



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
14.10.2015 Bulletin 2015/42

(51) Int Cl.:
F27B 21/08^(2006.01) C22B 1/14^(2006.01)

(21) Application number: **13859941.0**

(86) International application number:
PCT/KR2013/007108

(22) Date of filing: **07.08.2013**

(87) International publication number:
WO 2014/088184 (12.06.2014 Gazette 2014/24)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **07.12.2012 KR 20120142154**
15.07.2013 KR 20130083097

(71) Applicant: **Posco**
Pohang-si, Gyeongsangbuk-do 790-300 (KR)

(72) Inventors:
• **JUNG, Jae-Hoon**
Pohang-si
Gyeongsangbuk-do 790-300 (KR)
• **KIM, Do-Seung**
Pohang-si
Gyeongsangbuk-do 790-300 (KR)
• **SHIN, Myung-Chan**
Pohang-si
Gyeongsangbuk-do 790-300 (KR)

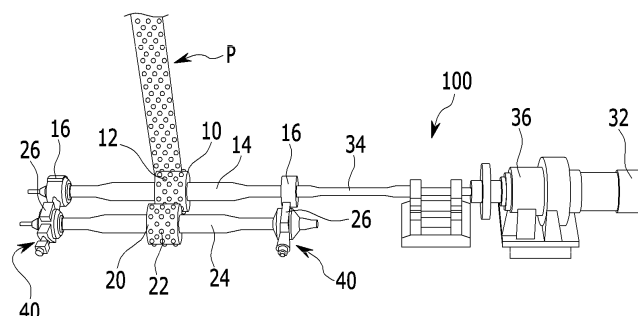
(74) Representative: **Zech, Stefan Markus**
Meissner, Bolte & Partner GbR
Postfach 86 06 24
81633 München (DE)

(54) **APPARATUS FOR SEPARATING PLATE-SHAPED HBI PARTICLES**

(57) In order to flexibly cope with a change in work load according to productivity and prevent clogging between rotors by an HBI when the productivity is increased, the present invention provides an apparatus for separating particles of a plate-shaped HBI, including: a motor; a driving rotor that is coupled to and rotated with a driving shaft of the motor and has first projections around the outer surface thereof; an idle rotor that is dis-

posed in parallel with the driving rotor, freely rotates, and has second projections around the outer side; and a control unit that adjusts a gap between the driving rotor and the idle rotor by moving the idle rotor with respect to the driving rotor, in which the gap between the driving rotor and the idle rotor is adjusted in accordance with the amount of a plate-shaped HBI sent between the idle rotor and the driving rotor.

FIG.1



Description**[Technical Field]**

[0001] The present invention relates to an apparatus for separating particles of a plate-shaped HBI.

[Background Art]

[0002] In general, DRI (Direct Reduction Iron) at 700 °C or more is pressed into HBI and briquetted through a briquetting machine. In the plate-shaped HBI, a massive HBI (Hot Briquetted Iron) has HBI particles continuously connected in a plate shape at their edges.

[0003] In an HBI for sale, a plate-shaped HBI should be divided into a predetermined size, and when an excessive amount of chips are produced due to excessive shock on the HBI or two or more massive HBIs are bonded due to insufficient particle separation, the yield decreases and the manufacturing cost of the HBI increases due to additional processes. In general, the size of an HBI for sale is 110 c³, with dimensions of 102 mm X 38 mm X 42 mm.

[0004] An apparatus for separating particles of a plate-shaped HBI needs to separate all of massive HBIs connected with each other into particles, while minimizing the number of chips. In the related art, as a technique for separating HBI into particles, a technique of putting a plate-shaped HBI into a drum and separating particles using shock energy that is applied when it drops from a predetermined height along a casing of the drum has been widely known.

[0005] However, the largest chronic problem with this technique is that when the productivity of an HBI increases, a drum is clogged, particle separation is poor, and it takes much time to remove the HBI clogging the drum at a high temperature and clean the drum. Accordingly, in the related art, because it takes much time to repair a drum, the operation rate of HBI separation equipment decreases and work load increases.

[0006] The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

[DISCLOSURE]**[Technical Problem]**

[0007] The present invention has been made in an effort to provide an apparatus for separating particles of a plate-shaped HBI having advantages of being able to flexibly cope with a change in work load.

