US009688922B2

(12) **United States Patent**
deMayo

(10) **Patent No.: US 9,688,922 B2**
(45) **Date of Patent: Jun. 27, 2017**

(54) **METHOD AND DEVICE FOR EXTRACTION OF LIQUIDS FROM A SOLID PARTICLE MATERIAL**

(71) Applicant: **Benjamin deMayo**, Carrollton, GA (US)

(72) Inventor: **Benjamin deMayo**, Carrollton, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 626 days.

(21) Appl. No.: **14/299,986**

(22) Filed: **Jun. 9, 2014**

(65) **Prior Publication Data**

US 2014/0360923 A1 Dec. 11, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/855,267, filed on Aug. 12, 2010, now abandoned.

(60) Provisional application No. 61/233,241, filed on Aug. 12, 2009.

(51) **Int. Cl.**

C10G 31/10	(2006.01)
C10G 1/00	(2006.01)
B04B 3/00	(2006.01)
B01D 21/00	(2006.01)
B01D 21/26	(2006.01)
B03B 9/02	(2006.01)
B04B 3/02	(2006.01)
B04B 3/04	(2006.01)
B04B 5/04	(2006.01)
B04B 15/02	(2006.01)
B01L 3/00	(2006.01)

(52) **U.S. Cl.**
CPC ***C10G 31/10*** (2013.01); ***B01D 21/009*** (2013.01); ***B01D 21/262*** (2013.01); ***B03B 9/02*** (2013.01); ***B04B 3/00*** (2013.01); ***B04B 3/025*** (2013.01); ***B04B 3/04*** (2013.01); ***B04B 5/0414*** (2013.01); ***B04B 5/0421*** (2013.01); ***B04B 15/02*** (2013.01); ***C10G 1/00*** (2013.01); *B01D 2221/04* (2013.01); *B01L 3/5021* (2013.01); *B04B 2005/0435* (2013.01)

(58) **Field of Classification Search**
CPC . C10G 1/00; C10G 1/04; C10G 1/045; C10G 1/047; B04B 3/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,718,141	A	6/1929	Hall
2,320,106	A	5/1943	South
2,840,240	A	6/1958	Snyder
2,871,180	A	1/1959	Lowman, Jr. et al.

(Continued)

OTHER PUBLICATIONS

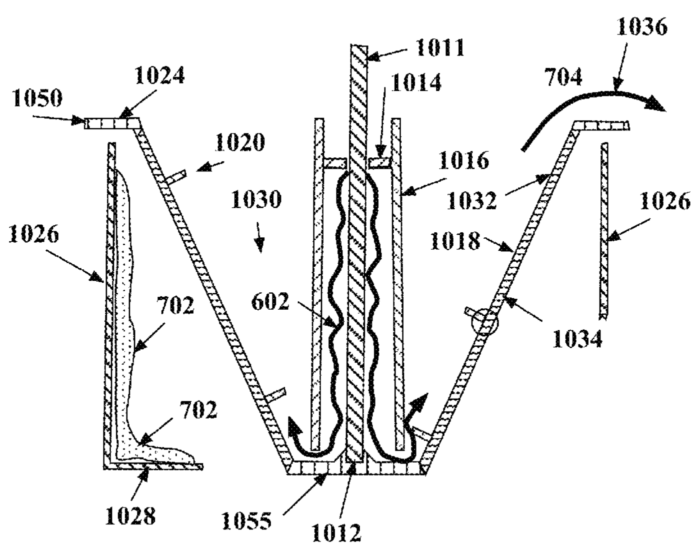
Budziak, Study of fines in bitumen extracted from oil sands by heat centrifugation, 1988 Fuel vol. 67 December pages 633-1638.

Primary Examiner — Renee Robinson

(57) **ABSTRACT**

A method, system, and device for separating oil from oil sands or oil shale is disclosed. The method includes heating the oil sands, spinning the heated oil sands, confining the sand particles mechanically, and recovering the oil substantially free of the sand. The method can be used without the addition of chemical extraction agents. The system includes a source of centrifugal force, a heat source, a separation device, and a recovery device. The separation device includes a method of confining the sands while allowing the oil to escape, such as through an aperture.

7 Claims, 42 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

3,161,581 A		12/1964	Tiedje et al.
3,466,240 A		9/1969	Steinmetz
3,530,041 A		9/1970	Erskine et al.
3,891,550 A		6/1975	Gray et al.
3,893,907 A		7/1975	Canevari
3,951,749 A		4/1976	Fairbanks, Jr. et al.
3,953,317 A		4/1976	Myers et al.
4,029,568 A		6/1977	Pittman et al.
4,110,194 A		8/1978	Peterson et al.
4,110,195 A		8/1978	Harding
4,224,138 A		9/1980	Kruyer
4,240,897 A		12/1980	Clarke
4,250,016 A		2/1981	Estes et al.
4,338,185 A		7/1982	Noelle
4,347,971 A		9/1982	Novoselac
4,459,200 A		7/1984	Dente et al.
4,498,971 A		2/1985	Angelov et al.
4,515,685 A		5/1985	Yeh
4,533,459 A		8/1985	Dente et al.
4,704,200 A		11/1987	Keane
4,906,355 A		3/1990	Lechnick et al.
4,966,685 A		10/1990	Hall et al.
5,122,259 A		6/1992	Nielson
5,223,148 A		6/1993	Tipman
5,320,746 A		6/1994	Green et al.
5,340,467 A		8/1994	Gregoli
5,520,605 A	*	5/1996	Leung B04B 1/20 494/50
5,626,743 A		5/1997	Humphreys
5,762,780 A		6/1998	Rendall et al.
5,770,049 A		6/1998	Humphreys
5,795,444 A		8/1998	Rendall et al.
5,876,592 A		3/1999	Tipman et al.
5,985,138 A		11/1999	Humphreys
6,004,455 A		12/1999	Rendall
6,119,870 A		9/2000	Maciejewski et al.
6,214,213 B1		4/2001	Tipman et al.
6,251,290 B1		6/2001	Conaway
6,576,145 B2		6/2003	Conaway et al.
7,192,092 B2		3/2007	Watson
2001/0030145 A1		10/2001	Conaway
2002/0003115 A1		1/2002	Conaway et al.
2004/0035755 A1		2/2004	Reeves
2004/0129646 A1		7/2004	Conaway et al.
2006/0016760 A1		1/2006	Bozack et al.
2006/0138055 A1		6/2006	Garner et al.
2007/0131590 A1		6/2007	Bozack et al.
2007/0181465 A1		8/2007	Collette
2007/0205141 A1		9/2007	Freeman et al.
2008/0000810 A1		1/2008	Garner et al.
2008/0035531 A1		2/2008	Coveley

* cited by examiner

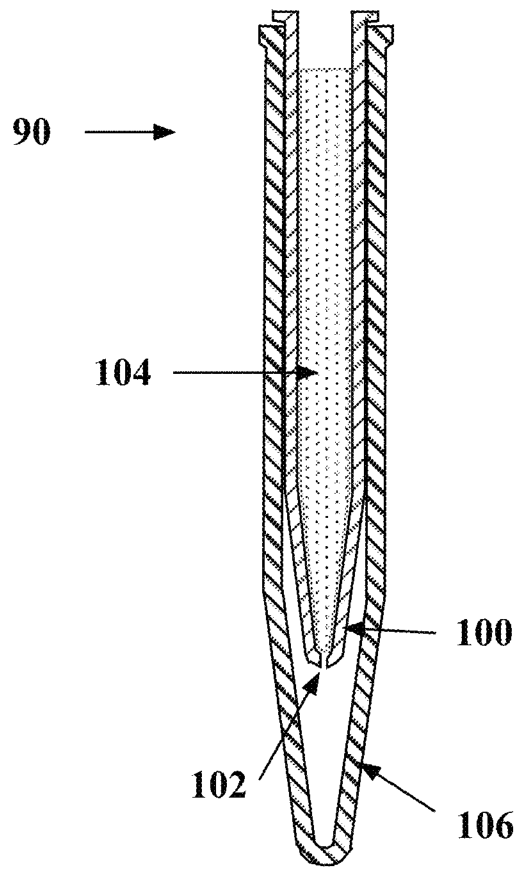


FIG. 1

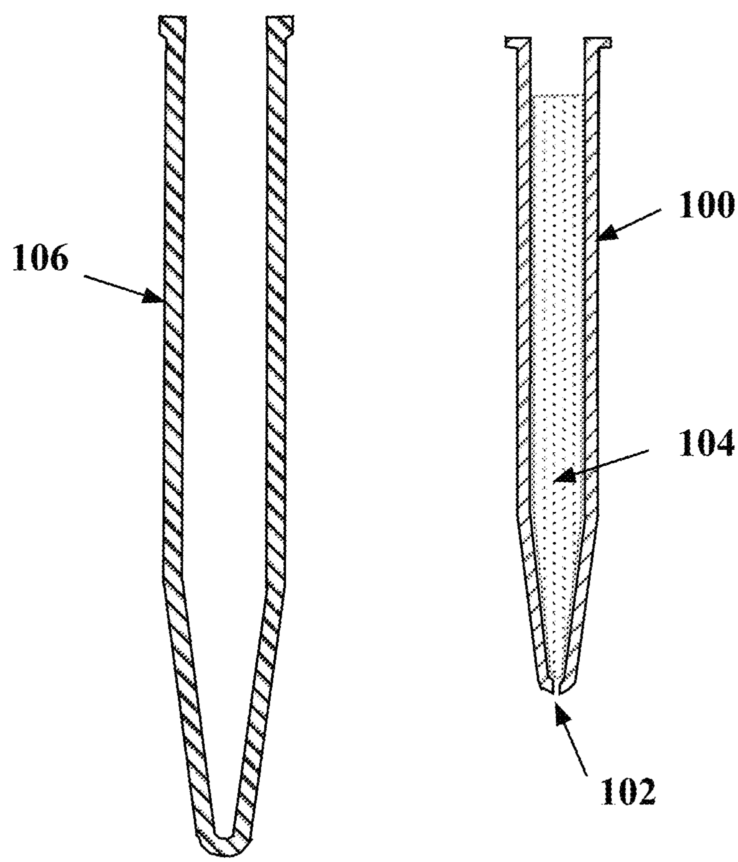


FIG. 2

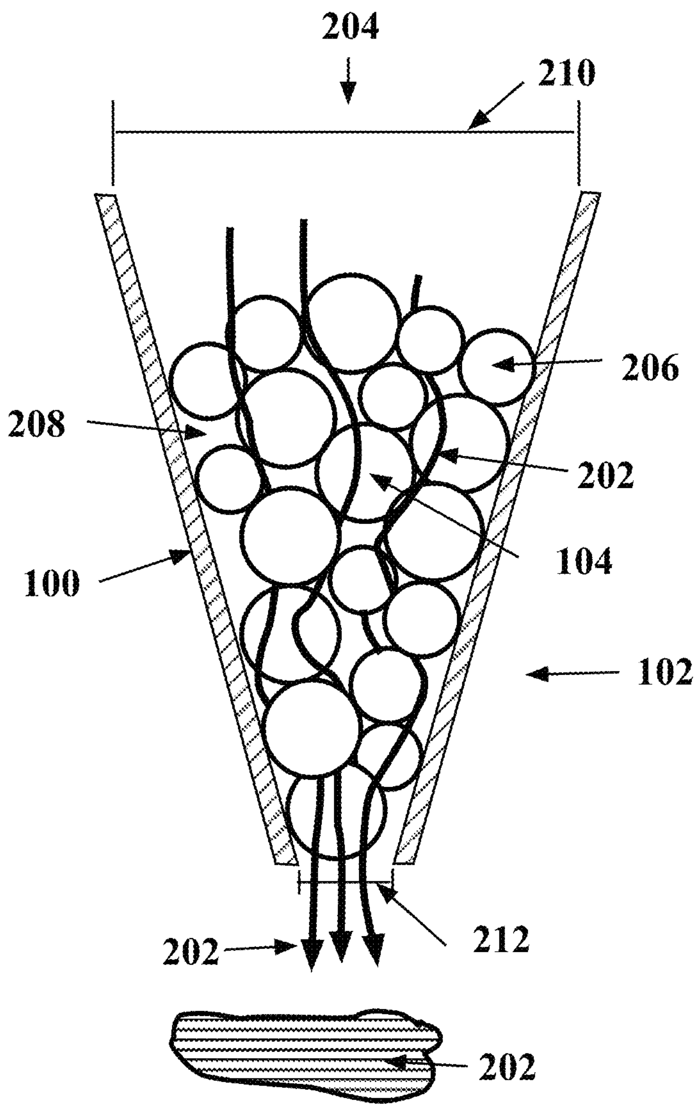
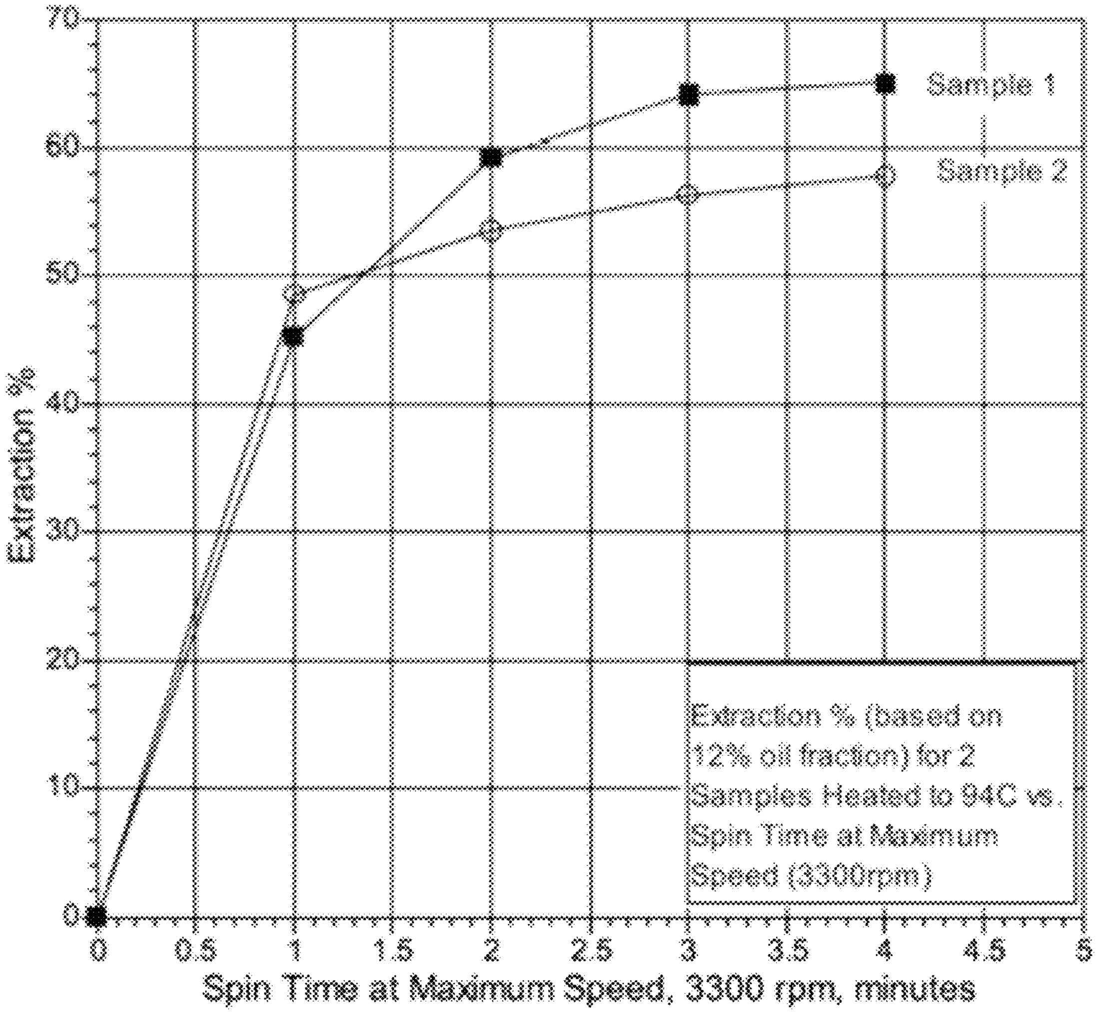


FIG. 3



70
60
50
40
30
20
10
0
Extraction %
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Spin Time at Maximum Speed, 3300 rpm, minutes
Sample 1
Sample 2
Extraction % (based on 12% oil fraction) for 2 Samples Heated to 94C vs. Spin Time at Maximum Speed (3300rpm)

FIG. 4

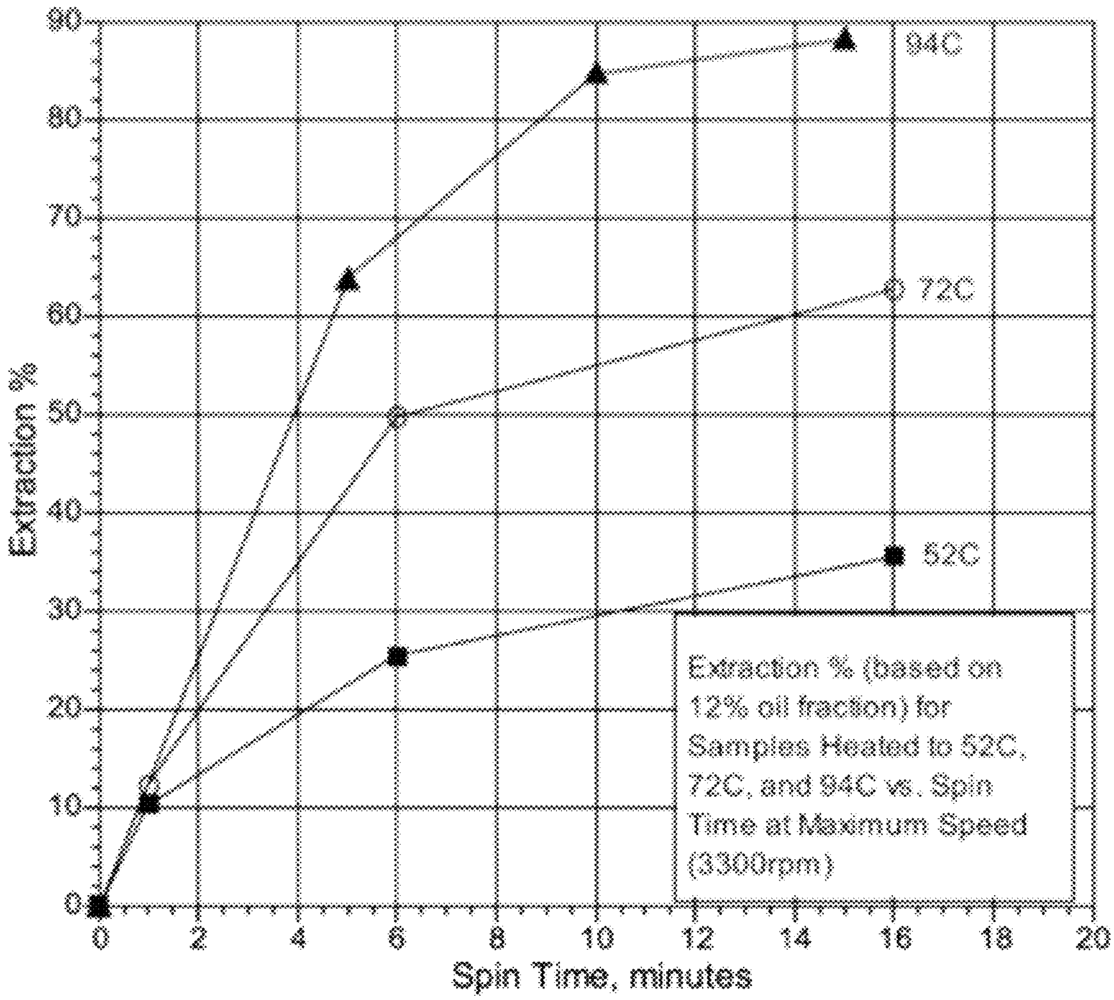

90
80
70
60
50
40
30
20
10
0
Extraction %
0
2
4
6
8
10
12
14
16
18
20
Spin Time, minutes
94C
72C
52C
Extraction % (based on 12% oil fraction) for Samples Heated to 52C, 72C, and 94C vs. Spin Time at Maximum Speed (3300rpm)

