



- (51) International Patent Classification:
B02C 17/18 (2006.01)
- (21) International Application Number:
PCT/EP2016/062054
- (22) International Filing Date:
27 May 2016 (27.05.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
15169557.4 28 May 2015 (28.05.2015) EP
- (71) Applicant: **ABB SCHWEIZ AG** [CH/CH]; Brown Boveri
Strasse 6, CH-5400 Baden (CH).
- (72) Inventor: **PISCHTSCHAN, Martin**; Fellstrasse 12E,
5413 Birmenstorf (CH).
- (74) Agent: **ABB PATENT ATTORNEYS**; Association 154,
c/o ABB Schweiz AG, Intellectual Property CH-IP Brown
Boveri Strasse 6, 5400 Baden (CH).
- (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, IR, IS, JP, KE, KG, KN, KP, KR,
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, 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).

Published:

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

- (54) Title: METHOD FOR DETERMINING A LIFTING ANGLE AND METHOD FOR POSITIONING A GRINDING MILL

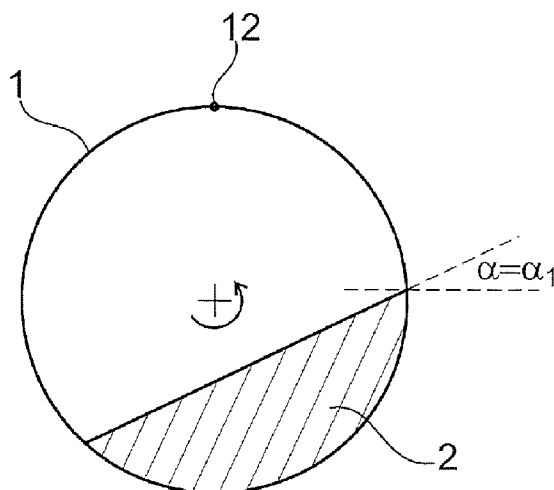


Fig. 7

(57) **Abstract:** The purpose of the invention to provide a method for determining a lifting angle of a charge inside a grinding mill at a specific point in time and a method for positioning a grinding mill which is more accurate. Method for determining a lifting angle (α) of a charge (2) inside a mill body (1) of a grinding mill being rotatable through a drive train, the method comprises the following steps of rotating the mill body (1); determining a reference lifting angle (α_{ar}) and a corresponding reference driving torque (M_r) of the drive train at a reference point in time; calculating a fill factor (K) for the reference point in time based on the reference lifting angle (α_r) and the reference driving torque (M_r); determining a driving torque (M) of the drive train; and calculating the lifting angle (α) based on the driving torque (M) and the fill factor (K).

DESCRIPTION

Method for determining a lifting angle and method for positioning a grinding mill

TECHNICAL FIELD

5 The invention relates to the field of grinding mills, in particular a method for determining a lifting angle α of a charge inside a grinding mill and a method for positioning the mill body of a grinding mill.

BACKGROUND OF THE INVENTION

10 Grinding mills, in particular ball mills, rod mills, autogenous mills, semi-autogenous mills, regrind mills, and pebble mills, are commonly used in grinding cement or ore into fine particles. The mills typically have a cylindrical mill body which contains the material to be ground. In
15 addition to the material, a charge of a mill may contain a grinding medium like for example metallic or ceramic balls, pebbles or rods, a transport medium like water, or both.

The mills are driven indirectly with a high-speed electric
20 motor and a gear box to reduce the speed, in particular ring-gear mill drives with one or two pinions, or they are driven directly with a low-speed motor, also known as a gearless mill drive, which is typically a ring motor with a rotor directly mounted to the mill body. The diameter of
25 the mill body is typically between 5 to 15 meters. Ring-gear grinding mills typically have a driving power of 1 to 15 Megawatts. Gearless grinding mills typically have a driving power of 3.5 to 36 Megawatts. A ring-gear mill drive is disclosed in US-2931583 A. A gearless mill drive
30 is disclosed in US-3272444 A.

As shown in Fig. 1, when a mill body 1 rotates in continuous operation (rotation indicated by an arrow), a charge 2 inside the mill body 1 is continuously elevated on a side of the mill body 1 to a point where the charge 2 continuously cascades to another side of the mill body 2. As a result, a surface of the charge 2 approximated by a plane 8 and the horizontal direction 9 define a lifting angle α .

