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(71) Applicant (for all designated States except US): M-I LLC

[US/US]; 5950 North Course Drive, Houston, TX 77072 (US).

(72) Inventors; and

(75) **Inventors/Applicants (for US only):** FREEMAN,

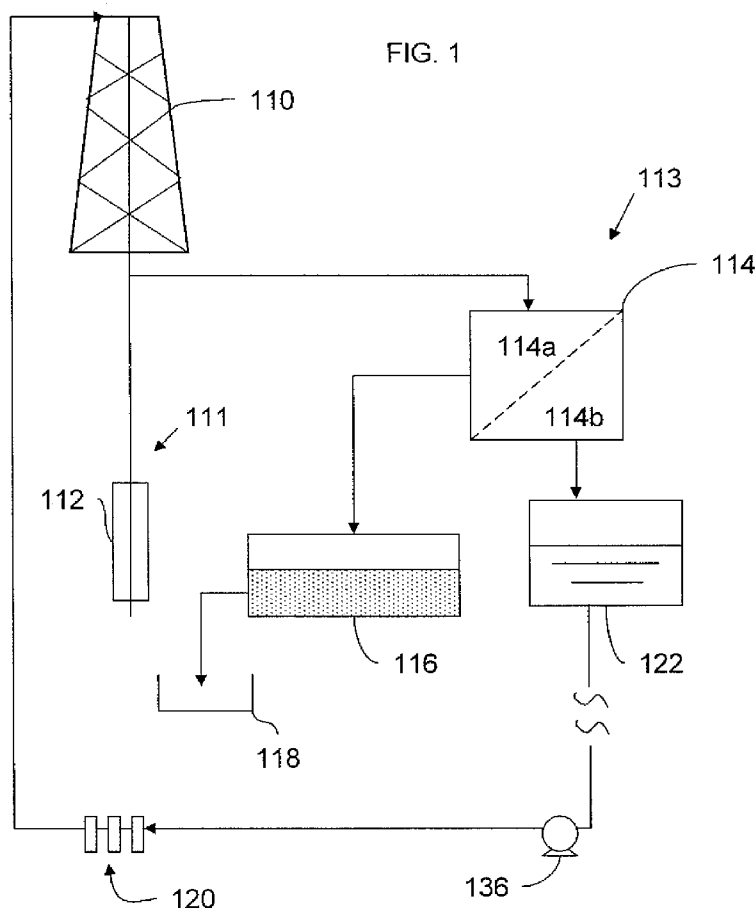
Michael, A. [US/US]; 3107 Greenwood Glen Dr., Kingwood, TX 77345 (US). **DABOIN, Nestor, W.** [US/US]; 23166 Tranquil Springs Lane, Katy, TX 77494 (US). **SIMPSON, Barry** [GB/VE]; Edificio Aguas Arriba, Apt. 3a, Calle B, Colinas De Valle Arriba, Caracas (VE). **ROBERTS, Nicholas, D.** [GB/BR]; Apt. 1002 Bloco 1, Av. Lucio Costa, 3600 Rio De Janeiro (BR). **BAYTER, Rafael** [CO/CO]; Calle 55A #27-41 Apto 501, Bucaramanga (CO).

(74) Agents: BERGMAN, Jeffrey, S. et al.; Osha - Liang LLP, 1221 McKinney St., Suite 2800, Houston, TX 77010 (US).

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[Continued on next page]

(54) Title: HEAVY OIL DRILLING AND RECOVERY



(57) Abstract: A method of drilling a formation containing heavy oil that includes providing a drilling fluid comprising: a base fluid; and a separating agent characterized as enhancing the separation of heavy oil from a drilling fluid; drilling the formation containing the heavy oil using the drilling fluid; returning the drilling fluid to a formation surface, wherein the returned drilling fluid contains a portion of the heavy oil therein; removing at least a portion of the heavy oil from the returned drilling fluid; and recirculating the drilling fluid into the formation is disclosed.



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HEAVY OIL DRILLING AND RECOVERY

BACKGROUND OF INVENTION

Field of the Invention

[0001] Embodiments disclosed herein relate generally to drilling and recovery techniques for heavy oil.

Background Art

[0002] When drilling or completing wells in earth formations, various fluids are used in the well for a variety of reasons. Common uses for well fluids include: lubrication and cooling of drill bit cutting surfaces while drilling, generally, or drilling-in (*i.e.*, drilling in a targeted petroliferous formation), transportation of “cuttings” (pieces of formation dislodged by the cutting action of the teeth on a drill bit) to the surface, controlling formation fluid pressure to prevent blowouts, maintaining well stability, suspending solids in the well, minimizing fluid loss into and stabilizing the formation through which the well is being drilled, fracturing the formation in the vicinity of the well, displacing the fluid within the well with another fluid, cleaning the well, testing the well, transmitting hydraulic horsepower to the drill bit, fluid used for emplacing a packer, abandoning the well or preparing the well for abandonment, and otherwise treating the well or the formation.

[0003] Depending on the type of formation being drilled, a drilling fluid engineer selects the fluid most appropriate for the particular formation. Drilling of subterranean tar, tar sands, or heavy oil presents unique challenges to the engineer in selecting a fluid. “Heavy oil” is defined in the industry as hydrocarbons having lower than 22° API gravity and viscosity greater than 100 cP, while “extra heavy oil” has less than 10° API gravity. “Bitumen” overlaps extra heavy oil and is characterized by a viscosity greater than 10,000 cP *in situ*. Heavy oil typically contains high boiling point, structurally complex asphaltenes and naphthenic acid components, as well as high heteroatom content, including S, N, O, and metals.

