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(54) NOVEL PROCESS FOR CONTROLLING DOWNHOLE GAS IN ABANDONED MINE

(57) The present invention discloses a novel process for controlling downhole gas in an abandoned mine. The process comprises steps of: 1) before closing an abandoned mine, blocking branched downhole drifts (1, 2, 3), and forming steel pipe holes in upper portions of squared stone blocking walls to enable the interior to communicate with the exterior; 2) connecting the steel pipe holes formed in the blocking walls (4) of the multiple branched downhole drifts with a downhole gas pumping main pipe (7) to conduct gas pumping; 3) communicating the blocked drift drainage water with main drift drainage water, constructing a water reservoir (11) somewhere low on the bottom of the mine, mounting a water drainage pump (12) and a water pipe to pump inflowing downhole water to the ground, in order to achieve normal pumping of inflowing downhole water after the mine is closed; 4) closing a main entrance and a secondary entrance of the abandoned mine, embedding steel pipes in loess-filled squared stone walls in an adit inclined shaft, blocking a main entrance and a secondary entrance of a vertical shaft with steel-reinforced concrete cover plates, and embedding steel pipes in the main entrance and the secondary entrance of the vertical shaft to enable the interiors of the entrances to communicate with the exteriors of the entrances; and 5) pumping downhole gas by a ground gas pumping equipment. The process of the present invention can achieve the purposes of comprehensive control and utilization of downhole gas in an abandoned mine.

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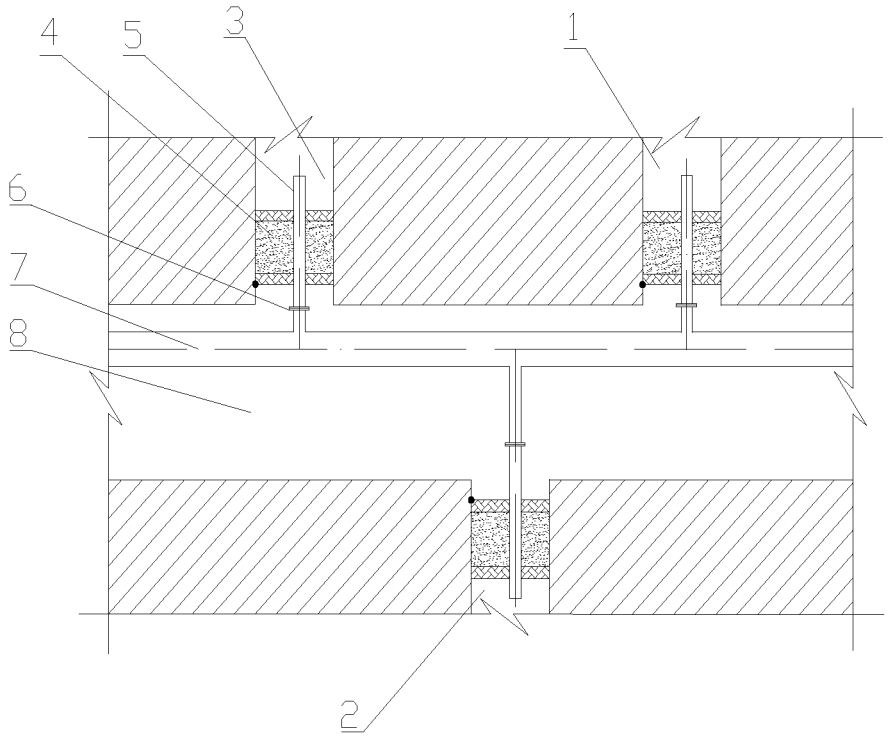

Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention belongs to the field of control of gas in mines, and particularly relates to a novel process for controlling gas in an abandoned mine.

