US010385673B2

(12) United States Patent
Xiao et al.

(10) Patent No.: US 10,385,673 B2
(45) Date of Patent: Aug. 20, 2019

(54) **FLUID DRIVEN COMMINGLING SYSTEM FOR OIL AND GAS APPLICATIONS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 290 days.

(21) Appl. No.: **15/088,745**

(22) Filed: **Apr. 1, 2016**

(65) **Prior Publication Data**

US 2016/0290116 A1 Oct. 6, 2016

Related U.S. Application Data

(60) Provisional application No. 62/141,434, filed on Apr. 1, 2015.

(51) **Int. Cl.**
E21B 43/12 (2006.01)
E21B 43/38 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 43/38*** (2013.01); ***E21B 43/121*** (2013.01); ***E21B 43/122*** (2013.01); ***E21B 43/128*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 43/121; E21B 43/122; E21B 43/128; E21B 43/38
See application file for complete search history.

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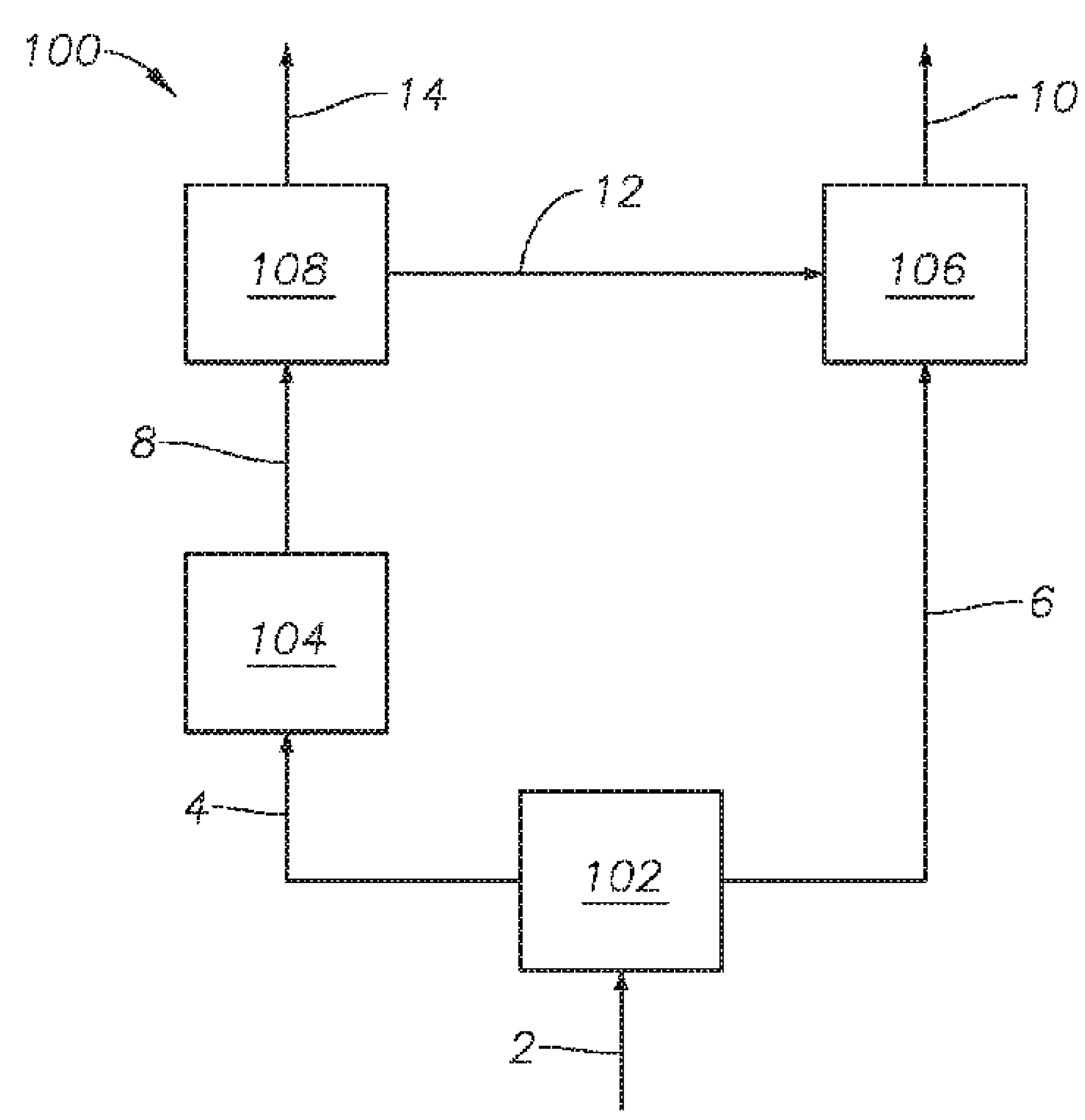
(57) **ABSTRACT**

A fluid management system positioned in a wellbore for recovering a multiphase stream from the wellbore. The system comprising a downhole separator configured to produce a carrier fluid having a carrier fluid pressure and a separated fluid having a separated fluid pressure, an artificial lift device configured to increase the carrier fluid pressure to produce the turbine feed stream having a turbine feed pressure, a turbine configured to convert fluid energy in the turbine feed stream to harvested energy, the conversion fluid energy from the turbine feed stream to harvested energy produces a turbine discharge stream having a turbine discharge pressure less than the turbine feed pressure, and a pressure boosting device configured to convert the harvested energy to pressurized fluid energy, the conversion of harvested energy to pressurized fluid energy produces a pressurized fluid stream having a pressurized fluid pressure greater than the separated fluid pressure.

