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(54) **CASCADING LIQUID AIR REMOVAL FILTER SYSTEM AND METHOD**

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(58) **Field of Classification Search**
USPC 166/276, 105.5, 173; 417/904
See application file for complete search history.

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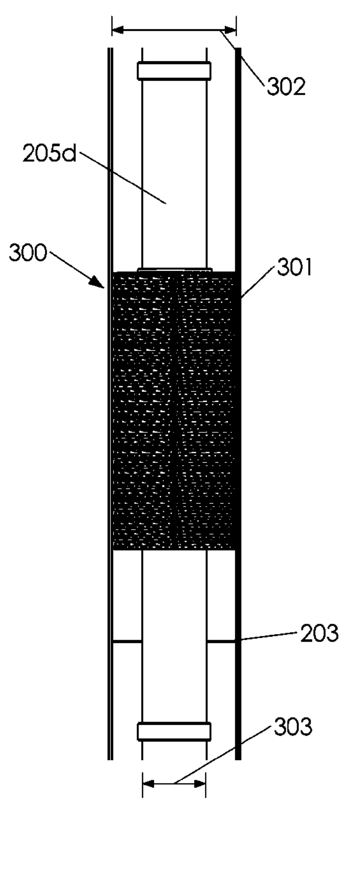
(57) **ABSTRACT**

A cascading liquid air removal filter system is disclosed. Said system comprising a filter system having a bristles element. Said bristle element comprises a plurality of bristles each having a first end and a second end. Said bristles element comprises a plurality of fluid passages between said bristles. Said filter system is attached to a column of a well having one or more sections, between said column and a casing of said well. Said filter system comprises a filter outside diameter. Said casing comprises a casing internal diameter. Said filter outside diameter is equal to or larger than said casing internal diameter. Said fluid passages comprise a plurality of non-linear paths through said bristles element for a liquid passing through said filter system. Said filter system provides only said non-linear paths for said liquid to travel from a first end to a second end of said filter system.

