

[72] Inventor **John D. Bennett**
Richardson, Tex.
 [21] Appl. No. **766,694**
 [22] Filed **Oct. 11, 1968**
 [45] Patented **Nov. 30, 1971**
 [73] Assignee **Sun Oil Company**
Philadelphia, Pa.

[54] **TAR SAND RETORTING**
8 Claims, 3 Drawing Figs.

[52] U.S. Cl. **208/11,**
 201/6, 201/32, 201/40, 202/117, 208/8
 [51] Int. Cl. **C10g 1/02,**
 C10b 53/06
 [50] Field of Search..... 208/11, 8;
 201/6, 32, 40; 202/117

[56]

References Cited

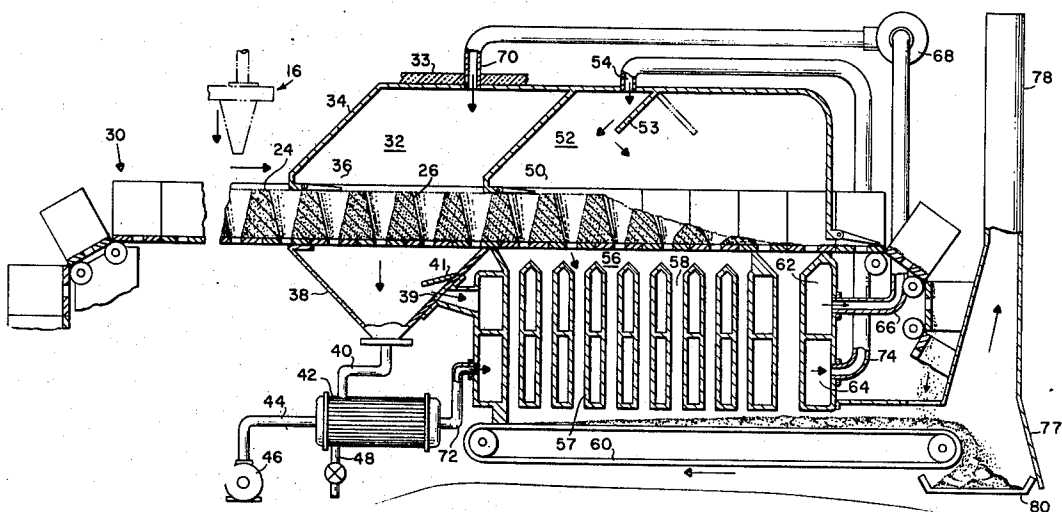
UNITED STATES PATENTS

3,009,863	11/1961	Angevine	201/6 X
3,258,409	6/1966	Schenck et al.....	201/6
3,487,002	12/1969	Chaney et al.....	208/11
3,509,027	4/1970	Savage et al.....	201/29

Primary Examiner—Curtis R. Davis

Attorneys—George L. Church, Donald R. Johnson, Wilmer E.
 McCorquodale, Jr. and John E. Holder

ABSTRACT: The particular embodiment described herein as illustrative of one form of the invention utilizes a system for retorting bituminous sands which includes a horizontal bed of such materials moving first through a retorting zone, and then a burning zone. Vertical openings are formed in the bed to provide for the flow of gases through the bed in the retorting operation. Heat exchangers utilize the heat of educted hydrocarbons and burning coke to supply heated gas to the retorting system.



