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(71) Applicant *(for all designated States except US)*: **COFCO LIMITED** [CN/CN]; COFCO Plaza, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **LIU, Xiaofeng** [CN/CN]; COFCO LIMITED, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN). **DU, Jinbao** [CN/CN]; COFCO LIMITED, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN). **JIANG, Yong** [CN/CN]; COFCO LIMITED, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN). **YU, Tianyang** [CN/CN]; COFCO LIMITED, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN). **ZHANG, Jijun** [CN/CN]; COFCO LIMITED, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN). **ZHANG, Yongxin** [CN/CN]; COFCO LIMITED, 8 Jian Guo Men Nei Avenue, Beijing 100005 (CN).

(74) Agent: **RUNPING & PARTNERS**; Suite 509, Yingu Mansion, No. 9 Beisihuanxilu, Haidian District, Beijing 100190 (CN).

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(54) Title: A SKIN-REMOVING METHOD FOR ROOT AND TUBER CROPS

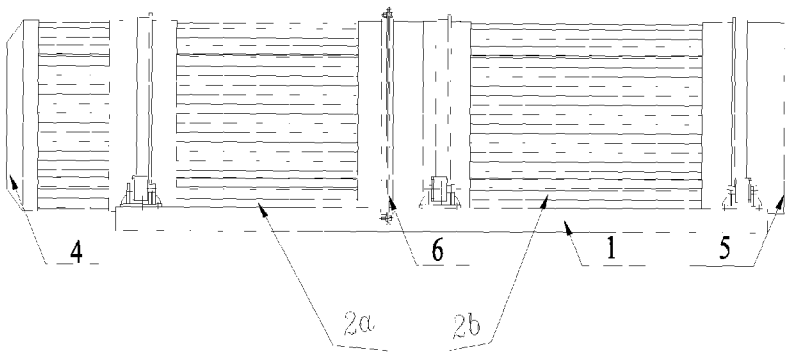

Fig. 1

(57) Abstract: Disclosed herein is a skin-removing method for root and tuber crops by using a skin-removing device which comprises a pedestal; a rotary drum rotatably fitted on the pedestal and having an inlet and a outlet; a helical screw feeder provided in the rotary drum and fixedly connected with the inner wall of the rotary drum; and a driving unit for driving the rotary drum and the helical screw feeder to rotate together, wherein the method includes feeding raw material of root and tuber crops into the rotary drum via the inlet, allowing the driving unit to drive the rotary drum and the helical screw feeder to rotate together. In the method according to the present invention, raw material of root and tuber crops is fed into the rotary drum via the inlet, and the driving unit drives the rotary drum and the helical screw feeder to rotate together. Under push action of the helical screw feeder, the raw material is continuously moved forward, and at the same time the raw material rotates along with the rotary drum and the helical screw feeder. During rotation, friction is generated not only among the raw material, but also between the raw material and the rotary drum wall and the helical screw feeder, so as to remove the skin of the raw material without damaging the flesh of root and tuber crops, such that the loss of raw material is low.

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A skin-removing method for root and tuber crops

Technical Field

The present invention relates to a skin-removing method for root and tuber crops.

Technical Background

Root and tuber crops, such as sweet potato, potato, and cassava etc., are rich in starch, and thus are widely used in production of sugar. Water is the primary chemical component of fresh root tuber of cassava, and carbohydrate is the second; additionally, cassava also contains a small amount of protein, fat, and pectin. The starch content of fresh cassava can reach 25-30wt%, while starch content of dry cassava is about 70wt%.

Ripe cassava has diameter of about 4-8cm, and length of 20-30cm, which is podgy and in shape of short cylinder. Cassava has structure of flesh and skin from inner to outer, wherein the skin comprises inner skin and outer skin. The outer skin is in dark brown color, and has spaced white circular strips, and the inner skin and flesh are in white color.

The skin of cassava, particularly inner skin, contains cyanide and cyanogenic glycoside, linamarin, which is capable of causing food poisoning. Linamarin can generate hydrocyanic acid after being hydrolyzed. Hydrocyanic acid and cyanide are both extremely toxic and can cause acute poisoning. If cyanide toxin is not removed, it may lead to inactivation of enzyme during enzymolysis and inactivation of yeast during fermentation, and thus subsequent enzymolysis and fermentation processes are affected. Therefore, available methods for producing ethanol from root and tuber crops, particularly cassava, generally comprise removing skin of root and tuber crops, and then pulverizing, enzymolyzing, and fermenting.