9 Claims, 6 Drawing Sheets



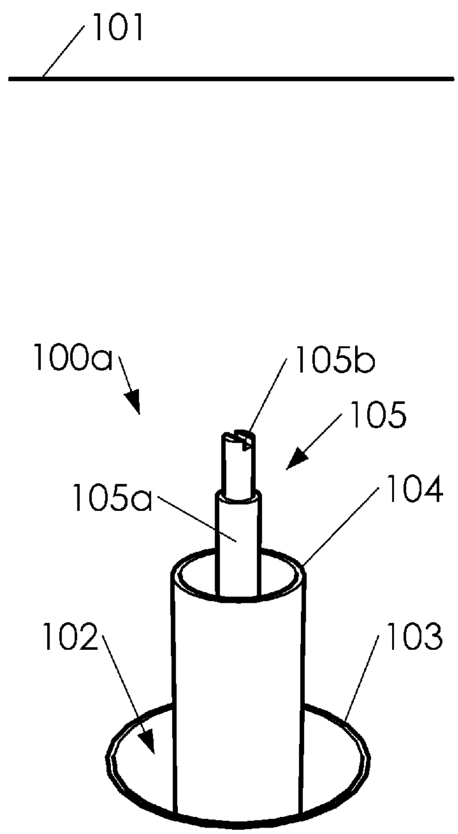


Fig. 1A

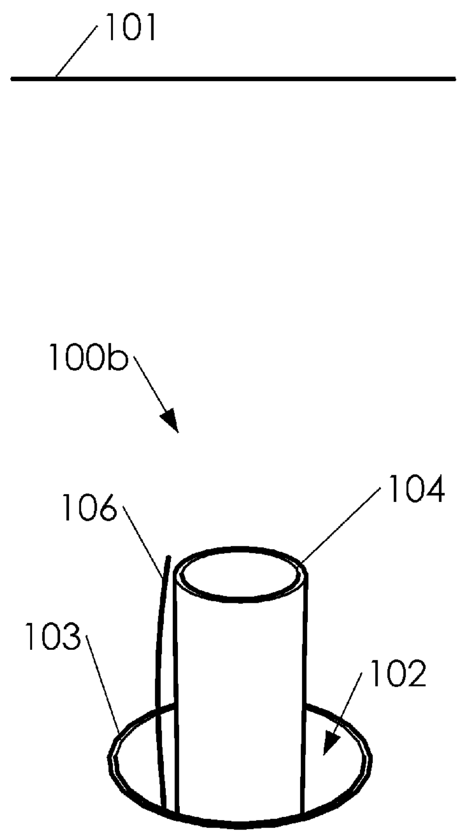


Fig. 1B

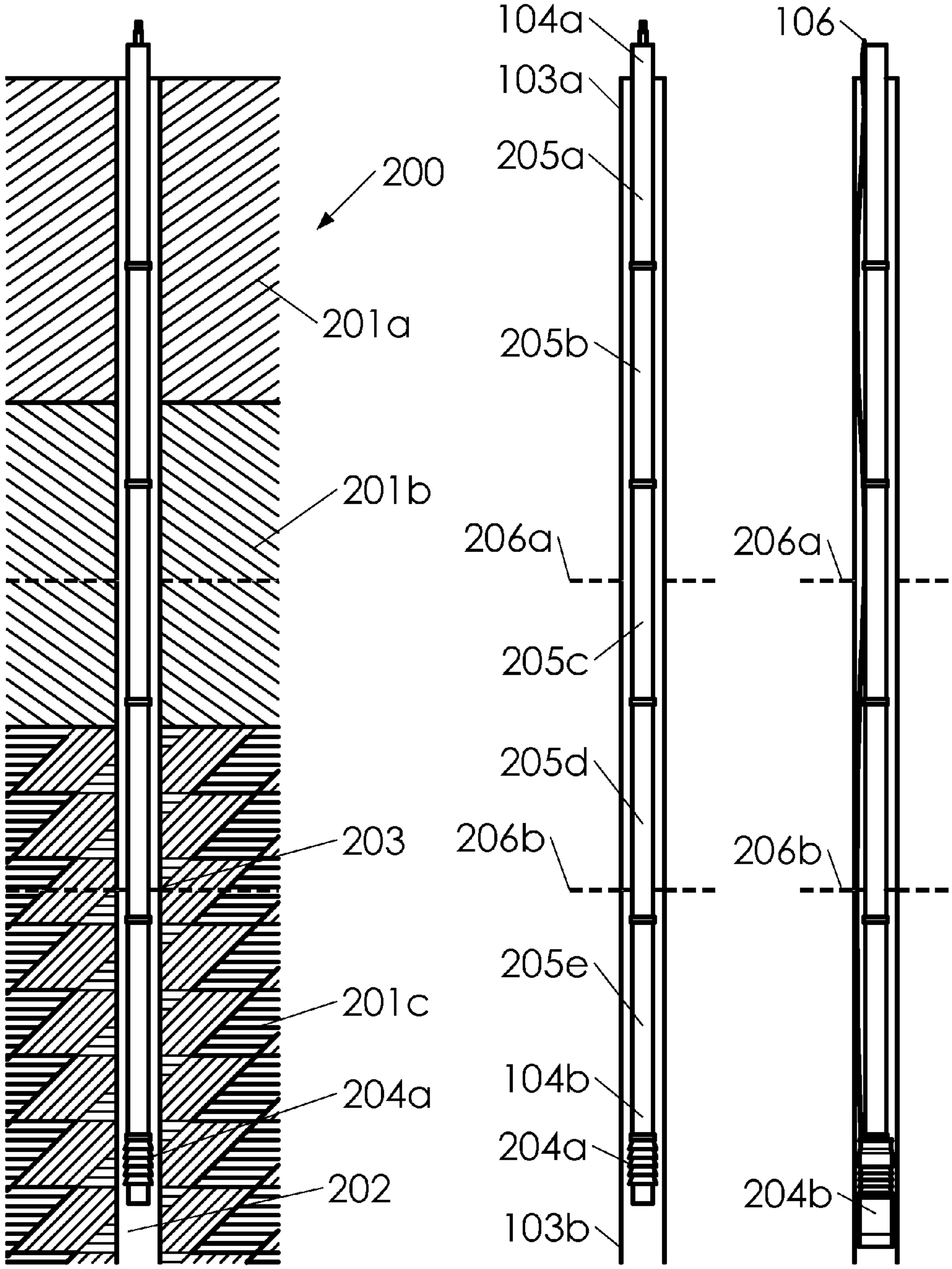


Fig. 2A Fig. 2B Fig. 2C

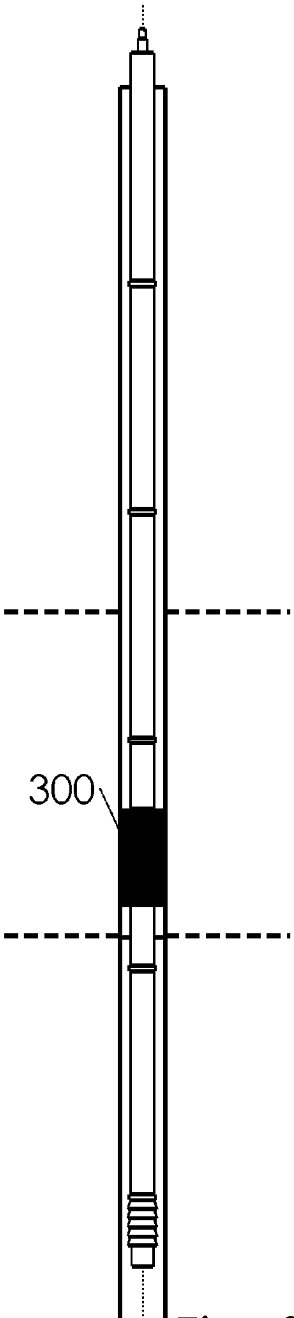


Fig. 3A

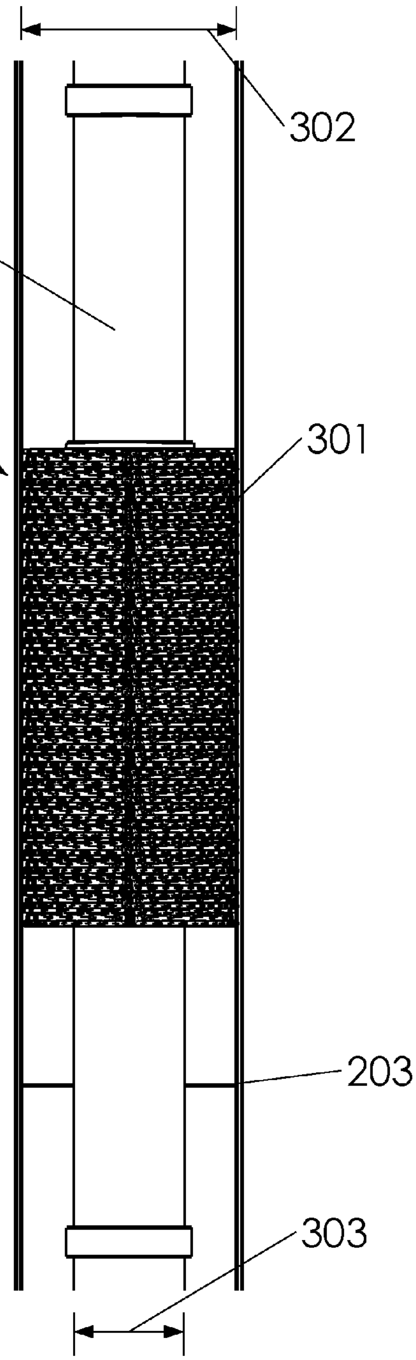


Fig. 3B

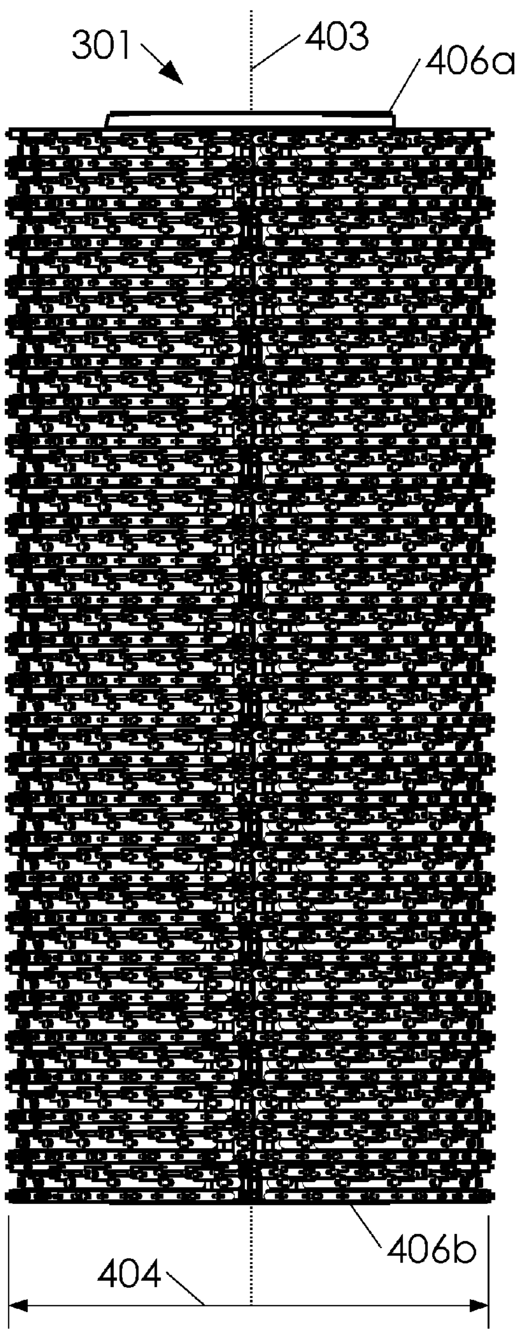


Fig. 4A

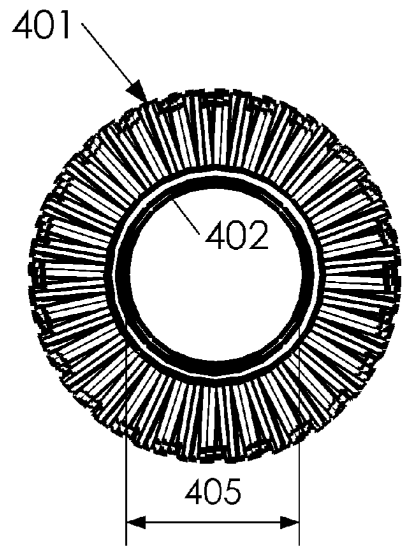


