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(54) **CONTROL METHOD FOR LIQUEFIED GAS TRANSPORT CONTAINER, PRESSURE CONTROL SYSTEM AND TRANSPORTATION TOOL**

(57) Disclosed is a control method, pressure control system, and a transport appliance of a liquefied gas transport container. The control method for the liquefied gas transport container includes the following steps: step S10, measuring a pressure in a container (12) in real time and calculating a remaining time T1 for the pressure to reach a discharge pressure, and acquiring a time T2 for the container to reach a non-discharge road section in real time; and step S20, when T1<T2, discharging gas when the pressure in the container reaches the discharge pressure, and when T1≥T2, discharging gas before the

container reaches the non-discharge road section, so as to keep the pressure in the container being lower than the discharge pressure or below before the container leaves the non-discharge road section. The problems that in the prior art, pressure relief action of a liquefied natural gas tank is uncontrollable and occurs in special road sections, which influences transport safety, are effectively solved.

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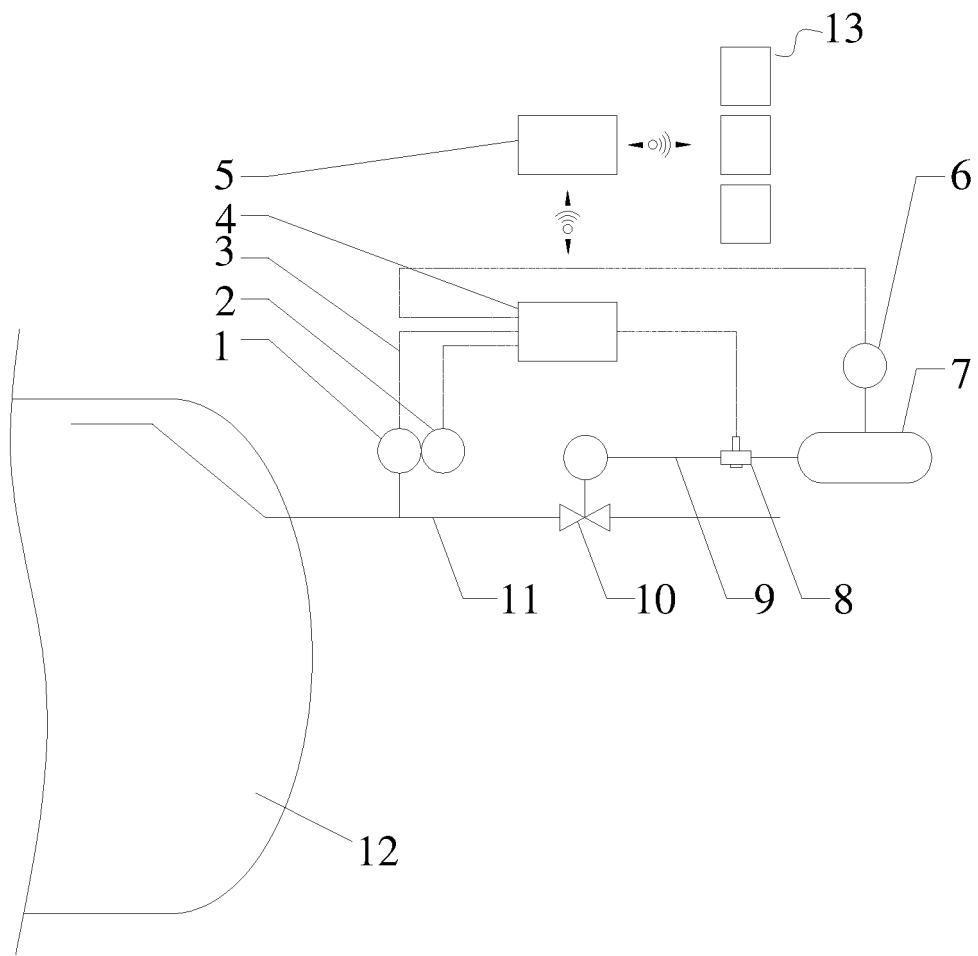


Fig.1

Description

Technical Field

[0001] The present invention relates to a field of liquefied gas transport, and in particular to a control method, a pressure control system and a transport appliance of a liquefied gas transport container.

