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[54] **METHOD OF CONTROLLING GAS
ACCUMULATION IN UNDERGROUND
MINES**

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[58] Field of Search 299/2, 10, 12, 4; 166/308,
166/271

[56] **References Cited****UNITED STATES PATENTS**

1,867,758	7/1932	Ranney	299/2
2,508,949	5/1950	Howard	299/2

3,058,730	10/1962	Bays	299/4
3,743,355	7/1972	Blackwell et al.	299/12

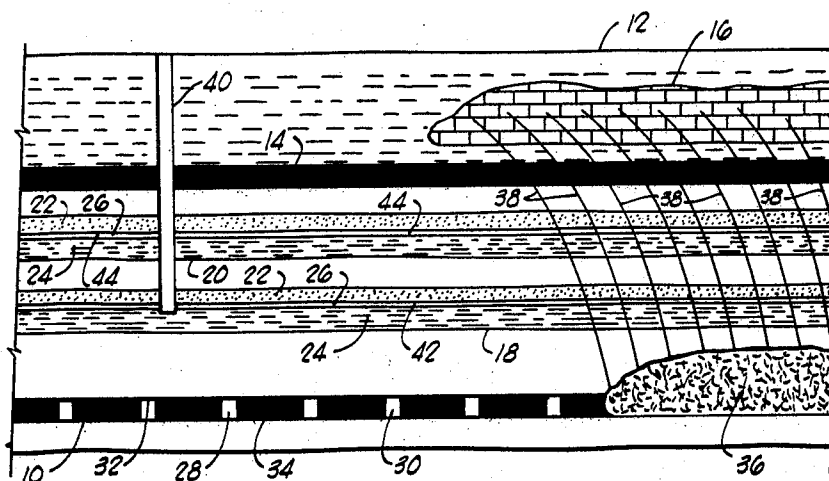
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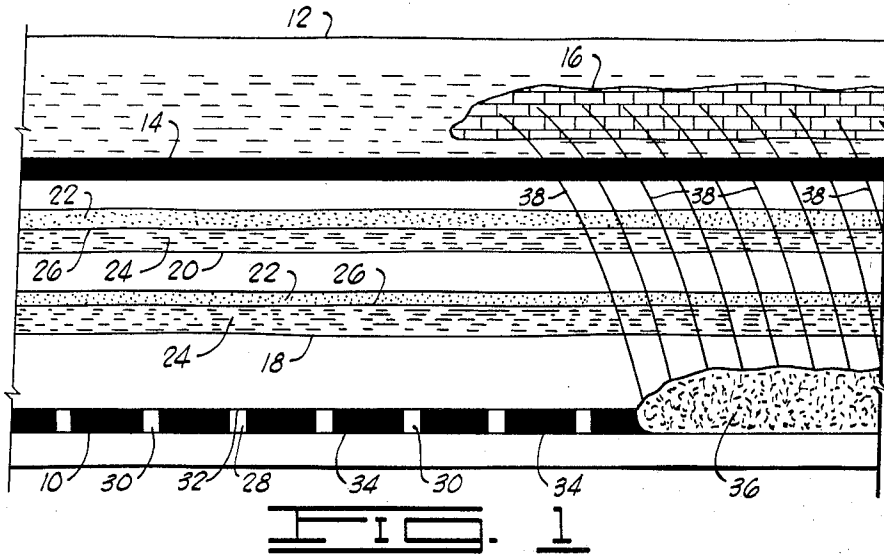
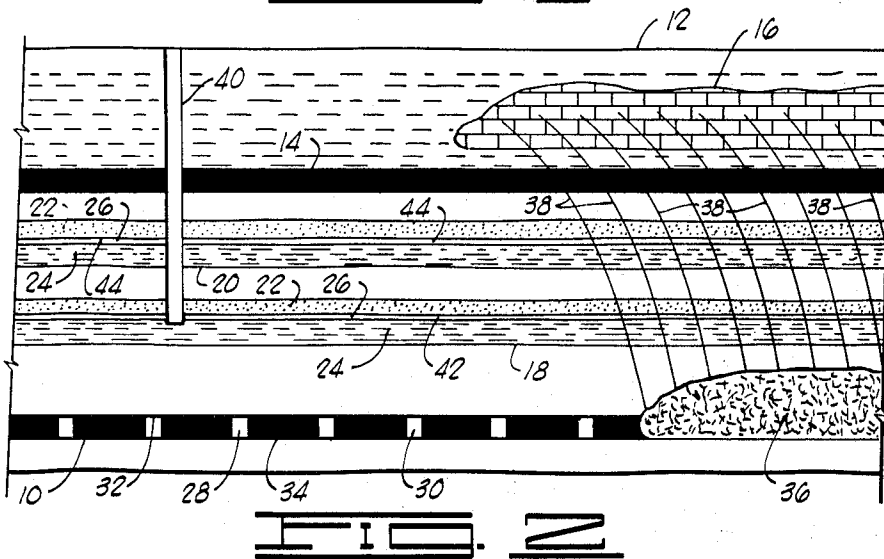
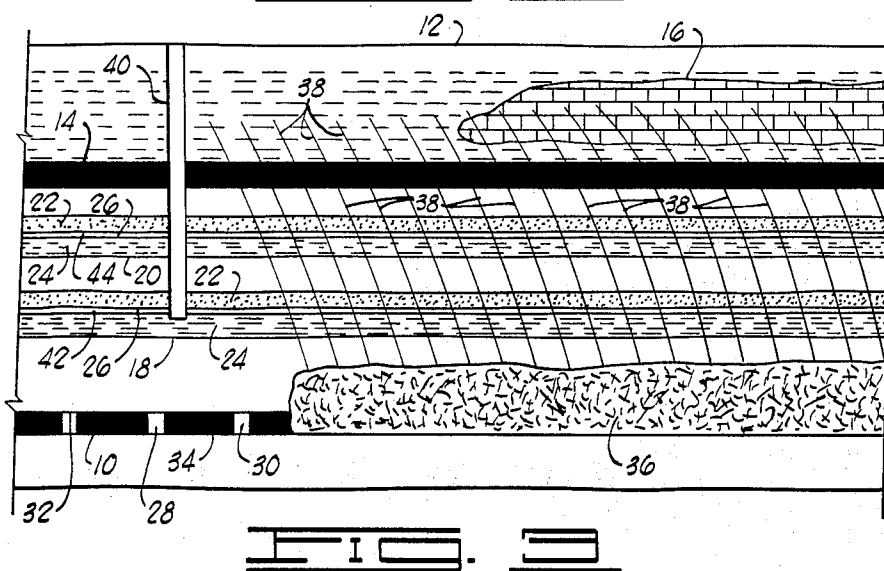
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[57] **ABSTRACT**

