodiment also comprises a device 10 for adding pellet fines 18 into the pelletizing feed 14. An additional feature of the embodiment of fig. 1 is a device 11 for adding mill scale 19 from a rolling mill into the pelletizing feed 14. Also a device 12 for adding sludgy dusts 20 into the pelletizing feed 14 is present, as well as a device 13 for adding dry dusts 21 into the pelletizing feed 14.

The devices 9, 10, 11, 12, 13 are optional, and the current plant 5 may comprise one or more of them, depending on the available raw material and the process economy of the operation in question. The positioning and design of said devices may be selected by the skilled person according to the plant 5 specif-

ics. One or more of said devices 9, 10, 11, 12, 13 may be operationally connected to a device for milling coarse raw materials to a desired fineness (not depicted in fig. 1). One milling device may be used for
5 milling one or more of the raw materials.

In the plant 5 according to the current disclosure, the pelletizing feed 14 is pelletized in a pelletizing apparatus 7, which may be a pelletizing drum or a disc pelletizer.

10 The moisture of the green pellets 15 was lower than 9% when an organic binder was used and no baghouse dust was included in the mixture. The moisture of the pellets was over 9% when a mixture of bentonite and organic binder was used as binding agent.
15 The moisture of the pellets was between 8 and 8.5% when only bentonite was used as binding agent. In the industrial scale, the moisture of the green pellets 15 can be expected to be somewhat higher.

The wet strength of the green pellets 15 varied from 1.8 to 3 kg for a pellet of 12 mm diameter. These are quite satisfactory values. The dry strength of the green pellets 15 was between 3.5 and 15 kg for a pellet of 12 mm diameter. The highest dry strengths could be reached when using from 7.5 to 10 w-%
25 baghouse dust. Addition of finely divided dolomite into the pelletizing mixture had a positive effect on the dry strength of the green pellets 15.

In the plant 5 according to the current disclosure, the green pellets 15 are sintered in a sintering furnace 1 according to the present disclosure.
30 The details of the sintering furnace 1 are described in connection with fig. 2.

The compression strength of the sintered pellets 16 is high enough for reduction and smelting. The
35 compression strength of sintered pellets 16 produced without baghouse dust was 170-300 kg/pellet. When the sintered pellets 16 contained bag filter dust, the

compression strength was 180-260 kg/pellet, depending on the amount of baghouse dust and the type of binding agent used.

The sintered pellets 16 are charged into a
5 smelting furnace 8, which may be a blast furnace, or an electric furnace.

FIGURE 2

In fig. 2, sintering equipment according to
10 the present disclosure is depicted. The green pellets 15 are fed into the sintering furnace 1, which is a steel belt sintering furnace. The green pellets 15 are lead through sequential process zones of the sintering furnace 1 along a gas-permeable conveyor belt 3. Thus,
15 the sintering is continuous. The process zones comprise at least one drying zone I, at least one heating zone II, at least one sintering zone III, IV and at least one cooling zone V, VI, VII. The temperature conditions in each process zone are independently con-
20 trollable by blowers 2 and burners B.

Circulation gas ducts 4a, 4b, 4c are located above the conveyor belt 3 for conducting gas from at least one cooling zone V, VI, VII to the drying zone I, heating zone II and sintering zone III, and onto
25 the bed of pellets. A first circulation gas duct 4a conducts gas from cooling zone VII to the drying zone I. A second circulation gas duct 4b conducts gas from cooling zone VI to the heating zone II. A third circulation gas duct 4c conducts gas from cooling zone V to
30 the sintering zone III.

Burners B are placed in the circulation gas ducts to heat the gas that travels in the circulation gas duct 4a, 4b, 4c. In the sintering equipment according to the current disclosure, each circulation
35 gas duct 4a, 4b, 4c comprises at least one burner B for controlling the gas temperature in the process zone I, II, III, V, VI, VII to which the circulation

gas duct conducts gas. In the embodiment of fig. 2, there are two burners B in each of the circulation gas ducts 4a, 4b, 4c. In the embodiment of fig. 1, sintering equipment comprising one burner in each circulation gas duct is shown.

