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(54) METHOD FOR FLUID CARRIAGE IN DEEP-SEAM COAL HYDRAULIC MINING

(57) The present invention relates to a method for fluid carriage in deep-seam coal hydraulic mining, aimed at the mining of coal seams buried underground at depths of 500 metres to below several thousands of metres. By means of methods such as well drilling and tubular columns, hydraulic power is conveyed to the coal seam excavation using tubular columns, to erode and cut coal buried underground, and by circulating fluid at a certain flow rate, cut coal is carried to the surface, achieving unmanned excavation in the shaft. The present method is an integrated coal exploitation technique achieving synchronous mining of coal field gas and solids, and is suitable for coal seams where conventional methods are unable to mine or mining is not economically viable, while also being suitable for establishing gasification channels for underground coal gasification.

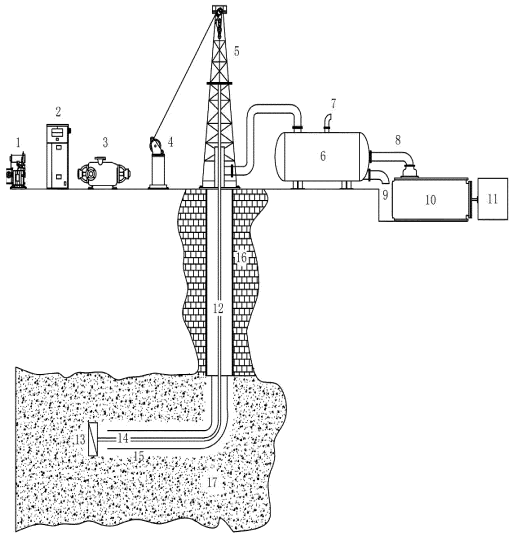

Fig.1

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Description

TECHNICAL FIELD

[0001] Embodiment of the present invention relates to a novel process for hydraulic mining and fluid carrying of deep-seam coal, mainly aiming at mining of coal seams buried in the ground under 500 meters to thousands of meters of depth.

BACKGROUND

[0002] It is in developing that by processes such as well drilling, tubular columns and the like, coal deeply buried in the ground is washed and cut, and the cut coal is brought out of the ground through the circulation of fluid. The tubular columns are utilized to transmit hydraulic power to the coal seams for tunneling and then transmit coal to the ground through fluid, realizing downhole unmanned tunneling.

SUMMARY

[0003] The novel process is a coal development technology for realizing the integration of synchronous mining of gas and solid of coal fields, is especially suitable for the coal seams which can not be mined with a conventional method or are uneconomically mined, and is suitable for establishment of gasification tunnels of underground gasification of coal.

[0004] To overcome the deficiencies of the prior art, embodiment of the present invention provides a novel process for hydraulic mining and fluid carrying of deep-seam coal, particularly a method for hydraulic mining and fluid carrying of coal seams buried in the ground with a depth under one thousand meters. The process includes:

1. an overall development scheme in resource area is drawn up according to the amount of resources from coal resource exploration and the actual situation of the geological formation;
2. the simultaneous development of a same layer of a single well or multiple wells is implemented according to the overall scheme;
3. the development of several sets of coal seams is required to follow a principle of development from a deeper seam coal seam to a less deeper coal seam;
4. the pressure coefficient of coal seams needs to be greater than 0.9 to ensure the economical implementation of the development scheme;
5. a well drilling process is utilized to establish a production well, that is, after drilling to the top of the deepest coal seam by utilizing the well drilling process, a casing is put down for well cementation, and then a cement plug is drilled to open the coal seams;
6. a directional drilling process is utilized, a specific hydraulic cutting drill and specific double-layer tubular columns are used, fluid with a certain performance is prepared, and production is performed by a ground mud pump;