[0004] Due to the high viscosity of heavy oils, natural production rates are low, and the total volume of reservoir that can be economically drained with one wellbore is than that with less viscous oils. Indeed, in the case of bitumen, the oil cannot be

produced without thermal stimulation or solvent injection. For example, tar sands generally refer to a combination of clay, sand, water, and bitumen. Due to the inability to pump the heavy oil from the ground in its natural state, tar sands are typically mined and processed to extract the hydrocarbons. However, for deposits buried too deep for mining, drilling and *in situ* production methods, such as steam assisted gravity drainage (SAGD), are in continuous development as the estimated volume of oil reserves found in such formations is steadily increasing. When using SAGD, two holes may be drilled horizontally, one hole being above the other. Steam injected into the upper hole liquefies the heavy oil for collection. However, many wells are required to be drilled to develop the reservoir.

[0005] Due to the complexity of drilling in tar sands or heavy oil, prior attempts to drill in such formations were unable to obtain most if not all of the following objectives: a) prevention of tar blinding the shaker screens; b) prevention or reduction of tar sticking to a bottom hole assembly (BHA) and causing high torque and drag; c) stripping of tar from the drilled sands; d) providing good hole cleaning in horizontal reservoirs; and e) minimization of harm to the productivity of the formation. Drilling fluids containing surfactants alone fail to remove tar and generally result in a foamy fluid. The use of cleaning solvents useful in cleaning tar has been found to aggressively dissolve the surrounding formation and thus destroy the wellbore. Further, it has been reported that the use of mixtures of surfactants and tar solvents generates fluids exhibiting both foaming and dissolution of the wellbore and formation.

[0006] In current drilling practices for tar sands or heavy oil, as the drilling progresses, tar sands are brought to the surface with the returned drilling fluid. In order to pass returned fluid through shaker screens without the tar blinding or clogging the shaker screens, diesel oil is added thereto to make the screens oil-wet and to allow the dissolution of heavy oil into the fluid so that the heavy oil is flowed through the screens. A small volume of heavy oil may be removed from the surface of the recovered drilling fluid; however, most of the heavy oil is recirculated with the recovered drilling fluid and is pumped through the system, through the drill string and is jetted out of the drill bit. With the pumping and high jetting pressures, the heavy oil becomes finely divided, and when jetted against the formation at high

impingement pressures, the finely divided heavy oil binds with fine formation particles, *i.e.*, clays. Once bound, the heavy oil-clay further agglomerates, forming a heavy and stiff mass. At this point, the heavy oil bound to the clays becomes irrecoverable.

[0007] Accordingly, there exists a continuing need for improved techniques for drilling in heavy oil or tar sands.

SUMMARY OF INVENTION

[0008] In one aspect, embodiments disclosed herein relate to a method of drilling a formation containing heavy oil that includes providing a drilling fluid comprising: a base fluid; and a separating agent characterized as enhancing the separation of heavy oil from a drilling fluid; drilling the formation containing the heavy oil using the drilling fluid; returning the drilling fluid to a formation surface, wherein the returned drilling fluid contains a portion of the heavy oil therein; removing at least a portion of the heavy oil from the returned drilling fluid; and recirculating the drilling fluid into the formation.

[0009] In another aspect, embodiments disclosed herein relate to a method of recovering heavy oil from a drilling fluid that includes providing a returned drilling fluid to a separating apparatus, wherein the returned drilling fluid comprises: a base fluid; a separating agent characterized as enhancing the separation of heavy oil from a drilling fluid; and heavy oil; separating the heavy oil from the drilling fluid; and collecting the separated heavy oil.

[0010] In yet another aspect, embodiments disclosed herein relate to a system for recovering heavy oil that includes a formation having heavy oil therein; a drilling assembly for forming a wellbore through the formation; a mud pump for pumping a drilling fluid through the drilling assembly and wellbore, the drilling fluid comprising: a base fluid; and a separating agent characterized as enhancing the separation of heavy oil from a drilling fluid; a separation apparatus in fluid connection with the wellbore for separating heavy oil entrained in a drilling fluid returned from the wellbore; and a collection unit for collecting the heavy oil separated from the returned drilling fluid.

[0011] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 shows a system for recovering heavy oil in accordance with embodiments disclosed herein.

[0013] FIG. 2 shows a system for recovering heavy oil in accordance with embodiments disclosed herein.

[0014] FIG. 3 shows a method of drilling a formation containing a heavy oil in accordance with embodiments disclosed herein.

[0015] FIG. 4 shows a method for recovering heavy oil in accordance with embodiments disclosed herein.

DETAILED DESCRIPTION

[0016] In one aspect, embodiments disclosed herein relate to methods and systems for drilling in heavy oil. In another aspect, embodiments disclosed herein relate to methods and systems for the recovery of heavy oil from a drilling process.

[0017] Referring to FIG. 1, a system for drilling a formation and recovering heavy oil from a drilling fluid in accordance with embodiments disclosed herein is shown. A drill bit (not shown) is used to dig many thousands of feet into the earth's crust, generally referred to as an earth formation. Oil rigs typically employ a derrick 110 that extends above the well drilling platform. The derrick 110 supports joint after joint of drill pipe connected end to end during the drilling operation. As the drill bit is pushed further into the earth, additional pipe joints are added to the ever lengthening "string" or "drill string". Therefore, the drill string includes a plurality of joints of pipe. The plurality of joints of pipes, the drill bit, and additional tools connected to the joints of pipe may be generally referred to as a drilling assembly 111.

[0018] The drilling assembly 111 drills a wellbore 112 in an earth formation. To facilitate drilling or completion of the well, a drilling fluid, also known as a drilling mud is pumped from the well drilling platform, through the drill string, and to the drill bit supported at the lower or distal end of the drill string. The drilling mud lubricates

the drill bit and carries away well cuttings generated by the drill bit as it digs deeper. The cuttings are returned to the well drilling platform at the formation surface by the drilling fluid, or returned drilling fluid, through the well annulus.

