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ABSTRACT

A system for measuring depths of cryogenic liquids is described. The indicating device is a modified differential pressure gage. The level sensing probes are of various types, either permanent or removable. The heat leak to cryogenic liquids may be made negligibly small.

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THE PRESSURE GAGE

The gage used is a modification of the "Magnehelic" gage (F. W. Dwyer Co.), a differential pressure gage available with a minimum full scale range of 15 in. of liquid hydrogen and a corresponding least count of 0.3 in. of liquid hydrogen. (See Fig. 1). This sensitivity is made possible by a unique magnetic coupling between the force-balance system and the indicating mechanism.

The pressure-sensing element is a flexible synthetic-rubber diaphragm. In the modification, this diaphragm is protected against overtravel and overpressures up to 40 psi in either direction. The case is redesigned to be vacuum tight (essential for purging) and to withstand an internal pressure of 150 psi. After modification, the gages are calibrated with an inclined-tube manometer and show typical errors of 4% of full scale.

THE LEVEL SENSING PROBES

These probes can be either permanent or removable. The permanent probes are those commonly used to measure a hydrostatic differential pressure, with the low-pressure tap in the vapor above the cryogenic liquid and the high-pressure tap coming out of the bottom of the liquid container. This latter tap is a stainless steel tube wound in a spiral with a slight upward cast from the horizontal. The length of tube in the spiral minimizes the heat leak; the upward cast insures a stable boiling interface. The free end of the stainless steel spiral is connected to a copper tube of low thermal resistance which leads out the top flange of the vacuum jacket.

The removable probes are of the gas-bubbler type. The low-pressure tap again is exposed to the vapor above the cryogenic fluid. The high-pressure tap is exposed to the liquid at the bottom of the container by means of a tube inserted through the top of the vessel. The liquid-vapor interface in the tube is kept at

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the bottom of the tube by slowly bleeding in a noncondensable gas. Continued flow of gas is not always necessary; these probes when charged with helium will measure liquid-hydrogen levels for many hours before helium must be added.

A more versatile type of probe is one that generates its own gas. This probe has two coaxial tubes leading to the bottom of the liquid. The outer tube furnishes vacuum insulation for the inner tube; the inner tube is a series combination of copper and stainless steel. The lower end of the inner tube is stainless steel with a large temperature gradient down its short length. This gradient keeps the boiling interface near the bottom of the stainless section and also keeps the vapor in the inner tube well above condensation temperature.

THE SYSTEM

Two or more pressure gages can be paralled to read from the same probe. The gages have been installed with a much as 40 ft of 3/16-O. D. connecting tubing between the gages and the probes. Because of the high sensitivity of the gage, the system must be vacuum tight to avoid erroneous readings. Jitter of the gage during filling and emptying of the vessel is not extreme for either the permanent probe or the gas-generating probe. Small fluctuations present can be damped out with a pneumatic RC circuit using the volume of the gage itself and a short piece of capillary tubing in series with the high-pressure tap.

Figure Legend

Fig. 1. The modified Magnehelic gage.