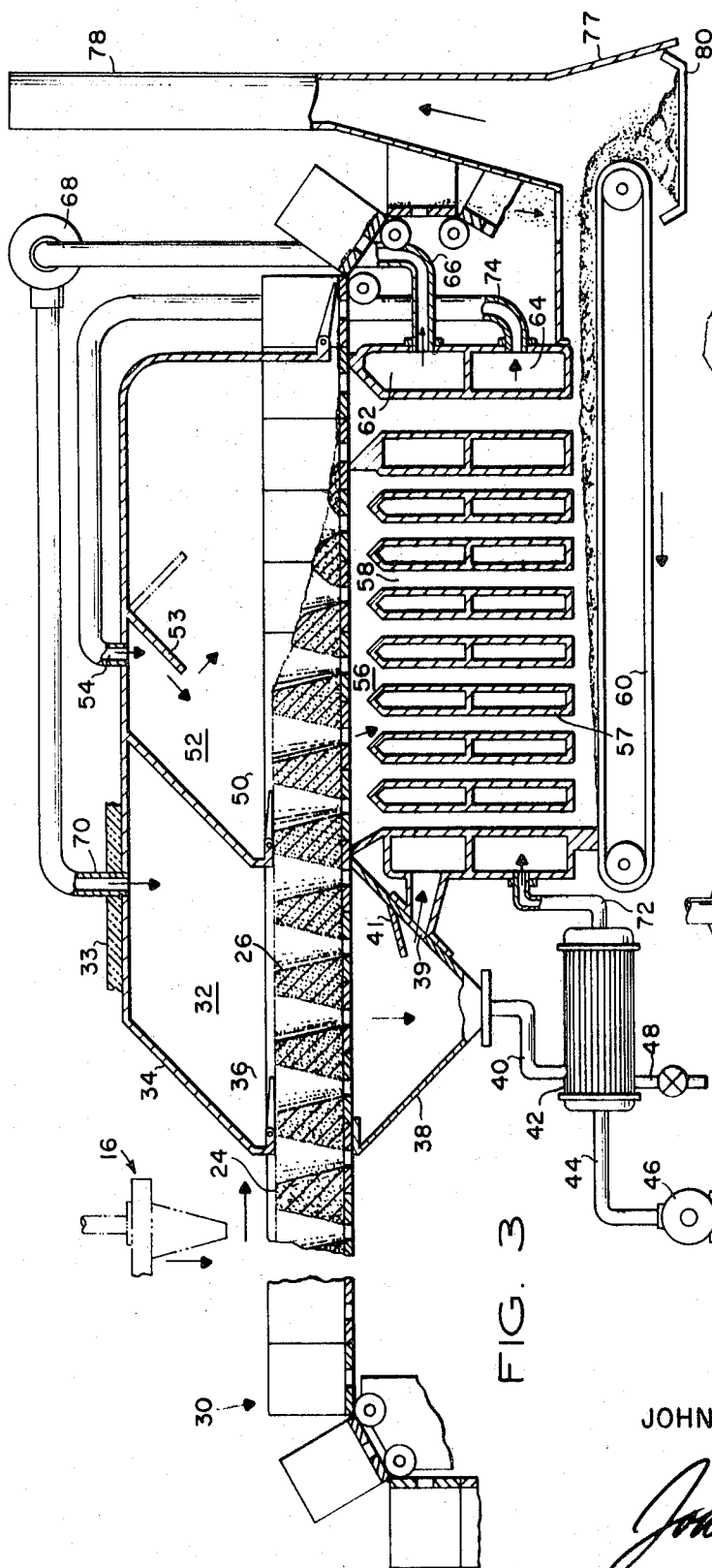


FIG. 3

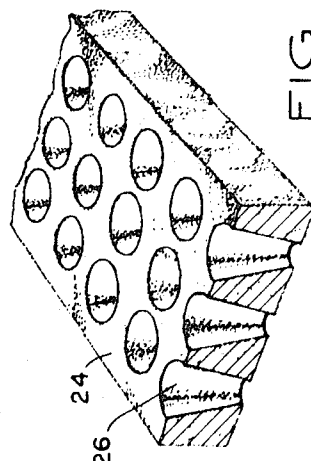


FIG. 2

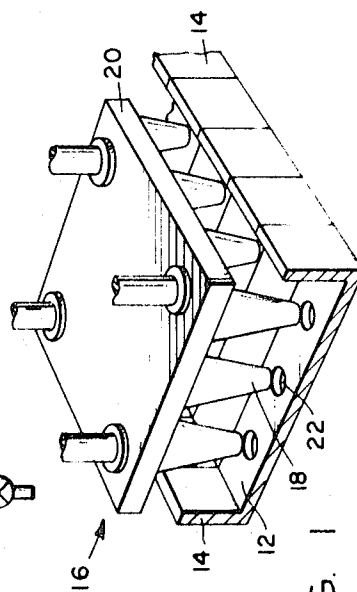


FIG. 1

INVENTOR
JOHN D. BENNETT

John E. Holder
ATTORNEY

TAR SAND RETORTING

BACKGROUND OF THE SYSTEM

This invention relates to the recovery of oil from bituminous sands, and more particularly, relates to an improved process and apparatus for the more effective recovery of valuable hydrocarbon products from oil-bearing minerals, such as tar sands.

