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(54) USE OF EDUCTOR FOR LIQUID DISPOSAL FROM VESSEL

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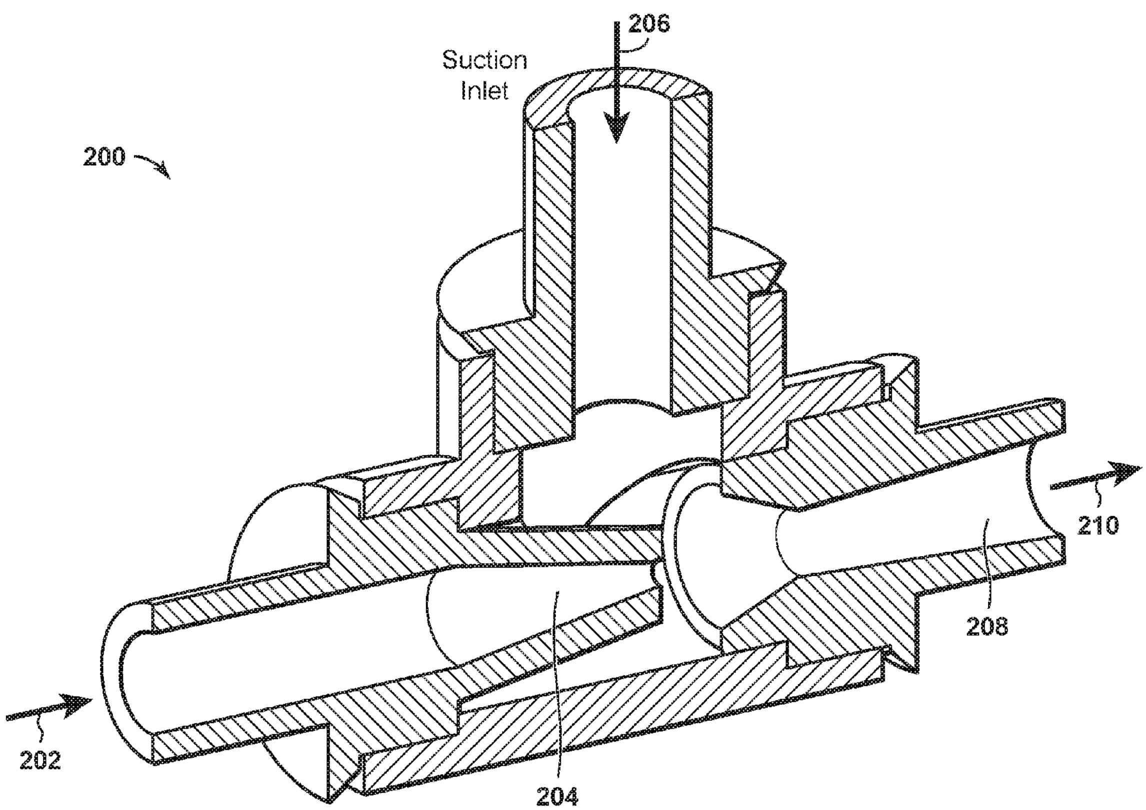
(57) **ABSTRACT**

A system for the processing of a hydrocarbon flare gas. An input gas stream contains a gas component and a liquid component. A knock-out drum separates the gas component from the liquid component. An eductor has a motive inlet, a suction inlet, and a discharge outlet. The separated liquid component is introduced into the suction inlet of the eductor. A high-pressure gas stream is introduced into the motive inlet of the eductor. The high-pressure gas stream has a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.