Fig. 4B

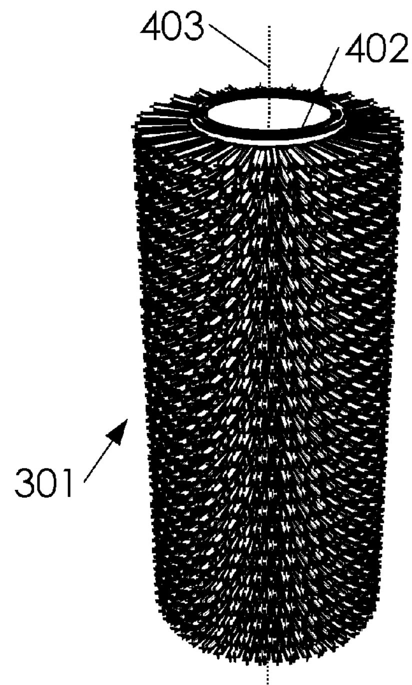


Fig. 4C

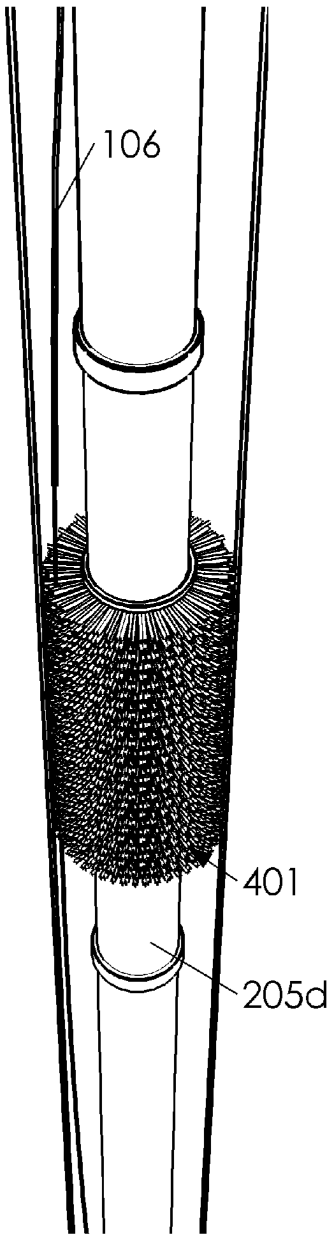


Fig. 5A

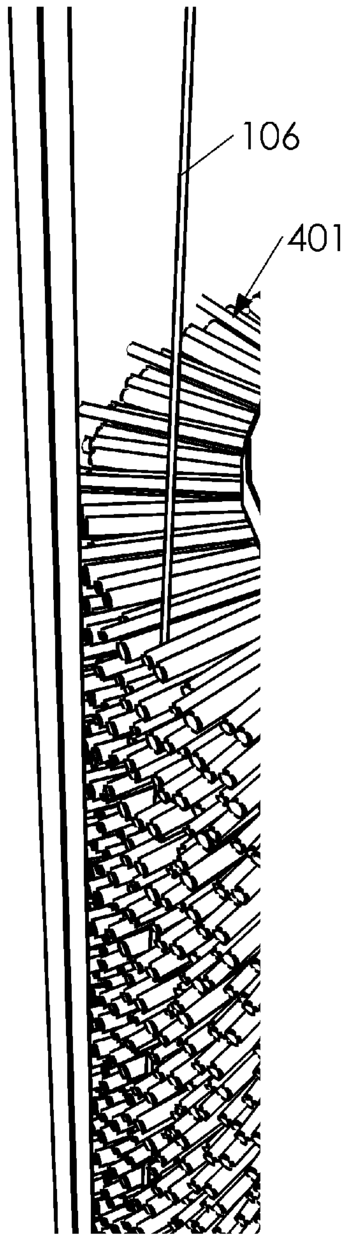


Fig. 5B

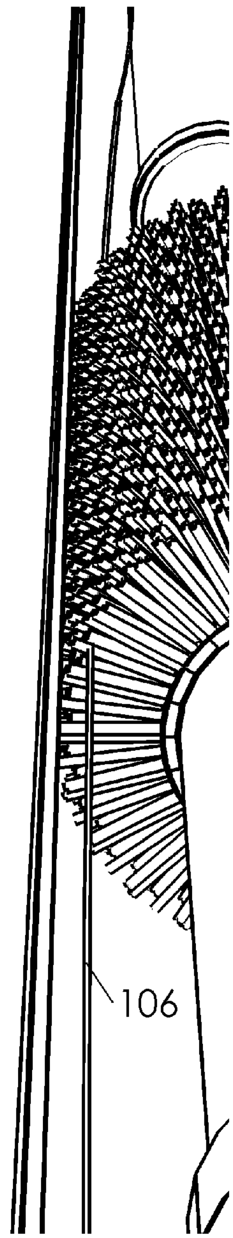


Fig. 5C

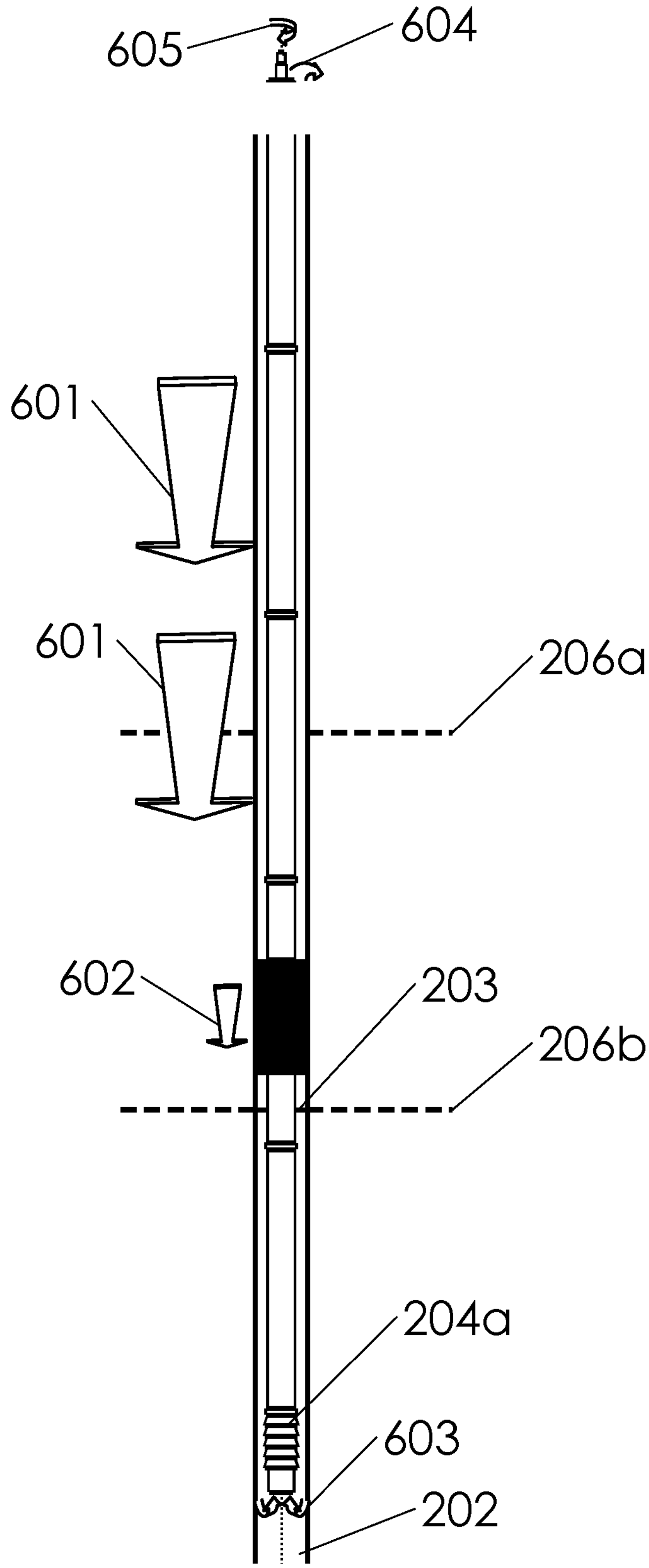


Fig. 6

CASCADING LIQUID AIR REMOVAL FILTER SYSTEM AND METHOD

BACKGROUND

This disclosure relates generally to a cascading liquid air removal filter system and method. In one embodiment, this disclosure relates to said cascading liquid air removal filter system and method installed in a well containing a water pump installed therein. In another embodiment, said cascading liquid air removal filter system and method can be installed in a well producing liquids other than water, such as an oil from an oil well.