[Technical Solution]

[0008] Further, the present invention provides an apparatus for separating particles of a plate-shaped HBI which can prevent the space between rotors from being clogged with an HBI when productivity is increased.

[0009] An exemplary embodiment of the present invention provides an apparatus for separating particles of a plate-shaped HBI that includes: a motor; a driving rotor that is coupled to and rotated with a driving shaft of the motor and has first projections around the outer surface thereof; an idle rotor that is disposed in parallel with the driving rotor, freely rotates, and has second projections around the outer side; and a control unit that adjusts a gap between the driving rotor and the idle rotor by moving the idle rotor with respect to the driving rotor, in which the gap between the driving rotor and the idle rotor is adjusted in accordance with the amount of a plate-shaped HBI sent between the idle rotor and the driving rotor.

[0010] The apparatus may further an inverter that is connected to the motor and adjusts a rotational speed thereof, so the rotational speed of the driving rotor can be adjusted in accordance with the amount of the plate-shaped HBI sent between the driving rotor and the idle rotor.

[0011] In the control unit, bearing blocks may be disposed at both ends of a rotary shaft of the idle rotor to be movable with respect to a frame side, and elastic members may be disposed between the bearing blocks and the frame side and may press the idle rotor to the driving rotor.

[0012] A guide rod may protrude from the bearing block and extend outward through a fastener on the frame side of the apparatus, a nut may be coupled to an end of the guide rod, the elastic member may be a spring, and the spring may be fitted on the guide rod and elastically disposed between the bearing block and the frame.

[0013] A bottom rail may be disposed in the movement direction of the bearing block on the bottom of the frame, and the bottom of the bearing block may be slidably fitted in the bottom rail.

[0014] A support bracket may be disposed over the bearing block on the side of the frame, a top rail may be disposed in the movement direction of the bearing block on the support bracket, and the top of the bearing block may be slidably fitted in the top rail.

[Advantageous Effects]

[0015] As described above, according to an exemplary embodiment, when too much of a plate-shaped HBI is supplied, the gap between two rotors is flexibly adjusted, so clogging between the rotors can be prevented. Therefore, it is possible to prevent a decrease in productivity of an HBI and reduce work load due to repairing clogged rotors.

[0016] Further, it is possible to normally work regard-

less of the inflow amount of a plate-shaped HBI due to a change in productivity.

[Description of the Drawings]

[0017]

FIG. 1 is a perspective view of an apparatus for separating particles of a plate-shaped HBI according to an exemplary embodiment.

FIG. 2 is a schematic plane cross-sectional view of the apparatus for separating particles of a plate-shaped HBI according to the exemplary embodiment.

FIG. 3 is a cross-sectional view showing the configuration of a control unit in the apparatus for separating particles of a plate-shaped HBI according to the exemplary embodiment.

[Mode for Invention]

[0018] Hereinafter, an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings so that those skilled in the art can easily achieve the present invention. As understood by those skilled in the art, the following exemplary embodiment may be modified in various ways without departing from the concept and scope of the present invention. Like reference numerals are used for like components in the drawings.

[0019] The terminologies used hereafter are only for describing a specific exemplary embodiment and are not intended to limit the present invention. Singular terms used herein include plural terms unless phrases clearly express opposite meanings. The term 'including' used herein refers to concrete specific characteristics, regions, positive numbers, steps, operations, elements, and/or components, without limiting existence or addition of other specific characteristics, regions, positive numbers, steps, operations, elements, and/or components.

[0020] All the terms, including technical terms and scientific terms used hereafter, have the same meanings as those that those skilled in the art generally understand. The terms defined in dictionaries should be construed as having meanings corresponding to the related prior art documents and those stated herein, and are not to be construed as being ideal or official, if not defined.

[0021] FIG. 1 is a perspective view of an apparatus for separating particles of a plate-shaped HBI according to an exemplary embodiment, and FIG. 2 is a schematic plane cross-sectional view of the apparatus for separating particles of a plate-shaped HBI according to the present exemplary embodiment.

[0022] An apparatus 100 is a rotor-type particle separator that includes two rotors and separates HBIs bonded in a plate shape into HBI particles.

