

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

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A. GENERAL

The emission standard for vinyl chloride requires the plant to have a formal leak detection program.

The Federal Register describes specific criteria which must be met within the program. This document describes the leak detection program. Each of the specific requirements will be met. Namely, this program describes:

The continuous VCM detection system which is used by the plant.

The portable hydrocarbon detectors which are used by the plant.

The calibration and maintenance procedures for the above equipment.

The Routine Leak Patrols and procedure when a leak is found by the portable hydrocarbon detector.

The location of the continuous monitoring points which are used for leak detection.

The criteria which will be used to identify the presence of an action level and a leak.

The action plan which will be used to eliminate a leak after it has been detected.

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B. VINYL CHLORIDE CONTINUOUS MONITORING SYSTEM

Introduction

The concentration of vinyl chloride in the atmosphere is continuously monitored by four flame ionization chromatographs, each of which is operated continuously. Each chromatograph is a Honeywell Model 1000 Process Gas Chromatograph manufactured by:

Honeywell Systems, Inc.
6625 McGrew Street
Houston, Texas

Each chromatograph sequentially measures, on a continuous basis, the vinyl chloride content in air samples taken from ten different locations. A total of forty (40) locations are monitored throughout the plant continuously and the concentrations at each point are recorded.

Description

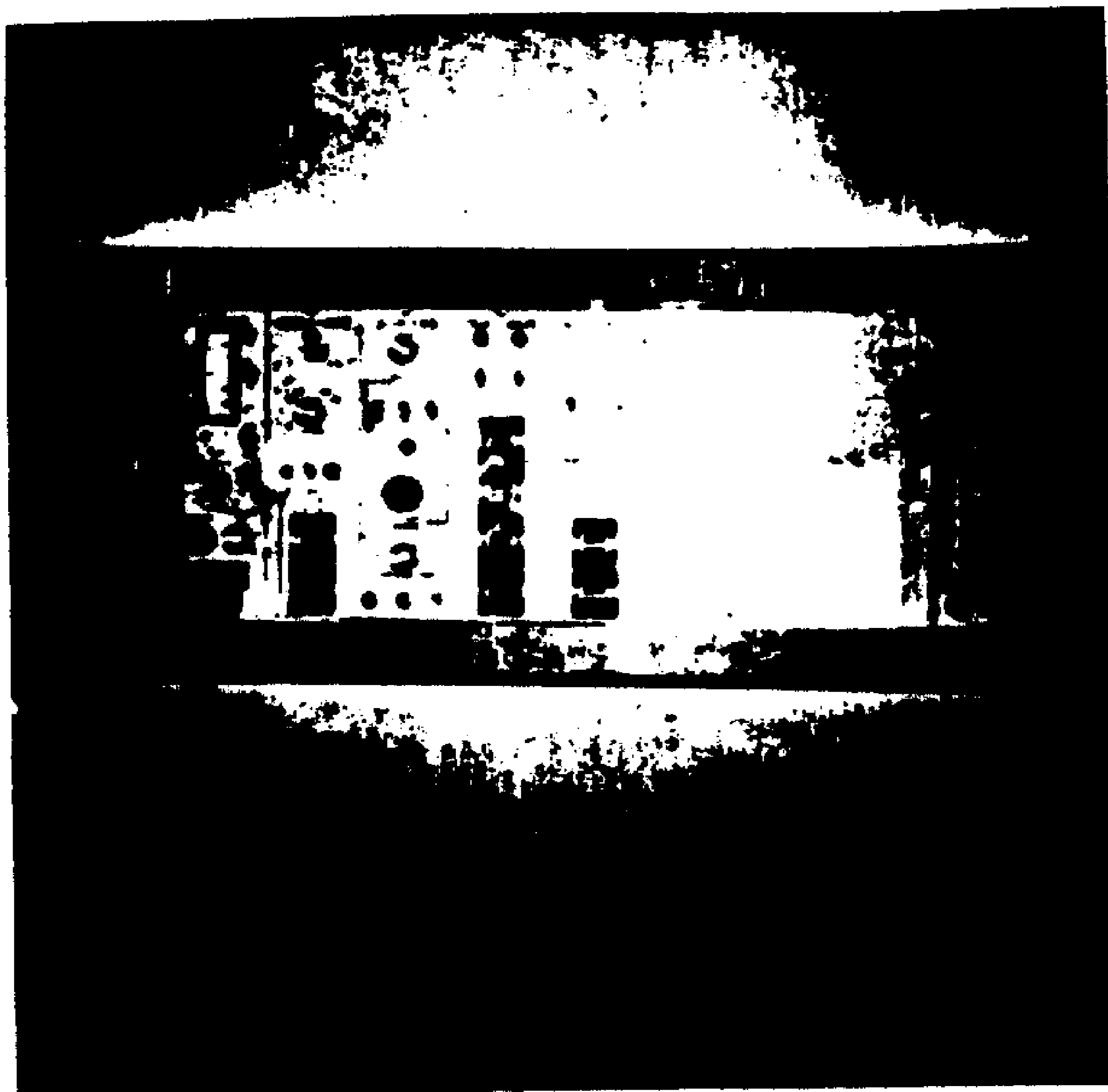
Analytical Technique

The Flame Ionization Detector used in the Honeywell 1000 Process Gas Chromatographs has a lower detection limit of 0.1 part per million.

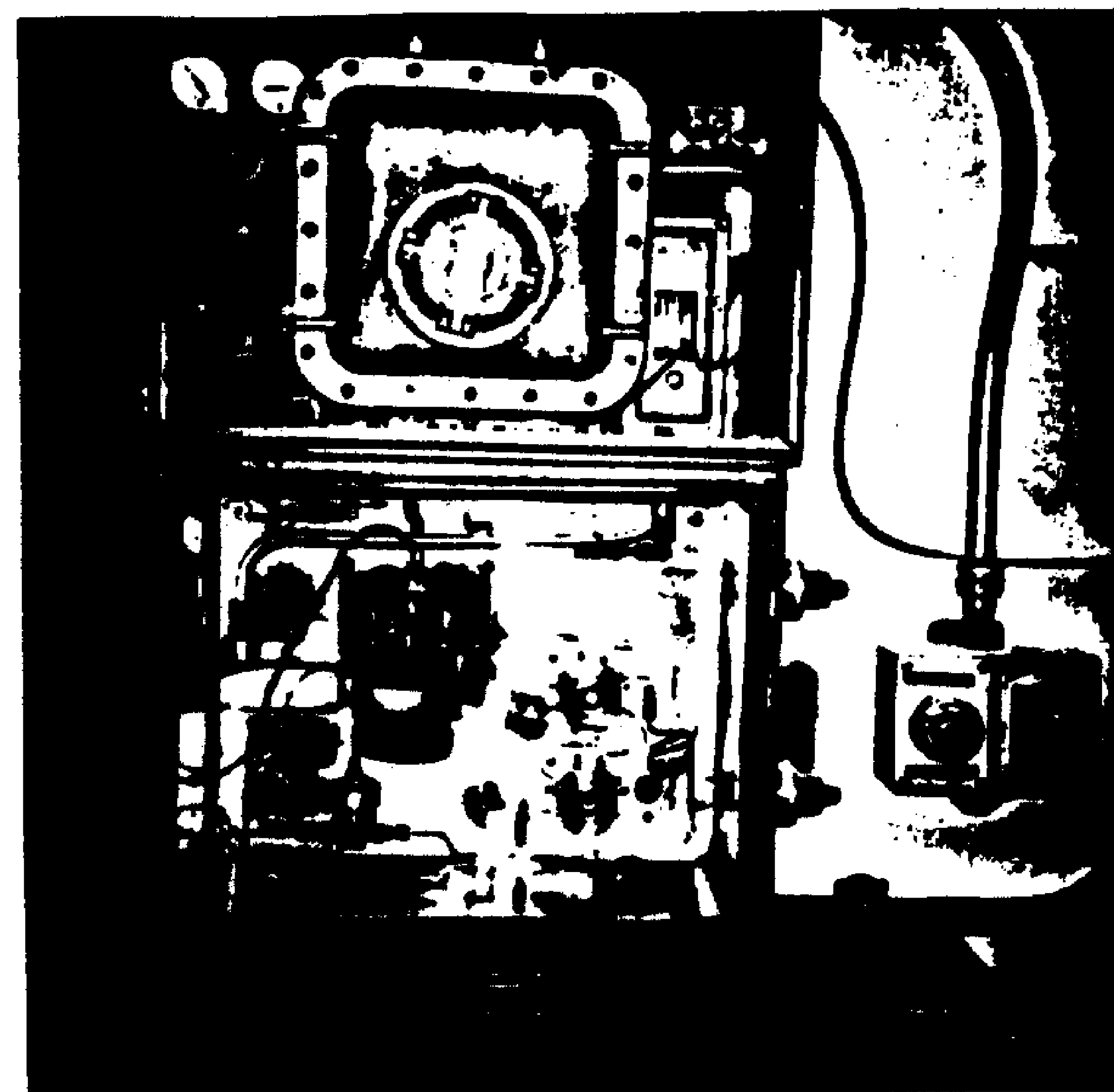
The special-purpose elements of the FID chromatograph are a flame cell, an FID Electrometer Assembly, a Temperature Control/Inverter Assembly, and a plug-in FID Amplifier Module which mounts in the Control Section.

The flame cell consists of an ignitor wire, a hydrogen-fed burner, and an electron collector. Within the cell, hydrogen combustion occurs in an electrical field created by the voltage from the ionization inverter. Because of the carbon-free property of hydrogen, ionization occurs only when a carbon-bearing sample is injected into the flame. Ionization causes current to flow from the collector in direct proportion to the amount of the hydrocarbon elements present in the sample. The output current from the flame cell is routed through the Electrometer (Preamp) in the Analyzer, and is applied to the input of the FID Amplifier in the Control Section. The gain is made available for external recording.