[0019] In one embodiment, the drilling fluid includes a base fluid and a separating agent characterized as enhancing the separation of heavy oil from a drilling fluid. In embodiments disclosed herein, the drilling fluid is aqueous based and may include water-wetting surfactants in addition to conventional aqueous based drilling fluid components and/or in addition to other components that may be helpful in drilling heavy oil formations, such as heavy oil solvents and oil emulsifying surfactants. In formulating the drilling fluids of the present disclosure, one of skill in the art will appreciate that a design criterion for the fluid may include facilitation of separating heavy oil from the fluid and/or prevention of blinding or clogging of shaker screens by heavy oil in a returned drilling fluid.

[0020] Types of such water-wetting surfactants that may be used in the fluid of the present disclosure include pyrophosphates, such as sodium acid pyrophosphate. One example of a pyrophosphate may include SAPPTM, a pyrophosphate commercially available from M-I LLC (Houston, Texas). In other embodiments, a separating agent of the present disclosure may include other types of water-wetting surfactants, such as alcohol ethoxylates, diethylene glycol ethers, and quaternary amine salts. SAFE-SURFTM O, commercially available from M-I LLC (Houston, Texas) is a blend of surfactants and water-wetting agents that may also be used as a separating agent in a fluid of the present disclosure. While reference has been made to certain types of water-wetting agents, one of ordinary skill in the art would appreciate that other types of water-wetting agents may be used as a separating agent of the present disclosure. For example, one of ordinary skill in the art would appreciate that other types of water-wetting surfactants, such as silicates, linear alkylbenzene sulfonates, may alternatively be used in the wellbore fluid of the present disclosure.

[0021] As previously noted the drilling fluids of the present disclosure can contain a wide variety of additives and components typical of wellbore fluids. Specifically, weighting agents may be included in the formulation of the drilling fluid to impart the desired density. Weighting agents or density materials suitable for use in the described drilling fluids include galena, hematite, magnetite, iron oxides, illmenite,

barite, siderite, celestite, dolomite, calcite, and the like. The quantity of such material added, if any, depends upon the desired density of the final composition. Typically, weight material is added to result in a drilling fluid density of up to about 24 pounds per gallon. The weight material is preferably added up to 21 pounds per gallon and most preferably up to 19.5 pounds per gallon.

[0022] Organophillic clays, normally amine treated clays, may be useful as viscosifiers in the fluid compositions of the disclosed subject matter. The amount of organophillic clay used in the composition should be minimized to avoid an adverse effect upon the rheological properties of the present inventive drilling fluids. However, normally about 0.1% to 6% by weight range is sufficient for most applications. VG-69 and VG-PLUS are organo-clay materials distributed by M-I L.L.C., Versa-HRP is a polyamide resin material manufactured and distributed by M-I L.L.C., and POLYPACTM R is a polyanionic cellulose commercially available from M-I LLC that may be used in drilling fluids in accordance with embodiments disclosed herein.

[0023] Additionally, as described above, other components that may be added in drilling heavy oil formations, such as heavy oil solvents and oil emulsifying surfactants, may included in the drilling fluid of the present disclosure. SAFESOLVTM OM is a blend of solvents and TARCLEANTM is a cleaning solvent, both commercially available from M-I LLC, which may also be used in a drilling fluid of the present disclosure.

[0024] Still referring to FIG. 1, when drilling in tar sands, the returned drilling fluid is contaminated with small pieces of shale and rock (known in the industry as well cuttings or drill cuttings), tar sand, and heavy oil, including bitumens. In accordance with embodiments disclosed herein, once the returned drilling fluid from wellbore 112 reaches the formation surface, the returned drilling fluid is conveyed to a separating apparatus 113. Separating apparatus 113 may include a shale shaker, a cyclone separator, any other separating device known in the art, or a combination of devices thereof.

[0025] In the embodiment shown, separating apparatus 113 is a shale shaker 114. Commercially available shale shakers that may be used in accordance with embodiments disclosed herein include the Mongoose® PT shaker, available from M-I

SWACO (Houston, TX). Shale shaker 114 includes a vibrating sieve (not shown), wherein as the returned drilling fluid moves over a cloth or mesh screen of the vibrating sieve, liquids and solids smaller than the mesh pass through the screen, shown at 114b, into a holding tank 122. Larger particles, including cuttings and tar sands, and/or viscous oils, including bitumen, retained on the screen, indicated at 114a, travel to the end of the shaker screen, and may be collected in a cuttings tank 116.

[0026] In one embodiment, the separating agent of the returned drilling fluid provides a water-wet surface on shale shaker 114. As used herein, 'water-wet' refers to a condition when the surface of the openings in the mesh of the shaker screen is entirely covered by a water-based material. A water-wet screen may be formed when a surfactant adsorbs to the screen surface, reduces the interfacial tension, and modifies the ability of water to wet the screen surface. When a surfactant, having a polar head and hydrophobic tail, is oriented such that the polar head is away from the screen surface, an increase in water-wetting will result.

[0027] When the surface of the shaker screen is water-wet, oil-based materials, including, for example, viscous oils, tar sands, and bitumen, may be retained on the shaker screen. Additionally, water-based materials, including returned drilling fluid, and drill cuttings smaller than the mesh openings pass through the shaker screen into holding tank 122. Because the surface of the shaker screen is water-wet, materials retained on the shaker screen, including oil-based materials and drill cuttings larger than the mesh openings may slide off or move down the surface of the shaker screen and into tank 116. Thus, in one embodiment, the separating agent of returned drilling fluid may reduce or prevent blinding of shale shaker 114. Drilling fluids and any drill cuttings smaller than the mesh openings of the shaker screen filtered through the shaker screen into holding tank 122. One of ordinary skill in the art will appreciate that any number of tanks may be fluidly connected and provided to transfer fluid between one or more tanks to provide further filtering of the returned drilling fluid, as needed, prior to recirculation of returned drilling fluid by mud pump 136 without departing from the scope of embodiments disclosed herein.