    1) a directional drilling process is utilized, and a downhole television set, a position finder and a direction instrument are used to ensure the quality of tunneling;
    2) for a specific hydraulic cutting drill, hydraulic cutting drills of different parameters are customized according to thicknesses and dip angles of the coal seams, and the parameters mainly include rotation speed, the diameter of nozzles, and the jet angle of nozzles;
    3) for specific double-layer tubular columns, tubular columns of different diameters are utilized according to capacity;
    4) the performance of the fluid is configured according to the pressure coefficient and density of coal seams, and the main performance indexes include density, viscosity and cutting force; the fluid (also called coal alkali liquor) is mainly prepared from water, bentonite, caustic soda (sodium hydroxide), coal powder and gangue powder;
    5) the main parameters of a mud pump include pressure (generally high pressure, which is greater than 10MPa) and displacement;

7. mixture of coal briquettes and coal gas (CH_4) is brought out of the ground through fluid with a certain flow velocity and then enters a processing system on the ground;

    1) the mixture of mud, coal and gas enters a three-phase separation system first so that the mud, coal and gas are separated simultaneously;
    2) the coal gas (CH_4) enters a gas processing station, is then compressed and transmitted to users;
    3) the coal briquettes enter a coal washing workshop and are then processed into cleaned coal, which is

transferred to a cleaned coal warehouse for sale; ash and gangue from the coal washing workshop enter a gangue grinding plant and are then processed into materials below 200 meshes for preparing mud; and waste water from the coal washing workshop is transferred to a mud preparation plant and used for preparing mud; and 4) the mud flows into a sedimentation tank from the three-phase separator for settling powdered coal and fine sand particles; and the sediment is transferred to the coal washing workshop for processing, and the mud is recycled to a circulation pool for recycling.

[0005] According to the development scheme, a multi-well and multilayer well pattern is implemented so as to perform the underground hydraulic mining of coal.

[0006] For a mining area having multiple coal seams, it is preferred to mine bottom coal seams and then upper coal seams successively.

[0007] Embodiments of the present invention has the following advantages:

1. the synchronous mining of gas and solid of a coal field is realized, and the utilization ratio of resources is high; the recovery ratio of coal may be 80% and above; the gas is completely recycled;
2. downhole unmanned and hydraulic operations are realized, so as to avoid production accidents such as gas explosion, collapse and the like during conventional coal mining;
3. this novel process is more advantageous in terms of environmental protection than the conventional coal mining, is free of damages to the ambient environment, and has small occupation of production land, no sewage discharge, no waste, gangue and dust; and, the coal gas is fully recycled;
4. stock resources in various places may be fully utilized, thereby avoiding the long-distance transportation of coal and reducing the energy consumption;
5. less investment in construction, short cycle and high production efficiency are realized; and
6. vigorous exploration and development of deep resources, mainly coking coal, may significantly make up the resource shortage and has good benefit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a cross-sectional view of flow of a process according to an embodiment of the present invention.

[0009] Reference numerals and corresponding explanation Fig. 1 are listed as below:

1	Electricity transformer and distributor	7	Natural gas processing station	13	Specific hydraulic mining drill
2	Power distribution cabinet	8	Separated liquid phase	14	Inner tubular column
3	Fluid circulating pump	9	Separated coal	15	Outer tubular column
4	Well winch	10	Sedimentation tank	16	Casing
5	Derrick	11	Sediment processing device	17	Coal seams
6	Three-phase separator	12	Fluid		

[0010] Fig. 2 is a planar graph of flow of the process according to an embodiment of the present invention.

[0011] Reference numerals and corresponding explanation in Fig. 2 are listed as below:

1	Electricity transformer and distributor	6	Natural gas processing station	11	Separated coal
2	Pump	7	Users	12	Coal washing workshop

3	Mud circulating pool	8	Sedimentation tank	13	Cleaned coal warehouse
4	Wellhead	9	Sediment processing device		
5	Three-phase separator	10	Separated liquid phase		

DETAILED DESCRIPTION

[0012] The specific embodiments of the present invention will be further described hereinafter with reference to the

accompanying drawings.

[0013] Referring to Fig. 1, according to the well drilling process of an embodiment of the present invention, a system which includes an electricity transformer and distributor (1), a power distribution cabinet (2), a mud circulating pump (3), a well winch (4) and a derrick (5) is utilized to perform drilling to the top of the deepest coal seam, a casing (16) is put down for well cementation, and then a cement plug is drilled to open the coal seams (17). The pressure coefficient of coal seams is required to be greater than 0.9 to ensure the economical implementation of the development scheme.

