upstream of the emergency release couplings so that it isolates the flexible second portion from the rest of the transfer line when the flexible second portion is disconnected from the manifold on the client vessel. With such a transfer system, if a valve is arranged upstream of the couplings in order to provide a satisfactory level of safety, it is necessarily arranged on the deck of the supplier vessel, i.e. at a significant distance, along the transfer line, from the end of the flexible second portion. As a result, in the event of disconnection, a significant quantity of liquefied gas is trapped in a buffer zone extending between the valve and the end of the flexible second portion. Such a buffer zone must be fully drained and rendered inert in order to ensure the complete absence of gas after each transfer operation, which results in a significant disconnection time after transfer.

Summary

One idea behind the invention is to propose a fluid transfer system that is simple and reliable, makes it possible to adapt to a wide variety of configurations and makes it possible to limit the length of the buffer portion of the transfer line that must be drained after the transfer operations.

According to one embodiment, the invention provides a system for transferring liquefied gas between a first facility and a second facility, said transfer system including:

- an articulated arm including a first proximal part suitable for being mounted so that it can rotate on the first facility about a first vertical axis, a second median part that is mounted pivoting on the first proximal part about a second axis and a third distal part that is mounted pivoting on the second median part about a third axis; and
- at least one transfer line, suitable for transferring liquefied gas between the first facility and the second facility, and including a flexible first proximal portion suitable for being connected to a liquefied gas storage tank of the first facility; a rigid second median portion that is fastened to the second median part of the articulated arm and a third distal portion that is suspended on the third distal part of the articulated arm and has an end suitable for being connected to a manifold of the second facility, the second median portion being provided with a flow rate adjustment valve.

Due it its aforementioned three-part structure, such an articulated arm thus makes it possible to adapt to a wide variety of different configurations.

Moreover, as the first proximal portion and the third distal portion of the transfer line are flexible, they permit the relative movements of the three parts of the articulated arm, without having to use rotating joints, which are costly and complex and can generate sealing defects.

In addition, as the transfer line includes a flow rate adjustment valve supported by the articulated arm, the quantity of liquefied gas trapped between the end of the third distal portion and the flow rate adjustment valve is limited. Moreover, the quantity of liquefied gas that can be trapped between the flow rate adjustment valve and the end of the third distal portion is all the more limited in that the flow rate adjustment valve is mounted on the second median portion of the transfer line, which is fastened to the second median part of the articulated arm.

Finally, in such an arrangement, as the flow rate adjustment valve is not held by the flexible third distal portion, it does not increase the difficulty of maneuvering said third distal portion, so that the operations to connect the transfer line to the manifold of the second facility are not negatively affected by the supporting of the flow rate adjustment valve by the articulated arm.

According to other advantageous embodiments, such a transfer system can have one or more of the following features.

According to one embodiment, the second axis is horizontal.

According to one embodiment, the third axis is horizontal.

According to one embodiment, the second median portion includes a first end and a second end respectively connected to the first proximal portion and to the third distal portion and the flow rate adjustment valve is arranged closer to the second end of the second median portion than to the first end thereof. This makes it possible to further reduce the quantity of gas trapped between the flow rate adjustment valve and the end of the third distal portion.

According to one embodiment, the second median portion extends along the second median part of the articulated arm.

According to one embodiment, the second median portion has a bent end oriented downwards and connected to the first proximal portion. According to one

embodiment, the second median portion has a bent end oriented downwards and connected to the third distal portion. This makes it possible to limit the stresses exerted on the first proximal portion and the third distal portion.

According to one embodiment, one of the ends of the second median portion is aligned or substantially aligned with the second axis of articulation. According to one embodiment, one of the ends of the second median portion is aligned or substantially aligned with the third axis of articulation. According to one embodiment, two ends of the second median portion are respectively aligned with the second axis of articulation and the third axis of articulation. This makes it possible to limit the length of the first proximal portion and the third distal portion of the transfer line.

According to one embodiment, the second median portion is laterally offset relative to the second median part of the articulated arm. This is advantageous to allow the incorporation of the flow rate adjustment valve when it has a significant height.

According to one embodiment, the second median portion is fastened to the second median part of the articulated arm by means of support members that are distributed along the second median part.

According to one embodiment, the support members include cross members fastened to the second median part and a clamping collar fastened to said cross members and through which the second median portion passes.

According to one embodiment, the support members further include an insulating sleeve interposed radially between the clamping collar and the second median part.

According to one embodiment, the first proximal portion rests on a support covered with a non-stick coating. This makes it possible in particular to limit the frictional wear of the first proximal portion.

According to one embodiment, the non-stick coating of the support is polytetrafluoroethylene.

According to one embodiment, the first proximal part of the articulated arm includes a protective cylindrical skirt including a non-stick coating. This also makes it possible to limit the frictional wear of the first proximal part.