[0023] The particle separation apparatus 100 according to the present exemplary embodiment includes a driv-

ing rotor 10 and an idle rotor 20 that are rotatably mounted on a frame of the apparatus and spaced in parallel with each other, a motor 32 for rotating the driving rotor 10, and a control unit 40 for adjusting a gap between the driving rotor 10 and the idle rotor 20 by moving the idle rotor 20 with respect to the driving rotor 10 in accordance with the amount of a plate-shaped HBI P put between the driving rotor 10 and the idle rotor 20.

[0024] The driving rotor 10 has a plurality of first projections 12 around the outer surface. As the driving rotor 10 rotates, the first projections 12 apply a shock to the plate-shaped HBI P put between the driving rotor 10 and the idle rotor 20, thereby separating particles. A rotary shaft 14 of the driving rotor 10 axially extends and is rotatably coupled to fixing bearing blocks 16 on a frame 30. The fixing bearing blocks 16 are fixed to the frame 30, so the driving rotor 10 cannot move from the frame 30.

[0025] The motor 32 is disposed on a side of the frame 30, and a driving shaft 34 is coupled to the rotary shaft 14 of the driving rotor 10. In the present exemplary embodiment, the motor 32 is connected to an inverter 36 for adjusting the rotational speed of the motor 32. The apparatus 100 adjusts the rotational speed of the motor 32 by controlling the motor 32 with the inverter 36 in accordance with the amount of plate-shaped HBI P put between the driving rotor 10 and the idle rotor 20. That is, when the amount of a plate-shaped HBI P put between the driving rotor 10 and the idle rotor 20 increases, the rotational speed of the motor 32 increases and the rotational speed of the driving rotor 10 coupled to the driving shaft 34 of the motor 32 increases. Accordingly, the driving rotor 10 rotates fast and a large amount of particles can be separated from the plate-shaped HBI P. As described above, the apparatus can minimize clogging and sticking of a plate-shaped HBI P between the driving rotor 10 and the idle rotor 20 by adjusting the rotational speed of the motor 32 in accordance with productivity of the plate-shaped HBI P, that is, the inflow amount of the HBI P.

[0026] The idle rotor 20 is disposed in parallel at a predetermined distance from the driving rotor 10 and is freely rotatably mounted on the frame 30. The idle rotor 20 has a plurality of second projections 22, which apply shock to the plate-shaped HBI P around the outer surface thereof. A rotary shaft 24 of the idle rotor 20 is supported by bearing blocks 26 on the frame 30. The bearing blocks 26 supporting the rotary shaft 24 of the idle rotor 20 can move with respect to the frame 30, which will be described below.

[0027] In the present exemplary embodiment, the idle rotor 20 is not connected to the motor 32, so it does not receive torque and freely rotates regardless of the driving rotor 10. The idle rotor 20 rotates and applies shock to the plate-shaped HBI P, when friction with the plate-shaped HBI P having moved down is generated.

[0028] The apparatus 100 adjusts the gap between the driving rotor 10 and the idle rotor 20 by moving the idle rotor 20 with respect to the driving rotor 10 using the control unit 40.

[0029] FIGS. 2 and 3 show the structure of the control unit. In the control unit 40, the bearing blocks 26 at both ends of the rotary shaft 24 of the idle rotor 20 are arranged to be movable with respect to a frame side 37, and elastic members applying an elastic force are disposed between the bearing blocks 26 and the frame side 37 and press the idle rotor 20 to the driving rotor 10. In the present exemplary embodiment, the elastic members may be springs 44, but it is possible to use any member that applies an elastic force rather than the spring 44.

[0030] Accordingly, as the idle rotor 20 is elastically moved in accordance with the inflow amount of the plate-shaped HBI P, the gap between the driving rotor 10 and the idle rotor 20 is adjusted, so the space between the rotors can be prevented from being clogged.

[0031] As shown in FIG. 3, the spring 44 is disposed between the bearing blocks 26 of the idle rotor 20 and the frame 30, and pushes the bearing blocks 26 of the idle rotor 20 to the driving rotor.