The material treated according to the method of the present invention is obtained from natural deposits existing in various parts of the world. Typical of such deposits are those found in the Province of Alberta Canada particularly in the vicinity of the Athabasca River. These tar sands, in their naturally existing states, are heavily saturated with a viscous oil, and may be mined or removed from their naturally existing state by conventional mining methods. The tar sands with which we are concerned here are to be distinguished from the highly carbonaceous solid shale materials, which on thermal treating yield hydrocarbon product.

In the following description, the phrases "bituminous sand" or "tar sand" are used to refer generally to all granular solid bituminous or petroliferous materials soaked with a usually highly viscous liquid or semiliquid hydrocarbonaceous material, although it specifically refers to a characteristic type of bituminous solid consisting of discrete particles of sand bound together by a continuous viscous hydrocarbon oil phase. This terminology is used for the sake of simplicity of description, and it should be understood that the process and apparatus herein described may be applied to other solids similarly containing a bituminous or viscous hydrocarbonaceous coating.

Tar sands are composed of a siliceous material, generally having a size greater than that passing a 325 mesh screen, saturated with a relatively heavy, viscous bitumen in quantities of from 5 to 21 weight percent of the total composition. More typically, the bitumen content of the sands is about 8 to 15 percent. This bitumen is quite viscous and contains typically 4.5 percent sulfur and 38 percent aromatics. Its specific gravity at 60° F. ranges typically from about 1 to about 1.06. The tar sands also contain clay and silt from 1 to 50 weight percent of the total composition. Silt is normally defined as mineral which will pass a 325 mesh screen, but which is larger than 2 microns. Clay is mineral smaller than 2 microns, including some siliceous material of that size.

There have been two well-known methods in use for the separation of crude oil from bituminous sands. One is what is known as the "hot water separation method," and the other is the so-called "cold water method."

In the hot water method, the bituminous sands are jetted with steam and mulled with a minor amount of hot water at temperatures in the range of 140° to 210° F. The resulting pulp is dropped into a stream of circulating hot water, and carried to a separation cell, sand settles to the bottom as tailings, and bitumen rises to the top in the form of an oil froth. An aqueous middlings layer containing some mineral and some bitumen is formed between these layers. A scavenger step may be conducted on the middlings layer from the primary separation step to recover additional amounts of bitumen. This latter step usually comprises aerating the middlings to form a froth. These froths may be combined, diluted with naphtha, and centrifuged to remove more water and residual mineral. The naphtha is then distilled off, and the bitumen is coked to a high-quality crude suitable for further processing.

According to the cold water method, a diluent such as kerosene is added to the bituminous sand as it enters the plant. The mixture of sand and diluent is passed through a mill where the lumps are broken down and the kerosene thoroughly mixed with the bitumen. The mixture is then introduced into a large volume of water, where most of the sand settles out, and an oil froth or emulsion is floated off the top in a manner similar to the hot water method. The oil froth recovered by this method is then put through a dehydrator, and is passed on to other steps of refining. Water, which is picked up in the froth, must be separated and disposed of.

Numerous problems are associated with the above methods. In the hot water process, fines in the water must be settled in order to dispose of the water. The settling process is time-consuming, and requires a great amount of space and equipment. In addition, fines in the oil require a centrifuging step for their removal. The cold water process, on the other hand, requires settling steps which are time-consuming, and in addition, water separation processes which are expensive. In addition, large amounts of solvent are used in the process which are not economically recoverable.

On the other hand, retorting methods which in the past have been applied to shale oils provide the additional advantage of partially coking the hydrocarbon during the separation process, to eliminate the disposal problem associated with the water separation process, and in particular, the disposal problem involved in settling the fines in the hot water process.