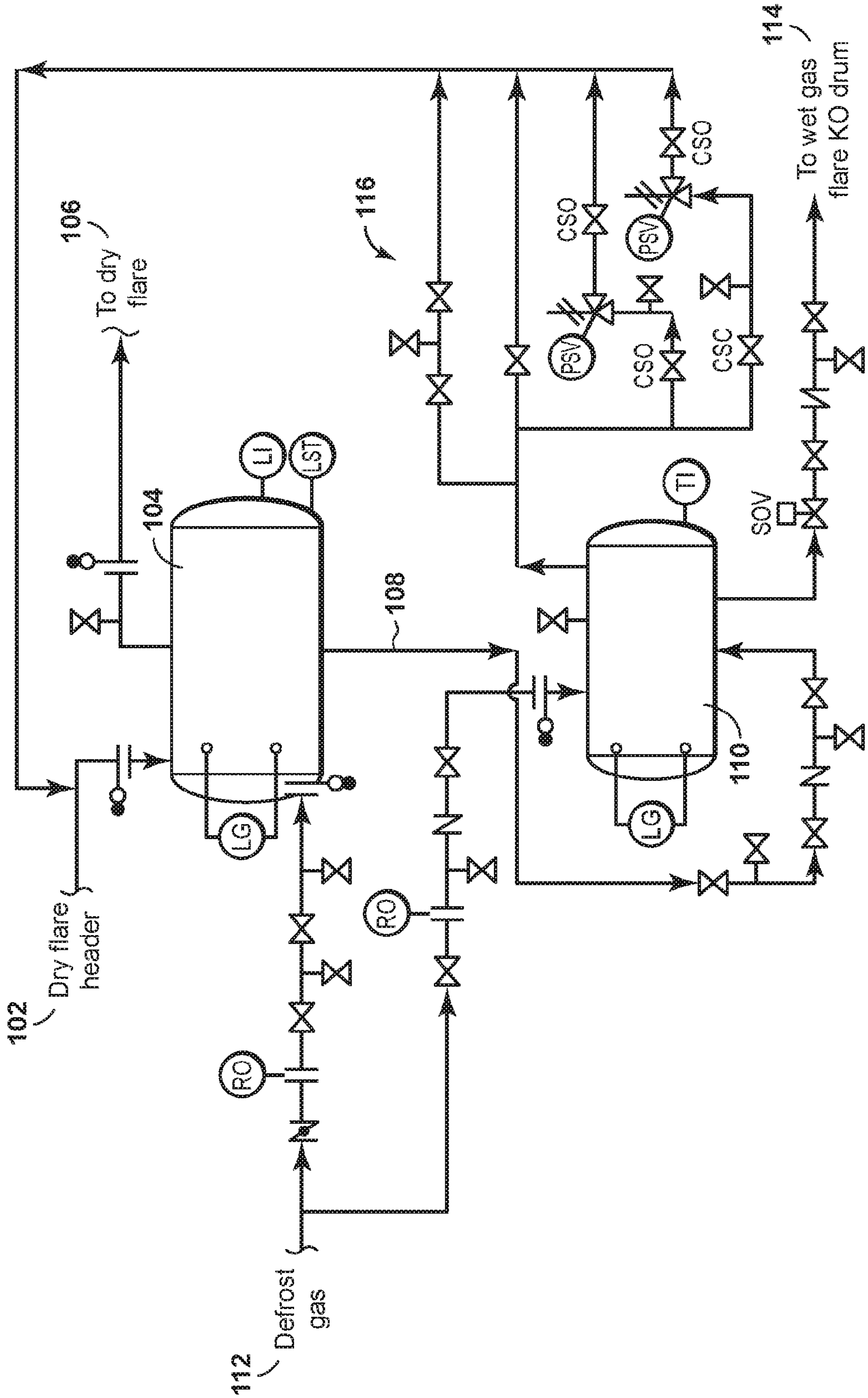


FIG. 1
(Prior Art)

