US 20090050324A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2009/0050324 A1**

(43) **Pub. Date: Feb. 26, 2009**

McNelly et al.

(54) **SYSTEM AND METHOD OF IN-SITU SHALE OIL RECOVERY UTILIZING AN INTENSE DOWN-HOLE SOLAR BEAM**

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(21) Appl. No.: **12/130,878**

(22) Filed: **May 30, 2008**

Related U.S. Application Data

(60) Provisional application No. 60/941,593, filed on Jun. 1, 2007.

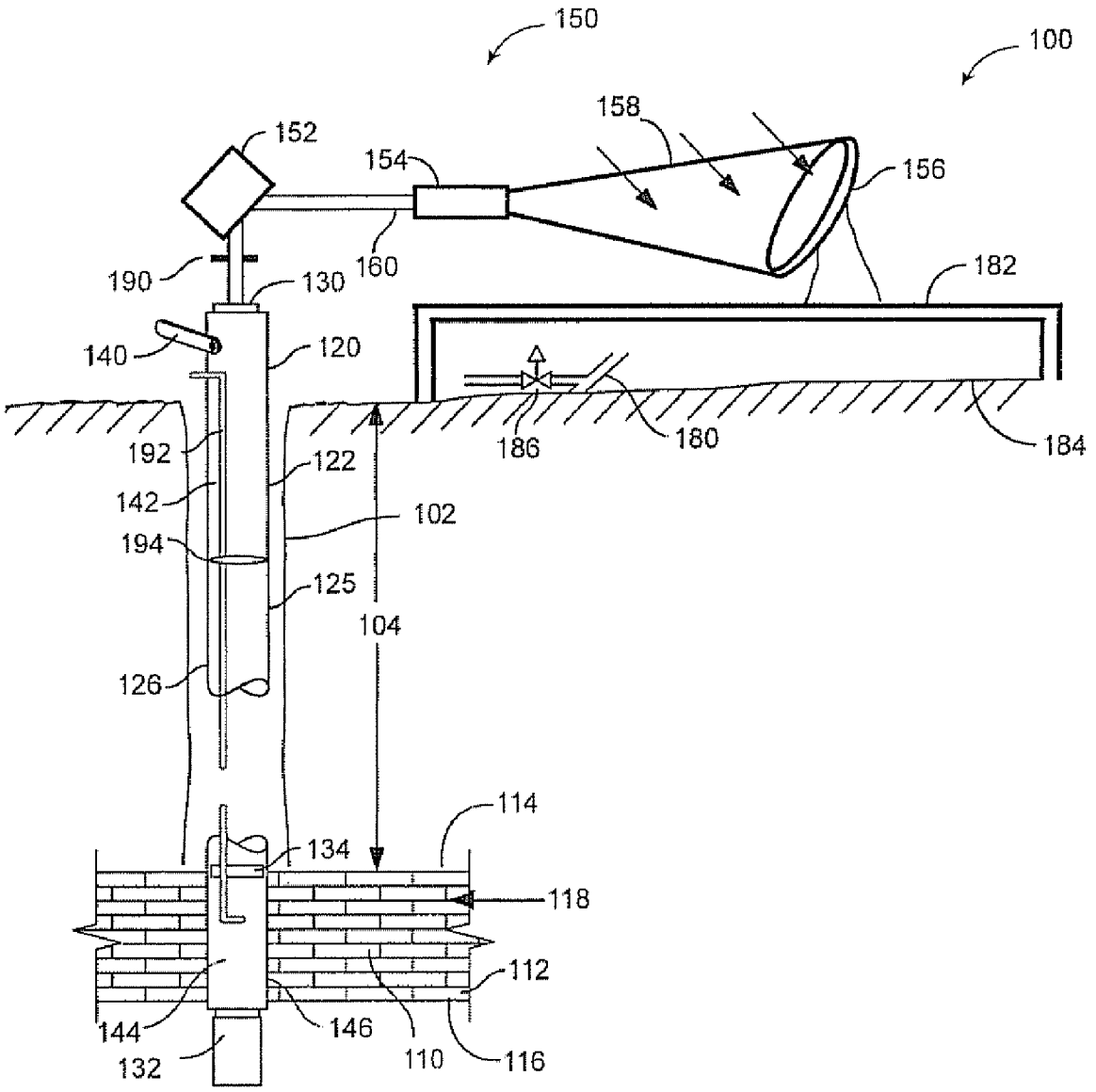
Publication Classification

(51) **Int. Cl.**
E21B 43/24 (2006.01)

(52) **U.S. Cl.** **166/302**; 166/57; 136/246

(57) **ABSTRACT**

A system for in-situ oil shale recovery, which includes a well casing having a leak-tight shaft liner, a gas evacuating system for removing gases from the well casing, and a solar collection system for directing a source of radiant energy through the well casing to a strata of oil shale.