BACKGROUND OF THE PRESENT INVENTION

[0002] Gas in abandoned mines means methane, which is in an adsorbed or free state, residual in remaining coal seams, surrounding rocks and downhole confined spaces in mines that are closed according to relevant provisions of the state due to the depletion of coal resources or other reasons such as inconformity to requirements and policies on safe production.The utilization of gas in abandoned mines means that gas is extracted and utilized by the existing gas pumping system on the ground, by taking certain blocking measures, before the mines are closed. In China, no successful experience and projects can be found in the field of control of abandoned mines, in spite of some theoretical studies. Although the pumping of gas by ground drilling has already been done in some mines, the real comprehensive control and utilization of gas in abandoned mines is blank yet. With the development of structural reform of the coal industry and elimination of backward production capacity in China, the number of the closed mines is increasing year by year. The hazards of gas escape, mine collapse, contamination of dirt and accumulated downhole water in abandoned mines are increasingly obvious. The ecological environment will be seriously threatened without scientific control. Meanwhile, these closed mines are rich in gas. It was reported that there may be a trillion cubic feet of gas resources in these abandoned mines in China. The popularization and industrial application of the process of the present invention all over the country will facilitate the development and utilization of unconventional natural gas resources during the China's "13th Five-Year Plan", and also the transformation of coal enterprises, the creation of new jobs and the reuse of abandoned resources, and more importantly, will solve the safety and environmental protection problems of abandoned mines and protect the ecological environment. It is of great social significance.

SUMMARY OF THE PRESENT INVENTION

[0003] In view of existing shortcomings in controlling downhole gas in abandoned mines, an objective of the present invention is to provide a novel process for controlling downhole gas in abandoned mines, by blocking downhole drifts in an abandoned mine, forming holes, connecting and reconstructing the gas pumping pipe system, reconstructing the water drainage system, pumping downhole gas by a pumping device on the ground, in order to achieve the purposes of comprehensive control and utilization of gas in an abandoned mine.

[0004] For this purpose, the technical solution comprises the following steps.

1) Before closing an abandoned mine, branched drifts with high downhole gas overflow are blocked at their joints with a main drift by squared stone walls, and pipes are embedded to extract gas and to pump inflowing water:

a: Blockage of downhole drifts: before closing an abandoned mine, at joints of branched downhole drifts in the mining area and goaf with a main drift, an internal wall with a thickness of 0.8m to 1m and an external wall with a thickness of 0.8m to 1m are built with squared stones, with loess filled between the walls. During the whole building process of the blocking walls, a pipe is embedded to enable the interior of the drift to communicate with the exterior. A removable enclosure is formed outside the communication pipe, so that a gas detector can be put into the enclosed drifts for detection. If a drift with high gas content is detected, this pipe is directly connected to the downhole gas main pipe. Also, water drainage holes are to be formed in lower portions of the blocking walls, to drain inflowing water from the drifts. The existing gas pumping pipe system is, after being reconstructed, kept in connection to the pumping system on the ground, to realize the pumping of downhole gas in the abandoned mine.

b: Pumping of inflowing downhole water: normally, downhole water always inflows to the goaf, and during the normal production of mines, the pumping of inflowing downhole water is also an important one of routine tasks in production of mines. However, after a mine is shut down and closed, if the inflowing downhole water is not drained in time, the accumulated inflowing downhole water will flood drifts in the goaf in the mine. Consequently, there is no space for the downhole gas to escape out, and as a result, it is unable to extract and utilize the downhole gas. In the present invention, after a mine is shut down and closed, an inflowing downhole water control and pumping system is redesigned, by which, by operating on the ground, the inflowing downhole water can be pumped to the ground without any operator in the mine. In this way, a space is reserved for the downhole gas to escape out and the accumulation of water in the mine is avoided. Meanwhile, the purpose of controlling gas in abandoned mines is realized.

In the present invention, when building squared

stone blocking walls for drifts, an overflow tank with a water seal is formed in the lower portion of the internal squared stone wall. The inflowing water in the drifts flows into the overflow tank and overflows out of the blocking wall through the water seal when the level of water reaches a certain height, while gas of a high concentration accumulated within the square stone walls will not flow out of the blocking wall through the overflow tank. The inflowing water overflown from the overflow tank with a water seal flows into the drainage ditch for the main drift. A water reservoir is formed somewhere lowest on the bottom of the mine. The water reservoir is usually built with squared stones, cement and sand. The volume of the water reservoir depends upon the amount of the inflowing water in the mine. The water in the drainage ditch for the main drift flows into the water reservoir. On the ground, by precisely positioning, a water drainage wellbore is formed, which runs to the water reservoir. On the ground, a water drainage pump and a connection pipe are mounted in the wellbore and the water drainage pump is put into about 2/3 of the depth of the water reservoir. When the level of water in the water reservoir reaches the inlet of the water drainage pump, the pump starts pumping water, in order to pump water in the water reservoir to the ground for reusing. In this way, the inflowing downhole water can be pumped to the ground after the mine is closed, to ensure an enough downhole space to release the stored gas. The purposes of comprehensive control and utilization of downhole gas in abandoned mines are achieved.