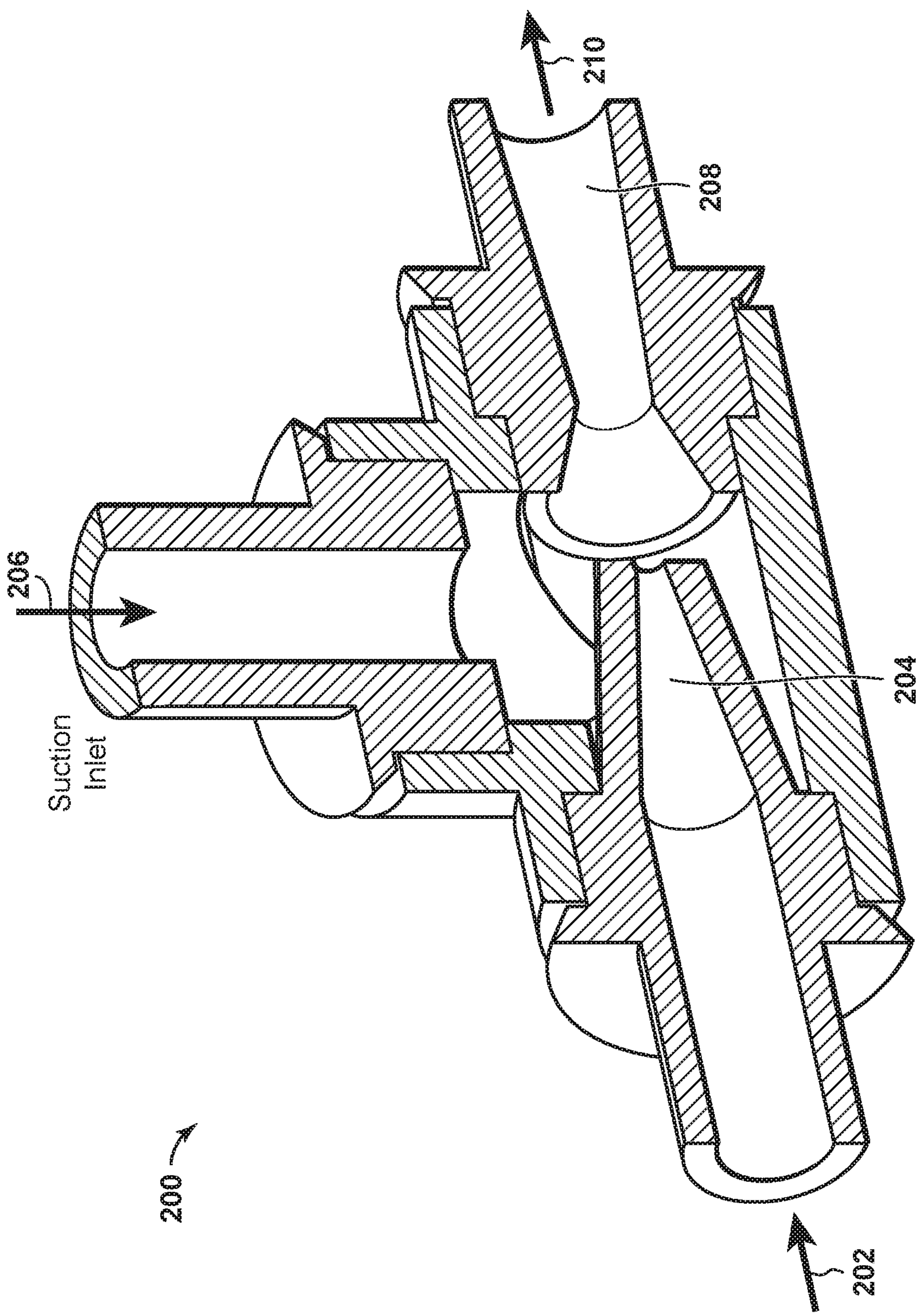


FIG. 2

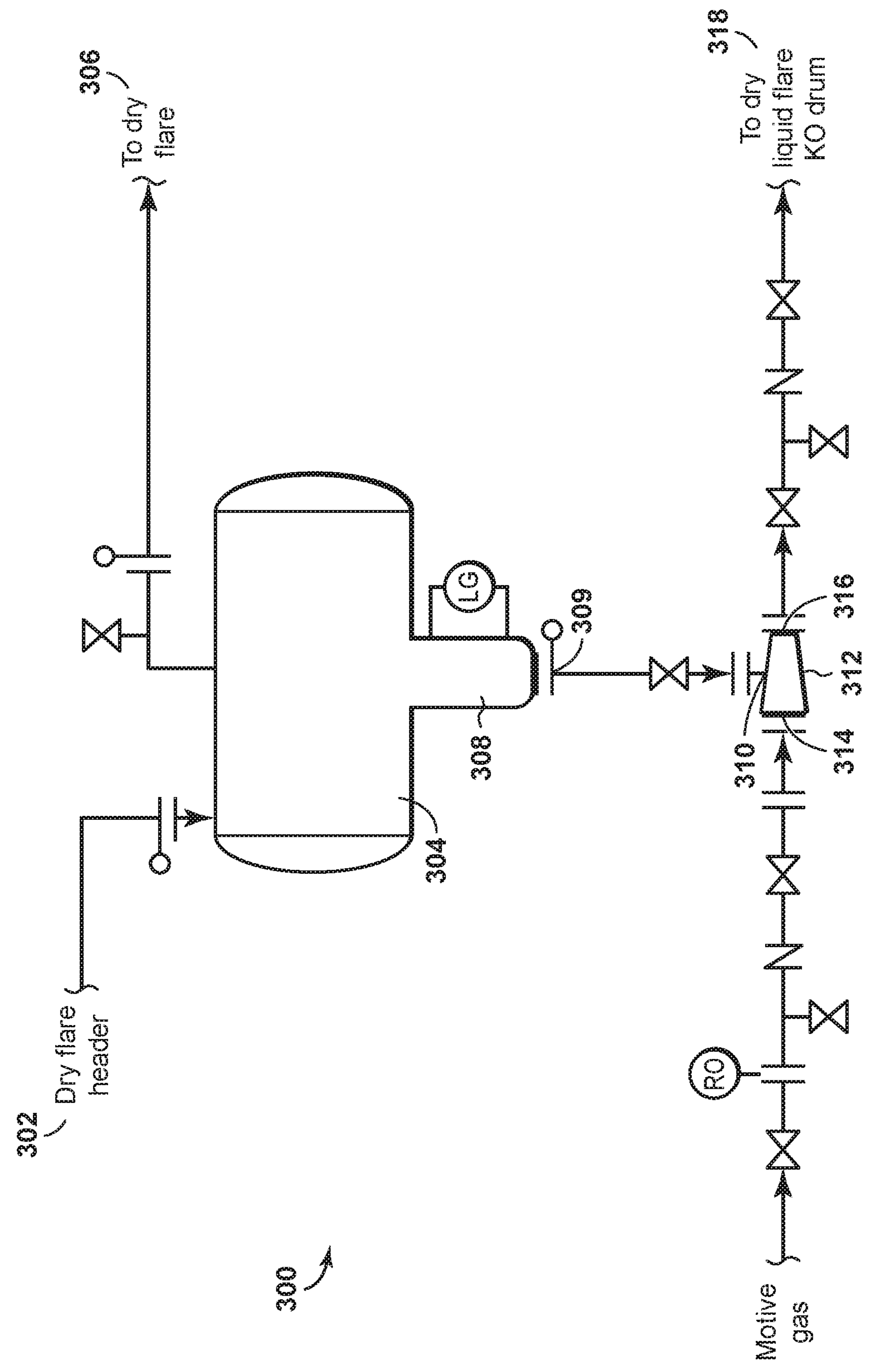

306
To dry
flare
318
To dry
liquid flare
KO drum
LG
309
316
312
308
310
314
304
302
Dry flare
header
RO
300
Motive
gas

FIG. 3

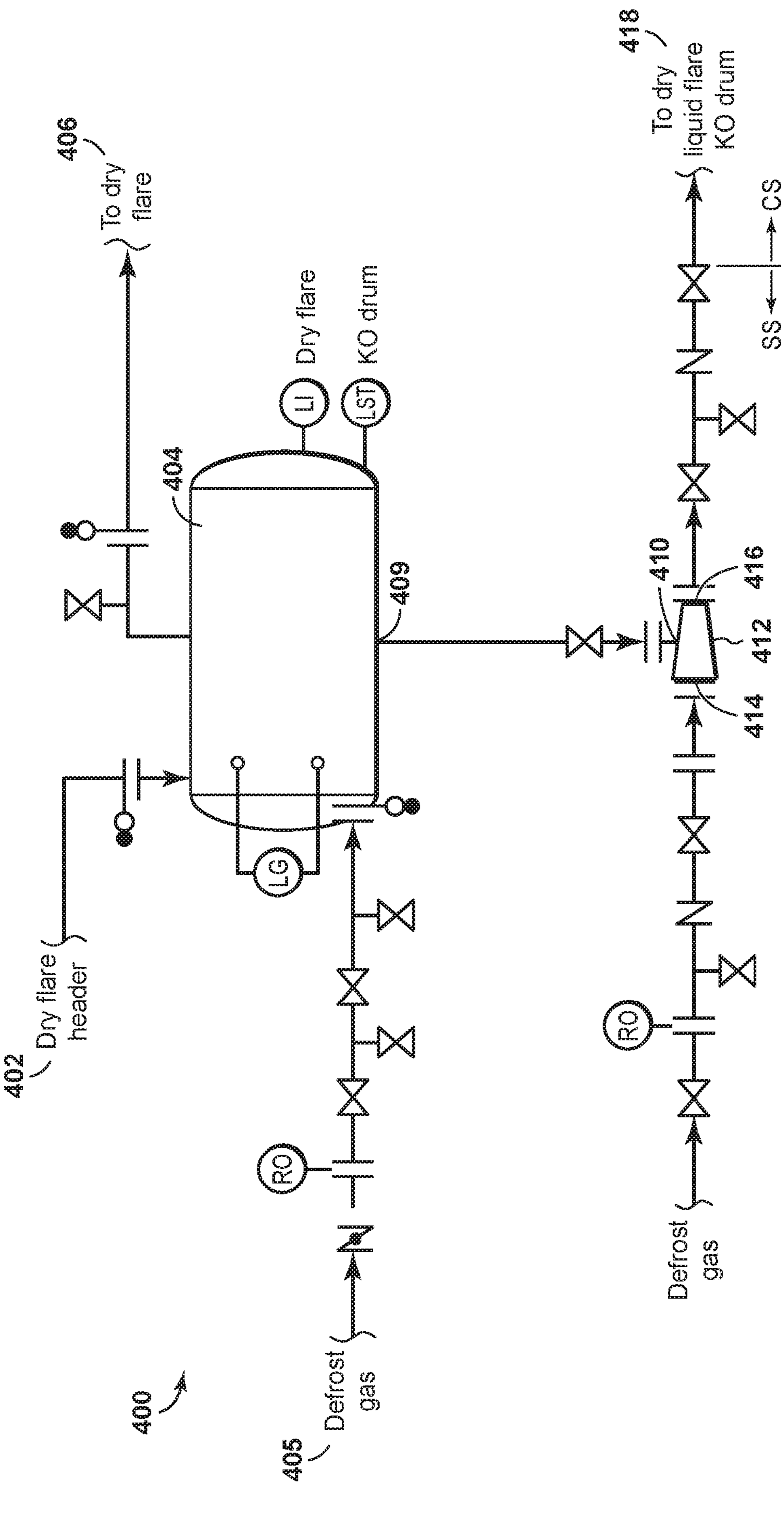

400
402
Dry flare header
404
406
To dry flare
LI
LST
Dry flare KO drum
LG
RO
405
Defrost gas
409
410
412
414
416
RO
Defrost gas
418
To dry liquid flare KO drum
SS
CS

FIG. 4

USE OF EDUCTOR FOR LIQUID DISPOSAL FROM VESSEL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of both U.S. Provisional Patent Application No. 62/422,690, filed Nov. 16, 2016 entitled USE OF EDUCTOR FOR LIQUID DISPOSAL FROM VESSEL and U.S. Provisional Patent Application No. 62/262,629, filed Dec. 3, 2015 entitled USE OF EDUCTOR FOR LIQUID DISPOSAL FROM VESSEL, the entirety of which is incorporated by reference herein.

BACKGROUND

[0002] Field of Disclosure

[0003] The disclosure relates generally to hydrocarbon processing, and more particularly, to methods and systems to remove liquids from a vessel.

[0004] Description of Related Art

