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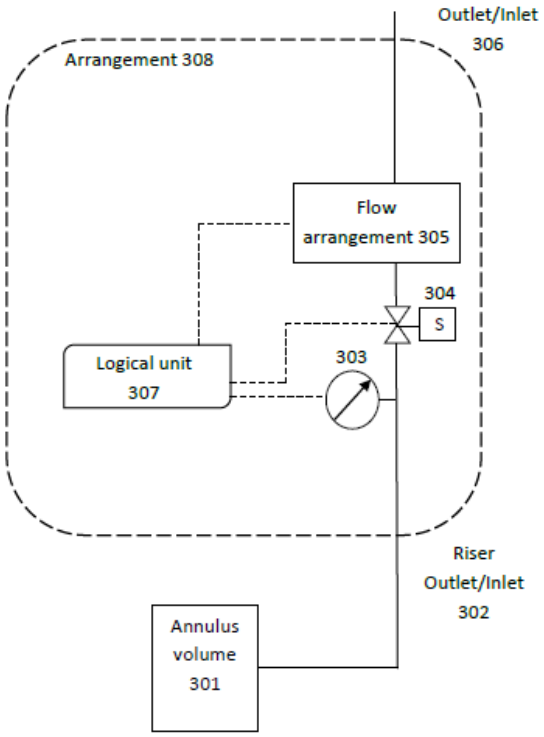
(56) References Cited:
WO 2014/000760 A1
Gregoire Adouin et al. “Flexible pipe integrity monitoring: A new system to assess the flexible pipe annulus condition”, Proceedings of Offshore Technology Conference, 20100503-20100506
WO 2010151144 A1, WO 2010036792 A2, WO 2009094630 A1

(57) Abstract

The present invention is related to integrity monitoring of an annulus free volume in a flexible pipe. More specifically, the invention is related to a portable arrangement for automatic determination of the annulus free volume of a flexible pipe.



PORTABLE ARRANGEMENT FOR AUTOMATICAL ANNULUS TESTING

TECHNICAL AREA

The present invention is a portable arrangement for automatically annulus free volume testing. More specifically the invention is a portable arrangement for determination of annulus free volume of a flexible pipe using an automated sequence.

INVENTION BACKGROUND

Monitoring and integrity evaluation are performed to control and map the condition and quality of the annulus volume, typically in a flexible riser or flowline. As shown in figure 1, the annulus volume 102 in a flexible pipe is defined as the volume between the outer sheath 101 and the pressure barrier 103. Annulus testing for determining the annulus free volume is a significant part of evaluating the pipe integrity.

Based on such an annulus test, the pipe integrity can be evaluated by comparing the measured annulus free volume and knowledge of the total annulus volume. The annulus volume in a flexible pipe is expected to be dry or experience a slow filling with time due to for instance diffusion through the pipe pressure barrier. Annulus free volume can be defined as the remaining free volume of the total annulus volume that is not filled with liquid or gas. Annulus free volume testing, hereafter referred to as annulus testing, of flexible risers is today typically performed annually at offshore installations using specialist personnel. Figure 2 shows an example sketch of a typical offshore installation which comprises a flexible riser 201, a platform 202 and a test location 203. The annulus testing of the flexible riser 201 is typically performed at test location 203.

As per today the annulus testing is typically performed manually, which requires specially trained personnel offshore to perform the test procedure. Thus, the testing is costly and prone to human errors and variations. Limited availability of specially trained personnel can also result in integrity tests not being performed as frequent as intended or according to schedule.

Systems for automatic measurement of annulus volumes of flexible risers exist. These systems are limited in functionality by not being portable due to physical and installation

characteristics. These systems are designed for permanent installation and for monitoring of a dedicated riser, i.e. the systems are not portable.

Some existing systems are described below.

WO 2014/000760 A1 describes an arrangement for venting an annular space between two sheaths in a riser. The arrangement comprises a permeate recovery device that recovers permeate by creating sub-atmospheric pressure in the annular space. A valve is included downstream of the device to prevent flow from the device back into the annular space. A pressure sensor can be arranged to monitor the pressure in the annular space; and operation of the permeate recovery device can be controlled based on the pressure sensor to maintain a predetermined pressure in the annular space.

WO 2010/036792 A2 describes a device and method for determining the presence of liquids in the annulus of a flexible riser or flow line. A housing element is disposed within, and in hydraulic communication with, the annulus. A sensor element is located within the housing element. Data acquisition equipment is provided that can use the sensor element to determine environmental characteristics of the annulus, and determine pressure, location and / or rate of collection of liquids based on the environmental characteristics.

