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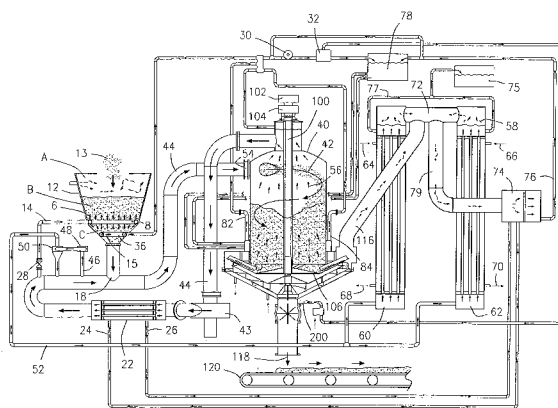
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- (71) Applicant (for all designated States except US): **GW TECHGROUP, LLC** [US/US]; 2939 South Tamarac, Denver, CO 80321 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **WEGNER, Paul** [US/US]; 1340 Eaton Avenue, San Carlos, CA 94070 (US).
- (74) Agent: **KACHIGIAN, Mark, G.**; Head, Johnson & Kachigian, 228 West 17th Place, Tulsa, OK 74119 (US).
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(54) Title: HANDLING AND EXTRACTING HYDROCARBONS FROM TAR SANDS



(57) Abstract: A method and system for handling tar sands and extracting bitumen or oil from the tar sands. The method includes the steps of depositing tar sands in a hopper assembly having a conical bottom. An organic solvent mixture is sprayed on the tar sands through a series of jets near the walls of the hopper. The oil or bitumen in the tar sands is dissolved by the organic solvent mixture. Sand from the tar sands is allowed to separate and fall toward the bottom of the hopper assembly. The sands and liquid in a slurry of fluid are transported from the hopper assembly to a rinse chamber. The slurry of fluid is delivered into the top of the rinse chamber tangentially to cause cyclonic action of the slurry in the rinsing chamber. Solvent introduced at the bottom of the rinse chamber and the solvent mixture is drawn from the top of the rinse chamber. Thereafter, the solvent and hydrocarbon, liquid mixture is pumped to a separator in order to separate the oil and bitumen from the solvent. Finally, the clean solvent is returned to be reused by introduction into the rinse chamber in order to form a closed loop process.

HANDLING AND EXTRACTING HYDROCARBONS FROM TAR SANDS

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention is directed to a method and apparatus for handling tar sands and extracting bitumen or oil from tar sands in an economical and efficient continuous
5 closed loop system.

2. Prior Art.

Tar sands, sometimes known as oil sands or bituminous sands, are a combination of clay, sand, water and bitumen. Bitumen is a semisolid form of oil. It is known to mine tar sands to extract the bitumen, which is upgraded into synthetic crude or refined directly into
10 petroleum products.

Tar sands deposits are found in over 70 countries throughout the world and represent as much as two-thirds of the world's reserves of oil.

In the processing of tar sands which contain oil-bearing bitumen, the oil-bearing sands must first be mined, the tar sand processed and the sand cleaned sufficiently to
15 alleviate environmental concerns upon disposal or proper placement back into the environment.

There are various known methods of extracting the bitumen or oil from the tar sands. In one known process, the tar sands are mined and hot water and caustic soda (NaOH) are added to the sand. The resulting slurry is piped to an extraction plant where it is agitated and
20 the oil skimmed from the top.

In an alternate known cold flow process, oil is pumped out of the sands using progressive cavity pumps which lift oil along with sand. This process only works well where the oil or bitumen is fluid enough to pump.

In an alternate known cyclic steam stimulation process, a well is put through cycles of steam injection, soaking, and oil production. Oil or bitumen is thereby extracted.

U.S. Patent No. 5,998,640 to Haeefele et al. discloses a solvent extraction method that utilizes pressure to assist the extraction. By providing a pressure differential, oil free solids may be
5 removed from an oil extraction chamber.

A large portion of the expense of tar sand processing is materials handling. The material is sticky, and tough. Conveyors, augers, and crushers wear quickly when handling tar sand. Solvent extraction processes are usually considered to be energy intensive and solvent loss is often an issue. The extraction efficiencies are normally no greater than 85%.
10 In addition, cold weather can shut down most operations.

In order for the extraction of tar sands to be an economical endeavor, the separation process should ideally be low energy, provide a simple material handling method, and recycle most of the chemicals added for processing.

The present invention also addresses issues concerning energy recycling and solids
15 handling.

Accordingly, it is a principal object and purpose of the present invention to utilize tar sands as a source of cooling for a solvent condenser.

It is a further object and purpose of the present invention to provide a handling and extraction system that does not require crushing.

20 It is a further object and purpose of the present invention to use an oil/solvent mixture to dissolve, transport and classify the tar sands.

It is a further object and purpose of the present invention to provide a continuous handling and extraction process at atmospheric pressure in a closed loop system.

SUMMARY OF THE INVENTION

The present invention is directed to a process and a system for handling and extracting hydrocarbon liquids from tar sands. Initially, the tar sands are deposited into an open top hopper assembly. The hopper or dissolution chamber may include a source of an organic solvent liquid mixture on the incoming tar sands. The mixture dissolves the oil or bitumen in the tar sands. Prior to entry into the dissolution chamber, the solvent will be heated by being passed in heat exchange relationship in a solvent heat exchanger.