In one embodiment, said water pump installed in said well can comprise a centrifugal pump. In one embodiment, said centrifugal pump can be a rotodynamic pump that uses a rotating impeller to increase the pressure of a fluid. Said fluid enters said rotating impeller along or near a rotating axis of said rotating impeller and accelerated by said impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits into a downstream piping system. In one embodiment, said water pump can comprise a turbine pump (i.e., a pump driven by a shaft driven form above surface), or a submergible pump. In one embodiment, said submergible pump can comprise an electrical pump located below a liquid surface and proximate to a bottom end of a well casing wherein a pipe contains and electrical line to said water pump.

When used in a water pump, water pumps (such as a centrifugal pump) encounter many problems. First, pumps with an impeller can become worn with continuous use, especially where said impeller encounters friction due to suspended solids in a liquid being pumped. Next, pumps can overheat due to low flow in liquid. Where pumps become worn, they can thereby have leakage occur along the rotating shaft. Further, many pumps, such as centrifugal pumps, must be filled with a fluid to be pumped in order to operate; that is, many pumps will not operate unless primed. In many cases, where a pump casing becomes filled with vapors or gases, said pump's impeller becomes gas-bound and incapable of pumping.

In one embodiment, to ensure that a centrifugal pump remains primed and does not become gas-bound, said centrifugal pumps are placed below a fluid source level, from which the pump is to take its suction. The same effect can be gained by supplying liquid to said pump's intake under pressure supplied by another pump placed in a suction line. Such an embodiment fails to account for air in said fluid source pushed below said fluid source level by cascading water. For example, in one embodiment, a water pump can be placed under water below a water level; wherein, said water pump typically draws said water into said pump but occasionally draws in air pushed below said water level by cascading water splashing at said water level.

In one embodiment, a pump can comprise one or more bowls which spin to push liquid through said pump. Where air is introduced into a fluid intake of said pump, non-uniformity at said fluid intake causes said bowls to cut a cast iron shell of said pump.

Systems and method for filtering air from cascading liquid have evolved over the years. In one embodiment, an elastic tube device is inserted into a cased well wherein said elastic tube device consists of (i) an elastic tube, a pipe having an inner bore, said pipe extending through said elastic tube, said elastic tube annularly surrounding an expansion space; (ii) tube clamps capable of fixedly attaching said upper and lower ends of the elastic tube to the outer surface of said pipe; and (iii) fluid transfer apertures capable of carrying fluids from the inner bore of the pipe to said expansion space. Wherein, said fluid transfer apertures interconnecting said expansion space and said inner bore of said pipe so that, upon extension of the device into said cased well, and upon introduction of a pressurized water into said inner bore of said pipe, water may flow from said inner bore of said elastic tube to expand radially outward into contact with said cased well's casing. Said embodiment sets out to enhance the function of an impeller or centrifugal pump installed within wells, allowing such pumps to create a pressure differential or vacuum effect at the water inlet ports of said well without drawing down said water level within said well. Such an embodiment leaves much to be desired in practice however. In one embodiment, said elastic tube becomes clogged and filled with solid materials, such as sand. Further, said elastic tube device is not easily removed from said cased well when defective. In one embodiment, complexity in removing said elastic tube device is encountered where said elastic tube when a material is lodged within said elastic tube and causes a counter weight to efforts at pulling said elastic tube device from said cased well. Another shortcoming of said elastic tube device is a relatively slow flow rate of liquids through said elastic tube device. Still further, another limitation of said elastic tube device occurs where a user cannot determine a static water level prior to installing said elastic tube device and therefore may accidentally block water flow between said water pump and a water source below said static water level. That is, said elastic tube device can seal holes in a casing wall in said well casing where a portion of said elastic tube pushes against said holes.

In another embodiment, a throttle valve is introduced below ground level in a well ("downhole") to continuously regulate the flow of water during recharge, injection or aquifer storage recovery. Said throttle valve include two concentric cylinders or tubular members, one of which has flow control ports, the other is connected to and selectively moved by a hydraulic actuator section, thereby setting the flow through the ports by varying their size. An inner tubular member with said control ports is stationery and an outer tubular member is moved vertically by hydraulic pressure in a double acting hydraulic actuator section. Speed of operation is adjusted by adjusting a hydraulic fluid flow control valve. Accordingly, said embodiment attempts filter air from cascading liquids by introducing a throttle valve between a fluid source and a pump. Nonetheless, said embodiment has many shortcomings. First, said inner and outer tubular members are prone to failure downhole. For example, said double acting hydraulic actuator section of said outer tubular member could easily fail and become lodged downhole. Also, variable speed of operation by said hydraulic fluid flow control valve is not necessary for the filtering of air in cascading fluids.

Accordingly, a system and/or method for filtering air from cascading liquid would be advantageous.

SUMMARY

Two cascading liquid air removal filter systems and one method are disclosed. First, a cascading liquid air removal filter system is disclosed comprising a filter system having a bristles element. Said bristle element comprises a plurality of bristles each having a first end and a second end. Wherein said filter system is attached to a column of a well having one or more sections, between said column and a casing of said well, and above a drawdown liquid level within said well.

Next, a cascading liquid air removal filter method is disclosed. Said method comprising minimizing a flow of a plurality of air bubbles into a pump under a liquid and in a well

by attaching a filter system to a column of a well between said column and a casing and above a drawdown liquid level within said well, and slowing a cascading liquid prior to splashing a liquid surface by forcing said cascading liquid to trickle through said filter system. Said liquid comprises said liquid surface at a top surface of said liquid in said well. Said liquid comprises said cascading liquid while falling toward said liquid surface. Said drawdown liquid level comprises a liquid level when said pump is pumping. Said well comprises said drawdown liquid level and a static liquid level. Said static liquid level comprises said liquid level when said pump is not pumping. Said filter system comprises a plurality of bristles.

