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MINING AND RETORTING OF OIL SHALE

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2 Sheets-Sheet 1

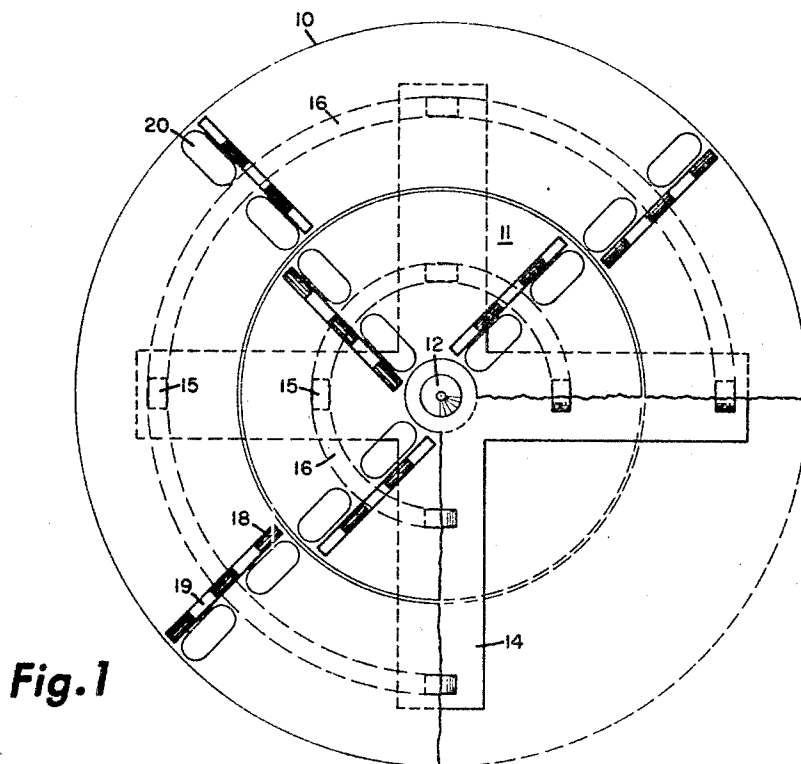


Fig. 1

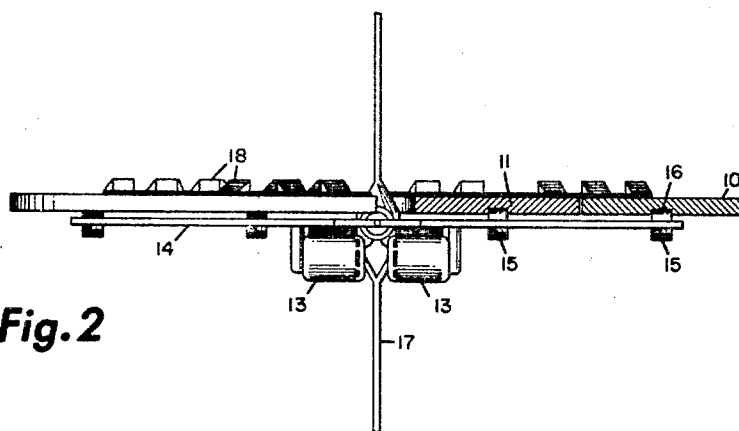


Fig. 2

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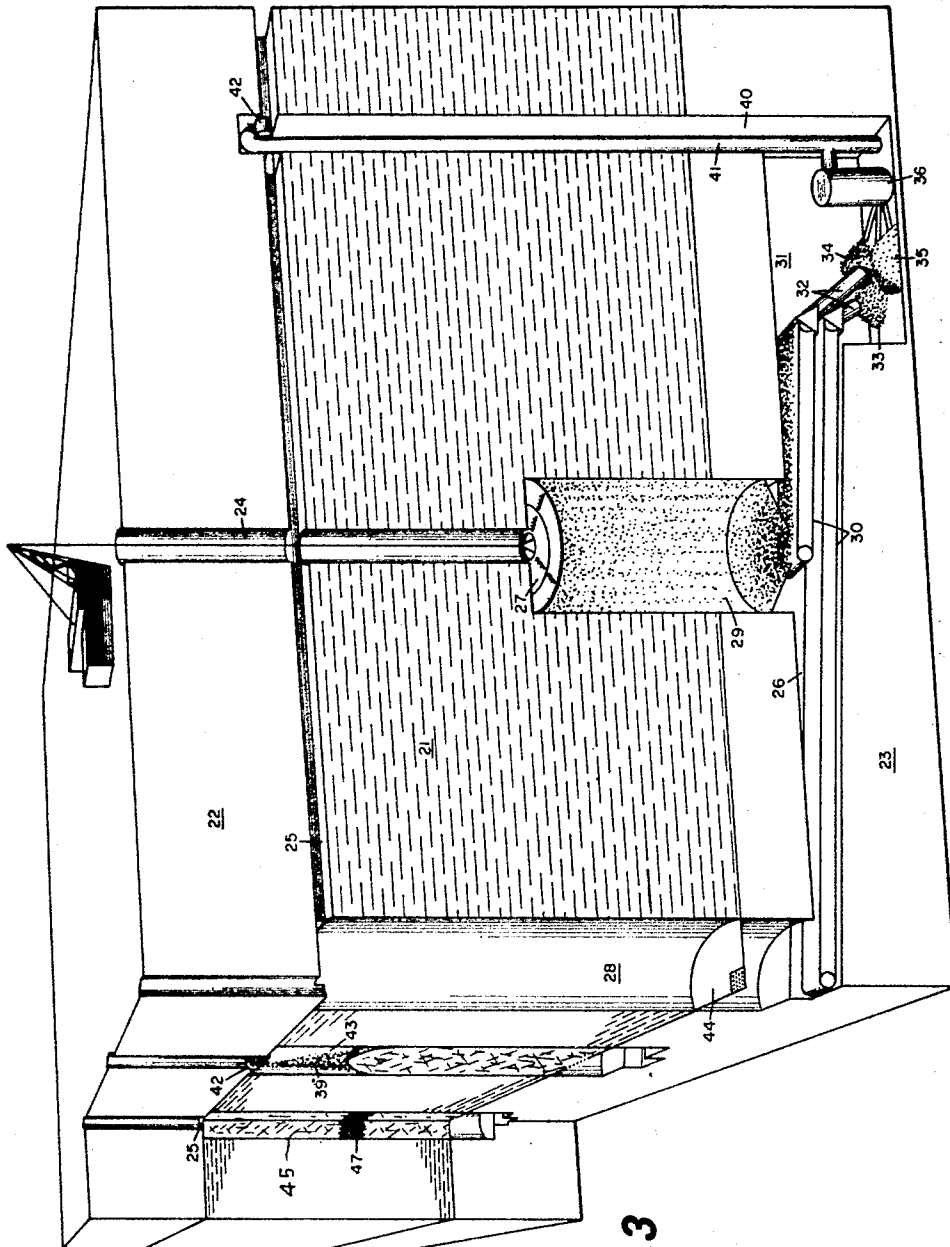


Fig. 3

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MINING AND RETORTING OF OIL SHALE

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7 Claims

ABSTRACT OF THE DISCLOSURE

Oil shale is retorted in situ by drilling a pilot hole through a shale bed, pull-through mining the shale to form a retort, and retorting the shale in situ. Lean shale is mixed with richer shales to obtain uniform retorting of the adjacent shale which forms the retort, as well as retorting of the shale within the retort.

This invention relates to the recovery of hydrocarbon from oil shales and more particularly to the preparation of in situ retorts and the retorting of shale therein.

United States Patent 3,001,776 issued to H. K. van Poollen on Sept. 26, 1961, teaches a recovery process wherein vertical retorts, terminating in cross drifts, are formed in oil shale. Shale in the retort is ignited and a combustion wave is passed through the retort to release hydrocarbons from the shale. The released oil gravitates downwardly and is collected via the cross drifts.

The Van Poollen process does not deal with the problem faced when a formation contains kerogen-lean or kerogen-rich strata which differ considerably from the norm of the formation. The present invention provides the solution to this problem and also provides a relatively inexpensive means of forming in situ retorts.

Additionally, Van Poollen taught the efficiency of mining a retort from the bottom upward. However, the problem of exerting sufficient pressure upward against a large area of rock face and through hundreds of feet of shale section has heretofore precluded mechanical mining other than the strip mining of oil shale. This invention solves that problem through use of pull-through mining procedures and equipment.

Pull-through mining is a process wherein a bore hole is drilled into a formation; a mining machine is placed on one side of the formation adjacent the section to be mined; a cable, drive shaft, or other pulling means is affixed to the mining machine; and the mining machine is pulled through the formation. Such machines are described in United States Patents 2,684,834; 2,746,719; and 2,775,439.

