June 21, 1960 J. STEENFELD ET AL 2,941,403

LIQUID DEPTH GAUGE

Filed April 29, 1955

Fig 2

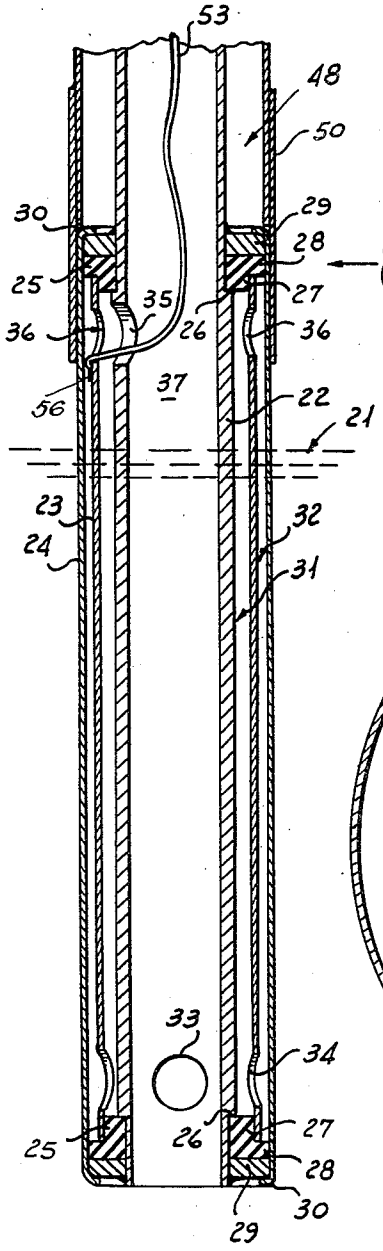
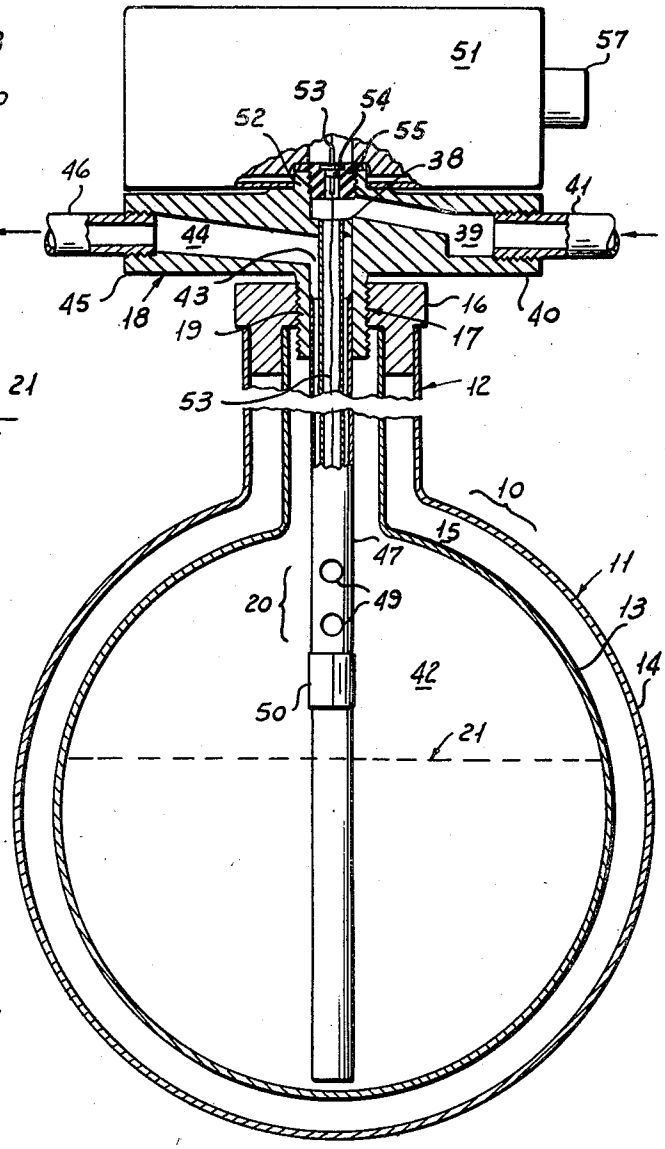



Fig 1




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# LIQUID DEPTH GAUGE

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This invention relates to liquefied gas converters, in which a supply of liquefied gas is maintained in a container, from which gas evaporated from the liquid is withdrawn as needed. Systems of this kind are used to supply oxygen to high-flying aviators.