Presently, manual or simple mechanical skin-removing methods are adopted to remove cassava skin through friction or pare the cassava. As cassava skin, particularly inner skin, is tightly attached on cassava flesh, skin-removing effect is not desirable when friction is adopted for skin removal, and a considerable amount of skin is left on cassava surface; therefore residual cyanide content in cassava is high (removal rate of cyanide is about 40-50%). On the other hand, when the cassava is pared, cassava flesh is likely to be removed together with the skin, and hence a large amount of raw material is wasted.

Summary of the Invention

To overcome the disadvantage of the available methods for removing skin of root and tuber crops, the present invention provides a skin-removing method for root and tuber crops by which the skin of root and tuber crops can be effectively removed and the loss of raw material is low.

The present invention provides a skin-removing method for root and tuber crops by using a skin-removing device comprising:

a pedestal 1;

a rotary drum 2 rotatably fitted on the pedestal 1 and having an inlet 4 and a outlet

5;

a helical screw feeder 3 provided in the rotary drum 2 and fixedly connected with the inner wall of the rotary drum; and

a driving unit for driving the rotary drum 2 and the helical screw feeder 3 to rotate together,

wherein the method includes feeding raw material of root and tuber crops into the rotary drum 2 via the inlet 4, allowing the driving unit to drive the rotary drum 2 and the helical screw feeder 3 to rotate together.

In the skin-removing method according to the present invention, raw material of root and tuber crops is fed into the rotary drum via the inlet 4, and the driving unit drives the rotary drum and the helical screw feeder to rotate together. Under push action of the helical screw feeder, the raw material is continuously moved forward, and at the same time the raw material rotates along with the rotary drum and the helical screw feeder. During rotation, friction is generated not only among the raw material, but also between the raw material and the rotary drum wall and the helical screw feeder, so as to remove the skin of the raw material without damaging the flesh of root and tuber crops, such that the loss of raw material is low.

Brief Description of the Accompanying Drawings

Fig.1 shows the front view of the skin-removing device for root and tuber crops used in the method according to the present invention;

Fig. 2 shows the longitudinal section view of the skin-removing device;

Fig. 3 shows the cross section view representing connection relationship of the chain wheel and the rotary drum.

Embodiments

The skin-removing method uses a skin-removing device for root and tuber crops.

As shown in Fig.1 and Fig. 2, the skin-removing device comprises:

a pedestal 1;
a rotary drum 2 rotatably fitted on the pedestal 1 and having an inlet 4 and a outlet 5;
a helical screw feeder 3 provided in the rotary drum 2 and fixedly connected with the inner wall of the rotary drum 2; and
a driving unit (not shown in the figures) for driving the rotary drum 2 and the helical screw feeder 3 to rotate together.
The skin-removing method comprises feeding raw material of root and tuber crops into the rotary drum 2 via the inlet 4, and allowing the driving unit to drive the rotary drum 2 and the helical screw feeder 3 to rotate together. The rotation speed of the rotary drum 2 and the helical screw feeder 3 can be 2-50 rpm, preferably 5-25 rpm. Under push action of the helical screw feeder 3, the raw material is continuously moved forward, and at the same time the raw material rotates along with the rotary drum 2 and the helical screw feeder 3. During rotation, friction is generated not only among the raw material, but also between the raw material and the rotary drum wall and the helical screw feeder, so as to remove the skin of the raw material; and the skin-removed material is discharged from the outlet 5.
The rotary drum 2 can be made from various wear-resistant materials, such as steel,

rubber, or rigid plastics. The rotary drum 2 can be further provided with spraying unit therein. The spraying unit can be fixedly fitted on the inner wall of the rotary drum, and located close to the inlet of the rotary drum. The spraying unit can be various common spraying units. The spraying unit can remove dirt (such as soil or impurities) on the raw material by spraying water on the material.