Background

[0002] With obvious superiority in transport of liquefied natural gas, railway tanks meet the development needs of domestic logistics and have been widely used. But as the tanks for transporting the liquefied natural gas continuously absorb heat of the environment during transportation, pressure in the tanks keeps rising, so it is necessary to set tank safety valves to discharge and relieve the pressure of the tanks. At present, discharge action of the liquefied natural gas tanks is uncontrollable, which may occur at any time. When the tanks pass through special road sections (for example, stations, tunnels, towns and other sections with relatively closed space or crowded population), the discharge action may cause gas accumulation, and accordingly, the risk of explosion may increase.

Summary

[0003] The present invention aims to provide a control method, a pressure control system and a transport appliance of a liquefied gas transport container so as to solve the problems that in the prior art, pressure relief action of a liquefied natural gas tank is uncontrollable and occurs in special road sections, which influences transport safety.

[0004] In order to realize the above object, according to an aspect of the present invention, a control method of a liquefied gas transport container includes following steps: step S10, measuring a pressure in a container in real time and calculating a remaining time T1 for the pressure to reach a discharge pressure, and acquiring a time T2 for the container to reach a non-discharge road section in real time; and step S20, when $T1 < T2$, discharging gas when the pressure in the container reaches the discharge pressure, and when $T1 \geq T2$, discharging gas before the container reaches the non-discharge road section, so as to keep the pressure in the container being lower than the discharge pressure before the container leaves the non-discharge road section.

[0005] In some alternative embodiments, a step of acquiring the time T2 for the container to reach the non-discharge road section in real time includes: obtaining the T2 according to a current geographic position of the container, a position of a non-discharge road section closest to a current position in a passage direction, and a moving speed of the container.

[0006] In some alternative embodiments, the non-dis-

charge road section includes one or more of a culvert, a station, and a town.

[0007] In some alternative embodiments, the step S20 specifically includes: when $T1 < T2$, discharging gas whenever the pressure in the container reaches the discharge pressure, so as to reduce a unit pressure in the container; and when $T1 \geq T2$, discharging gas circularly from the container to reduce the unit pressure in the container until the pressure in the container can be lower than the discharge pressure before the container leaves a special road section.

[0008] In some alternative embodiments, when $T1 \geq T2$, the step S20 specifically includes: obtaining a duration T3 for the container to pass through the special road section, and discharging, before the container enters the special road section, a pressure in the container to be lower than (P-p) or below according to a predicted pressure increase p in the container during the duration T3, wherein the P is preset discharge pressure.

[0009] According to another aspect of the present invention, a pressure control system of a liquefied gas transport container is provided, the pressure control system is used for realizing the above control method, and the pressure control system includes: a controller, a pressure sensor, a positioning sensor and a driving structure, wherein the pressure sensor is arranged on an exhaust pipe of a liquefied gas transport container and connected to the controller, the positioning sensor is arranged on a transport appliance for liquefied gas and connected to the controller, and the driving structure is connected between the controller and a valve of the exhaust pipe.

[0010] In some alternative embodiments, the pressure control system further comprises a remote server, the remote server being connected to the controller.

[0011] In some alternative embodiments, the valve is a pneumatic valve, the driving structure comprises a compressed gas cylinder and an electromagnetic valve, the compressed gas cylinder is connected to the pneumatic valve, and the electromagnetic valve is connected to the controller to control the compressed gas cylinder to be opened/closed.

[0012] According to another aspect of the present invention, a transport appliance includes a container for transporting liquefied gas and a pressure control system, wherein the pressure control system is the above pressure control system.