Fig. 5

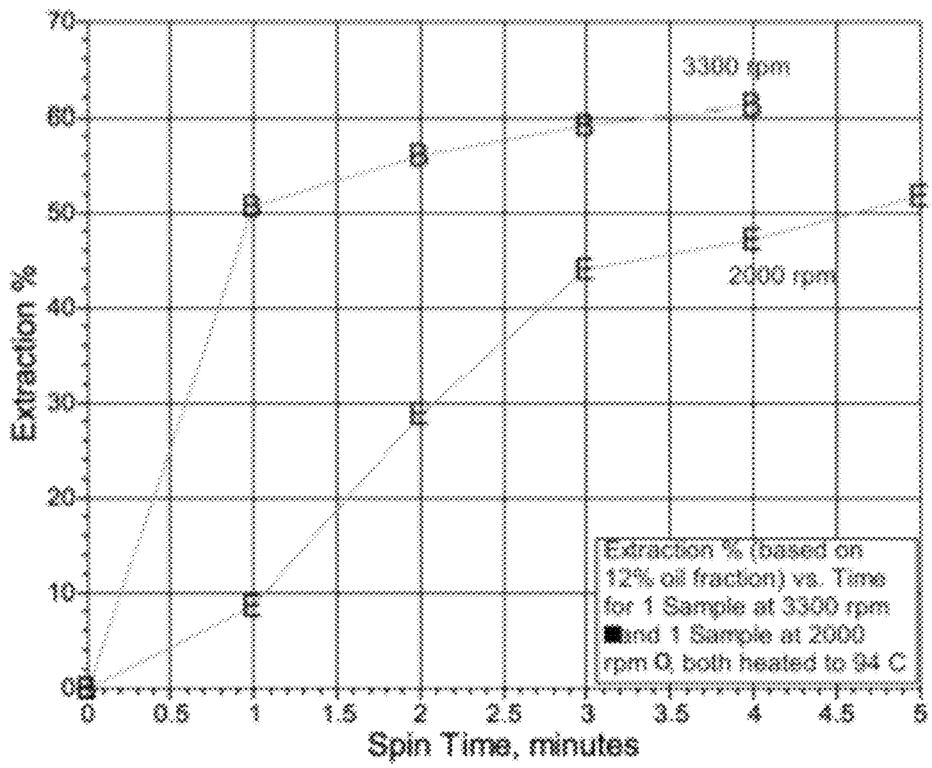

70
60
50
40
30
20
10
0
Extraction %
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Spin Time, minutes
3300 rpm
2000 rpm
Extraction % (based on 12% oil fraction) vs. Time for 1 Sample at 3300 rpm ■and 1 Sample at 2000 rpm O, both heated to 94 C