Prior art disclosures offer numerous processes primarily intended for retorting oil-bearing shales, but often described as being equally applicable to the retorting of tar sands. Examples are the following U.S. patents pertaining to retorting of carbonaceous materials, such as oil shale, coal and tar sands in bed form: U.S. Pat. Nos. 2,406,810; 2,885,338; and 3,130,132. Disclosures which include tar sands among the carbonaceous feed materials described generally fail to take into account the marked difference in character of tar sands as compared to oil shales. The latter material is hard rock which is nonpliable, and a bed composed of pieces of the oil shale rock has no tendency to collapse during retorting. On the other hand, tar sands are plastic material, and pieces thereof normally are incapable of maintaining their shapes under retorting conditions.

In view of the distinctly different physical characteristics of oil shales on the one hand, and tar sands on the other, prior procedures suitable for retorting oil shales have not proved to be applicable to tar sands. These processes are unsatisfactory for tar sands due to the fact that the chunks or particles will not retain their shape during heating, as a consequence of which the bed of material tends to collapse and the particles therein tend to fuse at the high temperature required for retorting. As this occurs, the pressure drop necessary to maintain a reasonable flow of hot gases through the bed rises inordinately. In order to drive out most of the oil from the mined sands, a relatively large volume of hot gas is required, usually in excess of 1 pound of hot gas per pound of bituminous sands, in order to heat the entire bed to the desired retorting temperature. The temperature must be in excess of 700° F., and desirably in the range of 1,000° to 1,500° F. As the chunks or particles of bituminous sands are heated toward such temperature levels, the particles soften and the weight of the bed causes it to collapse. With the bed in collapsed condition, the cost of compressing a sufficient amount of gas to heat the entire mass to retorting temperature becomes excessive, making such a retorting process uneconomical and impractical.

The present invention overcomes this problem resulting from collapsing of the tar sand bed during retorting and avoids the expense otherwise entailed in compressing retorting gas. Practice of the invention permits the retorting operation to be carried out utilizing fans or blowers to effect the necessary circulation of hot gas through the bed of bituminous sands instead of compressors.

It is therefore an object of the present invention to provide a new and improved method and apparatus for retorting tar sands.

SUMMARY OF THE INVENTION

With these and other objects in view, the present invention contemplates a retort system for retorting bituminous materials which includes a horizontally moving bed of such materials which are compacted and then perforated prior to entry into the retort. Such perforating provides vertical flow channels through the compacted bed of material to permit a controlled distribution of heat and burning within the retorting ap-

paratus. The retorting apparatus is comprised of two zones, the first being a retorting zone for educting volatile hydrocarbon materials from the horizontal bed. The second zone, into which the bed passes after eduction of hydrocarbons therefrom, comprises a burning zone which burns the remaining coke within the materials. Heat from such burning operation is transferred to the retort zone for providing retort heat. A heat exchanger also utilizes heat from the educted hydrocarbons for heating the burning zone.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of an apparatus for compacting a bed of bituminous materials and forming vertical holes therethrough;

FIG. 2 shows a horizontal compacted bed of such materials with holes formed therein; and

FIG. 3 shows a schematic representation of a retorting system carrying out the principles of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1 of the drawings, an apparatus is shown for forming vertical flow paths through a bed of bituminous sand material to be retorted. Bituminous materials which are mined from the earth are placed on top of the conveyor 12. The conveyor has side members 14 which form a trough for holding the materials in place on the conveyor. The conveyor is constructed in hinged sections to permit movement of the bottom and side members over a pulley. The materials are moved on the conveyor until they are aligned with a compacting and perforating device 16 which is positioned above the conveyor. The compacting and perforating device 16 is comprised of a body platen 20 having downwardly extending perforating members 18 which are formed in the shape of a truncated cone. Upon lowering the compacting and perforating device 16 onto the conveyor, the lower face of the platen 20 engages the materials on the conveyor and compacts these materials into the conveyor trough formed by the conveyor 12 and sidewalls 14. The platen is sized to be received on the conveyor between the sidewalls so that the top of the compacted material is below the top of the sidewall members 14 in the conveyor. The perforators 18 are arranged to be aligned with openings 22 in the conveyor. During the perforating operation the platen is lowered onto the material being carried by the conveyor. The material is thus compacted between the platen and the conveyor trough. The perforators form holes or conically shaped openings through the compacted material to provide communication between the top and bottom sides of the compacted bed of materials on the conveyor. It is to be understood that means (not shown) are provided for coordinating the movement of the conveyor and platen so that the perforating members 18 will be alignable with the holes 22 upon movement of the compacter into the bed of materials.

