June 16, 1964 R. B. JACOBS ETAL 3,137,143

CONDENSING VACUUM INSULATION

Filed April 23, 1962 2 Sheets-Sheet 1

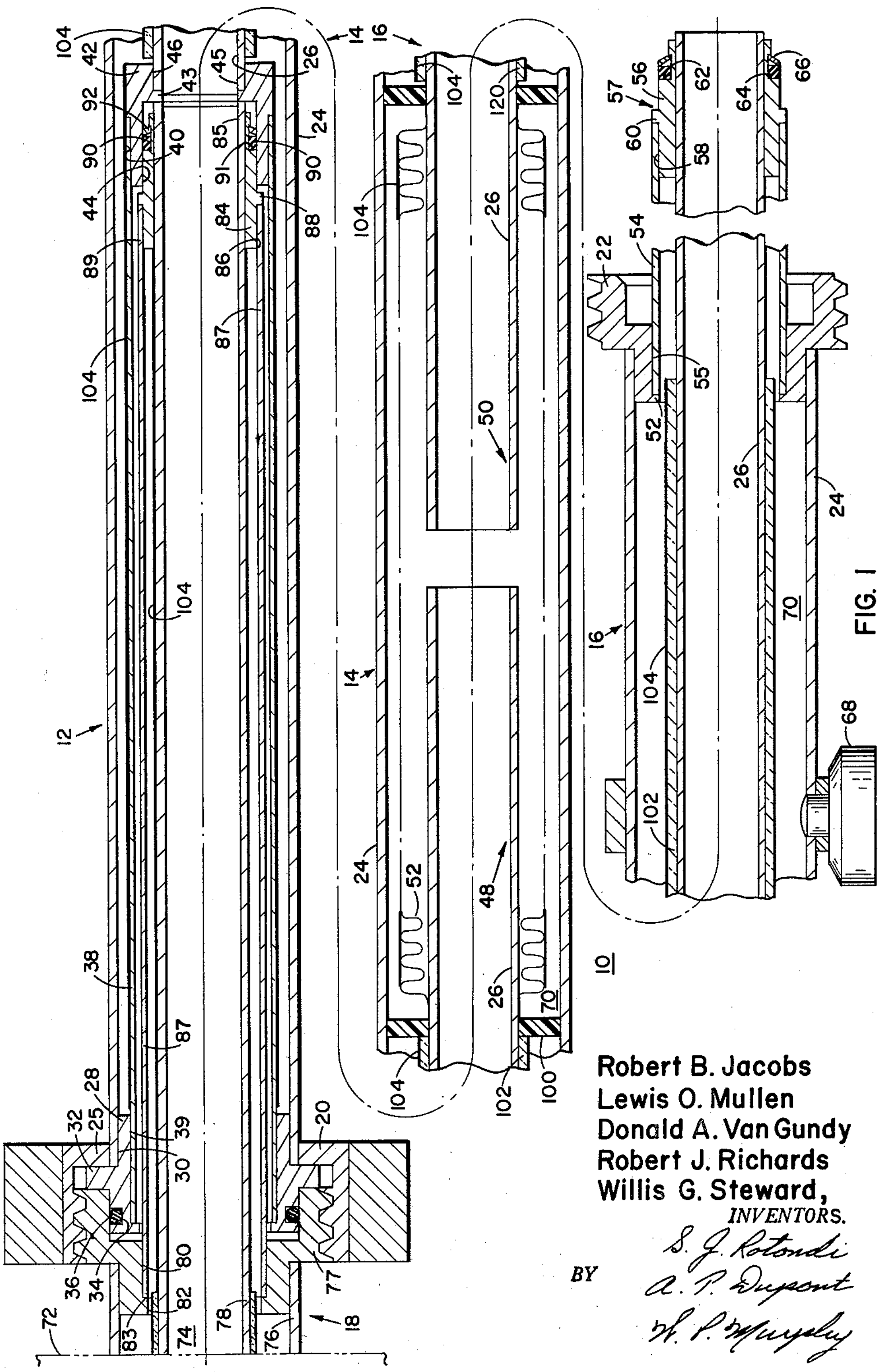

FIG. 1

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CONDENSING VACUUM INSULATION