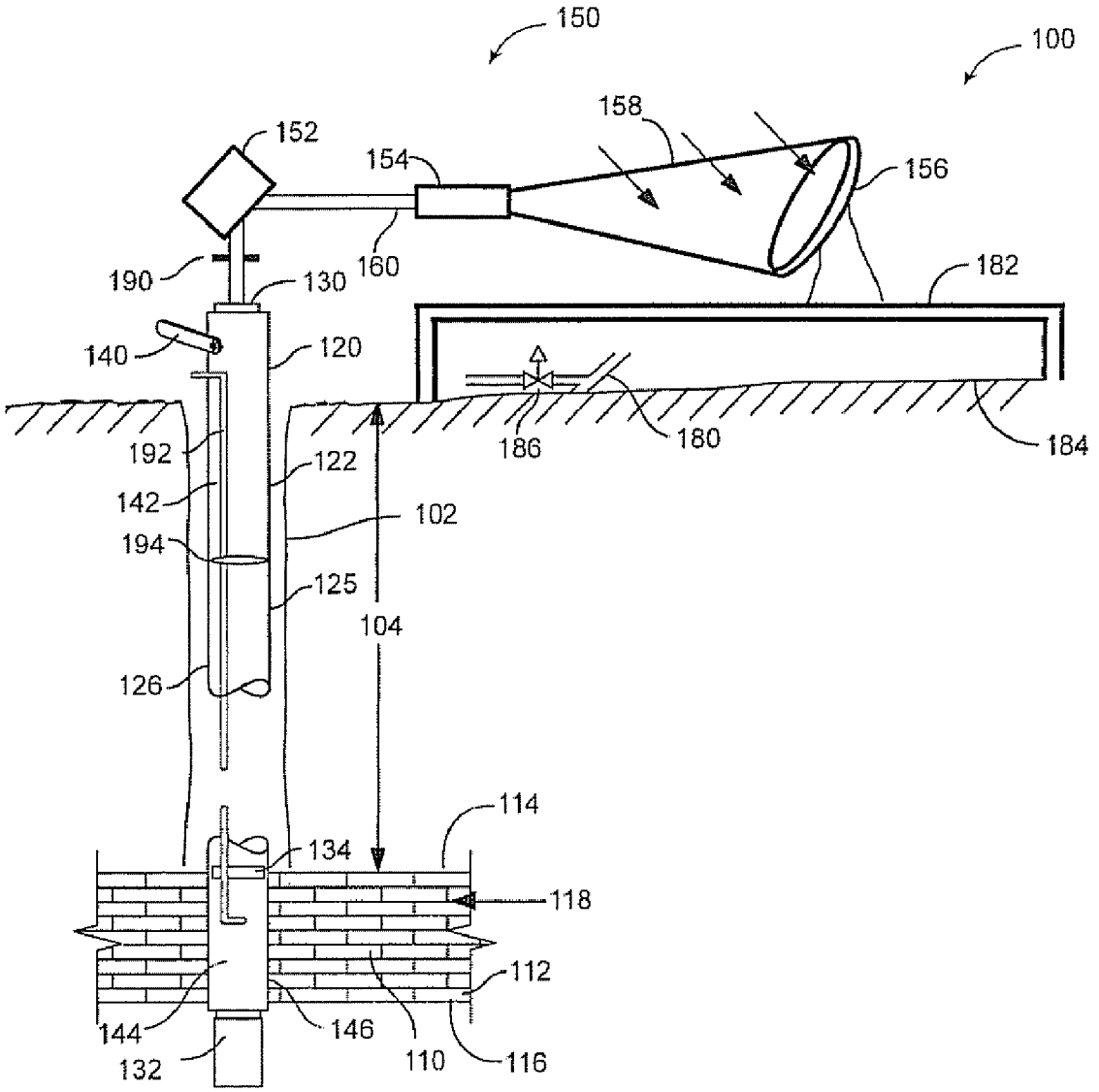

150
100
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152
154
156
160
190
130
182
140
120
186
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194
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104
126
114
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118
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144
146
110
116
132

FIG. 1

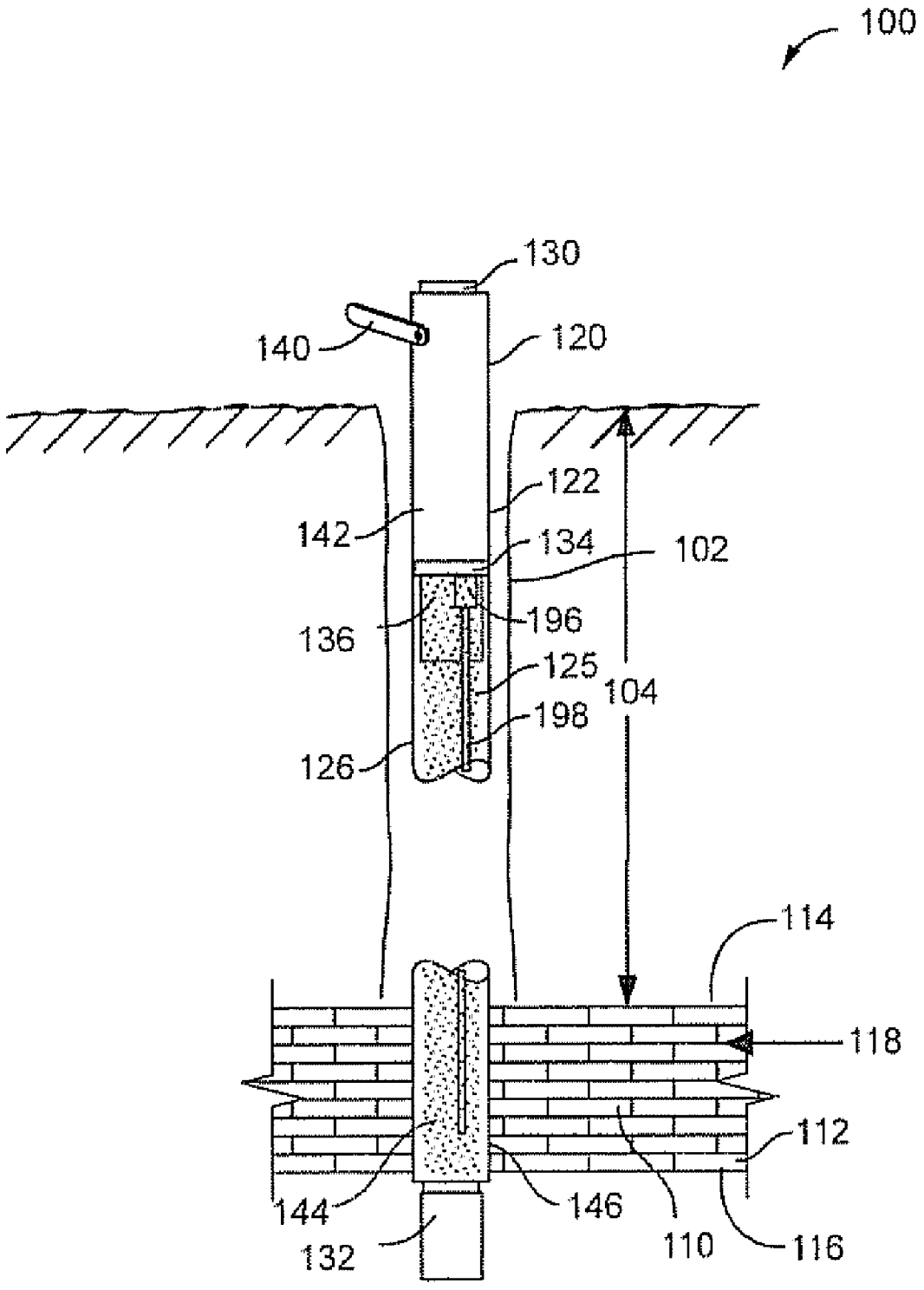

100
130
140
120
122
142
134
102
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196
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104
198
126
114
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144
146
110
116
132