At the startup of a mill after standstill, the charge is elevated but does not move due to friction. At a certain lifting angle α_c , the gravity force is higher than the friction resulting in the material to cascade. The behavior of the charge after the cascading heavily depends on various factors such as the duration of the standstill, the ball charge or the type of material to be ground. The charge might either slide down significantly after cascading, which results in a lower lifting angle ($\alpha < \alpha_c$) or the lifting angle might remain rather stable ($\alpha \approx \alpha_c$).

It is difficult to accurately position grinding mills when a charge is inside the mill body. The accurate positioning is particularly important during the maintenance of the mill like for example the wear liner replacement. When the mill rotates, the center of gravity of the charge is vertically not aligned with the center of the mill body due to the lifting angle resulting from the rotation. Therefore, the charge is in an unbalanced position. This results in a counter rotation of the mill body when stopping to apply a torque to the mill body by the drive. The counter rotation is in the opposite direction then the rotation caused by the torque of the drive. Typically the mill body oscillates back and forth for several minutes due to the high inertia of the mill body until the center of gravity of the charge is vertically aligned with the center of the mill body in a standstill of the mill body. This phenomena is also known as roll back, rocking, or shaking.

As described by the Brochure, Siemens, November 2006, Mining, "The operation modes of a grinding mill with gearless drive", page 6, paragraph "Inching", it is known to position a mill at a given angle β_g by stopping the mill to a standstill, then starting to rotate the mill, and measuring the cascading angle α_c . The mill continues to rotate until it reaches the sum of the given angle and the cascading angle. Then, the drive will turn back the mill using torque control until the torque will be zero. This results in that the charge will be in a balance position causing no roll back or oscillations. However, the accuracy depends on the assumption that the actual lifting angle at the time of the turn back is equal to the cascading angle. As discussed above, this assumption is at best a good approximation resulting in a slightly inaccurate positioning even in the favorable case that the lifting angle remains rather stable after cascading ($\alpha \approx \alpha_c$).

BRIEF SUMMARY OF THE INVENTION

It is an objective of the invention to provide a method for determining a lifting angle of a charge inside a grinding mill at a specific point in time and a method for positioning a grinding mill which is more accurate.

According to the invention, a reference lifting angle and a reference driving torque are determined during the rotation of the mill. Both values are determined at the same reference point in time and form a pair of values which correspond to each other. The value for the reference driving torque can be determined or approximated in various ways, e.g. by using a torque sensor or the motor current. Based on the pair of values, a fill factor is calculated. The fill factor is approximately constant during the rotation of the mill and summarizes or consolidates different characteristics of the charge, e.g. mass, volume, geometrical shape. The equation for the calculation of the fill factor is basically a model equation resulting

from an equilibrium of forces and moments of forces calculated for a model using different simplifications, e.g. homogenous mass distribution in axial, radial, and tangential direction, no change of the charge inside the mill, constant speed of the mill. Therefore, the equation for the calculation of the fill factor may vary, depending on the desired level of accuracy and the operational conditions, and may require additional input values, e.g. the change of charge inside the mill body. The lifting angle at a specific point in time is determined by determining the value for a driving torque at the specific point in time and calculating the lifting angle using said value of the driving torque and the fill factor. The driving torque at the specific point in time can be determined or approximated in various ways, e.g. by using a torque sensor or the motor current. Thus, it is possible to consolidate various parameters relevant to the lifting angle in the form of the fill factor, use a reference point to determine said fill factor and use the fill factor and the driving torque to account for changes of the lifting angle.

According to an first preferred embodiment of the invention, the current value of the driving torque after the reference point in time is used to continuously calculate the current lifting angle online or in real-time, where the values of the driving torque are used to calculate the lifting angle immediately after they become available as opposed to delaying the calculation to a later point in time.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter of the invention will be explained in more detail in the following paragraph with reference to preferred exemplary embodiments which are illustrated in the attached drawings, which schematically show:

Figure 1 a continuously rotating mill body from the state of the art filled with a charge in a radial cross-section perpendicular to a rotational axis of the mill body;

5 Figure 2 to 9 a sequence of figures of a mill body with a charge in a radial cross-section perpendicular to a rotational axis of the mill body during the steps of a maintenance procedure for the mill body using a method of positioning of the mill body at particular angles according to the invention; and

10 Figure 10 a graphical representation of a driving torque over the rotational angle of the mill body after starting the mill from standstill in a balanced position;

15 The reference symbols used in the drawings, and their meanings, are listed in summary form in the list of designations. In principle, identical parts are provided with the same reference symbols in the figures.

