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(54) Title: METHOD, ARRANGEMENT AND USE FOR TREATING NICKEL ORE

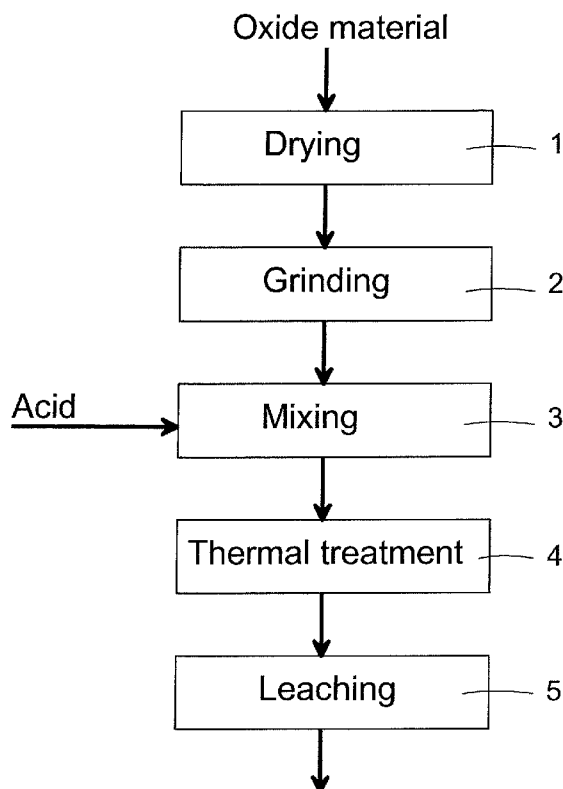


Fig. 1

(57) Abstract: A method and an arrangement for treating oxide material. The method comprises: a) a grinding step for grinding the oxide material, and b) a mixing step for mixing the oxide material with an acid. The grinding step and/or the mixing step comprise treating said oxide material in a high speed mixer.



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Method, arrangement and use for treating nickel ore

Background

The invention relates to a method and arrangement for treating nickel ore, more particularly to grinding of the nickel ore and to a mixing of said
5 nickel ore with an acid.

Treating processes of nickel ore, such as nickel laterite, for recovery of valuable metals are commonly known. WO 2010/061045, for instance, discloses this kind of process. The process comprises a grinding step where crushed ore is ground to smaller particles and a mixing step where said small-
10 er particles are mixed homogenously into an acid.

The grinding step disclosed in WO 2010/061045 takes place in a ball mill. The ball mill used in the grinding step may have problems caused by e.g. sticking of the ore in the mills. Furthermore, classification of the ground ore may be difficult and the resultant particle size may be too high.

15 The mixing step disclosed in WO 2010/061045 is carried out in, for instance, a screw mixer or drum-type reactor. A problem with the mixing step is that the ore and the acid tend to form pellets during the mixing. This is indicated by the fact that the surface of the pellets has been reacted with the acid while non-reacted laterite remains inside the pellet. The resulting non-
20 homogenous ore-acid mixture does not result in complete sulphation reaction required for acceptable nickel recovery.

Brief description

Viewed from a first aspect, there can be provided a method for treating oxide material, comprising a) a grinding step for grinding the oxide material,
25 and b) a mixing step for mixing the oxide material with an acid, wherein the grinding step and/or the mixing step comprises treating said oxide material in a high speed mixer. Thereby a method for high metal recovery may be achieved.

Viewed from a further aspect, there can be provided an arrangement for treating oxide material, comprising a) a grinder for grinding the oxide
30 material, and b) a mixer for mixing the oxide material with an acid, wherein the grinder and/or the mixer is a high speed mixer. Thus an effective arrangement for high metal recovery may be achieved.

According to an embodiment, the grinding step takes place in a high speed mixer. An advantage is that in the grinding may be quite easily achieved

the target level of the particle size that is essential for achieving high metal yield in the process.

According to an embodiment, the mixing step takes place in a high speed mixer. An advantage is that the mixing can be realized very intensive way. Thanks to this, the acid can added quickly in the oxide material and the mixing time can be kept very short. Thus reactions of the oxide material and the acid will not hamper the mixing of said materials homogenously to each other. A further advantage of the mixing step taking place in a high speed mixer is that the amount of the acid may be reduced due to the very homogenous mixing result.

According to an embodiment, both the grinding step and the mixing step take place in a high speed mixer. Advantages of this embodiment are disclosed above.