2) The pipes embedded in the squared stone walls are connected with a downhole gas pumping pipe to form a downhole gas pumping pipe system, and then the accumulated downhole gas in an abandoned mine is pumped by the existing gas pumping system device on the ground:
A firm steel-reinforced concrete cover plate, which is bigger than the cross section of the wellbore, is cast on the entrance of a vertical shaft. During the casting, two steel pipes are embedded in the steel-reinforced concrete cover plate. An end of the steel pipe running into the inner side of the wellbore is open, to communicate with the downhole space. A blind flange is mounted on the outer side of the wellbore, and connected by blots. For an inclined shaft and an adit inclined shaft, a brick, stone or concrete wall, which has a thickness of not less than 0.6m and must be firm and reliable, should be built at 20m inside the entrance. Then, soil is filled up to the entrance. And then, another brick, stone or concrete wall is built. After the mine is closed, the blind flange outside the embedded pipe is removed, and a gas detector or sampling device is put into the mine to detect the concentration of gas in the mine. If gas in the mine can be utilized, the pipe is connected to the gas pumping pipe on the ground. In this way, the pumping and utilization of accumulated downhole gas is achieved after the mine is closed.

3) The blocked drift drainage water is communicated with main drift drainage water, a water reservoir is constructed somewhere low on the bottom of the mine, a water drainage wellbore is formed from the ground to the water reservoir, and a water drainage pump and a water pipe are mounted to pump inflowing downhole water to the ground, in order to achieve normal pumping of inflowing downhole water after the mine is closed.

4) after finishing the above operations, for an adit inclined shaft, an entrance of the adit inclined shaft is closed by building internal and external walls with squared stones, cement and sand, with loess and clay filled between the walls, and steel pipes that run into the mine are embedded in an upper portion of the entrance of the adit inclined shaft; and for a vertical shaft, the entire entrance of the vertical shaft is blocked with steel-reinforced concrete cover plates, and steel pipes are embedded in the center of the steel-reinforced concrete cover plates to enable the interior to communicate with the exterior; and the connection with the existing gas pumping system device on the ground achieves the pumping, control and utilization of gas in an abandoned mine.

5) The existing gas pumping system device on the surface is connected with a downhole gas pumping main pipe to pump gas, thereby achieving the purposes of comprehensive control and utilization of downhole gas in an abandoned mine.

[0005] The present invention has the following beneficial effects. By compressive gas control measures, such as blocking downhole drifts in an abandoned mines, reconstructing the downhole gas pipe, reconstructing the pumping of inflowing downhole water, and closing the entrance of the abandoned mine, disasters caused by the accumulation and escape of downhole gas in the abandoned mine and the accumulation of downhole water are avoided. Meanwhile, the gas in the abandoned mine can be reused. Great economic, environmental and social benefits can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

Fig. 1 shows a downhole gas pipe system used in the process of the present invention;

Fig. 2 is an inflowing downhole water drainage system according to the present invention;

Fig. 3 is a schematic view of closing the entrance of a vertical shaft in an abandoned mine, according to the present invention; and

Fig. 4 is a schematic view of blocking an inclined shaft in an abandoned mine, and a gas pumping pipe, according to the present invention.

