

July 24, 1951

F. SQUIRES
PROCESS FOR PREPARING COAL VEINS FOR GASIFICATION
BY REMOVAL OF UNDERLYING CLAY

2,561,639

Filed June 29, 1949

3 Sheets-Sheet 1

Fig. 1.

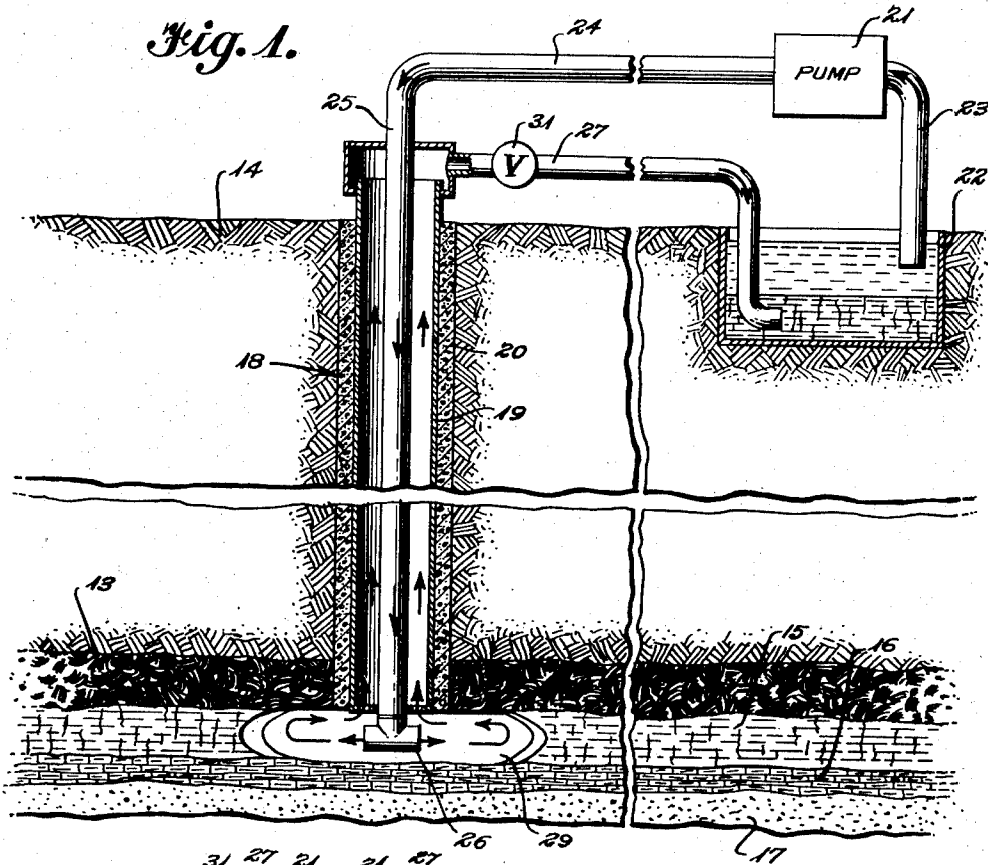


Fig. 2.

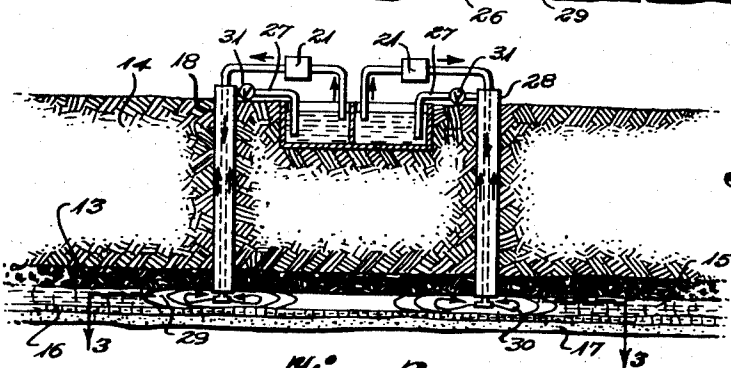
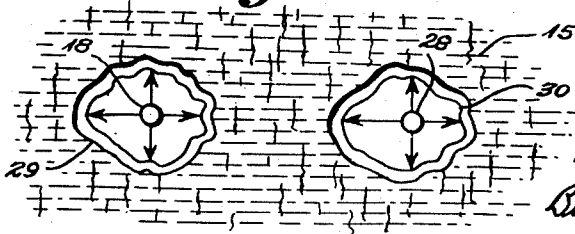


Fig. 3.



