Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2638663 C 2015/01/13

(11)(21) **2 638 663**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(22) **Date de dépôt/Filing Date:** 2007/07/20
(41) **Mise à la disp. pub./Open to Public Insp.:** 2009/01/20
(45) **Date de délivrance/Issue Date:** 2015/01/13

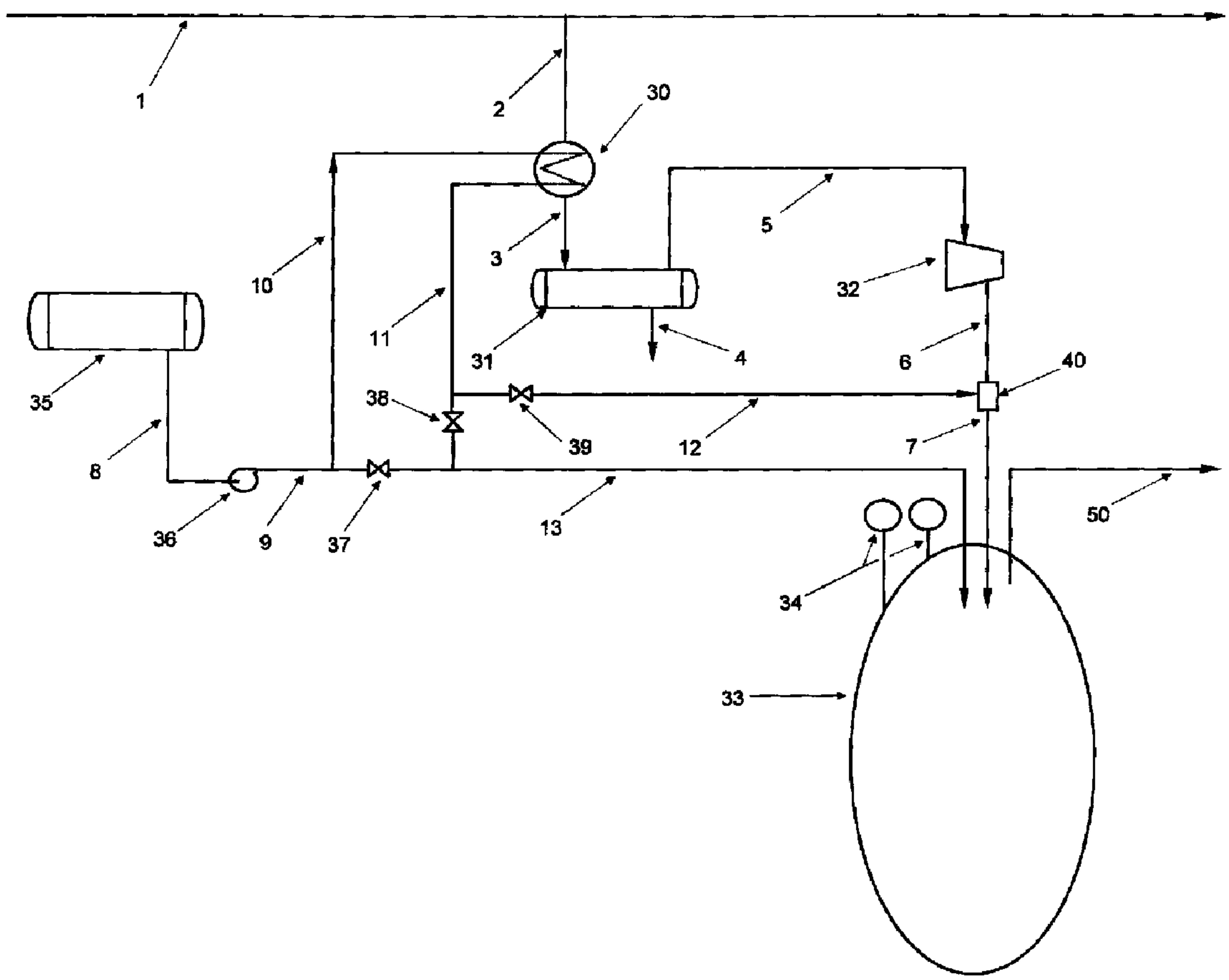
(51) **Cl.Int./Int.Cl.** ***B65G 5/00*** (2006.01), ***F17C 13/00*** (2006.01), ***F17C 5/00*** (2006.01), ***F28F 27/00*** (2006.01)