Preferably, as shown in Fig. 1, the rotary drum 2 comprises, from inlet end to outlet end, a first section rotary drum 2a and a second section rotary drum 2b which are communicated with each other, and a spraying unit is provided in the second section rotary drum 2b. The spraying unit can be fixedly fitted on the inner wall of the second section rotary drum 2b, and located close to the inlet of the second section rotary drum.

According to the method in the present invention, a friction structure may be further provided on the inner wall of the rotary drum 2 in order to achieve better skin-removing effect. The friction structure can be various structures with rough surface, preferably one or more ribbed steel bars, more preferably multiple ribbed steel bars. The ribbed steel bar has transversal ribs, and can be various conventional hot rolled ribbed steel bar and cold rolled ribbed steel bar, such as ribbed steel bar complying with Chinese National Standard GB1499-1998. The nominal diameter of the ribbed steel bar can be 6-25 mm, preferably 8-20 mm. The interval between the transversal ribs can be 3-16 mm, preferably 4-12mm. The grade of the ribbed steel bar includes, but is not limited to, HRB335, HRB400 and HRB500. The ribbed steel bar is fixedly connected with the inner wall of the rotary drum 2, such that it can exert friction action to the raw material during rotation of the rotary drum. For easily fixedly connecting the ribbed steel bar onto the inner wall of the rotary drum 2, preferably the ribbed steel bar is parallel to the central axis of the rotary drum.

The rotary drum 2 can be horizontally or obliquely installed on the pedestal 1. When the rotary drum is horizontally installed, the raw material is moved forward under push action of the helical screw feeder 3, and finally discharged via the outlet of the rotary drum. When the rotary drum is obliquely installed, since the position of the inlet is higher than that of the outlet, the raw material can be moved downward under its own gravity action (i.e. moved forward) as well. The inclination angle of the rotary drum 2 can be 0-15 degrees, preferably 5-10 degrees. The length of the rotary drum 2 can be 2-10 m, preferably 3.5-7 m. When the rotary drum comprises the first section rotary drum and the second section rotary drum, the length refers to sum of lengths of the first section rotary drum and the second section rotary drum. The inclination angle refers to included angle between the central axis of the rotary drum and the horizontal line. There is no special limitation on inner diameter of the rotary drum, which can be selected according to the amount of the raw material to be processed. For example, generally, the inner diameter of the rotary drum is 1-2 m.

The helical screw feeder 3 can be various common helical screw feeders in the mechanical field. The helical screw feeder 3 can be connected on the inner wall of the rotary drum 2 via various fixed connection means. For example, as shown in Fig. 2, the helical screw feeder 3 is fixedly connected on the inner wall of the rotary drum 2 via a fastener 8. To achieve better skin-removing effect, the pitch of the helical screw feeder 3 is preferably 0.3-0.8m, and the height of the screw thread is preferably 0.1-0.4m. The helical screw feeder can be made of various wear-resist materials, such as steel, rubber, or nylon, etc.

The present invention has no special limitation on the driving unit, as long as it can

drive the rotary drum 2 and the helical screw feeder 3 to rotate together. For example, the driving unit may comprise a driving source, a transmission chain, and a chain wheel 6. As shown in Fig. 3, the chain wheel may be fixed on the rotary drum 2. When the rotary drum 2 comprises the first section rotary drum 2a and the second section rotary drum 2b, the chain wheel 6 is preferably fitted between the first section rotary drum 2a and the second section rotary drum 2b. As the rotary drum 2 is rotatably fitted on the pedestal 1, the chain wheel can drive the rotary drum to rotate when the transmission chain transfers the driving power of the driving source to the chain wheel. The rotatable fitting manner can be realized by various common methods, for example, support roller or frame can be adopted to fit the rotary drum on the pedestal to allow the rotary drum to rotate around the central axis. The driving source can be various units capable of generating power, such as motor.

For the convenience of feeding, the skin-removing device may further comprise a windmill feeder 7. As shown in Fig. 1 or 2, the windmill feeder 7 is fitted at the inlet 4 of the rotary drum. The windmill feeder 7 can be various common windmill feeders in the mechanical field.

The skin-removing device used in the method of the present invention utilizes friction action among raw material and between the raw material and the rotary drum wall to remove skin of the raw material. By removing the skin of cassava material according to the method of the present invention, the cyanide removal rate can reach 75% or higher, and raw material loss rate can be kept below 5wt%, indicating that the skin of root and tuber crops can be effectively removed and the loss of raw material is low by the skin-removing method according to the present invention..