The tar sand is introduced at the top of the hopper. Below there is a inert gas blanket (inert blank zone A) is created by introduction of a inert gas such as nitrogen or cooled combustion exhaust to displace oxygen from the tar sand. This prevents oxygen from entering into the process. The layer of tar sand underneath the inert gas blanket acts as a solvent vapor absorbing media. Since fresh tar sand is introduced on a continuous basis new absorption media constantly replenishes the absorption layer (absorption zone B) Therefore, this layer never becomes saturated with solvent vapor. As an added insurance to prevent solvent vapor incursion into zone A, solvent vapor sucked out in a downward fashion through zone B. The solvent vapor inert gas mixture exhaust can be treated with a gas scrubber. The layer below is dissolved by contacting the tar sand with a warm solvent oil mixture (leach zone C). The resultant sand slurry passes the through a screen basket which retains rock, gravel, and coarse sand. This basket is emptied when it becomes full. The sand slurry combines with the recirculation loop fluid in mixing T 28.

Solvent vapors are prevented from leaving the dissolution chamber by a closed loop system. Solvent laden gas is drawn into ducts and removed and pumped to a chiller unit which assists in converting vaporized solvent to liquid.

Solvent vapors are prevented from leaving the dissolution chamber by having a layer of tar sands (absorption zone B) and by a closed loop system... to liquid. Any remaining vapors are stripped out with a gas scrubber.

The mixture of fine sand and liquid containing solvent and oil or bitumen is then transported from the base of the hopper to a rinse chamber in a fluid slurry. The slurry enters into a tangential cyclone port near the top of the rinse chamber. Centrifugal force will cause the sand to separate from the solvent. Slurry liquid gathers at the center and top of the rinse chamber while the sand moves downward in the rinse chamber.

A portion of the recirculating solvent and hydrocarbon liquid mixture is drawn off from the recirculation line to a pump where it is sent into a further cyclone separator to further polish off or remove small solid particles such as sand. The fluid which is free of sand is then pumped to two heat exchangers. Steam is circulated into the heat exchangers. As the combination solvent and liquid hydrocarbons are heated, the solvent will vaporize before the oil or bitumen to be recovered. The vaporized solvent will pass to the top of the heat exchangers to a vapor collection chamber where the vapors are directed to a condenser to condense the clean solvent vapors into liquid solvent. The liquid solvent is thereafter directed back to a solvent storage tank for clean solvent.

A portion of the solvent vapors directed through port(26) to the recirculation loop heat exchanger (22) to provide indirect heat to the recirculation loop solvent oil mixture, while the balance is directed to the condenser.

A shaft assembly in the rinse chamber may include a motor or motors. The shaft assembly and motors rotate a first tray in a first direction against the series of stationary plows. Downward progression of the sand in the rinse chamber is facilitated by the relative motion of the plows relative to the rotating tray. Rotation of the first tray relative to the

plows tends to lift the solvent saturated sand upward out of the bowl of the first tray above the fluid line so that the sand moves to the second tray. The sand residing in the second tray is heated both indirectly and directly with steam and direct steam injection. The heated sand which no longer contains liquid solvent has the remaining solvent vapors displaced with an inert gas (200). The solvent free sand will fall by gravity to a rotary valve where it is permitted to exit through the duct which has a inert gas blanket to prevent oxygen from entering the system.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified diagrammatic view of a system of handling and extracting hydrocarbons from tar sands constructed in accordance with the present invention;

Figure 2 is an enlarged view of a cyclone separator and rinse chamber used as a part
5 of the system shown in Figure 1;

Figure 3 is a sectional view taken along section line 3-3 of Figure 2; and

Figure 4 is a diagrammatic sequential flow chart of the system shown in Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments discussed herein are merely illustrative of specific manners in which to make and use the invention and are not to be interpreted as limiting the scope of the instant invention.

5 While the invention has been described with a certain degree of particularity, it is to be noted that many modifications may be made in the details of the invention's construction and the arrangement of its components without departing from the spirit and scope of this disclosure. It is understood that the invention is not limited to the embodiments set forth herein for purposes of exemplification.

10 The present invention is directed to a method and apparatus for handling and extracting oil from tar sands. The tar sands material is initially gathered or excavated from a deposit in various ways which are not a part of the invention. For example, the material is peeled off the tar sand deposit and dumped directly into an oil extraction or hopper assembly as large chunks sized from approximately .635 centimeter to 30.48 centimeters
15 (1/4 to 12 inches). While occasional large rocks may be crushed or removed, a key feature of the present invention is that the tar sands generally do not have to be crushed as a part of the process.

Referring to the drawings in detail, Figure 1 illustrates a schematic diagram of a system 10 of handling and extracting hydrocarbon from tar sands.

20 The system 10 may be located near a tar sands deposit so transportation and handling costs are low. In one embodiment, the tar sands 13 are initially peeled off a deposit in sheets, such as one foot wide sheets. The tar sands material 13 is then dumped into an oil extraction hopper or dissolution assembly 12. The hopper assembly 12 may be configured as an open topped cylinder or an open topped cone.

The hopper consist of four zones The inert gas blanket zone (zone A) which prevents oxygen from entering the hopper by providing a constant flow of inert gas such as nitrogen or combustion exhaust into this zone. The solvent absorption zone (zone B) where the continued introduction fresh tar sands into this zone absorbs any solvent vapors escaping from the leach zone. In leach zone (zone C) a heated solvent /oil mixture contacts the tar sand by one or more sources. The rock basket(optional) which prevents rocks, gravel and coarse sand from entering the mixing T (18) In this area solvent vapor maybe removed by a vacuum pump to retard the migration of vapor into zone A.

The hopper or dissolution chamber 12 may include a source 8 near the outer walls of the cone which provides an organic solvent liquid mixture, such as a hexane or pentane with bitumen, on the incoming tar sands as depicted by arrows 6. The solvent/bitumen mixture dissolves the oil or bitumen in the tar sands. It will be appreciated that other solvents may be utilized within the spirit and scope of the present invention.