FIG. 2

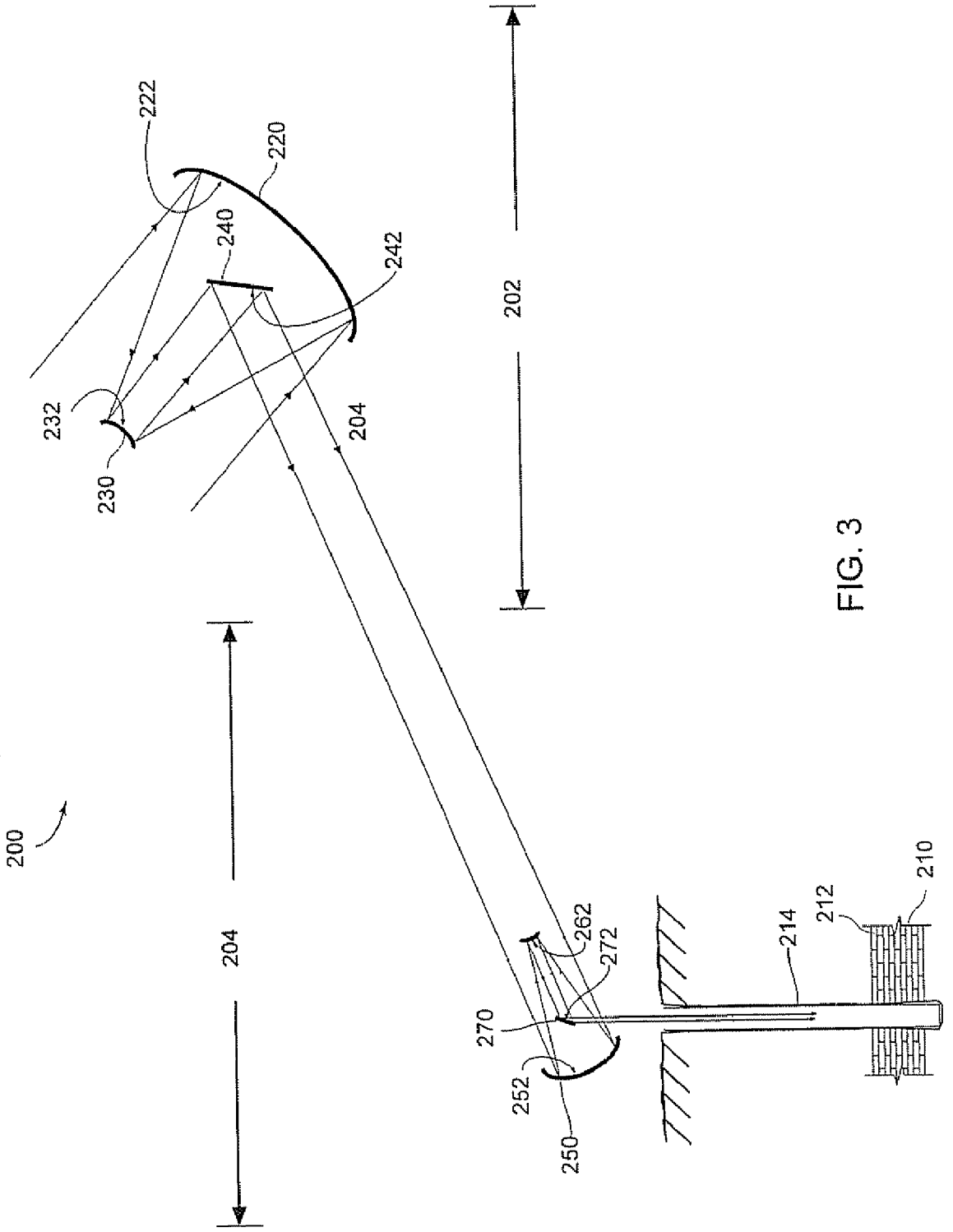

200
202
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FIG. 3

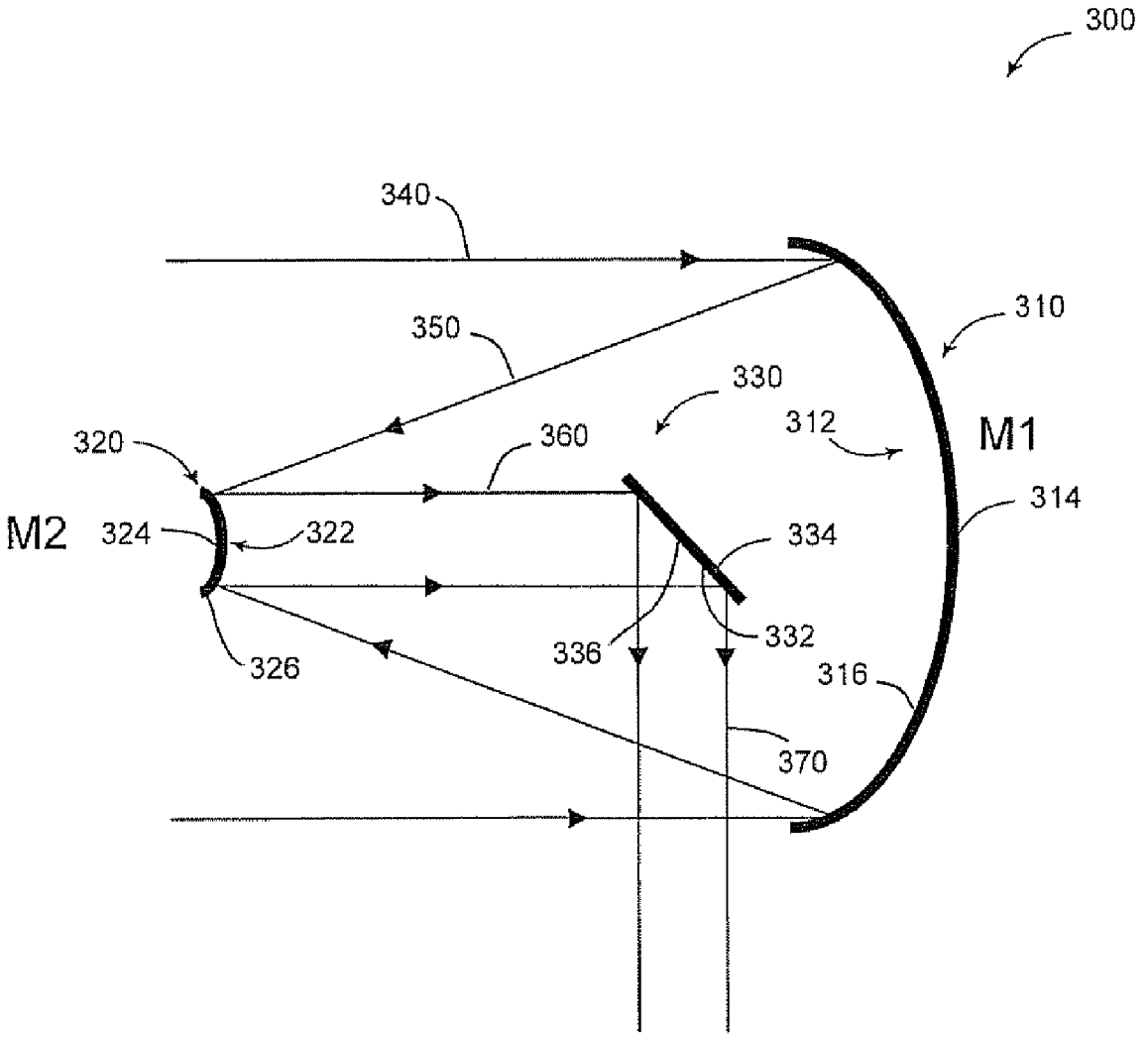

300
340
350
310
330
320
360
312
M1
M2
324
322
334
314
332
336
326
316
370

FIG. 4

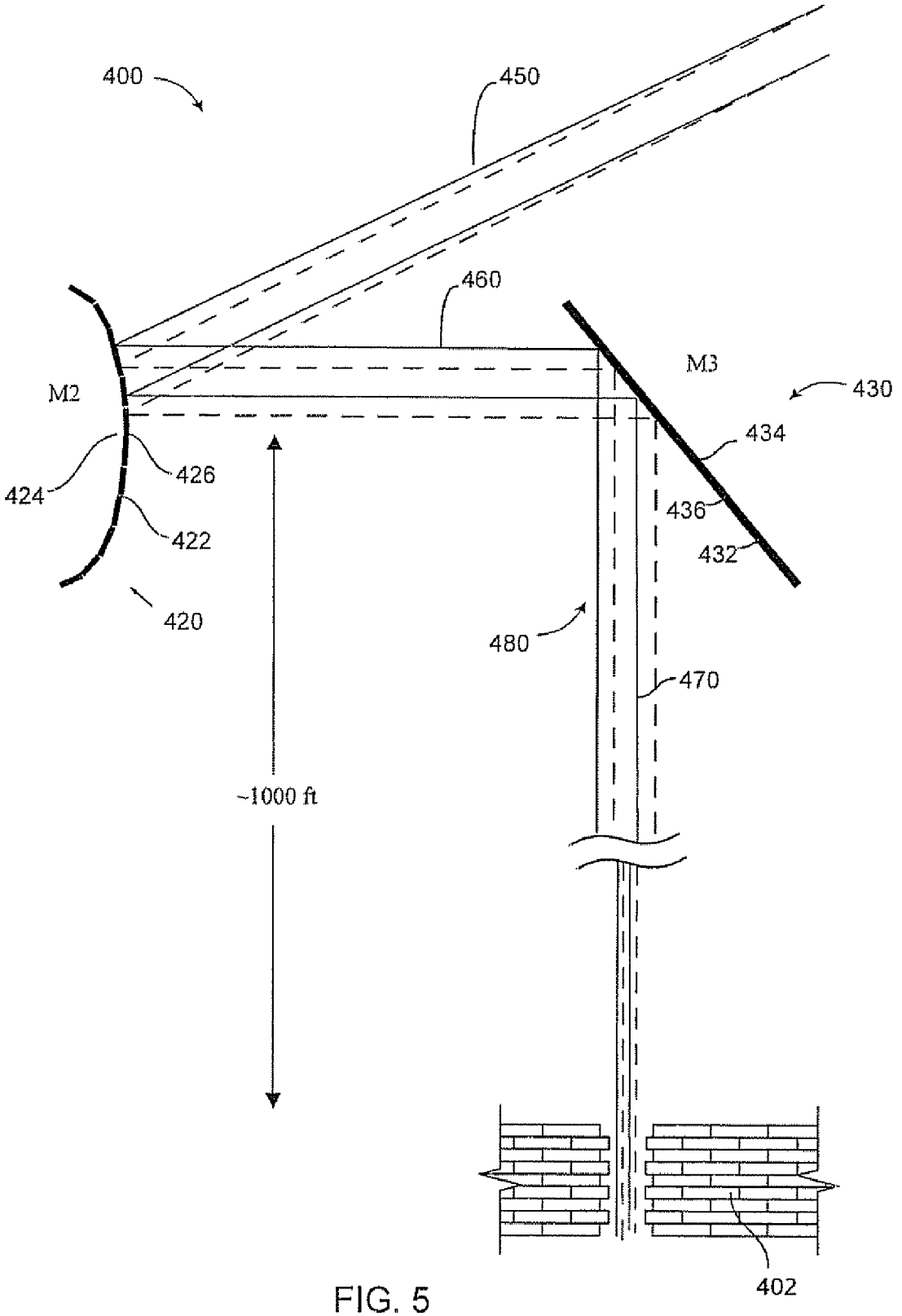

400
450
460
M2
M3
430
434
424
426
436
422
432
420
480
470
~1000 ft
402

FIG. 5

SYSTEM AND METHOD OF IN-SITU SHALE OIL RECOVERY UTILIZING AN INTENSE DOWN-HOLE SOLAR BEAM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 60/941,593, filed Jun. 1, 2007, which is incorporated herein by this reference in its entirety.

FIELD OF THE INVENTION

[0002] This application relates to a unique means of in-situ shale oil recovery utilizing an intense down-hole solar beam of radiant energy from the sun, and more particularly to a system and method of in-situ shale oil recovery utilizing an evacuated well casing, which conveys the intense solar beam of radiant energy to a strata of oil shale.

BACKGROUND

[0003] It has been estimated that two trillion barrels of crude oil are potentially recoverable from shale oil located in the eastern and western states of the United States. However, unlike oil and natural gas, oil shale is easy to locate using current technology. The Mahogany Research Project®, which is an initiative by the Shell Oil Company®, is designed to procure oil from the geologically-termed "Mahogany" layer of oil shale rock on the Colorado plateau. In accordance with the Mahogany Research Project, sections of the vast oil shale field are heated in situ (where it is) deep underground, releasing the oil and natural gas from the rock so that it can be pumped to the surface and made into fuel.

