(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 June 2015 (04.06.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/078097 A1

(51) International Patent Classification:
F03G 3/00 (2006.01)

(21) International Application Number:
PCT/CN2014/001067

(22) International Filing Date:
28 November 2014 (28.11.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201310621927.2 30 November 2013 (30.11.2013) CN

(72) Inventor; and
(71) Applicant : **LIU, Dianjun** [CN/CN]; No.1 Jinye Road, High-Tech Industrial Development Zone, Qingdao, Shandong 266111 (CN).

(74) Agent: **INSIGHT INTELLECTUAL PROPERTY LIMITED**; 19A, Tower A, InDo Building, No. 48A Zhichun Road, Haidian District, Beijing 100098 (CN).

(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))*

WO 2015/078097 A1

(54) Title: SYSTEM FOR PREPARING COMPRESSED AIR USING WEIGHT POTENTIAL ENERGY

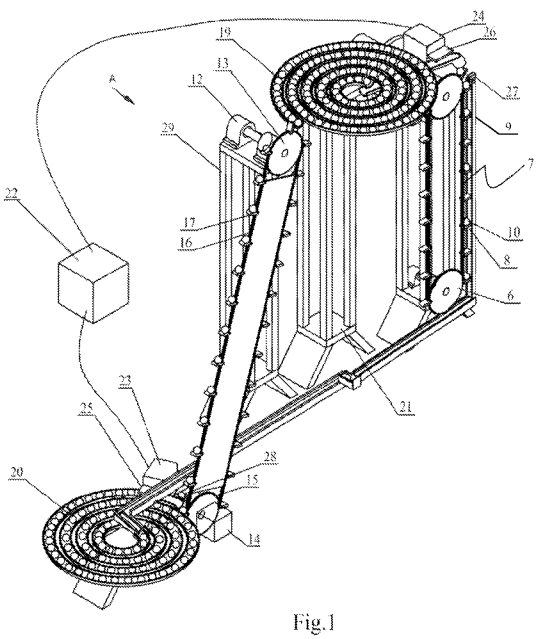

Fig.1

(57) Abstract: A system for preparing compressed air using weight potential energy which belongs to the technical filed of air compressing is disclosed. The system includes an air compressing device and a weight driving device for driving the air compressing device. The weight driving device includes a stand (21), a first weight storage device (19) disposed on the stand (21), and a potential-to-kinetic energy conversion device, and the potential energy of the weight is converted into the kinetic energy by the conversion device when the weight is dropping down from the first storage device (19) successively so as to drive the air compressing device to convert the atmospheric air into the compressed air. The system has the following advantage: higher energy storage density, less land occupation, shorter construction period, no specific geographical environment requirement and longer utilization.

SYSTEM FOR PREPARING COMPRESSED AIR USING WEIGHT POTENTIAL ENERGY

FIELD OF TECHNOLOGY

The present invention relates to a system for preparing compressed air using weight potential energy, in particular to a system which raises a weight to an elevated height using the off-peak electricity at night, and drops the weight from the elevated height when compressed air is needed during the day. A gravitational potential energy is converted into a kinetic energy to drive an air compressing device to convert atmospheric air into compressed air. The present invention pertains to a technical field of preparing compressed air.

BACKGROUND

The energy storage technology for preparing gas in prior art refers to converting the electric energy into compressed air at night when the power grid load is in an off-peak period, and sealing the compressed air in an abandoned mine, a cave, an oil and gas well, or a newly-built gas tank. The compressed air is released to work when it is needed during day. However, since gas storage facilities require large investment, its development is slowly.

SUMMARY

The object of the present invention is to solve the insufficiency and defects in the existing design principle for preparing compressed air. A system which raises a weight to an elevated height using the overnight off-peak electricity, and releases the weight from the elevated height successively during peak energy usage during the day, thereby a gravitational potential energy is converted into a kinetic energy to drive an air compressing device to convert atmospheric air into compressed air. The system has the following advantages: higher energy storage density, less land occupation, shorter construction period, no specific geographical environment requirement and longer utilization. Therefore, the system enables high power and large scale development. The system plays an important role in smoothing the demand fluctuation of the power grid.

To achieve the object of the invention, a system for preparing compressed air using weight potential energy is provided. The system includes an air compressing device and a weight driving device used for driving the air compressing device, wherein the weight driving device includes a stand, a first weight storage device disposed on the stand, and a potential-to-kinetic energy conversion device. The potential energy of the weight is converted into the kinetic energy by the conversion device when the weight descends from the first storage device successively to drive the air compressing device for converting the atmospheric air into the compressed air.