Reference numerals:

[0007] 1: branched downhole drift #1; 2: branched downhole drift #2; 3: branched downhole drift #3; 4: blocking wall for the branched downhole drift; 5: embedded pipe; 6: pipe flange; 7: downhole gas pumping main pipe; 8: main downhole drift; 9: water outlet fora branched downhole drift; 10: drainage ditch for the main downhole drift; 11: downhole water reservoir; 12: water drainage pump; 13: water drainage wellbore; 14: main entrance of the abandoned mine; 15:cover plate for blocking the entrance; 16: reserved gas pumping pipe; 17: main inclined shaft in the abandoned mine; 18: pipe embedded in the blocking wall; 19: internal squared stone blocking wall; 20: loess or sand filled section; 21: external squared stone blocking wall; and 22: gas pumping main pipe on the ground.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0008] As shown in Fig. 1, a novel process for comprehensively controlling downhole gas in an abandoned mine is provided. Before an abandoned mine is closed, a blocking wall 4 is built, respectively, at a position about 8m from the adit entrance of the branched drifts #1, #2 and #3 in the downhole mining area and goaf in the abandoned mine. Specifically, at a position 8m from the entrance of a branched drift, a blocking wall having a thickness of about 0.8m to 1m is built with squared stones, cement and sand to block the branched drift, and an external blocking wall having a thickness of about 0.8m to 1m is built with squared stones, cement and sand, with a layer of loess having a thickness of 5m filled between the walls. During the whole building process of the blocking walls, one embedded pipe 5 that is DN100-DN200 thick is embedded in the blocking walls at a position 0.2-0.3m from the top of the adit. By this embedded pipe 5, the branched drifts are communicated with the main drift 8. A pipe flange 6 is used outside the embedded pipe to close it. If gas reaches a concentration that can be utilized, the pipe can be directly connected to a downhole gas pumping main pipe 7 by the flange, and then the downhole gas is pumped and utilized by the existing gas pumping device on the ground.

[0009] Referring to Fig. 2, a system for pumping inflowing downhole water in an abandoned mine is shown. Before an abandoned mine is closed, when building blocking walls for the branched downhole drift #1, a water outlet 9 for a branched downhole drift is formed in the lower side of the blocking walls. The water outlet is in form of an overflow water seal. A water tank, which is plastered with cement mortar, is constructed inside the branched drift close to the blocking walls. The volume of the water tank depends upon the amount of inflowing water in the branched drift. The inflowing water in the branched drift flows into the water tank. When the level of the accumulated water reaches the overflow height, water flows out of the branched drift from the overflow tank in the lower portion of the blocking walls for the branched drift. In this way, the inflowing water in the branched drift can be drained, while gas in the branched drift will not escape from the water outlet 9 which is in form of an overflow water seal. The inflowing water overflown from each branched drift flows into a drainage ditch 10, which is arranged in the main drift and plastered with cement mortar. A water reservoir 11 is formed somewhere low on the bottom of the mine. The water reservoir is an adit dug somewhere lowest on the bottom of the mine. The water reservoir is plastered with cement mortar. The length, width and depth of the water reservoir depend upon the size of the downhole drift, the capacity of the pumping system, and the amount of inflowing water. Usually, the water reservoir consists of two water reservoirs connected in series, which are 20m long, 3m wide and 3m deep. A water drainage wellbore 13 is formed on the ground right above the water reservoir, so that the water reservoir is communicated with the ground by the water drainage wellbore 13. A water drainage pump 12 is mounted in the water drainage wellbore. An outlet of the water drainage pump 12 is connected to a water treatment device on the ground. By the water drainage pump, the inflowing downhole water accumulated in the water reservoir is drained, to ensure an enough downhole space to release the stored gas. In this way, the purposes of comprehensive control and utilization of downhole gas in abandoned mines are achieved.

[0010] As shown in Fig. 3, in the process of the present invention, at the main entrance 14 of the abandoned mine, a steel-reinforced concrete cover plate 15 is arranged to block the entrance. The distance from the upper surface of the cover plate to the ground, the thickness of the steel-reinforced concrete cover plate, the size of the used steel, the grade of concrete, and the proportion of steel and concrete depend upon the size of the entrance, and will be designed by professional structure design organizations. During the construction according to the design document, when the steel-reinforced concrete cover plate is prepared, one or two steel pipes 3 having a diameter of DN300-500mm are embedded in the steel-reinforced concrete cover plate. One end of the embedded pipe extends into the entrance by a length of greater than 15m, and the pipe orifice inside the entrance is open. The other end of the embedded pipe remains on the steel-reinforced concrete cover plate. A pipe flange is welded at 0.5m to 1m from the ground, and the blind flange and the flange are connected by bolts to block the pipe orifice. After removing the blind flange, a sam-

pling device is put into the pipe to sample and analyze the concentration of downhole gas. If gas reaches a concentration that can be utilized, the pipe is connected to the gas pumping system pipe on the ground to pump and utilize the accumulated downhole gas. In this way, the purpose of comprehensively controlling gas in abandoned mines is achieved.