Solvent is introduced to the dissolution chamber 12 from a solvent recirculation loop 14. The flow of solvent controls the rate and how well the nonporous rocks are washed. The flow of solvent and oil out through a mixing T 18, determines the concentration of sand transported to the rinse chamber (to be described) as a slurry. In one preferred iteration, a concentration of 5% sand in the outgoing slurry is acceptable.

Prior to entry into the dissolution chamber 12, the solvent will be heated by being passed in heat exchange relationship in a solvent heat exchanger 22.

Solvent vapors and/or solvent are introduced into the heat exchanger as shown at arrow 24. Steam maybe used but it is less desirable. Solvent vapor and condensate exits heat exchanger 22 as shown at arrow 26.

The mid portion of the hopper or dissolution chamber 12 contains sources 6 which are below the surface of the deposited tar sand. The solvent/bitumen mixture dissolves the oil or bitumen in the tar sands. The eroded sand from zone C falls to the bottom of the hopper 12 above the conical base of the hopper 12.

5 The sand flows through the rock basket which retains the rock etc while passing the sand to the bottom of the dissolution chamber.

The upper portion of the hopper 12 acts like a leach field in which the oil is leached from the tar sand. Once the oil and bitumen is dissolved, the sand flows to the bottom of the dissolution chamber.

10 As an option, a perforated screen (not shown) may be employed spaced above the conical base of the dissolution chamber. The perforated metal screen or grating only allows fully eroded sand to pass onto the rinse chamber for further processing. In that case, the tar sand will not enter the slurry transport system until it is small enough to pass through the perforated metal screen.

15 A valve 28 modulates the flow of oil solvent to leach zone C which controls the rate of sand erosion in the leach zone which in turn determines the rate sand flowing to mixing T 18.

Vapors are prevented from leaving the top dissolution chamber 12 by removing vapors from rock basket area. This retards the upward migration of vapor through vapor
20 absorption zone B towards the top of the hopper shown by arrow 15. Near the bottom of the hopper 12, solvent laden gas is drawn into ducts 36 and removed and pumped with gas pump 30 to a chiller unit 32 which assists in converting the vaporized solvent in to liquid. This followed by a gas scrubber unit. The resulting gas is directed to the bottom of conical tray
108 through port 200

The dissolution chamber 12 reduces or eliminates the need for a crusher and insures a high level of extraction. Surface oil is effectively removed from rocks occurring in the tar sand. Since the flow solvent is functioning in lieu of the crushing agent, there is little to wear out in the system.

5 The present invention uses the oil/solvent mixture to wash the tar sands in lieu of a crusher. This has several benefits. The oil/solvent mixture only dissolves oil/sand aggregates, while leaving the non oil bearing rocks essentially untouched. Moreover, the hot oil/solvent mixture heats up the tar sand to maximize the dissolution speed.

10 In many cases, the majority of the tar sand has a particle size of less than 1/16 of an inch. At this particle size, the washing of the oil and bitumen from the tar sand is rapid and efficient. The oil/solvent fine sand mixture provides an ideal mixture for easy transport of the mixture at the mining site to the wash chamber and desolventization chamber. The combination oil/solvent provides the proper amount of viscosity, lubrication, and density to facilitate the transport of the dissolved tar sand as slurry through a pipe. These features
15 eliminate the crushing operation and expensive transport tar sand from the mining pit to the processing area.

20 The mixture of fine sand and liquid containing solvent and oil or bitumen, is then transported from the base of the hopper 12 to near a top of a rinse chamber 40 in a pipe as a fluid slurry. The liquid oil or bitumen is then harvested from the rinse chamber 14 as will be described herein. The slurry enters into a tangential cyclone port 54 located at the top of the rinse chamber 40. Since only fine sand particles are allowed to enter, the slurry line transportation is simple and uniform. Since the slurry is pumped into the rinse chamber 40, centrifugal force will cause the sand to separate from the solvent as illustrated by arrows 42. Once the sand enters the rinse chamber, the cyclone action of the rinse chamber

configuration allows most of the sand to be removed from the oil solvent mixture before returning to the recirculation line 44 where it is recirculated back to the nozzles previously described and the motive power for the oil solvent sand mixture transport. Then the oil solvent mixture flows through the dissolution chamber ports and returns to cyclone intake
5 port.

Since the sand is removed prior to returning to the recirculation pump, wear issues are minimized for the pump and spray nozzles.

The slurry enters the top of the rinse chamber 40 tangentially which causes a cyclonic action within the rinsing chamber 40. Due to centrifugal force, slurry liquid gathers at the
10 center of the rinse chamber while the sand in the slurry moves toward the outer walls of the rinse chamber.

By the time the tar sands reach the rinse chamber 40, the vast majority of oil is dissolved out of the tar sands. The remaining oil is removed by displacement washing. The rinse chamber 40 configuration allows oil solvent mixture to be removed from the rinse
15 chamber on a continuous basis as a dirt free oil and solvent mixture. A mass flow meter measures the density of the mixture continuously such that oil solvent which is harvested maintains a constant concentration of oil. This permits uniform processing conditions independently of pay dirt oil concentration.

Oil free solvent is also introduced at and pumped to the bottom of the rinse chamber
20 40. As the dissolved sand progresses down the rinse chamber 40, the solvent progresses up the chamber in a counter current fashion as shown by arrows 56.

Solvent is removed via recirculation line 44 and moved by pump 43 in a loop past the connection with the dissolution chamber 12 mixing T 18.