Wherein, the potential-to-kinetic energy conversion device includes a first sprocket wheel 2 disposed on a stand 8, a second sprocket wheel 6 disposed on the ground, and a first chain 7 connecting the first sprocket wheel 2 with the second sprocket wheel 6. Trays 10 for receiving a plurality of metal balls are disposed on the first chain 7 uniformly. The first sprocket wheel 2 and the second sprocket wheel 6 are driven to rotate when the metal balls are dropped into the stand on the first chain successively. A crankshaft of the air compressing device is driven by the first sprocket wheel 2 or the second sprocket wheel 6.

Preferably, the system for preparing compressed air using weight potential energy further includes a weight lifting device. The weight lifting device comprises an electric-to-potential energy conversion device and a second weight storage device disposed on the ground. The weight stored in the second storage device is put into the first storage device by the electric-to-potential energy conversion device.

The electric-to-potential energy conversion device includes a third sprocket wheel 13 disposed on a stand, a fourth sprocket wheel 15 disposed on the ground, a second chain 16 connecting the third sprocket wheel with the fourth sprocket wheel 15, and an electromotor 14 used for driving the fourth sprocket wheel 15 to rotate. Trays 17 for receiving a plurality of metal balls are disposed on the second chain 16 uniformly. As the fourth sprocket wheel 15 is driven to rotate by the electromotor 14 so as to drive the second chain to move, the metal balls on its tray are transported to an elevated height successively and stored in the first storage device.

Preferably, the first storage device and the second storage device are in the shape of a spiral rail, in which the end receiving the metal balls is higher than the end throwing the metal balls.

Compared to the existing technology, the system for preparing compressed air

using weight potential energy provided by the present invention can raise the weight to an elevated height using the overnight off-peak electricity, and drop down the weight from the elevated height successively during peak energy periods during the day, thereby a kinetic energy is produced to drive the air compressing device to compress atmospheric air. The system has the following advantages: higher energy storage density, less land occupation, shorter construction period, no specific geographical environment requirement and longer utilization. Therefore , the system enables high power and large scale development. The system plays an important role in smoothing the demand fluctuation of the power grid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a system for preparing compressed air using weight potential energy in accordance with one embodiment of the present invention; and

FIG. 2 is a schematic diagram viewed from the A perspective of FIG.1 in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

The present invention will now be described in fully detail hereinafter with reference to the accompanying drawings. Like reference numerals refer to like elements throughout.

FIG. 1 is a schematic diagram of a system for preparing compressed air using weight potential energy provided by the present invention. FIG. 2 is a schematic diagram viewed from the A perspective of FIG.1 provided by the present invention. As shown in FIGS. 1 and 2, the system for preparing compressed air using weight potential energy provided by the present invention includes an air compressing device and a weight driving device used for driving the air compressing device. The weight driving device includes a stand 21, a first storage device 19 for the weight disposed on the stand 21, and a potential-to-kinetic energy conversion device. The potential energy is converted into the kinetic energy by the potential-to-kinetic energy conversion device when the weight is dropped from the first storage device successively so as to drive the air compressing device to convert the atmospheric air into the compressed air. The weight is preferably a metal ball. The potential-to-kinetic energy conversion

device includes a stand 8; a first sprocket wheel 2 disposed on the stand 8 via a bearing bushing seat 1; a second sprocket wheel 6 disposed on the ground via the bearing bushing seat; a first chain 7 connecting the first sprocket wheel 2 with the second sprocket wheel 6; a guiding rail 9 installed on the stand 8 and disposed at a side of the first chain 7, used for guiding a tray 10 bearing the weight balls. The trays 10 for receiving a plurality of metal balls are disposed on the first chain 7 uniformly. The first sprocket wheel 2 and the second sprocket wheel 6 are driven to rotate when the metal balls are dropped into the tray on the first chain successively. The first sprocket wheel 2 or the second sprocket wheel 6 is provided with a power output draft which is connected with a low-speed input draft of a speed-increasing gearbox 3 via a coupling. A flywheel 4 is installed on a high-speed output draft of the speed-increasing gearbox 3. The flywheel 4 connected with a crankshaft of the air compressing device plays roles in stabilizing speed and storing energy.