20 DETAILED DESCRIPTION OF THE INVENTION

In Fig. 2, a mill body 1 is filled with a charge 2 and in a balanced position so that a center of gravity 21 of the charge 2 is vertically aligned with a center of rotation 11 of the mill body 1 (gravity field in vertical direction as indicated by an arrow). Therefore, a gravity force of the charge 2 does not result in a torque in axial direction which would cause the mill body 1 to rotate. The mill body 1 is at the standstill, meaning that the mill body 1 does not rotate and the rotational speed is zero. The mill body 1 comprises a rotational reference point 12.

In Fig. 3, the mill body 1 has started to rotate due to the application of a driving torque to the mill body 1 (rotation indicated by an arrow around the center of rotation 11 of the mill body 1). Because to the rotation, the

charge 2 is in an unbalanced position, where the center of gravity 21 of the charge 2 is not vertically aligned with the center of rotation 11 of the mill body 1 so that there is an torsion arm of the gravity force of the charge with respect to the center of rotation 11 of the mill body 1 (torsion arm indicated by another arrow with two arrow-heads). The resulting torque caused by the gravity force is increasing with an increase of a lifting angle α of the charge 2 because the torque arm increases as the lifting angle α increase. The resulting torque is in the opposite direction as the driving torque and needs to be compensated by the driving torque in order for the mill body to continue to rotate.

A first imaginary straight line connecting the center of rotation 11 of the mill body 1 and the rotational reference point 12 of the mill body 1 together with a second imaginary straight line connecting the center of rotation 11 of the mill body 1 and the initial position of the rotational reference 12 form an angle β which defines the rotational position of the mill body 1.

During the rotation of the mill body 1, an operator 3 of the mill performs a visual inspection of the outside of the mill body 1. In order to give the operator enough time to perform said visual inspection, the rotational speed of the mill body 1 for such an inspection is usually much lower than the nominal speed of the mill. Such a rotation at low speeds is also referred to as inching or creeping. For a mill with a direct mill drive, it is possible to use said direct drive itself for the slow rotation of the mill body 1. For a mill with a ring-gearred mill drive, it is often necessary to have auxiliary inching drive. During the inspection, the operator 3 notices areas of the mill body 1 that require maintenance work. The operator 3 determines the rotational positions that the mill body 1 needs to be stopped in order to perform the maintenance and the respective angle β . In this particular example, β_1 is approximately 180° .

In Fig. 4, the mill body 1 has rotated further compared to Fig. 3. At this part of the mill body 1, the operator 3 notices another area which requires maintenance. In this particular example, the corresponding angle β_2 is approximately 270°.

It is possible to continue rotating the mill body 1 in order to identify more area of the mill body 1 that require maintenance and the respective rotational positions in the form of the angle β .

10 In Fig. 5, the mill body 1 has stopped. The rotational position of this stopping point does not matter. The rotation reference point 12 is at an arbitrary position. The operator has finished the inspection of the mill body 1 and both desired stopping points and the respective angles
15 β_1 , β_2 are known. The charge 2 is again in a balance position and in a standstill.

In Fig. 6, the mill body 1 has started to rotate again. The charge 2 is lifted up without cascading until the lifting angle reaches the critical value of the cascading
20 angle $\alpha = \alpha_c$. Because the charge 2 does not cascade, the lifting angle α is equal to an angle $\Delta\beta$. The angle $\Delta\beta$ is defined by the difference between the current position of the rotational position reference 12 and the arbitrary position on of the rotational position reference 12 in the
25 standstill from Fig. 5. It is common to obtain the value of the angle $\Delta\beta$ as an approximation for the lifting angle α before the cascading of the charge 2 from respective calculations based on the rotational angle values from the motor control. The motor current, which is a value easily
30 accessible through the motor control, is often used to approximate the driving torque M . However, it is also possible to use other way to obtain the value of the driving torque M and the angle $\Delta\beta$, e.g. through external sensors.

Fig. 10 shows the relationship between the driving torque
35 M and the angle $\Delta\beta$ for the time between the standstill in Fig. 5 ($\Delta\beta = 0$) and $\Delta\beta$ of approximately 90°. Starting with

$\Delta\beta = \alpha = 0$, the driving torque continuously increases due to the elevation of the charge 2 and the increasing vertical misalignment of the center of gravity 21 of the charge 2 and the center of rotation 11 of the mill body 1 resulting in an increasing torque in the opposite direction of the driving torque caused by the gravity force of the charge. When the charge 2 starts to cascade, the driving torque no longer continues to increase, because the lifting angle α no longer increases. Thus the torsional arm between the center of gravity 21 of the charge 2 and the center of rotation 11 of the mill body 1 does not increase anymore. After this point the driving torque oscillates around a mean value, at least in a first transitional period due to the discontinuities of the cascading process or discontinuities introduced by lifter shoulders (not shown) inside the mill body 1, which lifting shoulders help to lift up the charge 2.

