Rutherford Laboratory

Technical Leaflet

A20

# LIQUID HELIUM LEVEL GAUGE

A new helium level gauge has been devised using a loop of wire of the 'hard' superconducting alloy niobium zirconium. The liquid level is indicated by the voltage drop across the wire when a relatively high electric current is passed through it from a constant current generator.

The gauge has the following features:

Simplicity of sensing element and control unit;
Remote indication;
Continuous level reading with linear calibration;
Relatively little power introduced into the liquid helium;
Operates over wide pressure range, 1 to 760 torr;
Operates in presence of strong magnetic fields.

A description of the gauge and its mode of operation are now given.

The sensing element consists of a long loop of niobium-zirconium wire mounted in an insulated tube with open ends, and dipping into the liquid helium as shown in figure I. A constant current generator is connected across this loop, together with a voltmeter to indicate the helium level.

Before the gauge is turned on electrically, the wire loop is superconducting over almost its entire length, for even above the liquid level the helium gas is usually also well below 11°K, the temperature of transition between the normal and superconducting states for the alloy used. However, at the very top of the loop near the input connection, the wire is at or near room temperature, so that when the constant current source is switched on power will be dissipated in this part of the wire, and its temperature will rise. The boundary between the normal and superconducting parts of the wire is rapidly driven downwards through the region of cold gas since the heat generated in the wire is not easily transferred to the surrounding gas. However, the boundary cannot be driven past the liquid surface, for below this level the heat transfer between metal and liquid is so good that the wire remains superconducting. As the resistivity of the alloy used varies but slowly with temperature, the heat dissipated per unit length is also roughly constant and this in itself tends to stabilize the temperature. Thus a voltmeter connected across the top of the loop gives a reading directly proportional to the length of wire exposed above the liquid. By using the small bias battery shown in the figure, the voltmeter indicates the level directly.

The gauge can operate over a wide pressure range, for the heat transfer to the gas is roughly independent of pressure over the range 1 to 760 torr.

The sensing head will operate in magnetic fields in excess of 20,000 gauss.

Details of the control circuit, which uses a single transistor to stabilize the current, are given in figure I.

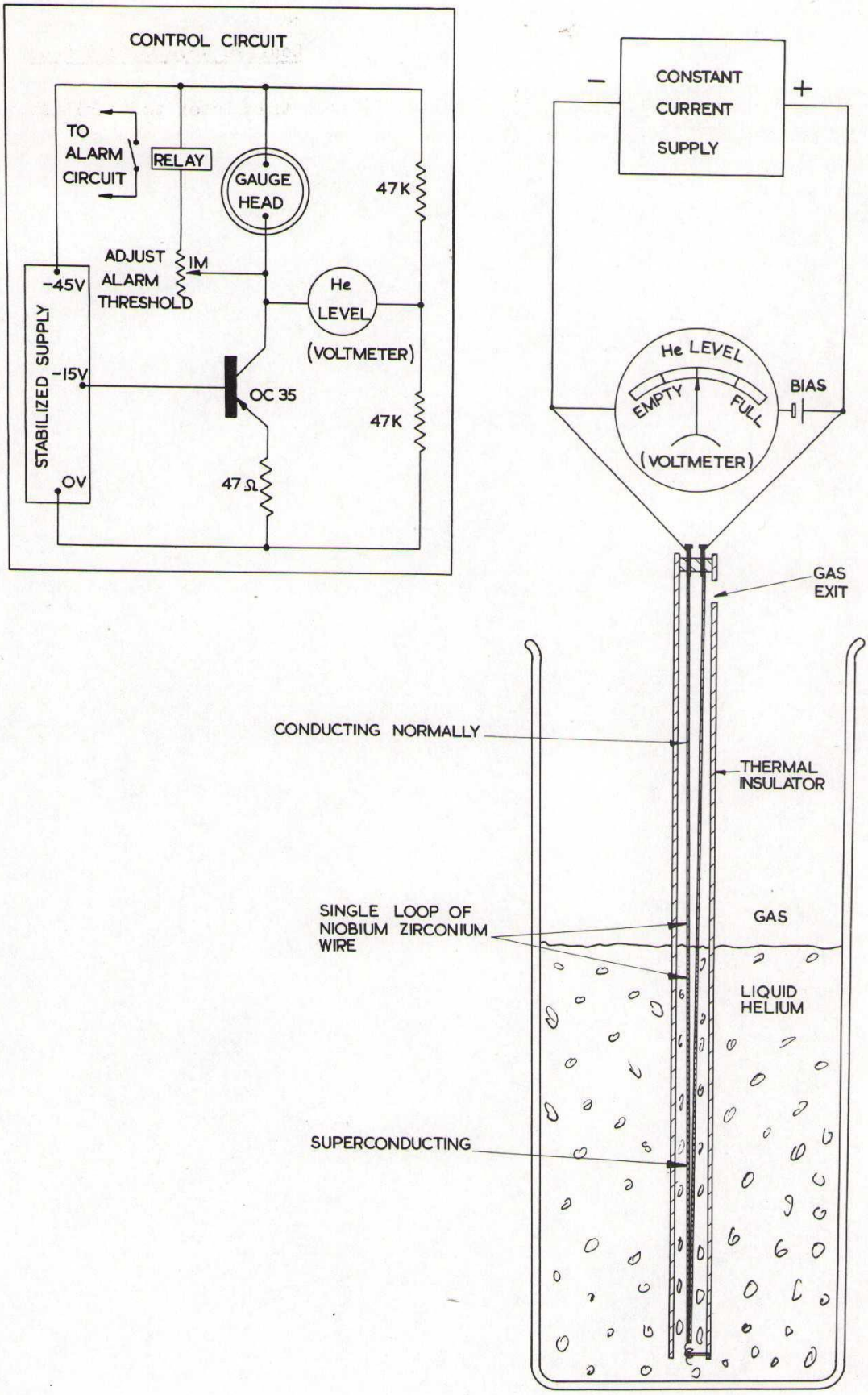


FIGURE 1. A NEW LIQUID HELIUM LEVEL GAUGE USING A 'HARD' SUPERCONDUCTING ALLOY