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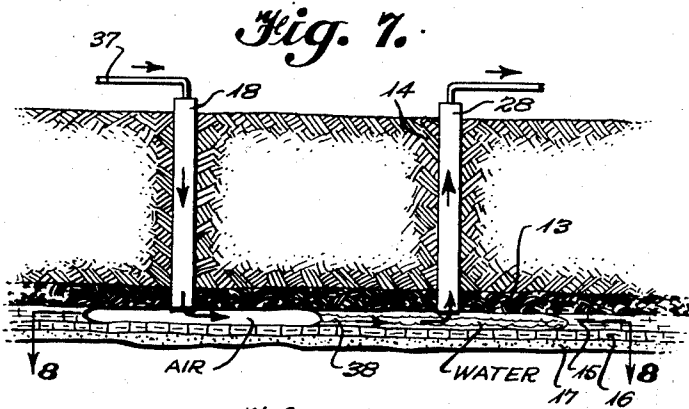
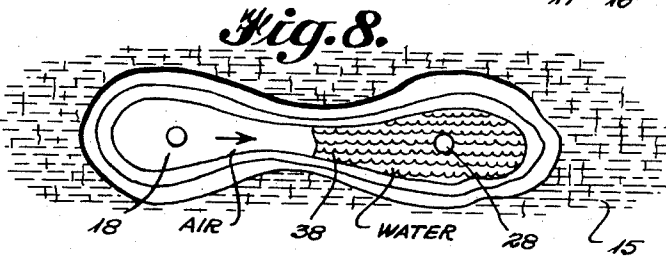
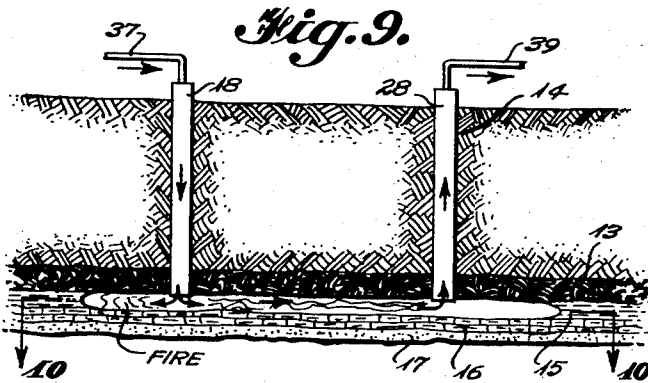
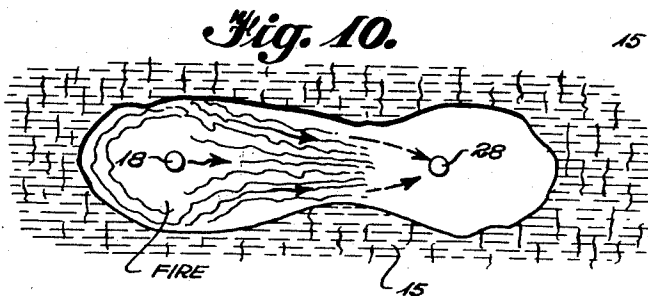
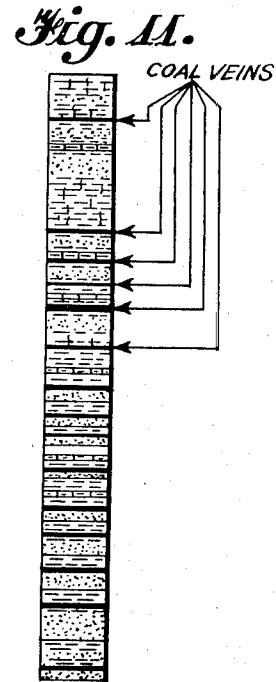
