Tracerlab

DIVISION OF LABORATORY FOR ELECTRONICS, INC.

CLATHRATE
GAS DETECTOR

INSTRUCTION MANUAL

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INTRODUCTION

The Tracerlab Clathrate Gas Detector is an instrument designed to detect concentrations of nitrogen dioxide gas in air. The sensing element is a krypton-85 quinol clathrate, which undergoes a chemical reaction with the gas being analyzed, with the ultimate release of a radioactive gas.

Krypton-85 quinol clathrates are compounds that contain krypton atoms that are completely enclosed by molecules of quinol in such a way that escape is prevented unless the forces that bind the quinol crystal are overcome. This can be compared to a honeycomb of quinol, with krypton-85 atoms inside the interstices. When the quinol is oxidized to quinone, the hydrogen bonds that enclose the cases are destroyed, and the radioactive krypton-85 can diffuse into the air stream and be swept along to the counting chamber. The counting rate is thus proportional to the concentration of the oxidizing substance. The instrument consists of two basic units, the gas detector proper and the unit used to measure the counting-rate output. The latter unit is a modified Tracerlab SC-79 ratemeter, an instruction manual for which is enclosed herein. The specifications for the gas detection unit itself and the operating instructions for the overall system are given below.

DESCRIPTION

A. Electrical Specifications:

--Voltages to operate pump motor and alarm circuit derived from ratemeter through a six conductor cable.

--Operating Voltage: 115 Volts AC @50/100 CPS

--Power Consumption: 120 watts

--Fusing: Fuse located in ratemeter (see instruction manual for ratemeter)

B. Mechanical Specifications:

--Dimensions: 7" high, 17" chassis width, 13" deep.

--Weight: 30 pounds.

--Finish: Bermuda Blue chassis; light gray panel, painted aluminum, epoxy coated.

OPERATING INSTRUCTIONS

A. Controls and Indicators - (See Fig. 1):

--Pump - Main Power: Applies power to the pump motor while ratemeter is off.

--Alarm Reset: This allows the operator to disconnect the audio alarm circuit when the detector has indicated "out-of-tolerance". Resetting this switch does not, however, interrupt the main alarm circuit. Visual indication will still be maintained until the main reset button is depressed. The latter is located on the SC-79 ratemeter front panel.

--Alarm Light: Gives visual indication of "out-of-tolerance" readings.

--Flow Meter: This is set for 0.3 SCFH (140 ml./min.) flow through the counting chamber.

--R.H. Control: This control is manually adjusted in accordance with the relative humidity and provides for the production of the same counting rate for the same gas concentration at different relative humidity values.

B. Connectors - (See Fig. 1):

--Input: Connection for sampling the atmosphere.

--Exhaust: The output of the sampling system. This must be lead to a well ventilated area.

--P-101: Main power and alarm circuits from ratemeter to gas detector.

--P-102: Signals from G.M. Tube to input of ratemeter.

C. Switching On Procedure:

Steps 1 through 6 should be observed as outlined in the ratemeter manual, page 3. The pump should be in operation and flow rate adjusted for 0.3 SCFH for at least 15 min. before taking a reading. The reason for this is to allow for equilibration of the air stream as to relative humidity. A recorder placed on the recorder output-jack (see ratemeter manual, page 3) will give an accurate account of warm-up and final equilibration. This equilibration should be well established for a period of five minutes. At this point adjust R.H. control in accordance with the calibration chart for the proper setting. The instrument will then be ready for use.

Note: If the gas detector has not been used for some time there will be an initially high counting rate due to normal leakage of krypton from the clathrate. This will be pumped off during the warm up period of the instrument.

PRINCIPLES OF OPERATION

A. Flow System:

The air flow is achieved by means of a diaphragm pump. After passing over the clathrate, the air is pulled through a 25 ml. counting chamber fitted with a .0008 inch Monel window. Flow rate indication is by means of a Brook-Mite Kel-F flow meter.

B. Alarm System:

The electronic alarm system is so designed that both audio and visual indications of excessive readings are displayed. If the gas analyzer reads a ppm concentration in excess of the alarm setting on the meter panel, a relay is energized which automatically engages an audio and visual alarm and disconnects the pump from operation. The instrument is also provided with an audio disconnect switch which disengages the audio alarm while the system is still in visual alarm function. The alarm set is incorporated into the API meter located on the ratemeter and allows the operator to set the limit of allowable concentration read by the Gas Detection before the alarm circuit is energized.