[0014] Referring to Fig. 1, a directional drilling process according to an embodiment of the present invention is utilized, the prepared fluid (12) with certain performance transmits hydraulic power to the coal seams for tunneling by a ground mud pump (3) via a specific double-layer tubular column (i.e., an inner tubular column (14) and an outer tubular column (15)), and the coal deeply buried in the ground is washed and cut by using a specific hydraulic cutting drill (13). The coal mixture is brought out of the ground through fluid with a certain flow velocity and then enters a ground processing system.

[0015] Referring to Fig. 1, the parameters of the mud pump (3) in an embodiment of the present invention mainly include pressure and displacement. The pressure is required to be a high pressure, generally greater than 10 MPa.

[0016] Referring to Fig. 1, for the specific double-layer tubular columns in an embodiment of the present invention, i.e., the inner tubular column (14) and an outer tubular column (15), the tubular columns (14, 15) of different diameters are utilized according to production capacity. The performance of the fluid (12) in an embodiment of the present invention is configured according to the pressure coefficient and density of coal seams, and the main performance indexes include density, viscosity and cutting force.

[0017] Referring to Fig. 1,for a specific hydraulic cutting drill (13) in an embodiment of the present invention, hydraulic cutting drills (13) of different parameters are customized according to thicknesses and dip angles of the coal seams (17), and the main parameters include rotation speed, the diameter of nozzles, and the jet angle of nozzles.

[0018] Referring to Fig. 1, the fluid (12) (also called coal alkali liquor) in an embodiment of the present invention is mainly prepared from water, bentonite, caustic soda (sodium hydroxide), coal powder and gangue powder.

[0019] Referring to Fig. 2, a planar graph of flow of the process is shown, including an electricity transformer and distributor (1), a pump (2), a mud circulating pool (3) and a wellhead (4). The coal mixture in an embodiment of the present invention enters a three-phase separation system (5) first so that the mud (10), coal (11) and gas (7) of three phases are separated, respectively.

[0020] Referring to Fig. 2, the coal gas (CH_4) in an embodiment of the present invention enters a gas processing station (6), is then compressed and transmitted to users.

[0021] Referring to Fig. 2, coal briquettes (11) in an embodiment of the present invention enter a coal washing workshop (12) and are then processed into cleaned coal, and the cleaned coal is transferred a cleaned coal warehouse (13) for marketing.

[0022] Referring to Fig. 2, the mud (10) in an embodiment of the present invention flows into a sedimentation tank (8) after separation, powdered coal and fine sand particles are settled by a sediment processing device (9), the sediment is transferred to the coal washing workshop (12) for processing, and the mud is recycled to a circulation pool (3) for recycling.

Claims

1. A novel process for hydraulic mining and fluid carrying of deep-seam coal, wherein:

   (1) the novel process is a coal development technology for realizing the integration of synchronous mining of gas and solid of coal fields and is especially suitable for the coal seams which can not be mined with a conventional method or are uneconomically mined;
   (2) meanwhile, the novel process is suitable for the establishment of gasification tunnels of underground gasification of coal;
   (3) by a directional drilling process, a hydraulic cutting drill and double-layer tubular columns are utilized, fluid with a certain performance is prepared and used as a carrier, and mixture of underground deep-seam coal is brought out of the ground through the fluid with a flow velocity;
   (4) mud, coal and gas in the mixture are simultaneously separated by a three-phase separator system; and
   (5) coal gas (CH_4) is fed into a gas processing station, is then compressed and transmitted to users; coal briquettes enter a coal washing workshop and are processed into cleaned coal, which is then transferred to a cleaned coal warehouse for subsequent sale; and the mud is recycled to a circulation pool for recycling.

2. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 1, wherein an overall development scheme is drawn up according to the amount of resources from coal resource exploration and the actual situation of the geological formation, and the simultaneous development of a same layer of a single well or

multiple wells is implemented according to the overall scheme.

3. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 1, wherein the novel process is also applicable to the establishment of gasification tunnels of underground gasification of coal.

4. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 1 or 2, wherein, the development of several sets of coal seams is required to follow a principle of development from a deep-seam coal seam to a shallow coal seam, and the pressure coefficient of coal seams is greater than 0.9, to ensure the economical implementation of the development scheme.

5. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 1, wherein the well drilling process is utilized to establish a production well; after drilling to the top of the deepest coal seam by the well drilling process, a casing is put down for well cementation, and then a cement plug is drilled to open the coal seams.

6. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 3 or 4, wherein the directional drilling process is utilized, a specific hydraulic cutting drill and specific double-layer tubular columns are utilized, fluid with a certain performance is prepared, and finally production is performed by a ground surface mud pump.

7. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 5, wherein the directional drilling process is utilized, and a downhole television set, a position finder and a direction instrument are used to ensure the quality of tunneling.

8. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 6, wherein, hydraulic cutting drills of different parameters are customized according to thicknesses and dip angles of the coal seams, and the parameters include rotation speed, the diameter of nozzles, and the jet angle of nozzles. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 6, wherein, the double-layer tubular columns of different diameters are utilized according to production capacity, the performance of the fluid is configured according to the pressure coefficient and density of coal seams, and indexes of the performance include density, viscosity and cutting force; the fluid (also called coal alkali liquor) is prepared from water, bentonite, caustic soda (sodium hydroxide), coal powder and gangue powder; and parameters of the mud pump include pressure (generally high pressure) and displacement.

9. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 1, wherein the mixture of coal briquettes and coal gas (CH4) is brought out of the ground through fluid with a certain flow velocity and then enters a processing system on the ground.

10. The novel process for hydraulic mining and fluid carrying of deep-seam coal according to claim 10, wherein the mixture of the fluid enters a three-phase separation system first so that the mud, coal and gas are separated simultaneously; the coal gas (CH4) enters a gas processing station, is then compressed and transmitted to users; the coal briquettes enter a coal washing workshop and are then processed into cleaned coal, and the cleaned coal is transferred a cleaned coal warehouse for subsequent sale; ash and gangue from the coal washing workshop enter a gangue grinding plant and are then processed into materials below 200 meshes for preparing mud; waste water from the coal washing workshop is transferred to a mud preparation plant and used for preparing mud; the mud flows into a sedimentation tank from the three-phase separator for settling powdered coal and fine sand particles; and the sediment is transferred to the coal washing workshop for processing, and the mud is recycled to a circulation pool for recycling.