Filed April 23, 1962 2 Sheets-Sheet 2

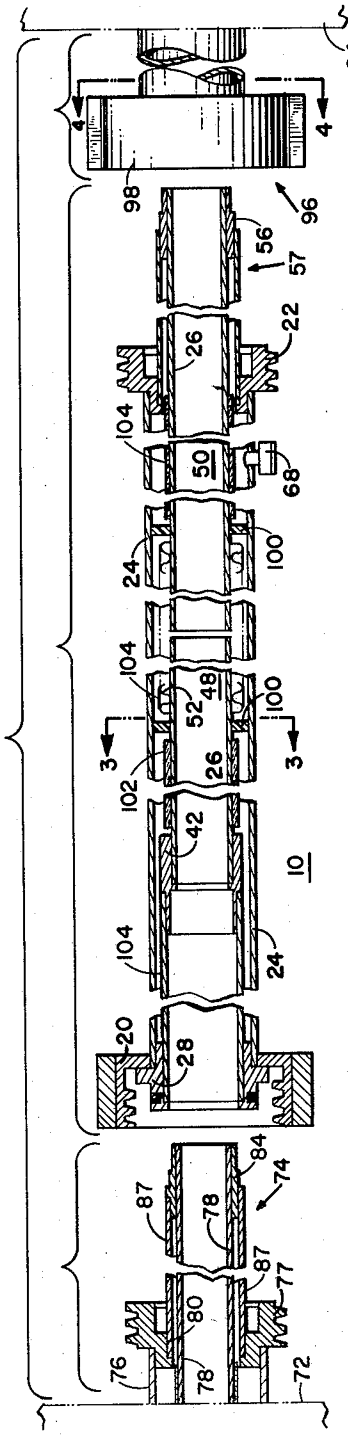

FIG. 2

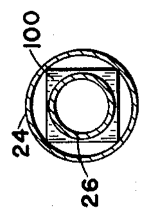

FIG. 3

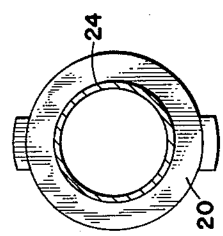

FIG. 4

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3,137,143

CONDENSING VACUUM INSULATION

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8 Claims. (Cl. 62—45)
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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to an apparatus for transfer of liquified gases, as for example, nitrogen, oxygen, etc., and more particularly to insulation for such apparatus.

In the transfer of liquified gases from either the production apparatus or from storage containers to other receptacles it is necessary to maintain the respective gases at low temperatures, ranging from 0° F. to approximately —300° F. in the case of liquified oxygen. The temperatures are lower in the case of hydrogen, nitrogen and other gases. Hence, special precautions must be taken in order to avoid losses due to evaporation which are considerable and, in the case of liquid hydrogen and oxygen, to avoid hazards such as possible combustion and explosion. It is, therefore, necessary that the delivery or transfer apparatus not only be strong and durable, but also that its design and construction be such that heat leakage from the ambient atmosphere to the liquified gas be kept at a minimum.

Conventional vacuum insulation to separate a cold region from a warm environment may be either dynamic or static. In the dynamic system, the vacuum space is continuously pumped. This system requires a pumping apparatus and the power to run it, be available in the vicinity of the dynamically pumped system.

The main problem of the static vacuum system comprises producing and maintaining an adequate vacuum. In order to maintain a static vacuum, the vacuum space must be absolutely leak tight, the walls and contents of the vacuum space must be treated in some manner so that no appreciable amount of gas is desorbed into the vacuum space, and the walls must be impervious to ambient molecules.

It is an object of our invention to provide a means for producing a vacuum in an insulating jacket surrounding a liquified gas carrying container.

It is a further object of our invention to provide an apparatus disposed for transfer of liquified gases and insulated by a gas that is condensable responsive to the cryogenic flow through the apparatus.

In our invention, an apparatus for transfer of liquified gas is provided with inner and outer conduits having an insulating space inbetween. A condensable gas is inserted into the insulating space to solidify responsive to passage of the liquified gas through the inner conduit, thereby creating a vacuum between the two conduits. The inner conduit is enclosed by glass wool to entrap the particles of the condensed gas, thereby preventing these particles from being re-evaporated in the vacuum and impairing the effectiveness of the insulation.

Other objects and advantages of our invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is an elevational sectional view of a transfer line and coupling.

FIGURE 2 is an exploded view of the transfer line disposed for connection between a receiving and a dispensing tank.

FIGURE 3 is a view along line 3—3 of FIGURE 2.

FIGURE 4 is a view along line 4—4 of FIGURE 2.