According to one embodiment, the non-stick coating of the protective cylindrical skirt is polytetrafluoroethylene.

According to one embodiment, the second median portion includes a double-walled hose having an intermediate space that is lined with an insulating material.

According to one embodiment, the first proximal portion and the third distal portion each include a composite hose or a corrugated double-walled hose that includes an intermediate space lined with an insulating material.

According to one embodiment, the transfer system includes a protective sleeve that is fastened to one end of the second median portion, which is connected to the first proximal portion, the protective sleeve accommodating one end of the first proximal portion and having a flared inner surface so that it ensures a minimum radius of curvature for said end of the first proximal portion.

According to one embodiment, the transfer system includes a protective sleeve that is fastened to one end of the second median portion, which is connected to the third distal portion, the protective sleeve accommodating one end of the first proximal portion and having a flared inner surface so that it ensures a minimum radius of curvature for said end of the third distal portion.

According to one embodiment, the transfer system includes at least two transfer lines and a bypass device that connects the median portion of the two transfer lines upstream of the flow rate adjustment valve provided on each of the median portions.

According to one embodiment, the transfer system includes an actuation device enabling that makes it possible to extend the articulated arm.

According to one embodiment, the actuation device includes a motor configured to pivot the first proximal part about the first axis.

According to one embodiment, the actuation device includes a first linear actuator having a first end mounted articulated on the first proximal part and a second end mounted articulated on the second median part and a second linear actuator having a first end mounted articulated on the second median part and a second end mounted articulated on the third distal part.

According to one embodiment, the invention provides a vessel provided with the aforementioned transfer system.

The second median portion 16 of the transfer lines 3, 4, 5 is rigid and consists of a cryogenic hose, such as a double-walled hose, for example made from stainless steel, the intermediate space of which is lined with an insulating material.

The second median portions 16 extend along the second median part 7 of the articulated arm 2, parallel to the longitudinal direction thereof. The second median portions 16 are arranged on one side or the other of the second median part 7 of the articulated arm 2. Thus, as shown in figure 3, the second median portion 16 of the first and second transfer lines 3, 4, and the second median portion of the third transfer line 5, are arranged laterally on either side of the second median part 7 of the articulated arm 2.

The second median portions 16 are fastened to the articulated arm 2 by means of support members 21 that are evenly distributed along said second median portions 16. According to one embodiment, the support members 21 include cross members that are welded to the second median part 7 of the articulated arm 2 and a clamping collar that is fastened to said cross members and through which the second median portion 16 passes. Advantageously, the support members 21 also include an insulating sleeve interposed radially between the clamping collar and the second median portion 16.

The second median portions 16 are also provided with cryogenic flow rate adjustment valves 22. The flow rate adjustment valves 22 are advantageously arranged near the front end of the second median portion 16, i.e., the end of the second median portion 16 that is connected to the third distal portion 17. This makes it possible to limit the quantity of liquefied gas downstream of said flow rate adjustment valves 22 when the transfer lines 3, 4, 5 are disconnected from the receiving manifold on the client vessel. The flow rate adjustment valves 22 are also advantageously arranged closer to the front end 24 of the second median portion 16 than to the rear end 23.

It will further be noted that, as shown for example in figure 4, the flow rate adjustment valves 22 have a significant height. As a result of this, in order to allow easy incorporation of said flow rate adjustment valves 22, the second median portions 16 are laterally offset relative to the second median part 7 of the articulated arm 2.

shown in figures 1, 5 and 6, that makes it possible to keep the coupling 25 substantially horizontal regardless of the tilt of the articulated arm 2.

In an advantageous embodiment, the transfer system 1 includes a bypass device 34, shown in dotted lines in figure 3, that makes it possible to connect the median portion 16 of the first, second and third transfer lines 3, 4, 5 upstream of the flow rate adjustment valves 22. Such a bypass device 34 makes it possible to facilitate the chilling of the first and second transfer lines 3, 4. The aim of such chilling is to create temperature and pressure conditions in the first and second transfer lines 3, 4 suitable for the transfer of liquefied natural gas. In order to achieve this chilling, liquefied gas is for example conveyed through the first and second transfer lines 3, 4, then passes through the bypass device 34 before returning to the tank on the supplier vessel 30, for example via the third transfer line 5.

Although the invention has been described with reference to several specific embodiments, it is obvious that it is in no way limited thereto and that it includes all technical equivalents of the means described and any combinations thereof if these fall within the scope of the invention.

The use of the verb “include” or “comprise” and its conjugated forms does not rule out the presence of elements or steps other than those set out in a claim.

In the claims, any reference sign between parentheses cannot be interpreted as limiting the claim.