Apparatus of this type must be provided with arrangements for introducing liquid to replenish the supply when required, and should include means for indicating the amount of liquid in the container. This is effectively accomplished by an electrical system including a Wheatstone bridge having in one arm a condenser immersed in the liquid and extending vertically throughout the liquid depth range, an oscillator circuit for energizing the bridge and a bridge output circuit containing an indicator actuated by variations in the capacity of the immersed condenser due to changes in liquid level. The indicator may be located at a point remote from the container, which is provided with a transmitter unit including the immersed condenser, and preferably the other bridge elements and the oscillator circuit. The unit must be associated with, and advantageously is removably mounted on, the container, which is designed to provide insulation for the low temperature liquid, frequently being constructed with insulated inner and outer walls and a long neck to minimize the heat transfer by conduction.

An object of the invention is to provide a novel arrangement for inserting and supporting an immersion condenser in a container.

Another object is to provide an arrangement of this type that is suitable for use with a container having an elongated neck.

A purpose is to provide a novel arrangement for introducing liquid and withdrawing gas from the container. A related purpose is to provide such an arrangement in combination with an immersion condenser.

An object is to provide a unitary combination structure functioning both as an immersion condenser and as liquid introduction and gas withdrawal means.

Another object is to provide a unitary fitting, removably mountable in the container mouth and carrying as a unit an immersion condenser, a liquid supply and gas removal system, components of an electrical circuit responsive to liquid depth, or any combination of these features.

A particular object is to provide an improved immersion condenser construction, and especially one that is readily produced from standard material and is conveniently and rapidly assembled, while maintaining high electrical efficiency and responsiveness to liquid level changes.

A further purpose is to provide an immersion condenser with simple and efficient radio frequency shielding suitable for efficient operation when the condenser is energized by a local oscillator circuit. A related purpose is to provide such shielding in a simple, efficient and rugged unitary construction.

Another object is to provide improved arrangements for gas withdrawal from gas space above a submerged condenser unit.



The foregoing and other objects, purposes and advantages of the invention will appear more fully from consideration of the detailed description which follows, in conjunction with the accompanying drawing wherein one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawing is for the purposes of illustration and description, and is not to be construed as defining the limits of the invention.

In the drawing:

Fig. 1 is a somewhat diagrammatic vertical central section through an oxygen converter system embodying the invention, with parts shown in perspective and broken away; and

Fig. 2 is an enlarged longitudinal central section through the lower portion of the immersion condenser probe.

The invention is illustrated in its application to an oxygen converter system which includes an insulated liquid oxygen container or bottle **10** having a body **11** and a neck **12**, both comprised of an inner wall **13** and an outer wall **14** with an insulating space **15**, normally evacuated, between them. Walls **13** and **14** are sealed at the upper end of neck **12** to a metal cap **16** having a central mouth or opening **17**. Insulated bottles of this type are known, and features thereof which would normally be included in practice have been omitted from this showing for purposes of simplicity, since they have no relationship to the invention.

A fitting **18** of electrically conducting metal is mounted in the bottle mouth **17**, as by threading neck **19** into said mouth so as to seal the bottle **10**. An immersion condenser assembly **20** is mounted in neck **19** and extends downwardly through the bottle neck **12** substantially to the bottom of the bottle **10**, this type of assembly being generally referred to as a probe. It includes a condenser unit formed of plates insulated from each other and extending from substantially the bottom of the bottle **10** to a point above the maximum height of the liquid level **21**.

The condenser unit forming part of assembly **20** may advantageously terminate substantially below the fitting neck **19**, and of course above the maximum liquid level, as shown in the form illustrated. In this form the condenser unit of probe **20**, shown in detail in Fig. 2, includes an inner tubular condenser element **22**, an intermediate tubular insulated condenser element **23** and an external tubular condenser element **24**, all concentrically arranged, and conveniently cylindrical as in the illustrated embodiment.

The intermediate element **23** is supported and insulated by rings **25** of insulating material fitted around the inner cylinder **22** and bearing against shoulders **26** on said cylinder. Rings **25** are advantageously L-shaped in cross-section, and include a cylindrical body portion **27** fitting against the inner face of intermediate cylinder **23**, and a radially extending flange **28** fitting the inner surface of outer cylinder **24** and bearing against the adjacent end of the intermediate cylinder **23**. Abutting against the axially outer faces of insulation rings **25** are annular metal retaining caps **29** fitting tightly around inner cylinder **22** and connected thereto as by soldering. Outer cylinder **24** fits snugly around caps **29** at its ends, and is suitably engaged to said caps, as by spinning the ends **30** of cylinder **24** around the adjacent margins of said caps.