FIG. 6

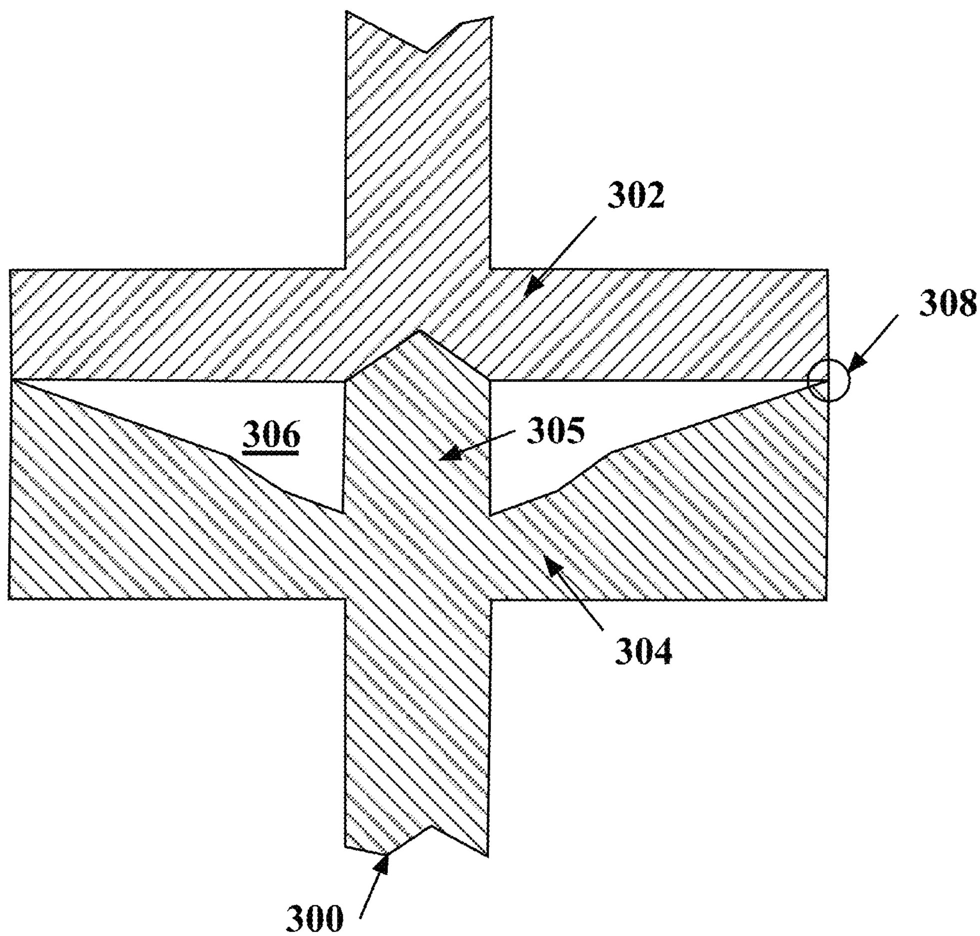


Fig. 7

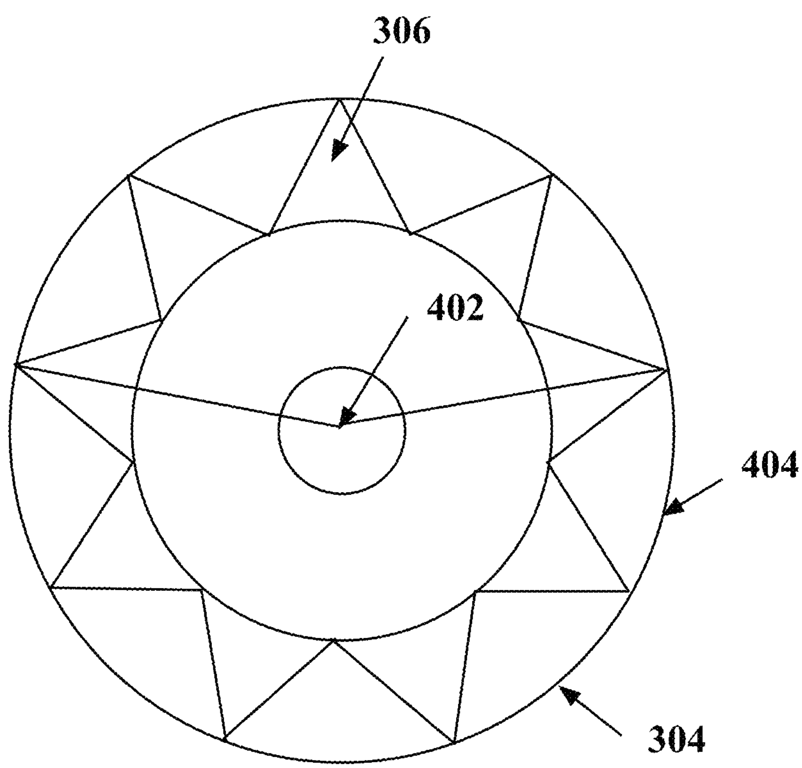


FIG. 8

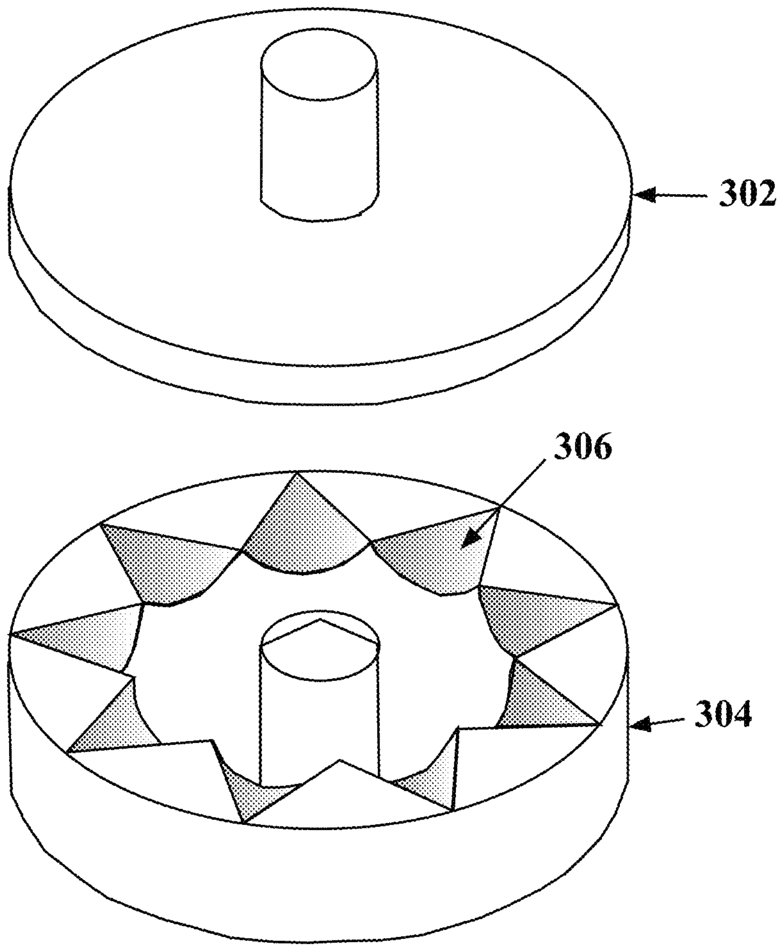


FIG. 9

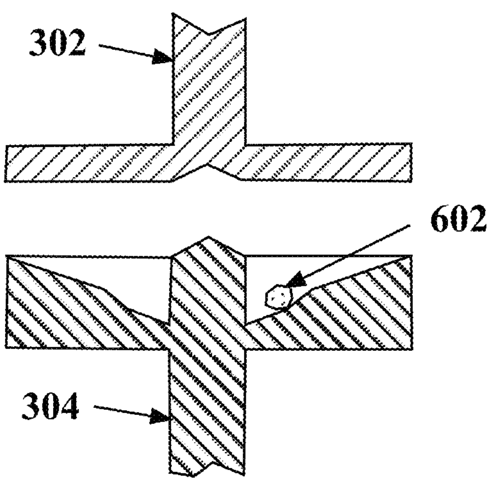


FIG. 10

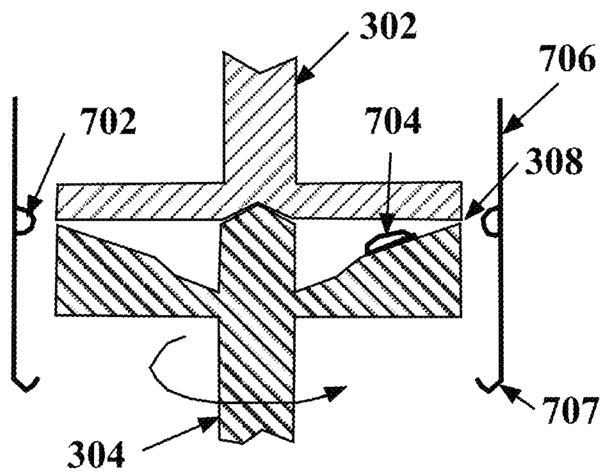


FIG. 11

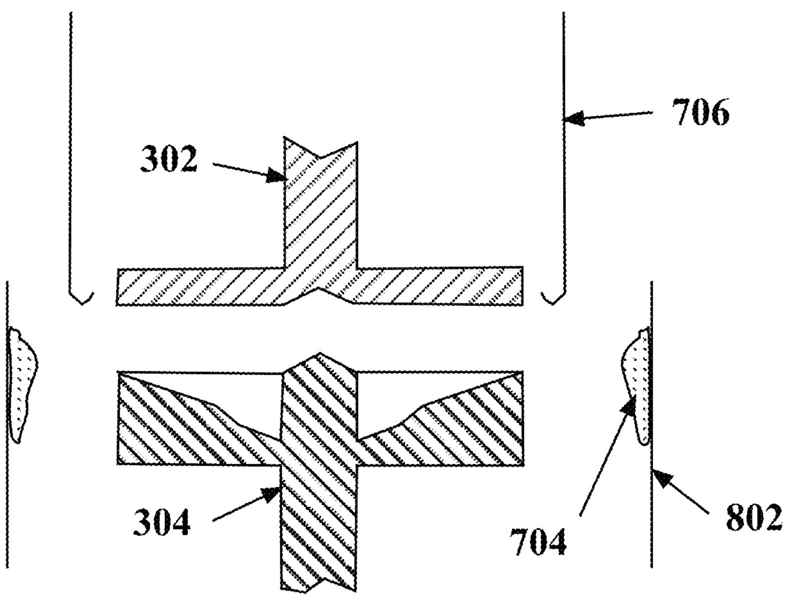


FIG. 12

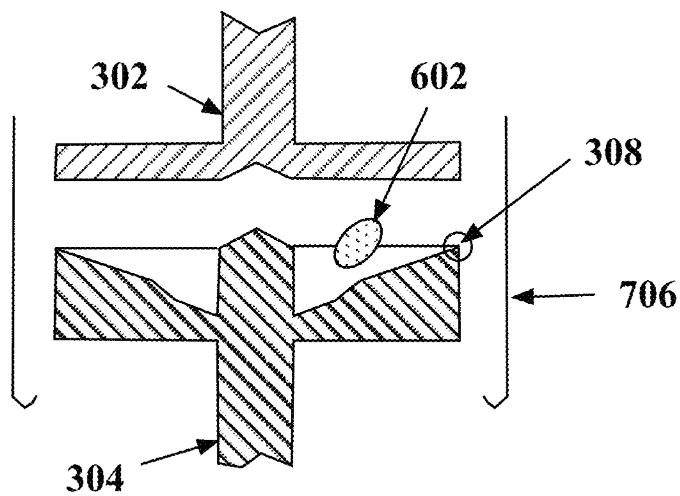


FIG. 13

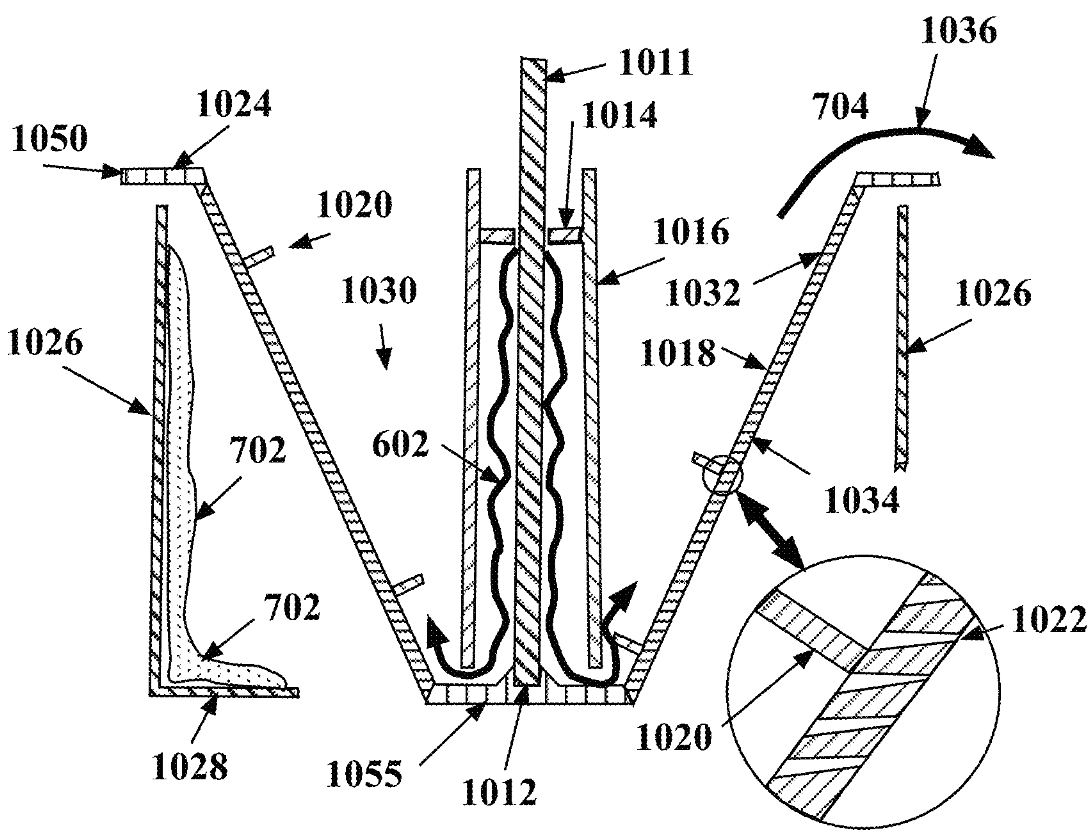


FIG. 14a

FIG. 14

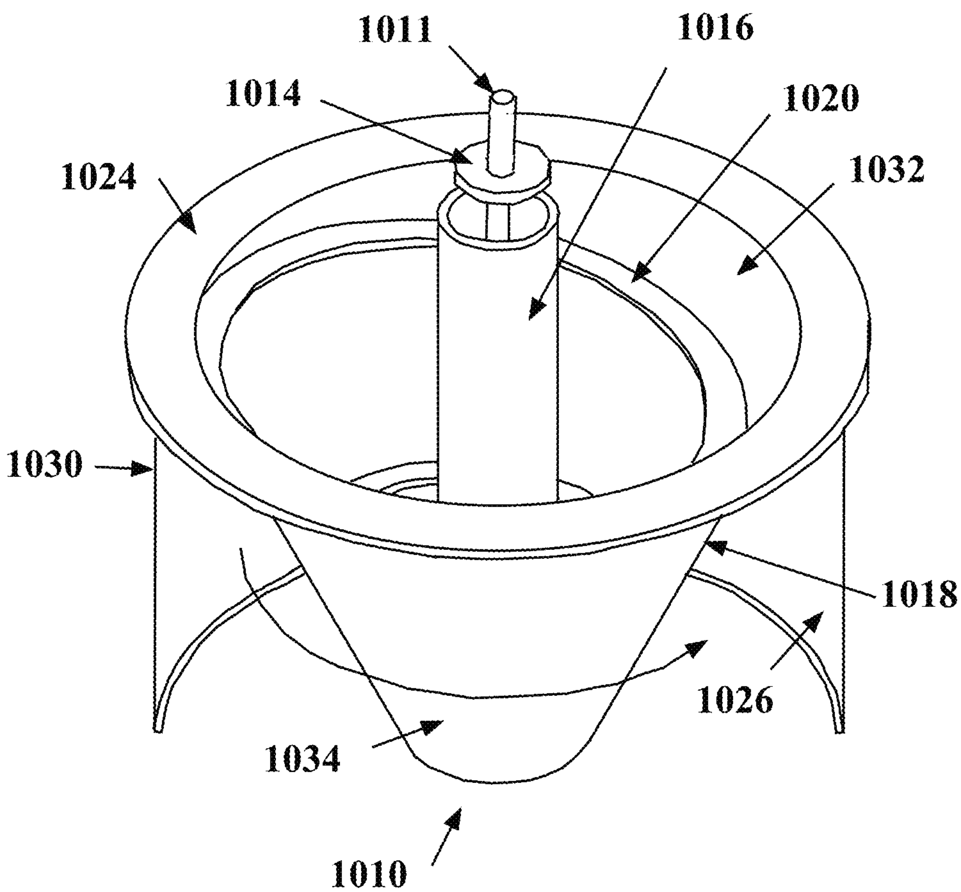


FIG. 15

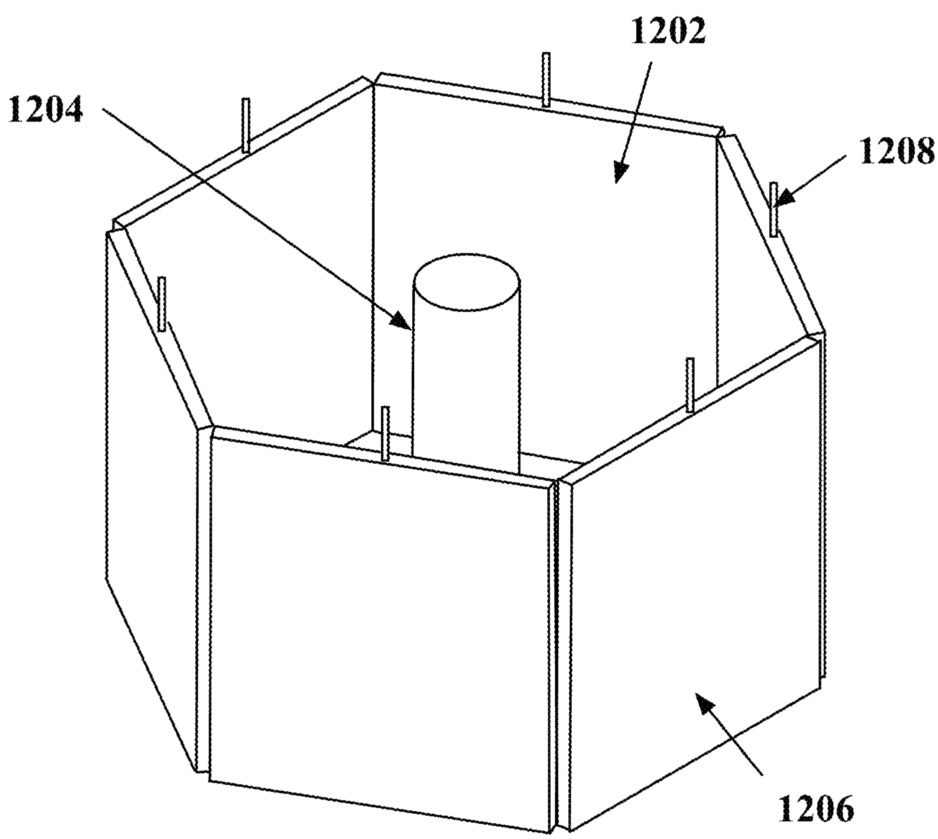


FIG. 16

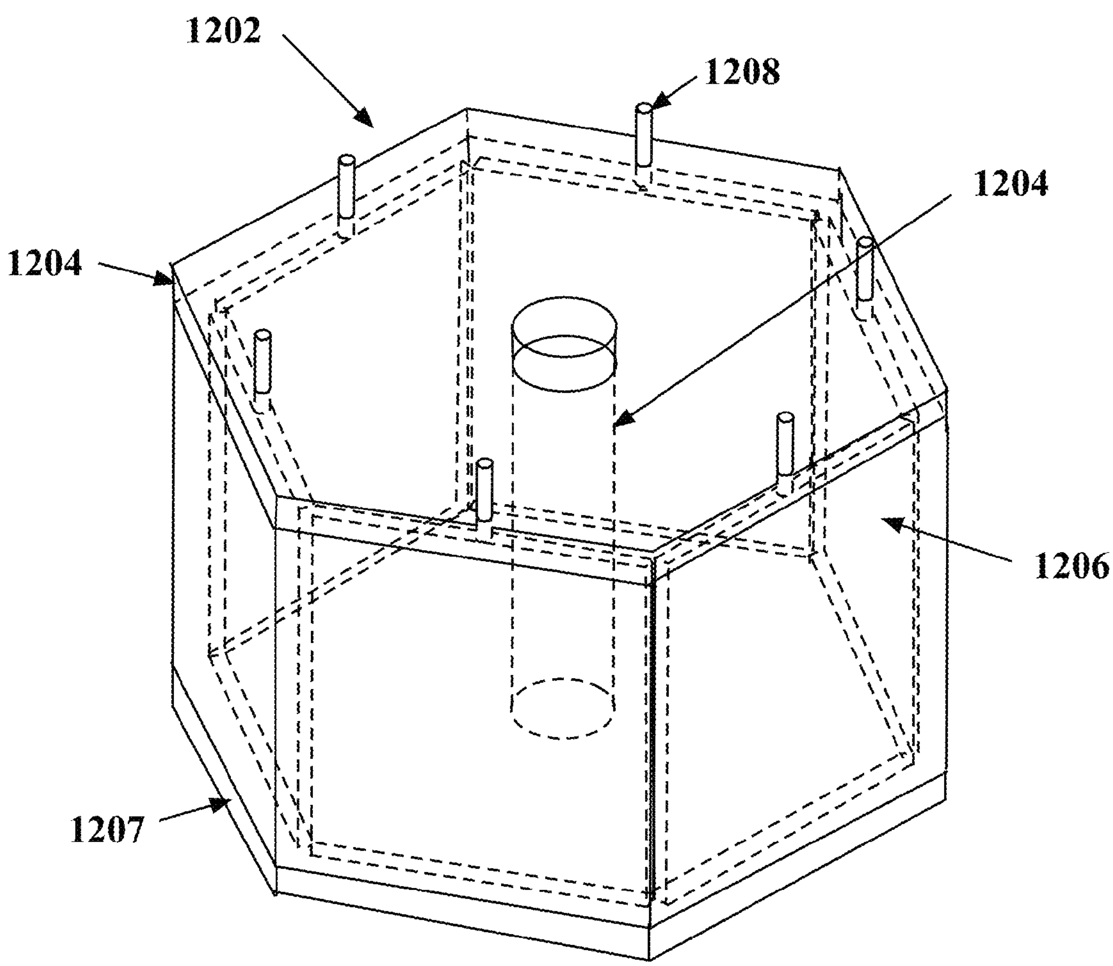


FIG. 17

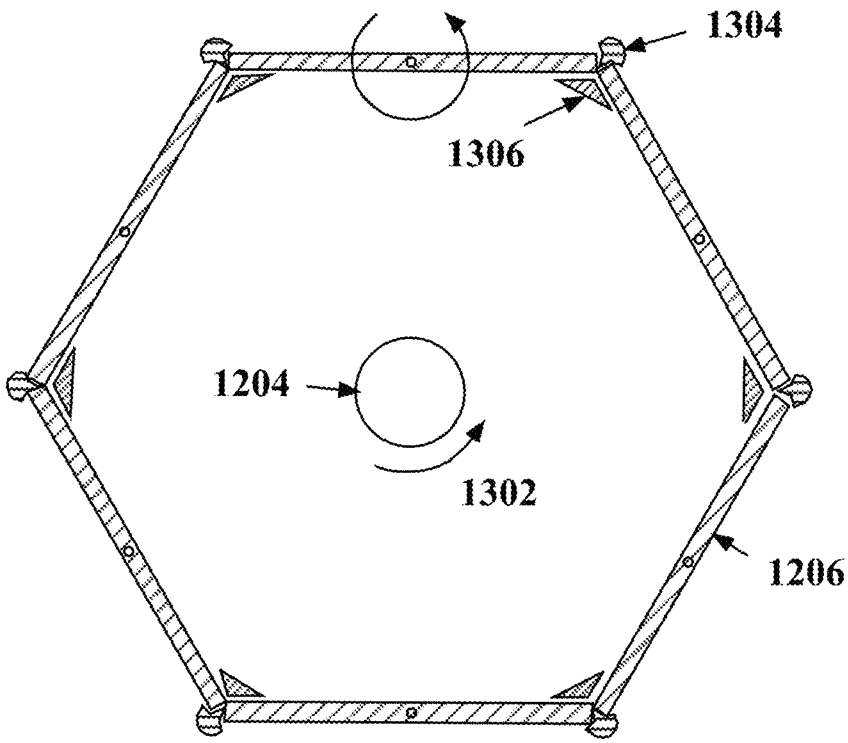


FIG. 18

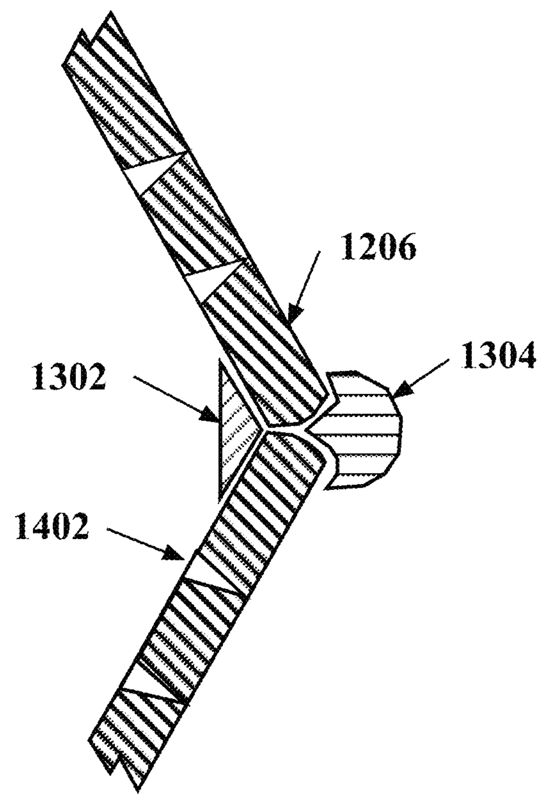


FIG. 19

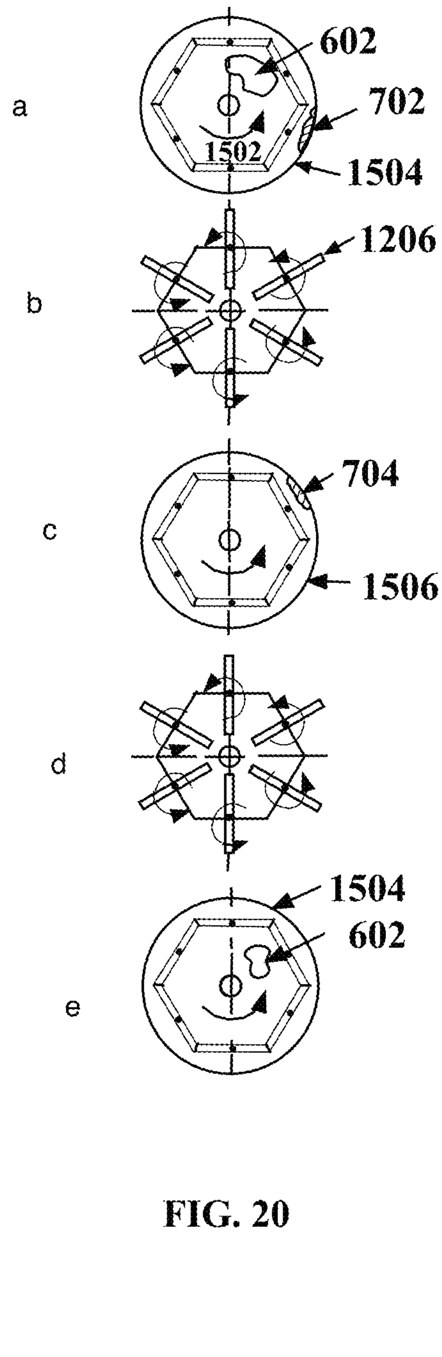


FIG. 20

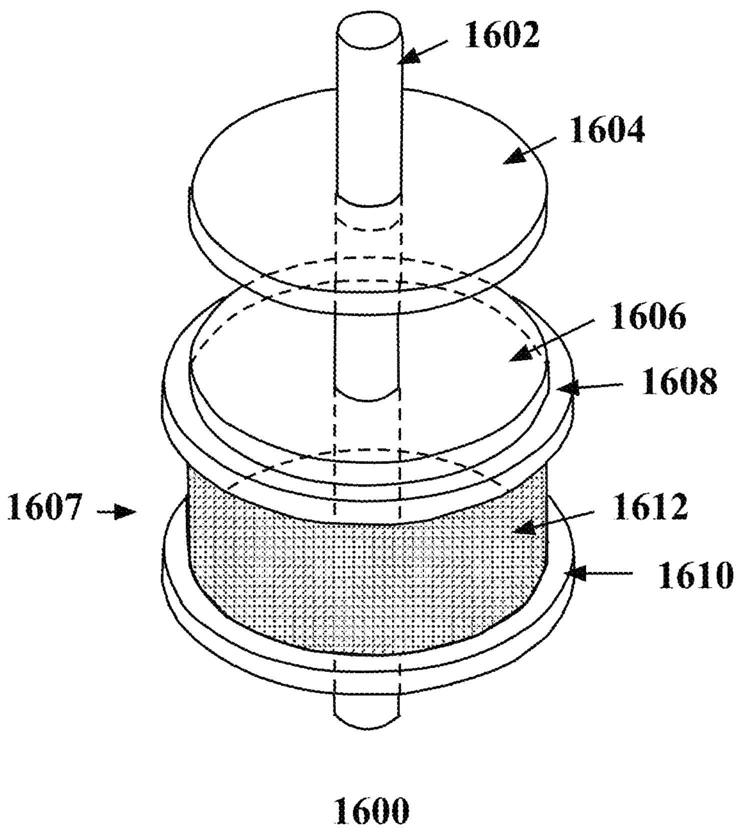


FIG. 21

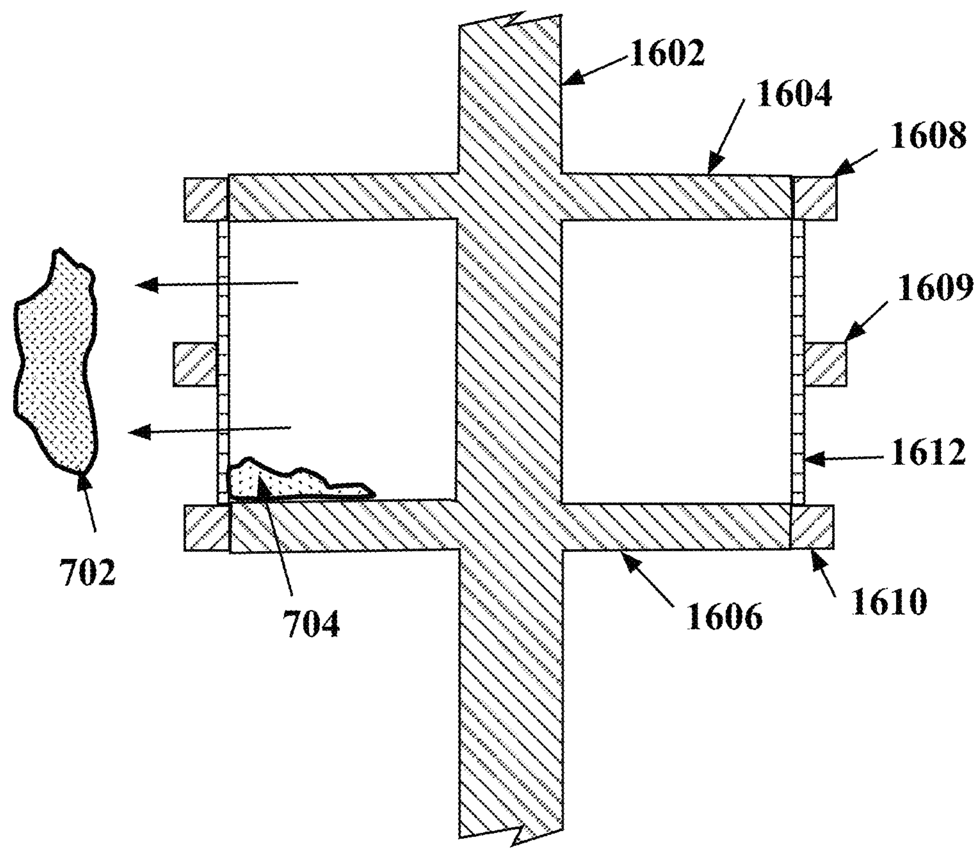


FIG. 22

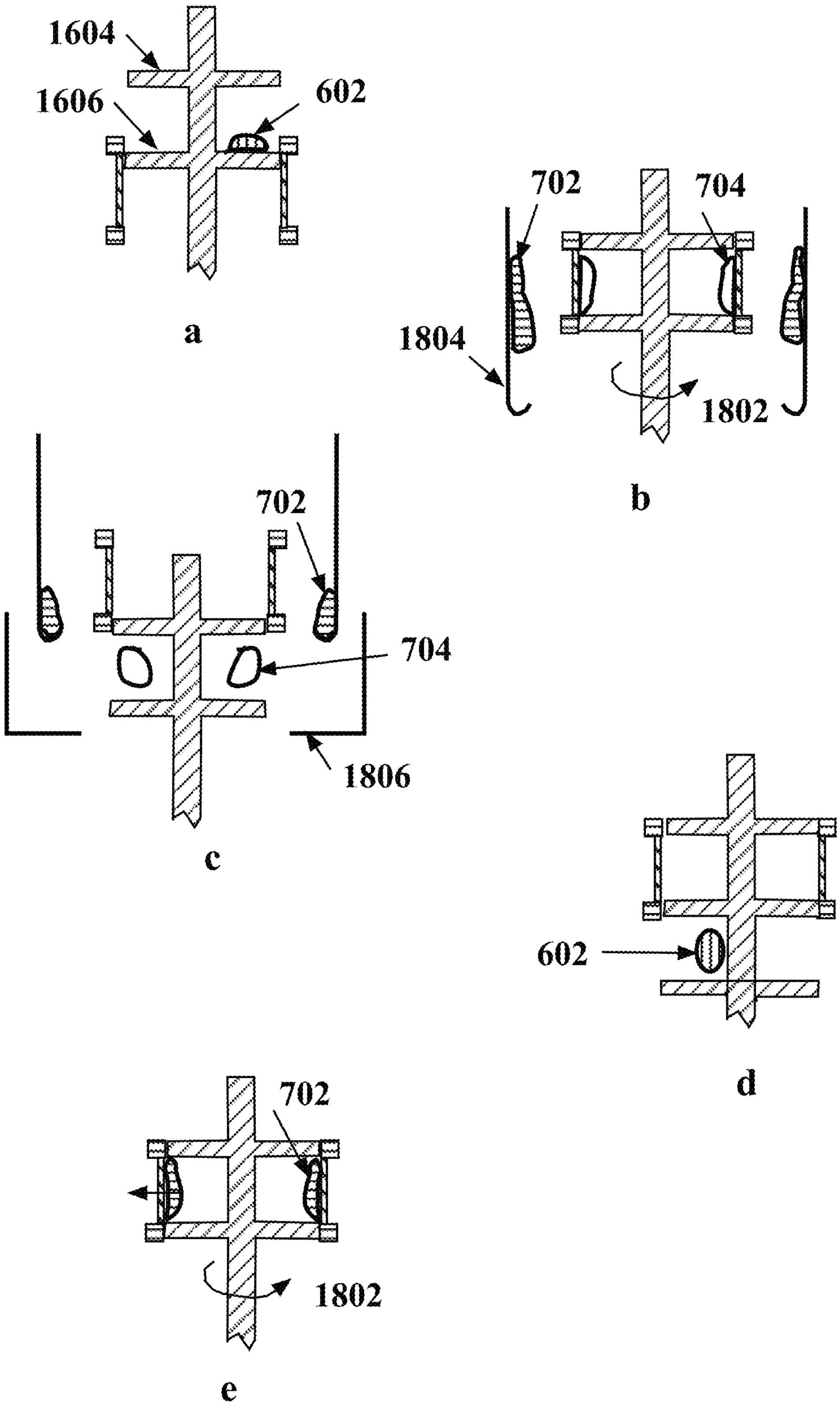

1604
1606
602
a
702
704
1804
1802
b
702
704
1806
c
602
d
702
1802
e

FIG. 23

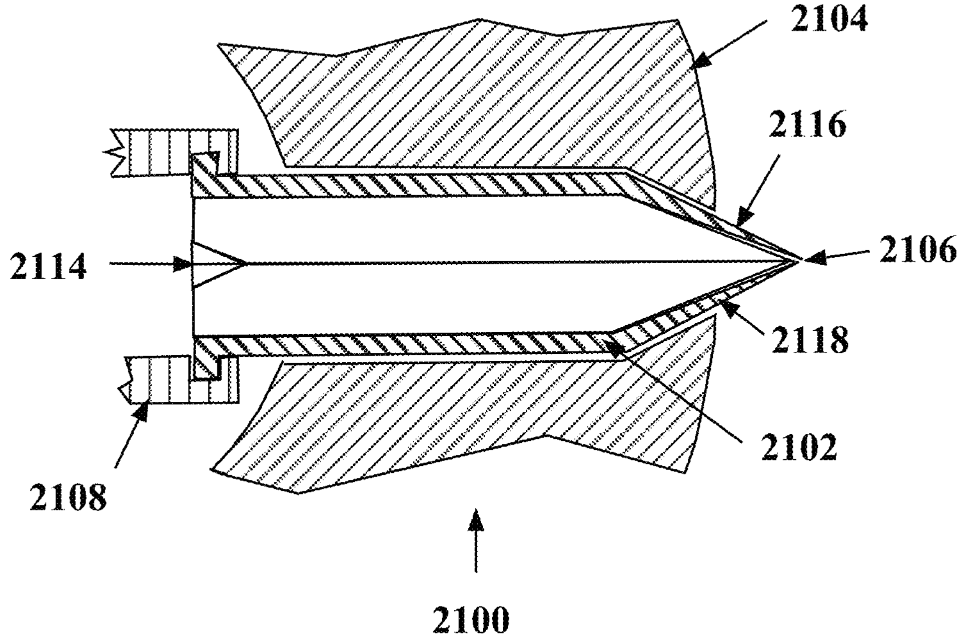


FIG. 24

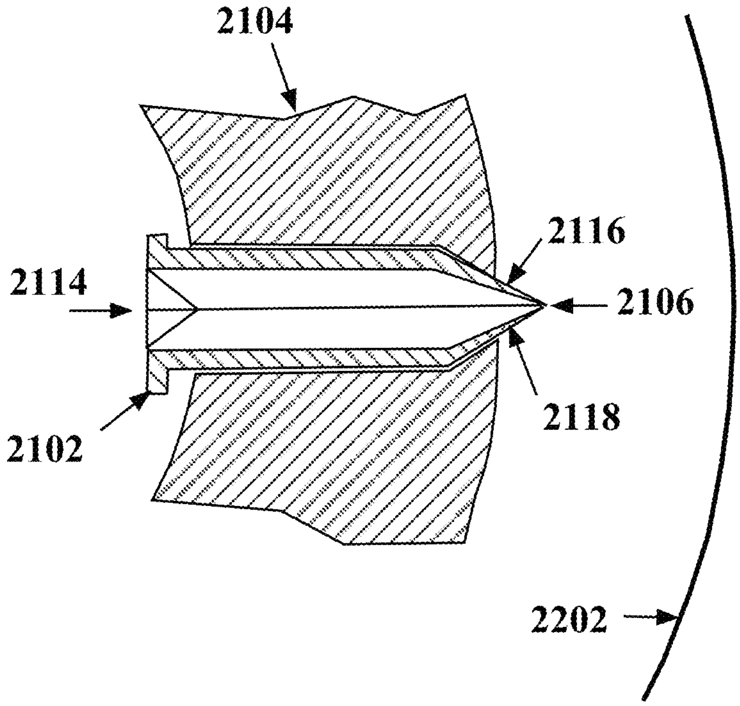


FIG. 25

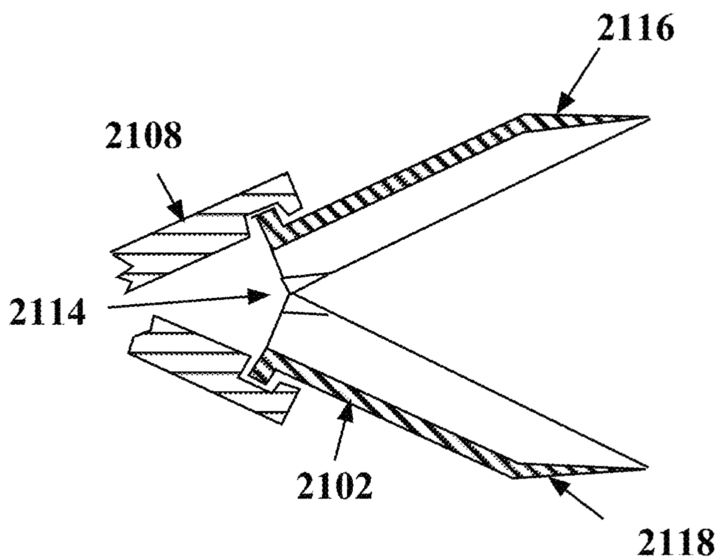


FIG. 26

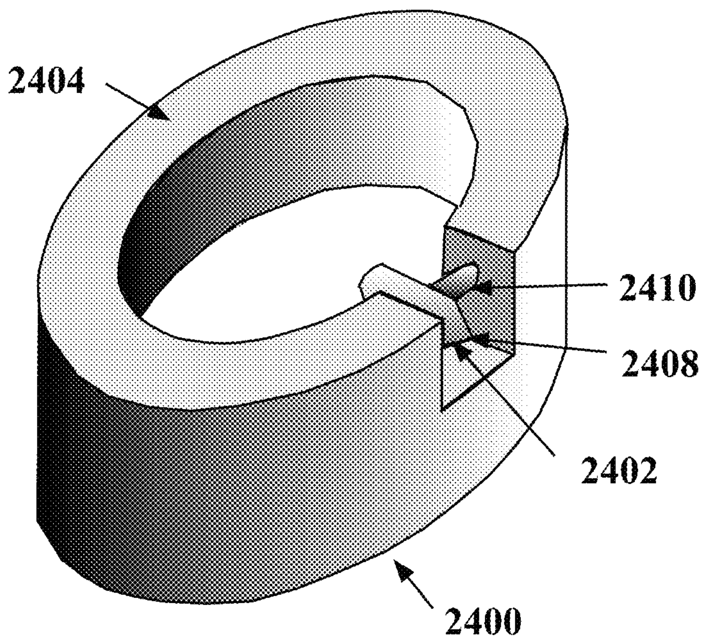


FIG. 27

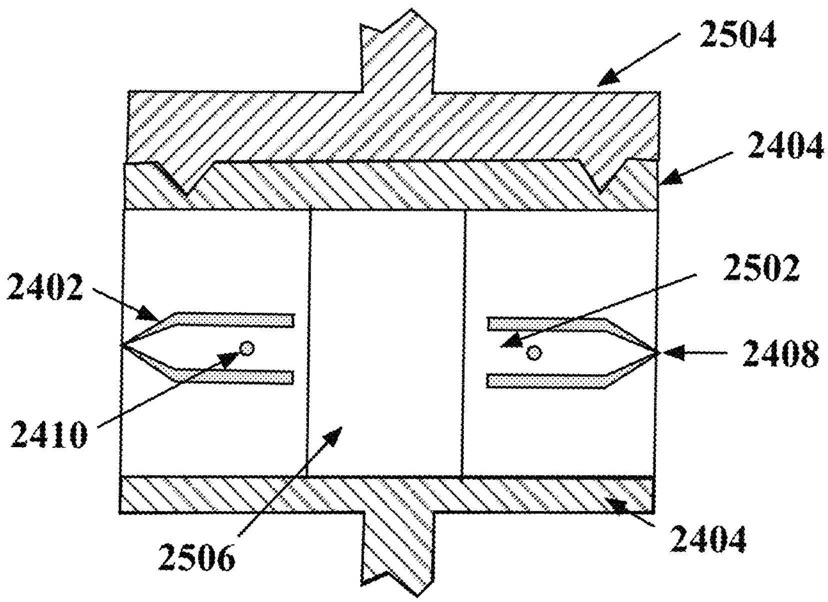


FIG. 28

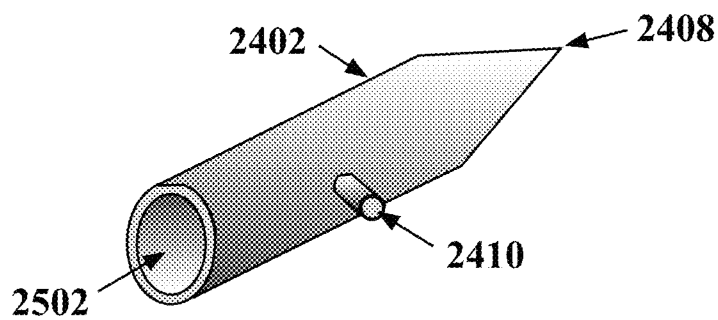


FIG. 29

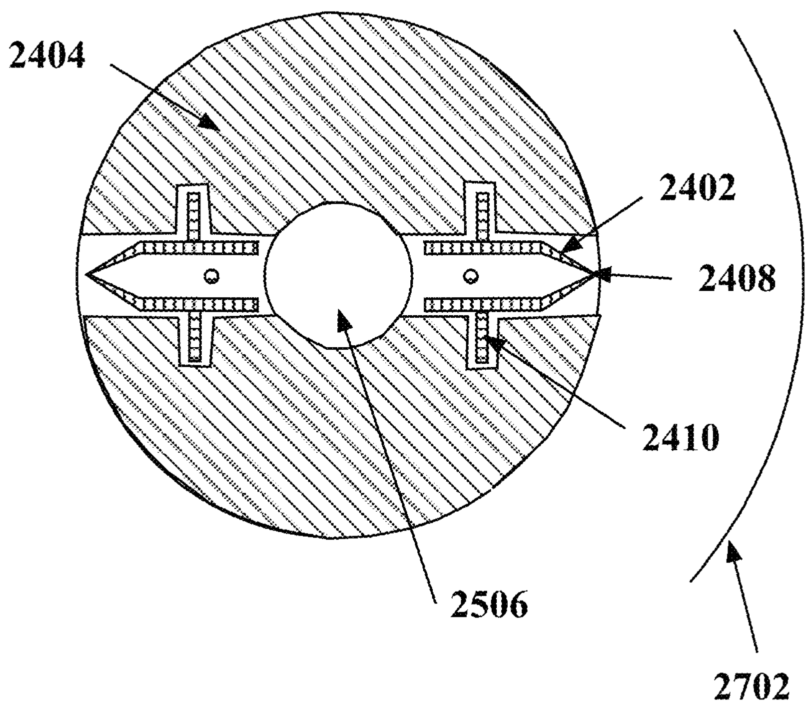


FIG. 30

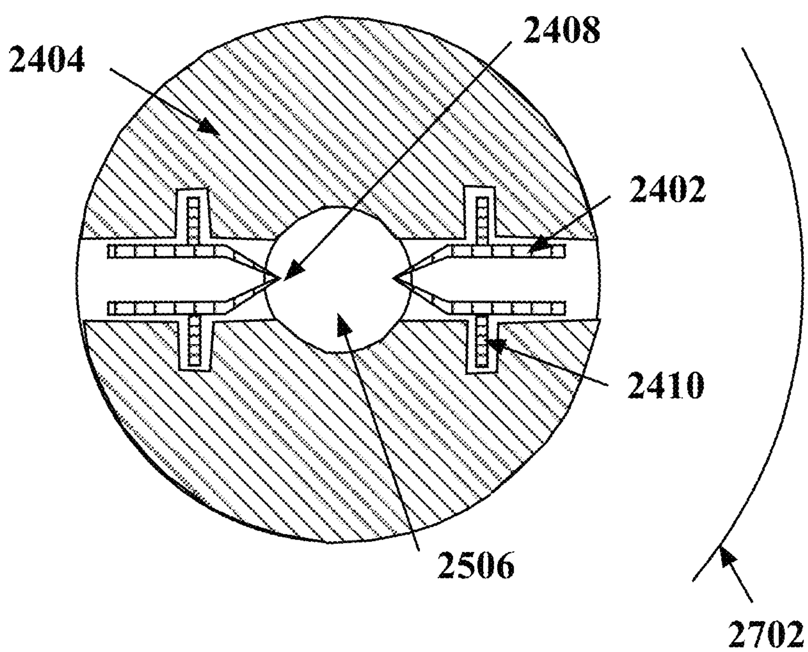


FIG. 31

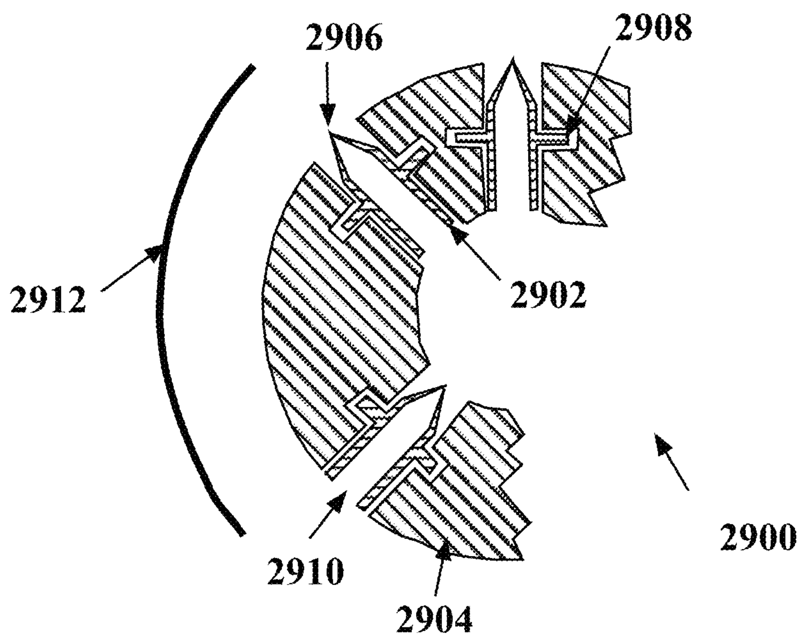


FIG. 32

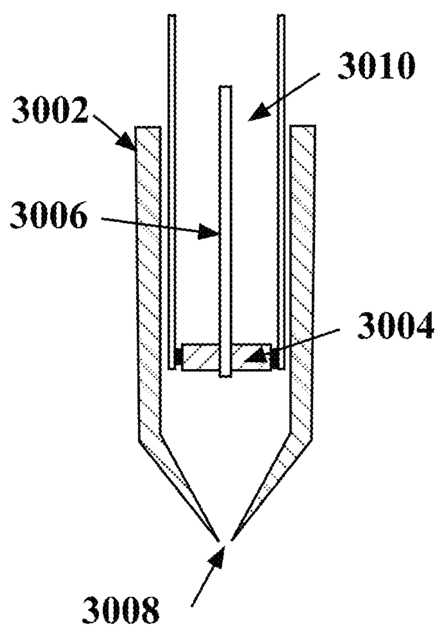


FIG. 33

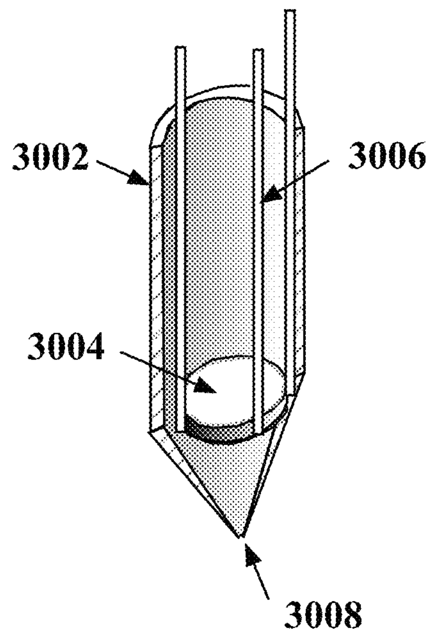


FIG. 34

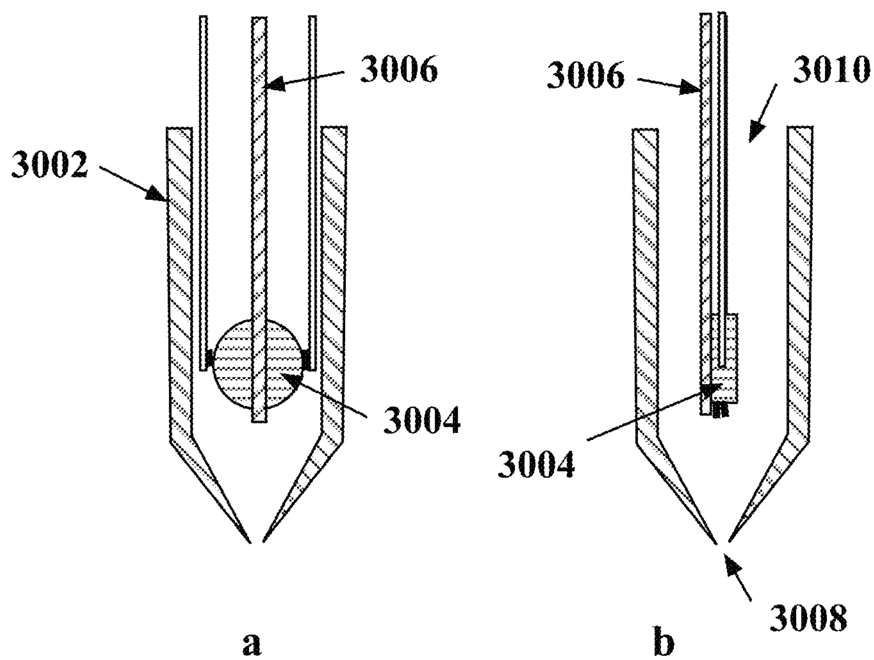


FIG. 35

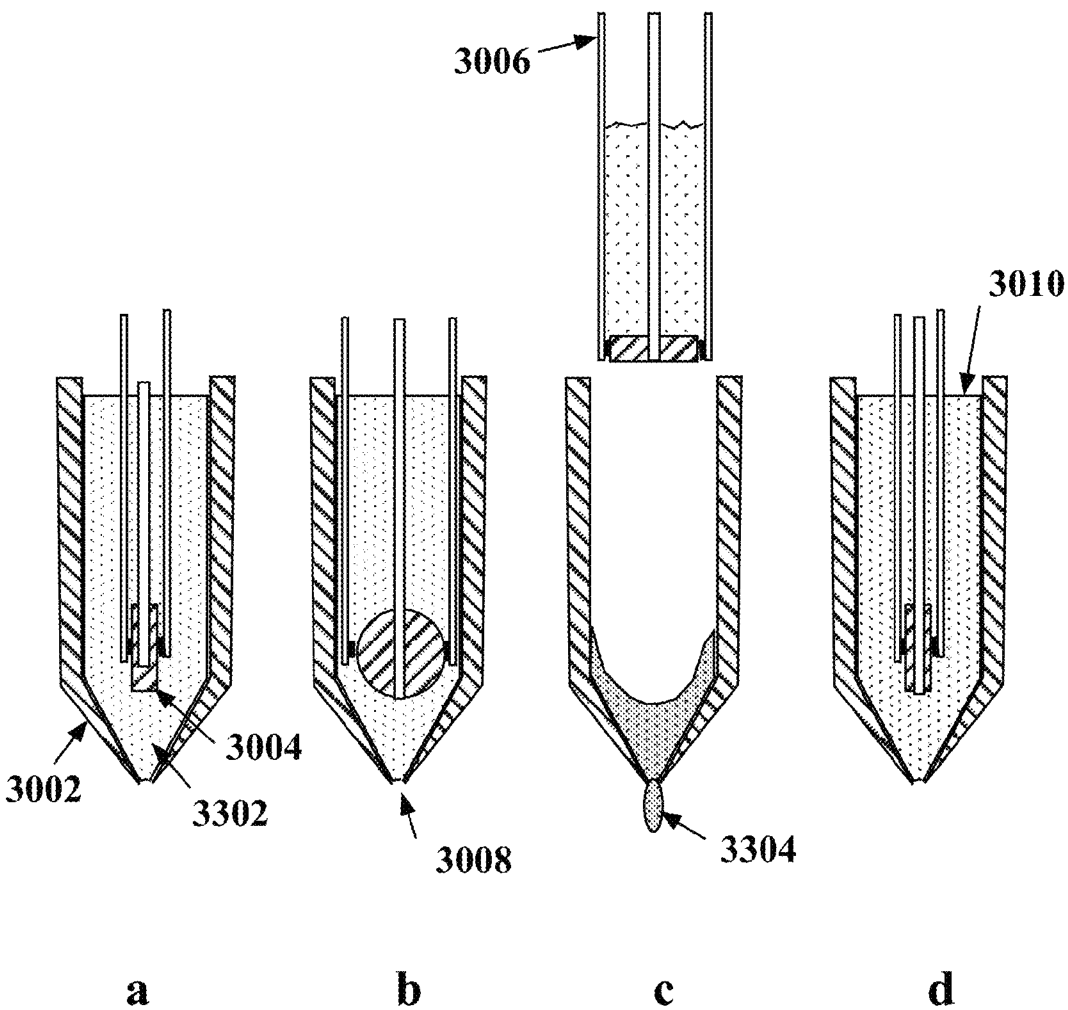


FIG. 36

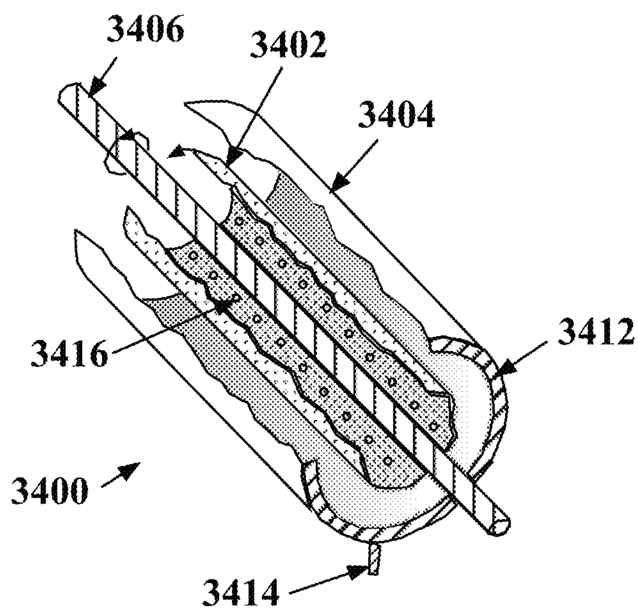


FIG. 37

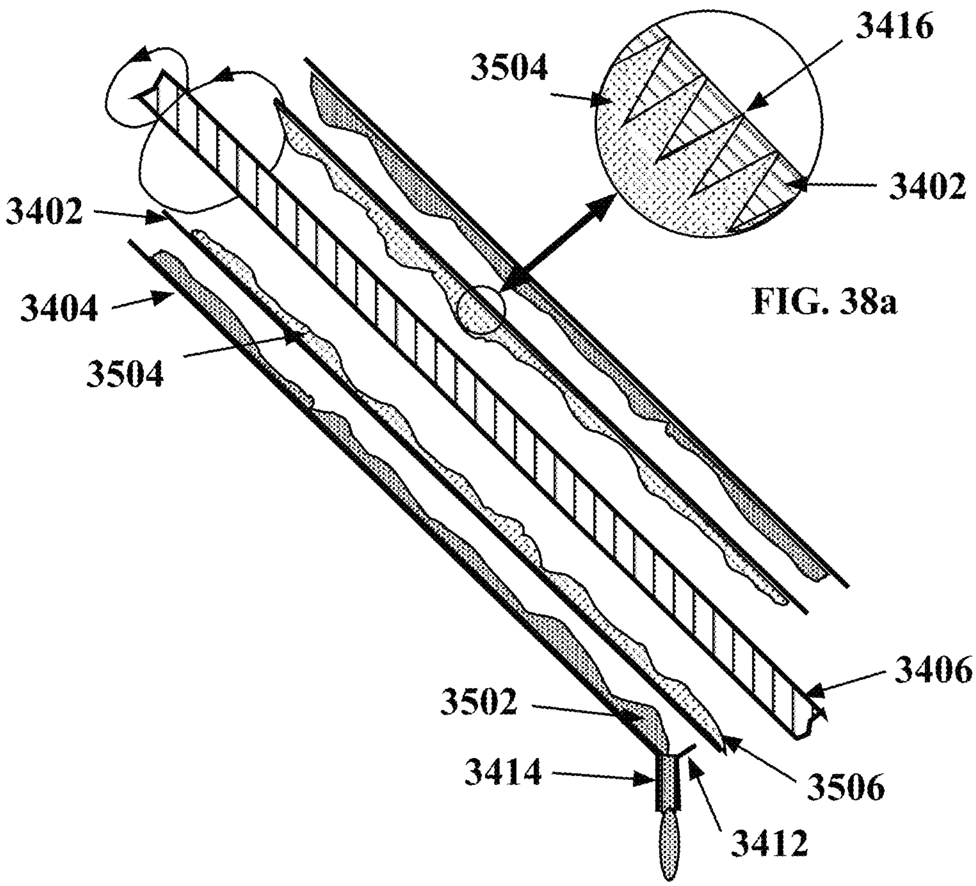


FIG. 38a

FIG. 38

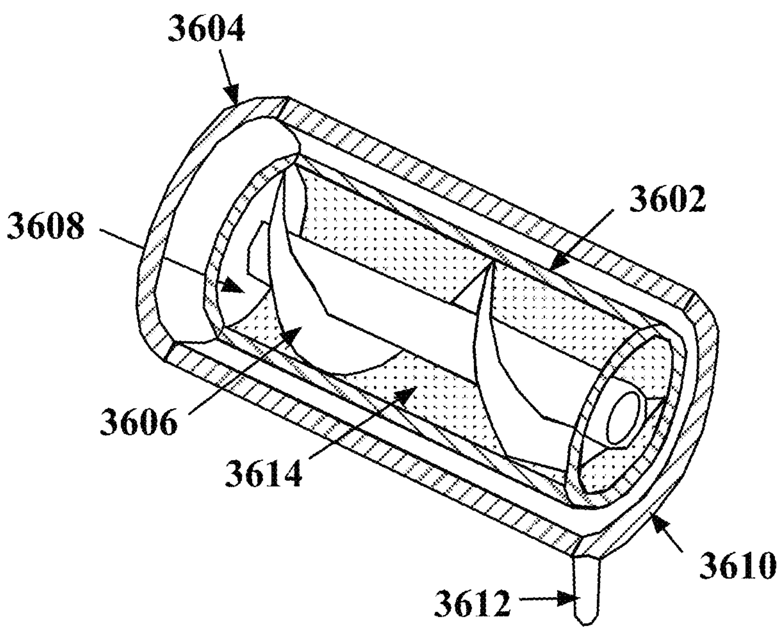


FIG. 39

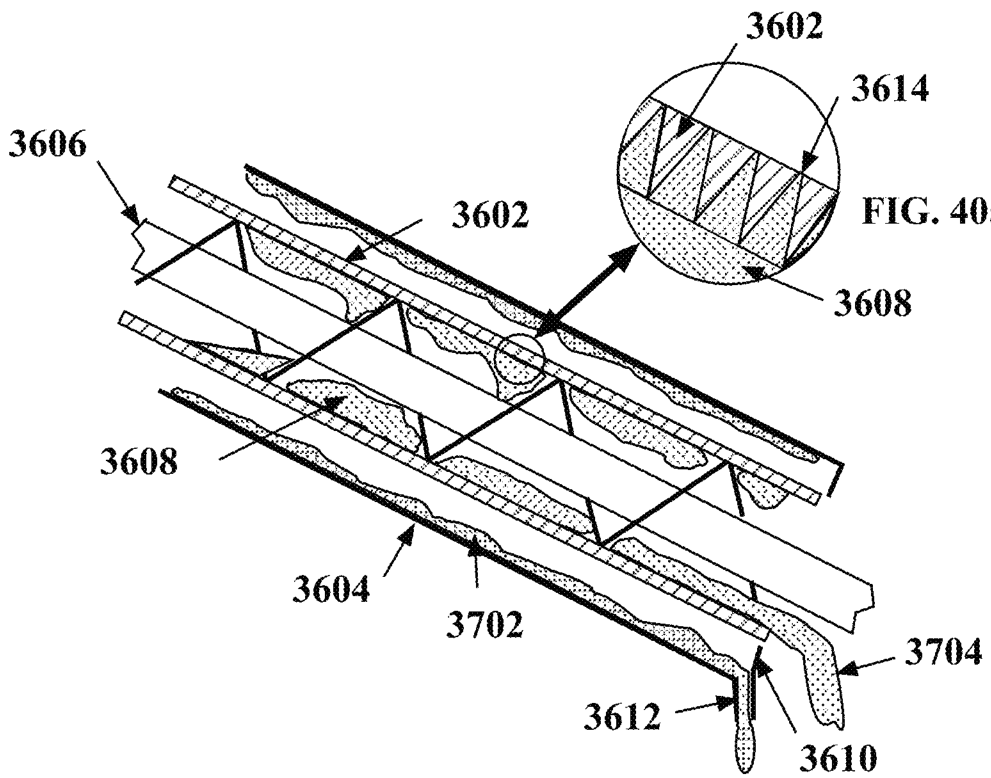


FIG. 40a

FIG. 40

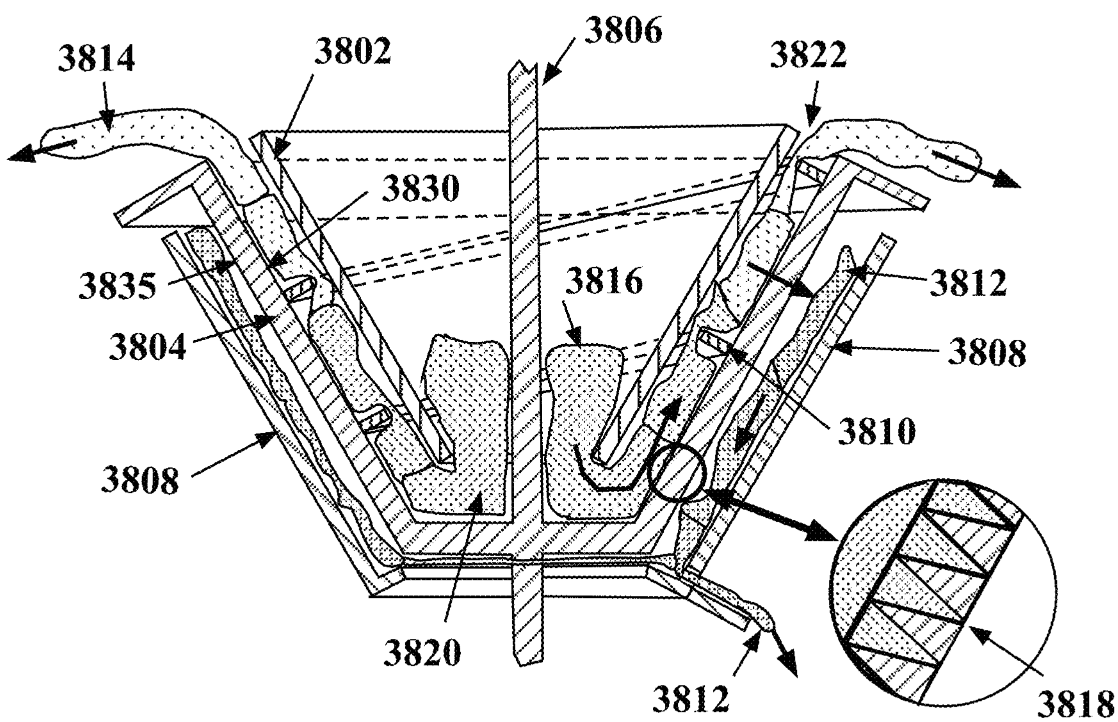


FIG. 41a

FIG. 41

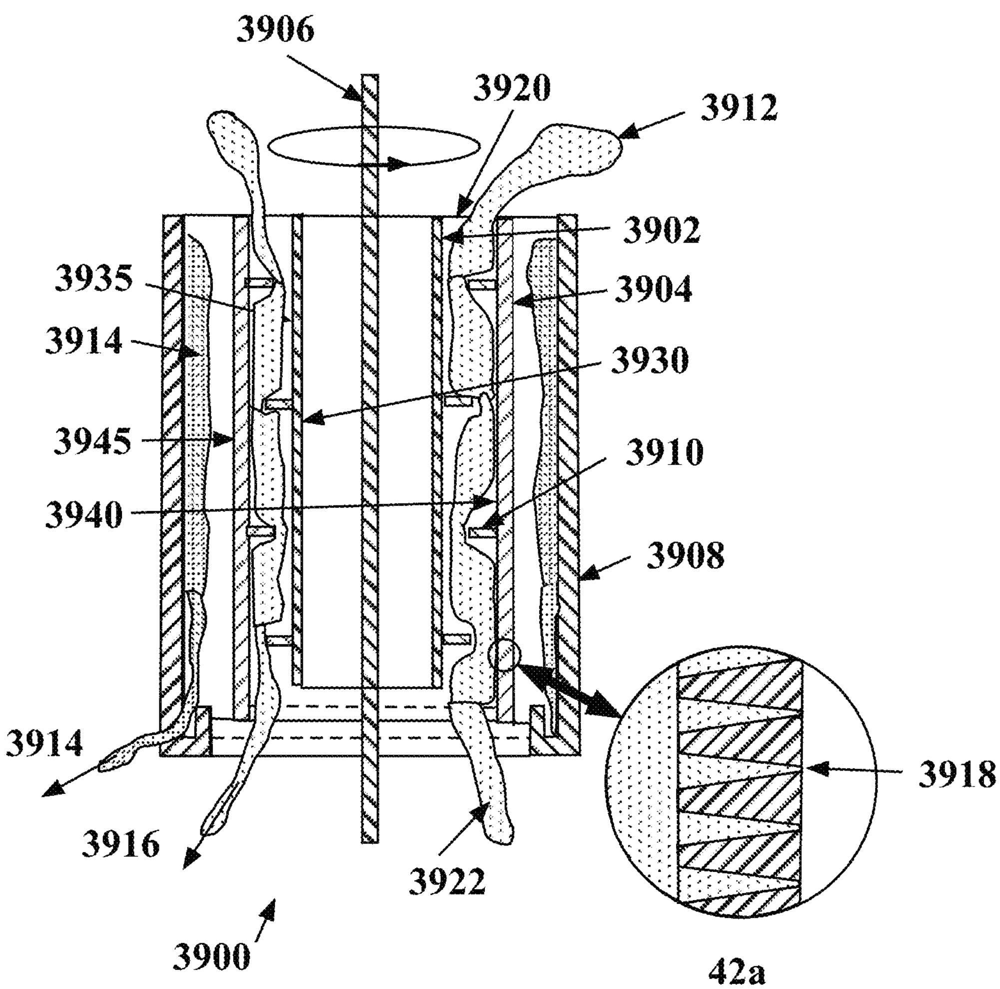

3906
3920
3912
3902
3935
3904
3914
3930
3945
3910
3940
3908
3914
3918
3916
3922
3900
42a

FIG. 42

METHOD AND DEVICE FOR EXTRACTION OF LIQUIDS FROM A SOLID PARTICLE MATERIAL

RELATED APPLICATIONS