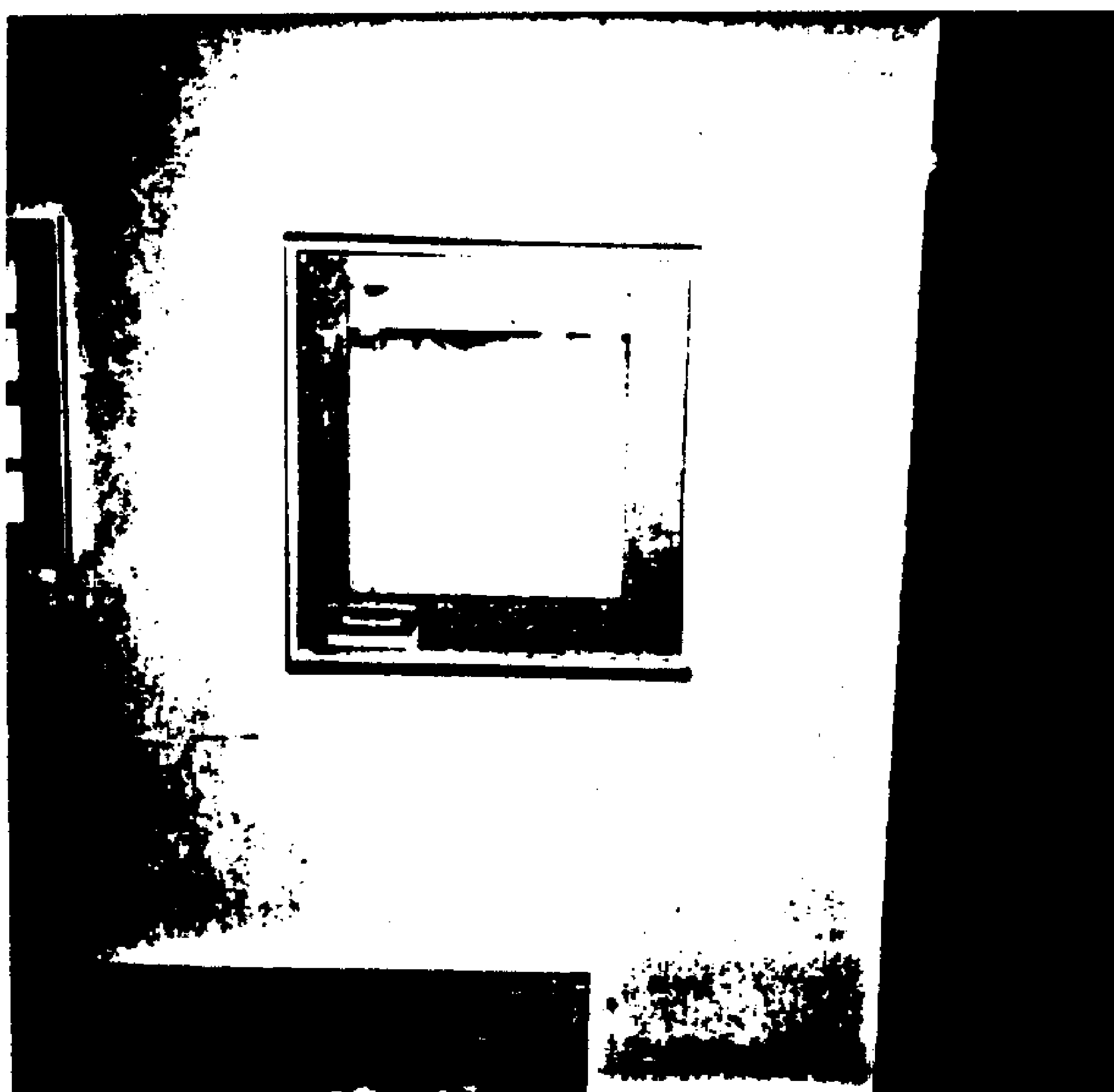
The FID Electrometer Assembly is physically divided into two major subassemblies: the Power Supply-Electrometer P.C. Card Assembly, and the Electrometer P.C. Card Assembly. The electrometer power supply accepts + 20 volt inputs from the Control Section power supply, and produces regulated plus and minus 15 volt outputs for operation of the electrometer circuits and the inverter located on the Temperature Control/Inverter P.C. Card Assembly. The inverter output is a -100 volt ionization potential which is applied to the base (burner) of the flame cell.



SEQUENCE
AND ANALYZER CONTROL
MODULE



ANALYZER SECTION



RECORDER



SAMPLE POINT

7

Depressing the IGNITE pushbutton switch applies 115 vac to the primary of a transformer, which in turn produces approximately 2.2 vac across the ignitor coil inside the flame cell. Depressing the IGNITE pushbutton also produces a ground connection which enables the solenoid driver circuit to open the hydrogen shut-off valve. With 2.2 vac applied to the ignitor coil, and the hydrogen shut-off valve open, the flame will ignite within five to 10 seconds.

When the flame ignites, current flow from the flame cell collector is amplified by the electrometer circuit, the output of which is routed to both the Control Section FID Amplifier and to a level detect circuit on the Power Supply-Electrometer P.C. Card Assembly. When the level detect circuit senses an electrometer output of sufficient magnitude to indicate that the flame is lit, the circuit produces a logic level output which lights the FID Amplifier "FLAME ON" indicator. In addition, the circuit de-energizes a relay which extinguishes the analyzer "FLAME OUT" indicator, and provides a ground to the solenoid driver circuit so that the hydrogen shut-off valve will be maintained in the open position when the IGNITE pushbutton is released.

During sustained operation, the level detect circuit continuously monitors the output of the electrometer circuit, and any momentary output drop below a selectable threshold level will cause the FID Amplifier FLAME ON indicator to momentarily extinguish. If the reduced signal level continues beyond a selectable time delay, the level detect relay will energize, thus closing the hydrogen shut-off valve and illuminating the analyzer FLAME OUT indicator. If this condition occurs, the IGNITE pushbutton must again be pressed and held to re-light the flame.

Electrometer P.C. Card Assembly

The functional center of the electrometer circuit is a 3430J high gain integrated circuit amplifier. The flame cell collector current is brought into the circuit via resistor R1 and the divider network at the amplifier input. HIGH/LOW range selection is accomplished by a RANGE control input from the FID Amplifier. When LO range is selected, relay K1 is energized and R7 is placed in parallel with R8 to reduce the over-all sensitivity of the circuit.

The signal OUTPUT at pin 21 is routed to the FID Amplifier input in the Control Section, and to the level detect circuit on the Power Supply-Electrometer P.C. Card Assembly.

Power Supply - Electrometer P.C. Card Assembly

The Power Supply - Electrometer P.C. Card Assembly contains both the electrometer power supply and the level detect circuitry associated with monitoring the status of the hydrogen flame. The power supply (IC1, Q1, Q2, etc.) accepts plus 20 vdc and minus 20 vdc from the control section, and produces regulated plus and minus 15 vdc for the electrometer circuits and for the ionization inverter on the Temperature Control/Inverter P.C. Card Assembly.

The level detect circuit consists of the operational amplifiers in IC-2; the -LEVEL DET ADJUST control (R7); the associated decoding logic in IC's 3, 4, 5,; and the level detect relay, K1. The electrometer output is brought into the circuit at pin 21, and is routed through operational amplifiers IC 2-1 and IC 2-7 to the input of IC 2-10.

The level at IC 2-9 is set by R7, so that if the electrometer output drops below a selected threshold, the flame will be considered extinguished and a positive transition will occur out of IC 2-8. In practice, the threshold level is set just below the quiescent electrometer output when only air and hydrogen are passing through the detector.

If the output of IC 2-8 goes positive, signifying an inadequate signal level, the logic-0 at IC 4-6 illuminates DS2 on the electrometer front panel, and the logic-1 at IC 4-8 extinguishes the FID Amplifier FLAME ON indicator. In addition, any positive level out of IC 2-8 will also trigger adjustable one-shot IC 3, which produces a selectable time delay before energizing relay K1 and illuminating DS1 on the electrometer front panel. This delay, which is adjustable from 2 to 20 seconds, and optionally from 2 to 200 seconds, ensures that the relay will not be energized by transient conditions in the flame cell or electrometer.

If the IC 2-8 output is still positive when the selected delay is completed, the resultant logic-1 levels at IC 5-1 and IC 5-2 produce a logic-0 at IC 5-6 which illuminates DS1 and energizes K1. In the energized condition, the closed contacts of K1 illuminate the analyzer "FLAME OUT" indicator and the open contacts remove the ground to the solenoid driver circuit, thus closing the hydrogen shut-off valve.

Temperature Control/Inverter Assembly

The temperature control circuit in the FID chromatograph is identical to that of the TC system.

The inverter circuit is of conventional design, and operates from the plus 15 vdc regulated input provided by the electrometer power supply. Transistors Q3 and Q4 and the associated elements form a free-running oscillator, the output of which is coupled through transformer T1 to produce plus and minus 100 vdc at the output. The -100 vdc is the ionization potential which is applied to the base of the flame cell.

Amplifier Module

The FID Amplifier is essentially the same as the TC Amplifier, except for the addition of a HI/LO gain range switch concentrically mounted around the MANUAL RANGE switch, and the addition of a FLAME ON indicator to the front panel. The HI/LO range switch controls relay K1 in the FID electrometer, to change the divider resistance values at the electrometer input, thus changing the electrometer sensitivity.

The FLAME ON indicator is controlled by a logic level input from the Power Supply - Electrometer P.C. Card Assembly in the electrometer. No time delay is provided between the level detect circuitry and the FLAME ON indicator, thus ensuring that any transient "flame off" conditions will be seen on the indicator.

Sample Analysis and Specific Chromatograph Parameters

Sample analysis is accomplished through a dual column with a backflush attachment. This column configuration insures that the analysis is specific for vinyl chloride. Separation and analysis is accomplished in the following manner:

The sample is injected with the dual column valve energized (light on), and with the backflush valve in the foreflush position. This allows the sample to be swept from the sample valve into column number one. Column number one separates inerts or other light components from the heavier components, but not from each other. The combined light components are allowed to pass into the second column where they are separated.