9 Claims, 2 Drawing Sheets



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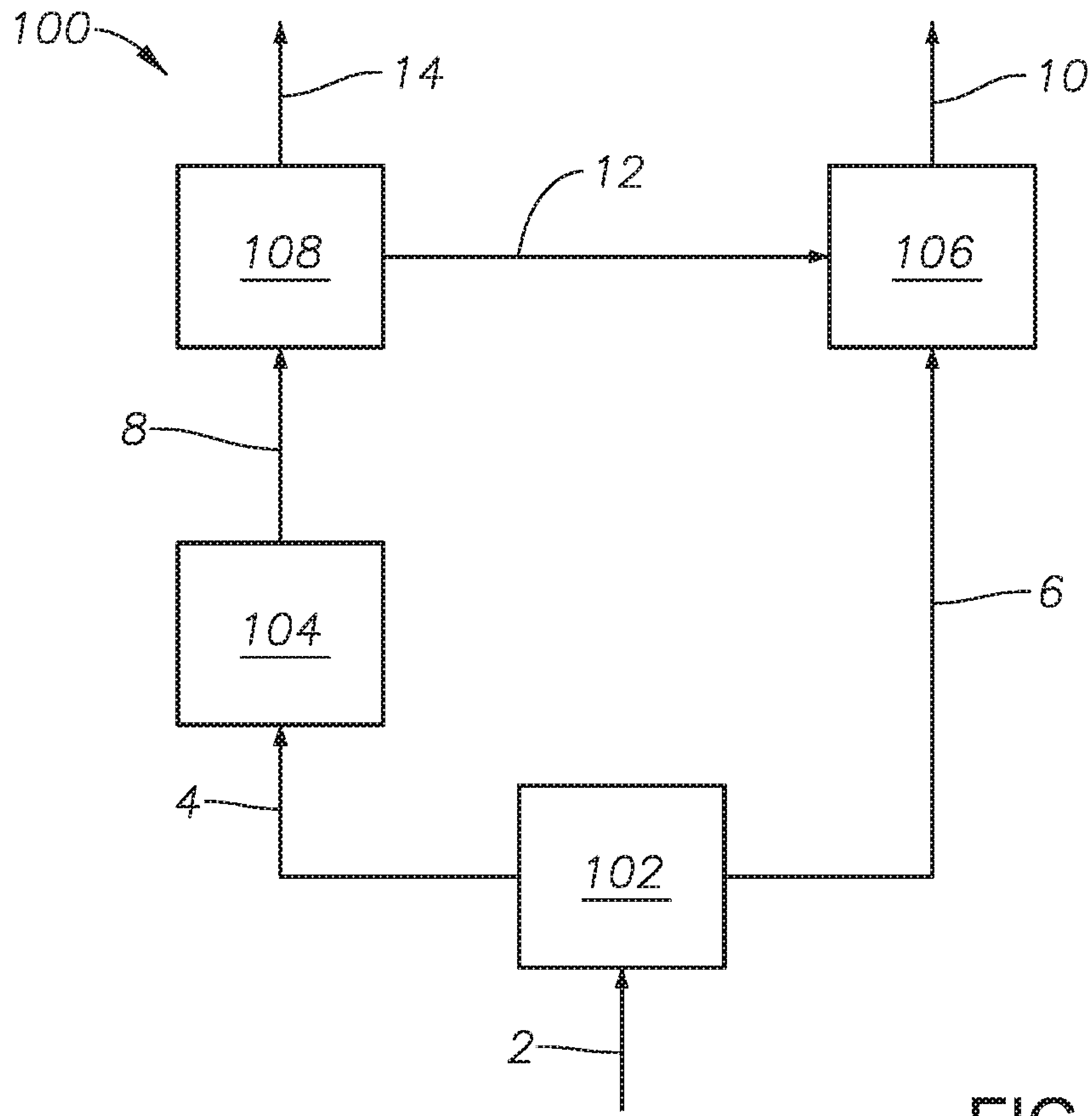