The system for preparing compressed air using weight potential energy further includes a weight lifting device. The weight lifting device comprises an electric-to-potential energy conversion device and a second storage device for the weight disposed on the ground. The weight stored in the second storage device is put into the first storage device by the electric-to-potential energy conversion device. The electric-to-potential energy conversion device includes a stand 29, a third sprocket wheel 13 disposed on the stand 29 via a bearing bushing seat 12, a fourth sprocket wheel 15 disposed on the ground via the bearing bushing seat, a second chain 16 connecting the third sprocket wheel with the fourth sprocket wheel 15, and an electromotor 14 used for driving the fourth sprocket wheel 15 to rotate. The trays 17 for receiving a plurality of metal balls are disposed on the second chain 16 uniformly. As the fourth sprocket wheel 15 is driven to rotate by the electromotor 14 so as to drive the second chain to move, the metal balls on its trays are transported to an elevated height successively and stored in the first storage device 19. The stand 8, the stand 21 and the stand 29 can be one stand or a ground located at a high elevation.

The first storage device 19 and the second storage device 21 are in the shape of a spiral rail, in which the end receiving the metal balls is higher than the other end throwing the metal balls. The lower end of the second sprocket wheel 6 directly facing the bottom of the first chain is provided with a sphere sliding rail. One end of the sliding rail is disposed beneath the first chain and the other end is connected with

a sphere receiving opening of the second storage device which is in the shape of a spiral rail. The end disposed beneath the first chain is higher than the end connected with the second storage device. The end of the sphere receiving opening of the second storage device which is in the shape of a spiral rail is higher than the end of a sphere throwing opening. The end of the sphere throwing opening is provided with a block plate 25. The power-output shaft of a servo motor 23 is provided with an eccentric wheel. Said eccentric wheel is provided beneath the front end of the block plate 25. The operating state of the servo motor is controlled by an optoelectronic switch 28. The end of a sphere receiving opening of the first storage device is disposed beside the third sprocket wheel and the end of a sphere throwing opening thereof is disposed beside the first sprocket wheel. The end of the sphere throwing opening is provided with a block plate 26. The power-output shaft of a servo motor 24 is provided with an eccentric wheel. The eccentric wheel is provided beneath the front end of the block plate 25. The operating state of the servo motor 24 is controlled by an optoelectronic switch 27. The servo motors 23 and 24 are controlled through the controller 22 by the optoelectronic switch 28 and optoelectronic switch 27, respectively.

The working process of the system for preparing compressing air using weight potential energy of the present invention is described as follows: the electromotor 14 is turned on when the power utilization is in an off-peak state at night, and the sprocket wheel 15 is driven to rotate by the electromotor 14, then the second chain 16 engaged with the sprocket wheel 15 is moving upward; the first tray on the second chain 16 is departing from a predefined position and moving upward, then the optoelectronic switch 28 is switched on, and the servo motor 23 drives the eccentric wheel on the power-output shaft to rotate so as to make the block plate moving downward, thereby one ball in the second storage device is thrown into the first tray. Next, the second tray passes into the predefined position, and then the optoelectronic switch 28 is switched off. The servo motor 23 drives the eccentric wheel connected to the power-output shaft thereof to rotate so as to make the block plate moving upward, thereby the ball is blocked. Above process is repeated, such that when the balls in the second storage are transported to the top of the sprocket wheel 13, the balls drop down with its own gravity and fall into the sphere receiving opening of the first storage device 19. In this way, the electric energy can be stored in the form of weight potential energy.

When the compressed air is needed, the servo motor 24 is turned on to drive the eccentric wheel disposed on its power-output shaft to rotate. As a result, the block plate moves downward. One ball in the first storage device 19 is thrown into the first tray in the first chain. Due to the own gravity of the ball, the first chain is driven to move down by the ball, so that the first sprocket wheel and the second sprocket wheel are driven to rotate by the first chain. Meanwhile, the optoelectronic switch 28 is switched on. The servo motor 24 drives the eccentric wheel disposed on its power-output shaft to rotate continually so that the block plate is driven to move upward and the second ball in the first storage device 19 is blocked. After the first ball moves a distance downward, the second tray on the first chain causes the optoelectronic switch 28 to switch off. The servo motor 24 drives the eccentric wheel disposed on its power-output shaft to rotate continually so that the block plate is driven to move downward and the second ball in the first storage device 19 drops into the second tray in the first chain. Due to the own gravity of the ball, the first chain is driven to move down by the ball, so that the first sprocket wheel and the second sprocket wheel are driven to rotate by the first chain. Above process is repeated, so that when the first sprocket wheel and the second sprocket wheel are rotating, the power-output shafts disposed on which are driven to rotate. The low-speed input shaft of the speed-increasing gearbox 3 is driven to rotate by the power-output shaft. The high-speed input shaft of the speed-increasing gearbox 3 is rotating so as to drive the flywheel 4 to rotate. The crankshaft of the air compressing device is driven to move by the flywheel 4 such that the atmospheric air filled in an air cylinder is compressed into high pressure air and is stored in a storage vessel.

