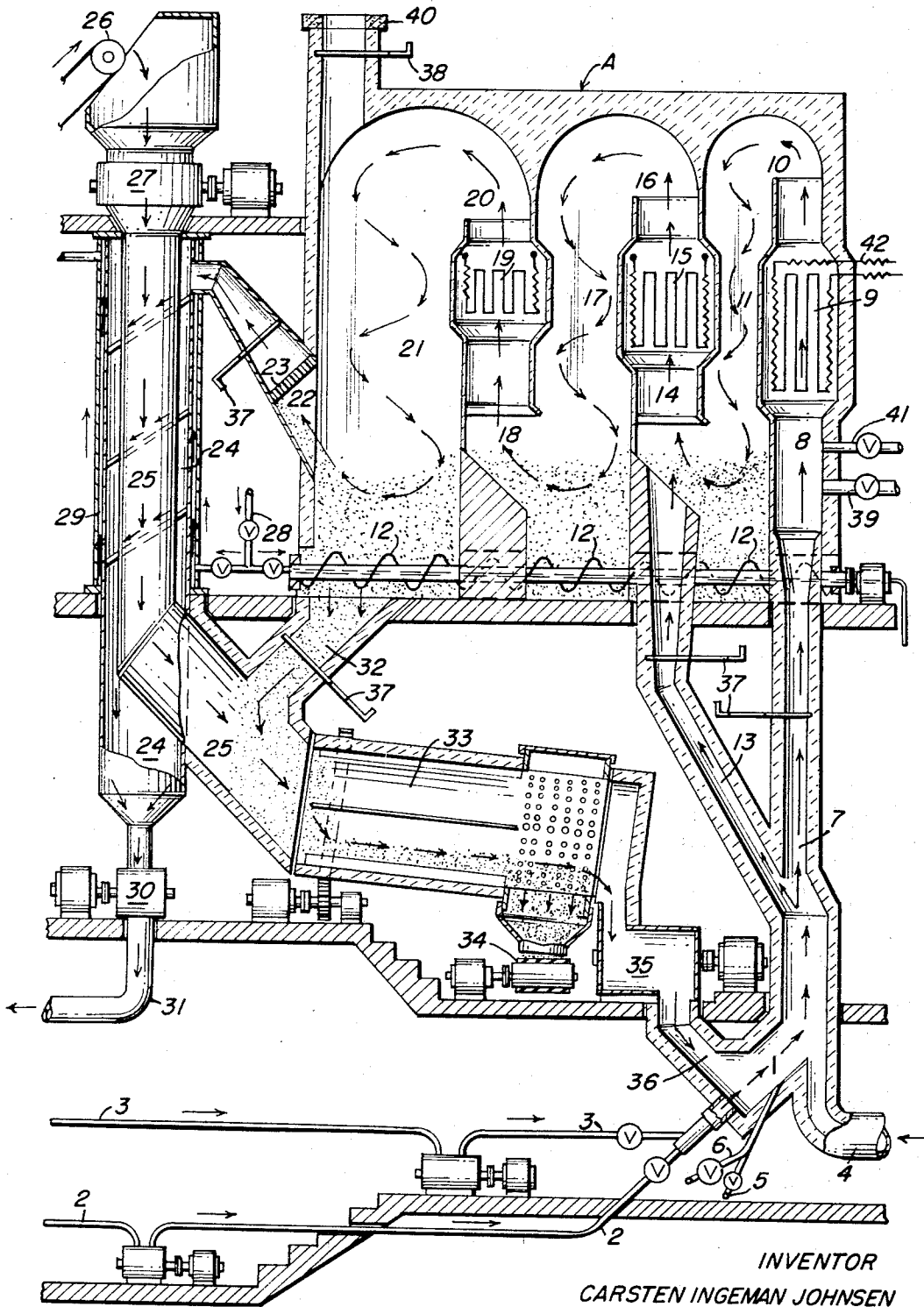


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C. I. JOHNSEN
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FROM PULVERIZED OIL SHALE
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1

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CONTINUOUS RECOVERY OF SHALE OIL AND GAS FROM PULVERIZED OIL SHALE

Carsten Ingeman Johnsen, Floral Park, N.Y.

(Sandvigen, Arendal, Norway)

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My invention relates to a process for the liberation and recovery of organic mineraloids imprisoned in oil shale, a sedimentary rock; said mineraloids freed and recovered in the form of liquid shale oil and shale gas.

Heretofore, methods and means have been proposed to effect said liberation and recovery, usually involving crushing of the host oil shale to coarse particles, then processed in retorts to vapor, gas and residue, heat being furnished by burning a portion of said oil shale, recovering and cooling liberated shale gas plus shale oil vapor to gas and shale oil. Other processes use indirect heating to transfer adequate heat to the oil shale, again burning a portion of oil shale or recovered products.

The relatively low yields obtained, consuming of much oil shale, contaminating of products and atmosphere by products of combustion as well as the low thermal efficiencies of the heretofore proposed methods leave much to be desired.