[0005] This section is intended to introduce various aspects of the art, which may be associated with the present disclosure. This discussion is intended to provide a framework to facilitate a better understanding of particular aspects of the present disclosure. Accordingly, it should be understood that this section should be read in this light, and not necessarily as an admission of prior art.

[0006] Conventional flare systems used in upstream hydrocarbon processes where cryogenic or cold hydrocarbon liquids are processed require multiple flares to accommodate wet and dry streams. Due to pressure and temperature reduction from a high pressure source to a lower pressure source—a process known as flashing—flared gas streams often contain liquids which have been condensed from fluids which have vented, blown-down, or relieved into the flare piping system. The flare piping system, which may be called a flare header, collects all vented, blown-down, or relieved streams and routes these fluid streams through the flare header and into a flare knock-out drum. The flare knock-out drum separates gas from liquids which as described above may have condensed in the gas stream, and routes the separated gas to a flare for combustion of any contained hydrocarbons, with the resultant combustion products emitted to the atmosphere. The liquids separated in the knock-out drum may collect and require disposal to ensure there is no liquid carryover into the gas stream leaving the flare knockout drum. Such liquid carry-over could cause slugging and unstable flare operation, excessive heat radiation from combustion, or even snuffing out of the flare flame which would result in not combusting the contained hydrocarbons.

[0007] There are several methods of disposing of such liquids accumulated within a flare knock-out drum. One method is to insert heating coils into the system to boil off or vaporize the liquids (if all hydrocarbon with no water), but the heating coils would require maintenance and additional operating cost. A pumping system may be used to pump such liquids to a suitable disposal location. However, the flare knock-out drum normally operates at a very low pressure and usually does not provide the suction pressure, known as the net positive suction head or NPSH, for pumping. A typical pumping system therefore requires the flare knock-out drum to be elevated to create the required NPSH. This elevation of the flare knock-out drum, the pumps, and the piping, valves, and controls systems for these pumps represent additional cost.