WO 2010/151144 A1 describes a method and apparatus to detect and quantify leakage in a pipe annulus. A measuring arrangement is installed that includes a flow meter and pressure gauge in fluid communication with the annulus. The pressure gauge is connected to pressure sensors that can measure a pressure difference in the annulus. A pressure regulating valve is arranged downstream of the measuring arrangement to provide a constant pressure difference in the annulus.

WO 2009/094630 A1 describes a method and system for monitoring a flexible pipe, including an inline sensor system coupled to the annulus of the flexible pipe to detect corrosion of the flexible pipe. Also described are a method and system for monitoring an amount of water being accumulated in an annulus of a flexible pipe, including collecting, with a microprocessor, pressure and flow measurement data from pressure and flow

measurement systems for determining the amount of water accumulated in the annulus based on the collected pressure and flow measurement data.

The paper “Flexible Pipe Integrity Monitoring: A New System to Assess the Flexible Pipe Annulus Condition” (Gregoire Audouin et. al.) describes a riser annulus condition surveillance system for monitoring riser integrity. Gas that permeates the riser sheath is depressurized whilst measuring its pressure, temperature and flow rate.

The duration of the annulus test has correlation with the differential pressure in riser annulus during testing. If a more accurate test method is present, the differential pressure can be lowered, thus reducing test duration. The manually performed annulus test normally requires a relatively long test duration to compensate for low data analysis capability and accuracy.

Hence, there is a need for an arrangement for determination of annulus volume that avoids the above mentioned problems.

Therefore, it is an object of the present invention to provide an apparatus for annulus testing that is fully automated.

Another object of the present invention is to provide an apparatus that can be transported with ease and requires simple mounting.

Yet another object of the present invention is to provide an apparatus that is flexible such that it does not require a permanent installation.

Yet another object of the present invention is to provide an apparatus that are efficient in order to reduce the test duration.

SUMMARY OF THE INVENTION

According to the present invention, the above mentioned problems are solved by an arrangement for portable and automatic determination of a riser’s annulus free volume.

The present invention relates to a portable automated unit for determination of an annulus free volume of an annulus volume in a riser. Which portable automated unit is arranged to be connected to the annulus volume and wherein the said unit comprises:

- at least one flow arrangement,
- at least one valve,
- at least one pressure instrument, and
- at least one logic unit.

The at least one flow arrangement is arranged for introducing a pressure into the annulus volume for pressurization of the annulus volume, and

wherein the at least one logic unit is arranged to read off the at least one pressure instrument, read off and control the at least one valve and read off the at least one flow arrangement, and wherein the annulus free volume is calculated based on the introduced pressure difference in annulus volume and the amount of gas added or removed from the annulus volume.

The arrangement is portable, by the meaning of one or more unit(s) that can be transported with ease to the desired location, and requires only simple mounting. This is made possible by fitting the entire arrangement for automatic annulus testing into one or more portable unit(s).

In a preferable embodiment of the present invention the arrangement is fitted into one portable unit. However, it is possible in some embodiments to divide the components inside arrangement into more portable units.

The system is fully automated, meaning that the unit will automatically perform the annulus volume test when the system is connected, and test sequence is initiated.

According to the invention, the at least one flow arrangement is arranged for pressurization and / or depressurization of the annulus volume. Preferably, the at least one flow arrangement is arranged for introducing a pressure into the annulus volume for pressurization of the annulus volume. More preferably, the media for introducing a pressure into the annulus is a feed gas or diffused gas.

Also, within the scope of the invention, a vacuum can also be used to lower the pressure in the riser annulus volume in order to measure the annulus free volume.

Further, the at least one flow arrangement is situated in line with the gas flow direction between the annulus volume and the outlet/inlet or after the outlet/inlet.

According to the invention, the at least one pressure instrument is connected between the at least one valve and the annulus volume.

The arrangement consists of at least one logical unit for controlling at least one valve, reading pressure from at least one pressure instrument and calculating at least one annulus free volume. However, it is possible in some embodiments to control one or more of the arrangement components manually. The arrangement further consists of at least one instrument for measuring amount of gas added or removed from the riser annulus. In another embodiment of the present invention, the portable unit can be used for flow rate measurement of the diffused gas from the annulus volume.

The arrangement is connected to the pipe annulus, and introduces a pressure difference in the annulus. The arrangement calculates the annulus free volume based on the introduced pressure difference in riser annulus and the amount of gas which is removed or added in the annulus volume.