A further advantage of using a high speed mixer in the grinding step and/or the mixing step may be that the investment costs are low and the equipment is small-sized compared to prior art equipment.

The method, arrangement and use are characterised by what is stated in the independent claims. Some other embodiments are characterised by what is stated in the other claims. Inventive embodiments are also disclosed in the specification and drawings of this patent application. The inventive content of the patent application may also be defined in other ways than defined in the following claims. The inventive content may also be formed of several separate inventions, especially if the invention is examined in the light of expressed or implicit sub-tasks or in view of obtained benefits or benefit groups. Some of the definitions contained in the following claims may then be unnecessary in view of the separate inventive ideas. Features of the different embodiments of the invention may, within the scope of the basic inventive idea, be applied to other embodiments.

Brief description of figures

Some embodiments illustrating the present disclosure are described in more detail in the attached drawings, in which

Figure 1 is a flow diagram of a method according to the invention,

Figure 2a is a schematic side view of a rotary mixer in partial cross-section,

Figure 2b is a schematic top view of the rotary mixer shown in Figure 2 in partial cross-section, and

Figure 3 is a schematic side view of another rotary mixer in partial cross-section.

In the figures, some embodiments are shown simplified for the sake of clarity. Similar parts are marked with the same reference numbers in the
5 figures.

Detailed description

Figure 1 shows a flow diagram of a method according to the invention. In the method, an oxide material is treated by grinding and mixing the ground oxide material with an acid.

10 Said oxide material may be e.g. metal ore, for instance nickel ore, such as nickel laterite. The oxide material may also be zinc-containing dust from steelmaking.

The oxide material may be dried in a drying step 1, but this is not compulsory. The oxide material is fed in the drying step preferably as crushed
15 or relatively small particles. According to an embodiment, the particle size of the oxide material subjected to the drying is 90% under 10 mm.

The drying may comprise e.g. steam drying.

After the drying step the moisture content of the dried oxide material is preferably 5 – 30 weight-%.

20 The dried oxide material is routed to a grinding step 2 where the oxide material is ground to smaller particles, typically to a particle size of 90% under 200 µm, preferably 90 % under 100 µm. This particle size has been discovered to contribute in achieving high metal recovery, even as high as 95%.

In the grinding step 2 the oxide material is subjected to grinding in a
25 high speed mixer. The high speed mixer may be, for instance, a mixer commercially known as Atrex type mixer or Eirich type mixer. The high speed mixers have several advantages compared to those mills known to be used in the grinding. For example, the grinding time is short, energy consumption is low, a classification is not needed, and tolerance to varying moisture content of the
30 material to be grinded.

The grinding step 2 may comprise one or more mixer units arranged in series or in parallel.

The ground oxide material is conveyed in a mixing step 3 where it is mixed homogenously into an acid.

35 The acid may comprise e.g. concentrated sulphuric acid, hydrochloric acid or nitric acid.

In the mixing step 3, the mixing takes place in one or more mixer units arranged in series or in parallel. The mixing unit comprises a high speed mixer.

5 The acid is added in such a quantity that it is at least in stoichiometric ratio with regard to the metals in the oxide material. As a result, a mixture of the oxide material and the acid is generated.

According to an embodiment, the temperature in the mixing step 3 is preferably not more than 100 °C so that reactions, e.g. sulfation reactions, between the oxide material and the acid do not take place in the mixing stage 3.

10 According to another embodiment, the temperature in the mixing step 3 is so high that said reactions between the oxide material and the acid begin in the mixing stage 3.

It is to be noted, however, that it is not necessary that both the grinding step 2 and the mixing step 3 are taking place in high speed mixers.

15 According to an embodiment, the grinding step 2 is realized in a high speed mixer whereas the mixing step 3 is taking place in a conventional apparatus, e.g. in a screw mixer, drum-type reactor etc.

According to another embodiment, the mixing step 3 is carried out in a high speed mixer whereas the grinding step 2 is taking place in a conventional apparatus, e.g. in a ball mill etc.

20 After the mixing stage the mixture is fed to a thermal treatment or reaction step 4. Here the temperature of the mixture is raised by e.g. means of external heating known per se. Also the reactions of the oxide material and the acid are typically exothermic producing thus heat. The reactions take place in temperature and pressure specific for the reacting materials.

The thermal treatment step 4 may also comprise an acid recovery stage where residual acid is removed from the mixture e.g. by evaporation.