A portion of the recirculating solvent and hydrocarbon liquid mixture is drawn off from the recirculation line 44 via line 46 to a pump 48 where it is sent into a further cyclone separator 50. The cyclone separator 50 serves to further polish off or remove small solid particles, such as sand, which are returned to the recirculation line 44.

5 The fluid which is free of sand is then pumped via line 52 to two heat exchangers 60 and 62. Steam is circulated into heat exchangers 60 and 62 through inputs 64 and 66 and then out therefrom through outputs 68 and 70. It will be appreciated that one or more heat exchangers may be employed within the spirit and scope of the invention.

As the combination solvent and liquid hydrocarbons are heated in the heat
10 exchangers 60 and 62, the solvent will vaporize before the oil or bitumen to be recovered. Accordingly, as shown by arrows 58, the vaporized solvent will pass to the top of the heat exchangers 60 and 62 to a vapor collection chamber 72 where a portion of the vapors are directed to line 24 to recirculation heat exchanger 24, while the remaining vapors from duct 79 and 26 are directed to condenser 74. The liquid solvent is thereafter directed via line 76
15 back to a solvent storage tank 78 for clean solvent.

At the same time, the liquid which is primarily hydrocarbon oil and bitumen is drawn off via lines 77 to oil storage tank 75.

The interior of the rinse chamber is kept at a pressure less than atmospheric pressure which eliminates any need for a depressurization chamber for removing desolventized sand
20 from the process. This, in turn, permits continuous production of desolventized sand without interruption. Accordingly, the desolventization or rinse chamber 40 is kept at atmospheric pressure or less to prevent solvent vapors from leaving the desolventized sand exit port.

Turning to a consideration of Figure 2 which shows a portion of the rinse chamber 40, and continuing consideration of the system 10 in Figure 1, a siphon chamber 80 is provided surrounding the rinse chamber 40 and is in fluid communication therewith. In the preferred embodiment shown, the siphon chamber 80 substantially circumnavigates the rinse chamber. The siphon chamber 80 is connected via line or lines 82 and 84 to the gas pump 30 which insures that a vacuum will be provided to the siphon chamber 80. Liquid solvent is provided from the solvent storage tank 76 via line 86 to the siphon chamber by action of a pump 38.

At the same time, solvent is allowed to travel via line 88 to an excess solvent chamber 90 whereby solvent is allowed to pass as shown by arrows 92 into an inner container 95 having an open top and return via line 94 to the liquid solvent storage tank 76. The level of the open top of the inner container 95 is adjustable by handle 93. The solvent level 97 in the rinse chamber 40 and in the excess solvent chamber 90 is maintained at a level as shown by arrows 96.

The vapor pressure equalization line 202 insures the pressure is the same between desolventization zone of the rinse chamber and the excess solvent chamber 90. Without this feature the level control system will not work, if the desolventization area has a pressure which is different from the siphon overflow chamber 90.

The same level of solvent is also maintained above the mixing T 18 of the hopper assembly so that the siphon will not be broken between the rinse chamber and the hopper T. The hopper T is located at a position low enough that gases are not sucked into the recirculation loop which could break the siphon.

A shaft assembly 100 may include a motor or motors 102 and 104. In a preferred embodiment, hydraulic motors are employed at the top of chamber 40. The shaft assembly

and motors rotate a first conical tray 106 in a first direction against a series of stationary plows 98. In one non-limiting embodiment, the first tray is rotated approximately 10 revolutions per minute (rpm).

The shaft assembly 100 will also rotate a second conical tray 108, which is coaxial therewith, in an opposite direction from rotation of the first tray. As best seen in the sectional view in Figure 3, extending from the second tray is a series of blades 99. In one preferred embodiment, the shaft assembly includes a shaft within a shaft to rotate the first and second tray.

Downward progression of the sand in the rinse chamber is facilitated by the relative motion of the plows 98 relative to the rotating tray 106. It will be appreciated that either the bowl or the trays may rotate. The rotation of the first tray 106 relative to the plows 98 tends to lift the solvent saturated sand upward out of the bowl of the first tray above the fluid line 96 so that the sand moves to the second tray 108. The sand residing in the second tray 108 is heated directly and indirectly with steam. Steam heat is applied to a chamber 110 via inlet 112 and is circulated therefrom via outlet 114. The sand will tend to vaporize the solvent which is drawn off to chamber 122 via line 116 to duct 79. The clean sand with the solvent removed will fall by gravity to a valve 124 with rotating paddles.

As best seen in Figure 1, as the valve paddles rotate, the clean sand will exit the system as shown by arrow 118 and may be transported by any mechanism, such as by conveyor 120.

The bird feeder style P- trap allows removal of the rinsed tar sand from the bottom of the rinse chamber in a controlled manner with a minimum amount of solvent associated with the sand. The rinse chamber 40 is arranged such that the liquid level is maintained by a siphon tube arrangement. The siphon is established by introducing a vacuum at the top of

the chamber to remove all gases from the upper rinse chamber and siphon tube areas.

The system will operate as a closed loop process. A key to starting the system up is establishing a siphon system. Solvent must be introduced into the bowl of the rinse chamber 40 and mixing T 28 to create a P trap seal which allows the siphon loops to be created. The

5 solvent can be introduced via the recirculation pump loop and the siphon pump loop.

Once the siphons are established, the solvent is supplied through the siphon pump loop.