[0013] According to the technical solution of the present invention, gas which influences safety or lives of residents is discharged before the transport container enters the non-discharge road section, and no gas is discharged in the non-discharge road section, so that the risk of explosion caused by gas accumulation is effectively reduced, and the influence on the lives of surrounding residents is reduced.

Brief Description of the Drawings

[0014] The drawings of the specification, which form a

part of the disclosure, are used to provide further understanding of the present invention, and illustrative embodiments of the present invention and the description thereof are used to explain the present invention, which are not intended to unduly limit the present invention. In the drawings:

Fig. 1 shows a structural schematic diagram of an embodiment of a pressure control system of a liquefied gas transport container according to the present invention.

[0015] The drawings include the following reference numerals:

1, pressure sensor; 2, positioning sensor; 3, explosion-proof connection pipe; 4, controller; 5, remote server; 6, pressure sensor; 7, compressed gas cylinder; 8, electromagnetic valve; 9, pneumatic pipeline; 10, pneumatic valve; 11, exhaust pipe; 12, container; 13, terminal.

Detailed Description of the Embodiments

[0016] It has to be noted that on the premise of no contradiction, embodiments in the disclosure and features of the embodiments may be combined mutually. The present invention is described in detail below with reference to the drawings and the embodiments.

[0017] The disclosure provides a control method of a liquefied gas transport container and a pressure control system of a liquefied gas transport container capable of realizing the control method, and as shown in Fig. 1, the pressure control system of the present embodiment includes: a controller 4, a pressure sensor 1, a positioning sensor 2 and a driving structure, wherein the pressure sensor 1 is arranged on an exhaust pipe of a liquefied gas transport container and connected to the controller 4 by an explosion-proof connection pipe 3, the positioning sensor 2 is arranged on a transport appliance of liquefied gas and connected with the controller 4, and the driving structure is connected between the controller 4 and a valve of the exhaust pipe. The controller 4 may control the driving structure to act according to feedback information of the pressure sensor 1 and the positioning sensor 2, thereby controlling the valve on the exhaust pipe to be opened/closed so as to discharge gas and relieve pressure from the liquefied gas transport container.

[0018] The liquefied gas transport container of the present embodiment is suitable for liquefied natural gas with a combustion characteristic, and is also suitable for other products such as frozen liquefied gas, high-pressure liquefied gas, low-pressure liquefied gas, compressed gas and common liquid with volatilization characteristics. Specifically, the control method for the liquefied gas transport container of the present embodiment includes the following steps:

step S10, a pressure in the container is measured in real time and a remaining time T1 for the pressure to reach discharge pressure is calculated, and a time T2 for the container to reach a non-discharge road section is acquired in real time; and

step S20, when $T1 < T2$, gas is discharged when the pressure in the container reaches the discharge pressure, and when $T1 \geq T2$, the gas is discharged before the container reaches the non-discharge road section, so as to keep the pressure in the container being lower than the discharge pressure before the container leaves the non-discharge road section.

[0019] The non-discharge road section here refers to road sections with relatively closed space or crowded population, such as a culvert, a station, a bridge and a town, where gas discharge and pressure relief may cause the gas accumulation, increase risk of explosion or influence lives of surrounding residents. Therefore, the disclosure provides the above control method to avoid the above situation.

[0020] According to physical and thermodynamic characteristics of transported liquid, and an environmental temperature, a speed, pressure in a tank, etc. at the time of transport operation, the remaining time T1 for the pressure in the tank to reach the discharge pressure may be estimated by means of thermodynamic calculation such as heat transfer calculation. When $T1 < T2$, the pressure in the transport container may reach the discharge pressure before the container reaches the above non-discharge road section, and at this moment, the gas may be discharged to relieve the pressure in a common mode. When $T1 \geq T2$, the pressure in the transport container may reach the discharge pressure after the container enters the above non-discharge road section, and if the gas may be discharged to relieve the pressure in a common mode, the dangerous situation mentioned above will occur, so the pressure of the container should be relieved in advance.