[0011] As shown in Fig. 4, in the process of the present invention, there is mainly an inclined shaft in an abandoned mine. In this case, when blocking the entrance of the main inclined shaft 17, at a depth more than 25m from the entrance, a squared stone sealing wall 3 having a thickness of not less than 1m is built with squared stones, cement and sand; then, loess or clay is filled in the loess or clay filling section 20 having a thickness of greater than 20m, up to the adit entrance of the inclined shaft; and then, a squared stone blocking wall 19 having a thickness of not less than 1m is built with squared stones, cement and sand. During the whole blocking process, one or two steel pipes 2 having a diameter of DN300-500mm are embedded in the upper portion of the adit entrance. One end of the embedded pipe 18 extends into the entrance 1 by a length of greater than 20m and is supported by a rack, and the pipe orifice inside the entrance is open. The other end of the embedded pipe remains outside the squared stone blocking wall 19 at the entrance of the inclined shaft. A pipe flange is welded at 0.5m to 1m from the blocking wall, and the blind flange and the flange are connected by bolts to block the pipe orifice. After removing the blind flange, a sampling device is put into the pipe to sample and analyze the concentration of downhole gas. If gas reaches a concentration that can be utilized, the pipe is connected to the existing gas pumping main pipe 22 on the ground to pump and utilize the accumulated downhole gas. In this way, the purpose of comprehensively controlling gas in abandoned mines is achieved.

Claims

1. A novel process for controlling downhole gas in an abandoned mine, wherein the process comprises steps of:

   1) before closing an abandoned mine, blocking branched drifts with high downhole gas overflow at their joints with a main drift by squared stone walls and embedding pipes to extract gas and to pump inflowing water;

   2) connecting the pipes embedded in the squared stone walls to extract gas with a downhole gas pumping pipe to form a downhole gas pumping pipe system, and then pumping accumulated downhole gas in an abandoned mine by an existing gas pumping system device on the ground;

   3) communicating the blocked drift drainage water with main drift drainage water, constructing a water reservoir somewhere low on the bottom of the mine, forming a water drainage wellbore from the ground to the water reservoir, and mounting a water drainage pump and a water pipe to pump inflowing downhole water to the ground, in order to achieve normal pumping of inflowing downhole water after the mine is closed;

   4) after finishing the above operations, for an adit inclined shaft, closing an entrance of the adit inclined shaft by building internal and external walls with squared stones, cement and sand, with loess and clay filled between the walls, and embedding steel pipes that run into the mine in an upper portion of the entrance of the adit inclined shaft; and for a vertical shaft, blocking an entire entrance of the vertical shaft with steel-reinforced concrete cover plates, and embedding steel pipes in the center of the steel-reinforced concrete cover plates to enable the interior to communicate with the exterior; and the connection with the existing gas pumping system device on the ground achieves the pumping, control and utilization of gas in an abandoned mine; and

   5) connecting the existing gas pumping system device on the ground with a downhole gas pumping main pipe to pump gas, thereby achieving the purposes of comprehensive control and utilization of downhole gas in an abandoned mine.