At a selected time during the analysis, column number two is switched out of the stream and the heavy components from column number one are routed to the detector via a restrictor. The light components, not yet eluted from column number two, remain in that column until the dual column valve is switched back to the dual column position. Then they are eluted through the detector. The resultant reverse flow through column number one causes those components still in the column to be eluted as a group.

The specific parameters for the Honeywell chromatographic column are as follows:

analysis cycle time: 70 sec.
carrier gas: nitrogen
carrier pressure: 50 psig
column vent flow: 35 cc/min.
backflush vent flow: 45 cc/min.
heater air: 50 psig
oven temperature: 80°C
sample loop length: 48 in.
sample loop I.D.: 0.043 in.
column: 1/16"
column material: SS
packing: 15% bis(2-ethoxyethyl) adipate on chromosorb P

Parameters for the air and hydrogen are as follows:

hydrogen flow equals 40 cc/min. @ 50 psig
air flow equals 350 cc/min. @ 220 psig

The Analyzer Section of the Model 1000 has been designed to permit the high-speed analyses required by the technological advances of the past few years.

The basis of this high-speed analytical system is the Micro Packed Column-High-Speed Micro Detector combination.

The resolution of the Micro Packed Column is enhanced by the High-Speed Micro Detector designed and manufactured by Honeywell with the following features: the cell volume is approximately 0.05 microliter; a semi-diffusion type of detector cell is utilized rendering it relatively insensitive to flow rate; the detector response to the presence of a component is suitable for analysis times of less than 1 second.

The Micro Packed Column, Micro Detector and associated sample and column-switching valves have been packaged in an analyzer designed to yield the high thermal stability and accessibility.

The temperature of the analyzer oven is controlled by an all solid state, proportional temperature controller. Several modifications to the widely used heated air type of temperature control system have resulted in an analyzer design that permits the full sensitivity of the Micro Detector to be utilized.

The use of each control of the analyzer is given in Table 1.

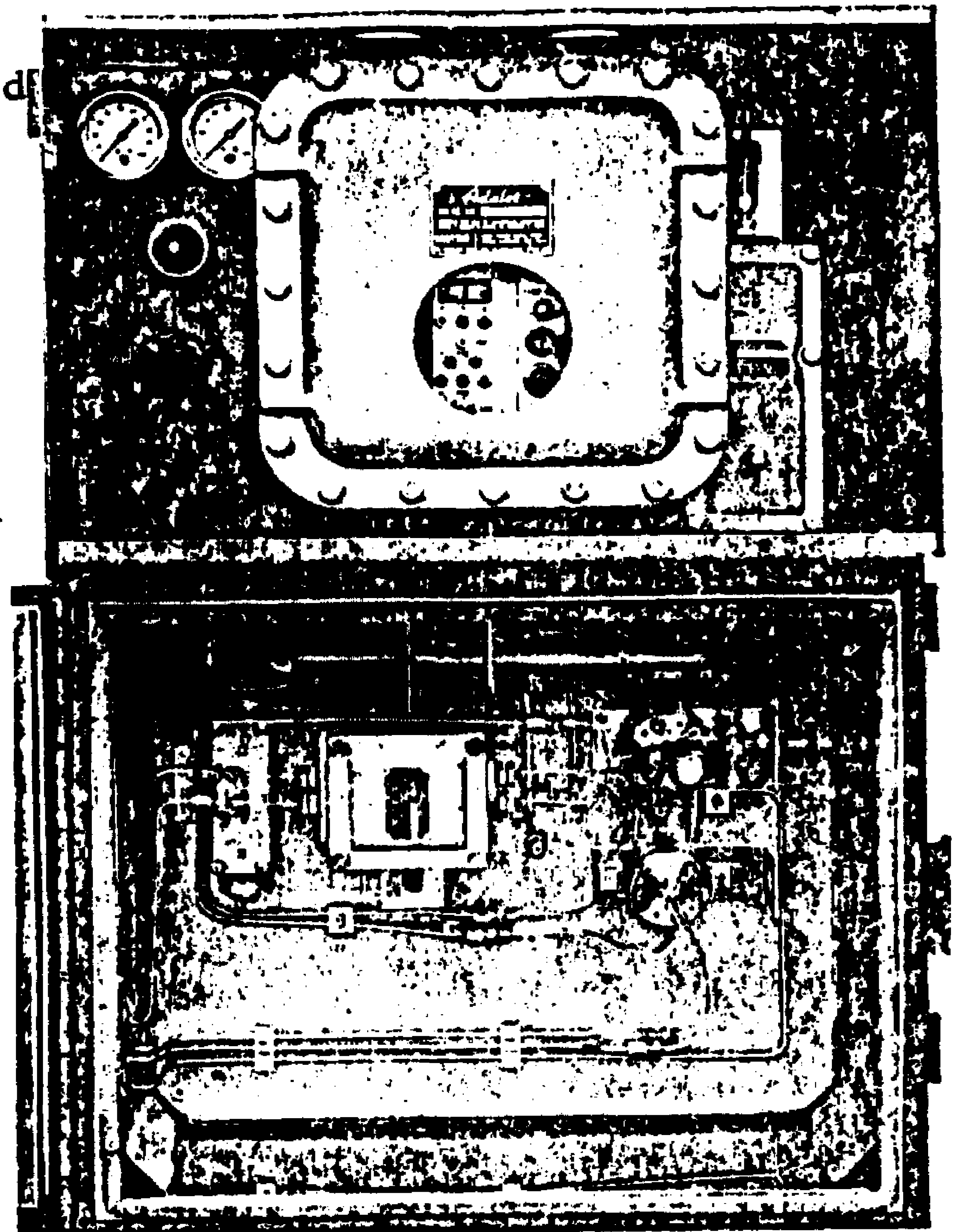


TABLE 1

ANALYZER SECTION, OPERATING CONTROLS AND INDICATORS

<u>Control or Device</u>	<u>Purpose or Use</u>
AIR Control	Controls air pressure to the valve actuating solenoid(s) and to the low mass heater.
AIR Gauge	Indicates air pressure (0-100 lbs.) set by the AIR control.
CARRIER Control	Controls carrier pressure to the column(s) (ultimately controlling the flow) and to the needle valves for reference, etc.
CARRIER Gauge	Indicates the carrier pressure (0-160 lbs.) set by the CARRIER control.
REF and AUX 1,2,3 Needle Valves	Used to precisely adjust carrier flow rates through the reference side of the detector and through three auxiliary valves.
Heater Air Shut-off Valve	Allows the heater air to be shut off, while air pressure is maintained on the air-actuated valves.
Remote Valve Switches and Indicators	Used to remotely actuate the Analyzer valves. Light emitting diodes are illuminated to indicate the corresponding air-control solenoid is energized.
Preamplifier Meter and BAL ADJ Control	Used to balance the preamplifier output.
Preamplifier Test Jacks	Meter/scope test points for monitoring the indicated preamplifier parameters.
Temperature Set Point Control	Used to set the oven temperature. Clockwise rotation increases the temperature, and counterclockwise decreases the temperature.
Temperature Control Indicator	Indicates the status of the oven temperature controller. Due to the proportional temperature control circuitry, and the overtemp switch on the heater barrel, the light will alternately glow and shut off, until the oven temperature begins to approach the ambient operating temperature. When the operating temperature has been reached, the indicator will remain on, but will be very dimly lighted.

TABLE 1 (Cont.)ANALYZER SECTION, OPERATING CONTROLS AND INDICATORS

<u>Control or Device</u>	<u>Purpose or Use</u>
Heater Barrel Over-Temp Control	Located behind the brass plug in the front cover of the heater housing, this control permits adjustment of the temperature cut-off point of the overtemp switch. This temperature can be monitored by connecting a pyrometer to the I/C thermocouple wire coiled under the explosion-proof housing. This temperature is normally factory adjusted for about 300°C.

Sample Injection Procedure

In this multi-stream application, the sample system permits continuous purge from the stream switching system, to and through the analyzer. This insures that the sample being analyzed is from the proper stream.

Sample input is measured by a "gas" valve. The "gas" valve is an external-volume sample valve, in which the sample volume is a length of tubing external to the valve. This valve is used to inject gas samples, and is also the valve used for column switching.

The column configuration by which sample injection is accomplished is the dual column backflush configuration. Normally, a sample is injected with the dual column valve energized and with the backflush valve in the foreflush position. This allows the sample to be swept from the sample valve into column number one. Column number one separates inerts or other light components from the heavier components, but not from each other. The combined light components are allowed to pass into the second column where they are separated.

At a selected time during the analysis, column number two is switched out of the stream, and the heavy components from column number one are routed to the detector via the restrictor. The light components, not yet eluted from column number two, remain in that column until the dual column valve is switched back to the dual column position. The resultant reverse flow through column number one causes those components still in the column to be eluted as a group, and recorded as one peak. Note that the combined components bypass column number two via the column bypass restrictor.

The sample volume is 1346 μ l. The injection valve specifications are as follows:

Sample valve:

Material: SS
Diaphragm: High-Temperature
Part Number: 30740492-002

Backflush:

Material: SS
Diaphragm: High-Temperature
Part Number: 30740492-002

Sample Handling Equipment

There are 40 sampling points at the Aberdeen Plant. At each sampling point, sample is drawn into a 1/8" I.D. nylon sampling line through a M.S.A. high efficiency small volume paper filter. The model number of these filters is DZ-78006. These end of line filters are manufactured by:

Mine Safety Appliance Company
408 Penn Center Blvd.
Pittsburgh, PA

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Samples are drawn through each of the sampling locations served by a single Honeywell unit, by a single vacuum pump. The vacuum pump is model number 289-EXP, with trademark "Dia-Vac", manufactured by:

Combination Control, Inc.
Kulpsville, PA 19443

Sample is drawn into the sampling line at a maximum rate of 1.5 cfm at 0 in. Hg vacuum. Sample inflow is continuous.

The Control Section of the Model 1000 consists of solid state, plug-in modules. Each module is self-contained to permit easy replacement for troubleshooting or maintenance. The modules require front access only for replacement. The contacts are gold-plated over nickel for resistance to corrosive atmospheres.