The alarm circuit consists of a D.C. operated relay which is energized by the API meter-relay. This meter is provided with a set of contacts and special locking winding. The applied signal causes the

moving contact to approach the adjustable contact. When contact is made, a small current flows through the locking coil. As this current increases it forces the contacts together and results in closure of the D.C. relay. The latter disconnects the pump motor on the gas detector chassis and energizes the alarm light and bell. The audio disconnect button is located on the gas detector chassis and disengages the bell by dropping out relay RY 101 (Fig. 1).

C. Humidity Compensation:

The gas detector sensitivity is compensated for humidity changes from 30% to 95% room humidity by means of a manually controlled room humidity adjustment. The adjustment mechanism consists of an adjustable camera shutter diaphragm placed between the counting chamber and the G.M. tube. As the shutter is closed, the beta rays are attenuated and the counting rate is lowered.

D. Ratemeter Modifications:

The tracerlab Standard SC-79 Ratemeter has been provided with the following modifications:

1. Provision for background suppression.

2. Two additional time constants ranges 60 sec. and 120 sec.

3. An alarm-type meter and associated relay (described above).

The zero suppress effectively rotates the scale to a new zero position by supplying negative basis to the cathode of V12-105B, the output cathode follower. A maximum of two scale decreases in background is allowable.

Two additional integration time constant ranges have been added to provide extra long integration times. They are 60 sec. and 120 sec. and are provided for by means of the main time-constant switch.

The detailed circuit changes have been incorporated into the schematic provided as part of the SC-79 instruction manual.

RADIOACTIVITY PRECAUTIONS

The possibility of exposure to radiation from the Kr^{85} clathrate used in the Tracerlab NO_2 Monitor is remote if the following precautions are observed.

The instrument exhaust must be vented into a well ventilated area, if possible into the air stream of an exhaust blower. The inlet to the NO_2 Monitor should be protected from the possibility of entry of any liquid substance, particularly water or organic solvents. The vapors of organic solvents are also harmful and should be excluded from the instrument to the greatest extent possible. It should be noted that unnecessary tubing connected to the inlet of the instrument will decrease its speed of response.

No measurable radiation could be found on the outside of the NO_2 Monitor. The radiation level is less than 0.3 mr per hour at the surface of the lead shield which contains the source. These and subsequent readings were taken with a properly calibrated Tracerlab ionization chamber radiation monitor model SU-1H.

A fresh source containing 100 millicuries Krypton 85 removed from the lead shield produces radiation levels of 8 mr per hour gamma and 20 mr per hour beta on the surface.

NOTE

As a general precaution, it is strongly advised that rubber or plastic gloves be used during any procedure involving the handling of the clathrate cell.

MAINTENANCE

A. General:

--Pump: Requires a light grade oil in both bearings twice a year. No other maintenance is required.

--G.M. Tube: Replacement should not be necessary throughout the life of the instrument provided that the high voltage is maintained within the tube's characteristics, viz., 500 to 600 volts. The operating voltage has been preset at the factory for 550 V.

B. Replacing the Clathrate Cell:

The clathrate cell is subject to depletion during exposure to NO_2. When a change in sensitivity of the instrument is noted, the cell is approaching exhaustion and should be replaced. Fresh cells are available on an exchange basis from Tracerlab.

CAUTION

The exhausted cell should not be destroyed, but should be returned to Tracerlab or given to an authorized person qualified to dispose of radioactive waste materials. Before attempting to replace the cell, read carefully the section entitled "Radioactivity Precautions" on pp 8.

The clathrate cell is a 4 inch length of 1/4 inch teflon tubing contained in a lead shield (See Fig. 2). It can be removed by disconnecting the right angle gas fittings from each end and by lifting it up and out of the lead shield. Handle this cell carefully. Remove the new cell

from its container and remove the end caps. Insert the new cell in the lead shield with the red dot down (nearest the counting chamber) and replace and tighten the right angle gas fittings. Place the end caps on the old cell and place it in the cell container for proper disposal.