FIG. 1

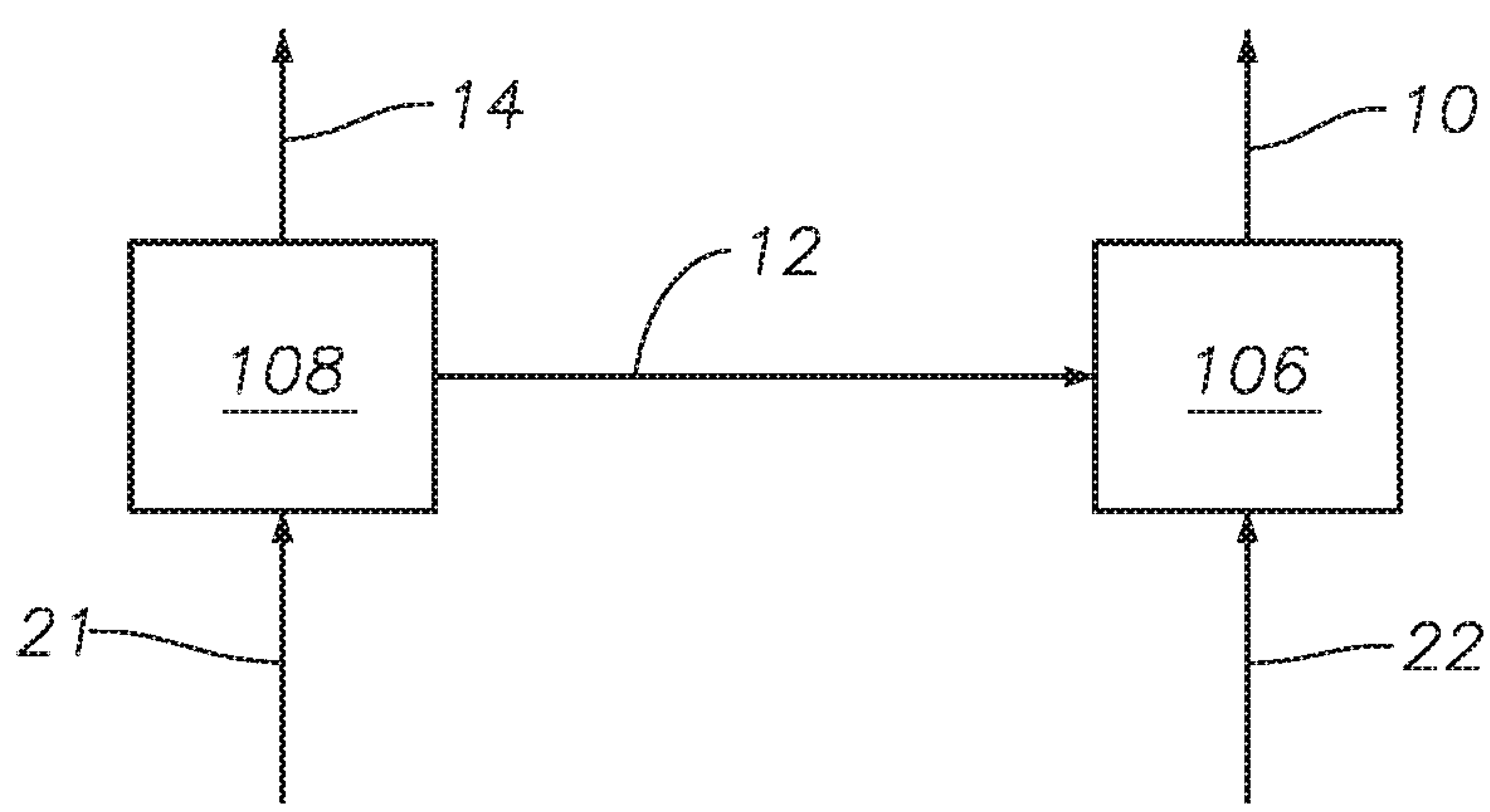

FIG. 3

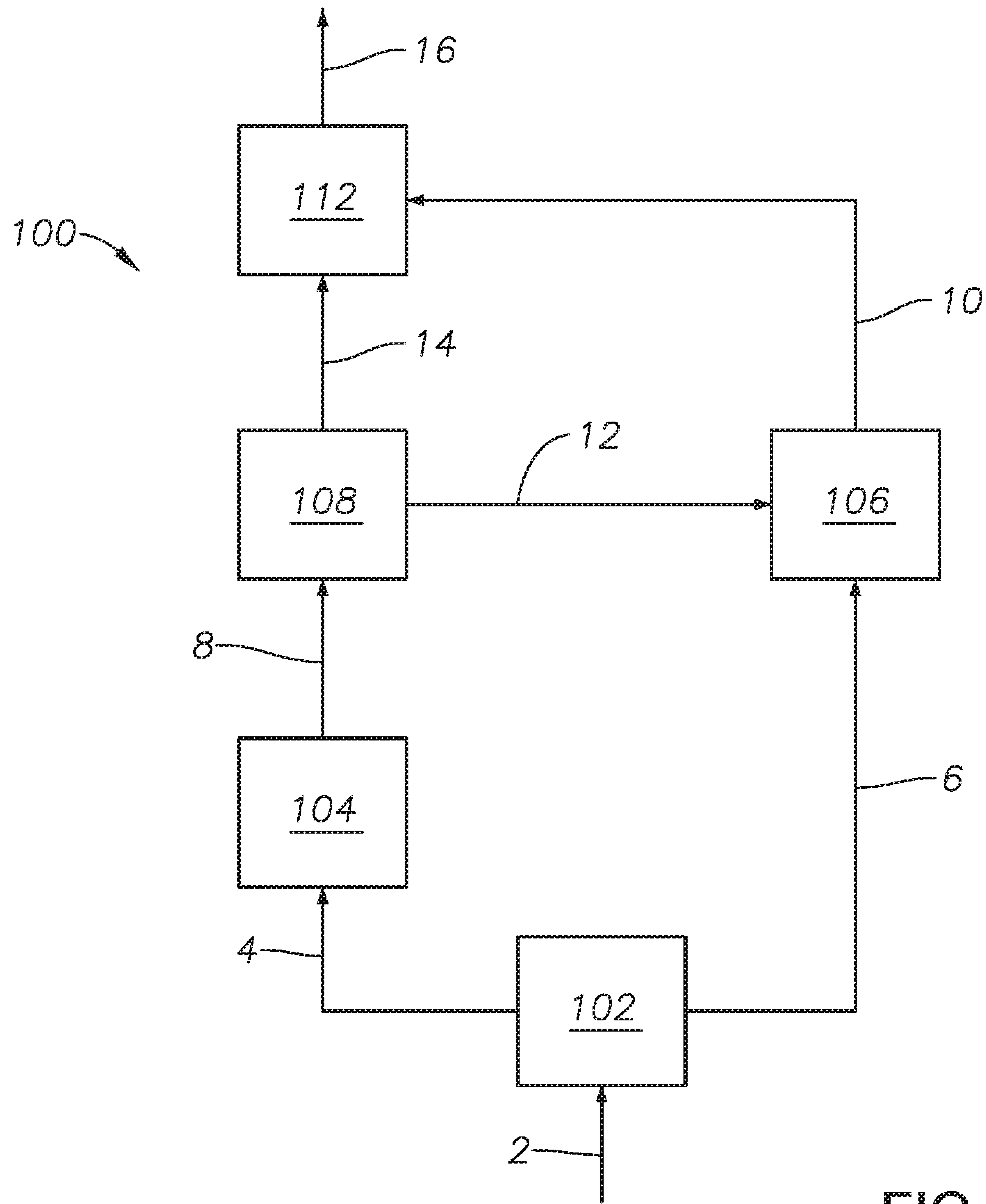

FIG. 2

FLUID DRIVEN COMMINGLING SYSTEM FOR OIL AND GAS APPLICATIONS

RELATED APPLICATION

This application claims priority from U.S. Provisional Application No. 62/141,434, filed on Apr. 1, 2015. For purposes of United States patent practice, this application incorporates the content of the Provisional Application by reference in its entirety.