In the case of the recirculation loop, once a seal is initiated, a vacuum is placed on the rinse chamber 40 to keep the solvent level near the top of the rinse chamber 40. The siphon pump is turned on to insure the solvent level in the bowl remains constant. This is

10 accomplished by siphon overflow stand pipe and a flow meter. The pump speed is adjusted such that the standpipe overflow is equal to or greater than zero. The rinse chamber 40 and the recirculation pump loop fill with solvent. Once the recirculation loop and rinse chamber is full of solvent, the siphon loop is established and application of a vacuum is no longer required as long as air does not enter the upper portion of the rinse chamber. In this case,

15 vacuum valve is open to remove the air trapped in the upper portion of the rinse chamber.

Once the siphon loop is established, the recirculation pump may be started. The siphon loop allows the solvent level to remain constant in the dissolution chamber even when the solvent recirculation pump is off. This feature also allows for the continuous introduction of tar sands into the dissolution chamber without interruption. The tar sand in the dissolution

20 chamber is gradually dissolved and transported to the rinse chamber as slurry. The amount of flow through the bottom T and the upper portion of the dissolution chamber is modulated to maintain the proper level solvent in the dissolution chamber to prevent the entrainment of air into the recirculation loop and the level solvent from getting too high in the dissolution chamber.

The fresh solvent used to displacement wash sand in the rinse chamber 40 is added around the bottom perimeter of the rinse chamber 40 by an annular ring. The annular ring of solvent is contained by the lower wall of the rinse chamber and a tube on the outside of the chamber, which is sealed between the rinse chamber wall and the top of outside tube.

5 This annular ring is also controlled by a siphon tube.

The rate of clean sand removal from the rinse chamber 40 is dictated by the plow configuration and the number and movement of the plows relative to the sand. The movement of the plows relative to the sand is achieved by the rotation of the plow or the bowl, which forms the annular P trap.

10 Figure 4 illustrates a simplified schematic diagram of the procedure to handle and extract hydrocarbons from tar sands. Initially, the hopper assembly 12 is loaded with tar sand and solvent is injected or sprayed onto the incoming tar sand as shown by box 130. Through use of the gas pump 30 and closed loop system, a vacuum is applied in order to assist in keeping the level of solvent at a desired level as shown at box 132.

15 Once the recirculation loop, rinse chamber and siphon pump loop are full of solvent, the application of vacuum is no longer required as long as gases do not enter the upper portion of the rinse chamber or the siphon pump loop in sufficient quantities to break either of these siphons. In this case, a vacuum valve is open to remove the gases trapped in the upper portion of the rinse chamber or the siphon pump loop.

20 After the solvent contacts the tar sands in the hopper assembly, the slurry of solvent, hydrocarbon liquids, and small sand particles are transported in a slurry to the rinse chamber as shown at box 134. Liquid solvent and hydrocarbon liquid is thereafter drawn off from the rinse chamber by force of the recirculation pump shown at box 136 and directed to the recirculation loop heat exchanger. A portion of the liquid is removed by an oil solvent pump

and transported to solvent/oil heat exchanger. The hydrocarbon oil and bitumen are harvested and delivered to a storage tank 75 as shown at box 140. The solvent, in the form of vapors, are drawn off and condensed as shown at box 142 and also pumped back to the rinse chamber as shown at box 144.

5 The sand at the base of the rinse chamber is delivered to the steam heating tray or cone where the sand and solvent therein are heated, as shown at box 148. The solvent vapors are delivered back to the solvent condenser 142 while the clean sand which is free of hydrocarbon oil and solvent is removed from the rinse chamber as shown at box 146.

 The invention uses the tar sands themselves as the cooling source for condensing the
10 solvent which is vaporized from the clean sand. The heat of condensation is used to heat up the incoming tar sand. This is accomplished by using an oil/solvent recirculation pump. The oil/solvent is pumped through the cooling side of the heat exchanger box 150. The solvent condenses on the heating side of the heat exchanger. The hot oil/solvent mixture is introduced onto the cold tar sand. The heat is transferred to the tar sand. The oil mixture
15 continues through the recirculation loop and eventually returns to the heat exchanger to be reheated. The recirculation loop heat exchanger can maintain a temperature approaching the condensation temperature of the solvent.

 In this manner, the majority of energy for heating the tar sands is provided by this heat exchanger loop and a significant portion of the cooling requirement is provided by the
20 heat exchanger. In some cases, the heating requirements for the sand are about the same as the condensation requirements.

 An additional benefit of this approach is that the hot oil/solvent mixture increases the dissolution rate of the tar sand regardless of incoming tar sand temperature.

The second aspect of this invention is dissolution, classification, and transport of the tars sand through the process on a continuous process. A considerable amount of expense is normally incurred during the mining, transport, and crushing of tar for processing. In addition, the degree of extraction is a function of the size of the oil bearing sand
5 agglomerates. Traditionally, this is dealt with through the use of a crusher. Crushers are expensive to buy, maintain, and operate. They are prone to jamming and the wear on the crush hammers is extensive. In addition, they are not selective in the crushing process and do not separate the oil bearing sand from the nonporous rock which typically accompany the tar sand. Crushers usually process the tar sand at ambient conditions or with the addition of
10 heat. Cold tar sand is less sticky but harder to crush into small particles. As the particle size requirement falls below one inch the energy and cost of operation grows rapidly.

Whereas, the present invention has been described in relation to the drawings attached hereto, it should be understood that other and further modifications, apart from those shown or suggested herein, may be made within the spirit and scope of this invention.