The present patent document is a division of patent application Ser. No. 12/855,267 filed Aug. 12, 2010, which claims the benefit of the filing date under 35 U.S.C. §119(e) of Provisional U.S. Patent Application Ser. No. 61/233,241, filed Aug. 12, 2009, each of which are hereby incorporated by reference in their entirety.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with Government support under contract NNG05GJ65H, awarded by NASA. The Government has certain rights in this invention.

BACKGROUND

Given high oil prices and the finite amount of crude oil available, unconventional petroleum reserves in the form of, for example, oil sands and oil shale are becoming more attractive as an alternative source of hydrocarbons. Oil sands are found in over 60 countries in the world, including the United States. The main deposits occur in Alberta, Canada, and represent the second largest reserves of petroleum in the world, after those in Saudi Arabia.

BRIEF SUMMARY

This invention relates to a process for extracting liquids, such as bitumen or crude oil, from discrete solid particles, such as sand or shale. The invention is particularly applicable to oil sands and oil shale in which oil is present as a highly viscous liquid.

BRIEF DESCRIPTION OF THE DRAWINGS

The physical process for extracting liquid such as oil from the solid-liquid mixture such as oil sands or oil shale involves submitting the heated mixture to centrifugal forces to allow the liquid to mechanically separate from the solid particles and exit the device through small apertures.

FIG. **1** is a cross-sectional view of a first system.

FIG. **2** is a cross-sectional view of the first system unassembled.

FIG. **3** is an exploded detail of the first system.

FIG. **4** is a diagram illustrating the effect of spinning time.

FIG. **5** is a diagram illustrating the effect of temperature.

FIG. **6** is a diagram illustrating the effect of the spin rate.

FIG. **7** is a cross-sectional view of a second system.

FIG. **8** is a top view of the bottom portion of the second system.

FIG. **9** is a perspective view of the top and bottom portions of the second system.

FIG. **10** is a cross-sectional view of the second system in an open conformation.

FIG. **11** is a cross-sectional view of the second system in a closed conformation and surrounded by a liquid collector.