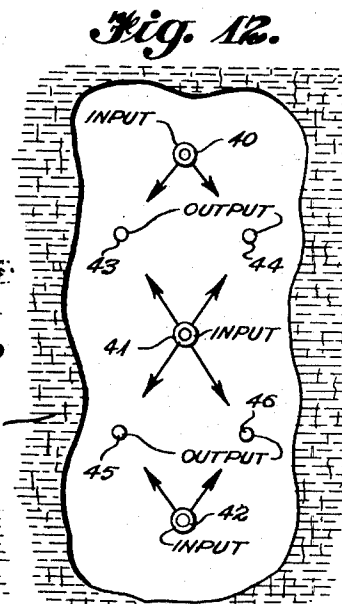
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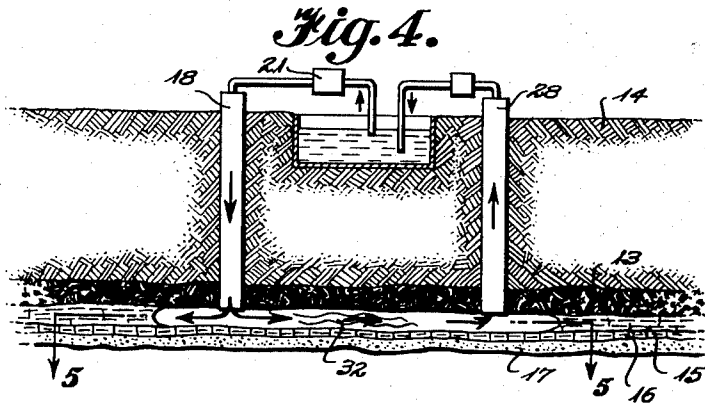
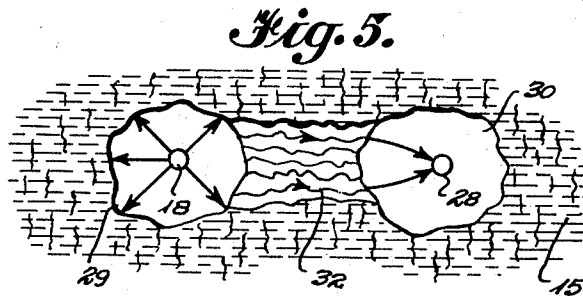
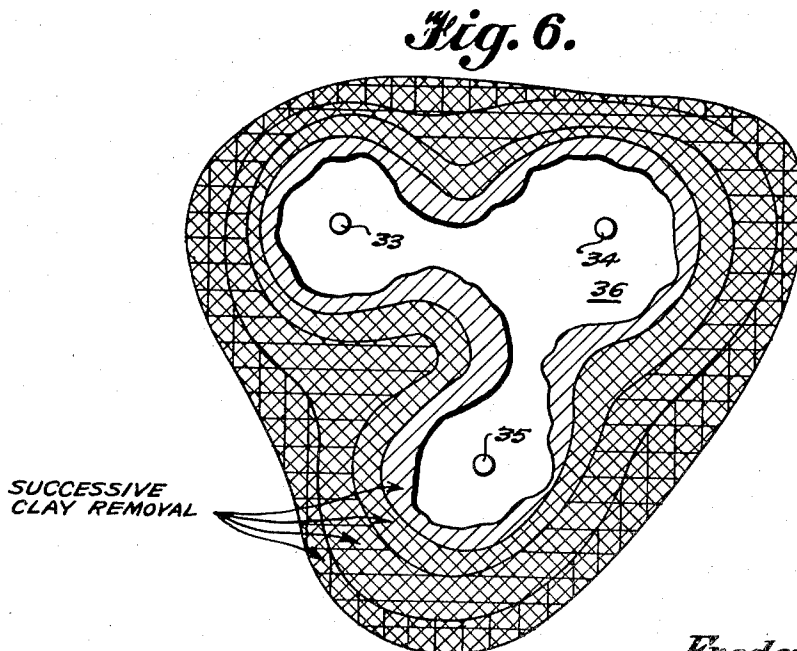
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,561,639