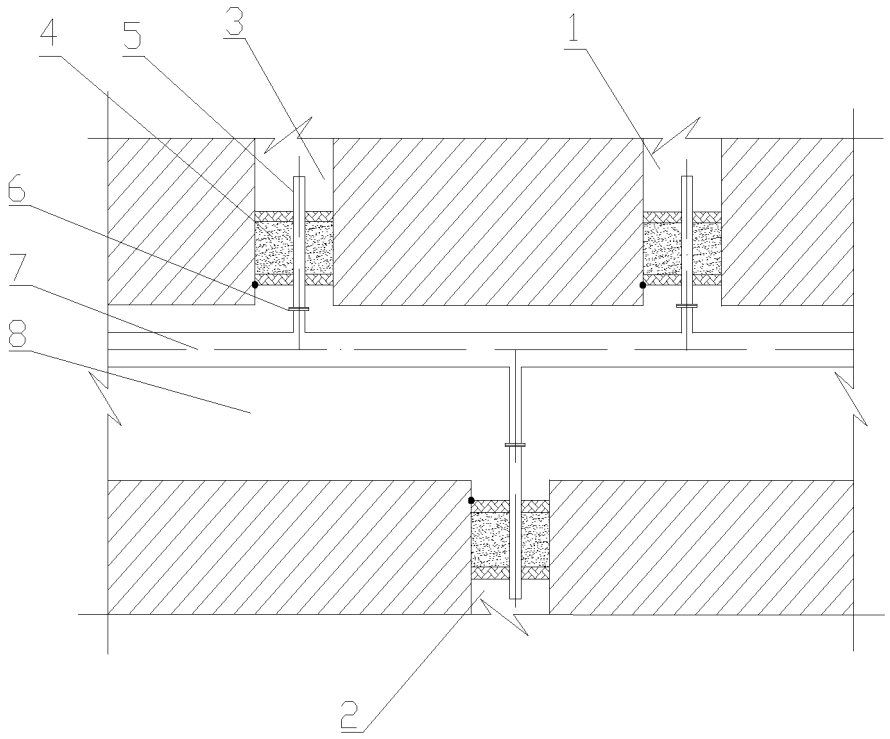

Fig. 1

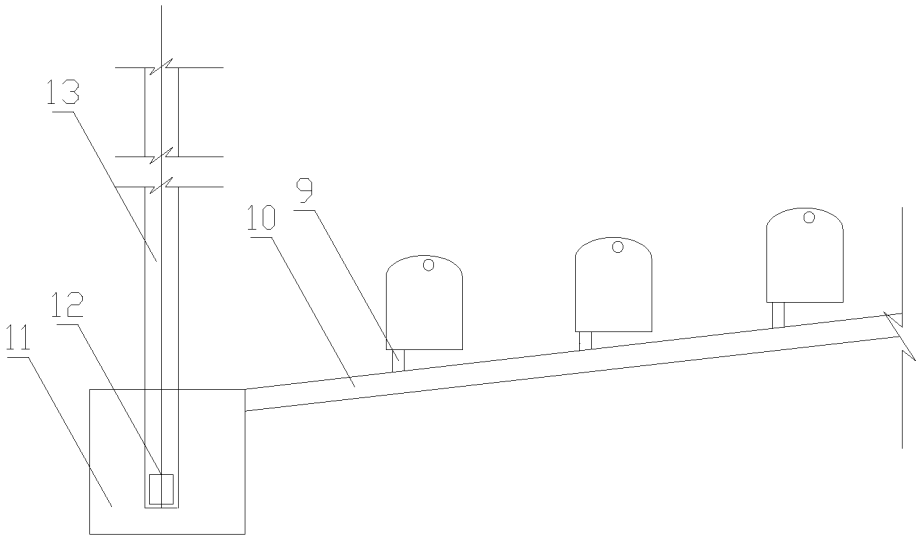

Fig. 2

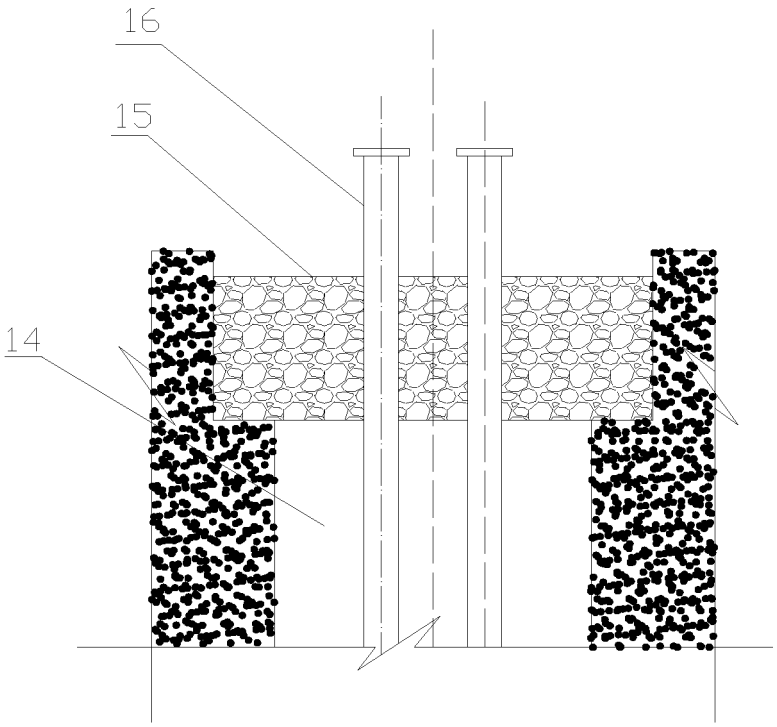

Fig. 3

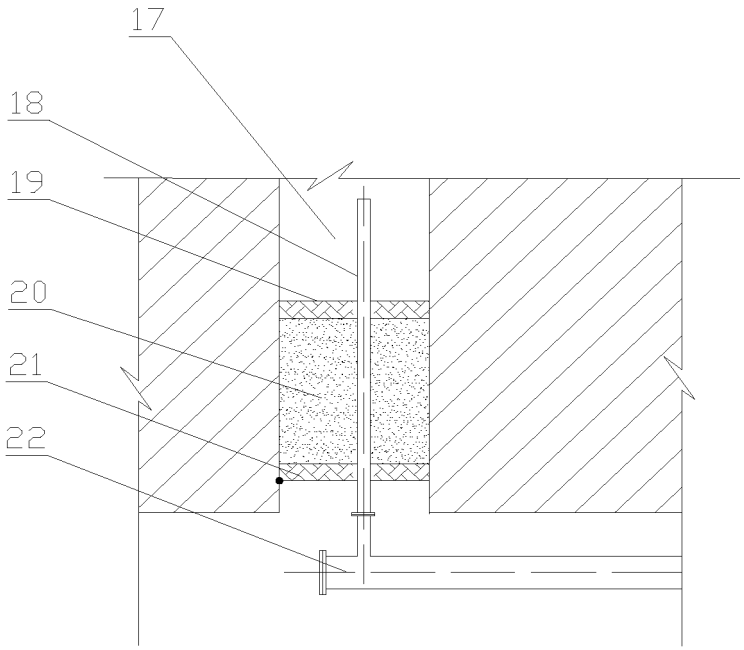

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/082635

A. CLASSIFICATION OF SUBJECT MATTER

E21F 7/00 (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)

E21F

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)

CNKI; CNTXT; CNABS; DWPI; SIPOABS: 报废, 废弃, 煤矿, 巷道, 井, 瓦斯, 甲烷, 煤层气, 抽, 排, 采, 封堵, 墙, 水, abandon+, wast+, min+, tunnel, bord, well, gas, methane, extract+, remov+, degass, drainag+, plug+, block+, wall, water

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 107035401 A (CECEP NINGXIA NEW ENERGY RESOURCES JOINT STOCK CO., LTD.), 11 August 2017 (11.08.2017), claim 1	1
A	CN 105715293 A (XI'AN HUIKE GEOLOGICAL TECHNOLOGY SERVICES CO., LTD.), 29 June 2016 (29.06.2016), description, paragraph 0008	1
A	CN 101476483 A (DU, Zhi'gang), 08 July 2009 (08.07.2009), entire document	1
A	CN 103670497 A (DATONG COAL MINE GROUP CO., LTD.), 26 March 2014 (26.03.2014), entire document	1
A	RU 2012150991 A (IKONNIKOV, Y.A. et al.), 10 June 2014 (10.06.2014), entire document	1

☐ 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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"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
14 May 2018	04 June 2018
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 BAI, Yulan Telephone No. 62085531

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/082635

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 107035401 A	11 August 2017	None	
CN 105715293 A	29 June 2016	None	
CN 101476483 A	08 July 2009	None	
CN 103670497 A	26 March 2014	None	
RU 2012150991 A	10 June 2014	None	

Form PCT/ISA/210 (patent family annex) (January 2015)