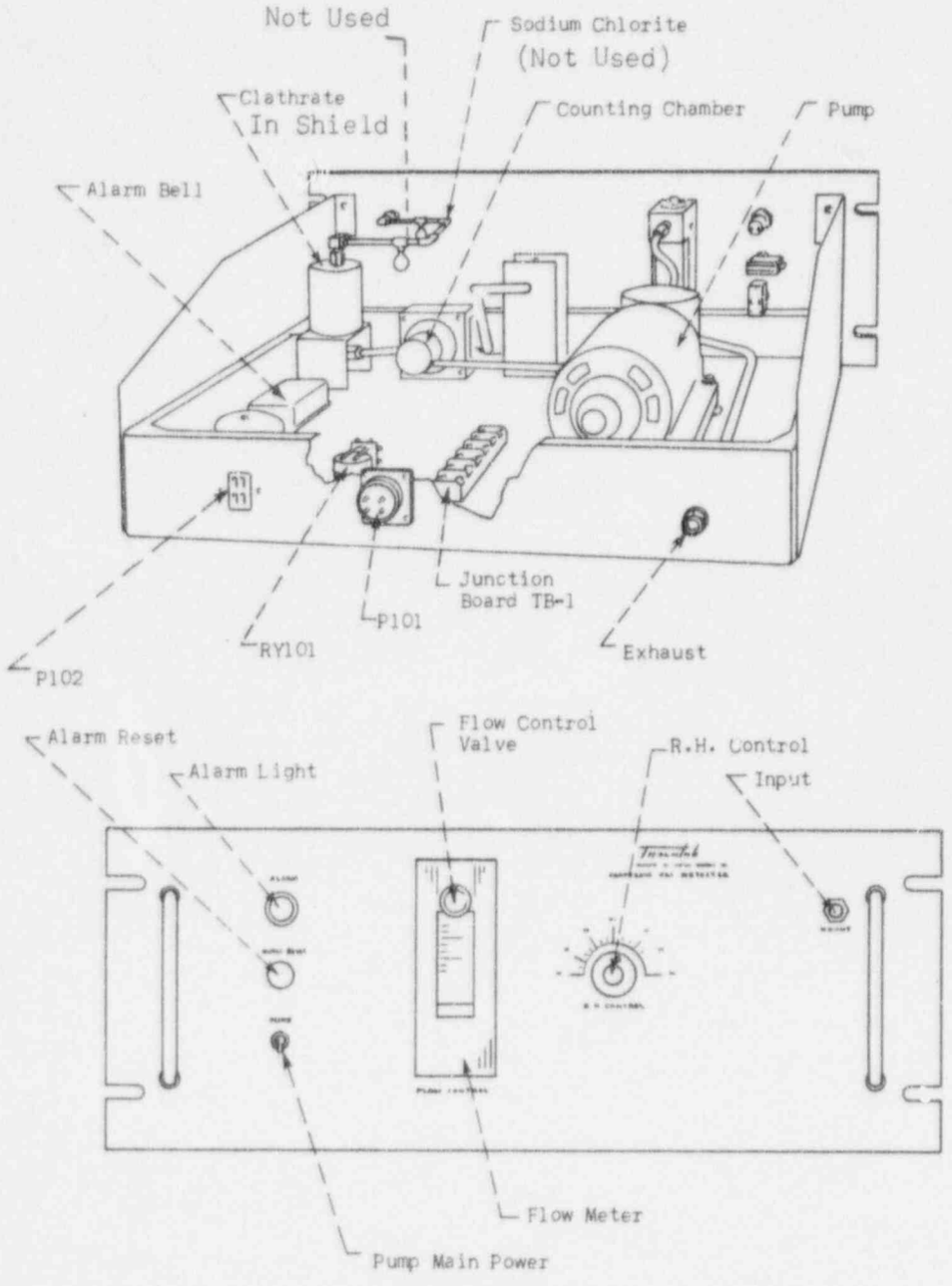