TECHNICAL FIELD

Described are a system and method for producing a multiphase fluid from a wellbore. More specifically, described are a system and method for extracting energy from a multiphase stream to drive a pressure boosting device.

BACKGROUND

There are a number of oil production operations where the use of downhole electric submersible pumps (ESPs) is necessary to ensure sufficient lift is created to produce a high volume of oil from the well. ESPs are multistage centrifugal pumps having anywhere from ten to hundreds of stages. Each stage of an electric submersible pump includes an impeller and a diffuser. The impeller transfers the shaft's mechanical energy into kinetic energy in the fluid. The diffuser then converts the fluid's kinetic energy into the fluid head or pressure necessary to lift the liquid from the well-bore. As with all fluids, ESPs are designed to run efficiently for a given fluid type, density, viscosity, and an expected amount of free gas.

Free gas, associated gas, or gas entrained in liquid is produced from subterranean formations in both oil production and water production. While ESPs are designed to handle small volumes of entrained gas, the efficiency of an ESP decreases rapidly in the presence of gas. The gas, or gas bubbles, builds up on the low-pressure side of the impeller, which in turn reduces the fluid head generated by the pump. Additionally, the volumetric efficiency of the ESP is reduced because the gas is filling the impeller vanes. At certain volumes of free gas, the pump can experience gas lock, during which the ESP will not generate any fluid head.

Methods to combat problems associated with gas in the use of ESPs can be categorized as gas handling and gas separation and avoidance.

In gas handling techniques, the type of impeller vane used in the stages of the ESP takes into account the expedited free gas volume. ESPs are categorized based on their impeller design as radial flow, mixed flow, and axial flow. In radial flow, the geometry of the impeller vane is more likely to trap gas and therefore it is limited to liquids having less than 10% entrained free gas. In mixed flow impeller stages, the fluid progresses along a more complex flow path, allowing mixed flow pumps to handle up to 25% (45% in some cases) free gas. In axial flow pumps, the flow direction is parallel to the shaft of the pump. The axial flow geometry reduces the opportunity to trap gases in the stages and, therefore, axial pumps can typically handle up to 75% free gas.

Gas separation and avoidance techniques involve separating the free gas from the liquid before the liquid enters the ESP. Separation of the gas from the liquid is achieved by gas separators installed before the pump suction, or by the use of gravity in combination with special completion design, such as shrouds. In most operations, the separated gas is then

produced to the surface through the annulus between the tubing and the casing. In some operations, the gas is produced at the surface through separate tubing. In some operations the gas can be introduced back into the tubing that contains the liquids downstream of the pump discharge. In order to do this, the gas may need to be pressurized to achieve equalization of the pressure between the liquid discharged by the pump and the separated gas. A jet pump can be installed above the discharge of the ESP, the jet pump pulls in the gas. Jet pumps are complex and can have efficiency and reliability issues. In some cases however, the gas cannot be produced through the annulus due to systems used to separate the annulus from fluids in the wellbore.

Non-associated gas production wells can also see multiphase streams. Wet gas wells can have liquid entrained in the gas. As with liquid wells, artificial lift can be used to maintain gas production where the pressure in the formation is reduced. In such situations, downhole gas compressors (DGC) are used to generate the pressure necessary to lift the gas to the surface. DGCs experience problems similar to ESPs, when the liquid entrained in the gas is greater than 10%.

In addition to ESPs and DGCs, equipment at the surface can be used to generate pressure for producing the fluids from the wellbore. Multiphase Pumps (MPPs) and Wet Gas Compressors (WGCs) can be used on oil and gas fields respectively. MPP technologies are costly and complex, and are prone to reliability issues. Current WGC technology requires separation, compression, and pumping, where each compressor and pump requires a separate motor.

SUMMARY

Described are a system and method for producing a multiphase fluid from a wellbore. More specifically, described are a system and method for extracting energy from a multiphase stream to drive a pressure boosting device.

In a first aspect, a fluid management system positioned in a wellbore for recovering a multiphase fluid having a carrier fluid component and an entrained fluid component from the wellbore is provided. The fluid management system includes a downhole separator, the downhole separator configured to produce a carrier fluid and a separated fluid from the multiphase fluid, the carrier fluid having a concentration of the entrained fluid component, the carrier fluid having a carrier fluid pressure, the separated fluid having a separated fluid pressure, an artificial lift device, the artificial lift device fluidly connected to the downhole separator, the artificial lift device configured to increase the carrier fluid pressure to produce a turbine feed stream, the turbine feed stream having a turbine feed pressure, a turbine, the turbine fluidly connected to the artificial lift device, the turbine configured to convert fluid energy in the turbine feed stream to harvested energy, where the conversion in the turbine of fluid energy from the turbine feed stream to harvested energy produces a turbine discharge stream, the turbine discharge stream having a turbine discharge pressure, where the turbine discharge pressure is less than the turbine feed pressure, and a pressure boosting device, the pressure boosting device fluidly connected to the downhole separator and physically connected to the turbine, the pressure boosting device configured to convert the harvested energy to pressurized fluid energy, where conversion of harvested energy to pressurized fluid energy produces a pressurized fluid stream having a pressurized fluid pressure, where the pressurized fluid pressure is greater than the separated fluid pressure.