[0028] In one embodiment, the mixture of sand, oils, and drill cuttings in cuttings tank 116 may be transferred to tank 118 for further processing to recover

hydrocarbons therefrom. Various recovery techniques are known in the art, including chemical and/or mechanical treatments. Examples of treatment systems that may be used to treat a mixture of sand, oils, and drill cuttings collected from the returned drilling fluid include those described in U.S. Patent Application No. 11/368,371 and U.S. Patent Publication No. 2006/0273051, both of which are assigned to the present assignee and incorporated by reference herein. While reference is made to these two treatment systems, one of ordinary skill in the art would appreciate that any other type of recovery technique may be used to separate and recover tar or heavy oils from the sand and drill cuttings.

[0029] Referring now to FIG. 2, another system for drilling a formation and recovering heavy oil from a drilling fluid in accordance with embodiments disclosed herein is shown. As described above with respect to FIG. 1, once the returned drilling fluid from wellbore 212 reaches the formation surface, the returned drilling fluid is conveyed to a separating apparatus 213. Separating apparatus 213 may include a shale shaker, a cyclone separator, any other separating device known in the art, or a combination of devices thereof. In the embodiment shown, separating apparatus 113 is a shale shaker 114. Commercially available shale shakers that may be used in accordance with embodiments disclosed herein include the Mongoose® PT shaker, available from M-I SWACO (Houston, TX). Shale shaker 114 includes a vibrating sieve (not shown), wherein as the returned drilling fluid moves over a cloth or mesh screen of the vibrating sieve, liquids and solids smaller than the mesh pass through the screen, shown at 114b, into a holding tank 122. Larger particles, including cuttings and tar sands, and/or viscous oils, including bitumen, retained on the screen, indicated at 214a, travel to the end of the shaker screen, and may be collected in a cuttings tank 216.

[0030] In one embodiment, the separating agent of the returned drilling fluid provides a water-wet surface on shale shaker 214. When the surface of the shaker screen is water-wet, oil-based materials, including, for example, viscous oils, tar sands, and bitumen, may be retained on the shaker screen. Additionally, water-based materials, including returned drilling fluid, and drill cuttings smaller than the mesh openings pass through the shaker screen into holding tank 222. Because the surface of the shaker screen is water-wet, materials retained on the shaker screen, including oil-

based materials and drill cuttings larger than the mesh openings may slide off or move down the surface of the shaker screen and into tank 216. Thus, in one embodiment, the separating agent of returned drilling fluid may reduce or prevent blinding of separating apparatus 214.

[0031] Thus, while a majority of the bitumen or heavy oil may be separated from the returned drilling fluid by separating apparatus 213, any oils that are passed through the separating apparatus 213 may be further removed from the system using additional filtration techniques, as described below.

[0032] Drilling fluids and any drill cuttings smaller than the mesh openings of the shaker screen filtered through the shaker screen into holding tank 222 may be pumped via pump 238 to a second tank 224. In the embodiment shown, second tank 224 is coupled to a third tank 226 and a fourth tank 228. Third tank 226 and fourth tank 228 may be provided to provide further filtration of the returned drilling fluid. One of ordinary skill in the art will appreciate that any number of tanks may be fluidly connected and provided to transfer fluid between one or more tanks to provide further filtering of the returned drilling fluid, as needed, without departing from the scope of embodiments disclosed herein.

[0033] In one embodiment, at least one of second tank 224, third tank 226, and fourth tank 228 include a settling tank that allows any bitumen or heavy oils that passed through shale shaker 214, drill cuttings and/or sand, and water, to segregate into layers. Thus, while a majority of the bitumen or heavy oil may be separated from the returned drilling fluid at shale shaker 214, for any oils that pass through the shale shaker 214, it may be desirable to include addition separation means to remove any contaminating oils still present in the returned drilling fluid.

[0034] Thus, in one embodiment, drill cutting passed through the mesh of the shaker screen of shale shaker 214 may settle to the bottom of second, third, and/or fourth tank 224, 226, 228. Additionally, bitumen oils may rise to the surface of the contained fluid in second, third, and/or fourth tank 224, 226, 228.

[0035] In one embodiment, a filter system (not shown) may be provided in one or more of second, third, and fourth tanks 224, 226, 228 to remove or filter any bitumen or heavy oil retained in the returned drilling fluid from the returned drilling fluid. In

one embodiment, the filter system may include a hydrocarbon removing device (not shown) to remove the bitumen oil from the surface of the water. For example, hydrocarbon removing device may be a disc skimmer configured to skim the surface of the contained fluid and remove bitumen oil. In other embodiments, the filter system (not shown) may include a number of different filters including, for example, hydrocarbon filters and filter presses, depending on the specific properties of the drilling fluid being processed. Those of ordinary skill in the art will appreciate that fluids containing substantially low levels of hydrocarbon content may merely be filtered through a hydrocarbon filter, while dense fluids including large amounts of solid matter may be filtered through a filter press, centrifuge, or other filtering means. The separated bitumen oil may be transferred to a collection tank 218a or, in some embodiments, to holding tank 222, through a conveying line (not shown in detail), an overflow, or any other process known to one of ordinary skill in the art.

[0036] While gravity separation may encourage bitumen oil to separate from solids and/or water-based fluids, agitation of returned drilling fluid in second, third, and/or fourth tanks 224, 226, 228, may assist in the process. In one embodiment, the agitation of the returned drilling fluid may occur through aeration supplied to second, third, and/or fourth tanks 224, 226, 228 from an air compressor (not shown). The air may be added to returned drilling fluid through holes drilled in the bottom of second, third, and/or fourth tanks 224, 226, 228. As the air rises through the returned drilling fluid, the air may promote the separation of any bitumen or heavy oils present from solids by trapping the bitumen oil on the surface of bubbles. The bubbles may then rise to the surface of the returned drilling fluid in the form of a froth. The froth may be removed from second, third, and/or fourth tanks 224, 226, 228 by a hydrocarbon removing device (not shown), and transferred to a collection tank or, in some embodiments, holding tank 222. In certain embodiments, it may be beneficial to use hot water separation, air agitation, and other processes of separation known to one of ordinary skill in the art, in the same system, to increase the rate of bitumen oil separation.