The shape of the perforating members causes the tar sands to be laterally displaced and thereby compacted upon entry of the conically shaped members into the material. Compacting of the material about the opening provides a strong structure which will retain its shape and thereby maintain an opening while the material is being moved through the retorting process.

FIG. 2 shows a cutaway view of a portion of such material as it appears after the compacting and perforating operation. The bed of materials 24 has conically shaped openings 26 formed therein with the large portion of the cone at the top of the bed and the small portion of the truncated cone at the bottom of the bed. The openings are spaced in the bed to provide an approximately equal thickness of material in all directions for purposes to be hereinafter described. The thickness of the bed, and size and spacing of the openings therein will be determined by the rate of movement of the bituminous materials through the retorting system.

The compacted material forming the bed together with the conical perforations therein create a bed of material which is characterized by a substantially greater strength than the unconsolidated materials which are originally placed on the conveyor belt. The conical openings provide a strong unsupported sidewall portion which is designed to maintain its form throughout the retorting operation, while being subjected to movement of the conveyor and movement of gaseous fluids therethrough during the retorting and burning operations to be described hereinafter. Such openings provide a means for passing gaseous fluids through the beds and at the same time expose a maximum amount of cross-sectional area of the bed to such gases, leaving an equal volume of such materials unexposed between the opening to effect a uniform exposure of such materials to the atmosphere within the retorting zones. By maintaining a proper feed of materials through the retorting system, such materials are uniformly treated and therefore a maximum amount of hydrocarbons may be educted therefrom together with a maximum amount of thermal energy which is derived from the materials during passage through the burning zone.

Referring now to FIG. 3 of the drawings, a conveyor 30 is shown for moving a continuous bed or bricquet 24 of bituminous materials into a retorting apparatus. While the conveyor 30 is shown passing over pulleys at the ends of the retorting mechanism, additional pulleys (not shown) are provided for diverting the conveyor outwardly around the retorting mechanism to produce a continuous conveying system. The apparatus includes a first retorting zone 32, provided with a housing 34 enclosing the zone. Insulating materials such as at 33 are used throughout the construction of the retort system to maximize the utilization of heat energy generated in the system. A swinging door seal 36, rides lightly along the top surface of the bed of material to provide a sealed enclosure to the interior of the retort zone. The door seal is sized to swing downwardly between the sidewall members 14 on the conveyor. A pipe 70 communicates with the top of the housing 34. Hot gases are forced through pipe 70 into the retort zone to bring the zone 32 to an approximate temperature range of from 1,000° to 1,300° F. Such heated gases move about and through the bed of materials to raise the temperature of such materials to a retorting temperature of approximately 750° - 900° F. Such heated gases pass through the openings 26 in the material and openings 22 in the conveyor into a funnel-shaped enclosure 38 positioned below the conveyor beneath the retort zone. Enclosure 38 has an opening 39 in its sidewall to permit passage of such hot gases from the enclosure. The enclosure 38 also provides a means for catching educted hydrocarbons which are driven from the bed of material during heating in the retort zone. A cover 41 prevents educted hydrocarbons from entering the opening 39. The funnel-shaped housing terminates in an outlet conduit 40 at the lower end thereof. The conduit 40 provides means for moving the educted hydrocarbon fluids into a heat exchanger 42. The heat exchanger 42 may be of any well-known type where heat is conducted through tubular members from one medium to another. In this case the heat exchanger provides a means for transferring heat energy in the educted hydrocarbons to a gas, such as fresh air, being blown through conduit 44 by means of blower 46. The hydrocarbon materials are thus cooled and leave the heat exchanger through the conduit 48. The educted hydrocarbons enter the exchanger from conduit 40 at approximately from 200° - 600° F. Air entering the heat exchanger through conduit 44 will absorb some of this heat energy, before exiting the heat exchanger through conduit 72 for purposes to be hereinafter described.