CLAIMS

1. A system (1) for transferring liquefied gas between a first facility and a second facility, said transfer system (1) including:

- an articulated arm (2) including a first proximal part (6) suitable for being mounted so that it can rotate on the first facility about a first vertical axis (A), a second median part (7) that is mounted pivoting on the first proximal part (6) about a second axis (B) and a third distal part (8) that is mounted pivoting on the second median part (7) about a third axis (C); and

- at least one transfer line (3, 4, 5), suitable for transferring liquefied gas between the first facility and the second facility, and including a flexible first proximal portion (15) suitable for being connected to a liquefied gas storage tank of the first facility; a rigid second median portion (16) that is fastened to the second median part (7) of the articulated arm (2) and a third distal portion (17) that is suspended on the third distal part (8) of the articulated arm (2) and has an end suitable for being connected to a manifold of the second facility, the second median portion (16) being provided with a flow rate adjustment valve (22).

2. The transfer system (1) as claimed in claim 1, in which the second median portion (16) extends along the second median part (7) of the articulated arm (2) and has two bent ends (23, 24) oriented downwards and connected respectively to the first proximal portion (15) and the third distal portion (17).

3. The transfer system (1) as claimed in claim 1 or 2, in which the two ends of the second median portion (16) are respectively aligned with the second axis of articulation (B) and the third axis of articulation (C).

4. The transfer system (1) as claimed in any one of claims 1 to 3, in which the second median portion (16) is laterally offset relative to the second median part (7) of the articulated arm (2).

5. The transfer system (1) as claimed in any one of claims 1 to 4, in which the second median portion (16) is fastened to the second median part (7) of the articulated arm (2) by means of support members (21) that are distributed along the second median part (7), the support members (21) including cross members fastened

to the second median part (7) and a clamping collar fastened to said cross members and through which the second median portion (16) passes.

6. The transfer system (1) as claimed in any one of claims 1 to 5, in which the first proximal portion (15) rests on a support (18, 19) covered with a non-stick coating.

7. The transfer system (1) as claimed in any one of claims 1 to 6, in which the first proximal part (6) of the articulated arm (2) includes a protective cylindrical skirt (20) including a non-stick coating.

8. The transfer system (1) as claimed in any one of claims 1 to 7, in which the third distal portion (17) is suspended on the third distal part (8) of the articulated arm (2) by means of a lifting device, the lifting device including a drum (26) that is fastened to the third distal part (8) of the articulated arm (2) and is associated with a motor and a cable (27) that is wound around said drum (26) and fastened to the third distal portion (17).

9. The transfer system (1) as claimed in claim 8, in which the cable (27) is fastened to the third distal portion (17) by means of a load distributing spreader (29).

10. The transfer system (1) as claimed in any one of claims 1 to 9, in which the third distal portion (17) is provided with an emergency release coupling (25).

11. The transfer system (1) as claimed in claims 9 and 10 in combination, in which the emergency release coupling (25) is hung on the load distributing spreader (29).

12. The transfer system (1) as claimed in claim 10, in which the emergency release coupling is arranged at the junction between the third distal portion (17) and the second median portion (16).

13. The transfer system (1) as claimed in any one of claims 1 to 12, including at least two transfer lines (3, 4, 5), the first proximal portions (15) of each of the two transfer lines (3, 4, 5) being respectively arranged laterally on either side of the first proximal part (6) of the articulated arm (2) and the second median portions

(16) of each of the two transfer lines (3, 4, 5) being respectively arranged laterally on either side of the second median part (7) of the articulated arm (2).

14. The transfer system (1) as claimed in any one of claims 1 to 13, in which the second median portion (16) includes a double-walled hose having an intermediate space that is lined with an insulating material.

15. The transfer system (1) as claimed in any one of claims 1 to 14, in which the first proximal portion (15) and the third distal portion (17) each include a composite hose or a corrugated double-walled hose that includes an intermediate space lined with an insulating material.

16. The transfer system (1) as claimed in any one of claims 1 to 15, including a protective sleeve (32) that is fastened to one end (23) of the second median portion (16), which is connected to the first proximal portion (15), the protective sleeve (32) accommodating one end of the first proximal portion (15) and having a flared inner surface so that it ensures a minimum radius of curvature for said end of the first proximal portion (15).

17. The transfer system (1) as claimed in any one of claims 1 to 16, including a protective sleeve (33) that is fastened to one end (24) of the second median portion (16), which is connected to the third distal portion (17), the protective sleeve (33) accommodating one end of the first proximal portion (15) and having a flared inner surface so that it ensures a minimum radius of curvature for said end of the third distal portion (17).

18. The transfer system (1) as claimed in any one of claims 1 to 17, including at least two transfer lines (3, 4, 5) and a bypass device (34) that connects the second median portion (16) of the two transfer lines (3, 4, 5) upstream of the flow rate adjustment valve (22) provided on each of the second median portions (16).

19. A vessel (30) provided with a transfer system as claimed in any one of claims 1 to 18.