The invention is also related to a method of determination of an annulus free volume in a riser, by use of the portable automated unit according to claim 1-6. Wherein the method comprises the step of:

- Transporting the portable automated unit to an offshore installation.
- Connecting the automated portable unit to an annulus volume of the riser.
- Introducing a pressure into the annulus volume by means of the flow arrangement.
- Reading the measured free annulus volume on a display.

FIGURE DESCRIPTION

Figure 1 shows the cross section of a flexible riser.

Figure 2 shows an example of an offshore installation which comprises a flexible pipe, in this case a flexible riser.

Figure 3 shows an arrangement for automated portable annulus testing and / or monitoring of the integrity of at least one annulus volume.

All figures are schematic and not to scale, and they show only the parts necessary to illustrate the invention, other parts are omitted or merely indicated.

INVENTION DESCRIPTION

The solution according to the present invention is achieved by an arrangement in accordance to the characterizing part of the independent claim.

The present invention is related to an arrangement for portable and automatic determination of a flexible riser's annulus free volume. The annulus testing is performed by use of a logic unit which controls the sequence of opening and closing at least one valve, and based on acquired pressure readings, calculates the annulus free volume.

The arrangement typically comprises, not limited by, the components inside container 308 in figure 3; at least one flow arrangement 305 for flow measurement, at least one valve 304 connected to at least one annulus volume 102 and the at least one flow arrangement 305 for pressurization and / or depressurization of the annulus volume 102, at least one pressure instrument 303 for pressure measurement of the annulus volume 102, where a logic unit 307 is arranged to read off at least one pressure instrument 303, read off and control at least one valve 304 and read off at least one flow arrangement 305, and calculate the annulus free volume 301 based on pressure measurement and flow measurements, all components fitted into at least one portable unit 308.

If the system is fully automated, the arrangement will automatically perform the annulus free volume test when the system is connected, and test sequence is initiated.

The portable arrangement 308 can measure annulus volume 301 using a gas feed or using diffused gas to achieve a pressure build-up in the riser annulus 102 . Alternatively, the portable arrangement 308 can measure annulus volume 301 using vacuum. Gas is then removed from riser annulus 102 by introducing a sub-atmospheric pressure in the riser annulus 102.

In a preferable embodiment of the present invention the arrangement 308 is fitted into one portable unit. However, it is possible in some embodiments to divide the components inside arrangement 308 into more portable units.

Also, in a preferable embodiment of the present invention the arrangement 308 is controlled by use of a logical unit 307. However, it is possible in some embodiments to control one or more of the arrangement 308 components manually.

In another embodiment of the present invention, the portable arrangement can be used for flow rate measurement of the diffused gas from the annulus volume 102.

In another embodiment of the present invention, the portable arrangement 308 calculates the annulus free volume 301 and shows the result on a display connected to the logical unit 307.

CLAIMS

1. A portable automated unit (308) for determination of an annulus free volume (301) of a annulus volume (102) in a riser (201),
which portable automated unit comprises:
- at least one flow arrangement (305),
- at least one valve (304),
- at least one pressure instrument (303), and
- at least one logic unit (307),
wherein the at least one flow arrangement (305) is arranged for introducing a pressure into the annulus volume (102) for pressurization of the annulus volume (102), and
wherein the at least one logic unit (307) is arranged to read off the at least one pressure instrument (303), read off and control the at least one valve (304) and read off the at least one flow arrangement (305), and
wherein the annulus free volume (301) is calculated based on the introduced pressure difference in annulus volume (102) and the amount of gas added or removed from the annulus volume (102).

2. The unit (308) according to claim 1,
characterized in that said portable automated unit comprises a display connected to the logical unit (307), which display shows the measured data and displays the calculated annulus free volume (301).

3. The unit (308) according to claim 1 or 2,
characterized in that the at least one flow arrangement (305) is situated in line with gas flow direction between the annulus volume (102) and an outlet/inlet (306) or after the outlet/inlet (306).

4. The unit (308) according to any one of the preceding claims,
characterized in that the at least one pressure instrument (303) is connected between the at least one valve (304) and the annulus volume (102).

5. The unit (308) according to any one of the preceding claims,
characterized in that the unit (308) measures annulus free volume (301) using a gas feed or diffused gas to increase the pressure in the riser annulus volume (102).

6. The unit (308) according to any one of the preceding claims, characterized in that the unit (308) is used for a flow rate measurement of the amount of a diffused gas from the annulus volume (102).