In certain aspects, the fluid management system further includes a mixer, the mixer fluidly connected to both the artificial lift device and the pressure boosting device, the mixer configured to commingle the turbine discharge stream and the pressurized fluid stream to produce a commingled production stream, the commingled production stream having a production pressure. In certain aspects, the artificial lift device is an electric submersible pump and the pressure boosting device is a compressor. In certain aspects, the artificial lift device is a downhole gas compressor and the pressure boosting device is a submersible pump. In certain aspects, a speed of the turbine is controlled by adjusting a flow rate of the turbine feed stream through the turbine. In certain aspects, the concentration of the entrained fluid component in the carrier fluid is less than 10% by volume. In certain aspects, the multiphase fluid is selected from the group consisting of oil entrained with gas, water entrained with gas, gas entrained with oil, gas entrained with water, and combinations thereof.

In a second aspect, a method for harvesting fluid energy from the turbine feed stream to power a pressure boosting device downhole in a wellbore is provided. The method includes the steps of separating a multiphase fluid, the multiphase fluid having a carrier fluid component and an entrained fluid component, in a downhole separator to generate a carrier fluid and a separated fluid, the carrier fluid having a concentration of the entrained fluid component, the carrier fluid having a carrier fluid pressure, the separated fluid having a separated fluid pressure, feeding the carrier fluid to an artificial lift device, the artificial lift device configured to increase the carrier fluid pressure to create the turbine feed stream, the turbine feed stream having a turbine feed pressure, feeding the turbine feed stream to a turbine, the turbine configured to convert fluid energy in the turbine feed stream to harvested energy, extracting the fluid energy in the turbine feed stream to produce harvested energy, where the extraction of the fluid energy from the turbine feed stream produces a turbine discharge stream, the turbine discharge stream having a turbine discharge pressure, where the turbine discharge pressure is less than the turbine feed pressure, and driving a pressure boosting device with the harvested energy, the pressure boosting device configured to convert the harvested energy to pressurized fluid energy, where the conversion of harvested energy to pressurized fluid energy produces a pressurized fluid stream having a pressurized fluid pressure, where the pressurized fluid pressure is greater than the separated fluid pressure.

In certain aspects, the method further includes the step of mixing the turbine discharge stream and the pressurized fluid stream in a mixer, the mixer configured to commingle the turbine discharge stream and the pressurized fluid stream to produce a commingled production stream, the commingled production stream having a production pressure. In certain aspects, the artificial lift device is an electric submersible pump and the pressure boosting device is a compressor. In certain aspects, the artificial lift device is a downhole gas compressor and the pressure boosting device is a submersible pump. In certain aspects, a speed of the turbine is controlled by adjusting a flow rate of the turbine feed stream through the turbine. In certain aspects, the concentration of the entrained fluid component in the carrier fluid is less than 10% by volume. In certain aspects, the multiphase fluid is selected from the group consisting of oil entrained with gas, water entrained with gas, gas entrained with oil, gas entrained with water, and combinations thereof.

In a third aspect, a method for employing fluid energy from an energized stream to drive a pressure boosting device is provided. The method including the steps of feeding the energized stream to a turbine, the energized stream having an energized pressure, the turbine configured to convert fluid energy in the energized stream to harvested energy, extracting the fluid energy in the energized stream to produce harvested energy, where the extraction of the fluid energy from the energized stream produces a turbine discharge stream, the turbine discharge stream having a turbine discharge pressure, where the turbine discharge pressure is less than the energized pressure, driving a pressure boosting device with the harvested energy, the pressure boosting device configured to convert the harvested energy to pressurized fluid energy, and increasing a pressure of a depressurized stream to generate a pressurized fluid stream, where the conversion of harvested energy to pressurized fluid energy in the turbine increases the pressure of the depressurized stream, the pressurized fluid stream having a pressurized fluid pressure, where the pressurized fluid pressure is greater than the pressure of the depressurized stream.

In certain aspects, the pressure boosting device is a compressor. In certain aspects, the pressure boosting device is a submersible pump. In certain aspects, a speed of the turbine is controlled by adjusting a flow rate of the energized stream through the turbine. In certain aspects, the energized stream is from an energized subterranean region. In certain aspects, the depressurized stream is from a depressurized subterranean region having a zonal pressure less than the energized subterranean region.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages will become better understood with regard to the following descriptions, claims, and accompanying drawings. It is to be noted, however, that the drawings illustrate only several embodiments and are therefore not to be considered limiting of the inventive scope as it can admit to other equally effective embodiments.

FIG. **1** is a flow diagram of an embodiment of the fluid management system.

FIG. **2** is a flow diagram of an embodiment of the fluid management system.

FIG. **3** is a flow diagram of an embodiment of the fluid management system.

DETAILED DESCRIPTION

While the invention will be described with several embodiments, it is understood that one of ordinary skill in the relevant art will appreciate that many examples, variations and alterations to the apparatus and methods described throughout are within the scope and spirit of the invention. Accordingly, the embodiments described throughout are set forth without any loss of generality, and without imposing limitations, on the claimed invention.

A method to produce multiphase fluids from a wellbore that allows for the separation of gases, while minimizing the complexity of the system is desired.

The fluid management system targets artificial lift and production boost either downhole or at the surface. In the example of an oil well producing some gas, a multiphase fluid is separated in a separator into a carrier fluid (a liquid dominated stream) and an entrained fluid (a gas dominated stream). A pump is used to energize the liquid dominated stream. The energized liquid dominated stream is then used to drive a turbine coupled to a compressor. The compressor is used to compress the gas dominated stream. The pump can be sized to provide sufficient power so that the pressure increase in both the liquid dominated stream and the gas dominated stream is sufficient to propel both streams to the surface.