(72) **Inventeurs/Inventors:**
LOURENCO, JOSE, CA;
MILLAR, MACKENZIE, CA

(73) **Propriétaires/Owners:**
1304342 ALBERTA LTD., CA;
1304338 ALBERTA LTD., CA

(74) **Agent:** WOODRUFF, NATHAN V.

(54) **Titre : PROCEDE PERMETTANT D'AUGMENTER LE DEBIT D'INJECTION MASSIQUE DE GAZ APPLIQUE AUX CAVITES DE STOCKAGE DE GAZ AU MOYEN DE GAZ NATUREL LIQUEFIE**
(54) **Title: METHOD TO INCREASE GAS MASS FLOW INJECTION RATES TO GAS STORAGE CAVERNS USING LNG**



(57) **Abrégé/Abstract:**
A method to increase gas mass flow loading rates to a gas storage cavern includes using liquid natural gas (LNG) to cool natural gas in a natural gas flow line upstream of a compressor used to compress gas for storage in to a gas storage cavern.

ABSTRACT OF THE DISCLOSURE

A method to increase gas mass flow loading rates to a gas storage cavern includes using liquid natural gas (LNG) to cool natural gas in a natural gas flow line upstream of a compressor used to compress gas for storage in to a gas storage cavern.

TITLE:

Method to increase gas mass flow injection rates to gas storage caverns using LNG.

FIELD

The present invention relates to a method of increasing gas mass flow injection rates to gas storage caverns using LNG.

BACKGROUND

Natural gas is traditionally stored in a gaseous form in large volume salt caverns and aquifers to meet peak demand and ensure a secure supply. The gas is added to storage by compression, resulting in an increment in cavern temperature and an increment in cavern pressure. These increments in pressure and temperature in the cavern decrease the rate at which gas can be added to the cavern..

SUMMARY

A method to increase gas mass flow injection rates to a gas storage cavern, includes using liquid natural gas (LNG) to cool natural gas in a natural gas flow line upstream of a compressor used to compress gas for storage in to a gas storage cavern.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to in any way limit the scope of the invention to the particular embodiment or embodiments shown, wherein:

FIG. 1 is a schematic diagram that depicts an embodiment of the teachings contained herein.

FIG. 2 is a variation on the embodiment shown in **FIG. 1.**

DETAILED DESCRIPTION

The preferred method to increase mass flow gas injection rates will now be described with reference to **FIGURE 1**.

Gas is supplied from main pipeline stream 1. The gas to storage is routed through line 2 to exchanger 30 where it is cooled by LNG. The cooler gas exits exchanger 30 via stream 3 to knock out drum 31, to remove any condensate and debris present in the stream. The condensate is removed through stream 4. The cold gas is routed through stream 5 to compressor 32 for injection into cavern 33 via stream 6. LNG is supplied from tank 35 and is routed through line 8 to pump 36 where it is pressurized and routed through line 9. The LNG is routed through line 10 to exchanger 30, to cool the gas to storage and exits the exchanger through line 11. The gas in stream 11 is colder than compressed gas in stream 6. The gas can then be routed through valve 39 and line 12 to mix directly with stream 6 in mixer 40, increasing the gas density of gas stream 7 to storage 33. The option of routing stream 11 through valve 38 and line 13 directly to storage cavern 33 is available. The operating conditions for the cavern are monitored by pressure and temperature sensors 34. The objective is to increase the gas injection rate of compressor 32 by lowering the temperature of the gas suction line to the compressor, making the gas denser, thus increasing the mass flow rate and also decreasing the compressor outlet temperature. The compressor outlet temperature can be further decreased by direct mixing of stream 12 with stream 6. For every incremental decrease in the temperature of gas entering cavern 33, the amount of gas cavern 33 is capable of storing increases. If it is desirable to further decrease the temperature of cavern 33, the option of routing stream 11 through valve 38 and line 13 directly to storage cavern 33 is followed.