Condenser assembly **20** is provided with openings through which liquid will pass into the spaces **31**, **32** on either side of intermediate cylinder **23** and promptly assume the same level as the liquid outside of said assembly. In the form illustrated, the inner cylinder **22** is provided with one or more openings **33** immediately adjacent to the bottom levels of said spaces **31**, **32**, and intermediate

cylinder 23 is likewise provided with one or more openings 34 at substantially the same level. The arrangement is such that by properly positioning and proportioning the lower cap 29 and adjacent insulation ring 25, liquid at a very low level in bottle 10 will enter the condenser arrangement and register on the indicating system.

Similar openings 35 in inner cylinder 22 and openings 36 in intermediate cylinder 23 are provided immediately adjacent to the upper ends of spaces 31, 32, and are located above the maximum height of liquid level 21.

The assembly or probe 20 includes an arrangement for suspending the condenser unit above described and for providing a connection between the passage 37 within the inner cylinder 22. In the construction shown, the latter cylinder is extended through fitting neck 19 into fitting 18, and is attached thereto, as by soldering said cylinder 22 to an annular supporting flange 38. The open upper end of passage 37 communicates with a liquid inlet passage 39 extending outwardly through a radial arm 40 of said fitting, and advantageously threaded at its outer end to receive a liquid supply pipe 41.

The space 42 in bottle 10 above liquid level 21 is filled with gas, which in the case of an oxygen supply system consists of gaseous oxygen evaporated from the liquid in the lower part of the bottle. An arrangement is provided for withdrawing gas from space 42 as desired. For this purpose the fitting neck 19 is provided with an axial bore larger in diameter than the inner cylinder 22, which passes through and is spaced from the walls of said bore to provide an annular passage 43 communicating with a gas outlet passage 44 extending through radial arm 45 of fitting 18, and advantageously threaded at its outer end to receive the gas discharge pipe 46. The radial arms 40 and 45 may conveniently be located opposite each other, with axially aligned outer openings, and passages 39 and 44 are preferably arranged with passage 49 sloping upwardly to the inlet of passage 37, while passage 44 slopes downwardly to a point below said inlet, flange 38 and the upper end of inner cylinder 22.

It will be understood that the liquid oxygen supply arrangement and the gas discharge arrangement will normally be provided with numerous features such as valves and controls, which are not relevant to this invention and therefore have been omitted in the interests of simplicity.

The probe 20 is advantageously provided with gas withdrawal means. In the form shown this comprises a cylindrical casing 47 fitting within and attached to the outer wall of the outlet passage 43 in neck 19, as by soldering, and extending downwardly to the upper end of outer cylinder 24. Casing 47 and inner cylinder 22 are spaced to form an annular gas passage 48 communicating with passages 43 and 44, and provided with suitable gas inlet means such as openings 49 in said casing, advantageously near the lower part thereof adjacent to the upper end of outer cylinder 24.

Casing 47 is preferably fixed to cylinder 24 to provide added support and rigidity, being axially aligned with said cylinder in the illustrated embodiment, abutting the upper end of the latter cylinder and attached thereto as by a cylindrical connecting collar 50 fitting against the outer faces of casing 47 and cylinder 22 and firmly attached to said casing and cylinder as by soldering. As already indicated the condenser unit forming the lower portion of probe 20 is electrically connected to a circuit responsive to variations in the capacity of said condenser caused by changes in the liquid level. A circuit of this type is shown, for instance, in application Serial No. 498,681, filed April 1, 1955, by George V. Zito. Components of such a circuit, advantageously including all elements thereof except the indicator unit, are enclosed in a casing 51 mounted on fitting 18 and forming a compact unitary structure with the probe. As illustrated, said fitting is provided with a central positioning boss 52 to which the casing 51 is attached.

An arrangement is provided for connecting the condenser unit formed by cylinders 22, 23 in said circuit. For this purpose electrically connected cylinders 22 and 24 may be on the ground side of the circuit and in communication through fitting 18 with the ground side of the components in casing 51. An insulated lead 53 from said circuit is carried through a connector 54 set in an insulating plug 55 into passage 37, the lower end of lead 53 passing through an opening 35 in the condenser portion of cylinder 22 and being electrically connected at 56 to the insulated intermediate cylinder 23. Casing 51 may be provided with the usual plug socket 57, through which leads to the remote indicator and source of electrical energy may be connected by a plug.

The probe 20 is arranged for convenient construction, assembly and mounting on fitting 18, the probe being formed of metal cylinders of standard commercial type, with identical caps 29 and insulating rings 25, which may be slid into place on the inner cylinder 22 and fixed in position engaging intermediate cylinder 23, after which the outer cylinder 24 may be fixed in place. The casing 47 with collar 50 can then be positioned and attached to cylinder 24. Likewise the casing 47 and inner cylinder 22 are arranged for convenient mounting in and attachment to fitting 18.