[0032] In order to install the springs 44, the bearing blocks 26 have a protruding guide rod 41, and the guide rod 41 extends outward through fastening members 42 on the frame side 37 of the apparatus. The guide rod 41 protrudes across the movement direction of the idle rotor 20, that is, the axial direction of the idle rotor 20. A thread is formed at the end of the guide rod 41 passing through the fastening member 42 of the frame to couple a nut 43. The spring 44 is fitted on the guide rod 41 and applies elastic force between the bearing block 26 and the side 37 of the frame 30. Accordingly, the spring 44 pushes the idle rotor 20 to the driving rotor 10 by pressing the bearing block 26 toward the fixed frame side 37.

[0033] It is possible to adjust the maximum movement distance of the guide rod 41 or the force applied by the spring 44 by loosening or tightening the nut 43.

[0034] A bottom rail 45 is disposed in the movement direction of the bearing block 26 on the bottom 38 of the frame 30, so the bottom of the bearing block 26 is slidably fitted in the bottom rail 45. Accordingly, the idle rotor 20 supported by the bearing block 26 can accurately move forward/backward to/away from the driving rotor 10 without axially moving.

[0035] A bearing bracket 46 is disposed over the bearing block 26 on the side 37 of the frame 30, and a top rail 47 is formed in the movement direction of the bearing block 26 on the support bracket 46, so the top of the bearing block 26 is slidably fitted in the top rail 47.

[0036] As described above, since the top and the bottom of the bearing block 26 of the idle rotor 20 slide on the top rail 47 and the bottom rail 45, it can more stably and accurately move without axially moving.

[0037] Hereinafter, the operation of the apparatus is described.

[0038] A plate-shaped HBI P pressed through a briquetting machine is supplied to the apparatus 100 and sent between the driving rotor 10 and the idle rotor 20.

[0039] As the apparatus 100 is started, the driving rotor 10 connected to the driving shaft 34 of the motor 32 ro-

tates. The driving rotor 10 is rotated by torque from the motor 32 that is an external power source, and the idle rotor 20 disposed at a predetermined distance from the driving rotor 10 is rotated by friction with the plate-shaped HBI P sent between the driving rotor 10 and the idle rotor 20.

[0040] As the driving rotor 10, or the driving rotor 10 and the idle rotor 20, rotate, the first projections 12 and the second projections 22 of the driving rotor 10 and the idle rotor 20 apply shock to the plate-shaped HBI P, and thereby particles are separated.

[0041] The inverter 36 adjusts the rotational speed of the motor 32 in accordance with the inflow amount of the plate-shaped HBI P. As the rotational speed of the driving rotor 10 changes in accordance with the rotational speed of the motor 32, the processed amount of the plate-shaped HBI P passing the driving rotor 10 changes. For example, when the inflow amount of the plate-shaped HBI P increases, the rotational speed of the driving rotor 10 increases and the plate-shaped HBI P is moved faster, so the plate-shaped HBI P is prevented from clogging between the rotors.

[0042] In this state, the idle rotor 20 has been pressed to the driving rotor by the elastic force of the springs 44.

In this state, when the amount of the plate-shaped HBI P sent between the driving rotor 10 and the idle rotor 20 increases, the idle rotor 20 is moved with respect to the driving rotor, so the gap between the rotors is adjusted in accordance with the inflow amount of the plate-shaped HBI P.

[0043] For example, when the inflow amount of the plate-shaped HBI P increases, a force applied to the driving rotor 10 and the idle rotor 20 by the plate-shaped HBI P increases. Accordingly, the idle rotor 20 is pushed back away from the fixed driving rotor 10 and the bearing blocks 26 of the idle rotor 20 move along the top rail 47 and the bottom rail 45. As the bearing blocks 26 move, the gap between the idle rotor 20 and the driving rotor 10 increases. Accordingly, the plate-shaped HBI P is smoothly discharged through the increased gap between the driving rotor 10 and the idle rotor 20. The springs 44 between the bearing blocks 26 and the frame side 37 are compressed by the bearing blocks 26 and apply elastic force to the bearing blocks 26. When the inflow amount of the plate-shaped HBI P returns to the normal state, the force applied to the idle rotor 20 is decreased and the bearing blocks 26 are moved to the driving rotor by the elastic force of the springs 44. Therefore, the gap between the driving rotor 10 and the idle rotor 20 can be reduced to fit to the inflow amount of the HBI.