By the use of my invention in its entirety or one of its novel features hereinafter described, substantial economies in the expenditure of materials and energy will result, as well as maximum recovery of uncontaminated products. New high thermal and economic efficiencies will be reached, changing a hoped for, distant possibility on this subject, to an imminent probability, apparent to those familiar with the pertinent arts.

My invention is illustrated in broad outlines by the accompanying drawing. In said drawing:

Unit A is a processing enclosure divided internally into one or more connected chamber groups, each group consisting of a heated chamber into which a gaseous or fluidized powder stream is introduced, directed upwardly and adequately heated; and a connected, enlarged, cooler chamber in which said stream is directed downwardly shedding therein residual particles, carried by said stream, as a result of abrupt changes in direction and radical decrease in velocity of stream in said enlarged chamber. Effecting tangential entry of stream into said enlarged, cooler chamber will cause said stream to flow downwardly in a spiral path producing relative velocities of stream ingredients, thus aiding shedding of said residual particles.

Said stream will be induced to flow from entrance to exit of Unit A impelled by convection currents thermally generated by differences in stream densities occurring during passage through said succession of heated and cooler chambers; Unit A being thus thermosyphonic pump.

When Unit A is employed in the liberation and recovery of imprisoned mineraloids in the form of shale oil vapor plus gas, the host oil shale will be crushed to coarse particles, then preheated in heat exchange relationship by hot liberated and recovered shale oil vapor plus gas issuing from Unit A. Said coarse particles are additionally preheated in heat exchange relationship by hot residual particles shedded in and ejected from said processing enclosure. Emerging from said heat exchanger, the now hot coarse particles are pulverized and mixed with pressurized carrying media to a fluidized powder stream injected into and through chamber groups of Unit A for processing therein to new shale oil vapor plus gas and new shedded and ejected residual particles, all more fully described hereinafter.

The number of said chamber groups in Unit A will

2

be determined by residence time needed to effect the degree of processing refinement desired. In said drawing three chamber groups are shown and deemed sufficient to obtain substantially complete liberation and recovery of available shale oil plus gas imprisoned in said host oil shale. Speed of flow of said stream being processed in Unit A will be controlled by a variable speed pump withdrawing liberated and recovered shale oil plus gas issuing from Unit A at desired rates of speed to achieve maximum processing effectiveness.

Pulverization of oil shale is advantageous aiding liberation of said shale oil plus gas by exposing large collective surface areas of a great many small particles of said oil shale to absorption of heat improving liberation activity substantially.

Heated chambers in Unit A will preferably be heated by electrical resistance heaters or incandescent arcs installed in said heated chambers and energized via 42 by electrical energy from an exterior source or from local internal combustion engine or gas turbine electric generator sets fueled by a portion of recovered products. The exhausts from said prime movers may, if desired, be disposed of by discharge into heated chambers of Unit A aiding thereby injection and heating of the stream while salvaging unreacted fuel values in exhausts and avoiding atmospheric pollution.

Describing normal liberating and recovery operations in more detail, Unit A will continuously receive a fluidized powder stream via injector 1 consisting of preheated pulverized oil shale on carrying media. Said media may be pressurized shale gas via 2, or pressurized and atomized shale oil via 3, or exhaust from internal combustion engine or gas turbine via 4, said media injected singly or in combinations of two or more. Hydrogen via 5 and a catalyst via 6 may be added to stream, improving recovered products.

All or a portion of said injected stream will be directed via 7 into chamber 8 wherein sufficient heat is absorbed by stream during passage through heater 9 to raise stream temperature to thermal decomposition level for oil shale particles in said stream; in addition, absorbing sufficient heat to effect vaporization and gasification of imprisoned mineraloids in said oil shale particles, said mineraloids liberated in the form of shale oil vapor plus gas.

Said stream now containing vapor, gas, unreacted oil shale particles and oil shale residues flows through port 10 and then downwardly in a spiral path, through enlarged, cooler chamber 11 shedding therein unreacted, coagulated oil shale particles as well as oil shale residues to watercooled conveyor 12 for ejection and employment outlined hereinafter. Simultaneously liberated shale oil vapor plus gas, unshedded particles and residues are directed into chamber 14.

A second portion of said fluidized powder stream originating in item 1 may, if desired, be diverted via 13 into chamber 14, joining, mixing with and being heated by said vapor, gas, unshedded particles and residues from chamber 11. The thus augmented stream is additionally heated during passage through heater 15 to effect liberation, vaporization and gasification of shale oil vapor plus gas from shale oil particles carried by said augmented stream as described hereinbefore, said stream containing upwardly and through port 16 into chamber 17 enlarged relative to chamber 11.

In chamber 17, said augmented stream will flow downwardly, again in a spiral path, shedding unreacted coagulated oil shale particles and oil shale residues to conveyor 12, ejected and employed as outlined hereinafter while liberated shale oil vapor plus gas, unshedded particles and residues are directed into chamber 18.