One illustrative embodiment of our invention is shown in FIGURE 1 in which a transfer line, generally designated at **10**, is disposed for connection to a suitable source of liquified gas. The transfer line is comprised of a plurality of sections **12**, **14**, and **16**.

The receiving end **18** of the transfer line carries a female coupling **20** and the opposite end or delivery end carries a male coupling **22**. The transfer line is provided with an outer conduit and an inner conduit **24** and **26**, respectively.

Female coupling **20** is mounted on the periphery of outer conduit **24** and is provided with internal threading and an inwardly extending shoulder **25**. An insert **28** secured to the inner surface **30** of conduit **24** is provided with an outwardly extending annular shoulder **32**. An annular groove **34** provided on the outer periphery of insert **28** is disposed to receive an O-ring seal **36** therein.

A conduit **38** smaller in diameter than conduit **24** is secured to an inner annular surface **39** of insert **28** and extends to partially enclose and to be secured in an annular recess **40** of a member **42**. Member **42** is provided with a pair of axial openings **44** and **46** in communication. The liquified gas conducting conduit **26** secured in the smaller opening **46** of member **42** extends therefrom into the intermediate section **14** of transfer line **10**. Member **42** includes an inwardly projecting shoulder **43** against which abuts one end **45** of conduit **26**.

Conduit **26** is comprised of a pair of portions **48** and **50**, portion **48** extends from section **12** into the intermediate section **14** of transfer line **10** and terminates just short of the middle of section **14**. Portion **50** of conduit **26** is slightly spaced from the portion **48** of conduit **26** and extends out of intermediate section **14**. The spacing between portions **48** and **50** of conduit **26** permits expansion and contraction of the liquified gas conducting conduit. A seamless bronze flexible tube **52** having annular corrugations is disposed around those portions **48** and **50** of conduit **26** that is within section **14** of line **10**. The flexible tube permits the uninterrupted flow of liquified gas while permitting the expansion and contraction.

Portion **50** of conduit **26** extends from intermediate section **14** of the transfer line and thru section **16** thereof. Outer conduit **24** terminates at section **16** and is secured to male coupling **22**. Coupling **22** is provided with an inwardly extending shoulder **52** and external threading. A conduit **54** abuts against shoulder **52** and is secured to the inner annular surface **55** of coupling **22**.

A projecting portion **57** includes conduit **54** which projects out of coupling **22** and encloses a portion of conduit **26** which also projects through coupling **22**. An end member **56** is provided with an annular recess **58** and an outwardly projecting shoulder **60**. Conduit **54** encloses recess **58** and abuts shoulder **60** and is soldered to member **56**. Member **56** is further provided with a recessed portion **62** into which is positioned a pair of ring members **64** and **66**.

A vacuum seal off valve **68** is mounted in outer conduit **24** of line **10**. Valve **68** is disposed to be opened to permit charging of the space **70**, between conduits **24** and **26**, with a condensable gas.

As shown in FIGURES 1 and 2, a gas dispensing tank **72** is provided with a projecting portion **74** similar in construction to projecting portion **57** of transfer line **10**. Projecting portion **74** includes an outer conduit **76** secured at one of its ends to tank **72**. A male coupling member **77** is secured to the other end of conduit **76**. An inner conduit **78**, partially enclosed by conduit **76**, communicates into tank **72** and extends therefrom. Male coupling member 77 is provided with an inner annular recessed surface 80 and an inwardly projecting shoulder 82. A conduit 87 is soldered in this recess so that one end 83 of conduit 87 abuts against the shoulder 82.

The inner conduit 78 extends from tank 72, through male coupling 77, and has an end member 84 secured around its other end 85.

End member 84 is provided on its outer annular surface with a recess 86 and an outwardly projecting shoulder 88. Conduit 87 extends from male coupling member 77 to enclose conduit 78 and is positioned at its end 89 into recess 86 of end member 84. The conduit may be secured to member 84 by soldering.

End member 84 is provided with an outer annular surface 91 into which is positioned a pair of ring members 90 and 92 which inhibit the flow of liquid between conduits 38 and 87. Ring member 90 is a piston ring which primarily inhibits said flow, while ring member 92 is a spring washer which holds ring member 90 in the proper position.

To connect the transfer line to the dispensing tank the receiving end 18 of line 10 is slipped over projecting portion 74. Conduit 78 extends into section 12 of the transfer line and the ring members 90 and 92 are seated against the inner annular surface of recess 44 provided in end member 42. Female coupling 20 is then threaded to male coupling 77 to assure a tight leakproof seal.