[0044] As described above, since the gap between the driving rotor 10 and the idle rotor 20 is flexibly adjusted, it is possible to uniformly separate particles regardless of the inflow amount of a plate-shaped HBI P. Further, even if a plate-shaped HBI is abnormally supplied to excess, the gap between the rotors is sufficiently opened and the plate-shaped HBI can be discharged quickly, so clogging between the rotors can be prevented.

[0045] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

Claims

1. An apparatus for separating particles of a plate-shaped HBI, comprising:

a motor; 15
 a driving rotor that is coupled to and rotated with a driving shaft of the motor and has first projections around the outer surface thereof;
 an idle rotor that is disposed in parallel with the driving rotor, freely rotates, and has second projections around the outer side; and 20
 a control unit that adjusts a gap between the driving rotor and the idle rotor by moving the idle rotor with respect to the driving rotor in accordance with the amount of a plate-shaped HBI sent 25
 between the idle rotor and the driving rotor, wherein the plate-shaped HBI is divided into particles between the driving rotor and the idle rotor.

2. The apparatus of claim 1, further comprising an inverter that is connected to the motor and adjusts a rotational speed thereof, 30
 wherein the rotational speed of the driving rotor is adjusted in accordance with the amount of the plate-shaped HBI sent between the driving rotor and the idle rotor. 35

3. The apparatus of claim 1 or claim 2, wherein, in the control unit, bearing blocks are disposed at both ends of a rotary shaft of the idle rotor to be movable with respect to a frame side of the apparatus, and elastic members are disposed between the bearing blocks and the frame side and press the idle rotor to the driving rotor. 40

4. The apparatus of claim 3, wherein a guide rod protrudes from the bearing block and extends outward through a fastener on the frame side of the apparatus, a nut is coupled to an end of the guide rod, the elastic member is a spring, and the spring is fitted 45
 on the guide rod and elastically disposed between the bearing block and the frame. 50

5. The apparatus of claim 4, wherein a bottom rail is disposed in the movement direction of the bearing block on the bottom of the frame, and the bottom of the bearing block is slidably fitted in the bottom rail. 55

6. The apparatus of claim 5, wherein a support bracket is disposed over the bearing block on the side of the frame, a top rail is disposed in the movement direction of the bearing block on the support bracket, and the top of the bearing block is slidably fitted in the top rail.