7. A method of determination of an annulus free volume (301) in a riser (201) by use of a portable automated unit (308) according to claim 1-6, wherein the method comprises the step of;

- transporting the said portable automated unit (308) to an offshore installation,
- connecting the automated portable unit (308) to an annulus volume (102) of the riser,
- introducing a pressure into the annulus volume (102) by means of the flow arrangement (305),
- reading the measured free annulus volume (301) on a display.

PATENTKRAV

1. En bærbar automatisert enhet (308) for bestemmelse av et ringroms frie volum (301) av et ringromsvolum (102) i et stigerør (201), hvor den bærbare automatiserte enheten omfatter:

- minst ett strømningsarrangement (305),
- minst én ventil (304),
- minst ett trykkinstrument (303), og
- minst én logisk enhet (307),

hvor det minst ene strømningsarrangementet (305) er arrangert for å innføre et trykk i ringromsvolumet (102) for trykksetting av ringromsvolumet (102), og

hvor den minst ene logiske enheten (307) er arrangert for å lese av det minst ene trykkinstrumentet (303), lese av og kontrollere den minst ene ventilen (304) og lese av det minst ene strømningsarrangementet (305), og

hvor ringrommets frie volum (301) beregnes basert på den innførte trykkforskjellen i ringromsvolum (102) og mengden gass tilsatt eller fjernet fra ringromsvolumet (102).

2. Enheten (308) ifølge krav 1,

karakterisert ved at den bærbare automatiserte enheten omfatter et display koblet til den logiske enheten (307), hvor displayet viser de målte dataene og viser det beregnede frie volumet (301) av ringsromsvolumet.

3. Enheten (308) ifølge krav 1 eller 2,

karakterisert ved at det minst ene strømningsarrangementet (305) er plassert på linje med gasstrømningsretningen mellom ringromsvolumet (102) og et utløp/innløp (306) eller etter utløpet/innløpet (306).

4. Enheten (308) ifølge hvilket som helst av de foregående kravene,

karakterisert ved at det minst ene trykkinstrumentet (303) er koblet mellom den minst ene ventilen (304) og ringromsvolumet (102).

5. Enheten (308) ifølge hvilket som helst av de foregående kravene,

karakterisert ved at enheten (308) måler ringrommets frie volum (301) ved å bruke en gasstilførsel eller sporgass for å øke trykket i stigerørets ringvolum (102).

6. Enheten (308) ifølge hvilket som helst av de foregående kravene,

karakterisert ved at enheten (308) brukes for en strømningshastighetsmåling av mengden av en sporgass fra ringromsvolumet (102).

7. Fremgangsmåte for bestemmelse av et ringroms frie volum (301) i et stigerør (201) ved bruk av en bærbar automatisert enhet (308) ifølge krav 1-6,

hvor fremgangsmåten omfatter trinnene å;

- transportere den bærbare automatiserte enheten (308) til en offshore-installasjon,
- koble den automatiserte bærbare enheten (308) til et ringromsvolum (102) av stigerøret,
- innføre et trykk i ringromsvolumet (102) ved hjelp av strømningsarrangementet (305),
- lese av det målte frie ringrommetssvolumet (301) på et display.