In operation, liquid oxygen is introduced through pipe 41 and passages 39 and 37, flowing out of the bottom of inner cylinder 22 into the bottle 10 and through openings 33 and 34 into the space 31 and 32, where the liquid level will be maintained at the same height as that in the bottle 10 and will suitably actuate the remote indicator. This makes it possible for the operator to regulate the supply of liquid oxygen by observing the indicator. Gas may be withdrawn as desired through pipe 46, passages 44, 43 and 48 and inlet openings 49, being replaced by evaporation from the liquid.

It will be evident that with this arrangement the entire liquid supply and gas discharge system is carried by the fitting 18, which also carries the condenser assembly or probe 20 and the electrical circuit elements in casing 51. This entire assembly may be inserted in or removed from a bottle 10 by simply screwing the neck 19 in or out of the bottle mouth 17.

It is also pointed out that the invention is effective for shielding the condenser elements and leads carrying radio frequency voltages. The outer and inner tubular condenser elements 22 and 24 are conductively connected to the fitting 18 and the frame of the circuit casing 51 which form one side of the circuit connected to a reference voltage, usually ground; and the lead 53 from the insulated intermediate plate 23 passes upward to the circuit elements in casing 51 through inner tubular element 47 and fitting 18, providing continuous shielding.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention, as the same will now be understood by those skilled in the art. For instance, the upper part of the inner cylinder 22 functions as a support for the condenser unit while the lower part operates as an element of said unit; and while these parts are shown as integral, this arrangement is not intended to be restrictive. Likewise, while the casing 47 in the form illustrated is fixed to the condenser unit and acts as a support, being connected to the interior of the container 10 to openings 49, the invention is not limited to the use of this casing nor its equivalent as a support, or to the particular type of gas inlet illustrated.

We claim:

1. A liquid level sensing system for use with a liquid container having a top opening, comprising a fitting for said opening, a tubular metal support element mounted

on said fitting and extending downwardly from the fitting, a coaxial tubular condenser unit carried by said support element and having an open passageway communicating with the interior of said tubular element, and a fluid passageway in the fitting communicating with the interior of said tubular element, arranged for the passage of fluid through said fitting and support element.

2. A liquid level sensing system for use with a liquid container having a top opening, comprising a fitting for said opening, a tubular metal support element mounted on said fitting and extending downwardly from the fitting, a tubular metal condenser element mounted concentrically on the lower part of and insulated from said support element, arranged for forming with the lower part of the support element and immersion condenser unit, and a fluid passageway in the fitting communicating with the interior of said tubular support element, arranged for the passage of fluid through said fitting and support element.

3. A liquid level sensing system for use with a liquid container having a top opening, comprising a fitting for said opening, a tubular metal support element mounted on said fitting and extending downwardly therefrom, a coaxial tubular metal condenser unit carried by said support element and having an open passageway communicating with the interior of said tubular element, and a fluid passageway in the fitting communicating with the interior of said tubular element, said fitting being provided with a second separate fluid passageway communicating with the upper part of the container.

4. A liquid level sensing system for use with a liquid container having a top opening substantially above the liquid level in the container, comprising a fitting for said opening, an inner hollow metal cylinder mounted on the fitting and extending downwardly therefrom, arranged to extend through said opening into the container below said liquid level, a liquid passageway through the fitting communicating with the interior of said cylinder, and an outer metal cylinder mounted on the fitting concentric with and spaced from the inner cylinder below the fitting, and including an opening for gas in the upper part contiguous to the fitting, said fitting including a gas passageway communicating with the space between said cylinders.



5. A liquid level sensing system including a liquid container having a top opening, a fitting mounted in said opening, a liquid level sensing condenser mounted on the fitting and extending downwardly into the container, including a tubular condenser comprising two concentric plates located in the container, a liquid supply passage in the fitting in communication with the interior of said tubular condenser, and a gas passage in said fitting in communication with the upper part of the container.

6. A liquid level sensing system including a liquid container having a top opening, a fitting mounted in said opening and provided with a passage, a first tubular metal condenser plate mounted on the fitting in communication with said passage and extending downwardly therefrom into the container, a second associated tubular condenser plate concentric with said first plate, and means for mounting the second plate in capacitive relation to and insulated from the first plate, said fitting including a second passage connected to an opening in the lower part of the fitting arranged to communicate with the upper part of the container.

7. A liquid level sensing probe for use with a liquid container having a top opening, comprising a fitting for said opening provided with a passage, a first tubular metal condenser plate mounted on the fitting in communication with said passage and extending downwardly from the fitting, a second associated tubular metal condenser plate concentric with said first plate and spaced from the fitting, and means for supporting the second plate from the fitting, said fitting being provided with a second passage having an opening in the lower face of the fitting, arranged for communication with the upper part of the container.

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