The moving bed of bituminous materials leaves the retort zone 32 and moves through a swinging door seal 50 into a second, burning zone 52. Heated air is supplied to the burning zone 52 by means of a pipe 54, which communicates with the top of the burning zone. A defuser 53 is positioned below the opening of pipe 54 into the burning zone. The defuser provides a means for regulating the distribution of hot gases

within the burning zone. The heated air entering the burning zone causes the "fixed" carbon or coke within the sand to be burned. The coke serves as a bonding material to hold the sand in its compacted and perforated shape. As the coke burns, the face of the exposed material becomes unconsolidated to the extent that the burned face sluffs off and drops by gravity through the openings in the conveyor. The openings in the material are thereby enlarged as the burning takes place until the material has substantially completely burned. The velocity and turbulence of hot gas moving through the openings 26 in the material will carry the material out the openings 22 in the conveyor. Means (not shown) may be provided at the end of the conveyor for sweeping any remaining sand from the conveyor before the conveyor exits the retort.

A heat exchange chamber 56 is formed below the conveyor belt, beneath the burning zone. The heat exchange chamber is provided with baffles 57 which form vertical channels 58 interconnecting the upper and lower portions of the chamber. The channels 58 provide a means for the unconsolidated sand to fall to the bottom of the chamber, where they collect on a conveyor belt 60 for removing spent sand to the exterior of the retort system. Upper and lower transverse flow ducts 62, 64 respectively, are formed within the baffles 57 positioned within the heat exchange chamber. The flow ducts establish a means for transferring heat energy from the burned sand to gases passing within the ducts 62 and 64. Additional baffles or surface area may be provided in the chamber 56 to facilitate such heat exchange. The upper duct 62 is connected at its left end, as viewed in FIG. 3, with the opening 39 in the funnel-shaped enclosure 38 beneath the retort zone. The opposite end of the duct 62 is connected by means of a conduit 66 with a blower 68 for moving gaseous fluids between the duct 62 and the pipe 70 communicating with the top of the retort zone 32. The flow path just described creates a continuous circulation of gases within the retort zone. The movement of such gases through duct 62 adds heat energy to the gases, and thereby maintains the temperature within the retort zone at a level which will insure retorting of the volatile constituents from the bituminous material. Such temperature may, for example, be in the range of 1,000° - 1,300° F. In the event that fogging occurs in the enclosure 38, a defogging device may be placed in the entry to duct 62 to prevent the fog from getting into the heat exchanger and forming coke deposits therein.

The lower transverse duct 64 within the heat exchange chamber communicates at its left end with a conduit 72 leading from the heat exchange device 42. The lower duct provides a means for passing gaseous fluids which emit from the heat exchanger 42 through the heat exchange chamber 56 for supplying additional heat energy to such gaseous fluids. The lower duct 64 connects at its other end with conduit 74, which in turn communicates with conduit 54 and the upper end of the burning zone within the retort system. Gases entering the burning zone through conduit 54 may have an approximate temperature range of from 500° - 1,000° F. Such heated gas flowing into the burning zone maintains the burning zone at a temperature which will insure burning of the coke or fixed carbon residue within the bituminous materials. The burning of such coke or fixed carbon materials provides additional heat to gaseous fluid flow through the heat exchange chamber to maintain temperatures within the retorting system. The burning coke may raise the temperature in the burning zone to an approximate range of from 1,300° - 1,700° F.

The hot gases which are moved into the upper end of the burning zone by means of the blower 46, pass downwardly through the burning sands, the conveyor, and outwardly through the vertical flow paths 58 within the chamber 56. Such gases then continue along the path taken by the spent material conveyor belt into a plenum 77 at the end of such conveyor, where they are permitted to escape through a flue gas chimney 78. Additional blowers other than those shown may be provided throughout the system to provide for necessary heat transfer. It is anticipated that a substantial amount of the heat energy will have been removed from such escaping

gases so that the temperature of the gas escaping through chimney 78 will be very low and contain relatively few unburned hydrocarbon elements. A transversely moving conveyor 80 at the bottom of the plenum 77 receives sand from conveyor 60 for removal to a disposal site.