A variation will now be described with reference to **FIG. 2**.

Gas is supplied from main pipeline stream 1. The gas to storage is routed through line 2 to exchanger 30 where it is cooled by LNG. The cooler gas exits exchanger 30 via stream 3 to knock out drum 31 to remove any condensate and debris present in the stream. The condensate is removed through stream 4. The cold gas is routed through stream 5 to compressor 32, where it is compressed and delivered through line 6 to exchanger 41 where

it is cooled. The compressed and cooled stream 7 mixes with stream 11 and is stored through line 12 into gas cavern storage 33. LNG is supplied from tank 35 and is routed through line 8 to pump 36 where it is pressurized and routed through line 9. The LNG is routed to exchanger 30, to cool the gas to storage and exits the exchanger through line 10. The gas in stream 10 is colder than compressed gas in stream 6. The gas stream 10 enters exchanger 41 to cool the compressor discharge gas. The gas can then be routed through valve 39 to mix directly with stream 7 to storage 33 through line 12. The option of routing stream 11 through valve 38 and line 13 directly to storage cavern 33 is available. The operating conditions for the cavern are monitored by pressure and temperature sensors 34. The objective is to increase the gas mass flow injection rate of compressor 32 by lowering the temperature of the gas suction line to the compressor, making the gas denser, thus increasing the mass flow rate whilst also decreasing the compressor outlet temperature. The compressor outlet temperature is further decreased by indirect mixing of stream 10 with stream 6 thus further improving the power requirements for compression. The described embodiment of Fig.3 provides the ability for gas cavern operators to increase the mass flow gas injection rates to cavern storage.
The stored gas exits the cavern via stream 50 to meet demand.

In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements.

It will be apparent to one skilled in the art that modifications may be made to the illustrated embodiments without departing from scope of the Claims.

What is Claimed is:

1. A method for gas injection to a gas storage cavern, comprising:

positioning at the gas storage cavern a tank of LNG, a gas compressor and a heat exchanger;

connecting the tank of LNG to a first flow line connected to a first flow path of the heat exchanger and also to a second flow line leading directly to the gas storage cavern, the selection of the first flow line or the second flow line being controlled by selectively opening and closing a series of valves;

connecting an outlet of the first flow path of the heat exchanger to a third flow line connected to a mixer positioned on the compressed gas stream line exiting the gas compressor to the gas storage cavern and also to the second flow line, the selection of the third flow line or the second flow line being controlled by selectively opening and closing a series of valves;

when the gas compressor is in operation, passing LNG from the tank along the first flow line to the heat exchanger, through the first flow path of the heat exchanger and discharging LNG exiting the first flow path of the heat exchanger to the third flow line connected to the mixer positioned on the compressed gas stream line exiting the gas compressor into the gas storage cavern and passing natural gas from a natural gas flow line through a second flow path of the heat exchanger; and

passing natural gas exiting the second flow path of the heat exchanger through the gas compressor which injects the natural gas into the gas storage cavern;

monitoring at least one of temperature or pressure of the gas storage cavern; and

when the gas compressor is not in operation, pumping LNG from the tank of LNG along the second flow line leading directly to the gas storage cavern to maintain a desired temperature or pressure.