[0008] FIG. **1** depicts part of a gas processing system **100** suitable for use with cryogenic liquids. System **100** includes a flare piping system or flare header **102**, which as previously described collects all vented, blown-down, or relieved streams and routes these fluid streams through the flare header **102** and into a flare knock-out drum **104**. The flare knock-out drum **104** separates gas from liquids and routes the separated gas to a flare **106** for combustion of any contained hydrocarbons. The liquids separated in the knock-out drum **104** are sent via a liquids stream **108** to a blow-case vessel **110**. To function properly, the blow-case vessel **110** requires a higher pressure gas stream and associated piping and valves. Therefore, the liquids stream **108** is pressurized with a dehydrated, higher pressure gas stream, which in FIG. **1** may be a defrost gas **112**, and then evacuated via a pressure driving force to a downstream drum **114** which may contain other liquefied condensed hydrocarbons and/or water. The liquids in the downstream drum **114** are then disposed via pumping to a suitable destination that is designed to handle such fluids. Separated gases in the blow-case vessel may be sent to another knock-out drum (not shown) for further processing and flaring, or alternatively the separated gases may be returned to the dry flare header using a series of valves and piping **116** configured to reduce the gas pressure to a level suitable for use in the flare knock-out drum **104**. The use of the blow-case vessel **110** represents a significant increase in cost and maintenance because of the amount of high-pressure valves and piping **116** needed to compensate for the difference between the operating pressures of the flare knock-out drum **104** and the blow-case vessel **110**. What is needed is a method of disposing of the liquids from a flare knock-out drum that reduces the installation and maintenance costs of a flare system.

SUMMARY

[0009] The present disclosure provides a system for the processing of a hydrocarbon flare gas. An input gas stream contains a gas component and a liquid component. A knock-out drum separates the gas component from the liquid component. An eductor has a motive inlet, a suction inlet, and a discharge outlet. The separated liquid component is introduced into the suction inlet of the eductor. A high-pressure gas stream is introduced into the motive inlet of the eductor. The high-pressure gas stream has a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.

[0010] The present disclosure also provides a cryogenic or cold gas processing system. An input gas stream contains a gas component and a liquid component. A knock-out drum separates the gas component from the liquid component. The knock-out drum has a fluid outlet through which the separated liquid component exits the knock-out drum. A flare flares the gas component of the input gas stream after the liquid component has been separated therefrom in the knock-out drum. An eductor has a motive inlet, a suction inlet, and a discharge outlet. The separated liquid component is introduced from the fluid outlet to the suction inlet of the eductor. A high-pressure gas stream is introduced into the motive inlet of the eductor. The high-pressure gas stream has a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.

[0011] The foregoing has broadly outlined the features of the present disclosure so that the detailed description that follows may be better understood. Additional features will also be described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and other features, aspects and advantages of the disclosure will become apparent from the following description, appending claims and the accompanying drawings, which are briefly described below.

[0013] FIG. **1** is a schematic diagram of a gas processing system according to known principles.

[0014] FIG. **2** is a cutaway view of an eductor that may be used with the disclosed aspects.

[0015] FIG. **3** is a schematic diagram of a gas processing system according to disclosed aspects.

[0016] FIG. **4** is a schematic diagram of a gas processing system according to disclosed aspects.

[0017] It should be noted that the figures are merely examples and no limitations on the scope of the present disclosure are intended thereby. Further, the figures are generally not drawn to scale, but are drafted for purposes of convenience and clarity in illustrating various aspects of the disclosure.

DETAILED DESCRIPTION

[0018] To promote an understanding of the principles of the disclosure, reference will now be made to the features illustrated in the drawings. The specific language used herein is not intended to limit the scope of the disclosure. Any alterations and further modifications, and any further applications of the principles of the disclosure as described herein, are contemplated as would normally occur to one skilled in the art to which the disclosure relates. For the sake of clarity, some features not relevant to the present disclosure may not be shown in the drawings.

[0019] At the outset, for ease of reference, certain terms used in this application and their meanings as used in this context are set forth. To the extent a term used herein is not defined below, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Further, the present techniques are not limited by the usage of the terms shown below, as all equivalents, synonyms, new developments, and terms or techniques that serve the same or a similar purpose are considered to be within the scope of the present claims.

[0020] As one of ordinary skill would appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name only. The figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in schematic form and some details of conventional elements may not be shown in the interest of clarity and conciseness. When referring to the figures described herein, the same reference numerals may be referenced in multiple figures for the sake of simplicity. In the following description and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus, should be interpreted to mean "including, but not limited to."

[0021] The articles "the," "a" and "an" are not necessarily limited to mean only one, but rather are inclusive and open ended so as to include, optionally, multiple such elements.

[0022] As used herein, the terms "approximately," "about," "substantially," and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numeral ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and are considered to be within the scope of the disclosure.