WHAT IS CLAIMED IS:

1 1. A method for handling tar sands and extracting bitumen or oil from said tar sands,
2 which method comprises:
3 depositing tar sands into a hopper assembly;
4 contacting an organic solvent mixture with said tar sands in said hopper assembly;
5 dissolving said oil or bitumen in said tar sands with said organic solvent;
6 allowing sand from said tar sands to separate and fall toward a bottom of said hopper
7 assembly;
8 transporting said separated sands and said liquid in a slurry of fluid from said hopper
9 assembly to a top of a rinse chamber;
10 delivering said slurry of fluid into a top of said rinse chamber tangentially to cause
11 cyclonic action of the slurry in said rinsing chamber to separate said sands from said fluid;
12 drawing and removing said solvent and said oil or bitumen mixture from said rinse
13 chamber;
14 drawing said solvent and said oil/bitumen mixture to a separator to separate said
15 oil/bitumen from said solvent; and
16 returning said solvent to said hopper assembly to be reused to form a closed loop
17 process.

1 2. A method for handling tar sands and extracting bitumen or oil as set forth in Claim
2 1 wherein said hopper has a conical bottom.

1 3. A method for handling tar sands and extracting bitumen or oil as set forth in Claim
2 1 including the additional step of separating solids below a certain size with a perforated
3 screen in said hopper assembly above said conical bottom.

1 4. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 1 including maintaining an inert gas blanket at a top of the hopper assembly.

1 5. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 1 wherein said separated sands from said rinsing chamber are heated to remove solvent.

1 6. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 5 wherein said separated sands are heated by steam heat.

1 7. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 1 wherein said organic solvent is heated in a heat exchanger prior to said step of providing

3 on said tar sands.

1 8. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 1 including maintaining a layer of said tar sand above an area where organic solvent contacts

3 said tar sand to maintain a vapor absorption barrier.

1 9. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 1 wherein said organic solvent is a mixture of hexane and bitumen.

1 10. A method for handling tar sands and extracting bitumen or oil as set forth in Claim

2 1 including maintaining liquid spring line in said hopper assembly.

1 11. A method for handling tar sands and extracting bitumen or oil as set forth in Claim
2 1 including maintaining a liquid spring line in said rinse chamber.

1 12. A method for handling tar sands and extracting bitumen or oil as set forth in Claim
2 1 including maintaining a common liquid spring line in both said hopper assembly and said
3 rinse chamber.

1 13. A method for handling tar sands and extracting bitumen or oil as set forth in Claim
2 1 including maintaining less than atmospheric pressure in said rinse chamber.