FIG. **1** provides a flow diagram of an embodiment of the fluid management system. Fluid management system **100** is a system for recovering multiphase fluid **2**. Fluid management system **100** is placed downhole in the wellbore to increase the pressure of multiphase fluid **2**, to recover multiphase fluid **2** at the surface. Multiphase fluid **2** is any stream being produced from a subterranean formation containing a carrier fluid component with an entrained fluid component. Examples of carrier fluid components include oil, water, natural gas and combinations thereof. Examples of entrained fluid components include oil, water, natural gas, condensate, and combinations thereof. In at least one embodiment, multiphase fluid **2** is oil with natural gas entrained. In at least one embodiment, multiphase fluid **2** is water with natural gas entrained. In at least one embodiment, multiphase fluid **2** is a combination of oil and water with natural gas entrained. In at least one embodiment, multiphase fluid **2** is natural gas with oil entrained. In at least one embodiment, multiphase fluid **2** is natural gas with condensate entrained. The composition of multiphase fluid **2** depends on the type of subterranean formation. The amount of entrained fluid in multiphase fluid **2** can be between about 5% by volume and about 95% by volume.

Downhole separator **102** of fluid management system **100** receives multiphase fluid **2**. Downhole separator **102** separates multiphase fluid **2** into carrier fluid **4** and separated fluid **6**. Downhole separator **102** is any type of separator capable of separating a stream with multiple phases into two or more streams. Examples of separators suitable for use in the present invention include vapor-liquid separators, equilibrium separators, oil and gas separators, stage separators, knockout vessels, centrifugal separators, mist extractors, and scrubbers. Downhole separator **102** is designed to maintain structural integrity in the wellbore. In at least one embodiment, downhole separator **102** is a centrifugal separator.

Carrier fluid **4** contains the carrier fluid component from multiphase fluid **2**. Examples of fluids that constitute carrier fluid **4** include oil, water, natural gas and combinations thereof. In at least one embodiment, carrier fluid **4** has a concentration of the entrained fluid component. The concentration of the entrained fluid component in carrier fluid **4** depends on the design and operating conditions of downhole separator **102** and the composition of multiphase fluid **2**. The concentration of the entrained fluid component in carrier fluid **4** is between about 1% by volume and about 10% by volume, alternately between about 1% by volume and about 5% by volume, alternately between about 5% by volume and about 10% by volume, and alternately less than 10% by volume. Carrier fluid **4** has a carrier fluid pressure. In at least one embodiment, the pressure of carrier fluid **4** is the pressure of the fluids in the formation.

Separated fluid **6** contains the entrained fluid component from multiphase fluid **2**. Separated fluid **6** is the result of the separation of the entrained fluid component from the carrier fluid component in downhole separator **102**. Examples of fluids that constitute separated fluid **6** includes oil, water, natural gas, condensate, and combinations thereof. Separated fluid **6** contains a concentration of the carrier fluid component. The concentration of the carrier fluid component in separated fluid **6** depends on the design and operating conditions of downhole separator **102** and the composition of multiphase fluid **2**. The concentration of carrier fluid component in separated fluid **6** is between about 1% by volume and about 10% by volume, alternately between about 1% by volume and about 5% by volume, alternately between about 5% by volume and about 10% by volume, and alternately less than 10% by volume. Separated fluid **6** has a separated fluid pressure. In at least one embodiment, the pressure of separated fluid **6** is the pressure of the fluids in the formation.

Carrier fluid **4** is fed to artificial lift device **104**. Artificial lift device **104** is any device that increases the pressure of carrier fluid **4** and maintains structural and operational integrity under the conditions in the wellbore. The type of artificial lift device **104** selected depends on the phase of carrier fluid **4**. Examples of phases include liquid and gas. In at least one embodiment, carrier fluid **4** is a liquid and artificial lift device **104** is an electric submersible pump. In at least one embodiment, carrier fluid **4** is a gas and artificial lift device **104** is a downhole gas compressor. Artificial lift device **104** increases the pressure of carrier fluid **4** to produce turbine feed stream **8**. Turbine feed stream **8** has a turbine feed pressure. The turbine feed pressure is greater than the carrier fluid pressure. Artificial lift device **104** is driven by a motor. Examples of motors suitable for use in the present invention include a submersible electrical induction motor and a permanent magnet motor.

Separated fluid **6** is fed to pressure boosting device **106**. Pressure boosting device **106** is any device that increases the pressure of separated fluid **6** and maintains structural and operational integrity under the conditions in the wellbore. The type of pressure boosting device **106** selected depends on the phase of separated fluid **6**. Examples of phases include liquid and gas. In at least one embodiment, separated fluid **6** is a liquid and pressure boosting device **106** is a submersible pump. In at least one embodiment, separated fluid **6** is a gas and pressure boosting device **106** is a compressor. Pressure boosting device **106** increases the pressure of separated fluid **6** to produce pressurized fluid stream **10**. Pressurized fluid stream **10** has a pressurized fluid pressure. The pressurized fluid pressure is greater than the separated fluid pressure.

Turbine feed stream **8** is fed to turbine **108**. Turbine **108** is any mechanical device that extracts fluid energy (hydraulic power) from a flowing fluid and converts the fluid energy to mechanical energy (rotational mechanical power). Turbine **108** can be a turbine. Examples of turbines suitable for use include hydraulic turbines and gas turbines. The presence of a turbine in the system eliminates the need for more than one motor, which increases the reliability of the system. Turbine **108** converts the fluid energy in turbine feed stream **8** into harvested energy **12**. The speed of turbine **108** is adjustable. In at least one embodiment, changing the pitch of the blades of turbine **108** adjusts the speed of turbine **108**. In at least one embodiment, a bypass line provides control of the flow rate of turbine feed stream **8** entering turbine **108**, which adjusts the speed (rotations per minute or RPMs) of turbine **108**. Changes in the flow rate (volume/unit of time) of a fluid in a fixed pipe results in changes to the velocity (distance/unit of time) of the fluid flowing in the pipe. Thus, changes in the flow rate of turbine feed stream **8** adjusts the velocity of turbine feed stream **8**, which in turn changes the speed of rotation (RPMs) in turbine **108**. In embodiments of the present invention, the fluid management system is in the absence of a gearbox due to the use of a bypass line to control the speed of turbine **108**, the absence of a gearbox reduces the complexity of fluid management system **108** by eliminating an additional mechanical unit.