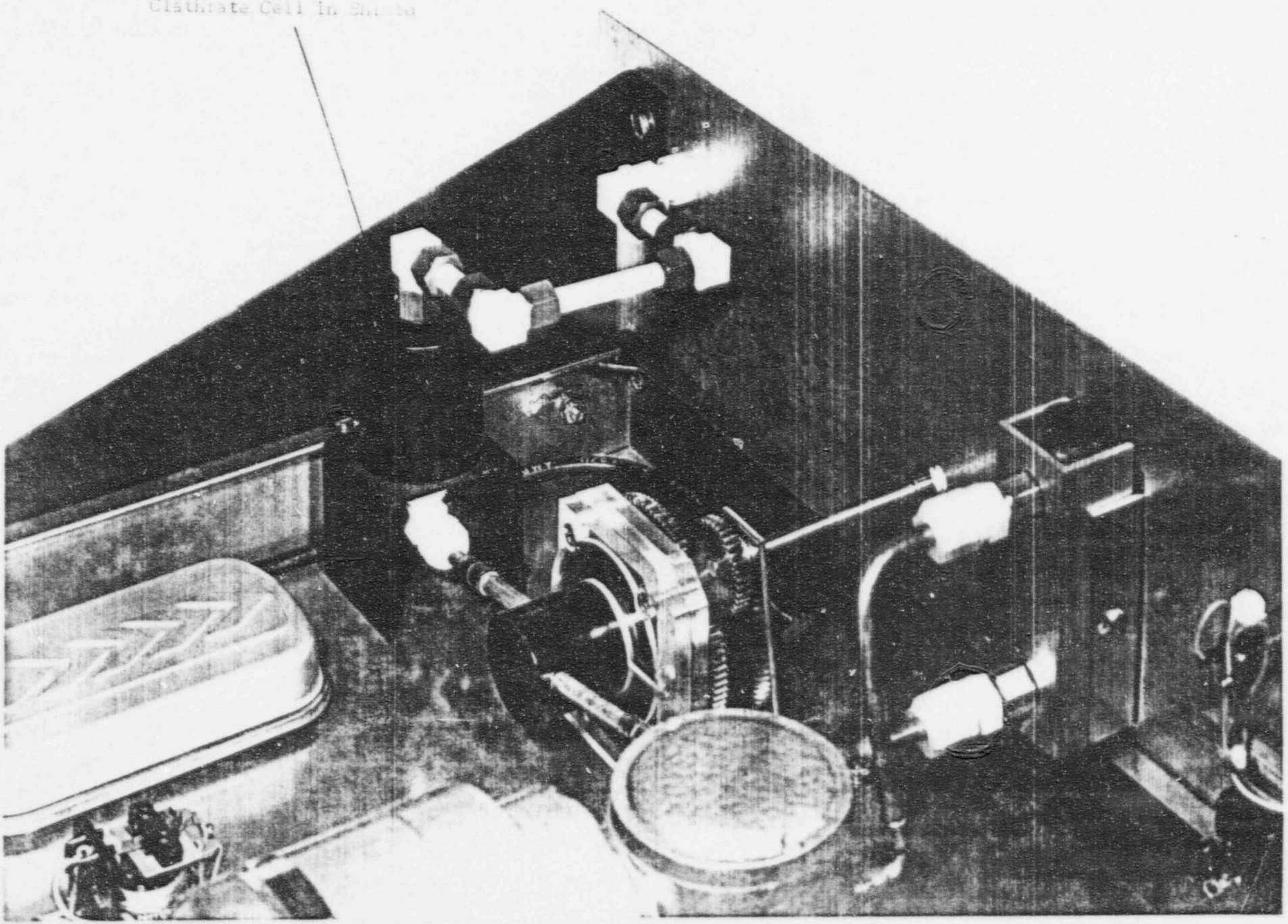
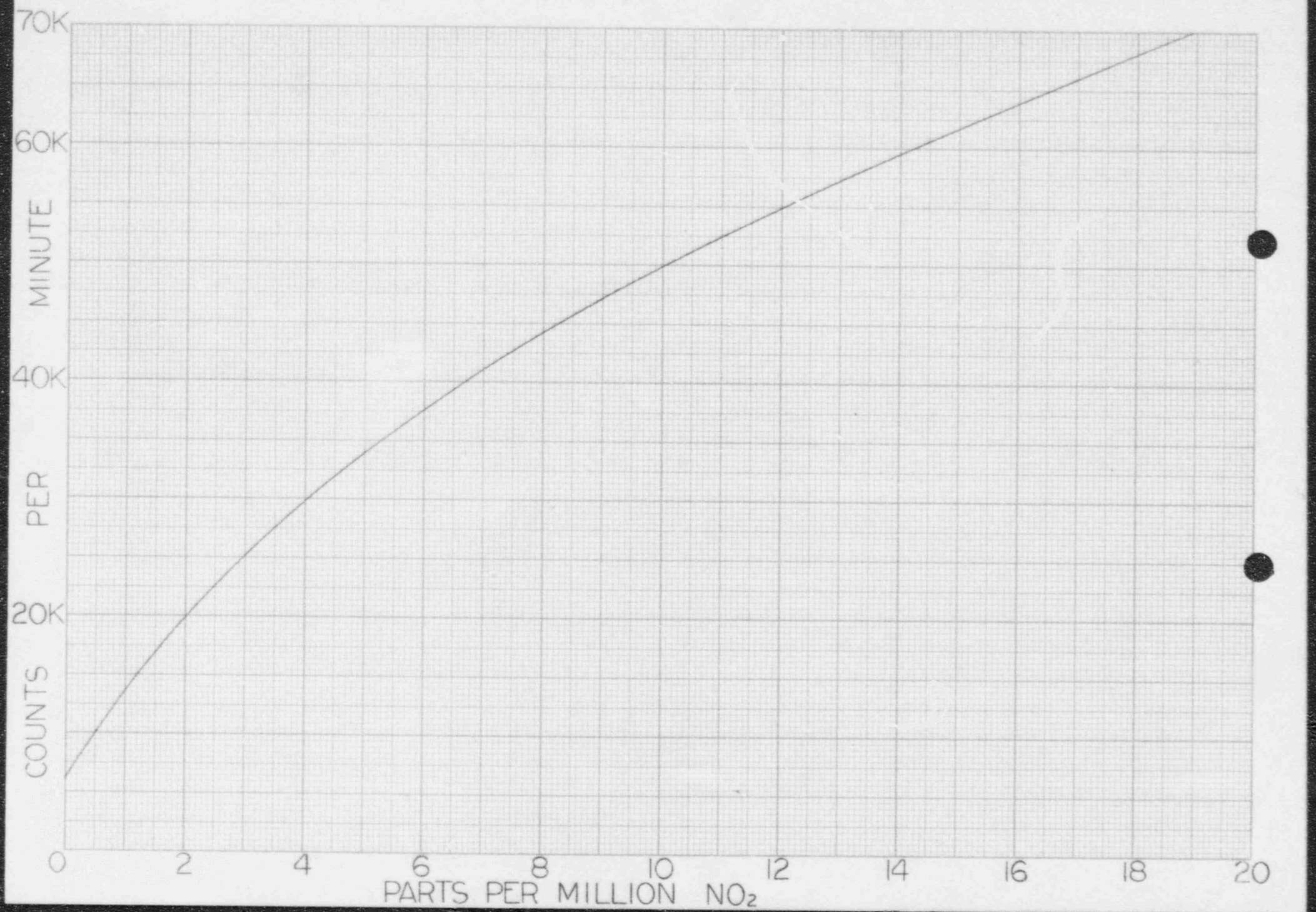