3

Additional treatment of said augmented stream is effected by absorption of heat during passage through heater 19, liberating, vaporizing and gasifying shale oil vapor plus gas in heretofore unreacted oil shale particles carried to chamber 18 while continuing upwardly and through port 20, entering chamber 21 substantially enlarged relative to chamber 17.

In chamber 21, said stream, now containing liberated shale oil vapor plus gas and heretofore unshedded oil shale residues, will move downwardly, again in a spiral path, through chamber 21, sloughing off the balance of oil shale residues to conveyor 12. The now substantially clean and hot shale oil vapor plus gas liberated from said fluidized powder stream is directed into space 22 and finally cleaned of remaining oil shale and residual particles by passage through screen or cyclone 23, shedded particles to conveyor 12.

Said hot and cleaned shale oil vapor plus gas from space 22 is directed into and downwardly, in a spiral path, via space 24, surrounding while exuding its sensible heat, in heat exchange relationship, to new, continuously supplied, oil shale host rock from item 26, crushed to coarse particles in crusher 27 and descending, while being heated, via conduit 25. Said shale oil vapor plus gas descending in cooling space 24 may be additionally cooled, if desired, by cooling water supplied via 28 directed through space 29 to water exit. Conveyor 12 may also be water cooled as illustrated.

Other things being equal, the degree of refinement of processing desired in Unit A will be controlled by variable speed evacuation pump 30, withdrawing via 24 and discharging via 31, said shale oil vapor plus gas liberated from said fluidized powder stream. Said vapor plus gas will be additionally cooled by methods and means, old to the art, not herein illustrated or described, effecting the separate recovery of liquid shale oil and shale gas to uses desired.

Said coarsely crushed oil shale host rock heated as described while descending in 25 is additionally heated in direct heat exchange relationship by intimate mixing, in a combination rotating drum and screen, item 33, with hot residual oil shale particles shedded in Unit A, heretofore described, delivered via conveyor 12 and conduit 32 to item 33. Said drum and screen, being adequately sized and operated, substantial heat equilization between said mixed substances will be closely approached, the cooled residual particles being screened from said mixture and disposed of via item 34.

The now relatively hot coarse oil shale particles from 33 are pulverized in pulverizer 35 to the desired fineness and delivered via 36 to injector item 1, joining and mixing therein with new carrying media supplied via 2 or 3 or 4, used singly or in combinations, to a new fluidized powder stream injected into Unit A as illustrated and fully described hereinbefore. The process is continuous.

Unit A will be constructed of steel, concrete, mechanical and electrical devices as well as insulated to retain supplied heat. During normal liberation residue separation and product recovery operations, air will be denied entry into said chambers. At long intervals, burning out of accumulated deposits may be necessary. Doing so, operations will cease, valves 37 closed and valve 38 opened. Air is admitted via 39, contents and deposits in chambers ignited and burned, products of combustion ejected via

4

stack 40. On completion chambers will be filled with steam or carbon dioxide for safety and operations resumed.

Having illustrated and described my invention relating to the substantially complete liberation of organic mineraloids imprisoned in host oil shale, liberated and recovered as liquid shale oil and shale gas separately,

I claim:

1. The method for the continuous liberation and recovery of organic mineraloids in the form of shale oil vapor plus gas from host oil shale which comprises the steps of crushing, preheating, pulverizing and mixing said pulverized oil shale with a carrying medium to form a fluidized powder stream; injecting said fluidized powder stream into a processing enclosure in the absence of air; said enclosure internally divided into a plurality of connected chamber groups, each of said groups having a heated chamber and a connected enlarged cooler chamber; passing the said fluidized powder stream introduced into the processing enclosure consecutively through the plurality of connected chamber groups; said stream directed upwardly in each heated chamber; said heated chambers being adequately heated to liberate, vaporize, and gasify the said mineraloids to shale oil vapor plus gas; said stream directed downwardly in each of said enlarged cooler chambers, effecting therein the shedding of residual particles from said stream by a decrease in the velocity of said stream in said enlarged cooler chambers; each successive cooler chamber being progressively enlarged in cross-sectional areas as the powder stream flows through the chambers to the enclosure exit; ejecting said hot shedded residues from said enclosure, and recovering shale oil vapor plus gas from the last chamber of said enclosure.

2. The method as claimed in claim 1 having in addition the step of effecting heat absorption by the crushed oil shale feed by contacting said crushed oil shale feed in a heat exchange relationship with the hot shedded residues ejected from the processing enclosure, and a second step of separating the now cooler residues from the now heated crushed oil shale feed, disposing of said residues and pulverizing the heated crushed oil shale feed prior to injecting said shale feed with a carrying medium in the form of a fluidized powder stream into the processing enclosure.

3. The method as claimed in claim 1 having in addition the step of injecting said pulverized oil shale into said processing enclosure on a carrying medium consisting of exhaust gases issuing from combustion engines driving electric generators, generating electrical energy, energizing electrical heating devices installed in said processing enclosure.

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DANIEL E. WYMAN, *Primary Examiner*.

65 P. KONOPKA, *Assistant Examiner*.