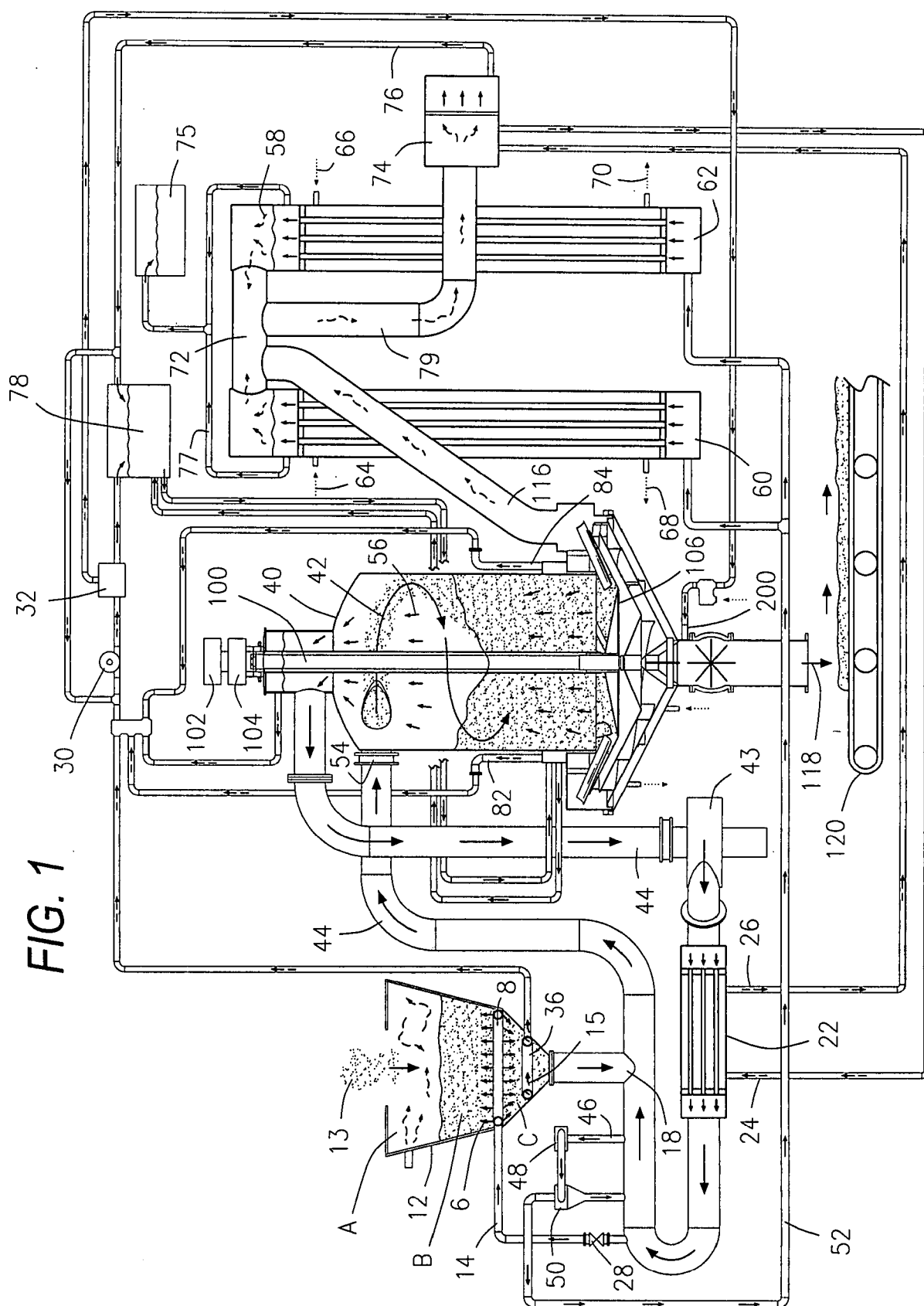


FIG. 1

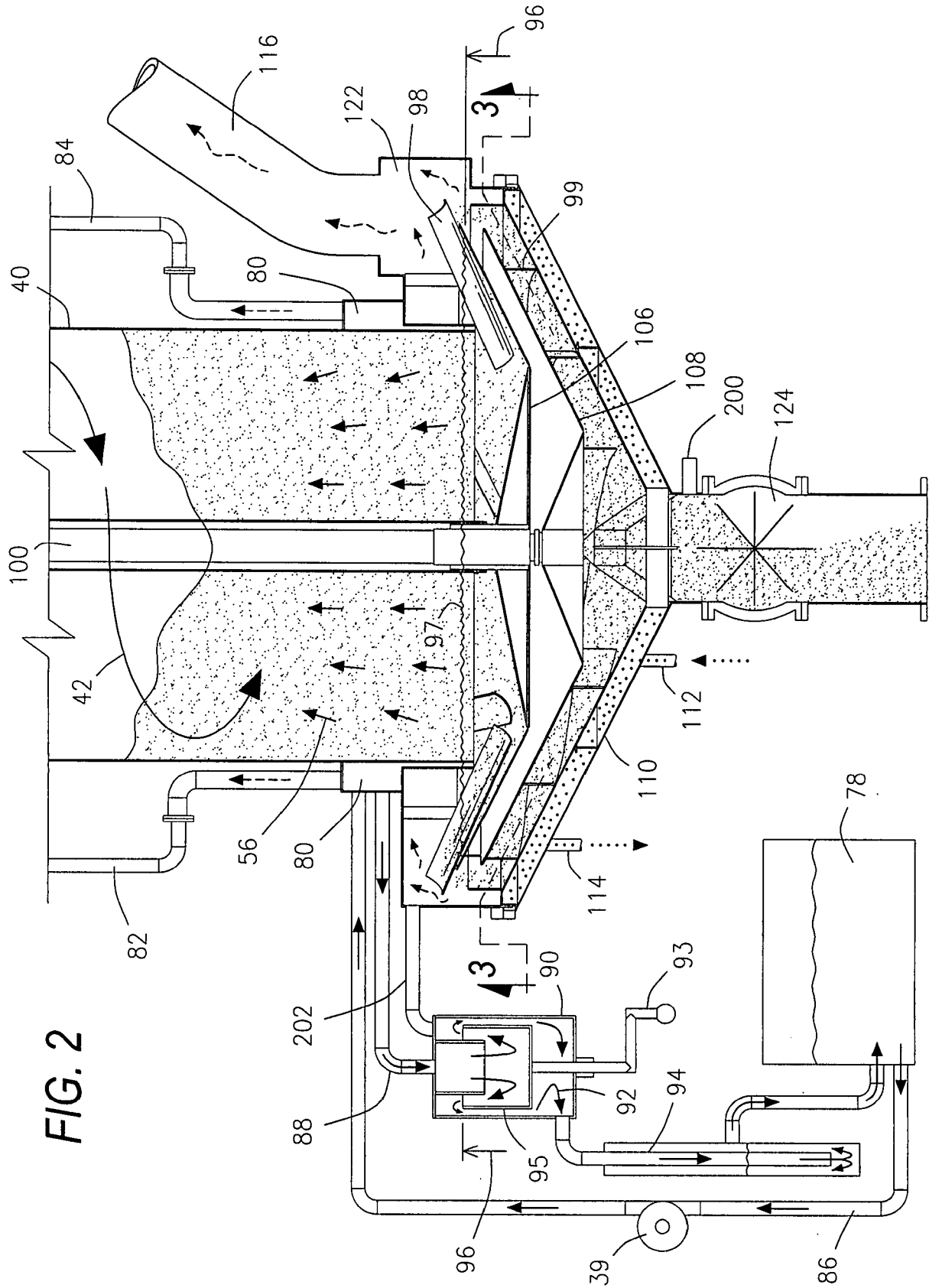


FIG. 2