It is possible to approximate the cascading angle α_c to be equal to the angle $\Delta\beta^*$ at which the driving torque does not increase more than the predefined increment. Alternatively, it is possible to use a graphical analysis of the driving torque and determine the start of the oscillation graphically. In the specific example of Fig. 10, the cascading angle α_c is approximately 42° . The corresponding driving torque is M_c .

Alternatively, the reference lifting angle can be determined optically, e.g. with laser measurement or a camera. These means of determining the reference lifting angle can also be performed at a reference point in time, which is different from the start of the cascading.

With the cascading angle α_c as the lifting angle at the occurrence of the cascading and the corresponding driving torque M_c , it is possible to calculate the fill factor K for the point in time when the cascading starts using for example the model equation for the calculation of the fill factor below, which model makes the follow assumptions:

homogenous mass distribution in axial, radial, and tangential direction, no change of the charge inside the mill, and constant speed of the mill (β : see Fig. 2):

$$M = m * g * r * \cos(\beta/2) * \sin(\alpha)$$

$$5 \quad K = \text{constant} = M / \sin(\alpha) = M_c / \sin(\alpha_c).$$

An alternative model equation considering the change of charge inside the mill (m_0 : original mass, Δm : change of mass) is:

$$M = (m_0 - \Delta m) * g * (4 * r * \sin(\beta/2)) / (3 * \beta - 3 * \sin(\beta)) * \sin(\alpha)$$

$$10 \quad K = \text{constant} = M / ((m_0 - \Delta m) * \sin(\alpha))$$

The beginning of the cascading is used as a reference point where the reference lifting angle ($\alpha_s = \alpha_c$) and the reference driving torque ($M_r = M_c$) are known. It is also possible to use alternative formulas, which for example
 15 consider the variation of the amount of charge inside the mill body over time. For the use of the above equation, it is advantageous to keep the amount of charge constant, e.g. avoiding material input to and output from the mill body.

20 In Fig. 7, the mill body 1 has rotated further compared to the beginning of the cascading in Fig. 6. The current lifting angle α_1 may be different from the beginning of the cascading where the lifting angle α was equal to the cascading angle α_c . In this specific example the charge 2 has
 25 significantly slid down so that the current lifting angle α_1 is smaller than the cascading angle α_c . Because the current driving torque is known to be M_1 , e.g. from the motor current of the motor control, it is possible to calculate the current lifting angle α_1 in real-time using for example
 30 the equation

$$\alpha_1 = \arcsin(M_1 / K).$$

The current lifting angle α can be calculated for every point in time following the beginning of the cascading.

For the accurate positioning of the mill body 1 at the particular rotational position β_1 , the mill body 1 is rotated to a rotational position where the current rotational position β minus the current lifting angle α is equal
5 to the particular rotational position β_1 .

$$\beta - \alpha = \beta_1$$

After reaching sets rotational position β , where the above condition is fulfilled, the mill is stopped and is rotated in the opposite direction by the amount of the actual
10 lifting angle at the time of stopping the mill body. After that, the driving torque M is set to zero. The charge 2 is in the balanced position and no further rotation of the mill body 2 occur so that the mill body 1 remains in the particular rotational position β_1 .

15 After finishing the maintenance at the particular rotational position β_1 , it is possible to restart the rotation of the mill body 1 and repeat the procedure described in Fig. 8 and 9 to stop the mill body 1 at the other particular rotational position β_2 . It is not necessary to calculate the cascading angle α_c or the fill factor K again.
20

LIST OF REFERENCE NUMERALS

1	mill body
11	center of rotation of the mill body
12	rotational reference point of the mill body
2	charge
21	center of gravity of the charge
3	operator
α	lifting angle
α_r	reference lifting angle
α_c	cascading angle
β	rotational angle (β) of the mill body
β_g	given rotational angle
M	driving torque
M_r	reference driving torque
K	fill factor