[0004] In the Mahogany Research Project, the oil shale rock is heated to a temperature of approximately 700° F. (371° C.) using heating elements that are embedded into the oil shale rock. The oil and natural gas is then baked out of the rock creating pools that can then be pumped to the surface. Although, this process requires a great deal of energy, it is anticipated that the process will produce more energy than it expends (approximately 3.5 times as much energy comes out as goes in) making it a viable option for the recovery of oil and natural gas.

[0005] Accordingly, it would be desirable to utilize an in-situ shale oil recovery system, which utilizes an intense down-hole solar beam of radiant energy from the sun.

SUMMARY

[0006] In accordance with one embodiment, a system for in-situ oil shale recovery comprises: a well casing having a leak-tight shaft liner; a gas evacuating system for removing gases from the well casing; and a solar collection system for directing radiant energy through the well casing to a strata of oil shale.

[0007] In accordance with another embodiment, a light tube comprises: one or more solar collectors for collecting and directing radiant energy; an evacuated well casing; a liner within the evacuated well casing, the liner having an internal surface treatment to minimize thermal absorption in an upper section of the well casing; one or more transparent, gas tight windows positioned within the well casing; and an absorber surface treatment on a lower section of the well casing, the lower section of the well casing being adjacent to a target rock strata, which produces an in-situ oil recovery by absorbing the radiant energy and effectively transmitting resultant heat to the target rock strata.

[0008] In accordance with a further embodiment, a method of in-situ oil shale recovery comprises: evacuating a well casing; lining an upper section of the well casing with an internal surface treatment to minimize thermal absorption; applying a surface treatment on a lower section of the well casing adjacent to a target strata of oil shale, the surface treatment adapted to absorb radiant energy; and producing in-situ oil recovery by transmitting the radiant energy to the target strata of oil shale.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a perspective view of a system and method of in-situ oil recovery utilizing a down-hole solar beam in accordance with an exemplary embodiment.

[0010] FIG. **2** is a perspective view of a system and method of in-situ oil recovery utilizing a down-hole solar beam in accordance with another exemplary embodiment.

[0011] FIG. **3** is a cross-sectional view of a system and method of in-situ oil recovery utilizing a non-imaging optic system in accordance with another exemplary embodiment.

[0012] FIG. **4** is a cross-sectional view of a solar collection system in accordance with an exemplary embodiment.

[0013] FIG. **5** is a cross-sectional view of a solar collection system in accordance with another exemplary embodiment.

DETAILED DESCRIPTION

[0014] In accordance with an exemplary embodiment, the system **100** as shown in FIG. **1**, provides a unique means of effectively applying radiant energy from the sun to a strata **110** below the earth's surface containing oil shale **112**. The system **100** uses a specially designed light tube comprising a well casing **120** located within a drill hole or drill shaft **102**. The well casing **120** includes a sealed and evacuated liner (i.e., a leak-tight liner) **122** positioned within the well casing **120**, which avoids thermal convection and unwanted movement of heat toward the upper regions of the well casing **120**. In accordance with an exemplary embodiment, the system **100** is configured to heat sections of an oil shale field in situ, releasing the oil and natural gas from the strata so that the oil and natural gas can be pumped to the surface and made into fuel.

[0015] In accordance with an exemplary embodiment, the evacuated liner or leak-tight liner **122** acts as a light tube, which utilizes a liner with an optionally included internal surface treatment **126**, which minimizes the thermal absorption in the upper section of the drill shaft **102** and conveys (i.e., delivers) a solar heat source or radiant energy to the targeted strata **110** of shale oil **112** within the shaft **102**. For example, in the Colorado plateau (i.e., the Mahogany Project), the targeted strata **110** of shale oil **112** is located at approximately one-thousand (1000) feet below a terrain surface **184**.

[0016] In accordance with an exemplary embodiment, the leak-tight liner **122** utilizes one or more transparent, gas tight windows **130**, **134**, which are positioned within the inner or interior portion **124** of the leak-tight liner **122**. The gas tight windows **130**, **134** are preferably made of refractory material, which contains a dispersed refractory material (not shown). The dispersed refractory material absorbs the solar rays and delivers a heat source in the form of radiant energy to the

target heating region of the shaft **102** and well casing **120**. It can be appreciated that the solar heat source or radiant energy is preferably a concentrated energy in the form of light, light rays, solar energy, or solar flux, which provide the energy to heat the oil shale strata **110** in situ.

[0017] In accordance with a further exemplary embodiment, the system **100** can include a solar collection system **150** comprised of one or more solar collectors and/or concentrators, and collimator systems, which collects and conveys (or directs) the resulting radiant energy in the form of intense solar light beam down through the well casing **120**, which has been drilled through the overburden soils and extending into the oil shale strata **110**. In accordance with an exemplary embodiment, the system **100** acts as a light tube that can withstand high temperatures and has minimal interaction with surrounding rock strata and products of in-situ oil recovery by absorbing radiant energy and effectively transmitting resultant heat to target rock strata.

[0018] In accordance with another exemplary embodiment, the system **100** acts as a light tube, which can convert the well casing **120** into a production well once the necessary rock strata temperatures have been reached, and oil and natural gas production can begin.

[0019] In accordance with an exemplary embodiment, the system **100** of in-situ oil recovery utilizing a down-hole solar beam of radiant energy enables long term heating of oil shale strata (i.e., an oil bearing formation) **110** by solar energy. In accordance with an exemplary embodiment, the system **100** permits in-situ conversion of oil shale **112** to an oil by-product. It can be appreciated that once the target strata **110** has reached approximately 650° F. to 700° F., the solar assembly or parts thereof (i.e., solar collection system **150**) can be moved to another site, and oil pumping can commence either through the existing shaft (i.e., well casing **120**) or through nearby separate drill holes.

[0020] As shown in FIG. **1**, the oil shale strata **110** include an upper edge or boundary **114** and a lower edge or boundary **116** with oil shale **112** therein. In accordance with an embodiment, the oil shale strata **110** can include a surrounding freeze barrier (not shown) to preclude or prevent the subterranean flow of water into the oil shale strata **110**.

[0021] In an exemplary embodiment, the system **100** includes a well hole or drill shaft **102** having a well casing **120**, which includes a leak-tight shaft liner **122**, and a gas evacuating system **140** to remove gases from an inner portion or interior **124** of the well casing **120**. The system **100** also preferably includes a solar collection system **150** for collecting and directing a collimated light beam **160** of radiant energy through the interior **124** of the shaft liner **122** of the well casing **120** to the targeted oil shale strata **110**. The system **100** can also include a flush tube **192** for removal of gases and/or other materials from within the inner or interior portion **124** of the well casing **120**.