FIG. 1

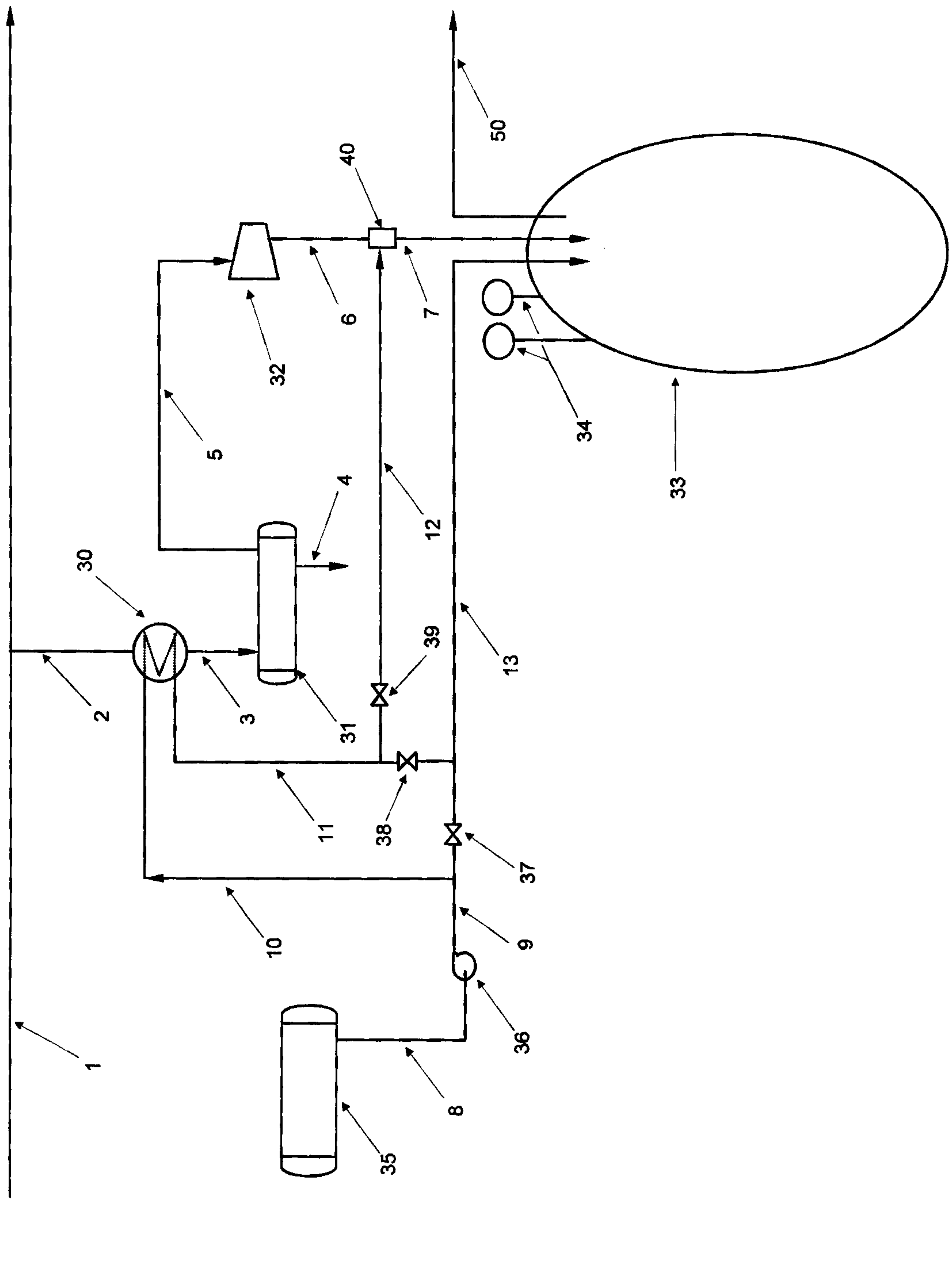