FIG. **12** is a cross-sectional view of the second system in an open conformation and surrounded by a cylindrical particle collector.

FIG. **13** is a cross-sectional view of the second system in open conformation with a solids-liquids mixture inside.

FIG. **14** is a cross-sectional view of a third system.

FIG. **15** is a perspective view of the third system.

FIG. **16** is a perspective view of the fourth system.

FIG. **17** is a perspective view of the fourth system with a top and a bottom.

FIG. **18** is a top view of the fourth system.

FIG. **19** is an exploded detail of the fourth system.

FIG. **20** is an exemplary top view of the spinning and cleaning process of the fourth system.

FIG. **21** is a perspective view of a fifth system.

FIG. **22** is a cross section view of the fifth system.

FIG. **23** is a cross-sectional view of an exemplary separation process in the fifth system.

FIG. **24** is a cross-sectional view of a sixth system.

FIG. **25** is a cross-sectional view of the sixth system surrounded by a liquid collector.

FIG. **26** is a cross-sectional view of the sixth system in an open conformation.

FIG. **27** is a perspective view of the seventh system.

FIG. **28** is a cross-sectional view of the seventh system in a closed conformation.

FIG. **29** is a perspective view of a component of the seventh system.

FIG. **30** is a cross-sectional view of the seventh system.

FIG. **31** is a second cross-sectional view of the seventh system.

FIG. **32** is a partial cross-sectional view of the eighth system.

FIG. **33** is a first cross-sectional view of the ninth system.

FIG. **34** is a second cross-sectional perspective view of the ninth system.

FIG. **35** is a third cross-sectional view of the ninth system.

FIG. **36** is a fourth cross-sectional view of the ninth system.

FIG. **37** is a perspective and cross-sectional view of the tenth system.

FIG. **38** is a cross-sectional view of the tenth system.

FIG. **39** is a perspective view of the eleventh system.

FIG. **40** is a first cross-sectional view of the eleventh system.

FIG. **41** is a second cross-sectional view of the twelfth system.

FIG. **42** is a cross-sectional view of the thirteenth system.