The skin-removing method according to the present invention is suitable for various root and tuber crops, such as sweet potato, potato, and cassava, etc., particularly cassava.

The present invention will be described in further details through following examples.

In the examples, the cassava material is fresh cassava harvested in same batch, with diameter of 4-8cm, length of 20-30cm, and water content of about 65wt%.

Example 1

In the present example, the skin-removing method according to the present invention is described.

The skin-removing device is shown in Fig. 1, 2, and 3.

A rotary drum 2 includes a first section rotary drum 2a and a second section rotary drum 2b from up to down, the first section rotary drum 2a and the second section rotary drum 2b are communicated, and the lengths of the first section rotary drum 2a and the second section rotary drum 2b are respectively 1.8m and 1.6m. The rotary drum 2 is made of steel, with inner diameter of 1.6m. 40 hot-rolled ribbed steel bars (Grade No. HRB335, and nominal diameter of 12mm) are fixed on the inner wall of the first section rotary drum 2a, parallel to the central axis of the rotary drum, and distributed at equal interval of 0.125m along circumference of the rotary drum inner wall. 50 hot-rolled ribbed steel bars (Grade No. HRB500, and nominal diameter of 16mm) are fixed on the inner wall of the second section rotary drum 2b, parallel to the central axis of the rotary drum, and distributed at equal interval of 0.1m along circumference of the rotary drum inner wall. The rotary drum 2 is obliquely fitted

on a pedestal 1 at inclination angle of 5 degrees. A helical screw feeder 3, which is made of rubber, and has pitch of 0.5m, and screw thread height of 0.2m, is fixedly connected on the inner wall of the rotary drum 2 via a fastener 8. A driving device comprises a motor, a transmission chain, and a chain wheel 6. The chain wheel is fixed on the rotary drum 2, the transmission chain transfers the power of the motor to the chain wheel, and the motor has a power of 5.5kW.

The motor is started to drive the rotary drum 2 and the helical screw feeder 3 to rotate around the central axis of the rotary drum at 7rpm. The harvested cleaned fresh cassava 100kg are continuously fed into the rotary drum 2 via the inlet 4, and the skin-removed cassava is discharged from the outlet 5 to obtain skin-removed cassava material 96kg.

The loss (ε_1) of raw material is calculated according to the following equation:

ε_1= （100-96）/100×100%=4%

Three pieces of skin-removed cassava are randomly fetched, and then pulverized into slurry (average particle size of 0.8mm), respectively. 20g of each slurry is taken out, and added with 180g of distilled water to give samples 1 to 3 to be tested. And then the samples are subjected to determination of cyanide content by EPA335.3 standard test method of US Environmental Protection Agency, and the average cyanide content is labeled as C1.

Three pieces of fresh cassava are randomly fetched, and then pulverized into slurry (average particle size of 0.8mm), respectively. 20g of each slurry is taken out, and added with 180g of distilled water to give samples 1 to 3 to be tested. And then the samples are subjected to determination of cyanide content by EPA335.3 standard test method of US Environmental Protection Agency, and the average cyanide content is labeled as C2.

Following equation is used for calculating cyanide removal rate after skin-removing process:

ε_2= （C2-0.96C1）/C2×100%

The calculated cyanide removal rate is 75%.

It can be observed from the aforementioned result, the loss of raw material is low and cyanide removal rate is high by using the skin-removing method according to the present invention, indicating that the skin of root and tuber crops can be effectively removed and the loss of raw material is low by using the skin-removing method according to the present invention.

Claims

1. A skin-removing method for root and tuber crops by using a skin-removing device which comprises:

a pedestal (1);

a rotary drum (2) rotatably fitted on the pedestal (1) and having an inlet (4) and a outlet (5);

a helical screw feeder (3) provided in the rotary drum (2) and fixedly connected with the inner wall of the rotary drum (2); and

a driving unit for driving the rotary drum (2) and the helical screw feeder (3) to rotate together,

wherein the method includes feeding raw material of root and tuber crops into the rotary drum (2) via the inlet (4), allowing the driving unit to drive the rotary drum (2) and the helical screw feeder (3) to rotate together.