30 After the thermal treatment step 4 the material containing water-soluble salts of the acid is routed to a leaching step 5 where water is added to the material. This step is realized in temperature and pressure specific for the material.

The leaching step 5 is usually followed by downstream processing steps known per se and thus they are not described further in this description.

Figure 2a is a schematic side view and Figure 2b a schematic top view of a rotary mixer shown in partial cross-section. This is so called Atrex type rotary mixer 6.

The rotary mixer 6 may comprise a rotating first rotor 7 and a second rotor 8 rotating relative to the first rotor and being concentric with it. The rotors 7, 8 are connected to rotate in opposite directions. The first rotor 7 is provided with first blades 9 on one blade circle. This blade circle forms a first surface with openings 10a, because there is an opening between two adjacent first blades 9.

The second rotor 8 is provided with second blades 11a, 11b on two blade circles on both sides of the blade circle formed by the first blades 9. These blade circles form a second and a third surface with openings 10b, 10c.

Said surfaces with openings are intermeshed and concentric with each other.

It is to be noted that the number of blade circles, the number of blades in them, the shape and dimensions of the blades and the like properties may differ from the rotary mixer 6 shown in Figures 2a, 2b. Furthermore, the rotors 7, 8 may have a conical shape etc.

The first rotor 7 and the first blades 9 arranged in them may be rotated via a first drive shaft 12, the second rotor 8 with its second blades 11a, 11b being rotated with a second drive shaft 13. The rotating speed of the rotors 7, 8 may be in range of 300 – 1000 rpm.

A feed opening 14 of the mechanical dispergator is arranged at the centre of the rotors. The material to be treated, e.g. oxide material or acid described earlier in this description, fed here passes through the surfaces with openings, i.e. from between the blades 9, 11a, 11b in the direction of the outer circle and further out through a discharge channel 15.

The material is subjected to intensive shear forces and impacts which breaks material particles in smaller size and/or mixes materials in homogenous mixture.

According to another embodiment of the Atrex -type rotary mixer 6, the rotors 7, 8 may be arranged to rotate in the same direction but with different speed.

According to another embodiment of the Atrex -type rotary mixer 6, one of the rotors 7, 8 may be replaced by a stator, i.e. the mixer 6 may comprise a stationary stator and a rotor rotating coaxially relative to the stator.

The dwell-time of the material to be treated in the mixer 6 may be very short, even less than 0.1 seconds. The dwell-time may be controlled various ways known per se. According to an embodiment, the grinding time is in range of 1 – 30 seconds, preferably 1 – 5 seconds. The mixing time is preferably in range of 1 – 10 seconds, more preferably 1 – 2 seconds.

Figure 3 is a schematic side view of another rotary mixer 6 in partial cross-section. This kind of mixer is commercially available under the trade name of Intensive Mixer from Eirich GmbH.

The mixer 6 comprises a mixing pan 16 which itself is rotatable, a high-speed rotation agitator 17 disposed eccentrically within the pan 16, and a stationary scraper 18.

The rotating mixing pan 16 and agitator 17 cooperate to achieve high-shear mixing, which is combined with a vertical counter flow created by the scraper 18. This way a high-efficiency kneading and mixing may be achieved.

The invention is not limited solely to the embodiments described above, but instead many variations are possible within the scope of the inventive concept defined by the claims below. Within the scope of the inventive concept the attributes of different embodiments and applications can be used in conjunction with or replace the attributes of another embodiment or application.

The drawings and the related description are only intended to illustrate the idea of the invention. The invention may vary in detail within the scope of the inventive idea defined in the following claims.

Reference symbols

	1	drying step
	2	grinding step
5	3	mixing step
	4	thermal treatment step
	5	leaching step
	6	rotary mixer
	7	first rotor
10	8	second rotor
	9	first blade
	10a - c	opening
	11a, b	second blade
	12	first drive shaft
15	13	second drive shaft
	14	feed opening
	15	discharge channel
	16	mixing pan
	17	rotation agitator
20	18	scraper