[0021] According to the technical solution of the present embodiment, through dynamic operation, the transport container automatically discharges the gas which influences the safety or the lives of residents before the transport container enters the non-discharge road section, and prevents the gas from being discharged in the non-discharge road section, so that the risk of explosion caused by the gas accumulation is effectively reduced, and the influence on the lives of surrounding residents is reduced.

[0022] Specifically, in the present embodiment, the step of acquiring the time T2 for the container to reach the non-discharge road section in real time includes the following steps that the T2 is obtained according to a current geographic position of the container, a position of a non-discharge road section closest to the current position in a passage direction, and a moving speed of the container. A real-time position of the container may be realized by systems with a satellite positioning function, such as Beidou and GPS Galileo, and the map information may use Baidu Map, Gaode Map or other map information.

[0023] Step S20 in the present embodiment specifically includes the following steps that when $T1 < T2$, the gas

is discharged whenever the pressure of the container reaches the discharge pressure, unit pressure in the container is reduced, after the container moves for a period of time, when the pressure in the container rises to the discharge pressure again, gas is discharged from the container again to relieve pressure, and these steps are repeated, so that the pressure in the container is kept lower than the discharge pressure. When $T1 \geq T2$, the container discharges the gas circularly to reduce the unit pressure in the container every time, till the pressure in the container can be kept lower than the discharge pressure before the container leaves a special road section. The discharge pressure P may be preset according to a physical characteristic of the container and characteristics of contents of the container, a pressure increase p in the container in the process of passing through the non-discharge road section of the container can be calculated according to a length of the non-discharge road section, the time $T3$ to pass through the non-discharge road section calculated by a current vehicle speed, and the heat transfer, and therefore, when $T1 \geq T2$, the pressure in the container should be reduced to $(P-p)$ or below before the container enters the non-discharge road section.

[0024] When a distance between two adjacent non-discharge road sections is too close to reduce the pressure to $(P-p)$ between the two non-discharge road sections, the two non-discharge road sections may be treated as one non-discharge road section to ensure that the pressure in the container cannot reach the discharge pressure in the process of passing through the two non-discharge road sections of the container and ensure safety.

[0025] As shown in Fig. 1, in the pressure control system of the present embodiment, the valve is a pneumatic valve 10, the driving structure includes a compressed gas cylinder 7 and an electromagnetic valve 8, the compressed gas cylinder 7 is connected with the pneumatic valve 10 by a pneumatic pipeline 9, and the electromagnetic valve 8 is connected with the controller 4 to control the compressed gas cylinder 7 to be opened/closed. When the gas needs to be discharged to relieve the pressure, the controller 4 controls the electromagnetic valve to open, compressed gas is ejected from the compressed gas cylinder to push the pneumatic valve 10 to open, and then the gas in the container 12 is discharged from the exhaust pipe 11, so that the pressure in the container decreases. In other embodiments not shown in the drawings, the driving structure may also control the gas discharge in other structural forms. In order to guarantee safe operation of the driving structure, the compressed gas cylinder 7 of the present embodiment is provided with a pressure sensor 6.

[0026] As shown in Fig. 1, the pressure control system of the present embodiment further includes a remote server 5, and a terminal 13 may be in wireless connection with the controller 4 by the remote server 5, so that the transport container can be monitored and controlled re-

motely. The terminal 13 may be a computer, or even mobile terminals such as a mobile phone and a tablet computer.

[0027] The disclosure further provides a transport appliance, which includes a container for transporting liquefied gas and a pressure control system, wherein the pressure control system is the pressure control system including the above part or all of technical features. The transport appliance of the disclosure may be a train for railway transportation, a car and a tank car for road transportation, a ship for sea transportation, and a container for combined transportation of road, railway, sea, etc. The transport appliance of the disclosure has the advantages of high safety and less influence on a passage residential environment.