DETAILED DESCRIPTION

Oil sands (also referred to as tar sands) are found in over sixty countries in the world, including the United States. Oil sands consist mainly of bitumen, water, mineral particles, sand, and clay. Bitumen is a natural, tar-like mixture of hydrocarbons that exists as a solid at room temperature. In nature, bitumen has a density range of 8° to 12° API, and at room temperature its viscosity is greater than 50,000 centipoises.

The physical process disclosed for separating liquids from solids uses fewer natural resources to produce bitumen from oil sand than the conventional method of separation. The conventional method of separating bitumen from oil sand requires more than 1,000 cubic feet of natural gas to separate one barrel of bitumen from two tons of oil sand, according to the National Energy Board of Canada. However, the physical process disclosed for separating liquids from solids requires less than 190 cubic feet of natural gas and no fresh water or other solvents to produce one barrel of bitumen.

The physical process disclosed produces a clean effluent. The only ingredient in the produced effluent is sand, which almost all of the oil is removed. On a laboratory scale, approximately over 85% of the available oil is removed. The physical process disclosed is also effective on a laboratory scale. Approximately 90% of the available oil is removed in less than 15 minutes.

The physical process disclosed is a simple mechanical method. Using less than 25% of the energy required of the conventional hot-water process method to separate oil from oil sands, the disclosed physical process is environmentally conscious.

As an illustration, the energy needed to heat oil sand is calculated by multiplying the oil sand specific heat at constant pressure by the mass of the oil sand and the change in temperature. For example, the energy needed to heat two tons (2,000 kg) of oil sand with a specific heat at constant pressure of 1 kJ/kg-K from 0° C. up to 100° C. equals 200,000 kJ. The specific heat at constant pressure of Utah oil sand ranges from 0.67 kJ/kg-K to 1.57 kJ/kg-K in the temperature range of 100-350° C. Converted to the energy units of BTU based on 1.055 kJ per BTU, 200,000 kJ equals 189,574 BTU. Each cubic foot of natural gas contains 1,028 BTU of energy, as a result, 189,574 BTU equals 184 cubic feet of natural gas. Therefore, the physical process disclosed for separating liquids from solids may require less than 190 cubic feet of natural gas to separate one barrel of bitumen from two tons of oil sand, which is 80% less than the 1,000 cubic feet used in the conventional separation method.

Additionally, the negative impact on the environment from the physical process disclosed for separating liquids from solids may be less than the conventional separation method because the physical process disclosed does not require any water to separate bitumen from oil sand. Conversely, the conventional separation process requires up to 4 barrels of fresh water to produce one barrel of bitumen from two tons of oil sand. The spent water used in the conventional oil separation process is suspected to cause environmental, wildlife, and health problems. The spent water may contain chemicals used in the conventional separation process and may enter rivers and fresh ground water supplies after leaking from spent water retention ponds. Therefore, the physical process disclosed for separating liquids from solids may be less harmful to the environment than the conventional separation method.

A physical process for separating liquids from solids is disclosed. As a non-limiting example, this physical process may be used to separate liquids, such as oil, from solid particles, such as sand or shale. The process may involve at least the following steps in any order (a) applying heat to a mixture of solids and liquids; (b) rapidly spinning the mixture; and (c) confining the solid particles mechanically.

A first system includes a separation device **90** as shown in FIG. **1**. The separation device **90** may be made up of one or more tubes such as test tubes. The separation device **90** may, for example, include a first tube **106** and a second tube **100**. The tubes **106**, **100** of this example are dimensioned such that the second tube **100** fits inside of the first tube **106**, for example, in a nested conformation. The second tube **100** has an aperture **102** at one end. In this example, the aperture may have a diameter of approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or 0.90-1.20 mm. The aperture may be funnel shaped as shown in FIG. **3**, and may have a diameter that decreases from its originating point to its terminating point. However, the optimal aperture size may vary with other variables, such as the type of solid or liquid being separated or other considerations.

The separation device **90** may be dimensioned as described below and illustrated by FIG. **2**. The dimensions are representative of this system but may be varied depending upon, for example the system, production needs, and type of solids and liquids being separated.

The first tube **106** of this example may be, for example but not limited to, a 15 ml centrifuge tube. The second tube **100** of this example may be, for example but not limited to, a 5 ml centrifuge tube. Again, recognized by those of ordinary skill in the art that dimensions, supply source, and specifications for the first tube **106** and the second tube **100** may be varied to suit the needs of a particular application.

The second tube **100** may have an aperture **102** at one end. The aperture may facilitate separation by retaining solids, such as sand or shale, within the second tube **100** while allowing liquids, such as oil, to escape. The aperture **102** may be added to a tube, for example, the second tube **100** using a tungsten probe. By way of example, to create an aperture, an area on the second tube **100** may be warmed and bored through with a super-heated tungsten probe. The tungsten probe may be a 1/16 inch tungsten probe which may be filed to a point. Other known methods may also be used to create an aperture **102**.

The process for removing, for example, oil from sand, may proceed as follows. A solids-liquids mixture **104**, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). The solids-liquids mixture **104** may be heated prior to loading into the separation device **90**. Alternatively, the solids-liquids mixture may be heated in the separation device, or during spinning. Before or after heating, the solids-liquids mixture may be loaded into the second tube **100**. In this example, the tube may be filled to approximately 3/5 of capacity; however, any amount of solids-liquids mixture **104** may be used. The second tube **100** may be placed inside the first tube **106**, before or after filling, to create a separation device **90**. The separation device **90** including the solids-liquids mixture **104** may then be placed into a centrifuge, such as an LW Scientific Ultra 8 Centrifuge. The separation process may be performed without the addition of chemicals. The separation process may be performed at atmospheric pressure and/or without the addition of gasses, and/or pressure and/or vacuum.

An example of the physical principles of operation is shown in FIG. **3**. FIG. **3** is an exploded view of the aperture **102** showing a shape of the aperture. The aperture **102**, as shown herein, may be funnel shaped. The aperture **102**, may have an originating point diameter **210** and a terminating point diameter **212**. The originating point diameter **210** may be the diameter of the aperture in closest proximity to the inside of the separation device. The terminating point diameter **212** may be the diameter of the aperture at the point where the liquid **202** escapes. The separation device **90** may be spun in a centrifuge or similar machine that generates a centrifugal force. The optimum range for the spin rate may be 500 rpm to 10,000 rpm. As a result of centrifugal force **204**, the liquid **202** may exit the aperture **102** and may collect in the bottom of the first tube FIG. **1**, **106**, which may be the outer tube. The solid particles **206** may remain in the second tube FIG. **1**, **100**, which may be the inner tube. The solid particles **206** may be retained in the second tube **100** rather than escaping through the aperture **102** because, for example, the centrifugal force **204** causes them to jam up in the funnel shaped aperture **102**, leaving gaps **208** through which the liquid **202** may move toward the terminating point of the aperture **102** and escape. The optimum time range for spinning may be 15 seconds to 20 minutes.

The aperture **102** size that is optimum for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. In the case of, for example, Athabasca oil sands, an aperture **102** larger than approximately 1.5 mm would let the solid particles **206** escape (e.g., absent the presence of supplementary retaining devices such as a screen). However, as recognized by those of skill in the art, the size of the aperture may be optimized to find an appropriate range for different combinations of solids and liquids, including oil sands from other regions, oil shale and including Athabasca oil sands that have different particle sizes.

The following example illustrates performance of the process in one system and also includes exemplary results. This example is merely illustrative of the effect on oil recovery from oil sands of different centrifuge speeds and temperatures. The example also illustrates oil extraction from oil sands without the addition of chemicals.

Athabasca oil sand was purchased from the Alberta Research Council. Materials accompanying the oil sand samples provided an estimated composition of 6-12 weight % bitumen, 5-20 weight % water and the balance sand. The bitumen content was not expressed with certainty, therefore a conservative estimate of 12% bitumen was used to calculate percent oil extracted, unless otherwise noted.

The oil sands were loaded into a separation device **90**. The separation device **90** was placed into a boiling water bath at approximately 94° C. for approximately 5 minutes or such time as it takes for the temperature of the sand to reach approximately 94° C.

At a spin rate of 3300 rpm and at an initial temperature of 94° C., about 90% of the extractable liquid **202** in FIG. **3** was recovered in 10 minutes (under the conservative assumption the oil sands contained 12 weight % bitumen). The configuration of the centrifuge used in this experiment caused the oil sands sample to experience a g-force of about 900 g's. At lower temperatures, down to 52° C., longer times were needed to remove smaller portions of liquid **202** (~64% at ~72° C. and ~35% at ~52° C., respectively) even at maximum rotation speeds (~3300 rpm). (All calculations assume that the oil sands contained 12 weight % bitumen.) See FIG. **5**. The separation process was performed without the addition of chemicals. The separation process was performed at atmospheric pressure, in aerobic conditions.

The following examples illustrate the effect on recovery of various process variables.

EXAMPLE 1

Effect of Spinning Time

The following example is included to illustrate the effect of spinning time on recovery in one system. This example is merely illustrative.

In this example, the effect of spinning time was investigated. The example was performed in duplicate. For this exemplary experiment two separation devices **90** were weighed. Each separation device **90** consisted of a first tube **106** and a second tube **100**. The second tube **100** was nested inside of the first tube **106** to form a separation device **90**. The second tube **100** included an aperture **102**.

Prior to spinning, the first tube **106** and the second tube **100** of each separation device **90** were weighed. Each separation device **90** was loaded with an approximately equal amount of solids-liquids mixture **104**, which in this example was oil sand. The separation devices **90** were loaded by inserting the solids-liquids mixture **104**, in this case oil sand, into the second tube **100** to a level of approximately ⅗ full. The second tube **100** was then nested into the first tube **106** and the resulting separation device **90** was reweighed to determine sample size (i.e., the difference between the weight of the unloaded assembled separation device versus the weight of the loaded and assembled separation device **90**). The weight of the bitumen present in each sample of oil sand was approximated by assuming that the samples contained 12 weight % bitumen.

Each loaded separation device **90** was then placed in a constant temperature bath at 94° C. until the temperature in each stabilized at 94° C. After heating, each loaded separation device **90** was then placed in the centrifuge and spun for approximately 1 minute at about 3300 rpm.

After spinning, each loaded separation device **90** was removed from the centrifuge. Each separation device **90** was disassembled by removing the second tube **100** from the first tube **106**. The first tube **106** of each device was weighed to determine the amount of liquid **202**, in this case oil, was deposited into the first tube **106** (as demonstrated by increased weight) by the spinning. The second tube **100** of each device was weighed to determine the amount of liquid **202** removed from the solids-liquids mixture **104** (as demonstrated by decreased weight) by the spinning.

After weighing, each separation device **90** was reassembled by inserting the second tube **100** into the first tube **106**. Each loaded separation device **90** was then placed in a constant temperature bath at 94° C. until the temperature in each stabilized at 94° C. After heating, each loaded separation device **90** was then placed in the centrifuge and spun for approximately 1 minute at about 3300 rpm. After spinning for 1 minute, each separation device **90** was again separated by removing the second tube **100** from the first tube **106**. The first tube **106** and second tube **100** were weighed to determine the degree of separation after 2 minutes. This process was repeated for 3 more cycles. The degree of separation at 1, 2, 3, and 4 minutes is illustrated in the following tables and plotted into FIG. **4**. Where the X-axis displays the total spin time and the Y-axis shows percent of the oil

Raw Data Summary

tubes 2&3	inner tube sample 1 (g)	outer tube sample 1 (g)	inner tube sample 2 (g)	outer tube sample 2 (g)	sample 1 outer tube mass gain (g)	sample 2 outer tube mass gain (g)	tube 1 % mass gain*	tube 2 % mass gain*
initial, empty	10.493	15.649	10.632	15.492				
w/oil sand	13.107		13.526					
oil sand		2.614		2.896				
spin 1 min	12.958	15.791	13.35	15.661	0.142	0.169	45.3	48.6
spin 2 min	12.911	15.835	13.331	15.678	0.186	0.186	59.3	53.5

-continued

tubes 2&3	inner tube sample 1 (g)	outer tube sample 1 (g)	inner tube sample 2 (g)	outer tube sample 2 (g)	sample 1 outer tube mass gain (g)	sample 2 outer tube mass gain (g)	tube 1 % mass gain*	tube 2 % mass gain*
spin 3 min	12.901	15.85	13.32	15.688	0.201	0.196	64.1	56.4
spin 4 min	12.889	15.853	13.313	15.693	0.204	0.201	65.0	57.8
hole size (mm)	Sample 1	0.79	Sample 2	0.93				

*percent gains based on oil fraction of 12% weight percent

Sample 1 Summary, Aperture Size 0.79 Mm

	Oil Sand (g)	Oil (g)	% Extracted
Start	2.614	0.314	
1 min	(0.149) (0.142)	0.146	46%
2 min	(0.196) (0.186)	0.191	61%
3 min	(0.206) (0.201)	0.204	65%
4 min	(0.218) (0.204)	0.211	67%

Sample 2 Summary, Aperture Size 0.93 Mm

	Oil Sand (g)	Oil (g)	% Extracted
Start	2.896	0.348	
1 min	(0.176) (0.169)	0.173	50%
2 min	(0.195) (0.186)	0.191	55%
3 min	(0.206) (0.196)	0.201	58%
4 min	(0.213) (0.201)	0.207	59%

All data is calculated based on an assumed, conservative value of 12 weight % oil per oil sand sample. Actual percent extraction is likely higher.

The combination of heating, spinning and an appropriate aperture size is highly effective at separating oil from oil sands, even in the absence of chemical extraction agents.

As illustrated in FIG. **4**, when the liquid is oil and the solid-liquid mixture is oil sands, the oil is removed rather quickly and in a large proportion to the amount available at 94° C. and 3300 rpm. These results are expected to vary, depending upon the nature of the device used and the starting materials.

EXAMPLE 2

Effect of Temperature

The following example is included to illustrate the effect of temperature on recovery. This example is merely illustrative.

In this example, the effect of temperature on recovery was investigated. The example was performed at three exemplary temperatures, 94° C., 72° C., and 52° C. For this exemplary experiment three separation devices **90** were prepared, each of which consisted of a first tube **106** and a second tube **100**. The second tube **100** was nested inside of the first tube **106** to form a separation device **90**. The second tube **100** included an aperture **102** as described above. Each separation device **90** was weighed prior to loading. The weight amount of the bitumen present in each sample of oil sand was approximated by assuming that the samples contained 12 weight % bitumen.

After weighing, each separation device **90** was loaded with an approximately equal amount of solids-liquids mixture **104**, which in this example was oil sand. The separation devices **90** were loaded by inserting the solids-liquids mixture **104**, in this case oil sand, into the second tube **100** to a level of approximately ⅗ full. The second tube **100** was then nested into the first tube **106** and the resulting separation device **90** was reweighed to determine sample size.

Each loaded separation device **90** was then placed in a constant temperature bath. In this example, each of the three separation devices **90** was warmed to a different temperature. One separation device **90**, represented in FIG. **5** as a triangle, was warmed in a constant temperature bath at approximately 94° C. until the temperature in the separation device **90** stabilized at approximately 94° C. A second separation device **90**, represented in FIG. **5** as a circle, was warmed in a constant temperature bath at approximately 72° C. until the temperature in the separation device **90** stabilized at approximately 72° C. A third separation device **90**, represented in FIG. **5** as a square, was warmed in a constant temperature bath at approximately 52° C. until the temperature in the separation device **90** stabilized at approximately 52° C.

After heating, each loaded separation device **90** was then placed in the centrifuge and spun for approximately 1 minute at about 3300 rpm. After spinning for one minute, each loaded separation device **90** was removed from the centrifuge. The separation device **90** was disassembled by removing the second tube **100** from the first tube **106**. The first tube **106** of each separation device **90** was weighed to determine the amount of liquid **202**, in this case oil, deposited into the first tube **106** (as demonstrated by increased weight) by the spinning. The second tube **100** of each separation device **90** was weighed to determine the amount of liquid **202** removed from the solids-liquids mixture **104** (as demonstrated by decreased weight) by the spinning.

After weighing, each separation device **90** was reassembled by inserting the second tube **100** into the first tube **106**. Each loaded separation device **90**, represented by a triangle, circle, and square, was then placed back into a constant temperature bath at approximately 94° C., 72° C., or 52° C., respectively until the temperature in each stabilized at approximately 94° C., 72° C., or 52° C., respectively. After heating, each loaded separation device **90** was then placed in the centrifuge and spun for approximately 5 minutes at about 3300 rpm. After spinning for approximately 5 minutes, each separation device **90** was again separated by removing the second tube **100** from the first tube **106**. The first tube **106** and second tube **100** were weighed to determine the degree of separation after 5 minutes.

After weighing, each separation device **90** was reassembled by inserting the second tube **100** into the first tube **106**. Each loaded separation device **90**, represented by a triangle, circle, and square, was then placed back into a constant temperature bath at approximately 94° C., 72° C., or 52° C., respectively until the temperature in each stabilized at approximately 94° C., 72° C., or 52° C., respectively. After heating, each loaded separation device **90** was then placed in the centrifuge and spun for approximately 10 minutes at about 3300 rpm. After spinning for 10 minutes, each separation device **90** was again separated by removing the second tube **100** from the first tube **106**. The first tube **106** and second tube **100** were weighed to determine the degree of separation after 10 minutes.

The degree of separation for each separation device **90** at three temperatures 94° C., 72° C., or 52° C. was plotted in FIG. **5**. The degree of separation at each temperature and at each of 1, 5, and 16 minutes is plotted.

As illustrated in FIG. **5**, even in the absence of chemical agents, the extraction percentage of oil from oil sands on laboratory scale at approximately 94° C. and approximately 3300 rpm levels off at about 10 minutes spinning time. These results are expected to vary depending upon the nature of the device and the starting materials.

EXAMPLE 3

Effect of Spin Rate on Recovery

The following example is included to illustrate the effect of spin rate on recovery in a laboratory scale system. This example is merely illustrative and not meant to be limiting.

In this example, the effect of spin rate on recovery was investigated. The example was performed at two exemplary spin rates, 3300 rpm and 2000 rpm. All other variables were identical between the two samples. For this exemplary experiment two separation devices **90** were prepared, each of which consisted of a first tube **106** and a second tube **100**. The second tube **100** was nested inside of the first tube **106** to form a separation device **90**. The second tube **100** included an aperture **102**. Each separation device **90** was weighed prior to loading.

After weighing, each separation device **90** was loaded with an approximately equal amount of solids-liquids mixture **104**, which in this example was oil sand. The separation devices **90** were loaded by inserting the solids-liquids mixture **104**, in this case oil sand, into the second tube **100** to a level of approximately ⅗ full. The second tube **100** was then nested into the first tube **106** and the resulting separation device **90** was reweighed to determine sample size.

Each loaded separation device **90** was then placed in a constant temperature bath. In this example, each separation device **90**, was warmed in a constant temperature bath at 94° C. until the temperature in the separation device **90** stabilized at 94° C.

After heating, each loaded separation device **90** was then placed in the centrifuge and spun for approximately 1 minute. One separation device **90** represented in FIG. **6** by the letter B, was spun at about 3300 rpm. A second separation device **90** represented in FIG. **6** by the letter E, was spun at about 2000 rpm. After spinning each separation device **90** at its respective speeds for one minute, each loaded separation device **90** was removed from the centrifuge. Each separation device **90** was disassembled by removing the second tube **100** from the first tube **106**. The first tube **106** of each device was weighed to determine the amount of liquid **202**, in this case oil, deposited into the first tube **106** (as demonstrated by increased weight) by the spinning. The second tube **100** of each device was weighed to determine the amount of liquid **202** removed from the solids-liquids mixture **104** (as demonstrated by decreased weight) by the spinning. The weight amount of the bitumen present in each sample of oil sand was approximated by assuming that the samples contained 12 weight % bitumen.