The timing system is a 240 KHz clock which generates a digital pulse each second.

The analysis is programmed as follows:

A digital pulse is chosen just prior to setting the exact time the occurrence of the function is desired (Coarse). An adjustable delay, triggered by the digital pulse, is then set to provide the exact (Fine) time of the function. In the case of setting a component time-span (gate), the digital pulse triggers an adjustable time-window. Gate duration adjustments are direct-setting.

Auxiliary test equipment is not required to make any of the adjustments of the Model 1000 Control Section. Test points, with front panel access, are provided on each module for maintenance trouble-shooting.

The basic programmer (Control Section) is composed of the following sub-systems:

The MONITOR MODULE contains a multiple point selector switch and readout meter to permit checking auto zero range, power supply voltages, detector preamp output, signal amplifier output and digital clock status. The memory output can also be checked with this switch, if this option is included in the basic control section. The Power switch is located on this module, as well as a Status switch (Normal/Bypass) and a Standard Sample switch for remote introduction if a calibration standard is desired. A recorder jack is included on the front panel to permit the use of a service recorder, if a dedicated recorder is not required for bargraph readout. An auto zero function is also included in this module.

THE SEQUENCER MODULE is a solid state, digital timing system with direct setting time adjustments for the sequenced functions. The adjustments for the sample valve "Inject Time" are located in this module. The basic sequencer is a 0-100 second clock with a digital pulse generated each second.

THE AMPLIFIER MODULE contains an auto zero status switch, manual range (Spectrum) switch, amplifier zero potentiometer, and a built-in calibration. The calibrator generates synthetic signals which may be used to set, or check, the full-scale range of the measured components. This module gives the basic 0-10 volt output signal.

THE VALVE MODULE is required for multi-column applications. Direct-setting switches are adjusted to provide the exact time for the signal required for the valve-switch to occur. An additional auto-zero circuit and its timing adjustment is provided in this module.

A COMPONENT MODULE is required for each component to be measured. The basic control section can be supplied with one to six component modules. Each module contains the necessary adjustments for setting the full-scale range of the measured component and for setting the time-span (gate). An auto zero is an integral part of the module.

The standard Control Section provides bargraph output signals for each measured component. A trend output of peak height or peak area (integration) for each component is also available. The necessary interface requirements for computer-input of data can be provided. Current or voltage output is available as a standard feature.

The signal from the detector bridge is amplified to a level of approximately 0.1 volt before leaving the analyzer section. Thus no low level signals are switched within the Model 1000 system. Since the electronic auto zero circuit performs the zeroing function in less than fifty (50) milliseconds, it is normally actuated by each component "on gate".

The specific functions of each control option are given in Tables 2 through 7.

TABLE 2

MONITOR MODULE, OPERATING CONTROLS AND INDICATORS

<u>Control or Indicator</u>	<u>Purpose or Use</u>
ON/OFF Switch	Controls AC input power to the Control Section.
PWR (Power) Indicator	Indicates the power on/off status of the Control Section.
DET/OFF Switch	Controls DC power to the bridge detector circuit in the Analyzer.
DET (Detector) Indicator	Indicates the power on/off status of the bridge detector.
STD SAMP/OFF Switch	Used to actuate a solenoid in the sample system (if provided) for automatic standard sample introduction. In the STD SAMP position a contact closure is provided at the Control Section rear panel.
STD SAMP Indicator	Lamp is illuminated when sample is flowing, and is off for normal operation.
STATUS NORM/BYPASS Switch	Provides a contact closure which can be used as a maintenance "out of service" switch, etc. Terminal connections are provided on the Control Section rear panel for connection to remote indicators, alarms, or a computer.
STATUS Indicator	Lamp is illuminated to indicate "bypass", and is off for normal operation.
Meter Display	Provides a visual indication of the Control Section operating conditions, as selected by the Meter Function Switch.
Meter Function Selector Switch	Selects the Control Section parameters to be presented on the Meter Display.
+20 and -20 Positions	Display the respective output levels from the Control Section DC power supply. Normal indication is approximately 50% of full-scale deflection, in the respective polarity direction.
SIG IN Position	Displays the signal amplifier input level received from the preamplifier in the Analyzer. (+0.1 volt range).

TABLE 2 (Cont.)

<u>Control or Indicator</u>	<u>Purpose or Use</u>
SIG OUT Position	Displays the output level of the signal amplifier. (+10 volt range).
AUTO ZERO Position	Displays the voltage required to bring the "baseline" back to zero. (+5 volt range).
CLOCK Position	Permits confirmation that the Control Section internal clock is functioning. Meter display will indicate 1/2-scale or better, and will drop to zero one second out of every 10 seconds.
C1 thru C6 Positions	Display the peak height voltages stored in the memory outputs for components 1 through 6. Can also be used for a rough setting of zero and span calibration of each memory.
RECORDER Connector	Provides AC power and chart advance levels to drive a portable "service" recorder for temporary spectra or gate readout. Back panel terminals are also available for permanent connections.
AUTO ZERO START Switches	A non-dedicated auto zero function which can be set to auto zero at any point during the analysis by dialing in the time (in seconds) on the thumbwheel switches. The fine adjustment allows delay of the start of Auto Zero from 0 to 2 seconds.

TABLE 3

SEQUENCER MODULE, OPERATING CONTROLS AND INDICATORS

<u>Control or Indicator</u>	<u>Purpose or Use</u>
SAMPLE VALVE Indicator	Lamp is illuminated when the valve is in the sample inject position.
MODE Selector Switch	Controls the operation of the Sequencer, and the readout to the recorder.
AUTO Position	Analysis events (sample inject, auto zero, component gating, etc.) occur automatically as programmed by Control Section front panel switches. The recorder is driven in the bargraph mode, and the amplifier output is enabled only during the selected "component gate" times.
GATE Position	Analysis events (sample inject, auto zero, component gating, etc.) occur automatically as programmed by Control Section front panel switches. The recorder chart is continuously driven, and the amplifier output is enabled only during the selected "component gate" times. This allows the programming gates to be visually checked.
SPEC (Spectrum) Position	Valve actuations occur automatically, as programmed by Control Section front panel switches. The recorder chart is driven continuously, and the amplifier output is continuously enabled. COMPONENT lights are gated to provide a visual indication of gate timing.

NOTE

The Amplifier module AUTO ZERO switch should be in the OFF position. The AUTO/MAN switch must be set to MAN to select the desired signal range.

MAN (Manual) Position

All functions must be operated manually. (Valve switches left in AUTO will cause the corresponding valves to go to the "on" condition). The recorder chart is continuously driven, and the amplifier output is continuously enabled.

NOTE

The Amplifier module AUTO/MAN switch must be set to MAN to select the desired signal range.

TABLE 3 (Cont.)

<u>Control or Indicator</u>	<u>Purpose or Use</u>
Sample VALVE DURATION Thumbwheel Switches	Permits adjustment of the duration of the sample inject period. At the end of the set duration time (in seconds), the sample valve goes to the off (samp: purge) position.

TABLE 3 (Cont.)

<u>Control or Indicator</u>	<u>Purpose or Use</u>
CYCLE Selector Switch	Permits selection of analysis time (length).
Time (lower) Position	Analysis time (in seconds) is determined by the setting of the TIME thumbwheel switch (0-99 seconds).
"100" Position	Analysis cycle time is a fixed 100 seconds, regardless of the TIME switch setting. The analysis will run in the time programmed, and will wait for the remainder of the 100 seconds before starting another analysis.
"600" Position	Analysis cycle time is a fixed 600 seconds, regardless of the TIME switch setting. The analysis will run in the time programmed, and will wait for the remainder of the 600 seconds before starting another analysis.
Sample Valve AUTO/MAN Switch	Permits selection of automatic or manual sample valve control.
AUTO Position	Sample valve is automatically controlled by the Sequencer module with "sampling length" selected by the VALVE DURATION thumbwheel switches.
Middle (off) Position	Sample valve is in the "bypass" position, and the sample is flowing through the sample volume ports.
MAN Position	Sample valve is in the "on" condition, and sample is being injected into the column.
SEQ. (sequence) RESET Pushbutton	Allows the Sequencer to be manually reset the start of an analysis.

NOTE

The SEQ. RESET pushbutton does not reset auxiliary valves. Therefore, before pushing the SEQ. RESET button, wait for the VALVE lights to return to their initial "program start" conditions, or switch the sample valve off until a complete cycle runs on the sequencer. If any VALVE light is on, then one complete cycle must be run before a satisfactory readout can be obtained.

If the CYCLE switch is in the "600" position, SEQ. RESET advances the timer to 100 seconds and an additional 500 seconds is required before the timer is reset.

TABLE 4

AMPLIFIER MODULE, OPERATING CONTROLS AND INDICATORS

<u>Control or Indicator</u>	<u>Purpose or Use</u>
RANGE CALIBRATE Control	Permits adjustment of an internally-generated calibration voltage so that the full-scale range and peak memory output level for each measured component can be set.
AUTO/CAL Switch	In the AUTO position, which is the normal operational position of the switch, the input to the amplifier is the bridge preamp output from the analyzer. In the CAL position, the input to the amplifier is an internally-generated calibration voltage, the level of which is controlled by the RANGE CALIBRATE Potentiometer.
AUTO/ZERO/OFF Switch	Controls the operational mode of the Auto Zero circuitry, which automatically compensates for any drift in the bridge preamp "zero" (baseline) output level. Auto Zero is normally actuated for 50 milliseconds by each component "on-gate", and at other times as determined by the setting of the non-dedicated Auto Zero function(s). A moveable jumper on each Component Module allows Auto Zero to be inhibited at the corresponding component gate opening, if so desired.
AUTO ZERO Position	Auto Zero level is automatically updated at each Auto Zero time to compensate for preamp baseline drift.
Middle Position	Allows the last Auto Zero signal level to be held in the Auto Zero circuitry. This leaves the baseline at recorder zero when switching to Manual or Spectrum operations.
Off Position	The Auto Zero function is inhibited with Auto Zero "off". The AMPLIFIER ZERO control must be used to zero (balance) the output to the recorder.
AUTO/MAN Switch	In the AUTO position, the amplifier gain changes during each component gate, as determined by the setting of each component RANGE potentiometer. In the MAN position, the amplifier gain is controlled exclusively by the setting of the MANUAL RANGE switch.