The conversion of fluid energy from turbine feed stream **8** in turbine **108** reduces the pressure of turbine feed stream

8 and produces turbine discharge stream **14**. Turbine discharge stream **14** has a turbine discharge pressure. The turbine discharge pressure is less than the turbine feed pressure.

Turbine **108** is physically connected to pressure boosting device **106**, such that harvested energy **12** drives pressure boosting device **106**. One of skill in the art will appreciate that a turbine can be connected to a mechanical device through a linkage or a coupling (not shown). The coupling allows harvested energy **12** to be transferred to pressure boosting device **106**, thus driving pressure boosting device **106**. Pressure boosting device **106** operates without the use of an external power source. In at least one embodiment, the only electricity supplied to fluid management system **100** is supplied to artificial lift device **104**. The linkage or coupling can be any link or coupling that transfers harvested energy **12** from turbine **108** to pressure boosting device **106**. Examples of links or couplings include mechanical, hydraulic, and magnetic. Pressure boosting device **106** is in the absence of a motor. The driving force of the pressure boosting device is provided by the turbine.

Artificial lift device **104**, pressure boosting device **106**, and turbine **108** are designed such that the turbine discharge pressure of turbine discharge stream **14** lifts turbine discharge stream **14** to the surface to be recovered and the pressurized fluid pressure of pressurized fluid stream **10** lifts pressurized fluid stream **10** to the surface to be recovered. Artificial lift device **104** is designed to provide fluid energy to turbine feed stream **8** so turbine **108** can generate harvested energy **12** to drive pressure boosting device **106**.

The combination of artificial lift device **104**, pressure boosting device **106**, and turbine **108** can be arranged in series, parallel, or concentrically. Artificial lift device **104** and pressure boosting device **106** are not driven by the same motor. The fluid management system can be modular in design and packaging because the artificial lift device and the pressure boosting device are not driven by the same motor. The fluid management system is in the absence of a dedicated motor for the artificial lift device and a separate dedicated motor for the pressure boosting device.

When conditions downhole allow, the fluid management system is in the absence of any motor used to drive either the artificial lift device or the pressure boosting device. If a well is a strong well, there is enough hydraulic energy and the turbine can be driven by the carrier fluid, such as is shown in FIG. **3**. As used here, "strong well" refers to a well that produces a fluid with enough hydraulic energy to be produced from the formation to the surface without the need for an energizing device and can drive a jet pump. As used here, a "weak well" refers to a well that produces a fluid that does not have enough hydraulic energy to be produced from the formation to the surface and thus requires the an energizing device, such as a jet pump.

Incorporating those elements described with reference to FIG. **1**, FIG. **2** provides an embodiment. Turbine discharge stream **14** and pressurized fluid stream **10** are mixed in mixer **112** to produce commingled production stream **16**. Commingled production stream **16** has a production pressure. Mixer **112** is any mixing device that commingles turbine discharge stream **14** and pressurized fluid stream **10** in a manner that produces commingled production stream **16** at the surface. In at least one embodiment, mixer **112** is a pipe joint connecting turbine discharge stream **14** and pressurized fluid stream **10**. In at least one embodiment, commingled product stream **16** is not fully mixed. In at least one embodiment, artificial lift device **104**, pressure boosting device **106**, and turbine **108** are designed so that the production pressure of commingled production stream **16** lifts commingled production stream **16** to the surface to be recovered. In at least one embodiment, the pressurized fluid pressure and the turbine discharge pressure allow the pressurized fluid stream **10** and turbine discharge stream **14** to be commingled in mixer **112**.

In at least one embodiment, artificial lift device **104** and pressure boosting device **106** are contained in the same production pipeline or production tubing. In an alternate embodiment, artificial lift device **104** is contained in a separate production line from pressure boosting device **106**.

In at least one embodiment, fluid management system **100** includes sensors to measure system parameters. Examples of system parameters include flow rate, pressure, temperature, and density. The sensors enable process control schemes to control the process. Process control systems can be local involving preprogrammed control schemes within fluid management system **100**, or can be remote involving wired or wireless communication with fluid management system **100**. Process control schemes can be mechanical, electronic, or hydraulically driven.

Referring to FIG. **3**, an embodiment of fluid management system **100** is provided. Energized stream **20** is received by turbine **108**. Energized stream **20** is any stream having sufficient pressure to reach the surface from the wellbore. Energized stream **20** has an energized pressure. In at least one embodiment, energized stream **20** is from an energized subterranean region, the pressure of the energized subterranean region providing the lift for energized stream **20** to reach the surface. In an alternate embodiment, energized stream **20** is downstream of a device to increase pressure. Turbine **108** produces harvested energy **12** which drives pressure boosting device **106** as described with reference to FIG. **1**.

Pressure boosting device **106** increases the pressure of depressurized stream **22** to produce pressurized fluid stream **10**. Depressurized stream **22** is any stream that does not have sufficient pressure to reach the surface from the wellbore. In at least one embodiment, depressurized stream **22** is from a depressurized subterranean region, the zonal pressure of the depressurized subterranean region being less than the energized subterranean region.

In certain embodiments, energized stream **20** is produced by a strong well and can be used to drive turbine **108**, which drives pressure boosting device **106** to increase the pressure of depressurized stream **22** which is produced by a weak well. In embodiments where the fluid management system is used to produce fluids from separate wells, for example where a fluid from a strong well is used to produce a fluid from a weak well, the fluid management system will be located on a surface.