2. The method according to claim 1, wherein a friction structure is provided on the inner wall of the rotary drum (2).

3. The method according to claim 2, wherein the friction structure is one or more ribbed steel bars.

4. The method according to claim 3, wherein the ribbed steel bar is parallel to the central axis of the rotary drum (2).

5. The method according to claim 1, wherein the rotary drum (2) has inclination angle of 0-15 degrees, and length of 2-10 m; and the rotation speed of the rotary drum (2) and the helical screw feeder (3) is 2-50 rpm.

6. The method according to claim 1, wherein the helical screw feeder (3) has a pitch of 0.3-0.8 m, and a screw thread height of 0.1-0.4m.

7. The method according to claim 1, wherein the driving unit comprises a driving source, a chain wheel (6) fixed on the rotary drum (2), and a driving chain for transferring the power of the driving source to the chain wheel.

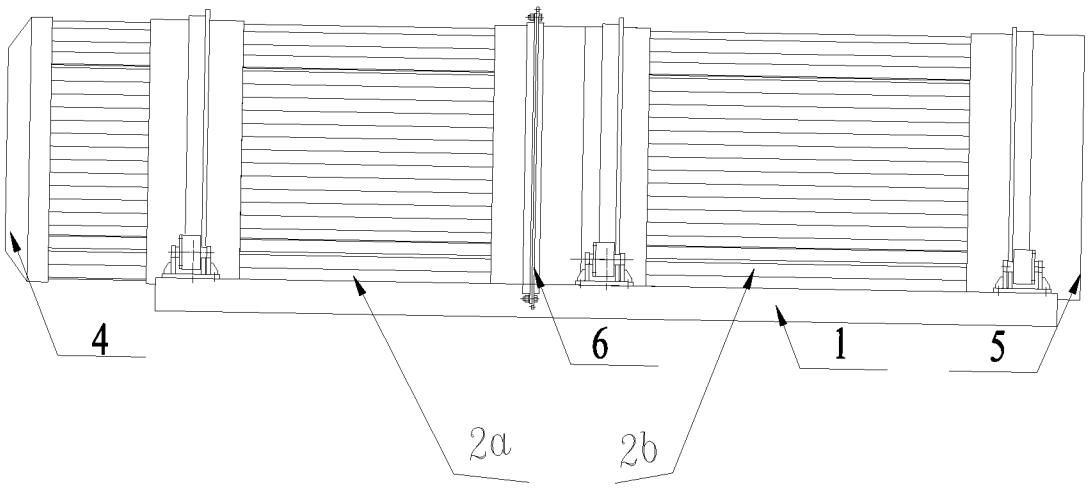

Fig. 1

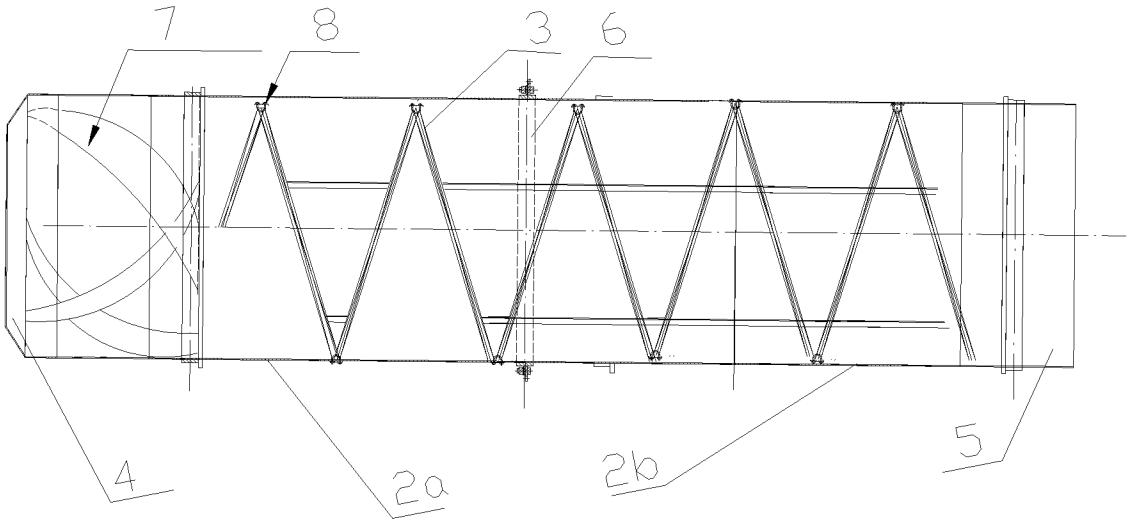

Fig. 2

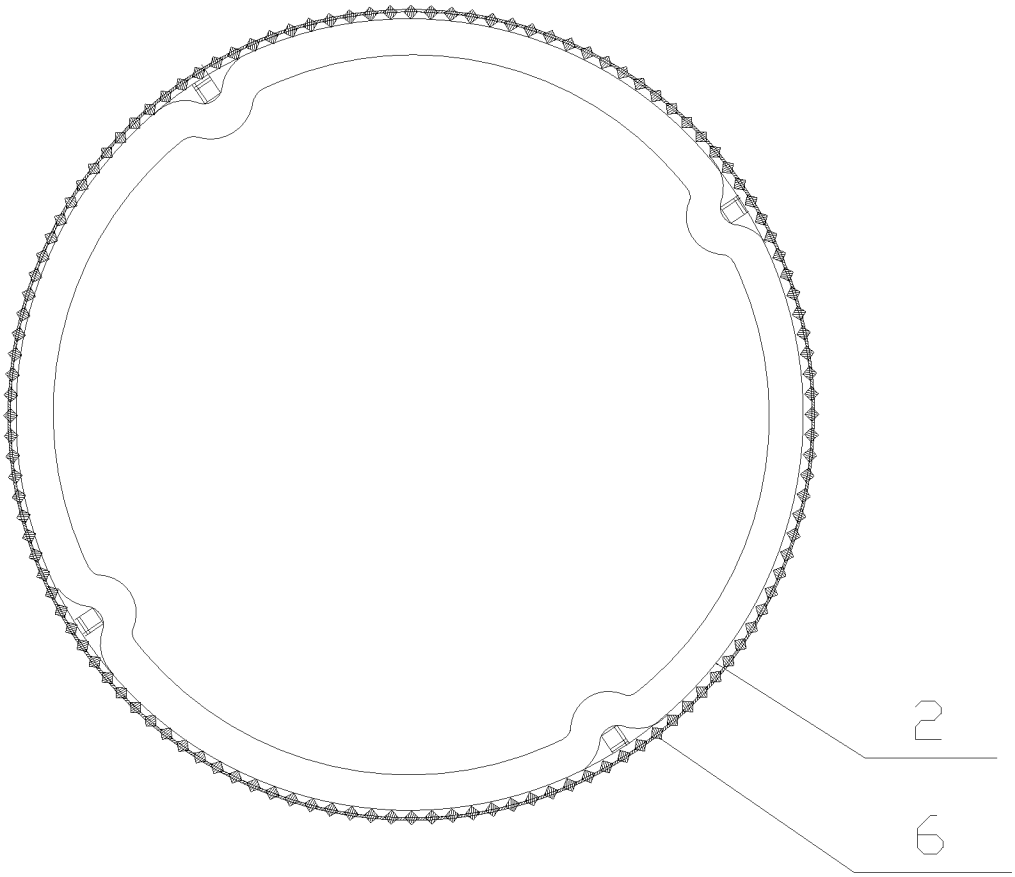

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

A23N7/02(2006.01)i

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:A23N7/02

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)

WPI,EPODOC,PAJ,CNPAT, CNKI: SCREW, THREAD,HELICAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US5245919A(Ronnie C. Neidigh et al)21 Sep.1993(21.09.1993) the whole document	1-7
A	FR2547168A(ALSTHOM ATLANTIQUE) 14 Dec. 1984(14.12.1984) the whole document	1-7
A	WO9530342A(NORRVIK et al) 16 Nov.1995(16.11.1995) the whole document	1-7
PX	CN101288500A(ZHONGLIANG GROUP CO LTD) 22 Oct.2008(22.10.2008) the whole document	1-7

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* Special categories of cited documents:

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"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
20 Mar.2009(23.03.2009)	**09 Apr. 2009 (09.04.2009)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer WANG, Rui Telephone No. (86-10)62085443

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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