Finally, a cascading liquid air removal filter system is disclosed. Said system comprising a filter system having a bristles element. Said bristle element comprises a plurality of bristles each having a first end and a second end. Said bristles element comprises a plurality of fluid passages between said bristles. Said filter system is attached to a column of a well having one or more sections, between said column and a casing of said well. Said filter system comprises a filter outside diameter. Said casing comprises a casing internal diameter. Said filter outside diameter is equal to or larger than said casing internal diameter. Said fluid passages comprise a plurality of non-linear paths through said bristles element for a liquid passing through said filter system. Said filter system provides only said non-linear paths for said liquid to travel from a first end to a second end of said filter system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B illustrate an above ground view of a turbine pump configuration and a submergible pump configuration, respectively.

FIG. 2A illustrates turbine pump configuration in a cutaway view of surface exposing a subsurface.

FIGS. 2B and 2C illustrate a side cutaway view of submergible pump configuration and turbine pump configuration, respectively.

FIGS. 3A and 3B illustrate an overview and detailed view of well with a filter system, respectively.

FIGS. 4A, 4B, and 4C illustrate a side view, top view, and an overview of bristles element.

FIGS. 5A, 5B, and 5C illustrate a top overview and detailed view, and a below overview of filter system in a cutaway section of casing, respectively.

FIG. 6 illustrates a detailed view of filter system arranged between static liquid level and drawdown liquid level.

DETAILED DESCRIPTION

Described herein is a cascading liquid air removal filter system and method. The following description is presented to enable any person skilled in the art to make and use the invention as claimed and is provided in the context of the particular examples discussed below, variations of which will be readily apparent to those skilled in the art. In the interest of clarity, not all features of an actual implementation are described in this specification. It will be appreciated that in the development of any such actual implementation (as in any development project), design decisions must be made to achieve the designers' specific goals (e.g., compliance with system- and business-related constraints), and that these goals will vary from one implementation to another. It will also be appreciated that such development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the field of the appropriate art having the benefit of this disclosure. Accordingly, the claims appended hereto are not intended to be limited by the disclosed embodiments, but are to be accorded their widest scope consistent with the principles and features disclosed herein.

FIGS. **1**A and **1**B illustrate an above ground view of a turbine pump configuration **100***a* and a submergible pump configuration **100***b*, respectively. Cascading liquid air removal filter system and method can comprise a well **100**. Well **100** can comprise turbine pump configuration **100***a* and submergible pump configuration **100***b*. In one embodiment, well **100** can be installed into a surface **101** by drilling a bore **102** in surface **101** and inserting well **100** into bore **102**, as is known in the art. Well **100** can comprise a casing **103** and a column **104**. In one embodiment, turbine pump configuration **100***a* can comprise a tubing-shaft **105**. Tubing-shaft **105** can comprise a tubing **105***a* and a shaft **105***b*. In one embodiment, shaft **105***b* can rotate freely within tubing **105***a*, as is known in the art. In one embodiment, submergible pump configuration **100***b* can comprise a wire **106**.

FIG. **2**A illustrates turbine pump configuration **100***a* in a cutaway view of surface **101** exposing a subsurface **200**. Subsurface **200** can comprise a plurality of geological layers **201**. In one embodiment, geological layers **201** can comprise a first layer **201***a*, a second layer **201***b*, and a third layer **201***c*, as shown in FIG. **2**A. Subsurface **200** can further comprise a liquid **202**. In one embodiment, liquid **202** can be held in geological layers **201**. In one embodiment, bore **102** can comprise, an aperture in surface **101** extending into a subsurface **200** to a sufficient depth to access a liquid **202** from below surface **101**. In one embodiment, liquid **202** can comprise water, oil, or some other liquid of significance. As is known in the art, liquid **202** can drain from subsurface **200** into well **100**. In one embodiment, liquid **202** can accumulate in well **100** and form a liquid surface **203**.

FIGS. **2**B and **2**C illustrate a side cutaway view of submergible pump configuration **100***b* and turbine pump configuration **100***a*, respectively. Casing **103** can comprise a top end **103***a* and a bottom end **103***b*. Column **104** can comprise a top end **104***a* and a bottom end **104***b*. Well **100** can comprise a pump **204**. Pump **204** can comprise a variety of different pump types such as a centrifugal pump, a turbine pump **204***a*, and/or a submergible pump **204***b*. Column **104** can comprise one or more sections **205**. Sections **205** can comprise a first section **205***a*, a second section **205***b*, a third section **205***c*, a fourth section **205***d*, and a fifth section **205***e*. In one embodiment, turbine pump configuration **100***a* can comprise turbine pump **204***a*. In one embodiment, turbine pump **204***a* can pump liquid **202** by attaching a rotary power source to a first end of shaft **105***b*, attaching a second end of shaft **105***b* to turbine pump **204***a*, and driving shaft **105***b* with said rotary power source. In one embodiment, submergible pump configuration **100***b* can comprise submergible pump **204***b*. In one embodiment, submergible pump **204***b* can pump liquid **202** by attaching submergible pump **204***b* to bottom end **104***b*, attaching a second end of wire **106** to submergible pump **204***b*, running a first end of wire **106** above surface **101**, applying power to submergible pump **204***b* through wire **106**, and pumping liquid **202** from bottom end **104***b* to top end **104***a*. In one embodiment, liquid surface **203** can rise and fall to one or more liquid levels **206** within well **100** as liquid **202** is static or pumping out of well **100**. For example, in one embodiment, liquid surface **203** can comprise a static liquid level **206***a* and a drawdown liquid level **206***b*. In one embodiment, static liquid level **206***a* can comprise a state of liquid level **206** wherein liquid surface **203** would naturally occur as pump **204** is not pumping. In one embodiment, drawdown liquid level **206***b* can comprise a state of liquid level **206** wherein liquid surface **203** would occur as pump **204** is pumping.