FIG.1

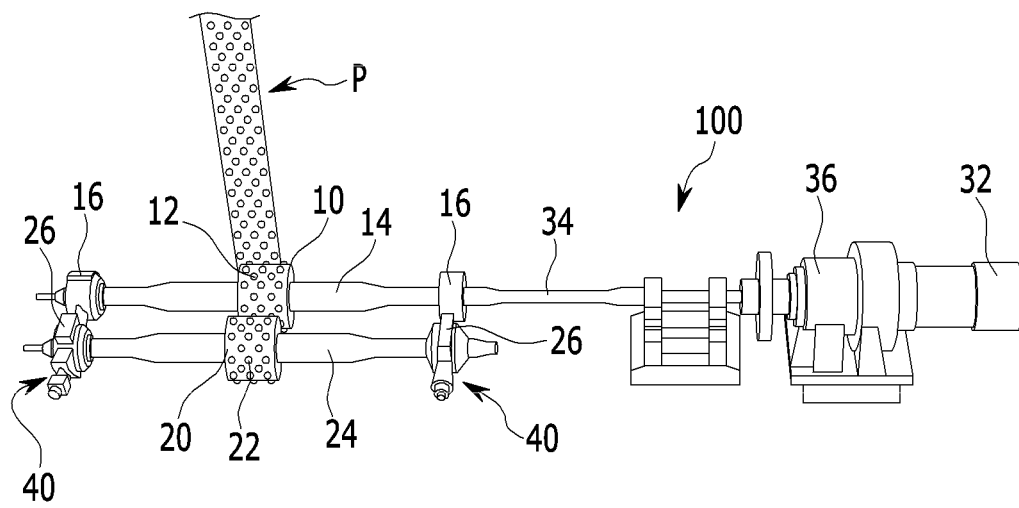


FIG.2

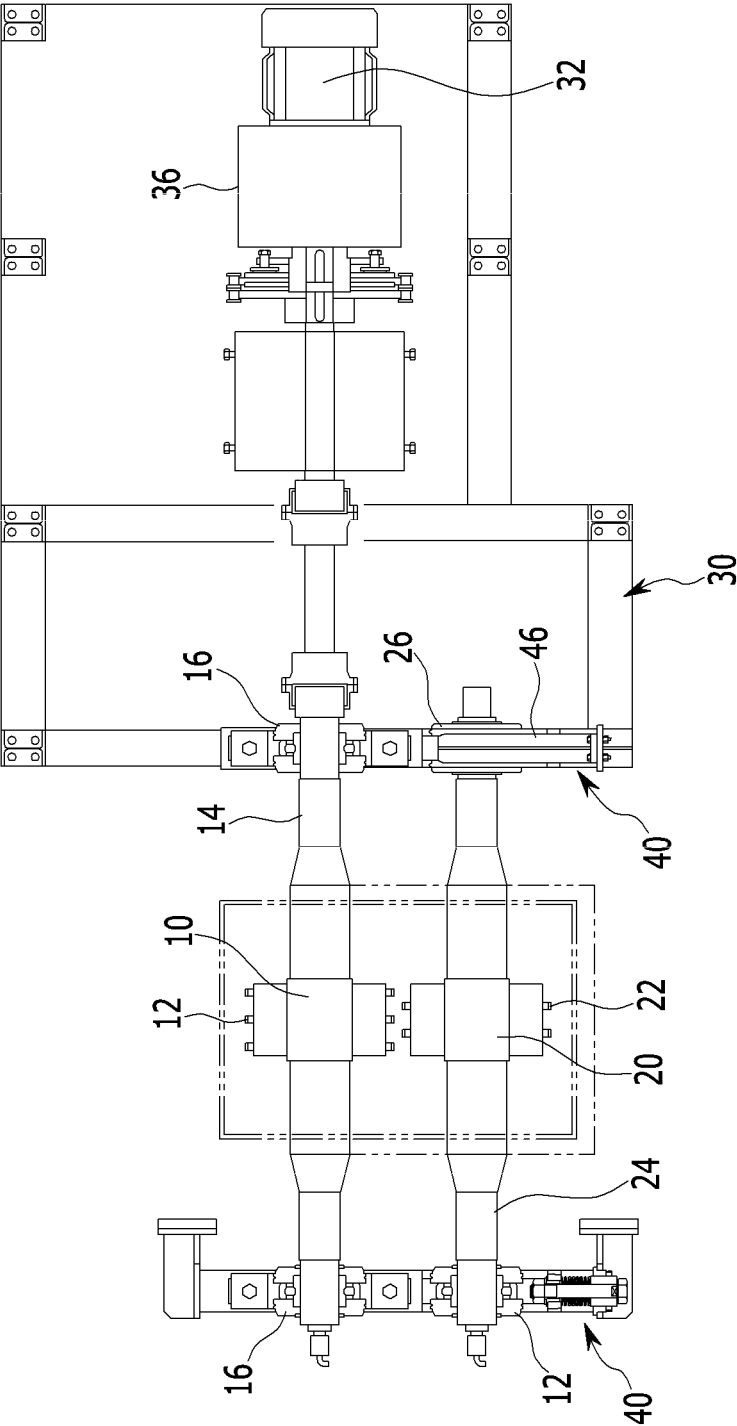
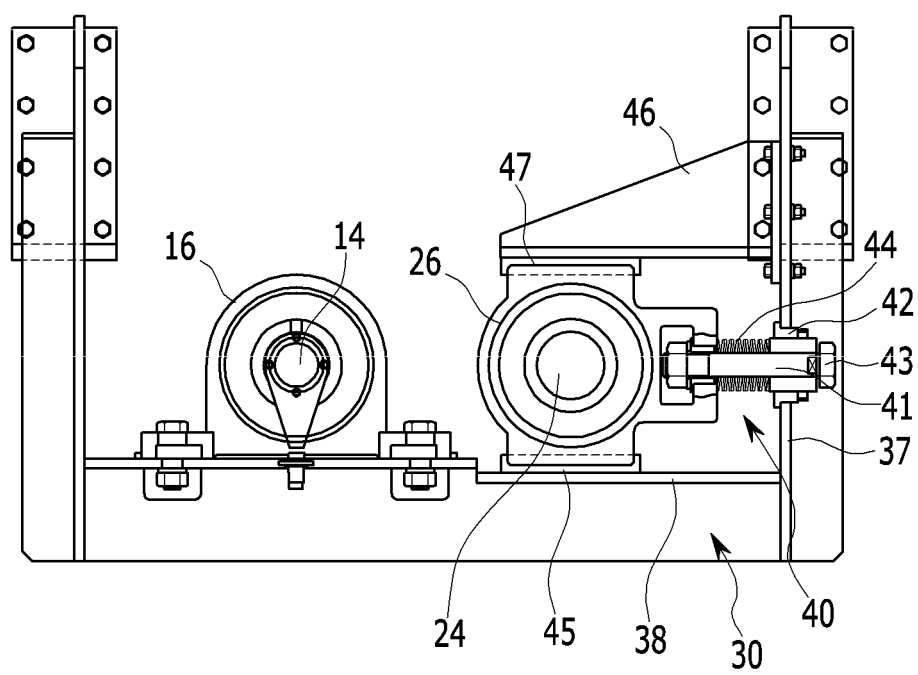