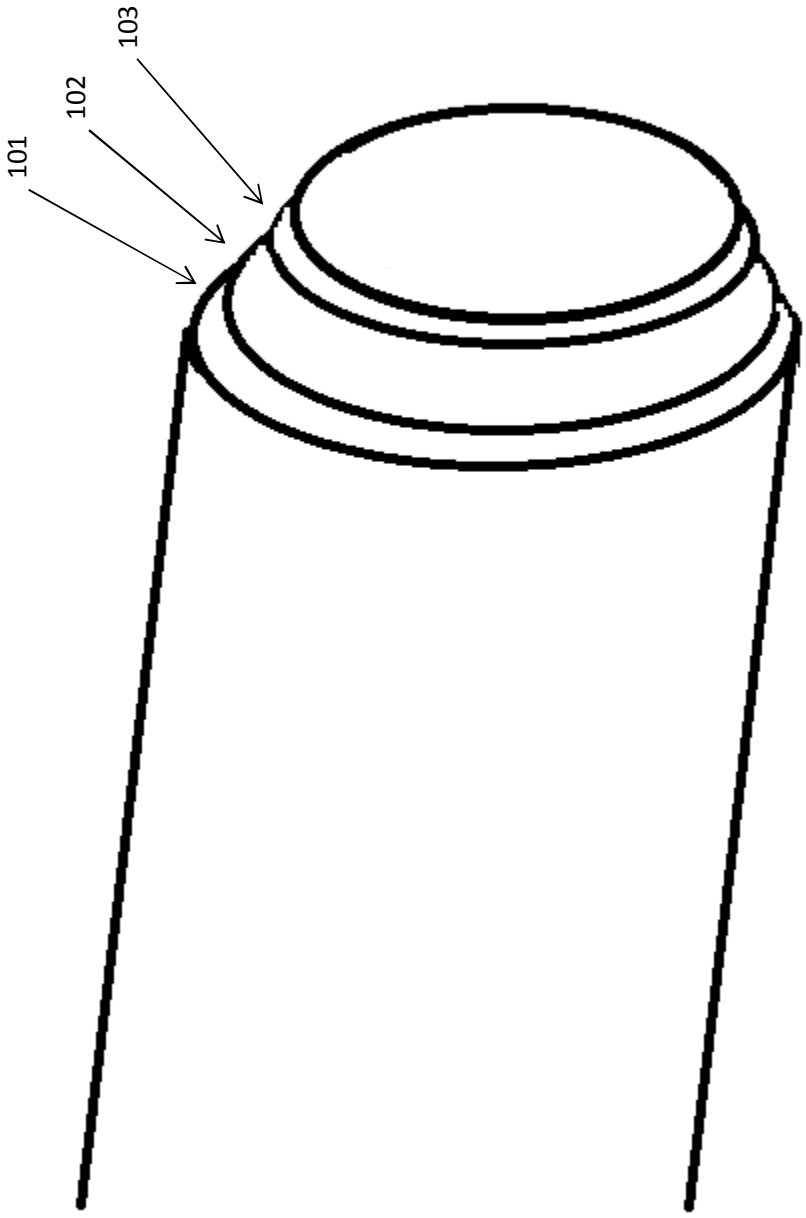


Figure 1

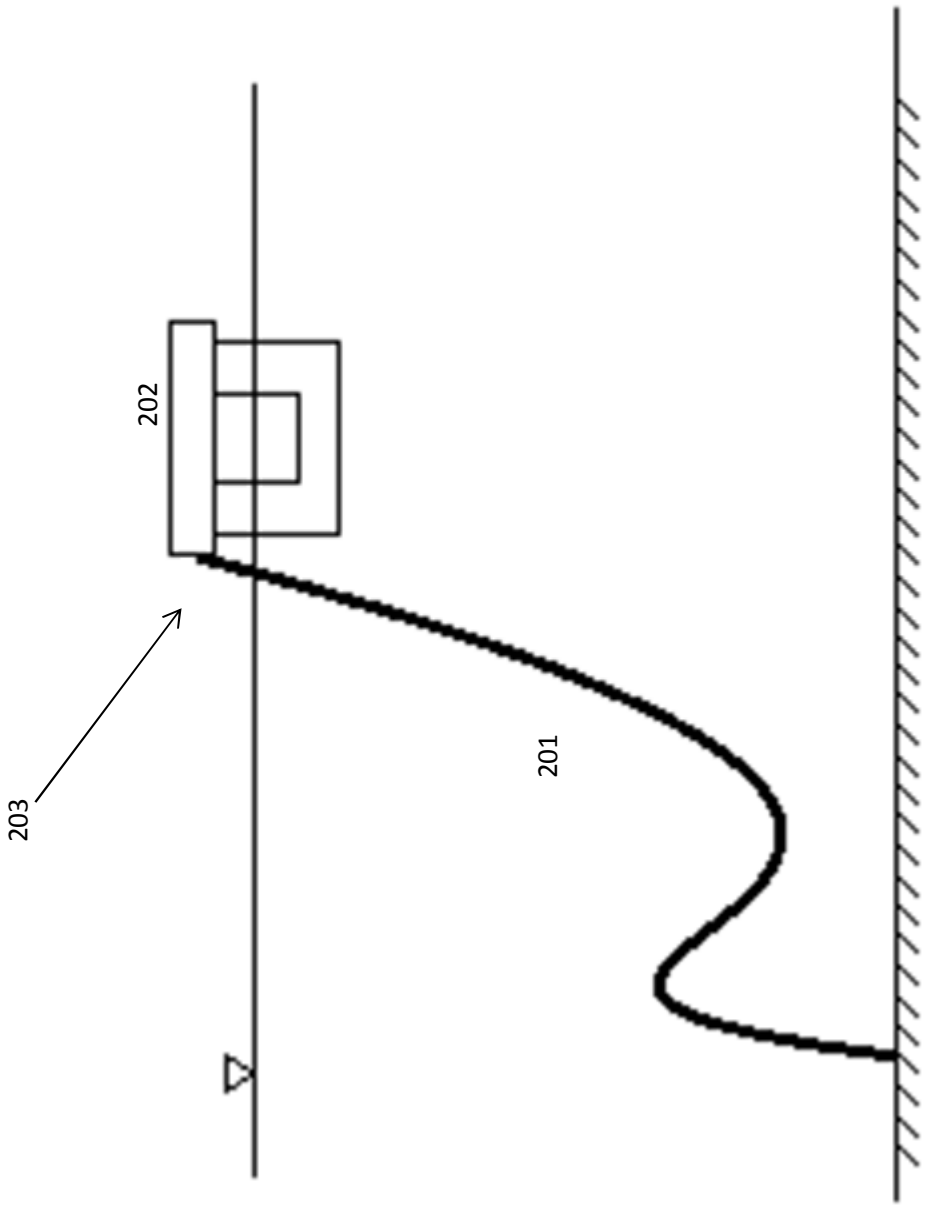


Figure 2

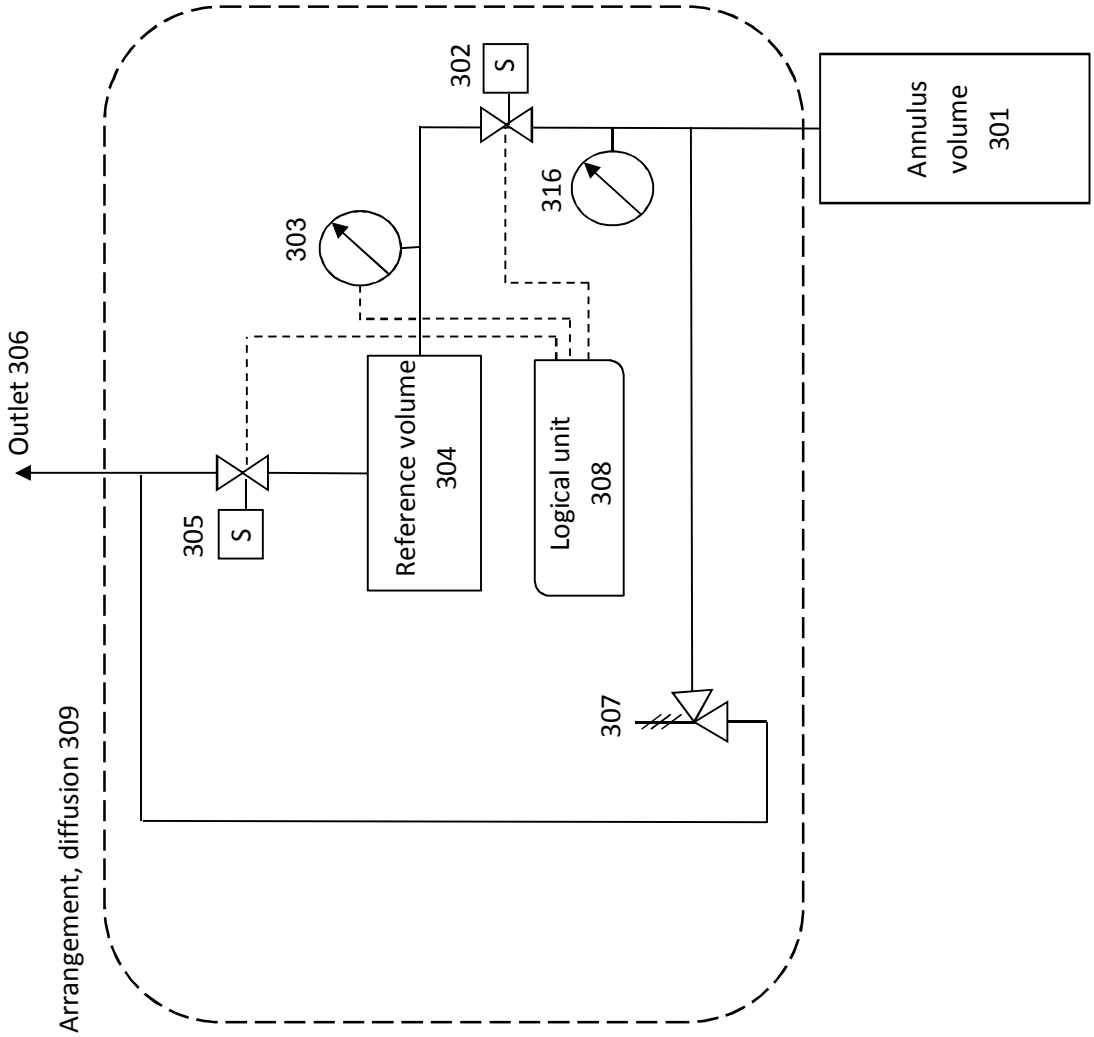