A method of preventing gas communication between a gas producing formation and a mine passage located therebelow. The method includes the drilling of a well bore into a fracturable rock formation disposed between the gas producing formation and the mine passage. The rock formation is then fractured and the fracture formed thereby is extended to the extent that the shear cracks to be formed by the subsidence of the overburden due to the collapse of the roof of the mine passage during the mining operation will intersect the extended fracture. Gas from the gas producing formation is allowed to flow through the shear cracks in the overburden to and through the fracture to the well bore where it is then vented to the atmosphere or otherwise suitably produced.

10 Claims, 3 Drawing Figures





METHOD OF CONTROLLING GAS ACCUMULATION IN UNDERGROUND MINES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the control of mine gas, and more particularly, but not by way of limitation, to a method of preventing gas communication between a gas producing formation and an underground mine passage located therebelow.

2. Description of the Prior Art

Customary methods of controlling methane or other naturally occurring gasses to prevent the formation of explosive gas/air mixtures within underground mines involve the use of large quantities of ventilating air to sweep out the methane gas, or the like, in concentrations of less than two percent methane gas. The lower explosive limit is generally considered to be five percent methane gas. Such practice has been reasonably successful in the case of the construction of development tunnels where all parts of the mined area are readily accessible and the ventilating air can be readily directed as desired.

The prior art practices have not, however, been as successful during the major extraction phase when the roof of the mine passage is allowed to collapse and large areas of rubble are permitted to form. These rubble areas are generally called "gob."