Described briefly in terms of one retort, the process of this invention comprises drilling a pilot hole terminating in cross drifts through an oil shale section, enlarging the pilot hole from bottom to top by pull-through mining, blending leaner kerogen shale with kerogen richer shale or other fuel, returning blended shale to the retort, and passing a combustion wave through the returned shale to retort hydrocarbons from the blended shale in the retort and the shale adjacent the retort.

The accompanying drawings aid in understanding the present invention. FIGURE 1 is a partially sectioned, plan view of a rock cutting device adapted to operate in a pull-through mining machine. FIGURE 2 is a side view of this device. FIGURE 3 depicts portions of three rows of retorts in a formation and a simplified picture of the various aspects of the mining and retorting processes.

Contrarotating cutting blades are utilized in the cutting device of FIGS. 1 and 2. As depicted, outer cutter frame 10 rotates counterclockwise while inner cutter

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frame 11 rotates clockwise to reduce rotation of the cutter device and consequent twisting of support cable 12. Oppositely disposed pairs of holddowns (not shown) can be utilized to prevent significant rotation of the miner where necessary. Sensors can also be utilized to determine twisting moments on cable 12 and to vary the speed of the drive motors so as to neutralize the torque moment. Drive motors 13 on support member 14 are connected by appropriate gearing and drive shafts to drive rollers 15 which fit into recess drive track 16. Cables 17 supply electrical energy to motors 13 from any suitable power source. Gripper teeth 18 are affixed to mounting 19 which is in turn attached to cutter frames 10 and 11 by appropriate means, such as by bolts or welding. The shale disengaged by teeth 18 is displaced downwardly through discharge ports 20.

The process is carried out in an oil shale bed 21 located between strata 22 and 23 which contain no hydrocarbon-bearing marl. Initially, a number of pilot holes 24 are drilled into the formation at intervals of about 25 to about 75 feet. Cross drifts 25 are drilled to connect pilot holes 24 at the top of shale bed 21. Cross drifts 26 are driven to connect pilot holes 24 at the bottom of shale bed 21. Pull-through miner 27 is utilized to break up the shale adjacent pilot holes 24 so as to form enlarged retorts 28. The broken shale 29 falls through discharge ports 20 onto conveyers 30 which carry the shale toward storage pit 31. One conveyer 30 is provided for each retort being excavated. Movable conveyers 32, in pit 31, direct shale 29 to the correct storage.

The marl in bed 21 is classified according to its hydrocarbon content; for purposes of illustration in three categories, i.e., lean, average, and rich; by examination of cuttings at intervals during the drilling of pilot holes 24. Conveyers 32 are positioned, from time to time, to deliver shale 29 received from conveyers 30 to a lean storage pile 33, an average storage pile 34, and rich storage pile 35 as shale 29 from a particular depth is dropped onto conveyer 30.

The shale can also be sized. A preferred size is 2—4 inches though smaller and much larger particles can be used. If the shale fracturing device does not furnish shale particles of desired size, the larger particles can be reduced in size by conventional means, for example, by crushing.

Screw conveyers then direct desired amounts of shale 29 from piles 33, 34, and 35 to mixer 36. Mixed marl 39 is then elevated through shaft 40 by screw conveyer 41 to drifts 25 where conveyers 42 direct the mixed marl into an excavated, partially filled retort 43. The marl is held in retort 43 by any suitable retaining means 44.

The mixed marl 39 dumped into retort 43 is blended so as to be sufficiently hydrocarbon-rich to provide heat, through partial combustion, sufficient to educe oil from the shale adjacent retort 43. The hydrocarbon content of the mixture of marl deposited in retort 43 varies with the fuel richness of the shale adjacent the retort and the distance between retorts. Additional solid or other fuel may be added to even a rich marl if the area adjacent the retort from which hydrocarbons are to be educed is great and the kerogen content of the shale is high.

After a retort is filled and sealed by conventional means, an oxidant, preferably air, is introduced into the retort and the marl ignited, at one end or the other, by conventional means. Both "direct" and "countercurrent" combustion processes can be utilized in carrying out this invention. If there is a considerable distance between the edges of the retorts, countercurrent combustion is preferred because of the high temperatures which remain behind the combustion zone for long periods of time. "Direct" combustion can be used where the distances between retorts are not so great.

Countercurrent combustion, generally conducted at temperatures in the range of about 700–1500° F., is depicted as progressing in retort 45. It is desirable to maintain the temperatures in and adjacent the retort below the temperatures at which the marl breaks down to yield carbon dioxide. Air is introduced into retort 45 through drift 25 and passes downwardly through marl 39 and retort 45 to combustion zone 47 which is passing upwardly through retort 45.