Claims

1. A method for treating oxide material, comprising
a) a grinding step for grinding the oxide material, and
b) a mixing step for mixing the oxide material with an acid,
5 c h a r a c t e r i z e d in that
the grinding step and/or the mixing step comprises treating said oxide material in a high speed mixer,
the high speed mixer being a rotary mixer comprising
a stator and a rotor rotating coaxially relative to the stator, the stator
10 and the rotor comprising alternate and concentric circular surfaces with openings.
2. The method as claimed in any of the preceding claims, c h a r -
a c t e r i z e d in that rotating speed in the grinding step is in range of 300 –
15 1000 rpm.
3. The method as claimed in any of the preceding claims, c h a r -
a c t e r i z e d in that the grinding is dry grinding, the moisture content of the nickel ore being preferably 5 – 30 % by weight.
- 20 4. The method as claimed in any of the preceding claims, c h a r -
a c t e r i z e d in that the grinding time is in range of 1 – 30 seconds, preferably 1 – 5 seconds.
- 25 5. The method as claimed in any of the preceding claims, c h a r -
a c t e r i z e d in that the nickel ore is grinded to a particle size of <200 μm .
6. The method as claimed in any of the preceding claims, c h a r -
a c t e r i z e d in that mixing speed in the mixing step is in range of 300 – 1000
30 rpm.
7. The method as claimed in any of the preceding claims, c h a r -
a c t e r i z e d in that the mixing time is in range of 1 – 10 seconds, preferably
1 – 2 seconds.

8. The method as claimed in any of the preceding claims, characterized in that the oxide material comprises nickel ore.

9. The method as claimed in claim 8, characterized in that
5 the nickel ore comprises nickel laterite.

10. The method as claimed in any one of claims 1 to 7, characterized in that the oxide material comprises zinc-containing dust from steelmaking.
10

11. The method as claimed in any of the preceding claims, characterized in that the acid comprises concentrated sulphuric acid.

12. The method as claimed in claim 11, characterized in that
15 sulfation reactions are allowed to take place in the high speed mixer.

13. An arrangement for treating oxide material, comprising
a) a grinder for grinding the oxide material, and
b) a mixer for mixing the oxide material with an acid,
20 characterized in that
the grinder and/or the mixer is a high speed mixer, the high speed mixer being a rotary mixer, comprising
a stator and a rotor that is coaxially arranged with the stator and arranged to rotate relative to the stator, the stator and the rotor comprising alternate and concentric circular surfaces with openings.
25

14. The arrangement as claimed in claim 13, characterized in that high speed mixer is arranged to grind the nickel ore to a particle size of <200 µm.
30

15. The arrangement as claimed any one of claims 13 to 14, characterized in that it comprises at least two high speed mixers which are connected in in series.

35 16. Use of a high speed mixer for grinding nickel laterite.

17. Use of a high speed mixer for grinding zinc-containing dust from steelmaking.

18. Use of a high speed mixer for mixing of nickel laterite and acid.

5

19. Use of a high speed mixer for mixing of zinc-containing dust from steelmaking and acid.

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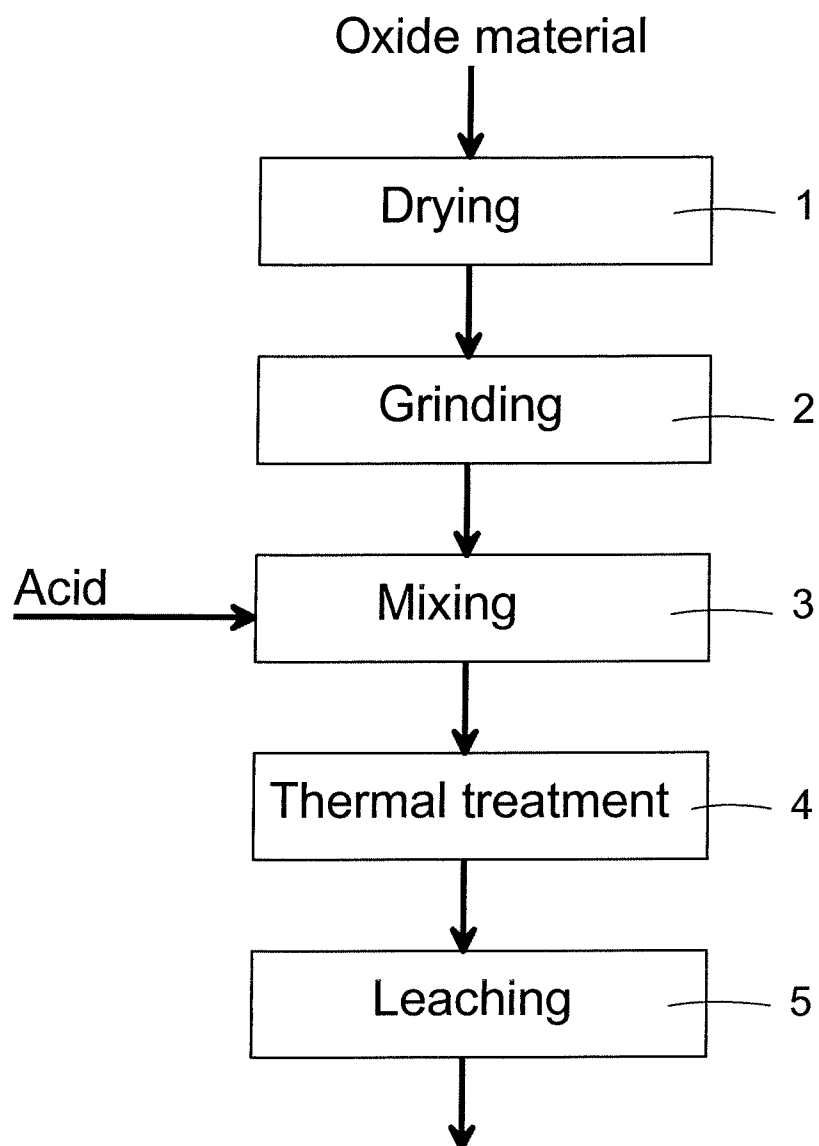