[0037] After settling and/or filtering of returned drilling fluid in one or more of second, third, and fourth tanks 224, 226, 228, the returned drilling fluid may be pumped via pumps 234 to clean tank 230. In alternate embodiments, filtered returned

drilling fluids from one or more of second, third, and fourth tanks 224, 226, 228, may be pumped via pumps 232, 234, to a hydrocyclone or centrifuge (not shown) for further filtration of the returned drilling fluids. In this embodiment, returned drilling fluid filtered by the hydrocyclone or centrifuge may then be pumped to clean tank 230. Pumps 232, 234, 238 may include a centrifugal pump, a conical pump, or any other pumping apparatus known in the art. In other embodiments, pumps 232, 234, 238 may include a grinding pump, as disclosed in U.S. Patent No. 5,129,469, and incorporated by reference herein, to further reduce the size of any entrained drill cuttings or particles in the returned drilling fluid.

[0038] Filtered returned drilling fluid stored in clean tank 230 may be pumped via pump 236 to at least one mud pump 220. Mud pumps 220 may then pump the filtered returned drilling fluid down through the drilling assembly 211 into wellbore 212. Thus, the drilling fluid used in embodiments of the present disclosure may be filtered and recycled.

[0039] In one embodiment, the mixture of sand, oils, and drill cuttings in cuttings tank 216 may be transferred to tank 218a for further processing to recover hydrocarbons therefrom. Various recovery techniques are known in the art, including chemical and/or mechanical treatments. Examples of treatment systems that may be used to treat a mixture of sand, oils, and drill cuttings collected from the returned drilling fluid include those described in U.S. Patent Application No. 11/368,371 and U.S. Patent Publication No. 2006/0273051, both of which are assigned to the present assignee and incorporated by reference herein. While reference is made to these two treatment systems, one of ordinary skill in the art would appreciate that any other type of recovery technique may be used to separate and recover tar or heavy oils from the sand and drill cuttings.

[0040] In an alternate embodiment, the larger particles, including cuttings and tar sands, and/or viscous oils, including bitumen, retained on the screen and collected in cuttings tank 216 may be diluted with sand in tank 218b. For example, in one embodiment, sand may be added to cuttings tank 216 to mix with the oils retained on shale shaker 214. A mixture of a predetermined ratio of oils, including bitumen, to sand may then be disposed of in accordance with environmental standards. In one embodiment, the mixture may be transferred to collection tank 218b for disposal or

further treatment. In some embodiments, the mixture of sand, oils, and drill cuttings may be disposed of in a sand pit.

[0041] Referring initially to FIG. 3, a general overview of a method of drilling a formation containing heavy oil in accordance with embodiments disclosed herein is provided. As shown, a drilling fluid having a base fluid and a separating agent is provided (ST302), and the formation containing heavy oil is drilled using the drilling fluid (ST304). The separating agent may be characterized as enhancing the separation of heavy oil from a drilling fluid, as described above. In one embodiment, the separating agent of the drilling fluid may include a water-wetting agent.

[0042] As a drill bit at a lower end of a drilling assembly drills through the formation, the drilling fluid exits through the drill bit to cool the drill bit during drilling and is returned to the surface of the formation (ST306), thereby transporting cuttings dislodged by the cutting action and a portion of the heavy oil to the surface. Once at the surface, the returned drilling fluid is conveyed to a separating apparatus to remove at least a portion of the heavy oil from the returned drilling fluid (ST308). In one embodiment, the separating apparatus may include a shale shaker. In this embodiment, at least a portion of the heavy oil, including, for example, bitumen, may be retained on the surface of the shale shaker screen. Because the separating agent of the drilling fluid may provide a water-wet surface on the shale shaker screen, the heavy oil is retained on the surface of the shale shaker and may slide off or down the screen and into a collection tank or apparatus.

[0043] Returned drilling fluid filtered through the shale shaker screen may then be recirculated into the formation (ST310). In some embodiments, additional tanks may receive the returned drilling fluid after it is filtered through the shale shaker, and may be configured to provide further filtration of the returned drilling fluid.

[0044] Referring to FIG. 4, a general overview of a method of recovering heavy oil in accordance with embodiments disclosed herein is disclosed. As described above, when drilling a formation containing heavy oil using a drilling fluid that contains a separating agent, the returned drilling fluid transports to the surface cuttings dislodged by the cutting action and a portion of the heavy oil from the formation. The returned drilling fluid, which contains heavy oil, is provided on the surface (ST402) and is conveyed to a separating apparatus to separate at least a portion of the heavy oil from

the returned drilling fluid (ST404). In one embodiment, the separating apparatus may include a shale shaker. In this embodiment, at least a portion of the heavy oil, including, for example, bitumen, may be retained on the surface of the shale shaker screen. Because the separating agent of the drilling fluid may provide a water-wet surface on the shale shaker screen, as described above, the heavy oil is retained on the surface of the shale shaker and may slide off or down the screen and into a collection tank or apparatus (ST406). In one embodiment, heavy oil and/or particulate matter collected from the surface of the shale shaker screen may be recovered and treated (ST408) to isolate the heavy oil from the particulate matter and produce commercial grade hydrocarbons.

[0045] Advantageously, embodiments disclosed herein provide a method of drilling a formation containing heavy oil. Further, embodiments disclosed herein provide a method of recovering heavy oil from a drilling fluid. In yet other embodiments, the present disclosure provides a system for recovering heavy oil. Specifically, the amount of recovered oil may be increased while simultaneously reducing the amount of waste produced.