[0022] In accordance with an exemplary embodiment, the leak-tight shaft liner **122** is a leak-tight stainless steel shaft liner of at least 4 inches in diameter, and more preferably of at least 8 inches in diameter having a ¼ inch wall or equivalent with a transparent top window **130**, which is configured to convey a collimated solar light beam **160** through the interior portion **124** of the shaft liner **122** to the target oil shale strata **110**. The well casing **120** also preferably includes a removable bottom plate or plug **132**. The removable bottom plate or plug **132** is preferably located at or below a lower edge or surface **116** of the target shale strata **110**. In an exemplary embodiment, the bottom plate or plug **132** is opaque.

[0023] In accordance with another exemplary embodiment, the system **100** can include a bottom window **134**, which is positioned within the interior **124** of the shaft liner **122** and at or slightly above an upper portion **114** of the oil shale strata **110**.

[0024] In accordance with an exemplary embodiment, the system **100** includes a gas evacuating system **140**, which is configured to remove gases **142** from the inner or interior portion **124** of the shaft or well casing **120**. The gas evacuating system **140** preferably includes a pump or other suitable suction device (not shown), which removes any and all gases from within the well casing **120**. The removal of any and all gases **142** from the inner or interior portion **124** precludes unwanted thermal convection and other down hole (or well casing **120**) losses.

[0025] In accordance with an exemplary embodiment, the solar collection system **150** includes at least one adjustable aiming mirror **152**, at least one beam collimator **154**, and at least one concentrator **156** having a heliostat (not shown).

[0026] The at least one concentrator **156** includes a reflective surface which redirects the sunlight and radiant energy from the sun to the collimator **154**. In order to maximize the amount of solar energy and heat generated by the system **100**, the concentrator **156** preferably is always directly facing the sun throughout each day and throughout each season of the year. Further, the concentrator **156** is also preferably designed to follow the daily path of the sun as the sun travels across the sky and also to allow the concentrator **156** to continually face the sun approximately perpendicularly throughout the year. In accordance with an exemplary embodiment, the concentrator includes a heliostat or other tracking mechanism (not shown) that tracks the movement of the sun.

[0027] In accordance with an exemplary embodiment as shown in FIG. **1**, the concentrator **156** is oriented such that it collects and directs (i.e. reflects) the sunlight and radiant energy from the sun to the collimator **154**, which directs a collimated beam of light **160** to the at least one adjustable aiming mirror **152**. The at least one adjustable aiming mirror **152** redirects the collimated beam of light (sunlight) along a fixed axis towards the gas tight window **130** positioned on an upper end of the well casing **120**.

[0028] In accordance with an exemplary embodiment, the system **100** also includes an adjustable aperture **190**, which receives the collimated light beam **160** from the aiming mirror **152** and directs the light beam though the casing **120** to the desired oil shale strata **110**. The adjustable aperture **190** can be any suitable hole or opening through which the collimated light beam **160** is admitted.

[0029] The at least one beam collimator **154** preferably gathers or collimates the plurality of solar light beams into a single intense narrow beam or collimated solar light beam **160**, which is directed by the at least one aiming mirror **152** down the hole or well casing **120**. It can be appreciated that the collimator **154** can be any suitable device that narrows a beam of particles or waves, such as a collimator **154** may consist of a curved mirror or lens with some type of light source and/or an image at its focus. The at least one adjustable aiming mirror **152** receives the collimated light beam **160** from the collimator **154** and directs the collimated light beam **160** through or down the well casing **120**.

[0030] In accordance with an exemplary embodiment, it can be appreciated that by removing all gases from the well

casing **120** prior to the collimated beam **160** of radiant energy reaching the targeted oil shale **112**, the system **100** can produce, generate and/or maintain sufficient heat within the well casing **120** to achieve a target temperature of approximately 650° F. to 700° F. without unnecessary heat losses through unwanted thermal convection.

[0031] In accordance with an exemplary embodiment, the shaft liner **122** can include a reflective inner surface or liner **126**, which acts as a light tube within the well casing **120** above the strata **112**. In addition, it can be appreciated that by adding a reflective inner surface or liner **126** to the well casing **120**, the reflective inner surface or liner **126** can reduce the collimator lens requirements of the system **100**.

[0032] As shown in FIG. **1**, the lower portion of the well casing **120**, which is adjacent to the oil shale strata **110** preferably includes a stainless steel fiber liner **144**, which absorbs the resultant radiant heat from the light beam **160** received from the aiming mirror **152**. The lower portion of the well casing **120** can also include an absorber surface treatment **146**, which is configured to absorb the heat from the well casing **120** to bake the oil shale **112**. In addition, at least one additional beam shaping lens **194** can be positioned within the inner or interior portion **124** of the well casing **120** to assist with the guidance of the collimated light beam **160** to a desired portion of the well casing **120**.

[0033] In accordance an exemplary embodiment, the system **100** as described herein, if located on the Colorado plateau could produce incident solar radiation of at least approximately 50 watts per hour (watts/hr) for at least 8 hours per day (hours/day) for at least 200 days per year (days/year), which would produce heating of 80 kilowatt hours per year (kwhr/year).

[0034] It can be appreciated that once the oil and natural gas is released from the oil shale strata **110**, the oil and natural gas is preferably removed from beneath the terrain surface **184** through an oil production pipe or system **180**. The oil production pipe or system **180** preferably includes a valve system **186**, which controls the flow and/or removal of the oil and natural gas from the oil shale strata **110**.

[0035] In accordance with an exemplary embodiment, the concentrator **156** and heliostats (not shown) can be supported on an elevated frame structure **182**. The elevated frame structure not only provides support for the concentrator **156** and/or heliostats, but also can be used to improve the light tube and passage of the sunlight and radiant energy to the collimator **154**, aiming mirror **152** and well casing **120**.

[0036] As shown in FIG. **2**, in accordance with another exemplary embodiment, the well casing **120** can also includes a heat transport material **125**, such as a liquid salt. The heat transport material **125** produces a negative thermal expansion coefficient, such that the heat or radiant energy from the solar light beam **160** is conveyed down-hole by convection. The heat transport material **125** is preferably a liquid salt or other suitable material, which transfers the heat from the solar collection system **150** and the associated radiant energy to the oil shale strata **110**. It can be appreciated that the heat transport material **125** can be selected based on the heat transfer properties of the material **125**, including desired temperature range and/or viscosity of the heat transport material **125**.