After weighing, each separation device **90** was reassembled by inserting the second tube **100** into the first tube **106**. Each loaded separation device **90**, represented by a B or an E, was then placed back into a constant temperature bath at approximately 94° C. until the temperature in each stabilized at approximately 94° C. After heating, each loaded separation device **90**, represented by a B or an E, was then placed in the centrifuge and spun for approximately 1 minute at about 3300 rpm and 2000 rpm, respectively. After spinning for 1 minute, each separation device **90** was again separated by removing the second tube **100** from the first tube **106**. The first tube **106** and second tube **100** were weighed to determine the degree of separation after 1 minute at about 3300 rpm and 2000 rpm, respectively.

After weighing, each separation device **90** was reassembled by inserting the second tube **100** into the first tube **106**. The cycle of heating, spinning, and weighing was repeated and results were plotted on FIG. **6** for each separation device **90** at 1, 2, 3, 4, and 5 minutes. FIG. **6** illustrates that percent extraction begins to converge at longer spin times.

Samples B & E	inner tube Sample B (g)	outer tube Sample B (g)	inner tube Sample E (g)	outer tube Sample E (g)	Sample B mass gain (g)	Sample E mass gain (g)	Sample B % gain*	Sample E % gain*
initial, empty	10.542	15.384	10.389	15.253				
w/oil sand	13.576		13.435					
oil sand		3.034		3.046				
spin 1 min	13.512	15.452	13.405	15.277	0.068	0.024	21.7	6.9
spin 2 min	13.429	15.533	13.335	15.35	0.149	0.097	47.5	27.9
spin 3 min	13.382	15.577	13.282	15.398	0.193	0.145	61.5	41.7
spin 4 min	13.348	15.609	13.271	15.408	0.225	0.155	71.7	44.6

-continued

Samples B & E	inner tube Sample B (g)	outer tube Sample B (g)	inner tube Sample E (g)	outer tube Sample E (g)	Sample B mass gain (g)	Sample E mass gain (g)	Sample B % gain*	Sample E % gain*
spin 5 min	13.338	15.621	13.255	15.421	0.237	0.168	75.6	48.3
hole size (mm)	tube 5	0.9906	tube 6	0.889				

*percent gains based on oil fraction of 12%

Summary Sample B
Hole size 0.99 mm

	Oil Sand (g)	Oil (g)	% Extracted
Start	3.034	0.36	
1 min	(0.064) (0.068)	0.066	18%
2 min	(0.147) (0.149)	0.148	41%
3 min	(0.194) (0.193)	0.194	54%
4 min	(0.228) (0.225)	0.227	63%
5 min	(0.238) (0.237)	0.238	66%

Summary Sample E
Hole size 0.89 mm

	Oil Sand (g)	Oil (g)	% Extracted
Start	3.046	0.37	
1 min	(0.030) (0.024)	0.027	7%
2 min	(0.100) (0.097)	0.099	27%
3 min	(0.153) (0.145)	0.149	40%
4 min	(0.164) (0.155)	0.160	43%
5 min	(0.180) (0.168)	0.174	47%

For another example, the following calculations may be helpful in the evaluation and description of the spin rate.

$$a_c = rw^2 \tag{1}$$

$$g_c = \frac{a_c}{g_o} \tag{2}$$

$$g_c = \frac{rw^2}{g_o} \tag{3}$$

a_c=centripetal acceleration (m/s^2)
r=radius (m)
w=angular velocity (rpm)
g_o=gravitational acceleration at Earth's surface (9.8 m/s^2)
g_c=G force (g)

FIGS. **7-13** illustrate a second system **300** of a separation device. The second system may have a clam shell-like formation which may further have a first portion **302** and a second portion **304**. The first portion **302** and the second portion **304**, depending on the orientation of the device, may be the top and the bottom of the separation device of the second system **300**. In FIG. **4**, the first portion **302** and the second portion **304** of the second system fit together with the aid of, for example, an aligning pivot **305**. The second portion **304** may have cavities **306**, wherein each cavity **306** may form an aperture **308** where the first portion **302** and second portion **304** of the second system come together.

FIG. **8** illustrates how the cavities **306** may align radially. For example, the cavities **306** may be roughly semi conical with an opening that is wider toward the center **402** of the second portion **304** of the second system **300** and narrows as it reaches the perimeter **404**. While the cavities **306** are illustrated as semi conical in FIG. **9**, other shapes may be used.

The second system **300** may also include a liquid collector **706**, as shown in FIG. **11**, which may be cylindrical, or any other shape. For example, the liquid collector may or may not approximate the shape of the second system separation device **300**. The liquid collector **706** may include a gutter **707** which may collect and funnel the liquid to a collection reservoir. The gutter **707** may be located on the lower edge of the liquid collector, or may be located in any other location. The liquid collector **706** may be arranged with the second system separation device **300** such that the second system separation device **300** may be raised and lowered into position with the liquid collector **706** as the separation process proceeds.

FIGS. **10-13** illustrate how the process for extracting liquids from solid particles might be adapted for the second system **300** separation device described above. The solids-liquids mixture **602** may be placed inside the cavities **306** in the second system **300**. In FIG. **10** the solids-liquids mixture **602** may be heated before loading, during loading, or after loading into the separation device of the second system **300**. The second system **300** may be lowered into a liquid collector **706** and may be spun as shown in FIG. **11**. Spinning may cause the liquid **702** to separate from the solid particles **704**. The liquid **702** may exit apertures **308**, and may accumulate, for example, on the liquid collector **706**, and/or in a gutter **707**. The solid particles **704** may remain inside the closed second system **300**. The apertures **308** may be funnel shaped, with the diameter of the aperture decreasing as it reaches the termination point of the aperture where the liquid escapes.

After separation has been accomplished, the liquid collector **706** may be raised, and the second system **300** may be opened as shown in FIG. **12**. The first portion **302** and second portion **304** may be spun such that the solid particles are spun out of the cavities **306**. A solid particles collector **802** may be used to catch the solid particles **704**.

The second system **300** may then be reused. A new load of heated or unheated solids-liquids mixture **602** may be inserted into the second system **300** and the liquid collector **706** may replaced into a position that will allow it to capture extracted liquids. The second system **300** may be closed and respun, as shown in FIG. **13**, continuing the cycle. Alternatively, the cycle may terminate after one use. The optimal aperture **308** size for removing oil from Athabsca oil sands is approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, and/or 9.90-1.20 mm. However, other sizes may be used.

FIG. **14** is a cross-sectional view of a third system **1010**, the confining portion **1030** of which may have a cyclone formation. The third system **1010** may include a confining portion **1030** and a collecting portion **1026**. The third system **1010** may also include a coaxial piston **1014** and a central shaft **1011** which may be supported by a bearing **1012**. The third system **1010** may also include a feed tube **1016**. The confining portion **1030** may be assembled inside of the collecting portion **1026**, for example, in a nested conformation. The feed tube **1016** may be assembled inside of the confining portion **1030**. In one example, the feed tube **1016** may be assembled with the central shaft **1011**.

The confining portion **1030** may be approximately conical in shape. The confining portion **1030** may have a top **1050** and a bottom **1055**. The top **1050** of the confining portion **1030** may be dimensioned larger than the bottom **1055** of the confining portion.

The confining portion **1030** may have walls **1018**. The walls **1018** may have an interior face **1032** and an exterior face **1034**. The interior face **1032** of the walls **1018** of the confining portion **1030** may have baffles **1020** located thereon. The baffles **1020** may be continuous with the interior face **1032**. The baffles **1020** may be arranged in a screw-thread-like fashion along the interior face **1032** of the walls **1018** of the confining portion **1030** of the third system **1010**. FIG. **14** shows a cross section view of the third system **1010**. Here, the baffles **1020** are shown in cross section protruding from the interior face **1032** of the walls **1018** of the confining portion **1030**. FIG. **14***a* is an exploded view further showing the baffles **1020** protruding from the interior face **1032** of the walls **1018** of the confining portion **1030**. The baffles **1020** may be continuous. The baffles **1020** may be arranged radially.

FIG. **15** shows a perspective view of the third system **1010**. Here, the baffles **1020** are shown protruding from the interior face **1032** of the confining portion **1030**. The collecting portion **1026** is shown in cut-away. FIG. **15** provides an illustration of the screw-thread-like fashion with which the baffles **1020** are assembled with the interior face **1032** of the confining portion **1030**.

The walls **1018** of the third system **1010** may further include small apertures FIG. **3**, **102** or apertures **1022**. An exploded exemplary view of a wall **1018** including apertures **1022** is illustrated in FIG. **14***a*. Alternatively or additionally, the apertures FIG. **3**, **102** may be funnel shaped as shown in FIG. **3**.

The collecting portion **1026** of the third system **1010** may be cylindrical or any other shape.

FIGS. **14**-**15** illustrate how the process for extracting liquids from solid particles might be adapted for the third system **1010** described above. The solids-liquids mixture **602**, for example, oil sands, may be heated prior to loading or may be heated during loading or, alternatively, in the third system **1010**. For example, the solids-liquids mixture **602** may be heated in the feed tube **1016**, in the confining portion **1030** (which may be cyclone in shape), or in a retaining tank attached to the feed tube, and etc.; alternatively, it may be heated prior to being loaded into the feed tube **1016**.

The heated or unheated solids-liquids mixture **602** may be loaded into the third system **1010** by a feed tube **1016**. The feed tube **1016** may be centrally located. A coaxial piston **1014** may push an amount of a heated solids-liquids mixture **602** down a feed tube **1016** and out the bottom of the feed tube **1016** into the confining portion. A centrifugal force may be applied to the confining portion **1030**. The confining portion **1030** may be rotated co-axially as shown in FIG. **15**. The heated solids-liquids mixture **602** may be centrifugally forced outward and upward along the baffles **1020** on the interior face **1032** of the wall **1018** of the confining portion **1030**.

The liquid **702** may escape through the small apertures **1022**, which may have a diameter of approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm or more preferably 0-0.90-1.20 mm. The apertures **1022** may be dimensioned as shown in FIG. **3**. Solid particles **704** may be centrifugally pushed upward and eventually go over the top of the third system **1010** (as demonstrated by FIG. **14** arrow **1036**) where it may be collected and recycled, disposed of or otherwise. The liquid **702** that is extracted may be collected by the collecting portion **1026**, for example, by accumulating at the bottom **1028**. This may be a continuous process by which the feed tube **1016** continually feeds solids-liquids mixture **602** into the third system **1010** to replace the liquid and solids that are removed.

FIG. **16** shows a fourth system which may be formed of rotating planes. The fourth system may have a chamber **1202**. This device may be self-cleaning. As shown in FIG. **17**, the rotating planes system may have a top plate **1205** and a bottom plate **1207**, which may be coaxially mounted with a main shaft **1204** so that the top plate **1205** can be raised and the bottom plate **1207** can be lowered. The chamber may be formed of multiple chamber walls **1206**. The chamber walls may have aperture **1402** through which liquid may be extracted from the liquids-solid mixture. The chamber **1202** can take many shapes depending on the number of walls **1206**, such as a hexagonal shape as shown in FIGS. **16**-**20**. Each of the walls **1206** may be centrally pivoted **1208**. The chamber **1202** rotating planes separator may have at least two configurations, for example, a closed configuration (see, e.g., FIGS. **16**, **17**, **20***a*, **20***c*, **20***e*) and an open configuration (see, e.g., FIGS. **20***b*, **20***d*). In the closed configuration, the walls **1206** may be sealed by outer **1304** and inner **1306** splines as shown in FIG. **19**. The apertures **1402** in the chamber walls **1206** may have a diameter of approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or 0.90-1.20 mm. The apertures **1402** may have a diameter that decreases from the originating point on the inner face of the wall to the terminating point on the outside face of the wall, where the oil escapes. (See, e.g., FIG. **3**) In the open configuration, the walls **1206** may be rotated on their pivot point such that they are no longer in contact. (See, e.g., FIGS. **20***b*, **20***d*)

In operation, heated solids-liquids mixture **602** may be placed in the chamber and the chamber may be spun, as shown in the top view in FIG. **20**. The liquid **702** separates from the solid particles **704** and may be collected by a liquid collector **1504** surrounding the chamber. The liquid collector **1504** may be, for example, cylindrical or may otherwise approximate the shape of the chamber **1202**. Alternatively, the liquid collector **1504** may be of any other shape or format. When separation has been completed and rotation has stopped, the bottom plate may be lowered. The top plate may be raised and the liquid collector **1504** may be raised even more, so that its bottom is above the top of the chamber walls **1206**, which are rotated as shown in the second step in FIG. **20***b*.

Next, the chamber walls **1206** may be locked by the splines at for example 180° so that the apertures face toward the center of the chamber. The chamber **1202** may be spun to cleanse the remaining solid particles **704**. The solid particles **704** removed from the chamber may be caught by a solid-particle collector **1506** as shown in the third step in FIG. **20***c*.

After cleaning, the chamber **1202** may be stopped; the solid-particle collector **1506** may be lowered away from the chamber **1202**. The chamber **1202** may be returned to a closed position by rotating the walls **1206** 180° as shown in the fourth step in FIG. **20***d*. The bottom plate may rise to complete the closed conformation. At that point, more solids-liquids mixture **602** may be placed inside the chamber, and the top may be lowered and the liquid collector **1504** raised into conformation for the next round of processing.

FIG. **21** shows a fifth system **1600** which may be a double piston type of a separator. The fifth system **1600** may have a rotating main shaft **1602**. The rotating main shaft **1602** may further have an attached a top piston **1604** and a bottom piston **1606**. The fifth system **1600** may also include a filtering portion **1607** which may have a top band **1608**, a bottom band **1610** and a screen **1612**.

The screen **1612** may be made of any material and may be of sufficient strength to withstand centrifugal force and retain the solid particles. The screen may be supported by bands **1608**, **1609** and **1610** as illustrated in FIG. **21**. The screen **1612** may have openings or apertures, which may be dimensioned to retain the solid particles **704** and let the liquid **702** through, as shown in FIG. **21**. For separation of oil from Athabasca oil sands, the aperture may have a diameter of approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or 0.90-1.20 mm. As stated above, the aperture size may vary depending on the properties of the liquid-solid material and the efficiency of the separation may vary as a function of aperture size.

The attached top piston **1604** and bottom piston **1606** may be separated by a distance such that, in the closed position, the top piston **1604** is even with the top band **1608** of the filtering portion **1607**, and the bottom piston **1606** is even with the bottom band **1610** of the filtering portion **1607**.

In operation, the top piston **1604** and bottom piston **1606** may be raised enough to introduce the solids-liquids mixture **602** as shown in the first step in FIG. **23**. The pistons may be lowered and aligned with the filtering portion **1607**. The apparatus may be spun, as shown in the second step **1802** in FIG. **23***b*. Heat may be applied to the mixture prior to loading or the apparatus may be heated before or during spinning.

During spinning the solid particles **704** may be restrained by the screen **1612**; the liquid **702** may pass through the screen **1612** and may be captured by the liquid collector **1804**.

After the spinning is completed and extraction has concluded, the apparatus may be cleaned as follows. The pistons may be lowered until the bottom edge of the top of the filter is even with the bottom edge of bottom band **1610**, as shown in the third step in FIG. **23***c*. The solid particles may be removed from the piston by spinning such that the solid particles **704** leave the fifth system **1600** and are collected by a solid-particle collector **1806**.

After cleaning, the process may be repeated. For example, a new batch of heated or unheated solids-liquids mixture **602** may be inserted into the double piston system, as shown in the fourth step in FIG. **23***d*.

While various systems of the invention have been described, it will be apparent to those of ordinary skill in the art that many more systems and implementations are possible that are within the scope of the invention.

FIG. **23** shows a cross sectional view of a sixth system **2100**, which may be a centrifugal type of separator. The sixth system **2100** may have a rotor **2104**. The rotor **2104** may spin a tube **2102**. The sixth system **2100** may include multiple tubes **2102** depending on the size of the tube **2102** and the rotor **2104**. The tube **2102**, may include multiple parts. For example, the tube **2102** may have a first part **2216** and a second part **2118**. The multiple parts may be connected, such as by a hinge **2114** or otherwise. When the first part **2116** and the second part **2118** are in contact, they may form a tube **2102**. The tube **2102** may include an aperture **2106** at one end. The aperture **2106** may facilitate separation of liquids, such as oil or water, from solids, such as sand or shale, by retaining solids within the tube **2102**. The sixth system **2100** may also include an extractor **2108**. As shown in FIG. **26**, the extractor **2108** may remove the tube **2102** from the rotor **2104**, may split the tube **2102** into its first part **2116** and second part **2118**, and may spin the tube **2102** to remove the solid particles.

The sixth system **2100** may include a liquid collector **2202**, as shown in FIG. **25**, which may be any shape capable of containing the liquid, such as a cylinder, rectangle, or hexagon.

The process for extracting liquids from solid particles may be adapted for the sixth system **2100**, described above, by placing a solids-liquids mixture in the tube **2102**, which may be placed in the rotor **2104**. The solids-liquids mixture may be heated before, during, or after placement in the tube **2102**. The solids-liquids mixture, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). The tube **2102** may be inserted into the rotor **2104** and spun perpendicular to the long axis of the tube **2102**. The tube **2102** may be spun to approximately 500 rpm to 10,000 rpm. Spinning may cause the liquid to separate from the solid particles. The tube **2102** may be spun for approximately 15 seconds to 20 minutes. The liquid may exit the aperture **2106** and may accumulate, for example, on the liquid collector **2202**. The optimum aperture **2106** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. The sixth system **2100** may then be reused with a new solids-liquids mixture.

FIGS. **27**-**31** show a seventh system **2400** which may be a centrifugal type of separator. The seventh system **2400** may have a rotor with multiple parts. The first part of the rotor **2404** may attach to a power generator or other source of power. The first part of the rotor **2404** may have an axial opening **2506**. The second part of the rotor **2504** may constrain the movement of a tube **2402** within the first part of the rotor **2404**, as shown in FIG. **28**, a cross-sectional view. The rotor **2404**, **2504** may spin a tube **2402**. The seventh system **2400** may include multiple tubes **2402** depending on the size of the tube **2402** and the rotor **2404**, **2504**. The tube **2402** may include one open end **2502**, as shown in FIG. **28**. The tube **2402** may include a smaller aperture **2408** at the other end. The aperture **2408** may facilitate separation of liquids, such as oil or water, from solids, such as sand or shale, by retaining solids within the tube **2402**. The tube **2402** may also include a pivot point **2410**, such as an axle, along the length of the tube **2402** that may be perpendicular to the tube length, as shown in FIG. **29**.

The seventh system **2400** may include a liquid collector **2702**, as shown in FIG. **30** and FIG. **31**, which may be any shape capable of containing the liquid, such as a cylinder, rectangle, or hexagon.

The process for extracting liquids from solid particles may be adapted for the seventh system **2400**, described above, by placing a solids-liquids mixture in the tube **2402**, which may be placed in the first part of the rotor **2404** and secured in place by the second part of the rotor **2504**. The solids-liquids mixture may be heated before, during, or after placement in the tube **2402**. The solids-liquids mixture, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). The tube **2402** may be inserted into the first part of the rotor **2404**, as shown in FIG. **30**, and spun perpendicular to the long axis of the tube **2402**. The tube **2402** may be spun to approximately 500 rpm to 10,000 rpm. The tube **2402** may be spun for approximately 15 seconds to 20 minutes. Spinning may cause the liquid to separate from the solid particles. The liquid may exit the aperture **2408** and may accumulate, for example, on the liquid collector **2702**. The optimum aperture **2408** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. Once the liquid has left the tube **2402**, the second part of the rotor **2504** may be moved to allow the tube **2402** to pivot along the pivot point **2410**. If the tube **2410** is spun, the remaining solid particles may exit the open end **2502** of the tube **2402**, as shown in FIG. **31**. The liquid collector **2702** may be changed to collect the solid particles. The seventh system **2400** may then be reused with a new solids-liquids mixture.