[0028] In view of the above description, it may be seen that the embodiments of the present invention realize the following technical effects:

gas which influences safety or lives of residents is discharged before the transport container enters the non-discharge road section, and no gas is discharged in the non-discharge road section, so that the risk of explosion caused by gas accumulation is effectively reduced, and the influence on the lives of surrounding residents is reduced.

[0029] The above has been described only as preferred embodiments of the present invention and is not intended to limit the present invention, which can be modified and changed, for those skilled in the art. Any modifications, equivalent replacements, improvements, etc. made within the spirit and principles of the present invention should be comprised within the scope of protection of the present invention.

Claims

1. A control method of a liquefied gas transport container, comprising following steps:

step S10, measuring a pressure in a container in real time and calculating a remaining time $T1$ for the pressure to reach a discharge pressure, acquiring a time $T2$ for the container to reach a non-discharge road section in real time, and keeping the pressure in the container being lower than the discharge pressure before the container leaves the non-discharge road section; and

step S20, when $T1 < T2$, discharging gas when the pressure in the container reaches the discharge pressure, and when $T1 \geq T2$, discharging gas before the container reaches the non-discharge road section.

2. The control method of the liquefied gas transport container as claimed in claim 1, wherein a step of acquiring the time $T2$ for the container to reach the

non-discharge road section in real time comprises: obtaining the T2 according to a current geographic position of the container, a position of a non-discharge road section closest to a current position in a passage direction, and a moving speed of the container.

3. The control method of the liquefied gas transport container as claimed in claim 1, wherein the non-discharge road section comprises one or more of a culvert, a station, a bridge and a town. 5
4. The control method of the liquefied gas transport container as claimed in claim 1, wherein the step S20 specifically comprises: 15
 - when $T1 < T2$, discharging gas whenever the pressure in the container reaches the discharge pressure, so as to reduce an unit pressure in the container; and when $T1 \geq T2$, discharging gas circularly from the container to reduce the unit pressure in the container until the pressure in the container is lower than the discharge pressure before the container leaves a special road section. 20
5. The control method of the liquefied gas transport container as claimed in claim 4, wherein when $T1 \geq T2$, the step S20 specifically comprises: obtaining a duration T3 for the container to pass through the special road section, and discharging, before the container enters the special road section, a pressure in the container to be lower than (P-p) according to a predicted pressure increase p in the container during the duration T3, wherein the P is a preset discharge pressure. 25 30 35
6. A pressure control system of a liquefied gas transport container, wherein the pressure control system is used for realizing the control method as claimed in any one of claims 1 to 5, and the pressure control system comprises: a controller (4), a pressure sensor (1), a positioning sensor (2) and a driving structure, the pressure sensor (1) being arranged on an exhaust pipe of the liquefied gas transport container and connected to the controller (4), the positioning sensor (2) being arranged on a transport appliance for liquefied gas and connected to the controller (4), and the driving structure being connected between the controller (4) and a valve of the exhaust pipe. 40 45
7. The pressure control system as claimed in claim 6, wherein the pressure control system further comprises a remote server (5), the remote server (5) being connected to the controller (4). 50
8. The pressure control system as claimed in claim 6, wherein the valve is a pneumatic valve (10), and the driving structure comprises a compressed gas cylinder (7) and an electromagnetic valve (8), the com- 55

pressed gas cylinder (7) being connected to the pneumatic valve (10), and the electromagnetic valve (8) being connected to the controller (4) to control the compressed gas cylinder (7) to be opened/closed.

9. A transport appliance, comprising a container for transporting liquefied gas and the pressure control system as claimed in any one of claims 6 to 8.