[0037] In accordance with an exemplary embodiment, a circulating pump system **196** can be used to pump (or force) the heat transport material **125** through an output pipe or tube **198** to a desired and/or required strata zone **118**. It can be appreciated that the circulating pump system **196** can be located at any desired depth within the well casing **120**. In a preferred embodiment, the depth and/or location of the circulating pump system **196** is preferably at a depth or location within the well casing **120**, which optimizes the radiant energy produced by the solar collection system **150**, the heat transfer properties of the heat transport material, and the depth of the oil shale strata **110**. The system **100** can also include a subterranean heat source (not shown), which can add additional heat to the radiant energy from the solar collection system **150** and/or the heat transport material **125**.

[0038] The system **100** as shown in FIG. **2**, includes a well hole or drill shaft **102** having a well casing **120**, which includes a leak-tight shaft liner **122**, and a gas evacuating system **140** to remove gases from an inner portion or interior **124** of the well casing **120**. The system **100** also includes a solar collection system **150** for collecting and directing a collimated light beam **160** of radiant energy to a thermal conductive body **136** located within the well casing **120**. The thermal conductive body **136** is preferably located within the well casing **120** at a location or depth generally above the oil shale strata **110**. The location or depth of the thermal conductive body **136** within the well casing **120** is preferably a function of the radiant energy produced by the solar collection system **150**, the heat transfer properties of the heat transport material **125**, and the depth of the oil shale strata **110**.

[0039] In accordance with an exemplary embodiment, the thermal conductive body **136** transfers or conducts the radiant energy from the solar collection system **150** to the heat transport material **125**. The heat or radiant energy from the solar light beam **160** is then conveyed down-hole by the heat transport material **125** via convection and/or with the assistance of the circulating pump system **196** and/or piping system **198**. It can be appreciated that the evacuated, optical portion of the shaft or well casing **120** prevents the radiant energy or heat from escaping away from the oil shale strata **110** (i.e., target area), and further an optimal level can be set for passive convection of the heat transport material **125**. In addition, the heat transport material **125** supports the delivery of the radiant energy to the oil shale strata **110** in directional drilling and non-linear well holes or well casings **120**.

[0040] It can be appreciated, that since the target oil shale strata **110** is generally horizontal in nature, the system **100** can utilize a plurality of spaced-apart well holes to provide long term heating to the oil shale strata **110**. Alternatively, the system **100** can implement a directional drilling or slant drilling system by drilling non-vertical wells from one or more well holes to increase the target area and allow the radiant energy to reach the generally horizontal oil shale strata **110**. In accordance with an exemplary embodiment, a directional drilling system can be utilized to provide a single well hole or well casing having a plurality of fingers or well bores (i.e., star formation) extending essentially horizontally outward from the single well hole or well casing **120** to allow the radiant energy generated by the system **100** to heat the oil shale strata **110** to the desired temperature. In accordance with an exemplary embodiment, the directional drilling system utilizes a heat transport material **125** to allow for the non-linear conditions in directional drilling or slant drilling systems.

[0041] FIG. **3** is a cross-sectional view of a system **200** of in-situ oil recovery utilizing a non-imaging optical system in accordance with another exemplary embodiment. As shown in FIG. **3**, the system **200** includes a solar collection area **202** having a steerable reflector system **206**, and an oil drilling area **204** having a fixed or stationary reflector system **208**,

which are used to concentrate solar energy radiating from the sun (not shown). The steerable reflector system **206** is preferably positioned within a solar collection area **202**, which can optimize solar conditions, including optimum sight lines and collection abilities. In accordance with an exemplary embodiment, the solar collection area **202** is preferably adjacent to the oil drilling area **204**.

[0042] The system **200** is preferably comprised of a non-imaging optical system, which optimizes the transfer of light radiation or radiant energy between the sun (not shown) and the oil shale strata **210**. As shown in FIG. **3**, the steerable reflector system **206** includes a plurality of reflective mirrors **220**, **230**, **240** having a corresponding reflective surface **222**, **232**, **242**. In accordance with an exemplary embodiment, the first reflective mirror **220**, having a heliostat associated therewith, has a curved reflective surface **222**, which is preferably concave, and more preferably spherical or parabolic in shape. A second reflective mirror **230** having a convex reflective surface **232** receives the beams of light from the first reflective surface **222**. A third reflective mirror **240** having a flat or planar reflective surface **242** receives the beams of light from the second reflective mirror **230** and directs the plurality of solar beams and radiant energy to the fixed or stationary reflector **208**.

[0043] The fixed or stationary reflector **208** includes a first reflective mirror **250** having a concaved reflective surface **252**, which is preferably spherical or parabolic in shape. A second reflective mirror **260** having a convex reflective surface **262** receives the beams of light from the first reflective surface **252**. A third reflective mirror **270** having a flat or planar reflective surface **272** receives the beams of light from the second reflective mirror **260** and directs the plurality of solar beams to the well casing **214** and oil shale strata **210** and oil shale **212** located below. It can be appreciated that unlike traditional imaging optics, the non-imaging optical system **200** as shown in FIG. **3** does not attempt to form an image or concentration of the radiant energy, but instead optimizes the radiative transfer from the source (i.e., sun) to the target (i.e. oil shale strata **210**) by directing a plurality of light beams having radiant energy through the well casing **214** to the strata **210** of oil shale **212**.

[0044] It can be appreciated that in accordance with a further embodiment, each of the well casings **214** can be associated with one or more non-imaging optical systems **200**, and wherein each system **200** includes a plurality of solar collection areas **202**, each having a steerable reflector system **206** and an oil drilling area **204** having at least one fixed or stationary reflector system **208**

[0045] FIG. **4** is a cross-sectional view of a solar collection system **300** in accordance with an exemplary embodiment, wherein the system **300** is a non-optical imaging system. As shown in FIG. **4**, the system **300** includes a first reflective mirror **310** having a heliostat (not shown), a second reflective mirror **320** and a third reflective mirror **330**. In accordance with an exemplary embodiment, the first reflective mirror **310** has a concaved reflective surface **312**, which is preferably spherical or parabolic in shape and an outer portion **314**. The concaved reflective portion **312** includes a reflective surface **316**, which receives (or collects) a source of solar heat preferably in the form of a plurality of beams of light, light rays, solar energy, solar flux or radiant energy **340** from the sun. The reflective surface **316** of the first reflective mirror **310** then directs (or distributes) the beams of light **340** to the second reflective mirror **320**.