[0023] Aspects provided herein are based on replacement of the blow-case system, internal heating coils, and/or pumping system of a traditional cryogenic or cold gas processing system, and instead using an eductor and a motive, higher pressure gas stream to evacuate the liquids collected within the flare knock-out drum. As shown in FIG. **2**, an eductor **200** (commonly called a jet-pump) is a type of pump where the energy from one fluid is transferred to another fluid via a venturi effect. This principle is based on Bernoulli's law where there is a transfer of kinetic energy to potential energy. As the motive fluid **202** passes through a tapered jet nozzle **204**, kinetic energy of the motive fluid increases and its pressure is reduced, thereby drawing fluid from the suction inlet **206** into the venturi diffuser **208** and through the discharge outlet **210**.

[0024] As can be seen, the eductor **200** is a very simple type of device with no moving parts. FIG. **3** depicts one implementation of the use of an eductor to dispose of liquid from the sump of a flare knock-out drum or other vessel in a cryogenic or cold gas processing system **300**. As shown in FIG. **3**, system **300** includes a dry flare header **302**, which as previously described collects all vented, blown-down, or relieved streams, and routes these fluid streams through the flare header **302** and into a dry flare knock-out drum **304**. The dry flare knock-out drum **304** separates gas from liquids and routes the separated gas to a dry flare **306** for combustion of any contained hydrocarbons. The liquids separated in the dry flare knock-out drum **304** collect in a boot or sump **308**, which is connected to the suction inlet **310** of an eductor **312**. Alternatively, no sump or boot is employed in the knock-out drum, and the separated liquids exit the knock-out drum **304** through a fluid outlet **309**. The gas input to the motive inlet **314** of the eductor **312** is a motive gas, which in some aspects may be a light hydrocarbon-containing gas stream. The motive gas may be provided at a pressure of about 100 psig, or at a different pressure that is higher than the pressure in the dry flare knock-out drum **304**. The pressure within the dry flare knock-out drum **304** is just above atmospheric pressure, and may be between 1-2 psig. As with known liquid disposal practices, a positive pressure is maintained within the dry flare knock-out drum via flare header purge gas to prevent ingress of oxygen from flange leakage when the eductor is being used. The difference in pressure between the motive gas and the dry flare knock-out drum **304** causes liquid to be drawn from the sump **308**, into suction inlet **310**, and out of the discharge outlet **316** of the eductor **312** combined with the motive gas. The discharge outlet **316** may be connected to a dry liquid flare knock-out drum **318**, where the liquids and gases may be separated according to known principles.

[0025] FIG. **4** depicts another implementation of the use of an eductor to dispose of liquid from the sump of a flare knock-out drum or other vessel in a cryogenic or cold gas processing system **400**. As shown in FIG. **4**, system **400** includes a dry flare header **402**, which as previously described collects all vented, blown-down, or relieved streams, and routes these fluid streams through the flare header **402** and into a dry flare knock-out drum **404**. A defrost gas **405** is introduced into the dry flare knock-out drum **404** to warm up and vaporize light liquefied petroleum gas (LPG) liquids. The dry flare knock-out drum **404** separates gas from liquids and routes the separated gas, including the vaporized LPG liquids, to a dry flare **406** for combustion of any contained hydrocarbons. The separated liquids exit the dry-flare knock-out drum **404** through a fluid outlet **409**, which is connected to the suction inlet **410** of an eductor **412**. The gas input to the motive inlet **414** of the eductor **412** may be a motive gas as shown in FIG. **3**, or alternatively may be a defrost gas. The defrost gas may be provided at a pressure of about 100 psig, or at a different pressure that is higher than the pressure in the dry flare knock-out drum **404**. The pressure within the dry flare knock-out drum **404** is just above atmospheric pressure, and may be between 1-2 psig. As with known liquid disposal practices, a positive pressure is maintained within the dry flare knock-out drum via flare header purge gas to prevent ingress of oxygen from flange leakage when the eductor is being used. The difference in pressure between the defrost gas and the dry flare knock-out drum **404** causes liquid to be drawn through the from the fluid outlet **409**, into suction inlet **410**, and out of the discharge outlet **416** of the eductor **412** combined with the defrost gas. The discharge outlet **416** may be connected to a dry liquid flare knock-out drum **418**, where the liquids and gases may be separated according to known principles.

[0026] The disclosed aspect of using an eductor to evacuate liquids from a flare knock-out drum enables the elimination of a substantial number of components, as demonstrated by a side-by-side comparison of FIGS. **1** and **3**. This reduction in components offers the benefits of lower capital investment cost and essentially no maintenance cost when compared to the conventional liquid disposal systems used in the industry currently.

[0027] Disclosed aspects may include any combinations of the methods and systems shown in the following numbered paragraphs. This is not to be considered a complete listing of all possible aspects, as any number of variations can be envisioned from the description above.