TABLE 4 (Cont.)

<u>Control or Indicator</u>	<u>Purpose or Use</u>																				
MANUAL RANGE Selector Switch	With the AUTO/MAN switch in the MAN position this switch permits manual selection of the signal output range by attenuating or amplifying the bridge preamp output as follows: <table><tr><th>Position</th><th>Factor</th></tr><tr><td>1</td><td>10</td></tr><tr><td>2</td><td>5</td></tr><tr><td>5</td><td>2</td></tr><tr><td>10</td><td>1</td></tr><tr><td>20</td><td>X2</td></tr><tr><td>100</td><td>X10</td></tr><tr><td>200</td><td>X20</td></tr><tr><td>500</td><td>X50</td></tr><tr><td>1000</td><td>X100</td></tr></table>	Position	Factor	1	10	2	5	5	2	10	1	20	X2	100	X10	200	X20	500	X50	1000	X100
Position	Factor																				
1	10																				
2	5																				
5	2																				
10	1																				
20	X2																				
100	X10																				
200	X20																				
500	X50																				
1000	X100																				
AMPLIFIER ZERO Control	Permits manual adjustments of amplifier "zero" output, to balance the recorder.																				
GND. IN and OUT Test Jacks	Meter/scope test points for monitoring the amplifier input and output levels.																				

TABLE 5

COMPONENT MODULE, OPERATING CONTROLS AND INDICATORS

<u>Control or Indicator</u>	<u>Purpose or Use</u>
COMPONENT Indicator	Lighted during the time the associated component gate is open.
RANGE Control	Permits full-scale range (gain) adjustment for the associated component. The resultant gain setting is in effect only when the associated component gate is open, and then only if the Amplifier Module AUTO/MAN switch is in the AUTO position.
MEMORY ZERO AND SPAN Controls	Used in conjunction with the Amplifier Module calibration voltage to calibrate the memory output signal (if used).
AUTO/OFF/CAL Switch	Controls the operational status of the respective Component Module.
AUTO Position	This position enables the normal operational mode of the module, in which the gate circuitry, the bargraph output, and the memory output are operational.
OFF Position	In this position, the bargraph output and all gate functions are inoperative, and memory holds the last value and is allowed to update.
CAL Position	Used in conjunction with the AUTO/CAL switch on the Amplifier Module to calibrate the Component Module RANGE and MEMORY ZERO AND SPAN.
RESET Pushbutton	Used in conjunction with the memory calibration to reset the memory output to the baseline.
GATE Adjustments	Permit setting the starting time and duration of the associated component gate.
COARSE Thumbwheel Switches	Permit selection of gate "start" time one-second increments from 0 to 99 seconds following sample inject.

(A)

TABLE 5 (Cont.)

<u>Control or Indicator</u>	<u>Purpose or Use</u>
FINE Control	Permits the gate "start" time to be delayed from 0 to 2 seconds beyond the setting of the COARSE thumbwheel switches.
DURATION Control	Permits vernier selection of gate duration from 0 to 10 seconds.
GND and OUT Jacks	Meter/scope test points for externally monitoring the memory output.

TABLE 6

VALVE MODULE, OPERATING CONTROLS AND INDICATORS

<u>Control or Indicator</u>	<u>Purpose or Use</u>
ON Indicator	Indicates power is applied to the actuating solenoid.
AUTO/OFF/MAN Switch	Controls the operational mode of the associated valve.
AUTO Position	In AUTO, the valve is actuated automatically at the times set on the ON-OFF/TIME thumbwheel switches.
OFF Position	The valve solenoid is de-energized.
MAN Position	The valve solenoid is energized.
AUTO ZERO Indicator	Indicates occurrence of the respective Auto Zero function.
AUTO ZERO ON/TIME Thumbwheel Switches	Permits selection of an Auto Zero "start" time, in one-second increments, from 0-99 seconds following sample inject.
Valve ON/TIME Thumbwheel Switches	Permits selection of the ON (solenoid energized) starting time in one-second increments, from 0-99 seconds following sample inject.
VALVE Control	Permits the valve ON starting time to be delayed from 0 to 2 seconds beyond the setting of the valve ON/TIME thumbwheel switches.
Valve OFF/TIME Thumbwheel Switches	Permits selection of the OFF (solenoid de-energized) starting time, in one-second increments, from 0-99 seconds following sample inject.
VALVE OFF Control	Permits the valve OFF starting time to be delayed from 0 to 2 seconds beyond the setting of the valve OFF/TIME thumbwheel switches.

TABLE 7

DUAL PREAMP MODULE, OPERATING CONTROLS AND INDICATORS

<u>Control or Indicator</u>	<u>Purpose or Use</u>
Toggle Switch	The toggle switch selects one or the other of two detector bridge preamplifier circuits to be monitored on the balance meter.
Balance Meter	A 1-0-1 volt meter which is used in balancing the selected detector bridge/preamplifier circuit.
DET. BAL. Controls	Adjusts the balance of the respective detector bridge/preamplifier circuit.
Preamplifier Test Jacks	Meter/scope test points for monitoring the indicated preamplifier parameters.
Terminal Strips	Provide connections for respective detector leads.

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

C. HNU PORTABLE HYDROCARBON DETECTORS

1. Introduction

The Aberdeen Chemical Plant uses HNU portable hydrocarbon detectors for routine leak patrols, to precisely locate potential leak sources when suspected leaks are indicated by the continuous monitoring system and to monitor vessels prior to entry. This analyzer is the:

HNU Photoionization Analyzer Model PI-101

The HNU portable analyzer is manufactured by:

HNU Systems
383 Elliot Street
Newton Upper Falls, Mass. 02164

The plant has found the HNU portable hydrocarbon detector reliable and easy to maintain. If a potential leak source registers more than 2000 ppm (the maximum range of the HNU), the TLV portable analyzer is used to determine if it is a leak.

The model PI-101 has been designed to measure the concentration of trace gases in many industrial or plant atmospheres. The analyzer employs the principle of photoionization for detection. This process is termed photoionization since the absorption of ultraviolet light (a photon) by a molecule leads to ionization via:



where RH = trace gas

$h\nu$ = a photon with an $\geq$ Ionization Potential of RH

The sensor consists of a sealed ultraviolet light source that emits photons, which are energetic enough to ionize many trace species (particularly organics) but do not ionize the major components of air such as O₂, N₂, CO, CO₂, or H₂O. A chamber adjacent to the ultraviolet source contains a pair of electrodes. When a positive potential is applied to one electrode, the field created drives any ions, formed by absorption of UV light, to the collector electrode where the current (proportional to concentration) is measured.

To minimize adsorption of various sample gases, the ion chamber is made of an inert fluorocarbon material, is located at the sampling point, and a rapid flow of sample gas is maintained through the small ion chamber volume.

The analyzer will operate either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger. A solid state amplifier board in the probe and a removable power supply board in the readout module enable rapid servicing of the unit in the field.

The useful range of the instrument is from a fraction of a ppm to about 2,000 ppm. For measurement at levels above 2,000 ppm, dilution of the sample stream with clean air is recommended. Some typical specifications for the model PI 101 Photoionization Analyzer are given in Table 8.

2. Operation

Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scaleplate. If the needle is in the lower portion of the battery arc, the instrument should be recharged prior to making any measurements. If red LED comes on, the battery should be recharged.

Next, turn the function switch to the on position. In this position the UV light source should be on. Look into the end of the probe to see the purple glow of the lamp.

A brief description of the instrument controls and functions is shown in Figure 1.

To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counterclockwise rotation yields a downscale deflection. Note: no zero gas is needed, since this is an electronic zero adjustment (see below). If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 or 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

The instrument is now ready for calibration or measurement by switching the function switch to the proper measurement range. The instrument is supplied calibrated to read directly in ppm (v/v) 0-20, 0-200, 0-2000 of benzene with the span position set at 9.8. For additional sensitivity, the span potentiometer is turned counterclockwise (smaller numbers) to increase the gain. By changing the span setting from 10.0 to 1.0 the sensitivity is increased approximately ten fold. Then, the 0-20, 0-200, and 0-2000 ppm scales become 0-2, 0-20, and 0-200 ppm full scale, respectively. This span control is also utilized to make the instrument scale read directly in ppm of

the compound being measure. E.g., it is adjusted to match the value of a calibration gas to that same reading on the instrument scale. The span control can be utilized to calibrate nearly any compound, measured by photoionization, to be direct reading on the 0-20 ppm range. For example, gain settings of 4.5 or 8.9, respectively, will provide direct reading capability (0-20, 0-200 ppm) for vinyl chloride and trichloroethylene, respectively. For a listing of approximate gain setting values see Table 11.

A small DC operated fan is used to pull air through the photoionization sensor at a flow rate of three to seven hundred cubic centimeters per minute (ca. 0.5 lpm). The fan provides nearly instantaneous response times (Figure 2) while consuming little power. The characteristics of a fan are such that it cannot tolerate a significant pressure drop without affecting the flow rate and therefore either the instrument reading or response time. Since photoionization is essentially a nondestructive technique, changes in flow rate do not affect the signal but if a large pressure drop is imposed at the inlet the probe, the sample may not reach the sensor.

The instrument was designed to measure trace gases over a concentration range from less than 1 ppm to 2000 ppm. Higher levels of various gases (to percentage range) can be measured but the recommended procedure is to dilute the sample with clean air to a concentration of less than 500 ppm. This is generally within the linear range of the instrument and if the measured concentration is multiplied by the dilution ratio the correct concentration in the stream can be determined. A typical calibration curve is shown in Figure 3. Note that the calibration curve for benzene (the photoionization standard) is linear (over more than three decades) up to about 600 ppm (v/v).