FIGS. **3**A and **3**B illustrate an overview and detailed view of well **100** with a filter system **300**, respectively. Filter system **300** can comprise one of sections **205** and a bristles element **301**. In one embodiment, filter system **300** can comprise bristles element **301** apart from one of sections **205**. In one embodiment, filter system **300** can be attached around and to fourth section **205***d*. In one embodiment, bristles element **301** can substantially fill a cavity between casing **103** and column **104**. In one embodiment, bristles element **301** can attach substantially above drawdown liquid level **206***b*. In one embodiment, wherein filter system **300** comprises a bristles element **301** and one of sections **205**, filter system **300** can replace one of sections **205** lacking said bristles element **301**. In one embodiment, wherein filter system **300** only comprises bristles element **301**, filter system **300** can attach to column **104** by sliding filter system **300** around an outer parameter of column **104**. In one embodiment, filter system **300** can be attached to column **104** by welding a portion of filter system **300** to a portion of column **104**. Casing **103** can comprise a casing internal diameter **302**. Column **104** can comprise a column external diameter **303**.

FIGS. **4**A, **4**B, and **4**C illustrate a side view, top view, and an overview of bristles element **301**. Bristles element **301** can comprise a plurality of bristles **401**, a central portion **402**, a central axis **403** and a filter outside diameter **404**. In one embodiment, central portion **402** can comprise a substantially long hollow cylinder comprising a central portion internal diameter **405**. In one embodiment, central portion internal diameter **405** can be substantially equal to or slightly larger than column external diameter **303**; wherein, central portion **402** can slide around column **104**. In one embodiment, bristles **401** can comprise a first bristle **401***a*, a second bristle **401***b*, and so on. In one embodiment, bristles element **301** can comprise a central axis **403** along a substantially vertical line at the center of central portion **402**. In one embodiment, bristles **401** can attach to central portion **402** at one end and extend in a plurality of substantially horizontal directions away from central axis **403**. In one embodiment, bristles **401** can comprise a bristle material capable of holding said substantially horizontal direction. In one embodiment, said bristle material comprises polypropylene. In another embodiment, said bristle material comprises plastic, or similar. In yet another embodiment, said bristle material can comprise a metal. In one embodiment, bristles **401** can comprise wire. In one embodiment, bristles **401** can attach along an external surface of central portion **402**. In one embodiment, bristles **401** cover said external surface of central portion **402** from a first end **406***a* to a second end **406***b* of central portion **402**, as illustrated in FIGS. **4**A-4C. In one embodiment, bristles **401** can attach to a portion of said external surface of central portion **402**. In one embodiment, bristles **401** can attach in a plurality of groupings between first end **406***a* and second end **406***b* such that there are gaps in bristles **401** along filter system **300**. In one embodiment, filter outside diameter **404** can be slightly larger than casing internal diameter **302**. For example, in one embodiment, filter outside diameter **404** can be 16" and casing internal diameter **302** can be 15.5", but these diameters are exemplary and not required for cascading liquid air removal filter system and method to properly function. In one embodiment, bristles **401** can scrape and clean a portion of casing **103** during installation by inserting bristles element **301** into top end **103***a*, pushing bristles element **301** down into well **100** toward bottom end **103***b*, and scraping bristles **401** against an internal surface area of casing **103**.

FIGS. **5**A, **5**B, and **5**C illustrate a top overview and detailed view, and a below overview of filter system **300** in a cutaway section of casing **103**, respectively. In one embodiment, bristles element **301** can comprise a plurality of fluid passages between bristles **401**; wherein, said fluid passages can each comprise a non-linear path through bristles element **301** for a fluid passing through filter system **300**. For example, in one embodiment, wire **106** can pass through filter system **300** by pulling wire **106** from first end **406***a* to second end **406***b* through bristles **401**; however, wire **106** is forced to take one of said fluid passages through filter system **300**. Likewise, in one embodiment, liquid **202** can pass through filter system **300** along one or more said fluid passages through filter system **300**.

FIG. **6** illustrates a detailed view of filter system **300** arranged between static liquid level **206***a* and drawdown liquid level **206***b*. Liquid **202** can comprise a cascading liquid **601**, a trickling liquid **602**, a pumping liquid **603**, and a produced liquid **604**. In one embodiment, cascading liquid **601** can comprise liquid **202** in an uninterrupted falling acceleration from subsurface **200** toward liquid surface **203**. In one embodiment, said uninterrupted falling acceleration can comprise liquid **202** falling due to the pull of gravity down well **100**. In one embodiment, as cascading liquid **601** splashes said liquid surface **203** a plurality of air bubbles can become injected into liquid **202** and thereafter said air bubbles can damage pump **204**. In one embodiment, said bubbles can damage pump **204** by pulling said air bubbles into pump **204**. In one embodiment, cascading liquid air removal filter system and method can comprise minimizing the flow of said air bubbles to pump **204** by attaching filter system **300** to well **100** and slowing cascading liquid **601** prior to splashing liquid surface **203**. In one embodiment, slowing cascading liquid **601** can comprise attaching filter system **300** above drawdown liquid level **206***b* and between casing **103** and column **104**, forcing cascading liquid **601** to pass through bristles **401**, and thereby slowing cascading liquid **601** into trickling liquid **602**. In one embodiment, attaching filter system **300** to well **100** can comprise attaching filter system **300** around one of sections **205**, substantially above drawdown liquid level **206***b*, and substantially filling a space between casing **103** and column **104** with bristles **401**. In one embodiment, cascading liquid air removal filter system and method can comprise attaching filter system **300** below static liquid level **206***a*. In one embodiment, forcing cascading liquid **601** to pass through bristles **401** can comprise blocking a portion of a space between static liquid level **206***a* and drawdown liquid level **206***b*. In one embodiment, blocking said portion of said space can comprise inserting filter system **300** between static liquid level **206***a* and drawdown liquid level **206***b*. Further, in one embodiment, slowing cascading liquid **601** into trickling liquid **602** can comprise trickling said liquid **202** through said non-linear path between first end **406***a* and second end **406***b* of filter system **300**. In one embodiment, cascading liquid **601** trickles through bristles **401** by hitting a plurality of bristles **401** as cascading liquid **601** is pulled downward through filter system **300**. In one embodiment, trickling liquid **602** drops from second end **406***b* to liquid surface **203** and collects below and around pump **204**. In one embodiment, cascading liquid air removal filter system and method can minimize damage to pump **204** as well **100** produces liquid **202** by slowing liquid **202** from cascading liquid **601** to trickling liquid **602** with filter system **300**, minimizing said air bubbles in liquid **202**, pumping liquid **202** through column **104** from bottom end **104***b* to top end **104***a*, and collecting liquid **202** as it exits well **100** as produced liquid **604**.