FIG.3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2013/007108

A. CLASSIFICATION OF SUBJECT MATTER

F27B 21/08(2006.01)i, C22B 1/14(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)

F27B 21/08; B30B 9/32; F27B 21/00; B30B 11/00; C22B 1/16; C22B 1/00; B23D 19/04; B23D 25/14; C22B 1/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

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

eKOMPASS (KIPO internal) & Keywords: HBI, briquette, separation, rotor, motor, interval and movement

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008-260982 A (KOBEL STEEL LTD.) 30 October 2008 See abstract; paragraphs [0016]-[0017]; claim 1; and figure 1.	1-6
A	KR 10-2007-0029950 A (POSCO) 15 March 2007 See abstract; page 4, lines 4-24; claim 1; and figure 1.	1-6
A	KR 10-2010-0066434 A (SINTOKOGIO,LTD.) 17 June 2010 See abstract; paragraphs [0008]-[0009]; claim 1; and figure 1.	1-6
A	JP 2004-202548 A (SANKI SEKKEI K.K. et al.) 22 July 2004 See abstract; claim 1; and figures 1,8.	1-6
A	KR 10-2006-0001365 A (POSCO) 06 January 2006 See abstract; claim 1; and figure 1.	1-6

☐ 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

22 OCTOBER 2013 (22.10.2013)

Date of mailing of the international search report

23 OCTOBER 2013 (23.10.2013)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701,
Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2013/007108

Patent document cited in search report	Publication date	Patent family member	Publication date
JP 2008-260982 A	30/10/2008	JP 5059472 B2	24/10/2012
KR 10-2007-0029950 A	15/03/2007	AU 2005-296406 A1	27/04/2006
		AU 2005-296406 B2	10/12/2009
		CA 2583493 A1	27/04/2006
		CA 2583493 C	28/08/2012
		CN 1842605 B	22/12/2010
		EP 1802780 A1	04/07/2007
		EP 1802780 A4	01/10/2008
		EP 1802780 B1	22/06/2011
		JP 2008-517162 A	22/05/2008
		JP 4966200 B2	04/07/2012
		KR 10-1118285 B1	20/03/2012
		KR 10-1118286 B1	20/03/2012
		US 2007-0216072 A1	20/09/2007
		US 7622071 B2	24/11/2009
		WO 2006-043770 A1	27/04/2006
KR 10-2010-0066434 A	17/06/2010	CN 101784357 A	21/07/2010
		JP 2009-083088 A	23/04/2009
		JP 5092699 B2	05/12/2012
		TW 200916241 A	16/04/2009
		WO 2009-035138 A1	19/03/2009
JP 2004-202548 A	22/07/2004	JP 3559555 B2	02/09/2004
KR 10-2006-0001365 A	06/01/2006	CN 1842606 B	27/10/2010
		EP 1776484 A1	25/04/2007
		EP 1776484 A4	26/12/2007
		EP 1776484 B1	14/03/2012
		EP 2314723 A1	27/04/2011
		KR 10-1072490 B1	11/10/2011
		WO 2006-004350 A1	12/01/2006