[0046] Advantageously, embodiments disclosed herein may provide a method and apparatus for recovering heavy oil that reduces the amount of heavy oil or tar recirculated downhole. Further, embodiments disclosed herein may provide methods and apparatuses that may reduce blinding or clogging of a separating apparatus.

[0047] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

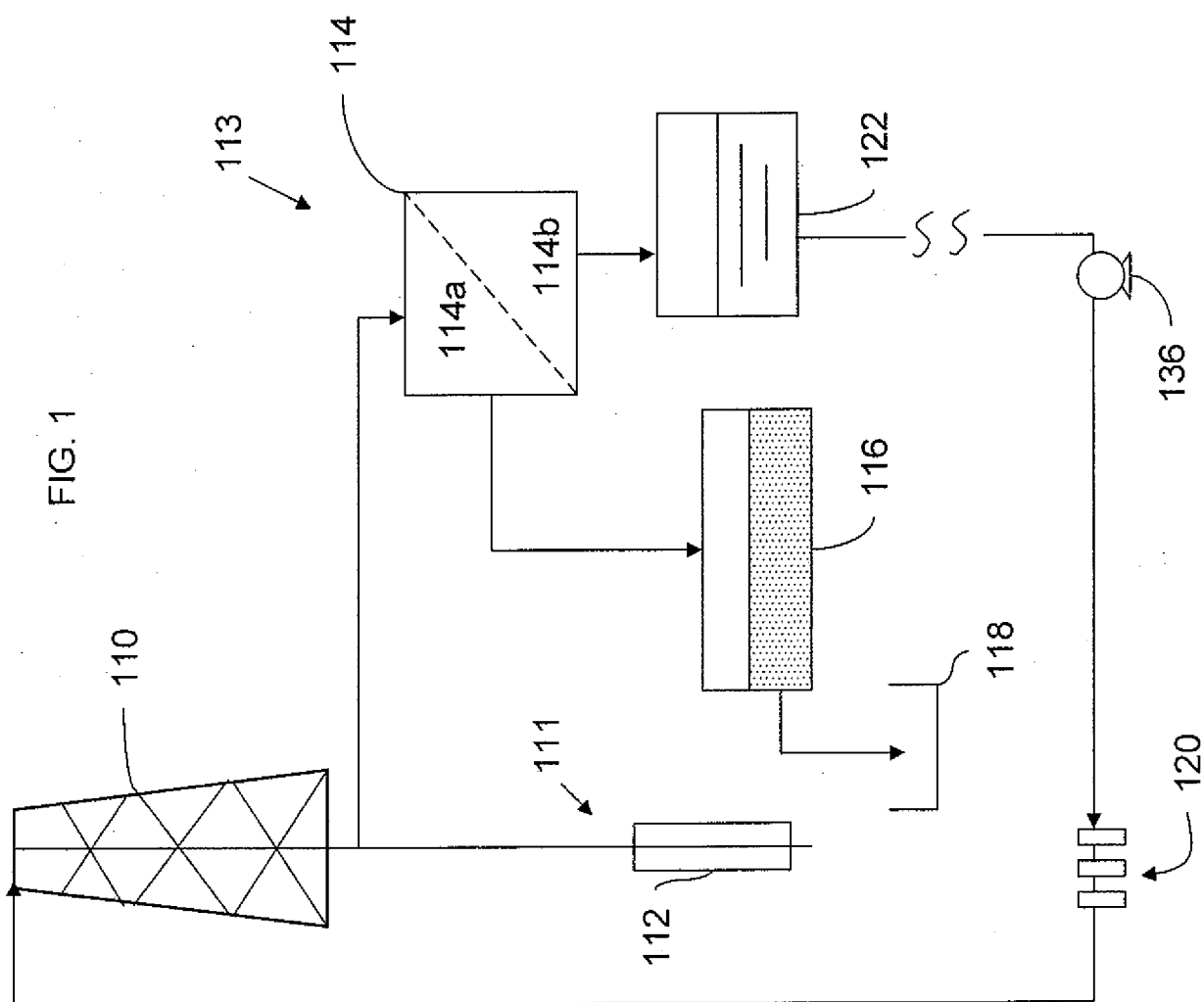
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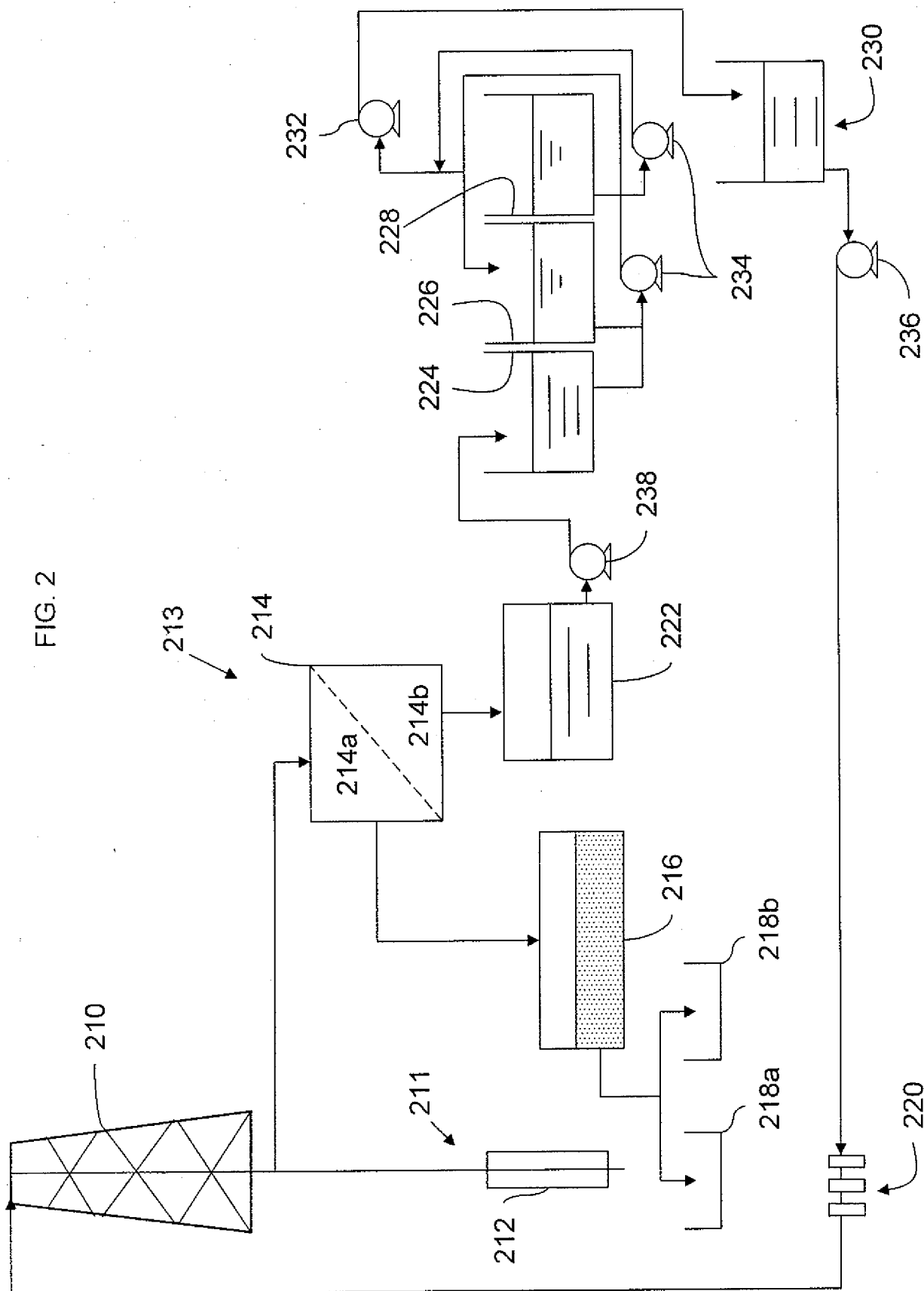
What is claimed:

1. A method of drilling a formation containing heavy oil, comprising:
providing a drilling fluid comprising:
a base fluid; and
a separating agent characterized as enhancing the separation of heavy oil from
a drilling fluid;
drilling the formation containing the heavy oil using the drilling fluid;
returning the drilling fluid to a formation surface, wherein the returned drilling fluid
contains a portion of the heavy oil therein;
removing at least a portion of the heavy oil from the returned drilling fluid; and
recirculating the drilling fluid into the formation.
2. The method of claim 1, wherein the removing comprises removing a substantial
majority of the heavy oil from the returned drilling fluid.
3. The method of claim 1, wherein the removing comprises continuous removal of the
heavy oil from the returned drilling fluid.
4. The method of claim 1, wherein the separating agent comprises a water-wetting agent.
5. The method of claim 1, wherein the returned drilling fluid further comprises drilled
particulate matter.
6. A method of recovering heavy oil from a drilling fluid, comprising:
providing a returned drilling fluid to a separating apparatus, wherein the returned
drilling fluid comprises:
a base fluid;
a separating agent characterized as enhancing the separation of heavy oil from
a drilling fluid; and
heavy oil;
separating the heavy oil from the drilling fluid; and
collecting the separated heavy oil.

7. The method of claim 6, wherein the separating comprises continuous separation of the heavy oil from the drilling fluid.
8. The method of claim 6, further comprising:
treating the separated heavy oil.
9. The method of claim 6, wherein the separating agent comprises a water-wetting agent.
10. The method of claim 9, wherein the separating agent at least reduces sticking of the heavy oil to the separation apparatus.
11. The method of claim 6, wherein the returned drilling fluid further comprises drilled particulate matter.
12. The method of claim 11, wherein the separating comprises separating the heavy oil and drilled particulate matter from the drilling fluid.
13. The method of claim 12, further comprising:
separating the heavy oil from the drilled particulate matter.
14. A system for recovering heavy oil, comprising:
a formation having heavy oil therein;
a drilling assembly for forming a wellbore through the formation;
a mud pump for pumping a drilling fluid through the drilling assembly and wellbore,
the drilling fluid comprising:
a base fluid; and
a separating agent characterized as enhancing the separation of heavy oil from
a drilling fluid;
a separation apparatus in fluid connection with the wellbore for separating heavy oil
entrained in a drilling fluid returned from the wellbore; and
a collection unit for collecting the heavy oil separated from the returned drilling fluid.
15. The system of claim 14, wherein the separating agent comprises a water-wetting agent.
16. The system of claim 14, wherein the separation apparatus comprises a shaker screen.

17. The system of claim 15, wherein the separating agent at least reduces sticking of heavy oil entrained in the drilling fluid to the separation apparatus.
18. The system of claim 14, wherein the drilling fluid returned from the wellbore further comprises drilled particulate matter.
19. The system of claim 14, further comprising:
a treatment unit for treating the collected heavy oil.