If the probe is held close to AC power lines or power transformers, an error may be observed. For measurements made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area, in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

The instrument is equipped with an automatic solid state battery protection circuit. When the battery voltage drops below ~11 volts, this circuit will automatically turn off the power to the instrument. This prevents deep discharging of the battery and considerably extends the battery life. If the instrument is unintentionally left on overnight, the battery will be unharmed because of the battery protection circuit. If the instrument battery check reads low and the lamp doesn't fire, plug the charger into the instrument. The power to the analyzer should then be returned.

To charge the battery, place the mini phone plug into the jacket on left side of the bezel prior to plugging charger into 120 VAC. When disconnecting charger, remove from 120 VAC before removing mini phone plug. The battery is completely recharged overnight (ca. 14 hours). To ensure that the charger is functioning, turn the function switch to the battery check position, place phone plug into jack and plug charger into AC outlet. The meter should go upscale if charger is working and is correctly inserted into the jack.

The instrument can be operated during the recharge cycle. This will lengthen the time required to completely recharge the instrument battery.

3. Detection Principle and Theory

The detection principle of this portable instrument is photoionization. A wide variety of organic compounds and some inorganic compounds can be measured with this technique. Photoionization (with 10 eV photons) applied to the analysis of trace gases in air can eliminate fragment ion formation (signals) from the major components of air yet still allow the ionization of many impurities of interest in industrial atmospheres. This is demonstrated by the listing of ionization potentials* in Table 12. Note the high (12 eV) ionization potentials for the major components of air. In addition, the choice of a sufficiently low ionization energy often permits the selective ionization of one or two components in a complex gas mixture.

While the ionization potential serves as a rough guide to whether or not a response is obtained, it does not predict what the quantitative response actually is. In some cases, a species with an ionization potential 10.3 or 10.4 eV will give a response. In these cases, however, the response is usually low because of its low ionization efficiency at 10 eV. A partial list of actual relative sensitivities obtained with a photoionization analyzer is given in Table 13. The use of the tables should allow a determination of the specificity of the instrument in a given application on many industrial processes; this instrument may not respond to the starting materials or by-products but will respond to a product. An example of this is seen in the vinyl chloride monomer plants where neither ethylene or dichloroethane is detected but vinyl chloride is detected.

A block diagram of the major components of the photoionization analyzer is shown in Figure 4. The instrument is separated into two units interconnected by multiconductor electrical cable. The probe contains a fan for moving the air into the sensor, the ultraviolet lamp which is ignited by applying a DC voltage between the anode and cathode, the ionization chamber which contains a pair of electrodes and is adjacent to the lamp, and a signal amplifier. The photons (10 eV) which are emitted from the lamp pass through a UV radiation by a

* Ionization potential is defined as the energy required to move an electron an infinite distance from the nucleus or more simply, the energy required to produce a positive ion and an electron.

molecule which has an ionization potential of 10 eV or less will lead to ion formation via:



A positively biased high voltage electrode is used to push any ions formed by absorption of UV to the collector electrode where the current (proportional to concentration) is measured. This current is then converted to a proportional voltage by the amplifier in the probe. An electrical diagram of the instrument is depicted in Figure 5. The amplifier is gain stabilized by negative feedback and provides a voltage source output to drive the analog meter readout as well as the gain control network. The sensitivity of the instrument is controlled by changing the loop gain of the amplifier. A 12 volt battery provides the primary power for a high efficiency DC-DC converter which supplies the various potentials required for instrument operation.

TABLE 8
SPECIFICATIONS FOR MODEL PI 101
PHOTOIONIZATION ANALYZER

performance (benzene referred)

range 0.1 to 2000 ppm
detection limit 0.1 ppm
sensitivity (max) 0-2 ppm FSD over 100 division meter scale
repeatability + 1% of FSD
linear range 0.1 to 600 ppm
useful range 0.1 to 2000 ppm
response time < 3 sec to 90% of full scale
ambient humidity to 95% RH
operating temperature ambient to 40°C*

physical

size: probe 6.3 DIA x 28.5L (cm)	(2-1/2 x 11-1/4")
readout 21W x 13D x 16.5H (cm)	(8-1/4 x 5-3/16 x 6-1/2")
stowed 21W x 13D x 24H (cm)	(8-1/4 x 5-3/16 x 9-1/2")
cable 80 cm long (32")	

weight: probe .55 kg (20 ounces)
readout 3.2 kg (7 pounds)
total (shipping) 5.4 kg (12 pounds)

controls and functions

mode switch Off, Battery Check, Standby (zero), 0-2000, 0-200, 0-20 ppm
low battery indicator light
zero (10 turn + 300% FDS max)
span (10 turn counting dial 1.0 to 10 times nominal sensitivity)
readout 4-1/2" (11.3 cm) meter Taut Band movement graduated 0-5-10-15-20,
divisions
signal output for recorder 0-(-5V) FSD
power output for recorder 12 VDC - jack on side of instrument

power requirements of operating times

continuous use, battery > 10 hours
continuous use with HNU recorder reduces instrument battery operating time
to 1/2 normal time
recharge time, max < 14 hours, 3 hours to 90% of full charge
recharge current, max .4 Amps @ 15 VDC

TABLE 8 - (Cont.)

construction

Designed to withstand the shock and abuse to which portable instruments are often subjected. The readout is housed in a two piece aluminum case, and finished with a solvent resistant baked acrylic textured paint.

The probe is fabricated from extruded aluminum sections and machined plastic.

serviceability

The probe and readout are of a modular design allowing rapid servicing and/or replacement of mechanical and electrical components. All module interwiring includes quick disconnects.

maintenance

The instrument contains only one moving part, and consumes no gases or reagents. The only routine maintenance procedure is cleaning the light source window every several weeks.

calibration check

Check instrument calibration at least once per week with HNU calibration standard to ensure that the high sensitivity of the instrument is maintained.

- * Instrument is temperature compensated so that a 20°C change in temperature corresponds to a change in reading of $\leq \pm 2\%$ full scale at maximum sensitivity.

TABLE 9

BRIEF DESCRIPTION OF INSTRUMENT

CONTROLS AND FUNCTIONS*

<u>Control</u>	<u>Function</u>
Six Position Switch	OFF - Shuts off all power and removes DC voltage ON - In any other function position or measurement mode, the electronics are on. BATTERY CHECK - Indicates the condition of the battery. If needle position is in lower portion of green battery arc, the instrument should be recharged. STANDBY - UV lamp is off but electronics are on. This position will conserve power and extend the useful operating time between recharges of the battery. This position is also utilized to adjust the electronic zero. RANGES - 0-20, 0-200, 0-2000 direct reading ranges available at minimum gain for benzene. Sensitivity is available by adjusting the span potentiometer.
Zero Potentiometer	A ten turn potentiometer is employed to adjust the zero electronically when the instrument is placed in the standby position with the probe attached. This eliminates the need for a hydrocarbon free gas.
Span Potentiometer	A ten turn counting potentiometer is utilized for upscale setting of the meter on calibration. Counter-clockwise rotation increases the sensitivity (10 times). This pot can increase the sensitivity to make the instrument direct reading for nearly any gas which the instrument responds to.

* For position of layout controls see Figure 1.