Arrangement, diffusion 309
Outlet 306
305
S
Reference volume
304
Logical unit
308
303
316
302
S
Annulus
volume
301
307

Figure 3

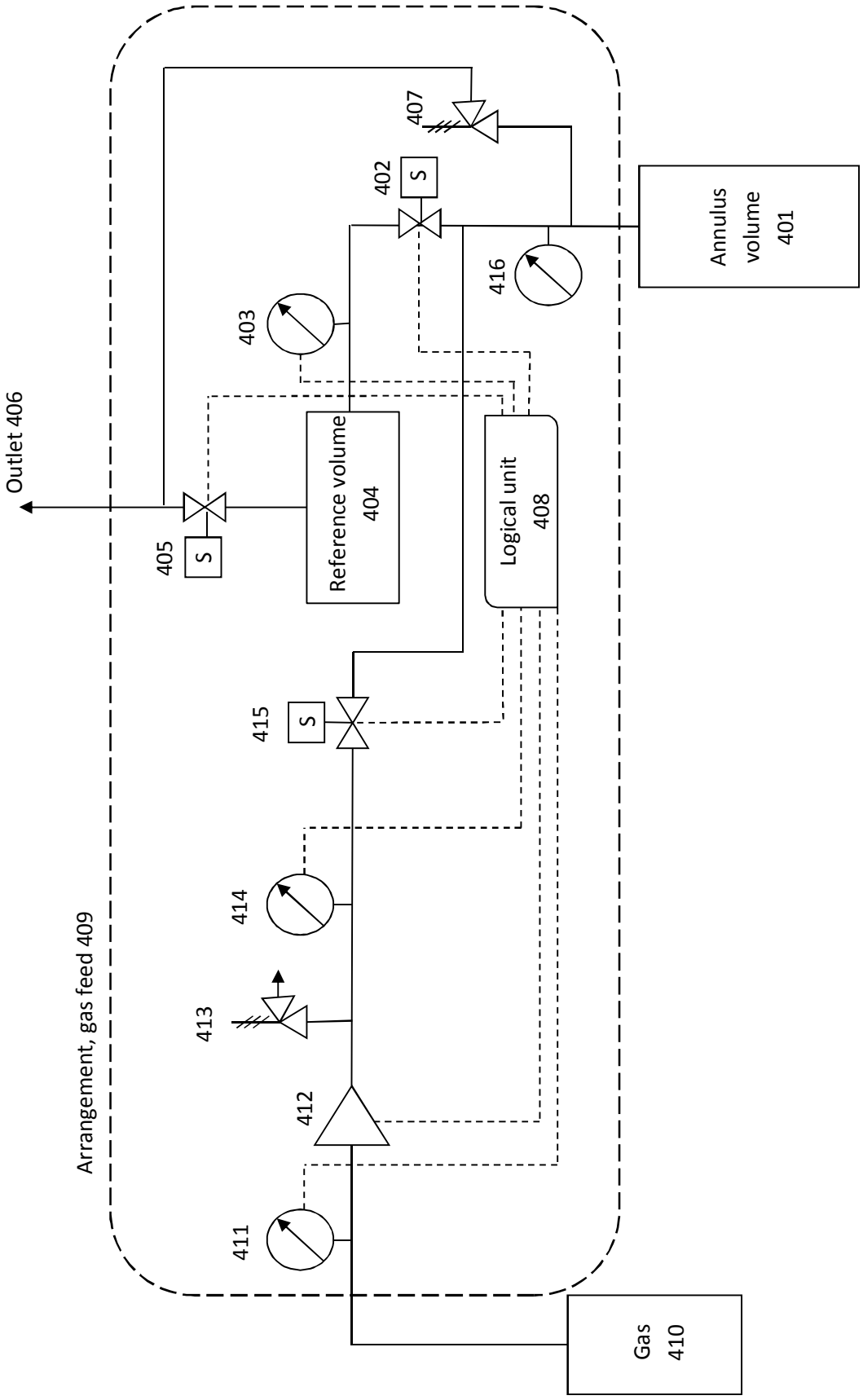

Arrangement, gas feed 409
Outlet 406
Annulus volume 401
Reference volume 404
Logical unit 408
Gas 410
S
402
403
405
407
411
412
413
414
415
416