[0028] 1. A system for the processing of a hydrocarbon flare gas, comprising:

[0029] an input gas stream containing a gas component and a liquid component;

[0030] a knock-out drum that separates the gas component from the liquid component;

[0031] an eductor having a motive inlet, a suction inlet, and a discharge outlet;

[0032] wherein the separated liquid component is introduced into the suction inlet of the eductor; and

[0033] a high-pressure gas stream introduced into the motive inlet of the eductor, the high-pressure gas stream having a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.

[0034] 2. The system of paragraph 1, wherein the knock-out drum has a sump, and wherein the separated liquid component is drawn from the boot or sump to the suction inlet of the eductor.

[0035] 3. The system of paragraph 1 or 2, wherein the high-pressure gas stream is a defrost gas stream.

[0036] 4. The system of any of paragraphs 1-3, wherein the high-pressure gas stream has a pressure of about 100 psig and the input gas stream has a pressure between 1-2 psig.

[0037] 5. The system of any of paragraphs 1-4, further comprising a dry flare that flares the gas component of the input gas stream after the liquid component has been separated therefrom in the knock-out drum.

[0038] 6. A cryogenic or cold gas processing system, comprising:

[0039] an input gas stream containing a gas component and a liquid component;

[0040] a knock-out drum that separates the gas component from the liquid component, the knock-out drum having a fluid outlet through which the separated liquid component exits the knock-out drum;

[0041] a flare that flares the gas component of the input gas stream after the liquid component has been separated therefrom in the knock-out drum;

[0042] an eductor having a motive inlet, a suction inlet, and a discharge outlet;

[0043] wherein the separated liquid component is introduced from the fluid outlet to the suction inlet of the eductor; and

[0044] a high-pressure gas stream introduced into the motive inlet of the eductor, the high-pressure gas stream having a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.

[0045] 7. The system of paragraph 6, wherein the high-pressure gas stream is a defrost gas stream.

[0046] 8. The system of paragraph 6 or 7, wherein the high-pressure gas stream has a pressure of about 100 psig and the input gas stream has a pressure between 1-2 psig.

[0047] While the disclosed aspects have been described in connection with the removal of liquids from a dry flare knock-out drum, it is possible to use the eductor to assist in the removal of liquids from other types of vessels.

[0048] It should be understood that the numerous changes, modifications, and alternatives to the preceding disclosure can be made without departing from the scope of the disclosure. The preceding description, therefore, is not meant to limit the scope of the disclosure. Rather, the scope of the disclosure is to be determined only by the appended claims and their equivalents. It is also contemplated that structures and features in the present examples can be altered, rearranged, substituted, deleted, duplicated, combined, or added to each other.

What is claimed is:

1. A system for the processing of a hydrocarbon flare gas, comprising:

an input gas stream containing a gas component and a liquid component;

a knock-out drum that separates the gas component from the liquid component;

an eductor having a motive inlet, a suction inlet, and a discharge outlet;

wherein the separated liquid component is introduced into the suction inlet of the eductor; and

a high-pressure gas stream introduced into the motive inlet of the eductor, the high-pressure gas stream having a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.

2. The system of claim **1**, wherein the knock-out drum has a boot or sump, and wherein the separated liquid component is drawn from the boot or sump to the suction inlet of the eductor.

3. The system of claim **1**, wherein the high-pressure gas stream is a defrost gas stream.

4. The system of claim **1**, wherein the high-pressure gas stream has a pressure of about 100 psig and the input gas stream has a pressure between 1-2 psig.

5. The system of claim **1**, further comprising a dry flare that flares the gas component of the input gas stream after the liquid component has been separated therefrom in the knock-out drum.

6. A cryogenic or cold gas processing system, comprising:

an input gas stream containing a gas component and a liquid component;

a knock-out drum that separates the gas component from the liquid component, the knock-out drum having a fluid outlet through which the separated liquid component exits the knock-out drum;

a flare that flares the gas component of the input gas stream after the liquid component has been separated therefrom in the knock-out drum;

an eductor having a motive inlet, a suction inlet, and a discharge outlet;

wherein the separated liquid component is introduced from the fluid outlet to the suction inlet of the eductor; and

a high-pressure gas stream introduced into the motive inlet of the eductor, the high-pressure gas stream having a pressure sufficient to draw the separated liquid component from the knock-out drum and through the discharge outlet.

7. The system of claim **6**, wherein the high-pressure gas stream is a defrost gas stream.

8. The system of claim **6**, wherein the high-pressure gas stream has a pressure of about 100 psig and the input gas stream has a pressure between 1-2 psig.

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