The buildup of methane gas or the like is usually controlled in one of two ways. In the first method, the gob is left open around the edges and openings called bleeder entries are left to carry off the gas in dilution with fresh air as it is forced from the gob by its own pressure together with the pressure of the conventional ventilation system. Under the second method, the gob is sealed using permanent stoppings formed of concrete block or some similar construction material.

Both current methods of gob gas control are considered very difficult to utilize because of restrictions set forth in recent federal coal mine safety legislation which limit concentrations of methane gas or the like to two percent or less in any accessible entries. Because of this difficulty, several coal companies are attempting to solve the gob gas problem by drilling vertical boreholes to the mine from the ground surface. These boreholes or wells tap the gas accumulation and produce it directly to the surface in order to reduce the methane concentrations in the ventilation system. This technique can be quite effective, but has been only moderately successful since only about 33 percent of the wells have been good.

One current method of completing a vertical well bore for gob gas control initially calls for drilling a hole to a point near the top of the coal seam being mined. This hole is drilled prior to the time subsidence of the overburden occurs resulting from the collapse of the mine passage roof. Next, a string of pipe is run down the well bore. The pipe string is solid at its upper portion and is slotted at its lower portion. The solid section of the pipe string is long enough to cover the water bearing strata near the surface of the ground and the annular space between the solid section of the pipe string and the well bore is filled with cement. The slotted section of the pipe string is positioned adjacent to the strata which are expected to yield gas as these strata are cracked during subsidence of the overburden.

SUMMARY OF THE INVENTION

The present invention is directed to a method of preventing gas communication between a gas producing formation and a mine passage having a roof and lying in a position below the gas producing formation, with at least one fracturable rock formation interposed between the gas producing formation and the mine passage, when the roof of the mine passage is allowed to collapse during the mining operation thereby forming shear cracks in the overburden communicating between the gas producing formation and the mine passage resulting from subsidence of the overburden. The method comprises the steps of drilling a well bore into a selected fracturable rock formation; fracturing the selected rock formation to form a fracture therein intermediate the gas producing formation and the mine passage and communicating with the well bore, so that the shear cracks formed by allowing the roof of the mine passage to collapse will intersect the fracture; and allowing gas from the gas producing formation to flow from the gas producing formation through at least one shear crack communicating between the gas producing formation and the fracture, and through the fracture to the well bore.

It is, therefore, an object of the present invention to provide an effective method for controlling the accumulation of methane gas or the like in underground mines such as coal mines which is more efficient and economical than prior methods.

Another object of the present invention is to provide an effective method for preventing the communication of methane gas or the like between a gas producing formation and a mine passage located therebelow when the roof of the mine passage is allowed to collapse during extensive mining operations.

A further object of the present invention is to provide a method for preventing the accumulation of undesirable gasses such as methane gas in underground mines in concentrations of an unsafe and illegal amount.

Other objects and advantages of the present invention will be evident from the detailed description when read in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a horizontal schematic sectional view depicting a mining operation illustrating the formation of shear cracks into the overburden as the roof of the mine passage is allowed to collapse.

FIG. 2 is a horizontal sectional view similar to FIG. 1 illustrating the application of the present invention thereto.

FIG. 3 is a horizontal sectional view similar to FIG. 2 illustrating a large number of shear cracks intersecting the fractures as the mining operation in the mine passage is continued.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and to FIG. 1 in particular, there is illustrated therein a typical coal mining operation. A first coal seam 10 is shown beneath the ground surface 12. A second coal seam 14 is also shown disposed between the first coal seam 10 and the ground surface 12. As is well known, coal seams are typically gas producing formations in which methane gas, among others, is present.

Another gas producing formation is illustrated at 16 and may typically be formed of limestone or sandstone. Intermediate the coal seams 10 and 14 are first and second fracturable rock formations 18 and 20. Each of these rock formations may suitably comprise a layer of tight sandstone 22 overlying a layer of unfractured shale 24, these layers being separated by a bedding plane 26. It will be noted that the bedding plane 26 in each of the rock formations 18 and 20 extends between the first coal seam 10 and the two gas producing formations 14 and 16.