[0046] The second reflective mirror **320** having a convex reflective portion **322** receives the beams of light **350** from the first reflective portion **312** and directs the beams of light to a third reflective mirror **330**. The second reflective mirror **320** also includes an outer portion **334** and a reflective surface **326**. The third reflective mirror **330** has a flat or planar reflective surface portion **332**, which receives the beams of light from the second reflective mirror **320** and directs the plurality of solar beams of radiant energy **370** to the well casing (not shown) and to the strata of oil shale (not shown) located below.

[0047] FIG. **5** is a cross-sectional view of the second and third reflective mirrors **420**, **430** of a solar collection system **400** in accordance with another exemplary embodiment. As shown in FIG. **5**, a plurality of light beams **450** are reflected off a first reflective or parabolic mirror (not shown) and which is received by the second reflective mirror **420**. In accordance with an exemplary embodiment, the second reflective mirror **420** is a non-imaging faceted mirror having a reflective surface **422** comprised of a plurality of facets **426**. It can be appreciated that in accordance with an exemplary embodiment, the plurality of facets **426** reduces the divergence within the system **400**.

[0048] The third reflective mirror **430** is preferably a flat or planar mirror, which receives the plurality of light beams **460** from the non-imaging faceted mirror **420**. The third reflective mirror **420** collects and distributes the light beams **470** in a light path **480**.

[0049] In accordance with an exemplary embodiment, the systems **300**, **400** as shown in FIGS. **4** and **5** can include a first reflective mirror (M**1**) having a 15 foot diameter and a f**1** of 7.5 feet (with inherent divergence of approximately 10 mrads), a second reflective mirror (M**2**) having a 12 inch diameter and a f**2** of approximately 0.45 feet and spaced from the first reflective mirror at a distance of approximately 7 feet, and third reflective mirror (M**3**). In accordance with an exemplary embodiment, the second reflective mirror is a non-imaging faceted mirror having a 12 inch diameter with approximately 400 facets, which can reduce the divergence to 0.5 mrad with focus at 1000 feet. With the above-mentioned 12 inch faceted mirror and a third planar mirror, a light path **480** can be produced having a ½ inch width per facet (0.5 mrad divergence after the second reflective mirror **420**) for a target (i.e., strata of oil shale) at 1000 feet, the light path having a width of ½ of an inch preferably fits within a well casing having a diameter of at least 6.5 inches (D**1**=0.5+ 1000×12×1/2,000=6.5 inches).

[0050] In accordance with another exemplary embodiment, it can be appreciated that with the non-imaging optical systems **200**, **300**, **400** can employ a variety of technologies alone or in combination, for example, compound parabolic concentrators as shown in FIGS. **3-5**, adaptive mirror arrays with Fresnel lens (i.e., computer controlled mirrors that focus the mirrors on a common target), parabolic trough generators, hemispherical solar concentrators, and/or Fresnel lenses or prisms.

[0051] It can be appreciated that the system and methods **100**, **200**, **300**, **400** as described herein can be extended or applied to other mineral operations, which benefit from a subterranean heat source.

[0052] It will be understood that the foregoing description is of the preferred embodiments, and is, therefore, merely representative of the system and method. It can be appreciated that many variations and modifications of the different

embodiments in light of the above teachings will be readily apparent to those skilled in the art. Accordingly, the exemplary embodiments, as well as alternative embodiments, may be made without departing from the spirit and scope of the articles and methods as set forth in the attached claims.

What is claimed is:

1. A system for in-situ oil shale recovery comprising:
a well casing having a leak-tight shaft liner;
a gas evacuating system for removing gases from the well casing; and
a solar collection system for directing radiant energy through the well casing to a strata of oil shale.

2. The system of claim **1**, wherein the solar collection system comprises at least one concentrator, at least one collimator, and at least one aiming mirror.

3. The system of claim **2**, further comprising a heliostat.

4. The system of claim **1**, wherein the solar collection system is a non-imaging optical system.

5. The system of claim **4**, wherein the non-imaging optical system includes a plurality of non-imaging reflective mirrors.

6. The system of claim **1**, wherein the well casing includes a transparent top window and an opaque bottom plug.

7. The system of claim **6**, further comprising a bottom window, the bottom window positioned within the well casing at or slightly above an upper portion of the strata of oil shale.

8. The system of claim **1**, wherein a lower section of the shaft liner adjacent to a target strata of oil shale includes a surface treatment, which absorbs heat from the radiant energy.

9. The system of claim **8**, wherein the surface treatment is a heat resistant stainless steel fiber.

10. The system of claim **1**, wherein an upper portion of the liner includes a reflective surface treatment.

11. The system of claim **2**, wherein the at least one concentrator further includes at least one beam shaping lens.

12. The system of claim **1**, further comprising a flush tube, which is adapted to remove gaseous materials from the well casing.

13 The system of claim **1**, further comprising a heat transport material having a negative thermal expansion coefficient so that heat from the radiant energy is conveyed down-hole by convection.

14. The system of claim **13**, wherein the heat transport material is a liquid salt.

15. A light tube comprising:
one or more solar collectors for collecting and directing radiant energy;
an evacuated well casing;
a liner within the evacuated well casing, the liner having an internal surface treatment to minimize thermal absorption in an upper section of the well casing;
one or more transparent, gas tight windows positioned within the well casing; and
an absorber surface treatment on a lower section of the well casing, the lower section of the well casing being adjacent to a target rock strata, which produces an in-situ oil recovery by absorbing the radiant energy and effectively transmitting the resultant heat to the target rock strata.

16. The light tube of claim **15**, wherein the one or more solar collectors are non-imaging reflective mirrors.

17. The light tube of claim **16**, wherein the non-imaging reflective mirrors comprise a pair of non-imaging reflective mirror systems having a concave reflective mirror, a convex reflective mirror, and a planar reflective mirror.

18. A method of in-situ oil shale recovery comprising:
evacuating a well casing;
lining an upper section of the well casing with an internal surface treatment to minimize thermal absorption;
applying a surface treatment on a lower section of the well casing adjacent to a target strata of oil shale, the surface treatment adapted to absorb radiant energy; and
producing in-situ oil recovery by transmitting the radiant energy to the target strata of oil shale.

19. The method of claim **18**, further comprising collecting and directing the radiant energy by collimating a plurality of solar beams into a single solar beam.

20. The method of claim **18**, further comprising collecting and directing the radiant energy using a plurality of non-imaging reflective mirrors.

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