Lower exhaust gas ducts 22 are located below the conveyor belt 3 for conducting the gas that exits the drying zone I, heating zone II and sintering zone III and that has been conducted through a pellet bed on the conveyor belt 3 and through the conveyor belt 3. Blowers 2 are arranged in the lower exhaust gas ducts 22 to provide gas movement. In the embodiment of figure 2, a blower 2 is depicted for each lower exhaust gas duct 22. A lower exhaust duct 22 is connected to each compartment of the drying zone (I) and the heating zone (II). The first sintering zone III comprises only one compartment, and the lower exhaust gas duct 22 connected to it is also equipped with a blower 2. The blower configuration in the embodiment of fig. 2 allows the regulation of the temperature gradient in the drying zone I and heating zone II so that the sintering process in the sintering equipment may be adjusted according to the pellets fed into the sintering equipment.

Lower inlet gas ducts 23 are located below the conveyor belt 3 for conducting the gas to the cooling zones V, VI, VII. Blowers 2 are arranged in the lower inlet gas ducts 23 to provide gas movement.

The green pellets 15 are first led to a drying zone I comprising two compartments, in which they are dried. The drying time used in the sintering furnace 1 may be 8-13 minutes depending on the composition of the mixture used. The temperature of the drying gas supplied into the drying zone I is 220-230° C, although it may vary between 200 °C and 250 °C. Such

low drying temperatures allows avoiding disintegration of the green pellets 15.

The drying zone I is followed by a heating zone II. Although in the embodiment of fig. 2 there are two heating compartments, embodiments may be envisaged where the heating zone II comprises only one compartment. The duration heating is configured to be, for example, 10, or, in the case of two compartments, 5 minutes in each. With such configuration, a suitable temperature rise velocity may be achieved. Drastic oxidation of iron and iron oxides could be observed in the heating zone at 900 °C. The gas temperature supplied into the heating zone was 1,150-1,180 °C.

After the heating zone(s) II, the pellets are lead to two sintering zones (III, IV). The retention time in the sintering zones is, for example, 6 minutes. The retention time may be varied depending on the composition of the pelletizing feed 14 and the moisture of the green pellets 15. At the end of the sintering zone III, the temperature in the material bed is between 1,270 and 1,390 °C depending on the feed composition, while the gas temperature of the heating gas fed into the sintering zone III is 1,200-1,250 °C.

The total porosity of sintered pellets 16 containing no bag filter dust may be, for example, 33-35%. The total porosity may be 25-27% when the sintered pellets 16 contain bag filter dust. These values are high in view of reduction.

Abrasion strengths of the sintered pellets 16 produced in the sintering equipment are high. The abrasion strength may become slightly reduced when baghouse dust was added in the pelletizing feed 14.

Sintered pellets have been tested according to ISO 11257 standard. The metallization degree of iron was found to be 94.4-100%, which is very high.

Fines formation remains minimal when the current sintering furnace 1 is used for the production of sintered pellets 16. The strength of the sintered pellets 16 after reduction may be approximately 50 kg, which
5 is a good value.

During sintering, a part of detrimental substances are vaporized into the dusts. Dusts containing detrimental substances can be recycled. From time to time the detrimental substances must be removed from
10 the process recirculation.

Experiments carried out with iron-containing dusts, waste and materials showed that it is possible to technically upgrade those materials to such a form which is suitable for feeding into a direct reduction
15 furnace, a blast furnace or an electric arc furnace.

It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in various
20 ways. The invention and its embodiments are thus not limited to the examples described above; instead, they may vary within the scope of the claims.

CLAIMS

1. Sintering equipment for continuous sintering of pelletized mineral material, wherein the sintering equipment comprises

5 - a sintering furnace (1), comprising sequential process zones (I-VII), the temperature conditions in each process zone (I-VII) being independently controllable; the process zones comprising at least one drying zone (I), at least one heating zone (II), at least
10 one sintering zone (III, IV) and at least one cooling zone (V, VI, VII);

 - a gas-permeable conveyor belt (3) for conveying the mineral material through the process zones (I-VII);

15 - a first circulation gas duct (4a) for conducting gas from at least one cooling zone (V, VI, VII) to at least one drying zone (I);

 - a second circulation gas duct (4b) for conducting gas from at least one cooling zone (V, VI, VII) to
20 at least one heating zone (II);

 - a third circulation gas duct (4c) for conducting gas from at least one cooling zone (V, VI, VII) to at least one sintering zone (III);

characterized in that the first circulation
25 gas duct (4a) comprises at least one burner (B) for controlling the gas temperature in the at least one drying zone (I).

2. The sintering equipment according to claim 1, wherein the sintering furnace (1) comprises three
30 cooling zones (V, VI, VII).