The coal seam 10 includes a mine passage 28 which is formed during the first mining in the development phase of the coal seam 10. The mine passage 28 may typically be formed by utilizing the room and pillar technique. In the first mining operation rooms 30 are formed in the coal seam 10 by removing a portion of the coal from the coal seam. The roof 32 of the mine passage 28 is supported by pillars 34 of coal which are not removed during the first mining operation.

It should be understood that while the mine passage 28 is described as being formed by the room and pillar method, the method of the present invention will find suitable application in other forms of underground mining such as the form known as the longwall technique.

After the first mining operation is completed, it is common practice to mine the coal in the supporting pillars 34 and allow the roof 32 to progressively collapse. When the roof is allowed to collapse a rubble zone or gob 36 is formed in the mine passage 28. As a result of the collapse of the roof 32 the overburden is left partially unsupported and is subject to subsidence. During subsidence, substantially vertical shear cracks 38 are formed in the various strata in the overburden, many of which provide gas communication between the rubble zone 36 and the gas producing formations 14 and 16. High pressure methane gas, or the like, will then flow from the gas producing formations 14 and 16 through the shear cracks 38 to the gob 36, thereby introducing undesirable gasses into the mine passage 28. This situation is most clearly illustrated in FIG. 1.

The method of the present invention is directed to the prevention of gas communication between the gas producing formations 14 and 16 and the gob 36 in the mine passage 28 as described above. Referring now to FIGS. 2 and 3, a borehole 40 is drilled by conventional methods from the ground surface 12 into the overburden above the mine passage 28 as the first step of the method of the present invention. The borehole or well 40 is sunk to a depth such that it intersects the fracturable rock formations 18 and 20. Suitable casing is positioned in the borehole 40 and cemented in place. The formation 18 is then fractured and propped open at the bedding plane 26 by a suitable fracturing method, such as hydraulic fracturing. Hydraulic fracturing is a well known technique and therefore need not be described in detail herein.

The fracturing of the rock formation 18 forms a substantially horizontal fracture 42 along the respective bedding plane 26. By the application of additional hydraulic pressure, the fracture 42 is extended to the point that any shear cracks 38 to be later formed by the subsidence of the overburden resulting from the collapse of the roof 32 of the mine passage 28 will intersect the fracture 42. It is desirable to utilize high viscosity fracturing fluids for extending the fracture 42 so

that suitable propping agents may be readily dispensed throughout the fracture 42 thereby maximizing the fracture opening when the fracturing fluid is removed from the fracture.

The high viscosity property of the fracturing fluids should be of a temporary nature (as a cellulose base, biodegradable fluid for instance) in order that the low pressures in the gas zone can displace it from the fracture.

When the fracturing fluid is removed from the fracture 42, the pillars 34 may then be mined or robbed thereby removing a portion of the support of the roof 32. As the roof 32 progressively collapses, due to removal of the supporting pillars 34, forming the rubble zone or gob 36, the shear cracks 38 are formed in the overburden strata communicating between the gas producing formations 14 and 16 and the fracture 42. The gas from the gas producing formations 14 and 16 is then allowed to flow through the shear cracks 38 to the fracture 42, and through the fracture 42 to the borehole 40 where the gas may be vented to the atmosphere or otherwise suitably produced and disposed of.

In a similar manner, the bedding plane 26 of the fracturable rock formation 20 may also be fractured and propped as described above, forming an additional fracture 44 along the respective bedding plane 26. Such additional fracturing will provide additional flow paths for the gas emanating from the gas producing formations 14 and 16 and flowing through the shear cracks 38 and into the fracture 44 formed in the rock formation 20, to flow through the fracture 44 to the borehole 40.

As clearly illustrated in FIG. 3, successive mining or robbing of the pillars 34 results in progressive collapse of the roof 32 and increased formation of gob 36 in the mine passage 28 and occurrence of shear cracks 38 in the overburden strata.

It is important to note that the fracturing of the fracturable rock formations 18 and 20 should be performed prior to the secondary mining operation or robbing of the pillars 34 so that maximum extension of the fractures 42 and 44 will be obtained. It is well known that a hydraulically formed fracture usually cannot be extended beyond the first major crack encountered since such a major crack would absorb virtually all the applied hydraulic force. The shear cracks 38 formed during the subsidence of the overburden strata have been found to extend several hundred feet above a coal seam being mined.