As shown in FIGURE 2, a receiving tank 94 is provided with a connecting portion 96 similar to section 12 of the transfer line into which is inserted the projecting portion 57 of transfer line 10. A female coupling 98 provided on connecting portion 96 is disposed to be threaded to the male coupling member 22 of line 10 to complete the connection.

The transfer line is provided with spacers 100 positioned around conduit 26 and secured to conduit 26 to support conduit 26 throughout its length. These spacers are preferably made of "Teflon" and are substantially rectangular in cross-section to permit the condensable gas to flow around the spacers and fill the space 70.

The space 70 is full of the condensable gas at all times and when the connection is made between the receiving and dispensing tanks the gas is disposed to condense responsive to the cryogenic flow through the line thus creating a vacuum in space 70.

Because the condensate may not adequately adhere to the inner conduits, the inner conduits 26 and 38 are wrapped with a material 102, having entrapping interstices such as laminated unbonded Fiberglas. Material 102 is disposed to trap solid condensed particles of the condensing gas. Another advantage of this particular type of construction is that the solid particles can adsorb gases. However, in conventional high vacuum insulation, these gases would remain in the vacuum space and serve to deteriorate the vacuum insulation.

Because the trapping material has a high absorptivity for infra-red radiation, the resultant vacuum insulation would be very poor. Therefore, a highly polished material 104, such as aluminim foil is wrapped around material 102 to provide surfaces of low absorptivity and thus produce an insulation of high effectiveness.

While the above discussion has been directed to a transfer line utilizing carbon dioxide as a condensable gas this is to be taken in an illustrative sense rather than in a limiting sense. Obviously various modifications may be resorted to, such as utilizing other condensable media for creation of a vacuum or applying the principles of the invention to apparatus such as transport containers, storage tanks, valves, etc., but these modifications are within the spirit and scope of the appended claims.

We claim:

1. Apparatus for flow of low temperature fluids therethrough comprising:

(*a*) an elongated outer tubular member having a re-

ceiving end provided with a coupling for attachment to a supply of cryogenic fluid;

(*b*) an inner tubular member including a receiving end section disposed in communication with said supply of cryogenic fluid and secured thereto by said coupling and disposed for cryogenic flow therethrough, said inner tubular member axially disposed within said outer tubular member to provide therewith an annular chamber;

(*c*) a condensible gas disposed in said chamber for condensation responsive to cryogenic flow through said inner tubular member;

(*d*) a material possessing entrapping interstices wrapped on said inner tubular member and disposed for adsorbing molecules of said condensible gas for concentration thereof at said material to provide thereon a layer of solidified gas enclosing said inner tubular member and providing insulation thereto, said gas disposed to materially decrease pressure within the chamber for evacuated enclosure of said inner tubular member responsive to the solidification; and

(*e*) a member forming a radiation shield enclosing said entrapping material and said inner tubular member, said radiation shield and said entrapping material being spaced from said outer tubular member to aid in solidifying and preventing re-evaporation of said solidified gas by keeping said solidified gas from contact with said outer tubular member.

2. The apparatus of claim 1 wherein said entrapping material is glass wool.

3. The apparatus of claim 1 wherein said radiation shield is aluminum foil.

4. The apparatus as set forth in claim 1 including rectangular spacers carried by said inner tubular member and secured to the outer surface of said inner tubular member for support therein of said inner tubular member.

5. Apparatus as in claim 1 wherein said outer tubular member is provided with a delivery end section:

(*a*) a coupling carried on said delivery end section for attachment thereof to a receiving tank; and

(*b*) said inner tubular member provided with a delivery end section extending through said coupling and protruding into said receiving tank.

6. Apparatus as in claim 5 wherein said inner tubular member includes:

(*a*) an intermediate discontinuous section including a pair of portions in axial alignment, one portion thereof provided with an end disposed adjacent one end of said receiving end section; and

(*b*) sealing means secured on said adjacent ends and disposed to inhibit cryogenic flow into said chamber.

7. Apparatus as in claim 6 including a flexible tube having annular corrugations disposed around said portions and extending over the space between said portions to permit expansion and contraction of said portions.

8. Apparatus as in claim 6 wherein said sealing means includes:

(*a*) a collar mounted on said one adjacent end of said portion and partially enclosing said one end of said receiving end section; and

(*b*) a piston ring carried on said one end of said receiving end section for engagement with said collar to inhibit said cryogenic flow into said chamber.

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