Patent Claims

1. Method for determining a lifting angle (α) of a charge (2) inside a mill body (1) of a grinding mill being rotatable through a drive train, wherein the method
5 comprises the following steps:
 - a) Rotating the mill body (1);
 - b) Determining a reference lifting angle (α_r) and a corresponding reference driving torque (M_r) of the drive train at a reference point in time;
- 10 **characterized in that,** the method further comprises the following steps:
 - c) Calculating a fill factor (K) for the reference point in time based on the reference lifting angle (α_r) and the reference driving torque (M_r);
 - 15 d) Determining a driving torque (M) of the drive train; and
 - e) Calculating the lifting angle (α) based on the driving torque (M) and the fill factor (K).
2. Method according to claim 1, wherein after the calculation of the fill factor (K) in step (c) the calculation of the lifting angle (α) through the steps (d) and (e) is performed online or in real-time after the reference point in time.
3. Method according to claim 1 or 2, wherein the mill
25 body (1) rotates with a constant rotational speed.
4. Method according to one of the claims 1 to 3, wherein a change of volume of the charge (2) over time is determined and taken into account for the calculation of the fill factor (K) in step (c) and/or for the calculation of the lifting angle (α) in step (e).
30

5. Method according to claim 4, wherein the change of volume of the charge (2) over time is determined using a measurement of a volume of a material input to the mill body (1) and a measurement of a volume of a material output from the mill body (1).
6. Method according to claim 4 or 5, wherein the change of volume of the charge (2) over time is zero.
7. Method according to one of the claims 1 to 6, wherein the reference point in time is a point in time where a first cascading of the charge (2) occurs.
8. Method according to claim 7, wherein the determination of the reference lifting angle (α_r) uses an analysis of the driving torque (M) as a function of a rotational angle (β) of the mill body (1) and a recognition of an increase of the driving torque (M) that is smaller than a pre-defined increment.
9. Method according to claim 7, wherein the determination of the reference lifting angle (α_r) uses an analysis of the driving torque (M) over a rotational angle (β) of the mill body (1) and a identification of a beginning of oscillations of the driving torque (M).
10. Method for positioning a mill body (1) of a grinding mill at a given rotational angle (β_g), **characterized in that**, the method comprises the following steps:
- c) Rotating the mill body (1) to a rotational angle (β^*)
- d) Calculating the corresponding lifting angle (α^*) for the point in time when the mill body (1) reaches the rotational angle (β^*) using a method according to one of the claims 1 to 9;
- e) Repeating steps (a) to (b) until the rotational angle (β^*) minus the corresponding lifting angle (α^*) is equal to the given rotational angle (β_g).

:

d) Setting the driving torque to zero after reaching the rotational angle (β^*) that fulfills the condition of step (c).

11. Method for positioning a mill body (1) of a grinding mill at a given rotational angle (β_g), **characterized in that**, the method comprises the following steps:

a) Rotating the mill body (1) to a rotational angle (β^*)

b) Calculating the corresponding lifting angle (α^*) for the point in time when the mill body (1) reaches the rotational angle (β^*) using a method according to the one of the claims 1 to 9;

c) Repeating steps (a) to (b) until the rotational angle (β^*) minus the corresponding lifting angle (α^*) is equal to the given rotational angle (β_g).

d) Rotating back the mill body (1) using the drive train by the amount of the lifting angle (α^*) after reaching the rotational angle (β^*) that fulfills the condition of step (c).

12. Method according to claim 11, wherein the drive train is torque controlled while rotating back the mill body (1) and the drive train stops the rotation when the driving torque reaches zero.