FIG. **32** shows an eighth system **2900**, which may be a centrifugal type of separator. The eighth system **2900** may include a rotor **2904**. The rotor **2904** may spin a tube **2902**. The eighth system **2900** may include multiple tubes **2902** depending on the size of the tube **2902** and the rotor **2904**. The tube **2902** may be open on one end **2910** and may include a smaller aperture **2906** at the other end. The aperture **2906** may facilitate separation of liquids, such as oil or water, from solids, such as sand or shale, by retaining solids within the tube **2902**. The tube **2902** may include a lockable pivot point **2908**, such as a geared axle, along the length of the tube that may be perpendicular to the tube length.

The eighth system **2900** may include a liquid collector **2912**, as shown in FIG. **32**, which may be any shape capable of containing the liquid, such as a cylinder, rectangle, or hexagon.

The process for extracting liquids from solid particles may be adapted for the eighth system **2900**, described above, by placing a solids-liquids mixture in the tube **2902**, which may be positioned within the rotor **2904** and secured in place by the lockable pivot point **2908**. The solids-liquids mixture may be heated before, during, or after placement in the tube **2902**. The solids-liquids mixture, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). The rotor **2904** may spin the tube **2902** perpendicular to the long axis of the tube **2902**. The tube **2902** may be spun to approximately 500 rpm to 10,000 rpm. The tube **2902** may be spun for approximately 15 seconds to 20 minutes. Spinning may cause the liquid to separate from the solid particles. The liquid may exit the aperture **2906** and may accumulate, for example, on the liquid collector **2912**. The optimum aperture **2906** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. Once the liquid has left the tube **2902**, the lockable pivot point **2908** may allow the tube **2902** to pivot such that the remaining solid particles may exit the open end of the tube **2902** if it is spun. The liquid collector **2912** may be changed to collect the remaining solid particles. The eighth system **2900** may then be reused with a new solids-liquids mixture.

FIG. **33** shows a ninth system **3000**, which may be a centrifugal type of separator. An exemplary cross-sectional perspective view of the ninth system **3000** is shown in FIG. **34**. The ninth system **3000** may include a tube **3002**. The tube **3002** may be open on one end **3010**. The tube **3002** may include a smaller aperture **3008** at the other end. The aperture **3008** may facilitate separation of liquids **3304**, such as oil or water, from solid particles **3306**, such as sand or shale, by retaining solid particles **3306** within the tube **3002** if it is spun. The ninth system **3000** may include a disk **3004**. The disk **3004** may be contained within the tube **3002**. The disk **3004** may be held in place such that the disk **3004** is perpendicular to the length of the tube **3002**, as shown in FIG. **33** and FIG. **34**. The disk **3004** may also be moved by rods **3006** such that the disk **3004** is parallel to the length of the tube **3002**, as shown in the front view in FIG. **35***a* and in the side view in FIG. **35***b*.

The process for extracting liquids **3304** from solid particles **3306** may be adapted for the ninth system **3000**, described above, by placing a solids-liquids mixture **3302** in the tube **3002** with the disk **3004** positioned parallel to the length of the tube **3002**, as shown in front view in FIG. **36***a* and inside view in FIG. **36***b*. The solids-liquids mixture **3302** may be heated before, during, or after placement in the tube **3002**. The solids-liquids mixture **3302**, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). Spinning the tube **3002** perpendicular to the long axis of the tube **3002** may cause the liquid **3304** to separate from the solid particles **3306**. The tube **3002** may be spun to approximately 500 rpm to 10,000 rpm. The tube **3002** may be spun for approximately 15 seconds to 20 minutes. The liquid **3304** may exit the aperture **3008** for collection later. The optimum aperture **3008** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. Once the liquid **3304** has left the tube **3002**, the disk **3004** may be repositioned perpendicular to the length of the tube **3002** and removed from the tube **3002**, as shown in FIG. **36***c*, extracting the remaining solid particles **3306** as it is removed. The ninth system **3000** may then be reused with a new solids-liquids mixture **3302**, as shown in FIG. **36***d*.

FIGS. **37-38** show a tenth system **3400**, which may have a cylindrical formation. The tenth system **3400** may include a shaft **3406**. The shaft **3406** may be placed within a first cylinder **3402**. The shaft **3406** may be angled to allow the movement of a solids-liquids mixture **3504** down the inside of the first cylinder **3402** by gravity. The first cylinder **3402** may include apertures **3416**. An exploded exemplary view of the first cylinder **3402** including apertures **3416** is illustrated in FIG. **38***a*. The apertures **3416** may facilitate the separation of liquids **3502**, such as oil or water, from solids, such as sand or shale, by retaining solid particles **3506** within the first cylinder **3402**. The first cylinder **3402** may be placed within a second cylinder **3404**. As shown in FIG. **37**, the second cylinder **3404** may include a protrusion **3412**. The protrusion **3412** may collect and direct the liquid **3502** to a collection point **3414**.

The process for extracting liquids **3502** from solid particles **3506** may be adapted for the tenth system **3400**, described above, by placing a solids-liquids mixture **3504** on the inside of the spinning first cylinder **3402** and allowing it to travel along the surface of the first cylinder **3402** by gravity. The solids-liquids mixture **3504** may be heated before, during, or after placement in the first cylinder **3402**. The solids-liquids mixture **3504**, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). Spinning the first cylinder **3402** may cause the liquid **3502** to separate from the solid particles **3506**. The first cylinder **3402** may be spun to approximately 500 rpm to 10,000 rpm. The first cylinder **3402** may be spun for approximately 15 seconds to 20 minutes. The liquid **3502** may exit the first cylinder **3402** through the apertures **3416**. The optimum aperture **3416** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. The liquid **3502** may accumulate on the second cylinder **3404** and may be contained by the protrusion **3412** and drained at the collection point **3414**. A person skilled in the art may be able to adjust the angle of the first cylinder **3402**, the rotational rate of the first cylinder **3402**, and the feed rate of the solids-liquids mixture **3504** such that a majority of the liquid **3502** may be removed by the time the solids-liquids mixture **3504** reaches the lower end of the first cylinder **3402**. The tenth system **3400** may be used in a continuous process.

FIGS. **39**-**40** show an eleventh system **3600**, which may have a cylindrical formation. The eleventh system **3600** may include a rotating screw shaft **3606**. The rotating screw shaft **3606** may be placed within a first cylinder **3602**. The rotating screw shaft **3606** may facilitate the separation of liquids **3702**, such as oil or water, from solids **3704**, such as sand or shale, by retaining solids **3704** within the first cylinder **3602**. The first cylinder **3602** may include apertures **3614**. An exploded exemplary view of the first cylinder **3602** including apertures **3614** is illustrated in FIG. **40***a*. The apertures **3614** may facilitate the separation of liquids **3702**, such as oil or water, from solids **3704**, such as sand or shale, by retaining solids **3704** within the first cylinder **3602**. The first cylinder **3602** may be placed within a second cylinder **3604**. As shown in FIG. **40**, the second cylinder **3604** may include a protrusion **3610**. The protrusion **3610** may collect and direct the liquid to a collection point **3612**.

The process for extracting liquids **3702** from solid particles **3704** may be adapted for the eleventh system **3600**, described above, by placing a solids-liquids mixture **3608** on the inside of the spinning first cylinder **3602** and using the rotating screw shaft **3606** to move the solids-liquids mixture **3608** along the inner surface of the first cylinder **3602**. The solids-liquids mixture **3608** may be heated before, during, or after placement in the first cylinder **3602**. The solids-liquids mixture **3608**, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). Spinning the first cylinder **3602** may cause the liquid **3702** to separate from the solids **3704**. The first cylinder **3602** may be spun to approximately 500 rpm to 10,000 rpm. The first cylinder **3602** may be spun for approximately 15 seconds to 20 minutes. The liquid **3702** may exit the first cylinder **3602** through the apertures **3614**. The optimum aperture **3614** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. The liquid **3702** may accumulate on the second cylinder **3604** and may be contained by the protrusion **3610** and drained at the collection point **3612**. A person skilled in the art may be able to adjust the rotational rate of the screw shaft **3606**, the feed rate of the solids-liquids mixture **3608**, and the rotational rate of the first cylinder **3602** such that a majority of the liquid **3702** may be removed by the time the solids-liquids mixture **3608** reaches the end of the first cylinder **3602**. The eleventh system **3600** may be used in a continuous process.

FIG. **41** shows a cross sectional view of a twelfth system **3800**, which may which may have a cyclone formation. The twelfth system **3800** may include a first cone **3802** and a second cone **3804**, placed concentrically around a shaft **3806**. The first cone **3802** placed inside the second cone **3804**, e.g., the first cone **3802** closest to the shaft **3806**. The second cone **3804** may have an interior face **3830** and an exterior face **3835**. The interior face **3830** may include baffles **3810** protruding therefrom. The baffles **3810** may be arranged in a screw-thread-like fashion on the interior face **3830** of the second cone **3804**, in the space between the first cone **3802** and the second cone **3804**. The second cone **3804** may include apertures **3818**. An exploded exemplary view of the second cone **3804** including apertures **3818** is illustrated in FIG. **41***a*. The apertures **3818** may facilitate the separation of liquids **3812**, such as oil or water, from solid particles **3814**, such as sand or shale, by retaining solid particles **3814**, within the second cone **3804**. The twelfth system **3800** may also include a liquid collector **3808**. The liquid collector **3808** may surround the second cone **3804**. For example, the second cone **3804** may be nested within the liquid collector **3808**.

The process for extracting liquids **3812** from solid particles **3814** may be adapted for the twelfth system **3800**, described above, by placing a solids-liquids mixture **3816** within the cavity of the first cone **3802** and feeding it into the space **3820** between the first cone **3802** and second cone **3804**. The solids-liquids **3816** mixture may be heated before, during, or after placement in the first cone **3802**. The solids-liquids mixture **3816**, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C.; 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). The process to feed the solids-liquids mixture **3816** into the space between the first cone **3802** and second cone **3804** may include, by way of example, gravity, compressed air, an auger, a piston, and a plunger. The solids-liquids mixture **3816** may travel up the inside surface of the spinning second cone **3804** by centrifugal force, by the action of the baffles **3810**, or by suction force. Spinning the second cone **3804** may cause the liquid **3812** to separate from the solid particles **3814**. The second cone **3804** may be spun to approximately 500 rpm to 10,000 rpm. The second cone **3804** may be spun for approximately 15 seconds to 20 minutes. The liquid **3812** may exit the second cone **3804** through the apertures **3818** and may be collected on the liquid collector **3808**. The optimum aperture **3818** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10

mm. The remaining solid particles **3814** may exit space **3822** between the first cone **3802** and second cone **3804** near the top of the second cone **3804**. A person skilled in the art may be able to adjust the angle of the first cone **3802** and second cone **3804**, the rotational rate of the second cone **3804**, the feed rate of the solids-liquids mixture **3816**, and the placement of the baffles **3810** such that a majority of the liquid **3812** may be removed by the time the solids-liquids mixture **3816** reaches the top of the second cone **3804**. The twelfth system **3800** may be used in a continuous process.

FIG. **42** shows a cross sectional view of a thirteenth system **3900**, which may include a cylindrical formation. The thirteenth system may include a vertical first cylinder **3902** and a vertical second cylinder **3904**, placed concentrically around a shaft **3906**. The first cylinder **3902** may have a first face **3930** and a second face **3935**. The second face **3935** of the first cylinder **3902** may have baffles **3910** protruding therefrom. The second cylinder **3904** may have a first face **3940** and a second face **3945**. The first face **3940** of the second cylinder **3904** may have baffles **3910** protruding therefrom. The first face **3940** of the second cylinder **3904** may be positioned facing the second face **3935** of the first cylinder **3902**.

The baffles **3910** may be positioned in the space between the first cylinder **3902** and the second cylinder **3904**. The baffles **3910** may control the movement of a solids-liquids mixture **3912**. The second cylinder **3904** may include apertures **3918**. An exploded exemplary view of the second cylinder **3904** including apertures **3918** is illustrated in FIG. **42** *a*. The apertures **3918** may facilitate the separation of liquids **3914**, such as oil or water, from solid particles **3916**, such as sand or shale, by retaining solid particles **3916** within the second cylinder **3904**. The twelfth system may also include a liquid collector **3908**. The apertures **3918** may be dimensioned as shown and described in FIG. **3**. The liquid collector **3908** may surround the second cylinder **3904**. For example, the second cylinder **3904** may be nested within the liquid collector **3908**.

The process for extracting liquids **3914** from solid particles **3916** may be adapted for the thirteenth system **3900**, described above, by placing a solids-liquids mixture **3912** in the space **3920** between the rotating first cylinder **3902** and rotating second cylinder **3904**. The solids-liquids mixture **3912** may be heated before, during, or after placement in the space between the first cylinder **3902** and second cylinder **3904**. The solids-liquids mixture **3912**, for example oil shale or oil sands, may be heated to approximately 25° C.-200° C., 50° C.-175° C., 75° C.-150° C., 95° C.-125° C., and preferably approximately 92° C.-110° C. and more preferably approximately 94° C. (e.g., in a water bath). The size and placement of the baffles **3910** may adjust the movement of the solids-liquids mixture **3912**. Spinning the first cylinder **3902** and second cylinder **3904** may cause the liquid **3914** to separate from the solid particles **3916**. The first cylinder **3902** and second cylinder **3904** may be spun to approximately 500 rpm to 10,000 rpm. The second cylinder **3904** may be spun for approximately 15 seconds to 20 minutes. The liquid **3914** may exit the second cylinder **3904** through the apertures **3918** and may be collected on the liquid collector **3908**. The optimum aperture **3918** size for extracting oil from Athabasca oil sands may be, for example, approximately 0.40-1.50 mm, 0.45-1.35 mm, 0.80-1.30 mm, or preferably approximately 0.85-1.10 mm. The remaining solid particles **3916** may exit the space **3922** between the first cylinder **3902** and second cylinder **3904** near the bottom of the second cylinder **3904** alternatively or additionally, the remaining solid particles **3916** may exit the space **3922** between the first cylinder **3902** and the second cylinder **3904** near or at the top of the second cylinder **3904**. The space **3922** between the first cylinder **3902** and the second cylinder **3904** that may allow the solid particles to exit may be continuous. A person skilled in the art may be able to adjust the rotational rate of the first cylinder **3902** and second cylinder **3904**, the feed rate of the solids-liquids mixture **3912**, and the placement of the baffles **3910** such that a majority of the liquid **3914** may be removed by the time the solids-liquids mixture **3912** reaches the bottom of the second cylinder **3904**. The thirteenth system **3900** may be used in a continuous process.

A method for separating oil from oil sands comprising: heating the oils sands; spinning the heated oil sands; confining mechanically sand particles present in the oils sands away from the oil; and recovering the oil substantially free of the sand. Further, the oil sands heated to approximately 25-200 degrees C. The oils sands heated to approximately 92 degrees C. to 110 degrees C. The particles are confined away from the oil by an aperture. The aperture is about 0.40 to about 1.5 mm in diameter. The aperture is about 0.80 to about 1.20 mm in diameter. The oil sands are subjected to centrifugal force. The oil is extracted from the oil sands without the use of chemicals.

A separation device for separating liquids from a solid particulate material, the separation device comprising: a structure for confining the sand particles, a structure for recovering the oil; and where the separation device is subjected to centrifugal force.

A separation device for separating liquids from a solid particulate material, the separation device comprising: a structure for confining the sand particles, a structure for recovering the oil; and where the separation device is subjected to centrifugal force. The structure for confining sand particles comprises a first tube and a second tube; the first tube and the second tube being dimensioned such that the first tube fits inside the second tube; the first tube including at least one aperture sized smaller than the oil sand; the first tube for confining the sand particles mechanically; and the second tube for recovering the oil.

A separation device for separating liquids from a solid particulate material, the separation device comprising: a structure for confining the sand particles, a structure for recovering the oil; and where the separation device is subjected to centrifugal force. The structure for confining the particles has a clam shell formation including a first portion and a second portion; the first portion and the second portions being dimensioned to fit together with an aligning pivot; the first portion including at least one cavity; the second portion including at least one cavity that mirrors the cavity of the first portion; and where, when the first portion and the second portion are fit together, the cavity in the first portion and the cavity in the second portion align to form one cavity; and the cavities terminate to form an aperture through which oil escapes; and the aperture is dimensioned to confine the sand particles within the cavity.

A separation device for separating liquids from a solid particulate material, the separation device comprising: a structure for confining the sand particles, a structure for recovering the oil; and where the separation device is subjected to centrifugal force. The structure for confining the particles has a conical formation with one or more walls, the walls including apertures, the walls also including baffles located along the interior of the conical separator, the baffles being continuous and arranged radially, and wherein the separation device further comprises a structure for recovering the oil.

A separation device for separating liquids from a solid particulate material, the separation device comprising: a structure for confining the sand particles, a structure for recovering the oil; and where the separation device is subjected to centrifugal force. The structure for confining the particles includes three or more planes, the planes being freely rotatable about a central axis; the central axis having a pivot; the planes being oriented so that they form walls of a closed chamber when rotated to a closed formation; the planes further including apertures through which oil escapes; and a structure for recovering oil.

A separation device for separating liquids from a solid particulate material, the separation device comprising: a structure for confining the sand particles, a structure for recovering the oil; and where the separation device is subjected to centrifugal force. A rotating main shaft; a top piston and a bottom piston removably attached to the main shaft; a filtering portion; the filtering portion having a top band, a bottom band, and a screen; the screen having apertures through which oil escapes; the screen, the top piston, and the bottom piston being arranged such that the pistons may be raised or lowered out of the plane of the screen.

A system for separating oil from oil sands comprising a source of centrifugal force; a heat source; a separation device; and a recovery device.

Through a simple mechanical method, the physical process disclosed for separating liquids from solids uses no water or other solvents and less than 190 cubic feet of natural gas to produce one barrel of bitumen. Minimizing the environmental impact, the disclosed process produces a clean affluent with the sole ingredient of sand. In comparison to the conventional method, the physical process disclosed requires fewer natural resources and less than 25% of the energy of the amount required in the conventional hot-water process to separate oil from oil sands. Further, on a laboratory scale, the disclosed method effectively separates over 85% of the available oil in less than 15 minutes.

I claim:

1. A separation device for separating oil from oil sands, the separation device comprising:

a centrifugal force generator;

a sand confining structure operably connected to the centrifugal force generator;

the sand confining structure having a cone shape;

the sand confining structure having a top and a bottom;

the top of the sand confining structure dimensioned larger than the bottom of the sand confining structure;

the sand confining structure comprising an interior face and an exterior face;

a baffle protruding from the interior face of the sand confining structure;

the sand confining structure nested within collecting portion;

the sand confining structure further comprising apertures there through;

the apertures having an origination point on the interior face of the sand confining structure and a termination point on the exterior face of the sand confining structure;

the aperture having a diameter; and

the diameter of the aperture at the origination point greater than the diameter of the aperture at the termination point.

2. The device of claim **1** wherein the baffle is arranged radially.

3. The device of claim **1** wherein the baffle is continuous with the interior face of the sand confining structure.

4. The device of claim **1** wherein the baffle is arranged in a screw-thread fashion.

5. The device of claim **1** wherein the oil recovering structure is stationary and wherein the sand confining structure is rotatable.

6. A method of separating oil from oil sands, the method comprising the steps of:

(a) providing a device for separating oil from oil sands; the device comprising:

a sand confining structure;

the sand confining structure having a cone shape;

the sand confining structure having a top and a bottom;

the top of the sand confining structure dimensioned larger than the bottom of the sand confining structure;

the sand confining structure comprising an interior face and an exterior face;

a baffle protruding from the interior face of the sand confining structure;

the sand confining structure nested within collecting portion;

the sand confining structure further comprising apertures;

the apertures having an origination point on the interior face of the sand confining structure and termination point on the exterior face of the sand confining structure;

the aperture having a diameter;

the diameter of the aperture at the origination point greater than the diameter of the aperture at the termination point;

(b) loading oil sands into the confining structure, the oil sands comprising a sand component and an oil component;

(c) providing a centrifugal force;

(d) rotating the sand confining structure co-axially; and

(d) collecting the sand component from the top of the sand confining structure.

7. The method of claim **6**, further comprising rotating the sand confining structure co-axially at 500 rpm to 10,000 rpm.

* * * * *