The working principle of the present invention has been described above in details by combining with the accompanying drawings. However, the specific embodiment is used to illustrate the present invention exemplarily. The specification is only used to explain the claims. The scope of the present invention is not limited to the specification. The modification and replacement easily thought of by any skilled in the art within the technical scope disclosed in the present invention should fall within the scope of the present invention. Therefore, the scope of the present invention should be limited by the scope of the claims.

CLAIMS

1. A system for preparing compressed air using weight potential energy including an air compressing device and a weight driving device used for driving the air compressing device, characterized in that,

the weight driving device includes a stand, a first weight storage device disposed on the stand, and a potential-to-kinetic energy conversion device, wherein the potential energy of the weight is converted into the kinetic energy by the potential-to-kinetic energy conversion device when the weight is dropped down from the first storage device successively to drive the air compressing device to convert the atmospheric air into the compressed air.

2. The system for preparing compressed air using weight potential energy according to claim 1, characterized in that,

the system for preparing compressed air using weight potential energy further includes a weight lifting device, wherein the weight lifting device comprises a electric-to-potential energy conversion device and a second weight storage device disposed on the ground, wherein the weight stored in the second storage device is put into the first storage device by the electric-to-potential energy conversion device.

3. The system for preparing compressed air using weight potential energy according to claim 2, characterized in that,

the first storage device and the second storage device are in a spiral rail shape , in which the end receiving the metal balls is higher than the other end throwing the metal balls.