Figure 1 Control Panel Functions of Photoionization Analyzer

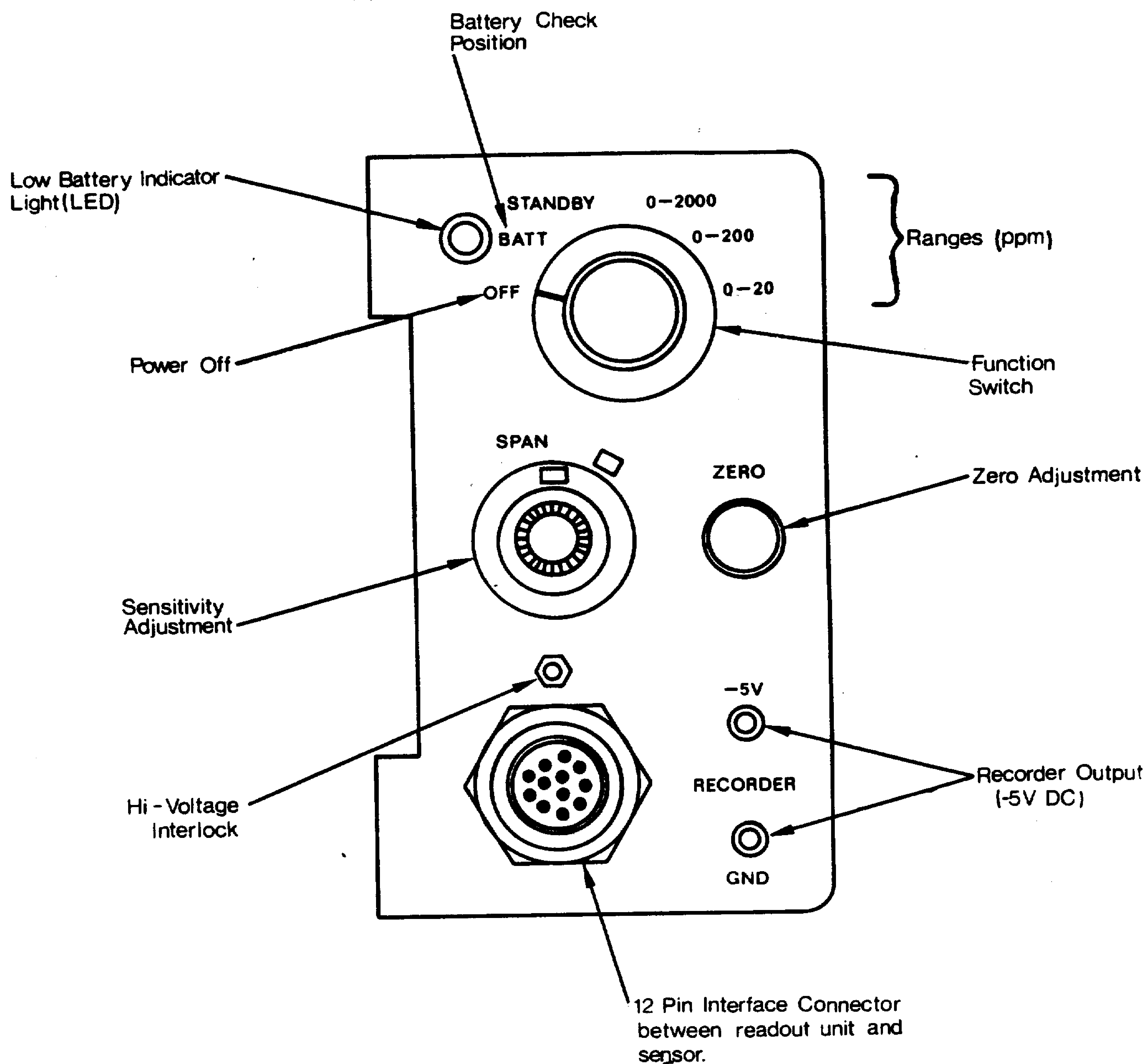


TABLE 10
VERIFICATION OF ELECTRONIC ZERO FOR
PHOTOIONIZATION ANALYZER*

<u>Sample</u>	<u>Instrument Reading (ppm)</u>	<u>% of F.S.</u>
Room Air	0.7	35
Room Air Passed Through 6" x 3/4" OD Charcoal Scrubber	0.1	5
Zero Air	0.25	12.5
Zero Air Passed Through 6" x 3/4" OD Charcoal Scrubber	0.04	2

* Maximum Gain = 2 ppm full scale.

TABLE 11
RELATIVE PHOTOIONIZATION SENSITIVITIES*
FOR VARIOUS GASES

<u>Chemical Grouping</u>	<u>Relative Sensitivity</u>	<u>Examples</u>
Aromatic	10.0	Benzene, Toluene, Styrene
Aliphatic Amine	10.0	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	5-7	MEK, MIBK, Acetone, Cyclohexe
Unsaturated	3-5	Acrolein, Propylene, Cyclohex
Sulfide	3-5	Allyl Alcohol Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C ₅ -C ₇)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	-
Paraffin (C ₁ -C ₄)	0	Methane, Ethane...

* Sensitivities in ppm (v/v).



TABLE 12
SOME DERIVATIVES OF OLEFINS

<u>Molecule</u>	<u>IP (eV)</u>
vinyl chloride	9.995
cis-dichloroethylene	9.65
trans-dichloroethylene	9.66
trichloroethylene	9.45
tetrachloroethylene	9.32
vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
CF ₃ CCI=CCICF ₃	10.36
n-C ₅ F ₁₁ CF=CF ₂	10.48
acrolein	10.10
crotonaldehyde	9.73
mesityl oxide	9.08
vinyl methyl ether	8.93
allyl alcohol	9.67
vinyl acetate	9.19

TABLE 13
RELATIVE SENSITIVITIES FOR VARIOUS GASES
(10.2 eV LAMP)

<u>Species</u>	<u>Photoionization Sensitivity*</u>
p-xylene	11.4
m-xylene	11.2
benzene	10.0 (reference standa
toluene	10.0
diethyl sulfide	10.0
diethyl amine	9.9
styrene	9.7
trichloroethylene	8.9
carbon disulfide	7.1
isobutylene	7.0
acetone	6.3
tetrahydrofuran	6.0
methyl ethyl ketone	5.7
methyl isobutyl ketone	5.7
cyclohexanone	5.1
naptha (86% aromatics)	5.0
vinyl chloride	5.0
methyl isocyanate	4.5
iodine	4.5
methyl mercaptan	4.3
dimethyl sulfide	4.3
allyl alcohol	4.2

Figure 2 Time Response for the Photoionization Analyzer.

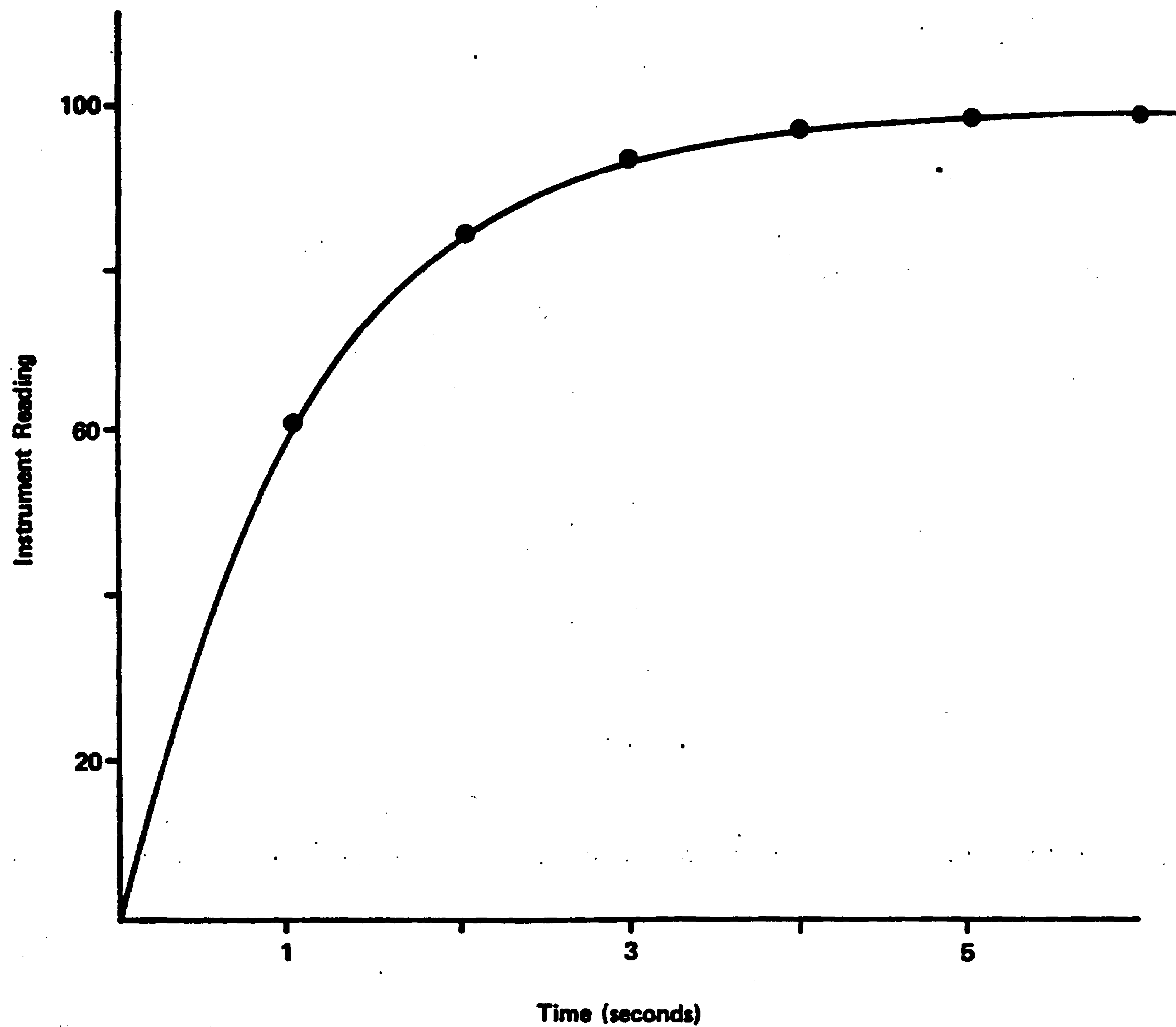
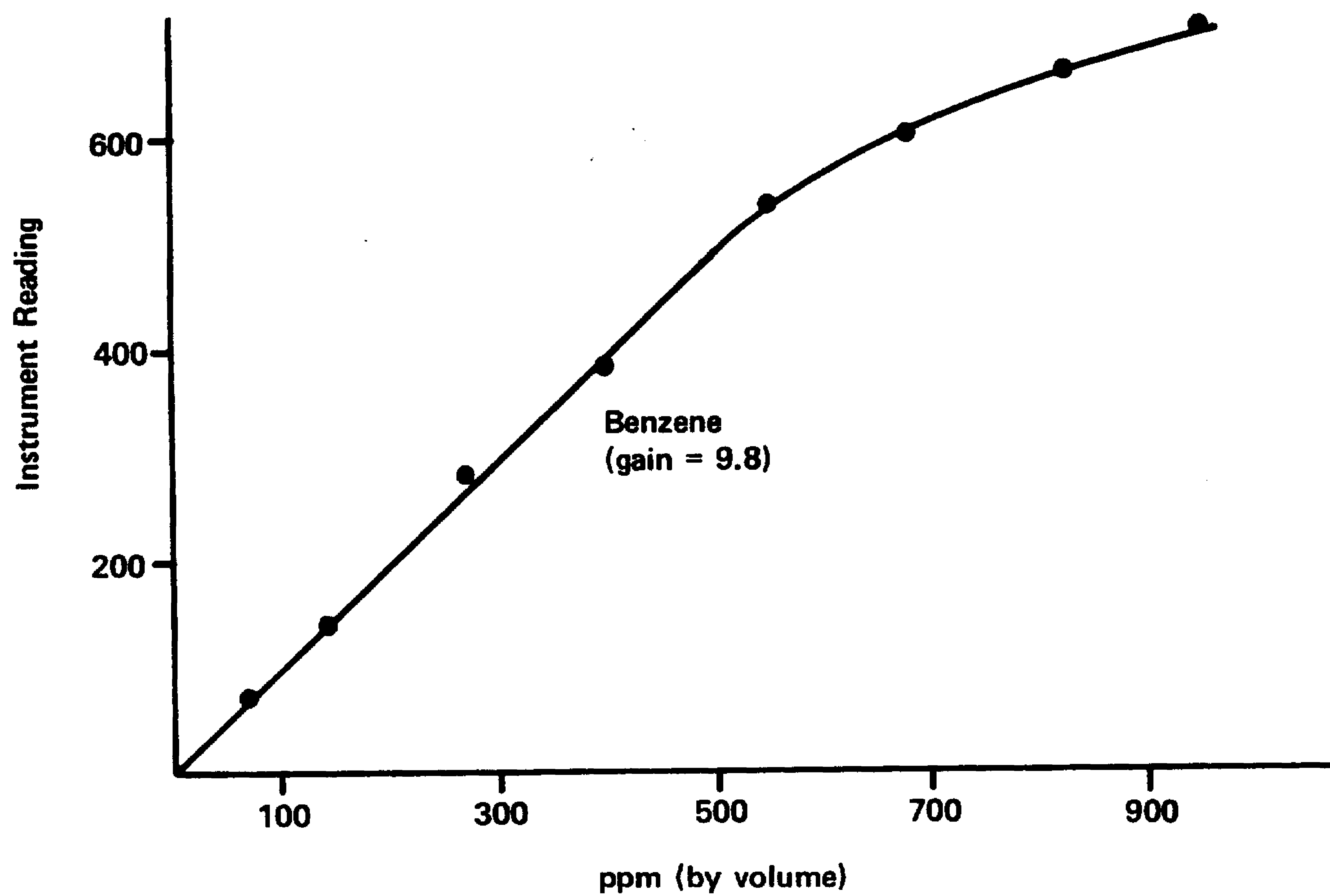




Figure 3 Typical Calibration Curve for Photoionization Analyzer.