Figure 4

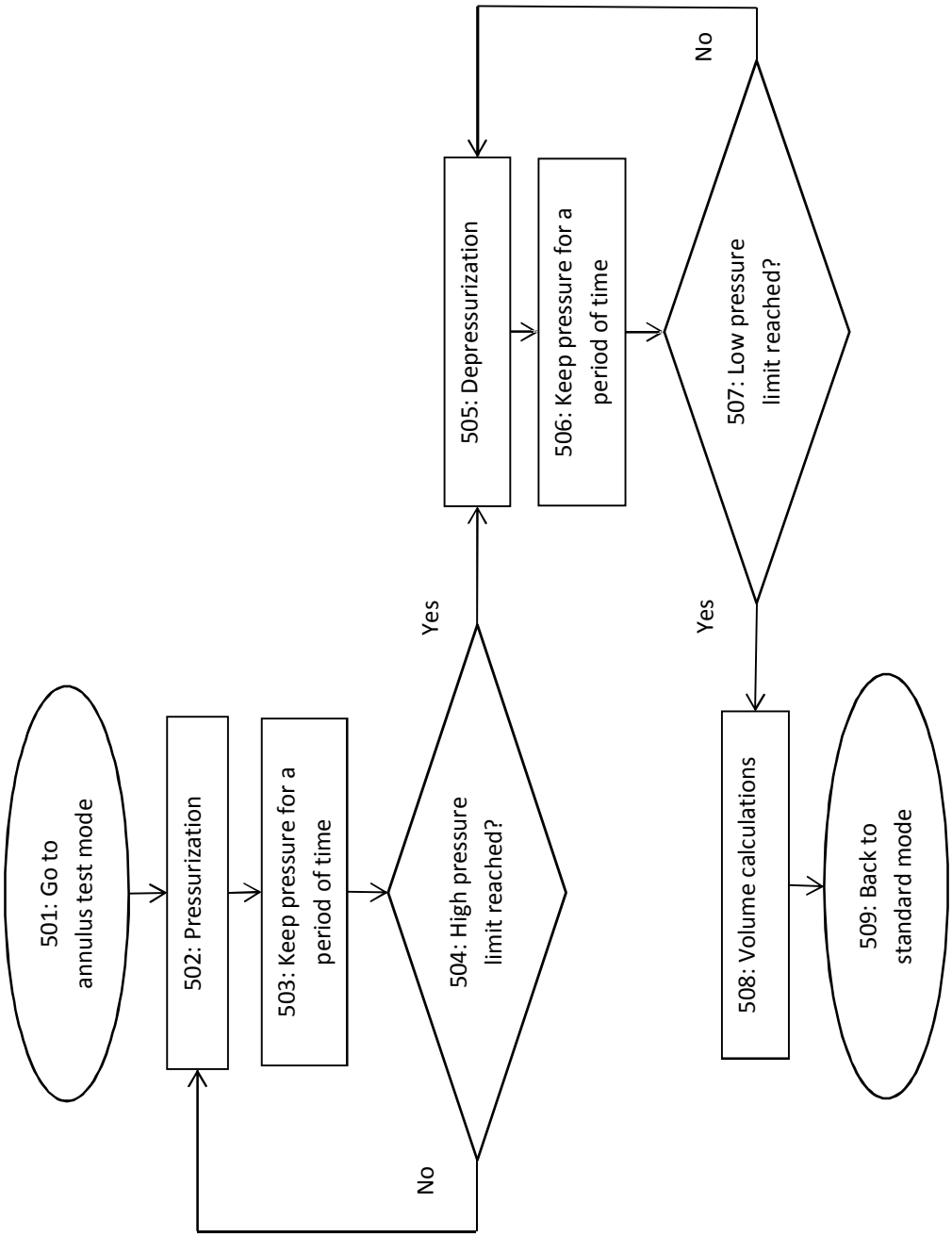

501: Go to annulus test mode
502: Pressurization
503: Keep pressure for a period of time
504: High pressure limit reached?
No
Yes
505: Depressurization
506: Keep pressure for a period of time
507: Low pressure limit reached?
No
Yes
508: Volume calculations
509: Back to standard mode

Figure 5