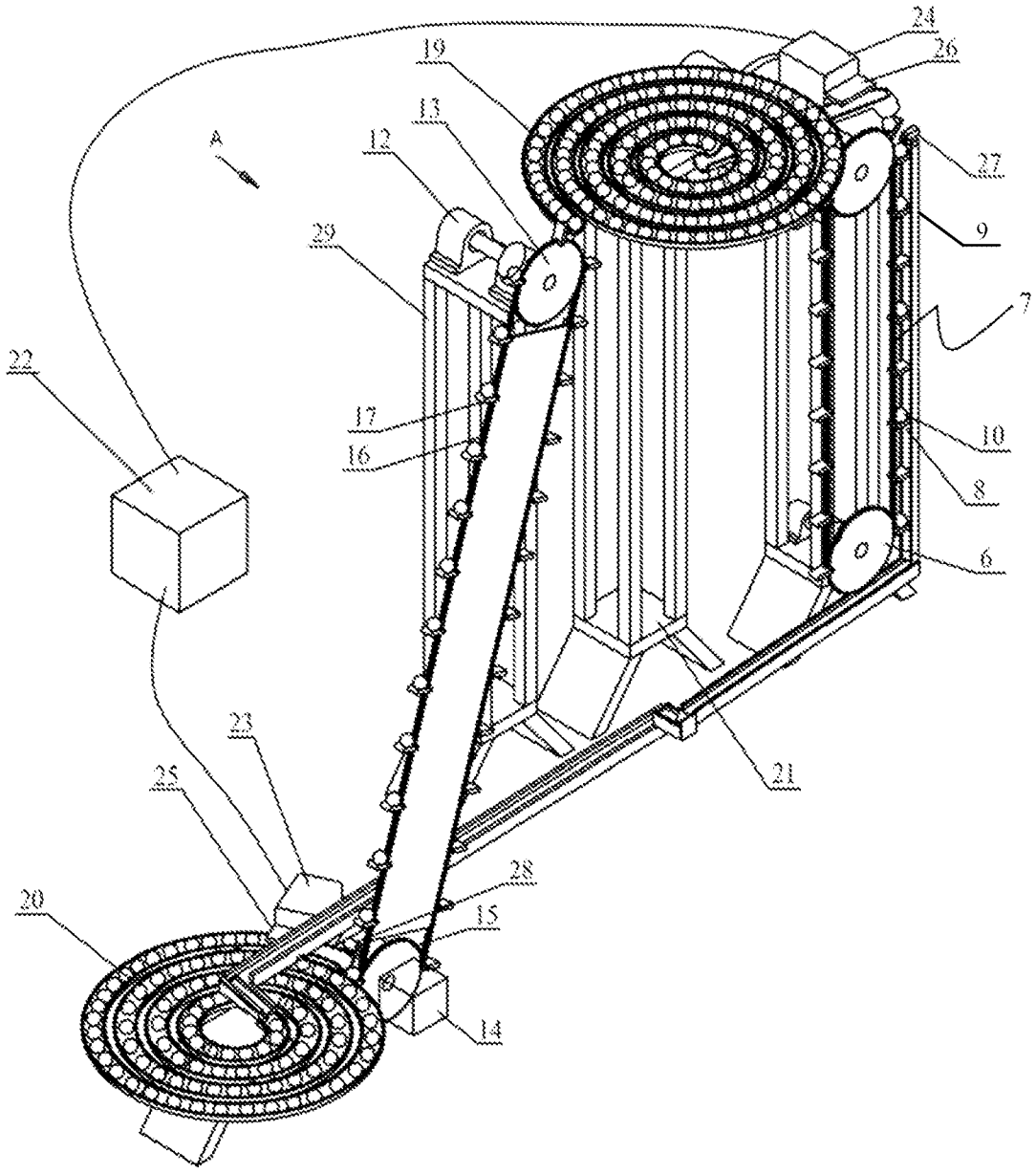

Fig.1

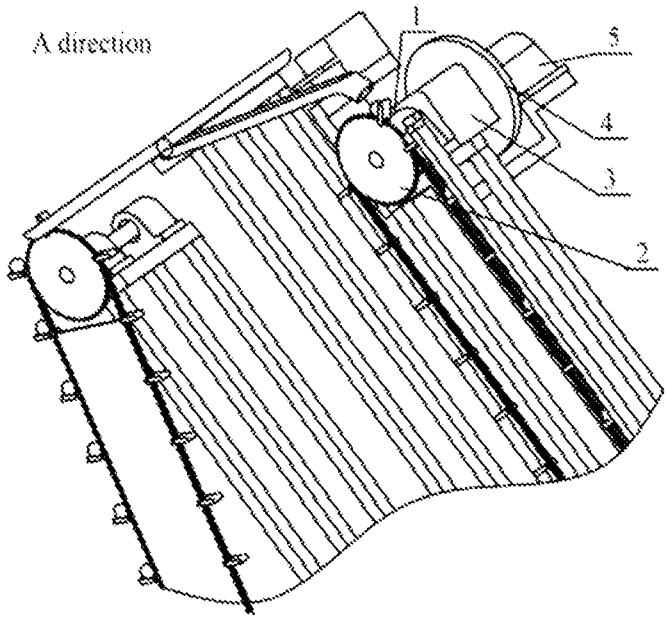

Fig.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/001067

A. CLASSIFICATION OF SUBJECT MATTER

F03G3/00(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)

F03G

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)

SIPOABS,CNABS,CNKI,VEN:weight,potential,compress+,air,kinetic,势能,重物,空气;

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 203614337 U (青岛格兰德新能源有限公司) 28 May 2014 (2014-05-28) Abstract, Figure 1	1-3
PX	CN 103670961 A (青岛格兰德新能源有限公司) 26 March 2014 (2014-03-26) Abstract, Figure 1	1-3
X	DE 102007002122 A1 (DANGE MADHUKAR) 24 July 2008 (2008-07-24) Abstract, Figure 1-4	1-3
X	US 2012161450 A1 (CUTTS JUSTIN BREDAR) 28 June 2012 (2012-06-28) Description paragraphe 63-68, Figure 1-4	1-3
A	FR 2985789 A1 (CHAZOT DANIEL) 19 July 2013 (2013-07-19) The whole document	1-3

☐ 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	Date of mailing of the international search report
08 January 2015	**27 January 2015**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN)** **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China** Facsimile No. **(86-10)62019451**	Authorized officer **TAN,Kai** Telephone No. **(86-10)62085291**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/001067

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 203614337 U	28 May 2014	Non e	
CN 103670961 A	26 March 2014	Non e	
DE 102007002122 A1	24 July 2008	Non e	
US 2012161450 A1	28 June 2012	Non e	
FR 2985789 A1	19 July 2013	Non e	