Summarizing the operation just described, mined bituminous tar sand materials are loaded on a conveyor 30 where they are compacted and perforated by means of an apparatus as shown in FIG. 1 for performing this operation. Such perforated and compacted material is then moved into a first sealed retort zone 32 where heated gases are passed downwardly through openings 26 within the material to heat the material and permit the flow of volatile hydrocarbon fluid therefrom into the funnel-shaped enclosure 38 below the retort zone. Next, the retorted bituminous materials are passed into a burning zone 52 where the remaining fixed carbon or coke therein is burned. While such coke is burning, a gaseous fluid is passed through the burning zone to move the heat energy evolving therefrom into a heat exchange chamber 56 below the conveyor 30. A pair of transverse heat exchange ducts 62, 64 within the chamber 56 move gaseous fluids through the chamber to remove the heat energy from the burning zone gas for: (1) Heating the circulating fluid through the retort zone; and (2) Supplying additional heat to the burning zone. As the coke is burned from the bituminous material in zone 52, the sands containing such coke become unconsolidated and are permitted to drop through the openings 22 within the conveyor belt and vertical channels 58 within the chamber 56 onto a spent material conveyor belt 60, which removes such unconsolidated sands from the retort zone to the disposal conveyor 80.

It is pointed out that while approximate temperature operating ranges have been described in conjunction with this retort system, such operating conditions are not intended to be limiting. Retort operating conditions would, of course, be dependent on factors peculiar to each system and the physical properties of the material to be retorted. In addition, while the overall system has been described with respect to a belt-type conveyor, it is readily seen that other conveying system, for example, a circular hearth-type system, might be employed to move the materials in a retort.

Therefore, while particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A method of retorting bituminous tar sands materials comprising the steps of: compacting a bed of bituminous materials; forming flow channels in such bed of materials; moving the materials on a horizontal conveyor through a retorting apparatus, such conveyor having passages in alignment with the flow channels; passing a treating fluid through such flow channels to educt volatile hydrocarbons from the materials; passing the educted hydrocarbons out of the retort apparatus through the passages; moving the bed of materials into a burning apparatus; further heating the materials to burn remaining hydrocarbon constituents in the materials until the materials are unconsolidated; and passing the unconsolidated materials out of the burning apparatus through the passages.

2. The method of claim 1 wherein the flow channels are formed by producing vertical holes through such bed of materials.

3. The method of claim 2 wherein said holes are in the shape of a truncated cone.

4. The method of claim 1 wherein said bed is horizontally disposed.

5. A method of retorting bituminous sand material comprising the steps of: moving a horizontal bed of such material into a retort zone on a conveyor, such conveyor having vertical passages therein; passing heated fluid through vertical

7

formed in the bed of material to substantially remove all the hydrocarbons from the material, leaving coke in the material; moving the coke containing material into a burning zone; passing fluid through the vertical holes in the material while the coke in such material is burned to heat the retorting fluid; and passing coked material of the burning zone through the vertical holes and through the conveyor passages to continuously expose fresh coke to the burning zone.

6. The method of claim 5 wherein the bituminous sand materials, prior to passing through the retorting zone, are compacted into a substantially impermeable bed which is then perforated to form vertical holes through the bed.

7. A method for retorting tar sand comprised of noncarbonaceous materials bonded together by volatile hydrocarbon and fixed carbon constituents comprising the steps of: horizontally moving a bed of such materials on a conveyor into a retort having first and second zones, the bed of materials and conveyor having openings therein; moving hot fluids through such openings to heat the bed of materials in the first zone to a temperature sufficient to educt the volatile

8

hydrocarbon constituents therefrom; and thereafter moving hotter fluids through such openings to heat the bed of materials in a second zone to a temperature sufficient to burn the fixed carbon constituents in said materials so that the remaining noncarbonaceous materials become unconsolidated and fall through the openings in the conveyor.

8. In an apparatus for retorting bituminous sands: means for moving a horizontal bed of such materials through the retorting apparatus, said apparatus including a first zone for educting volatile hydrocarbons from such material and a second zone for burning the residue of said first zone; first fluid transfer means for passing a fluid into said second zone; first heat exchanger means for transferring heat from said educted hydrocarbons to said fluid passing into said second zone; second fluid transfer means for passing a fluid into said first zone; and second heat exchanger means for transferring heat from said burned residue to said fluid passing into said first zone.

* * * * *

25

30

35

40

45

50

55

60

65

70

75