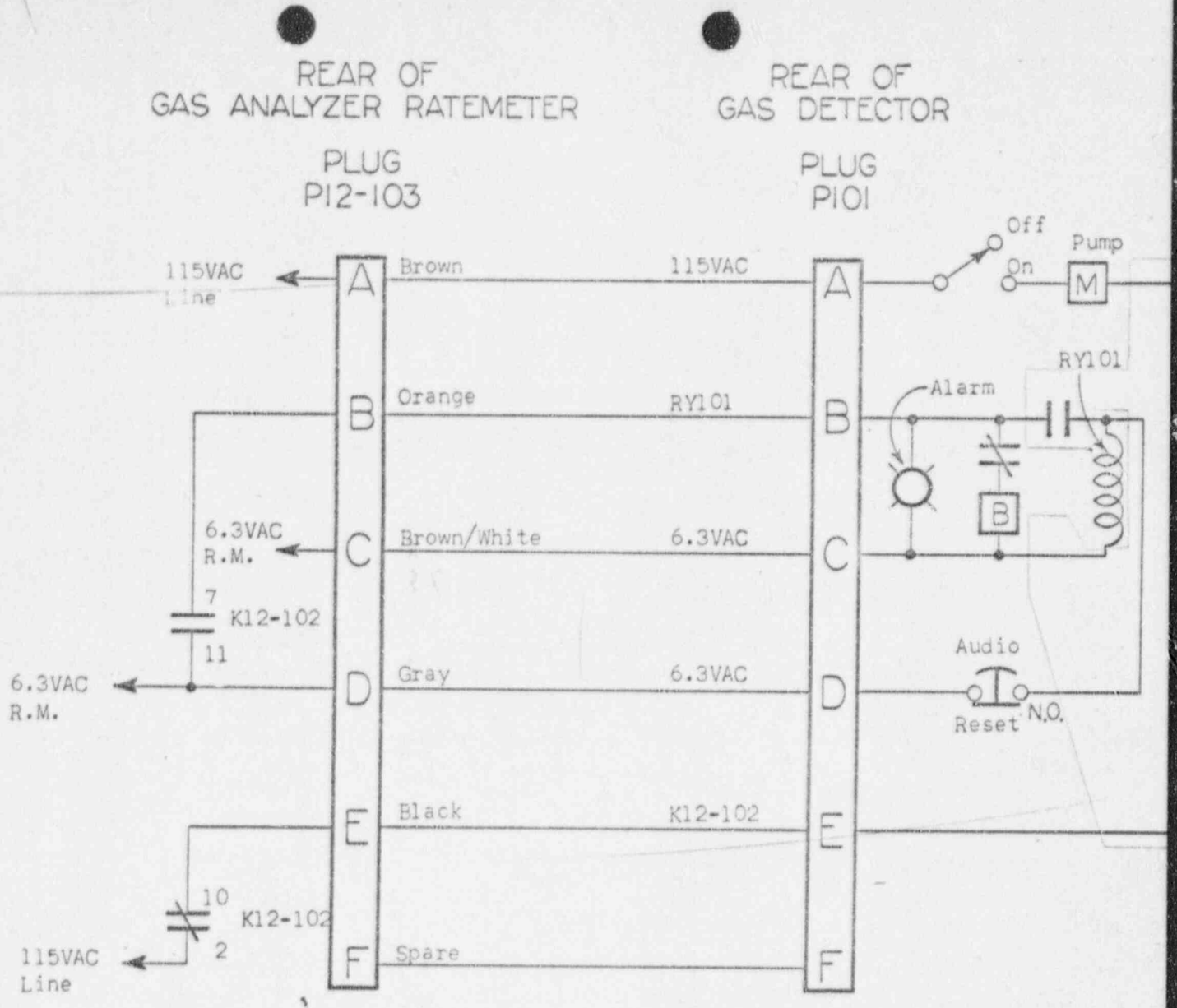