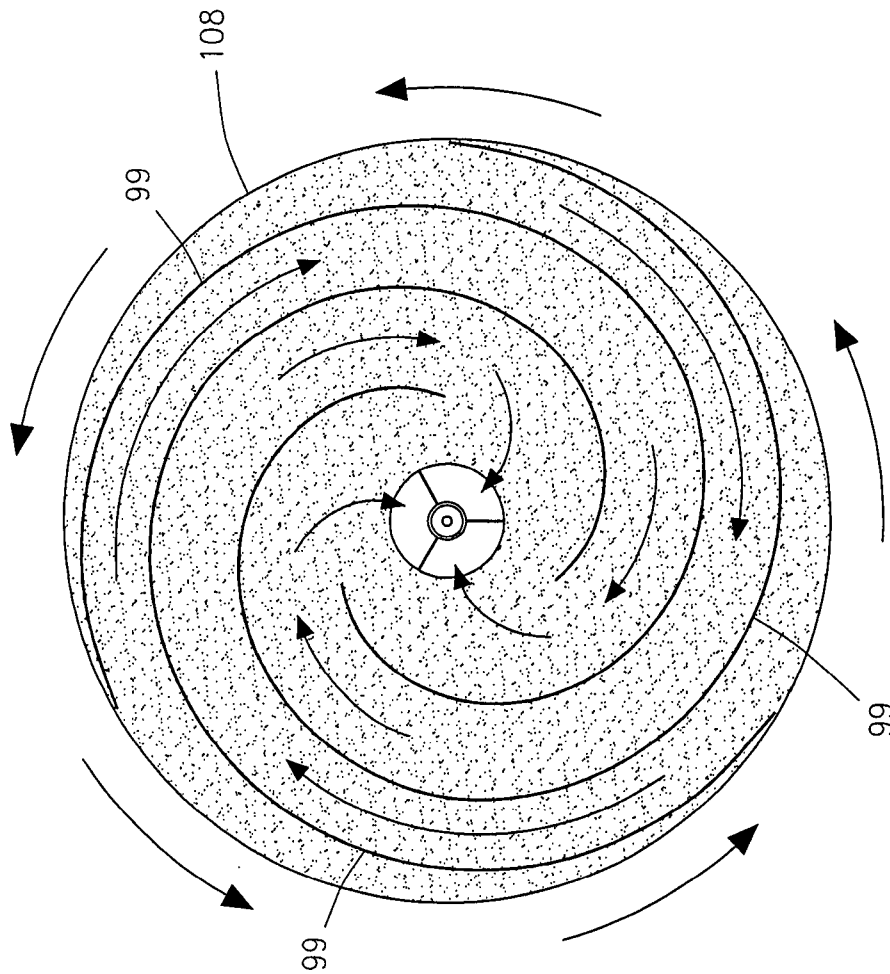


FIG. 3

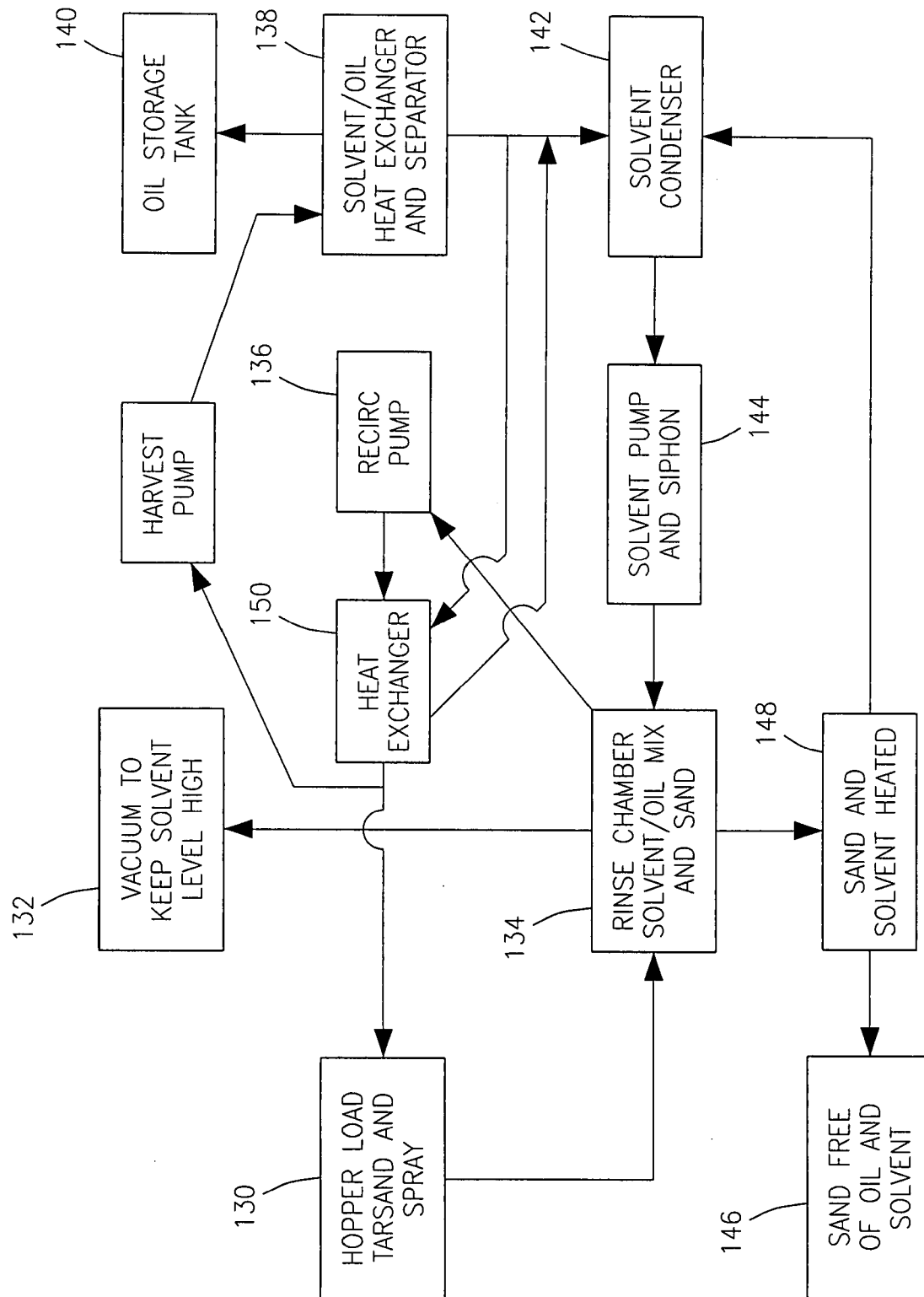


FIG. 4