PROCESS FOR PREPARING COAL VEINS FOR
GASIFICATION BY REMOVAL OF UNDER-
LYING CLAY

Frederick Squires, Champaign, Ill.

Application June 29, 1949, Serial No. 101,997

4 Claims. (Cl. 262-1)

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The present invention relates to a process for preparing coal veins for gasification in situ in the earth by removal of the clay underlying the coal veins to expose the undersurfaces of the coal veins. Gasification of coal in situ in the earth requires an inlet for air or other combustion supporting gas, a fire in the coal and an outlet for the gaseous products. It has heretofore been proposed to dig an inlet shaft from the surface of the earth to the coal vein, to form a tunnel through the coal vein, and to dig a second shaft from the surface of the earth to the end of the tunnel opposite the inlet shaft, this second shaft forming an outlet for the gaseous products. In the practice of this prior proposal the coal is burned along the sides of the tunnel. Combustion of the coal results in formation of ash which soon smothers combustion and tends to choke the tunnel. Insufficient coal is exposed for combustion to justify the expense of forming the inlet and outlet shafts and the tunnel through the coal vein.

My invention relates to a procedure or process which overcomes the difficulties outlined above and which greatly reduces the cost of preparing coal veins for gasification. My process involves the drilling of two or more horizontally spaced wells from the surface of the earth through the coal vein and into the clay underlying the vein. The clay immediately underlying most coal veins is readily water dispersible and by discharging water laterally from the wells into this clay I am able to form large cavities or voids surrounding the wells and immediately underlying the coal vein. Water under high pressure can then be introduced into the bottom of one or more of the wells and this pressure forces breaks in the remaining clay between the wells which has not already been removed. I then flow water between the wells through the breaks and additional clay is dispersed to enlarge the breaks and to form passageways between the wells. The roof of the voids surrounding the wells and of the communicating passageways between wells is formed by the lower surface of the coal vein. This surface of the coal vein can be exposed for combustion by removing the water from the wells and from the voids and passageways in the underlying clay. The lower surface of the coal vein can then be ignited and combustion will proceed from the bottom of the vein upwardly therethrough. Ash formed by combustion will not close the voids and passageways for the reason that depletion of the coal by combustion increases the height or thickness of the voids and passageways. Large areas of the

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undersurface of the coal vein are exposed by my process and combustion over these substantial areas proceeds readily because of the fact that the combustion occurs at the lower surface of the coal.

Among the objects of my invention are to provide a simple and inexpensive procedure for preparing coal veins for gasification in situ in the earth, to provide a procedure which can be practiced with readily available equipment which is inexpensive, to provide a process which exposes large areas of the undersurface of the coal veins for efficient combustion and to provide a process which recovers large quantities of clay which is suitable for manufacture of fire bricks in a location where combustible gases are available for burning the bricks.

The foregoing and other objects and advantages of the invention will be more fully understood from the following detailed description which has reference to the accompanying drawings wherein:

Fig. 1 is a vertical sectional view showing the manner in which voids are formed in the water dispersible clay underlying the coal vein and illustrating suitable apparatus for forming these voids;

Fig. 2 is a vertical sectional view comparable to Fig. 1 showing the manner in which the voids are simultaneously produced beneath the coal vein around two horizontally spaced wells;

Fig. 3 is a horizontal sectional view taken in the direction of the arrows along the line 3-3 of Fig. 2;

Fig. 4 is a vertical sectional view illustrating the manner in which a break is forced through the clay underlying a coal vein between horizontally spaced wells and also illustrating the manner in which the break is enlarged to form a passageway between these wells;

Fig. 5 is a horizontal sectional view taken in the direction of the arrows along the line 5-5 of Fig. 4;

Fig. 6 is a horizontal sectional view through the clay underlying a coal vein and illustrates three horizontally spaced wells which have been placed in communication with each other by my process;

Fig. 7 is a vertical sectional view illustrating one procedure which is suitable for removing the water from the voids and passageways beneath the coal vein to expose the lower surface of the coal vein for combustion;

Fig. 8 is a horizontal sectional view taken in the direction of the arrows along the line 8-8 of Fig. 7;

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Fig. 9 is a vertical sectional view illustrating the manner in which combustion occurs along the exposed lower surface of the coal vein;

Fig. 10 is a horizontal sectional view taken in the direction of the arrows along the line 10—10 of Fig. 9;

Fig. 11 illustrates a geologic column showing a typical sequence of coal veins in a coal basin; and

Fig. 12 is a horizontal sectional view illustrating a suitable arrangement of input and output wells communicating with a void underlying a coal vein.

The reference numeral 13 designates a subterranean coal vein covered by the earth formation 14. Such a coal vein usually overlies an underclay 15 of readily water dispersible clay which is suitable for the manufacture of fire bricks. Beneath the underclay 15 there is usually a stratum of calcareous clay 16 which is not water dispersible to any appreciable extent. A stratum of limestone 17 conventionally underlies the calcareous clay 16.