3. The sintering equipment according to claim 1 or 2, wherein each circulation gas duct (4a, 4b, 4c) comprises at least one burner (B) for controlling the gas temperature in the process zone to which the gas
35 circulation gas duct conducts gas.

4. The sintering equipment according to any of the preceding claims, wherein each circulation gas duct (4a, 4b, 4c) comprising at least one burner (B) comprises two burners (B).

5 5. The sintering equipment according to any of the preceding claims, wherein the temperature of the gas conducted into the drying zone (I) is regulated to be 200-250 °C, preferably 220-230 °C by the at least one burner (B) in the first circulation gas duct
10 (4a).

6. The sintering equipment according to any of the preceding claims, wherein the drying zone (I) comprises two compartments.

7. The sintering equipment according to any
15 of the preceding claims, wherein blowers (2) are arranged below the drying zone (I) for regulating gas flow and/or gas distribution in the drying zone (I).

8. The sintering equipment according to any of the preceding claims, wherein temperature of the
20 gas conducted into the heating zone (II) is regulated to be 1,100-1,230 °C, preferably 1,150-1,180 °C by the at least one burner (B) in the second circulation gas duct (4b).

9. The sintering equipment according to any
25 of the preceding claims, wherein temperature of the gas conducted into the sintering zone (III) is regulated to be 1,150-1,300 °C, preferably 1,200-1,250 °C by the at least one burner (B) in the third circulation gas duct (4c).

30 10. The sintering equipment according to any of the preceding claims, wherein product bed temperature at the end of the sintering zone (III) is 1,220-1,410 °C, preferably 1,270-1,390 °C.

11. The sintering equipment according to any of the preceding claims, wherein exhaust gas from the sintering equipment is cleaned to remove detrimental substances.

5 12. A plant (5) for exploiting dusts and waste materials from iron production comprising:

 - a pelletizing feed production station (6) for mixing dusts, waste materials and binding agent for producing pelletizing feed (14);

10 - a pelletizing apparatus (7) for pelletizing the pelletizing feed (14) to produce green pellets (15);

 - the sintering equipment according to any of claims 1-11 for producing sintered pellets (16); and

15 - optionally a smelting furnace (8), such as a blast furnace, or an electric furnace, for smelting the sintered pellets (16).

 13. A plant (5) according to claim 12, further comprising a device (10) for adding pellet fines (18) from a direct reduction process into the pelletizing feed (14).

 14. A plant (5) according to any of claims 12-13, further comprising a device (11) for adding mill scale (19) from a rolling mill into the pelletizing feed (14).

 15. A plant (5) according to any of claims 12-14, further comprising a device (12) for adding finely divided sludgy dusts (20) from a direct reduction process into the pelletizing feed (14).

30 16. A plant (5) according to any of claims 12-15, further comprising a device (13) for adding finely divided dry dusts (21) separated by a bag fil-

ter from the exhaust gas of an electric arc furnace into the pelletizing feed (13).

17. A plant (5) according to any of claims 12-16, further comprising a device (9) for adding underflow (17) of pellets feed to sintering into the pelletizing feed (14).

18. A plant (5) according to any of claims 12-17, further comprising a device for milling coarse raw materials to a desired fineness before adding to the pelletizing feed (14).