While we have disclosed the employment of multiple fractures per well, it is believed that a single fracture as described above would be sufficient in most cases. In practicing the method of the present invention, it is believed most advantageous to select for fracture the fracturable rock formation nearest the roof of the coal seam being mined so that, as nearly as possible, only those shear cracks in communication with the mine passage would be tapped by the fracture formed therein. It should also be noted that additional boreholes may be sunk in the overburden communicating with the fractures formed therein for the purpose of extending these fractures over a wider area.

From the foregoing detailed description of the method of the present invention, it may be seen that the present invention readily obtains the objectives set forth herein. Changes may be made in the arrangement or combination of apparatus or the specific techniques

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employed in practicing the method of the present invention as described in the drawings and the specification without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A method of preventing gas communication between a gas producing formation and a mine passage having a roof and lying in a position below the gas producing formation, with at least one fracturable rock formation interposed between the gas producing formation and the mine passage, when the roof of the mine passage is allowed to collapse during the mining operation thereby forming shear cracks in the overburden communicating between the gas producing formation and the mine passage resulting from subsidence of the overburden, comprising the steps of:

drilling a well bore into a selected rock formation; fracturing the selected rock formation to form a fracture therein intermediate the gas producing formation and the mine passage and communicating with the well bore, so that the shear cracks formed by allowing the roof of the mine passage to collapse will intersect the fracture; and

allowing gas from the gas producing formation to flow from the gas producing formation through at least one shear crack communicating between the gas producing formation and the fracture, and through the fracture to the well bore.

2. The method as defined in claim 1 wherein the step of fracturing the rock formation is characterized further as including the application of hydraulic pressure to the rock formation.

3. The method as defined in claim 1 characterized further to include the additional steps of:

fracturing at least one additional fracturable rock formation to form a fracture therein intermediate the gas producing formation and the mine passage and communicating with the well bore so that shear cracks formed by allowing the roof of the mine passage to collapse will intersect the additional fracture; and

allowing gas from the gas producing formation to flow through at least one shear crack communicating between the gas producing formation and the additional fracture, and through the additional fracture to the well bore.

4. The method as defined in claim 1 characterized further to include the additional step of:

extending the fracture to the extent that at least a portion of the shear cracks formed by the subsidence of the overburden resulting from the collapse of the roof of the mine passage will intersect the extended fracture.

5. The method as defined in claim 4 characterized further to include the additional step of:

propping the extended fracture with a propping agent

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to retain the fracture in an open condition and facilitate gas flow therethrough.

6. A method of preventing gas communication between a gas producing formation and an underground mine passage having a roof and extending beneath the gas producing formation, with at least one fracturable rock formation interposed between the gas producing formation and the mine passage, when the roof of the mine passage is allowed to collapse during mining operations, thereby forming shear cracks in the overburden communicating between the gas producing formation and the mine passage resulting from subsidence of the overburden, comprising the steps of:

drilling a borehole into a selected fracturable rock formation;

fracturing the selected rock formation to form a fracture therein communicating with the borehole;

extending the fracture to the extent that at least a portion of the shear cracks to be formed by the subsidence of the overburden resulting from the collapse of the roof of the mine passage will intersect the fracture; and

allowing gas from the gas producing formation to flow through at least one shear crack communicating between the gas producing formation and the fracture, and through the fracture to the borehole.

7. The method as defined in claim 6 characterized further to include the additional step of:

propping the extended fracture with a propping agent to retain the fracture in an open condition and facilitate gas flow therethrough.

8. The method as defined in claim 6 wherein the step of fracturing the rock formation is characterized further as including the application of hydraulic pressure to the rock formation.

9. The method as defined in claim 6 characterized further to include the additional steps of:

fracturing at least one additional fracturable rock formation to form a fracture therein communicating with the borehole;

extending each additional fracture to the extent that at least a portion of the shear cracks to be formed by the subsidence of the overburden resulting from the collapse of the roof of the mine passage will intersect each additional fracture; and

allowing gas from the gas producing formation to flow through at least one shear crack communicating between the gas producing formation and each additional fracture, and through each additional fracture to the borehole.

10. The method as defined in claim 6 characterized further to include the additional step of:

producing the gas from the borehole.

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