Fluid management system **100** can include one or more packers installed in the wellbore. The packer can be used to separate fluids in the wellbore, isolate fluids in the wellbore, or redirect fluids to the different devices in the system.

In at least one embodiment, fluid management system **100** can be located at a surface to recover multiphase fluid **2**. Examples of surfaces includes dry land, the sea floor, and the sea surface (on a platform). When fluid management system **100** is located at a surface, fluid management system **100** is in the absence of a packer. A fluid management system located a surface can be used to boost the pressure of fluids in the same well or from neighboring (adjacent) wells. A fluid management system located downhole can be used to boost the pressure of fluids in the same well.

In at least one embodiment, fluid management system **100** is in the absence of a jet pump. The combination of turbine and compressor in fluid management system **100** has a higher efficiency that a jet pump.

In at least one embodiment, fluid management system **100** is in the absence of reinjecting into the wellbore or reservoir any portion of turbine discharge stream **14**, pressurized fluid **10**, or commingled production stream **16**.

Although embodiments of the present invention have been described in detail, it should be understood that various changes, substitutions, and alterations can be made without departing from the principle and scope of the invention. Accordingly, the scope of the present invention should be determined by the following claims and their appropriate legal equivalents.

The singular forms "a," "an," and "the" include plural referents, unless the context clearly dictates otherwise.

"Optional" or "optionally" means that the subsequently described event or circumstances can or may not occur. The description includes instances where the event or circumstance occurs and instances where it does not occur.

Ranges may be expressed as from about one particular value to about another particular value. When such a range is expressed, it is to be understood that another embodiment is from the one particular value and/or to the other particular value, along with all combinations within said range.

Throughout this application, where patents or publications are referenced, the disclosures of these references in their entireties are intended to be incorporated by reference into this application, in order to more fully describe the state of the art to which the invention pertains, except when these references contradict the statements made here.

As used throughout and in the appended claims, the words "comprise," "has," and "include" and all grammatical variations thereof are each intended to have an open, non-limiting meaning that does not exclude additional elements or steps.

As used throughout, terms such as "first" and "second" are arbitrarily assigned and are merely intended to differentiate between two or more components of an apparatus. It is to be understood that the words "first" and "second" serve no other purpose and are not part of the name or description of the component, nor do they necessarily define a relative location or position of the component. Furthermore, it is to be understood that that the mere use of the term "first" and "second" does not require that there be any "third" component, although that possibility is contemplated under the scope of the present invention.

What is claimed is:

1. A method for harvesting fluid energy from a turbine feed stream to power a pressure boosting device downhole in a wellbore, the method comprising the steps of:

separating a multiphase fluid, the multiphase fluid having a carrier fluid component and an entrained fluid component, in a downhole separator to generate a carrier fluid and a separated fluid, the carrier fluid having a concentration of the entrained fluid component, the carrier fluid having a carrier fluid pressure, the separated fluid having a separated fluid pressure;

feeding the carrier fluid to an artificial lift device, the artificial lift device configured to increase the carrier fluid pressure to create the turbine feed stream, the turbine feed stream having a turbine feed pressure;

feeding the turbine feed stream to a turbine, the turbine configured to convert fluid energy in the turbine feed stream to harvested energy;

extracting the fluid energy in the turbine feed stream to produce harvested energy,

wherein extraction of the fluid energy from the turbine feed stream produces a turbine discharge stream, the turbine discharge stream having a turbine discharge pressure,

wherein the turbine discharge pressure is less than the turbine feed pressure; and

driving a pressure boosting device with the harvested energy, the pressure boosting device configured to convert the harvested energy to pressurized fluid energy,

wherein conversion of harvested energy to pressurized fluid energy produces a pressurized fluid stream having a pressurized fluid pressure,

wherein the pressurized fluid pressure is greater than the separated fluid pressure.

2. The method of claim **1**, further comprising the step of:

mixing the turbine discharge stream and the pressurized fluid stream in a mixer, the mixer configured to commingle the turbine discharge stream and the pressurized fluid stream to produce a commingled production stream, the commingled production stream having a production pressure.

3. The method of claim **1**, wherein the artificial lift device is an electric submersible pump and the pressure boosting device is a compressor.

4. The method of claim **1**, wherein the artificial lift device is a downhole gas compressor and the pressure boosting device is a submersible pump.

5. The method of claim **1**, wherein the concentration of the entrained fluid component in the carrier fluid is between 1% by volume and 10% by volume.

6. The method of claim **1**, wherein the multiphase fluid is selected from the group consisting of oil entrained with gas, water entrained with gas, gas entrained with oil, gas entrained with water, and combinations thereof.

7. A method for employing fluid energy from an energized stream to drive a pressure boosting device, the method comprising the steps of:

feeding the energized stream to a turbine, the energized stream having an energized pressure, the turbine configured to convert fluid energy in the energized stream to harvested energy, wherein the energized stream is from an energized subterranean region;

extracting the fluid energy in the energized stream to produce harvested energy,

wherein extraction of the fluid energy from the energized stream produces a turbine discharge stream, the turbine discharge stream having a turbine discharge pressure,

wherein the turbine discharge pressure is less than the energized pressure;

driving the pressure boosting device with the harvested energy, the pressure boosting device configured to convert the harvested energy to pressurized fluid energy; and

increasing a pressure of a depressurized stream to generate a pressurized fluid stream,

wherein the depressurized stream is from a depressurized subterranean region having a zonal pressure less than the energized subterranean region,

wherein conversion of harvested energy to pressurized fluid energy in the turbine increases the pressure of the depressurized stream, the pressurized fluid stream having a pressurized fluid pressure,

wherein the pressurized fluid pressure is greater than the pressure of the depressurized stream.

8. The method of claim **7**, wherein the pressure boosting device is a compressor.

9. The method of claim **7**, wherein the pressure boosting device is a submersible pump.

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