19. Use of the sintering equipment according to any of claims 1-11 for the production of sintered pellets.

1/2

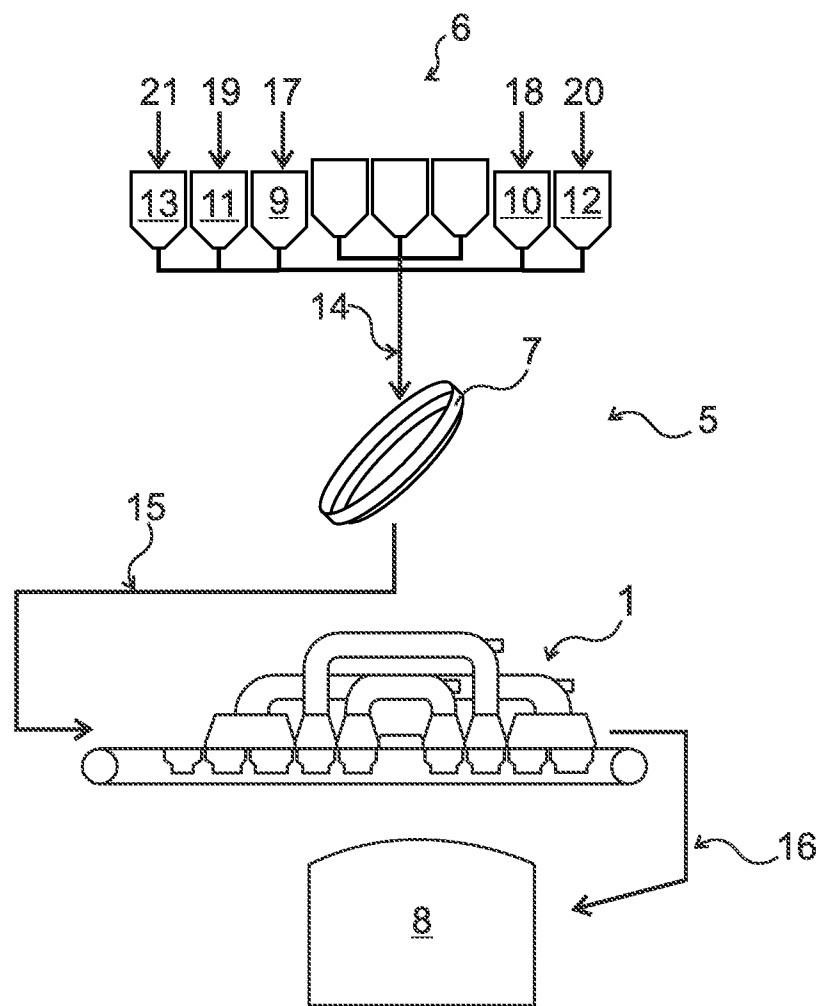


Fig. 1

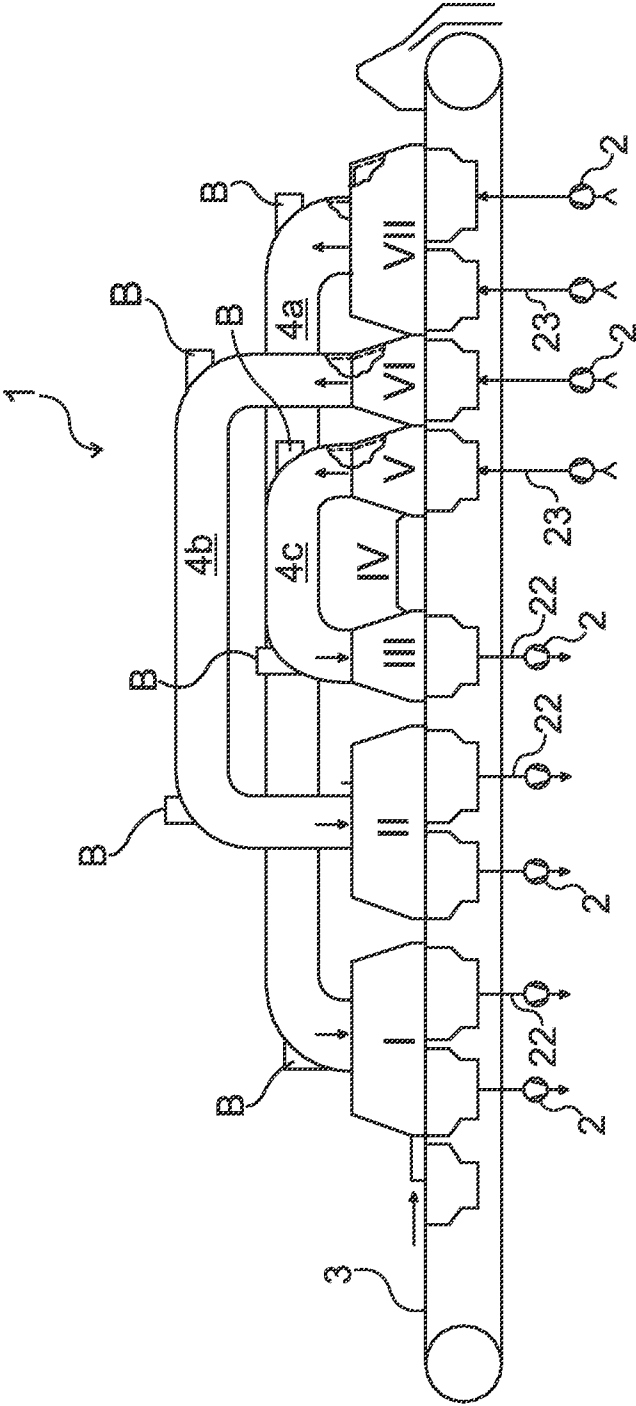


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2016/050785

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: F27B, C22B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPODOC, EPO-Internal full-text databases, Full-text translation databases from Asian languages, WPIAP, PRH-Internal, COMPDX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 0223111 A1 (OUTOKUMPU OY [FI]) 21 March 2002 (21.03.2002) whole document, especially page 4, lines 4-31; figure 1	1-4, 11-19 5, 7, 8-10
X Y	WO 2012164142 A1 (OUTOTEC OYJ [FI]) 06 December 2012 (06.12.2012) whole document, especially page 13, line 18-page 14, line 19; figure 6	1-4, 6, 11-19 5, 8-10
Y	WO 2015092136 A1 (OUTOTEC FINLAND OY [FI]) 25 June 2015 (25.06.2015) whole document, especially page 4, line 20-page 5, line 10	5, 8-10
Y	GB 2042144 A (LUOSSAVAARA KIIRUNAVAARA AB) 17 September 1980 (17.09.1980) whole document, especially figure 2	7

☒ Further documents are listed in the continuation of Box C.
☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

14 February 2017 (14.02.2017)

Date of mailing of the international search report

15 February 2017 (15.02.2017)

Name and mailing address of the ISA/FI
Finnish Patent and Registration Office
P.O. Box 1160, FI-00101 HELSINKI, Finland
Facsimile No. +358 9 6939 5328

Authorized officer
Anu Keski-Honkola
Telephone No. +358 9 6939 500

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2016/050785

CLASSIFICATION OF SUBJECT MATTER

IPC

F27B 21/06 (2006.01)

C22B 1/16 (2006.01)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2016/050785

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2012172174 A1 (OUTOTEC OYJ [FI]) 20 December 2012 (20.12.2012) whole document, especially pages 2 and 3; figure 1	1-19