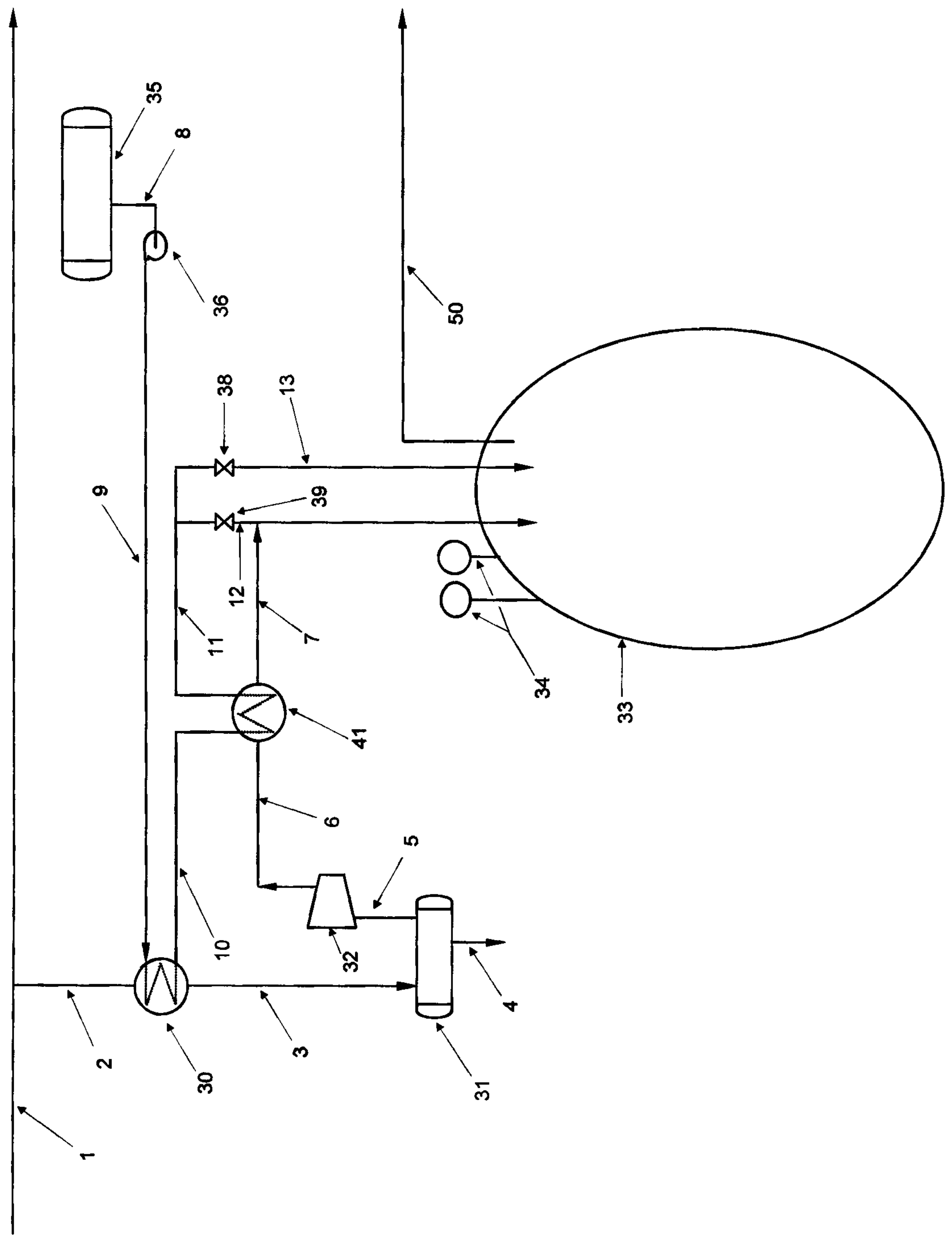
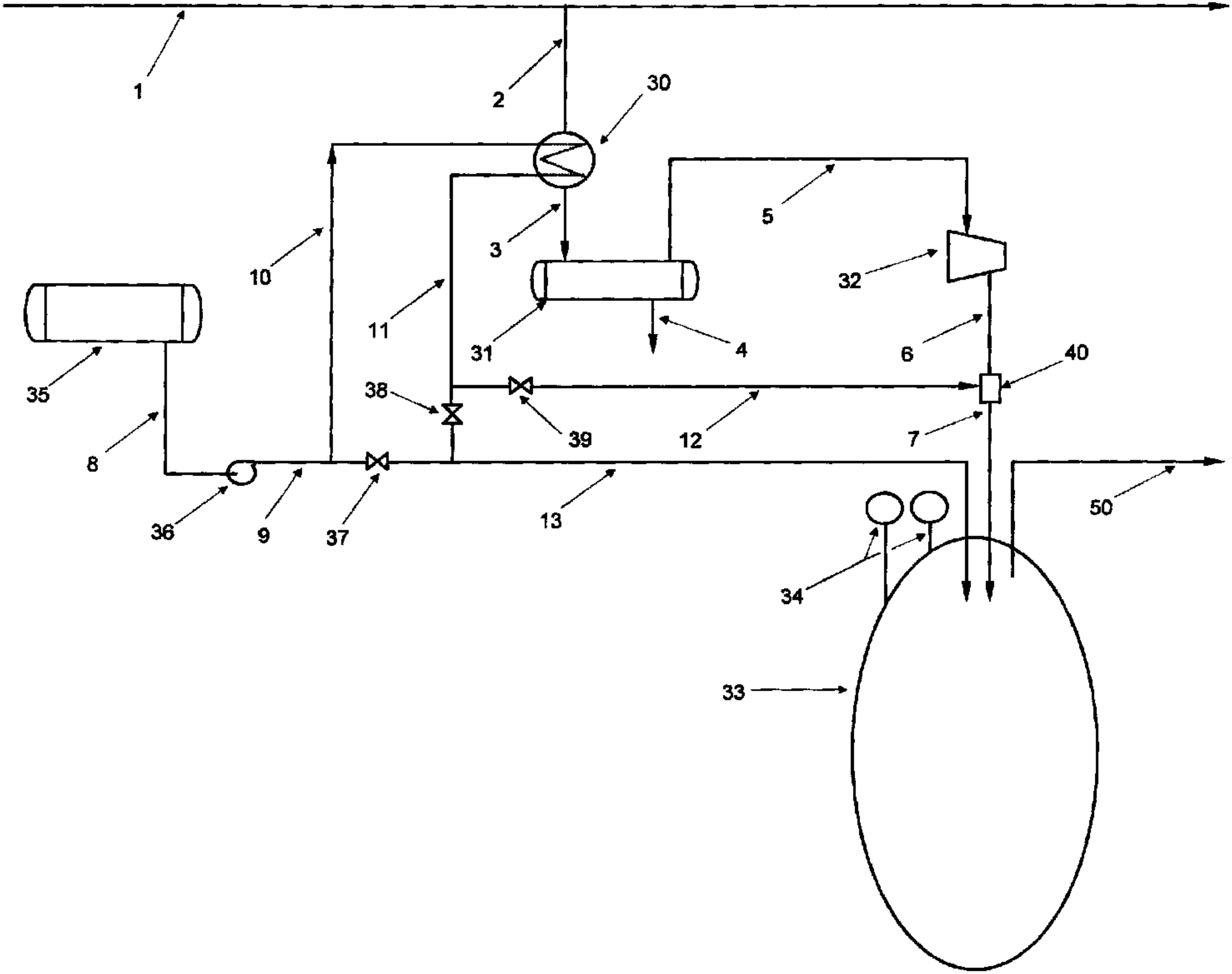


FIG.2




1
2
30
3
5
10
11
31
4
32
6
35
40
38
39
12
7
8
36
9
37
13
50
34
33