Combustion gases pass downwardly through retort 45 and are exhausted along with kerogen vapors and liquids, through drift 26 and thence removed to the surface through shaft 40.

A considerable amount of hydrocarbons will condense in drift 26 and tunnel 40. However, it may be desirable to cool the effluent gas stream to condense additional hydrocarbons. The gas stream may require filtration to remove hydrocarbons in the gas stream. Such a filtration can be accomplished utilizing a device such as that taught in United States Patent 3,059,393.

While the process of this invention has been described both generally and specifically, various facets of the process and equipment will now be discussed in further detail.

Appropriate gearing can be affixed in track 16 and drive gears substituted for rollers 15.

The broken shale 29 is depicted as falling onto belt conveyer 30 from whence it is deposited on an appropriate storage pile by belt conveyer 32. In an alternate procedure, the lower end of pilot holes 24 can be fixed with a hopper having a directional outlet. In this embodiment of the invention, multiple conveyer belts would be laid the entire length of drifts 26 and would be directed, at the exit end, to an appropriate storage pile. The hopper outlet would be directed from belt to belt as the kerogen density of the shale varied, thereby separating the broken shale 29 into fractions of desired kerogen content.

Screw conveyors are depicted as being used in the storage pit area and to lift the mixed marl 39 vertically. Other types of conveyers can be utilized in these situations with equal facility. Thus, a bucket conveyer can be readily substituted for screw conveyer 41.

While the process has been described in terms of retorting all of the shale in situ, a portion of the shale can be retorted aboveground. This is possible where an excess of kerogen-rich shale exists. The clinkers from the above ground retorting are used to fill shaft 40 when the operation is finished.

On completion of excavation in a row of retorts, the cross drifts necessary for the next row are drilled and the equipment moved to the new location. Cross drifts 26 are angled so as to direct combustion products downwardly toward storage pit 31 from whence the condensed hydrocarbons can be pumped by conventional means.

It is intended that these and other embodiments of our invention obvious to those skilled in the art be included within the scope of our invention as claimed.

Now having described our invention, what we claim is:

1. In a process for recovering hydrocarbons by partial in situ combustion of oil shale wherein a hole is drilled into an oil shale section from which hydrocarbon is to be recovered, the hole is enlarged to form a retort in said oil shale section, and a combustion front is passed

through shale in said retort, the steps comprising:

- (a) pull-through mining the shale surrounding the said hole to form a retort and fractured shale,
- (b) classifying the fractured shale according to the fuel content of said fractured shale,
- (c) blending materials of relatively higher fuel content with relatively hydrocarbon-lean fractions of said fractured shale to form a shale mixture having a fuel content greater than that of said lean fraction, and
- (d) passing a combustion front through said shale mixture to educe fluid hydrocarbon from said shale mixture.

2. The process of claim 1 wherein the combustion front is maintained at temperatures of from about 700 to about 1500° F.

3. The process of claim 1 wherein the oil shale adjacent the retort is fractured prior to passing a combustion front through the shale mass in the retort.

4. The process of claim 1 wherein a relatively hydrocarbon-rich fractured shale is mixed with a relatively hydrocarbon-lean fractured shale fraction.

5. The process of claim 1 wherein at least one material of relatively higher fuel content is a hydrocarbon.

6. The process of mining shale for the retorting of oil shale comprising

- (a) locating a pulling means above a shale bed;
- (b) locating a disintegrating means below the shale to be removed;
- (c) connecting a linking means between the disintegrating means and the pulling means through a pilot hole drilled through the oil-shale bed;
- (d) applying a pulling force from the pulling means to the disintegrating means through the linking means to force the disintegrating means against the face of the shale to be removed;
- (e) rotating disintegrating surfaces of said disintegrating means against the shale to remove shale from the bottom shale face around the pilot hole; and
- (f) introducing shale removed by the said disintegrating means into the area from which shale has been removed, retorting the introduced shale by passing a combustion zone therethrough, and recovering hydrocarbon liberated by passing the combustion zone through the introduced shale.

7. The process of claim 6, wherein the oil shale adjacent the area from which shale has been removed by the disintegrating means is fractured prior to passing a combustion zone through the introduced shale.

References Cited

UNITED STATES PATENTS

1,919,636	7/1933	Kerrick	299—2
3,001,776	9/1961	Van Poolen	299—2
3,228,468	1/1966	Nichols	166—40 X
3,233,668	2/1966	Hamilton et al.	166—11 X

FOREIGN PATENTS

833,334	3/1952	Germany.
117,894	7/1958	U.S.S.R.
1,038,050	9/1953	France.

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