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2016/050785

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
WO 0223111 A1	21/03/2002	AT 348305 T	15/01/2007
		AU 8597001 A	26/03/2002
		BR 0113800 A	08/07/2003
		BR 0113800 B1	11/08/2009
		CA 2420175 A1	21/03/2002
		CN 1454306 A	05/11/2003
		CN 100354590 C	12/12/2007
		DE 60125209 D1	25/01/2007
		DE 60125209 T2	05/04/2007
		EA 004854 B1	26/08/2004
		EP 1325275 A1	09/07/2003
		EP 1325275 B1	13/12/2006
		FI 20001998 A	12/03/2002
		FI 112112 B	31/10/2003
		NO 20030854 D0	24/02/2003
		NO 20030854 A	29/04/2003
		US 2003165789 A1	04/09/2003
		US 6767206 B2	27/07/2004
		ZA 200301564 B	05/09/2003
			
WO 2012164142 A1	06/12/2012	CA 2832674 A1	06/12/2012
		CA 2832674 C	07/07/2015
		CN 103562664 A	05/02/2014
		CN 103562664 B	13/01/2016
		EA 201391678 A1	30/05/2014
		EA 024686 B1	31/10/2016
		FI 20136271 A	16/12/2013
		FI 126234 B	31/08/2016
		US 2014099587 A1	10/04/2014
		US 9429316 B2	30/08/2016
		ZA 201309666 B	27/05/2015
.....			
WO 2015092136 A1	25/06/2015	CN 105829551 A	03/08/2016
.....			
GB 2042144 A	17/09/1980	GB 2042144 B	09/02/1983
		AU 5521780 A	14/08/1980
		AU 528058 B2	14/04/1983
		BR 8000699 A	14/10/1980
		CA 1137319 A	14/12/1982
		DE 3003014 A1	07/08/1980
		DE 3003014 C2	18/10/1990
		JP S55104438 A	09/08/1980
		JP S6338411 B2	29/07/1988

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2016/050785

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
		SE 7901052 L	07/08/1980
		SE 420507 B	12/10/1981
		US 4321085 A	23/03/1982
.....			
WO 2012172174 A1	20/12/2012	BR 112013032335 A2	20/12/2016
		CA 2833829 A1	20/12/2012
		CA 2833829 C	09/06/2015
		CN 103582529 A	12/02/2014
		EA 201391679 A1	30/05/2014
		EP 2720797 A1	23/04/2014
		FI 20114064 U0	15/06/2011
		FI 9406 U1	11/10/2011
		FI 20145019 A	13/01/2014
		US 2014117128 A1	01/05/2014
		ZA 201400282 B	29/10/2014
.....			