A well bore 18 is drilled through the earth formation 14 and the coal vein 13 into the stratum of water dispersible clay 15. The well bore is preferably provided with a casing 19 which may be surrounded by a layer 20 of fire-proof cement. A pump 21, which may be of the type known in the drilling art as a mud pump, pumps water from near the upper surface of a settling tank 22 through an inlet pipe 23, an outlet pipe 24 and a tubing 25 which extends through the casing 19 to the bottom of the well. The lower end of the tubing 25 is provided with any suitable nozzle means for directing jets of water horizontally against the stratum of water dispersible clay 15. The nozzle means is designated by the reference numeral 26 and preferably includes some suitable means for rotation to cause the horizontal jets to impinge on the clay strata 15 in all horizontal directions from the well.

Jets of water from the nozzle means 16 strike the stratum 15 of water dispersible clay and the clay becomes dispersed in the water. Any suitable agents may be added to the water to increase the amount of clay becoming dispersed through the mechanical action of contact of the jets of water. Gas may be entrained in the water to increase agitation at the bottom of the well if this seems desirable. Water with clay dispersed therein flows upwardly in the annular space between the casing 19 and the tubing 25 and is discharged through a conduit 27 to the bottom of the settling tank 22. Any conventional agent may be added to the settling tank 22 to facilitate or expedite settling or flocculation of the water dispersed clay.

Figs. 2 and 3 illustrate the well 18 and a similar well 28 laterally spaced therefrom. The well 28 is preferably also provided with the equipment described above. The water jets form a void 29 in the water dispersible clay 15 at the bottom of the well 18 and a similar void 30 at the bottom of the well 28. As the voids 29 and 30 become larger, the distance between the adjacent edges of the voids becomes less, as will be apparent from Fig. 3. This distance will eventually become sufficiently small that it is possible to force a break through the clay stratum 15 by increasing the pressure at the bottom of one or both wells. The pressure at the bottom of the wells can be increased by closing the valves 31 in the outlet conduits 27 while the pumps 21 continue to operate. The break will usually take

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the form of a generally horizontal fissure through the clay stratum. This break permits initial limited flow of water from the void 29 to the void 30 or vice versa.

Figs. 4 and 5 illustrate the manner in which the break can be enlarged to expose additional portions of the undersurface of the coal vein 13. The pump 21 associated with the well 18 is permitted to continue operation, while the corresponding pump 21 associated with the well 28 is not functioning. Clay which forms the walls of the break becomes dispersed in the water flowing through the break and the break gradually enlarges to form the passageway 32. A large volume of clay is thus removed from beneath the coal vein.

In some instances the voids 29 and 30 may be enlarged by the jets of water from the wells to an extent sufficient to cause them to overlap or communicate with each other. In the instances the use of water pressure to force a break through the clay will be unnecessary.

Fig. 6 illustrates my process as applied to three horizontally spaced wells which are designated by the reference numerals 33, 34 and 35. Generally circular voids are first formed in the water dispersible clay surrounding each of these wells in the manner described above. The pressure in one or more of the wells may then be increased to form the initial breaks through the water dispersible clay and flow of water between the wells can then be relied upon to form the passageways connecting these wells. The differences in the degree of shading in Fig. 6 illustrate various stages in the progress of removal of the water dispersible clay from beneath the coal vein. The unshaded area 36 has already had the clay removed therefrom and the area from which the clay becomes removed will gradually increase in size as the circulation of water around and between the wells continues.

Figs. 7 and 8 illustrate one suitable method for driving the water from the voids at the bottom of a pair of wells and from the passage connecting those voids. Compressed air is introduced into the well 18 through a conduit 37. This compressed air will drive the water 38 from the voids and passageways and outwardly through the well 28. Removal of the water exposes the undersurface of the coal vein.

Figs. 9 and 10 illustrate the manner in which combustion proceeds on the exposed lower face of the coal vein. Combustion is started in any suitable manner on the lower surface of the coal vein adjacent the well 18. Air or other combustion supporting gas is introduced into the well 18 through the conduit 37. The products of combustion pass upwardly through the well 28 and are conveyed through the conduit 39 to suitable collecting and recovering apparatus not shown.

The nature or character of the products of combustion can be controlled by controlling the amount of combustion supporting gas supplied through the well 18. The earth formation provides excellent heat insulation and considerable heat can be applied to the coal vein with a minimum of actual active combustion of the coal. The temperature of the coal vein can be controlled by controlling the fire and many valuable products can be derived from the coal and recovered in the gaseous products which are vented through the well 28. The fire-proof cement 20 which surrounds the casings of the wells prevents excessive loss of heat from the

hot gaseous products and thus prevents trouble from condensation.