Fig. 1

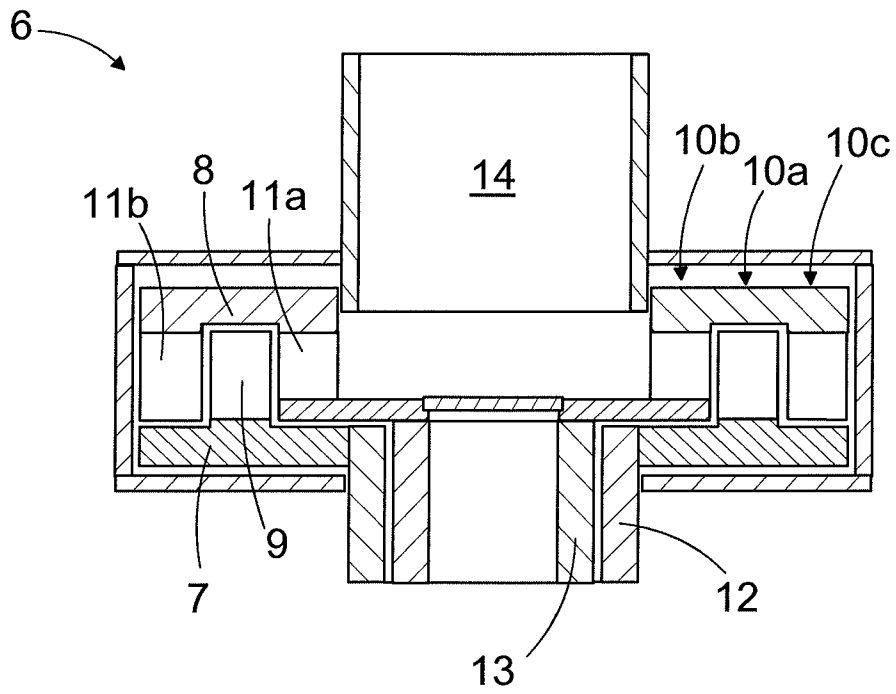


Fig. 2a

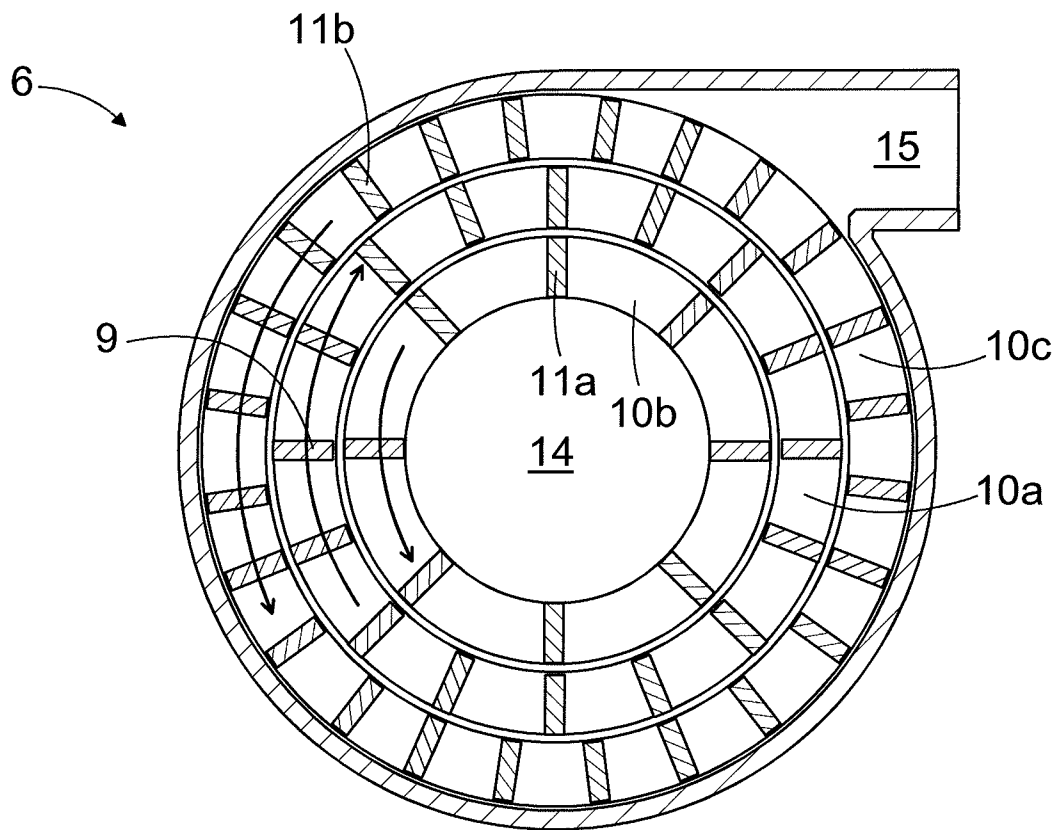


Fig. 2b

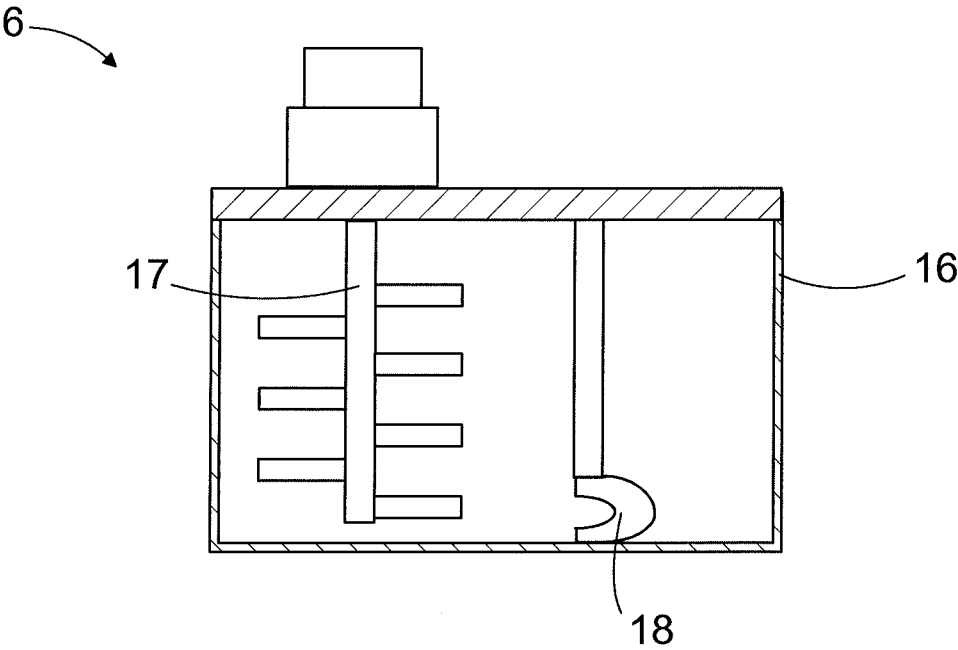


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2015/050147

A. CLASSIFICATION OF SUBJECT MATTER
INV. C22B3/00 B01F7/16 C22B7/02 C22B19/04
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)
C22B B01F

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 03/004709 A1 (OMG FINLAND OY [FI]; AALTONEN ANTTI [FI]; KARPALE KAUKO [FI]; MALMSTRO) 16 January 2003 (2003-01-16) the whole document	1-19
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A	US 4 610 722 A (DUYVESTeyN WILLEM P C [NL] ET AL) 9 September 1986 (1986-09-09) the whole document	17,19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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