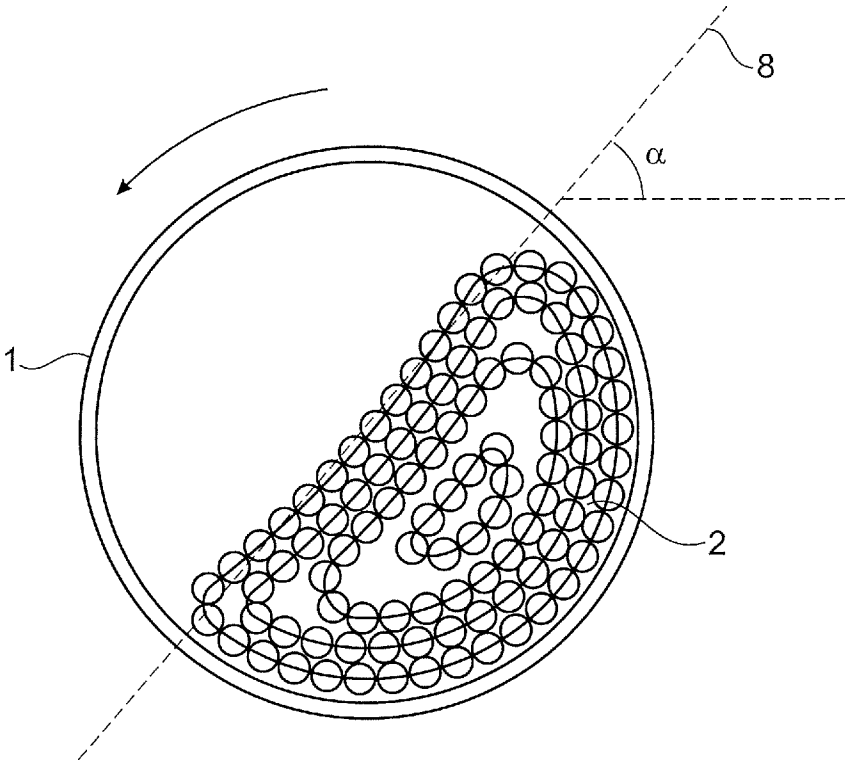


Fig. 1

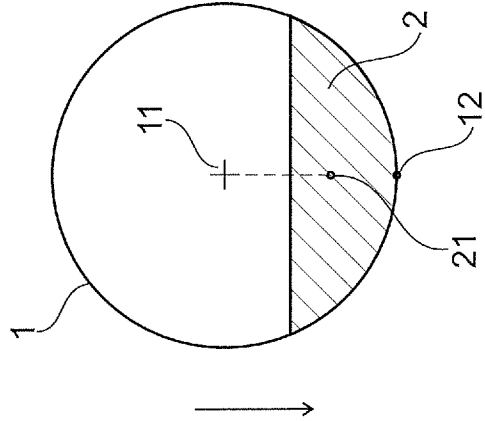


Fig. 2

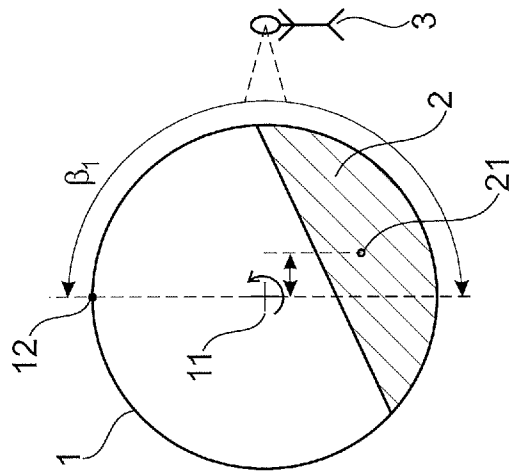


Fig. 3

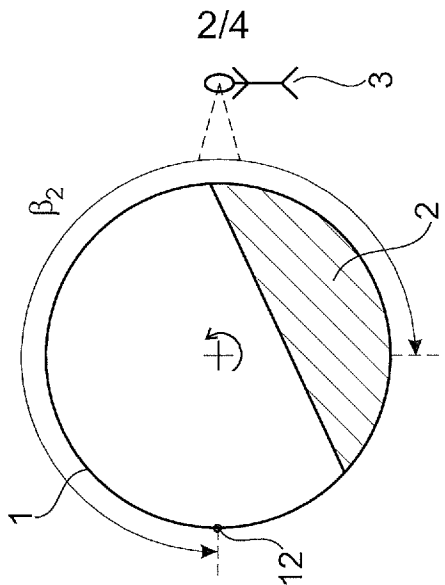


Fig. 4

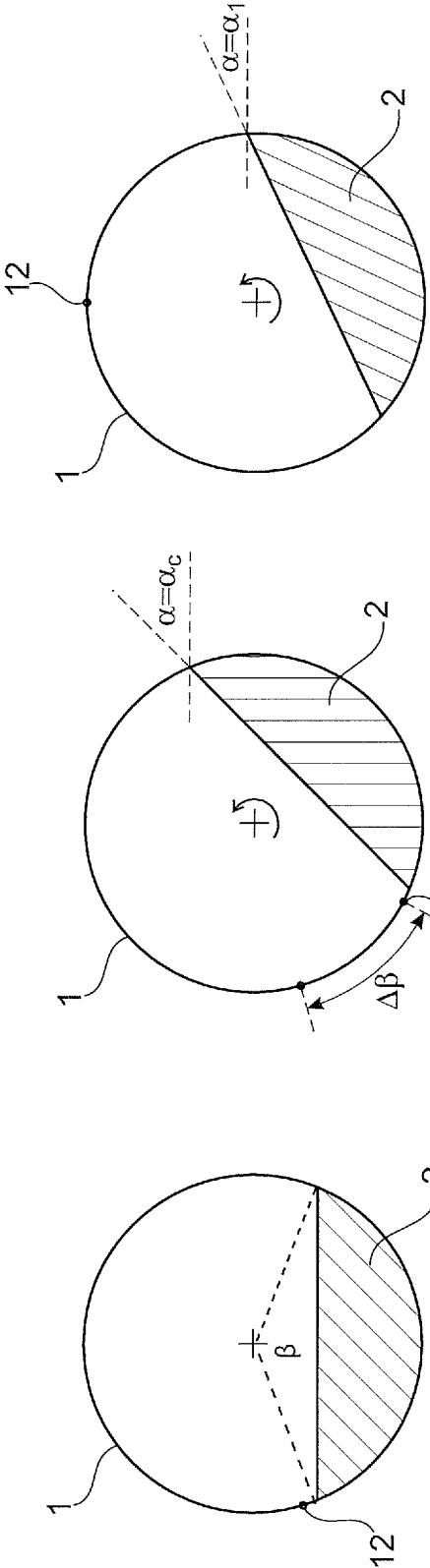


Fig. 5

Fig. 6

Fig. 7

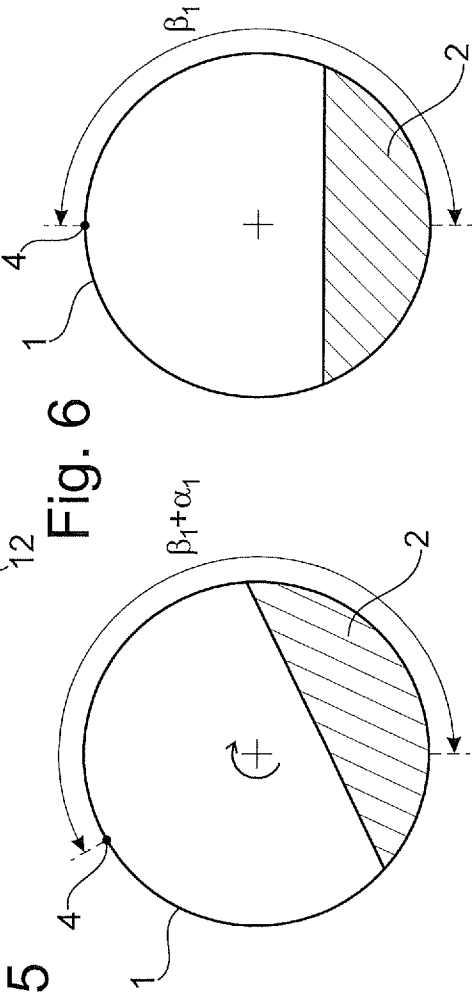


Fig. 8

Fig. 9

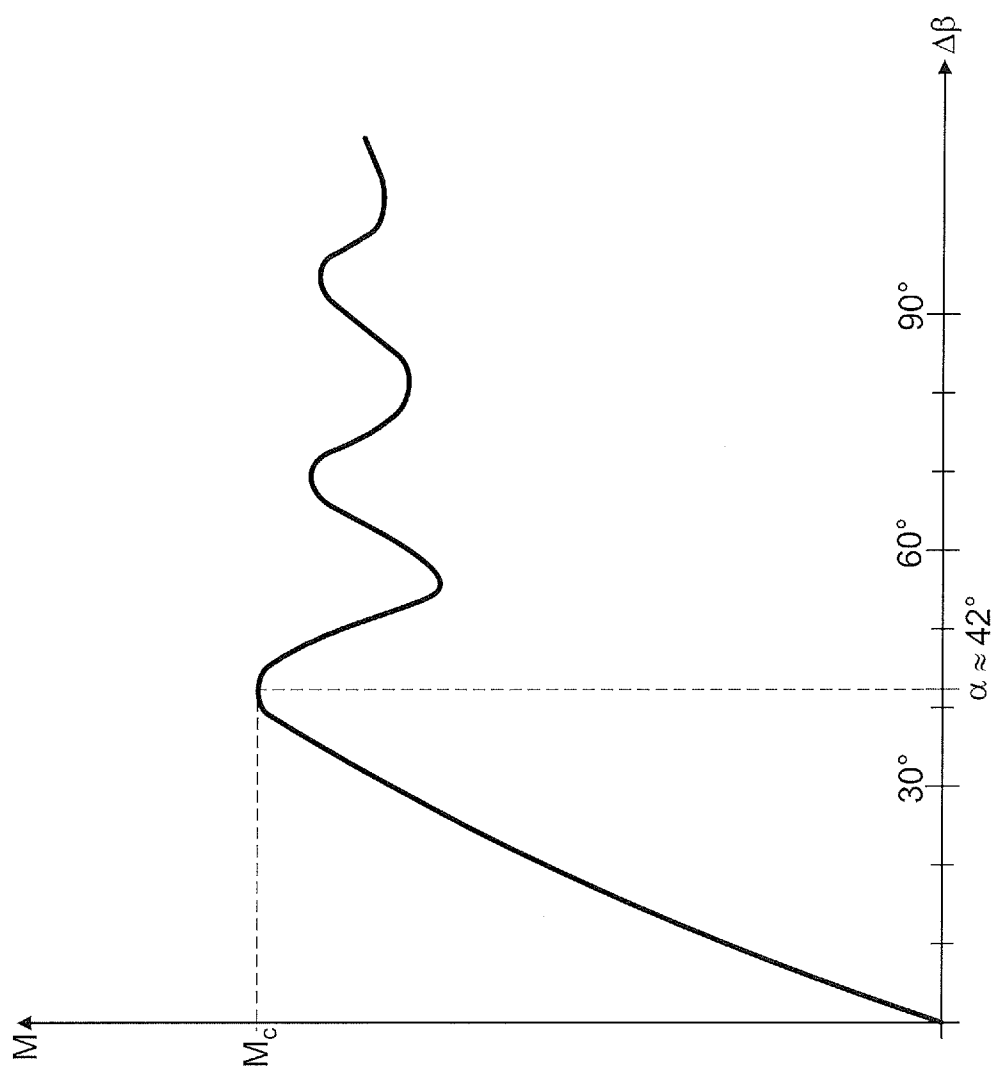


Fig. 10

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/062054

A. CLASSIFICATION OF SUBJECT MATTER

INV. B02C17/18

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)

B02C

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2004/065014 A1 (OUTOKUMPU OY [FI]; JAERVINEN JUSSI [FI]) 5 August 2004 (2004-08-05) page 3, line 13 - page 5, line 21; figure 1 -----	1-12
A	EP 2 051 811 B1 (SIEMENS AG [DE]) 30 May 2012 (2012-05-30) paragraph [0007] - paragraph [0009]; figures 1-7 -----	1-12