FIGURE 1
CLATHRATE GAS DETECTOR

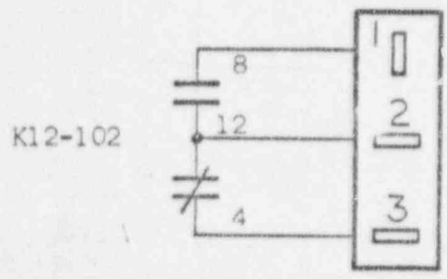
Fig. .
Clathrate Cell in Shield



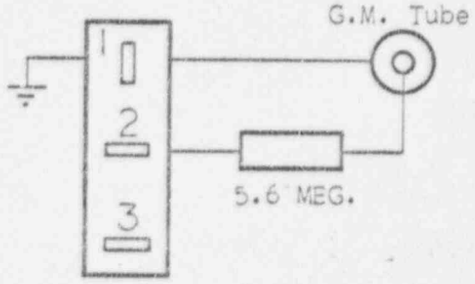

70K
60K
40K
20K
0
2
4
6
8
10
12
14
16
18
20
COUNTS PER MINUTE
PARTS PER MILLION NO_2



INTERCONNECTION DIAGRAM
GAS ANALYZER RATEMETER TO GAS DETECTOR



EXTRA
ALARM CONTACTS



RATEMETER
INPUT