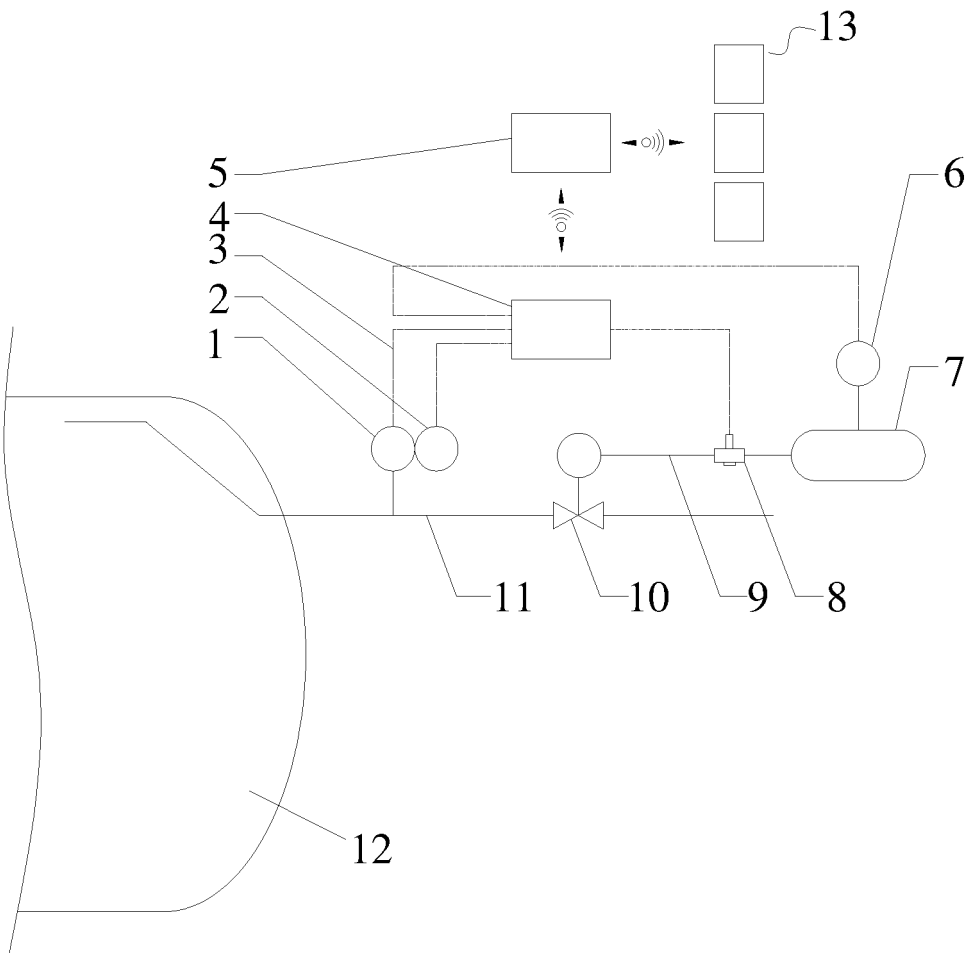


Fig.1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/101679

A. CLASSIFICATION OF SUBJECT MATTER

F17C 9/02(2006.01)i; F17C 13/00(2006.01)i; F17C 13/02(2006.01)i; F17C 13/04(2006.01)i; F17C 13/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F17C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: 中车齐齐哈尔车辆有限公司, 大连中车铁龙集装箱技术装备研发有限公司, 液化气, 液化天然气, 泄压, 卸压, 排气, 排压, 排放, 泻压, 压力, 时间, 涵洞, 场站, 隧道, 桥梁, 城镇, 运输, 输送, 运送, 安全, 危险, 定位, GPS, LNG, liquefied natural gas, gas, exit+, exhaust+, discharg+, blowdown, blowoff, decompress+, pressure, time, culvert, tunnel, bridge, station, town, carriage, conveyance, transit+, transport+, traffic, safe, danger, locat+, position+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

17 September 2020

Date of mailing of the international search report

28 September 2020

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/101679

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Information on patent family members

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