A	US 2004/256505 A1 (DE HAAS BERNARD [BE]) 23 December 2004 (2004-12-23) paragraph [0017] - paragraph [0019]; figures 1-6 ----- -/-	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"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

6 July 2016

Date of mailing of the international search report

18/07/2016

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

Swiderski, Piotr

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/062054

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Norbert Becker, Kurt Tischler, Stefan Smits, Volkmar Krestel: "Mining. The operation modes of a grinding mill with gearless drive", 30 November 2006 (2006-11-30), SIEMENS AG [DE], XP002747227, pages 1-8, cited in the application page 4, column 2 -----	1-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/062054

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004065014	A1	05-08-2004	AT 448878 T 15-12-2009
		AU 2003290137 A1 13-08-2004	
		BR 0318006 A 29-11-2005	
		CA 2514859 A1 05-08-2004	
		CN 1738680 A 22-02-2006	
		EP 1590091 A1 02-11-2005	
		ES 2337047 T3 20-04-2010	
		FI 20030078 A 18-07-2004	
		MX PA05007512 A 08-03-2006	
		US 2006138258 A1 29-06-2006	
		WO 2004065014 A1 05-08-2004	
		ZA 200505100 A 28-06-2006	
EP 2051811	B1	30-05-2012	AR 062324 A1 29-10-2008
		AU 2007286366 A1 21-02-2008	
		BR PI0715891 A2 19-02-2013	
		CA 2661445 A1 21-02-2008	
		CL 2007002357 A1 11-04-2008	
		CN 101500710 A 05-08-2009	
		DE 102006038014 B3 30-04-2008	
		EP 2051811 A1 29-04-2009	
		PE 06432008 A1 02-08-2008	
		RU 2009109192 A 27-09-2010	
		US 2010237175 A1 23-09-2010	
		WO 2008019904 A1 21-02-2008	
		ZA 200900631 A 27-01-2010	
US 2004256505	A1	23-12-2004	AT 383201 T 15-01-2008
		AU 2002366196 A1 10-06-2003	
		BE 1014486 A3 04-11-2003	
		BR 0214198 A 31-08-2004	
		CA 2466593 A1 30-05-2003	
		CN 1589178 A 02-03-2005	
		DE 60224561 T2 30-04-2008	
		DK 1448304 T3 26-05-2008	
		EP 1448304 A1 25-08-2004	
		ES 2297054 T3 01-05-2008	
		NO 20041757 A 15-07-2004	
		US 2004256505 A1 23-12-2004	
		WO 03043740 A1 30-05-2003	
		ZA 200403559 A 08-03-2005	