In one embodiment, cascading liquid air removal filter system and method can comprise installing filter system **300** in well **100**. In one embodiment, installing filter system **300** can comprise determining static liquid level **206***a* and drawdown liquid level **206***b*, and attaching filter system **300** to a portion of column **104** corresponding to a location between static liquid level **206***a* and drawdown liquid level **206***b*. In one embodiment, determining static liquid level **206***a* can comprise testing one or more well conditions within well **100** without pump **204** pumping. In one embodiment, determining drawdown liquid level **206***b* can comprise estimating drawdown liquid level **206***b* based upon an average draw down distance in view of said well conditions. In another embodiment, determining drawdown liquid level **206***b* can comprise testing said drawdown level with pump **204** pumping. Other means of determining static liquid level **206***a* and drawdown liquid level **206***b* will be apparent to those skilled in the art herein discussed.

Various changes in the details of the illustrated operational methods are possible without departing from the scope of the following claims. Some embodiments may combine the activities described herein as being separate steps. Similarly, one or more of the described steps may be omitted, depending upon the specific operational environment the method is being implemented in. It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments may be used in combination with each other. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein."

The invention claimed is:

1. A cascading liquid air removal filter method comprising minimizing a flow of a plurality of air bubbles into a pump under a liquid and in a well by:
- attaching a filter system to a column of a well between said column and a casing and above a drawdown liquid level within said well,
- slowing a cascading liquid prior to splashing a liquid surface by forcing said cascading liquid to trickle through a plurality of bristles in said filter system;
- slowing said cascading liquid comprises
  - forcing said cascading liquid to pass through said filter system and
  - slowing said cascading liquid into a trickling liquid by
    - blocking a portion of a space between a static liquid level and said drawdown liquid level,
    - allowing said cascading liquid to penetrate said plurality of bristles along a one of a plurality of non-linear paths between a first end and a second end of said filter system, and
    - trickling said liquid through said filter system and thereby slowing said cascading liquid into a trickling liquid;
- trickling said cascading liquid through said filter system comprises hitting said cascading liquid with said plurality of bristles as said cascading liquid is pulled downward through said filter system; and wherein,
  - said liquid comprises said liquid surface at a liquid level of said liquid in said well
  - said liquid comprises said cascading liquid while falling toward said liquid surface,
  - said drawdown liquid level comprises said liquid level when said pump is pumping,
  - said static liquid level comprises said liquid level when said pump is not pumping,
  - said filter system comprises said plurality of bristles, and
  - said filter system comprises a bristles element having a plurality of bristles attached to a central portion of said filter system.

2. The cascading liquid air removal filter method of claim **1** wherein attaching said filter system to said column comprises
- installing said filter system by determining said static liquid level and said drawdown liquid level and
- attaching filter system to said column above said drawdown liquid level.

3. A cascading liquid air removal filter method comprising minimizing a flow of a plurality of air bubbles into a pump under a liquid and in a well by:
- attaching a filter system to a column of a well between said column and a casing and above a drawdown liquid level within said well,
- slowing a cascading liquid prior to splashing a liquid surface by forcing said cascading liquid to trickle through a plurality of bristles in said filter system;
- slowing said cascading liquid comprises
  - forcing said cascading liquid to pass through said filter system and
  - slowing said cascading liquid into a trickling liquid by
    - blocking a portion of a space between a static liquid level and said drawdown liquid level,
    - allowing said cascading liquid to penetrate said plurality of bristles along at least one of a plurality of non-linear paths between a first end and a second end of said filter system, and
    - trickling said liquid through said filter system and thereby slowing said cascading liquid into a trickling liquid;
- trickling said cascading liquid through said filter system comprises hitting said cascading liquid with said plurality of bristles as said cascading liquid is pulled downward through said filter system; and wherein,
  - said liquid comprises said liquid surface at a liquid level of said liquid in said well,
  - said liquid comprises said cascading liquid while falling toward said liquid surface,
  - said drawdown liquid level comprises said liquid level when said pump is pumping,
  - said static liquid level comprises said liquid level when said pump is not pumping,
  - said filter system comprises said plurality of bristles, and
  - said filter system comprises a bristles element having a plurality of bristles attached to a central portion of said filter system.

4. The cascading liquid air removal filter method of claim **3** wherein attaching said filter system to said column of said well comprises:
- sliding said filter system around an outer parameter of said column; and wherein,
  - said filter system comprises said central portion having a central portion internal diameter,
  - said casing comprises a column external diameter, and
  - said central portion internal diameter is equal to or larger than said column external diameter.

5. The cascading liquid air removal filter method of claim **3** wherein attaching said filter system to the column of the well further comprises:
- securing said filter system to said column.

6. The cascading liquid air removal filter method of claim **5** wherein securing said filter system to said column further comprises:

welding a portion of said filter system to a portion of said column.

7. The cascading liquid air removal filter method of claim **5** wherein securing said filter system to said column further comprises:

replacing a one of a one or more sections in said column with said filter system.

8. The cascading liquid air removal filter method of claim **3** further comprising:

attaching each of a first ends of said plurality of bristles to an external surface of said central portion of said bristles element.

9. The cascading liquid air removal filter method of claim **3** wherein blocking said portion of said space between said static liquid level and said drawdown liquid level further comprises:

blocking a space between said casing and said column; wherein,

a filter outside diameter is equal to or larger than a casing internal diameter,

said casing internal diameter comprises an internal diameter of said casing, and

said filter outside diameter comprises an external diameter of said filter system.

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