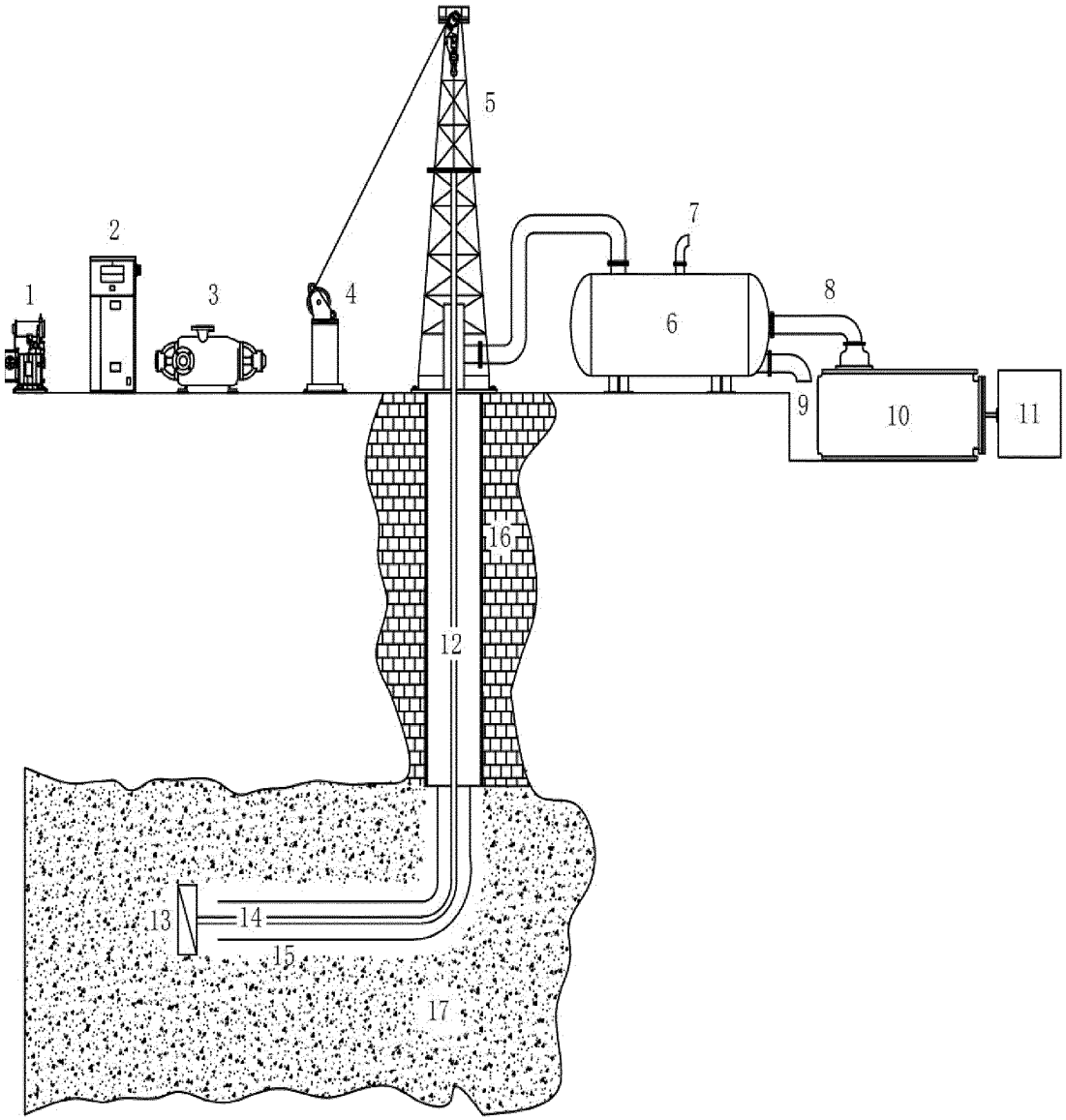

Fig.1

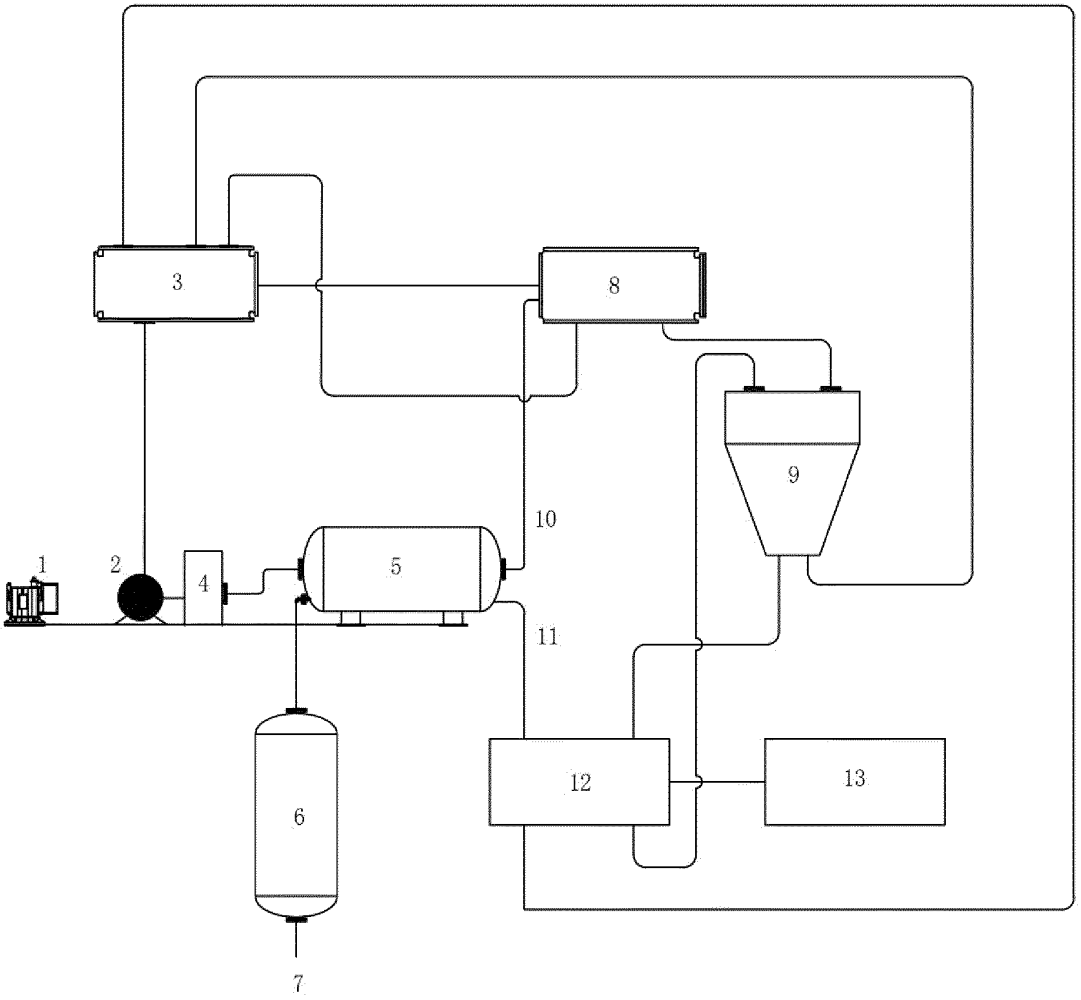

Fig.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075447

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet
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: E21B 43/-; E21C 41/-

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, CNKI, CNPAT, CA: QIN YONG, GUO ZHUNAN, LI JIANPING, CARRY, DEEP, COAL, MINE, HYDRAULIC, FLUID, GAS, SOLID, SYNCHRONOUS, INTEGRATE, DEVELOP, PROCESS, FINE, AFTER, PRESSURISED, BLOCK, WASHING,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 102777151 A (QIN, Yong et al.) 14 November 2012 (14.11.2012) see description, paragraphs [0005] to [0020], claims 1-10	1-10
A	CN 101881168 A (SICHUAN DAZHU COAL & ELCETRICITY CO.,LTD.) 10 November 2010 (10.11.2010) see description, paragraphs [0025] and [0026] and figures 1 and 2	1-10
A	CN 101979832 A (UNIV. ZHEJIANG) 23 February 2011 (23.02.2011) see description, paragraphs [0025] to [0036] and figures 1 and 2	1-10
A	WO 2007/140204 A1 (HONEYWELL INTERNATIONAL INC.) 06 December 2007 (06.12.2007) see description, paragraphs [0004] to [0009]	1-10
A	CN 202020940 U (SHENMUFUYOU ENERGY TECHNOLOGY CO.,LTD.) 02 November 2011 (02.11.2011) see description, paragraphs [0003] to [0011]	1-10

☐ 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

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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 July 2013 (20.07.2013)	15 August 2013 (15.08.2013)
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer WANG, Chunhui Telephone No. (86-10) 82245415

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/075447

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102777151 A	14.11.2012	None	
CN 101881168 A	10.11.2010	None	
CN 101979832 A	23.02.2011	WO 2012055233 A1	03.05.2012
WO 2007/140204 A1	06.12.2007	EP 2019906 A1	04.02.2009
		IN 200809751 P1	20.03.2009
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		CN 101495712 A	29.07.2009
CN 202020940 U	02.11.2011	None	

Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

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E21B 43/00 (2006.01) i

E21B 43/34 (2006.01) i

E21B 41/18 (2006.01) i

Form PCT/ISA /210 (extra sheet) (July 2009)