The clay which is recovered by my process is suitable for manufacture of fire bricks. The gasification of the coal produces inflammable gases which are available for firing the bricks. The clay and the fuel for burning the bricks are thus available at the same site.

I have heretofore described my process as it is used for gasification of a single coal vein. Fig. 11 illustrates a geologic column which includes a plurality of coal veins at different levels. These coal veins are shown as separated by layers of water dispersible clay, calcareous clay and limestone. My process as described above may be used to expose the lower surface of the uppermost coal vein and the process may then be repeated on successively lower coal veins. Alternatively, the process of the invention can be used to expose the lower surface of plurality of coal veins simultaneously. Gasification of the coal veins may then proceed successively or concurrently. Heat evolved during gasification of one coal vein will aid in the concurrent or subsequent gasification of other coal veins in the formation. It is advantageous to remove the clay from beneath the uppermost coal vein first for the reason that the void thus produced reduces the overburden over lower veins and facilitates forming the breaks through the clay underlying lower coal veins.

Fig. 12 illustrates a suitable arrangement of input and output wells for gasification of a coal vein overlying the clay strata 15. After combustion has been started air or other combustion supporting gas is introduced through the input wells 40, 41 and 42, and the gaseous products are vented through the output wells 43, 44, 45 and 46. Other arrangements of input and output wells may be used and that illustrated in Fig. 12 is given by way of example only.

The layer of water dispersible clay underlying a coal vein is usually thin and since it overlies a layer of calcareous clay which is not readily dispersible by water, the amount of material which must be removed to expose the undersurface of the coal vein is relatively small. It sometimes happens that the strata of calcareous clay is missing and in those instances the water dispersible clay immediately overlies the limestone. The limestone is not appreciably dispersed by water so in these instances the water dispersible clay strata is all the material that need be removed to expose the undersurface of the coal vein.

I have illustrated and described what I now consider to be the preferred process for practicing my invention. It is to be understood, however, that various alterations and modifications may be resorted to without departing from the broader scope of my invention as defined by the following claims.

Having thus described my invention, I claim:

1. A process for preparing coal for gasification in situ in the earth which comprises drilling a

pair of horizontally spaced wells through an underground coal vein into the clay stratum underlying said coal vein, discharging water laterally from each well into said clay stratum to disperse the clay surrounding the well, flowing the water dispersed clay upwardly through the wells, increasing the pressure of the water in at least one of said wells to force a break in the remaining clay between said wells, flowing water from one well to the other through such break to form an enlarged passageway between said wells, and displacing the water in said wells and said passageway by air to support combustion along the undersurface of the coal vein.

2. A process for preparing coal for gasification in situ in the earth which comprises drilling a plurality of spaced wells through an underground coal vein into the water dispersible clay stratum underlying said coal vein, discharging water laterally from each well into said clay stratum to disperse the clay and to form a void around each well beneath the coal vein, flowing the water dispersed clay upwardly through the wells, increasing the pressure in at least some of said voids to force breaks in the clay remaining between said voids, flowing water between wells through such breaks to disperse additional clay and to form enlarged passageways between said voids, and displacing with air the water in said voids and passageways to support combustion along the undersurface of the coal vein.

3. A process for preparing a plurality of vertically spaced coal veins for gasification in situ in the earth which comprises drilling a plurality of spaced wells through said coal veins and through the water dispersible clay strata underlying said coal veins, discharging water laterally from each well into said clay strata to disperse the clay and to form voids around each well beneath each coal vein, flowing the water dispersed clay upwardly through the wells, increasing the pressure in at least some of said wells to force breaks through the clay remaining between the voids, flowing water through such breaks to disperse additional clay and to form enlarged passageways connecting the voids, and displacing the water in said voids and passageways with air to facilitate combustion along the undersurfaces of the coal veins.

4. A process for preparing coal for gasification in situ in the earth which comprises drilling a pair of spaced wells through the coal vein into the water dispersible clay stratum underlying said coal vein, discharging water laterally from each well into said clay stratum to disperse the clay and to form voids surrounding each well beneath said coal vein, flowing the water dispersed clay upwardly through the wells, continuing to disperse the clay until said voids are in communication with each other, and then displacing the water in said voids with air to facilitate combustion along the undersurface of the coal vein.

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No References Cited.