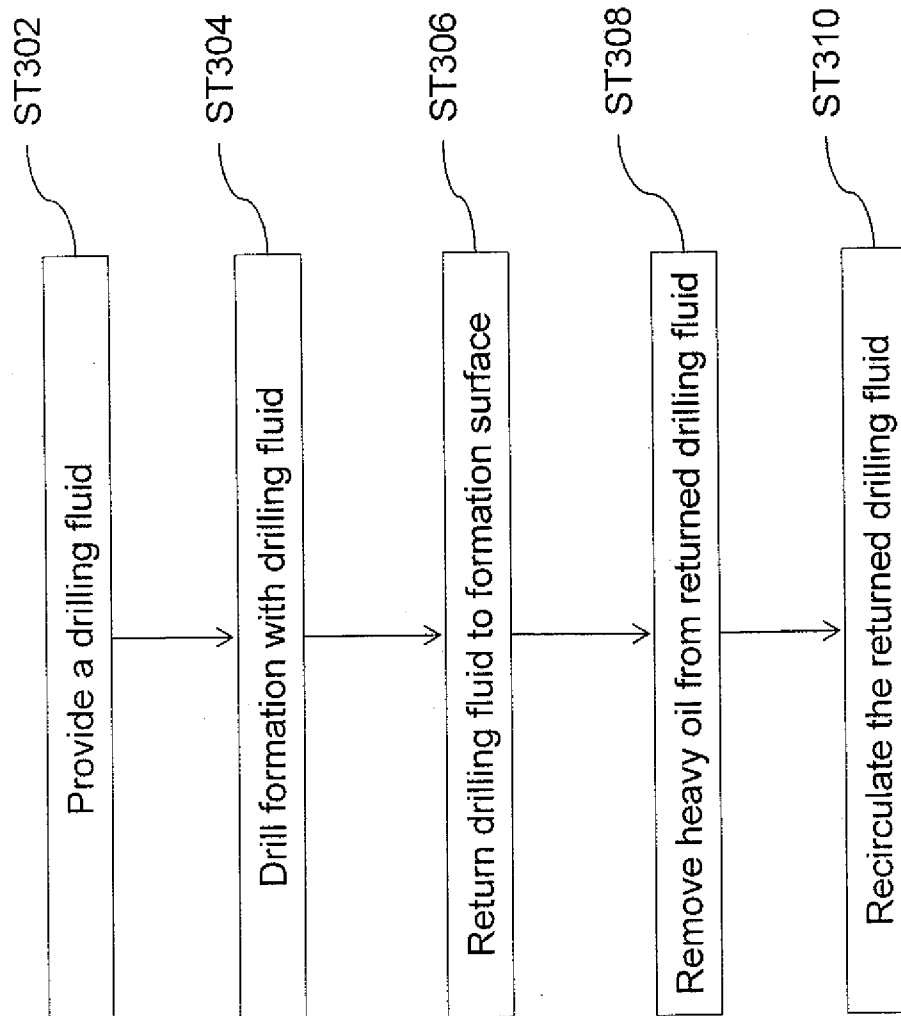


FIG. 3

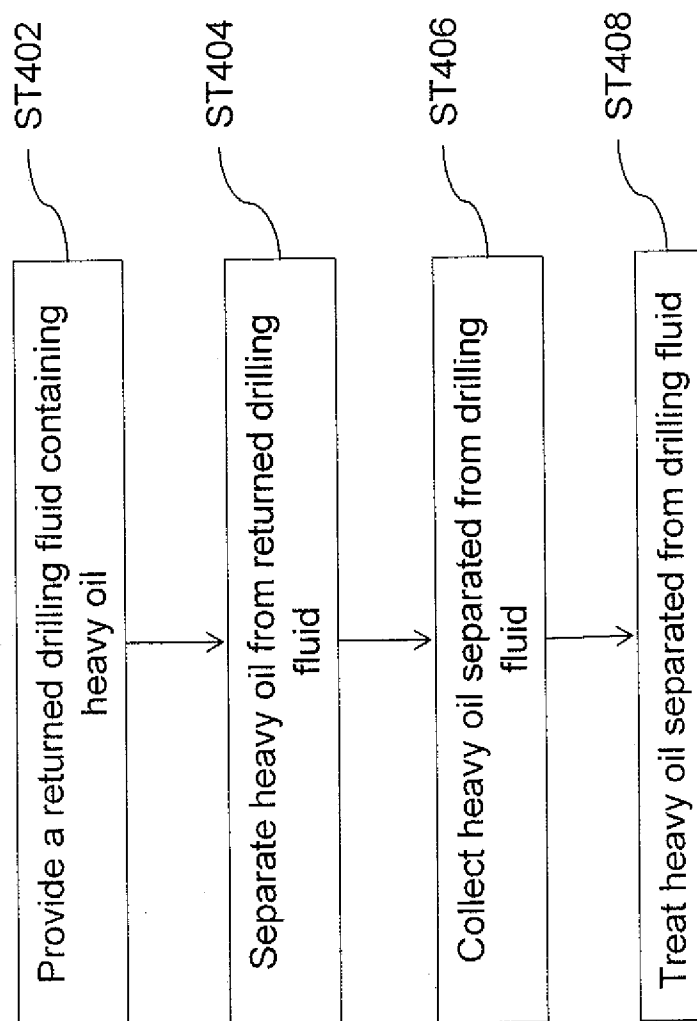


FIG. 4

A. CLASSIFICATION OF SUBJECT MATTER***E21B 43/24(2006.01)i, E21B 21/00(2006.01)i***

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 : E21B 43/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility Models and applications for Utility Models since 1975

Japanese Utility Models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal)"separation", "return", "recirculating"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5129469 A(JAMES E. JACKSON) 14 JULY 1992 See Column 2, Line 27-Column 4, Line 54; Figures 1-2.	1-19
A	US 5109933 A((JAMES E. JACKSON) 05 MAY 1992 See Column 2, Line 24-Column 4, Line 50; Figure 1-2.	1-19
A	US 5431236 A(JASPER N. WARREN) 11 JULY 1995 See Column 3, Line 4-Column 6, Line 18; Figure 1.	1-19
A	US 4942929 A(EDWARD MALACHOSKY, DONNA M. LANTERO) 24 JULY 1990 See Column 2, Line 14-Column 5, Line 6; Figure 1.	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 JULY 2008 (29.07.2008)

Date of mailing of the international search report

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Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-
gu, Daejeon 302-701, Republic of Korea

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Authorized officer

RYU, Jei Jun

Telephone No. 82-42-481-8219



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2008/055060

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US 4942929 A	24.07.1990	NONE	