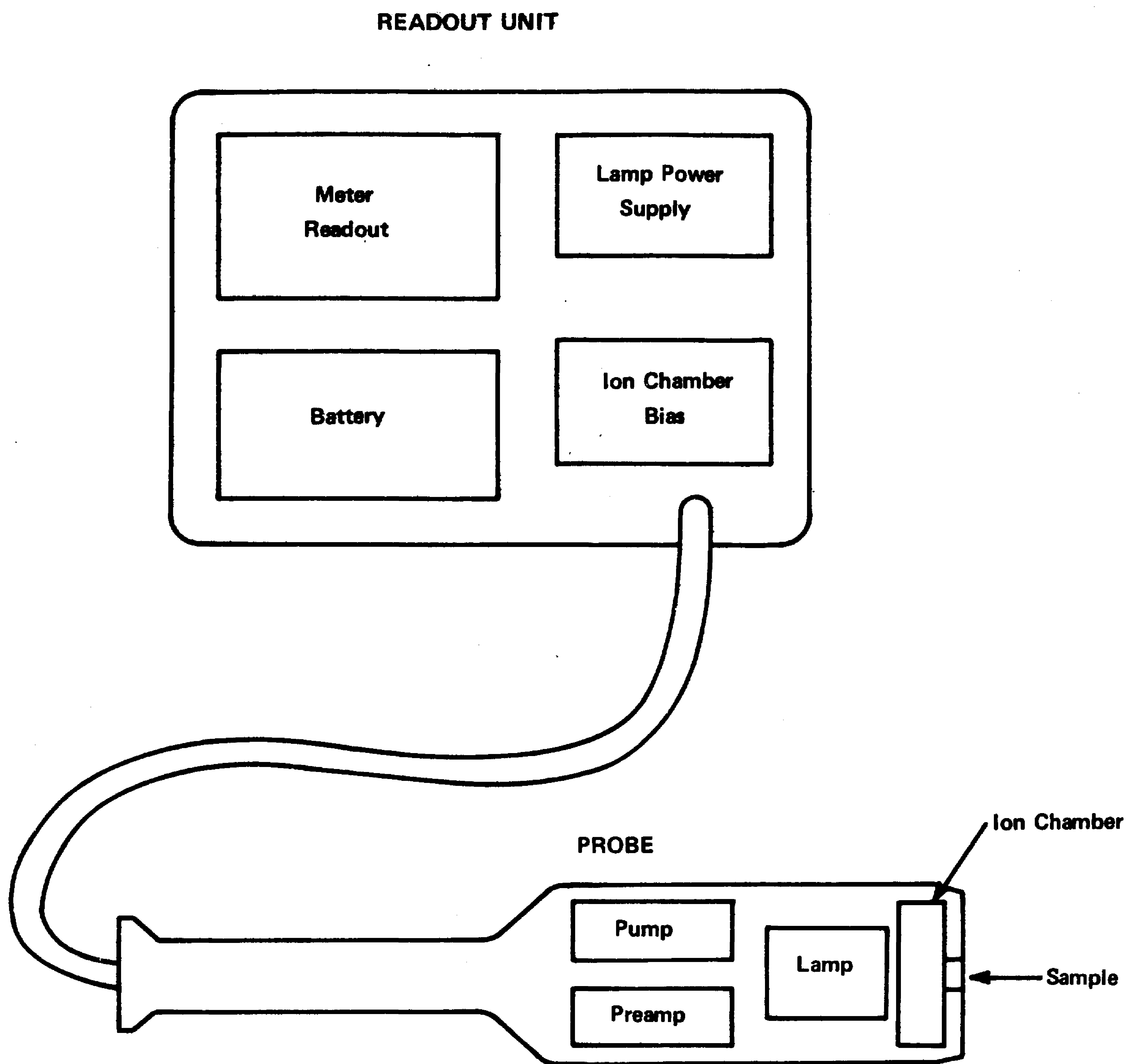
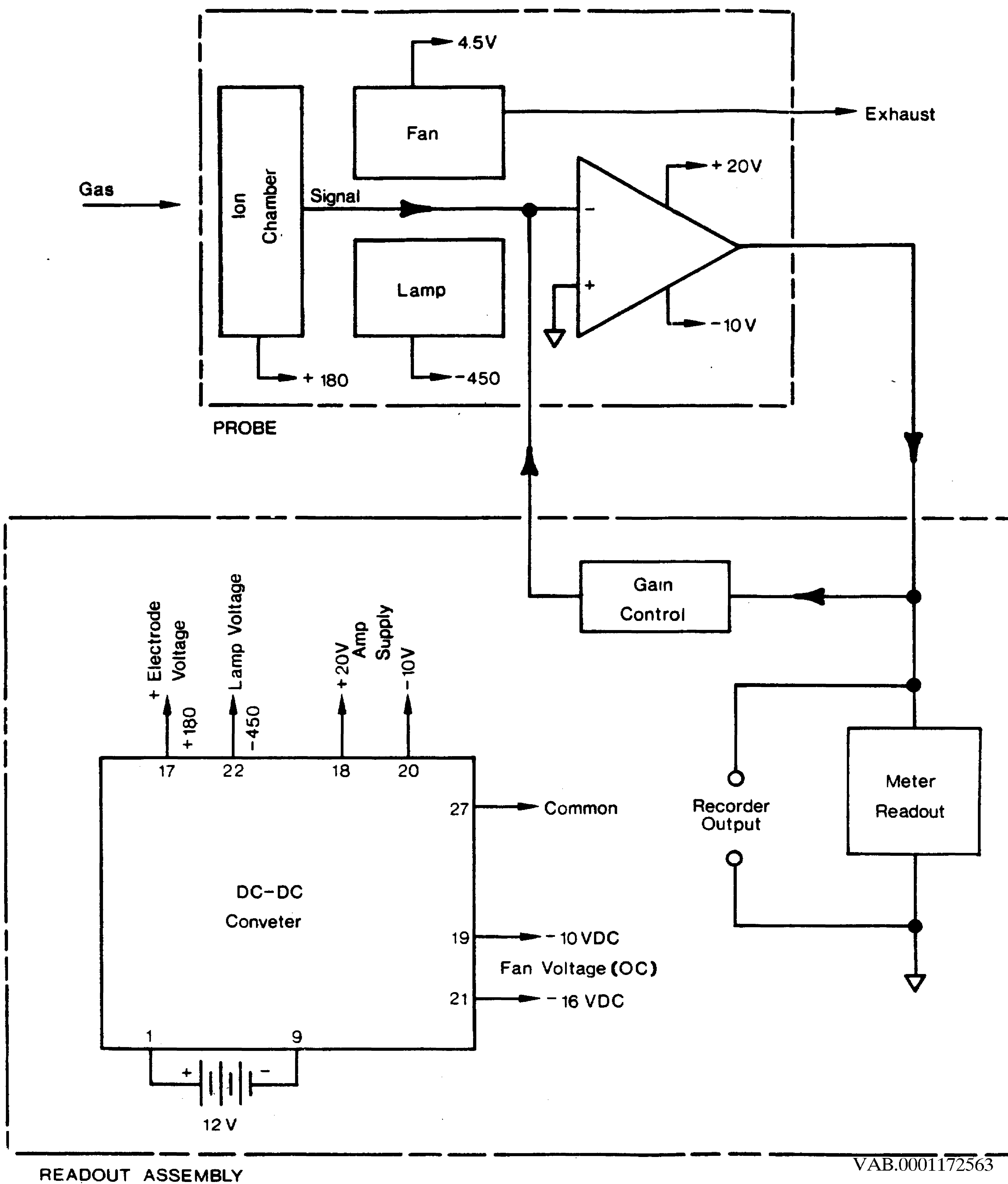


Figure 4 Block Diagram of Portable Photoionization Analyzer.

Figure 5 Electrical Block Diagram of Photoionization Analyzer



LEAK DETECTION AND ELIMINATION PLAN

ABERDEEN CHEMICAL PLANT

D. TLV PORTABLE HYDROCARBON DETECTORS

1. Introduction and Detection Principle

The Aberdeen Chemical Plant uses TLV portable hydrocarbon detectors to determine if potential leak sources identified with the HNU detector meet or exceed the definition of a leak. The TLV is also used to complete leak surveys required in the NESHAP regulations. The TLV is manufactured by:

Bacharach Instruments
301 Alpha Drive
Pittsburgh, PA 15238

To detect and measure concentrations of combustible gas in the air, the TLV Sniffer catalytically oxidizes gas in a pumped-in sample of air by means of a catalyst-coated resistance element. The resistance of this element changes with changes in heat that are proportional to the amount of oxidized gas, thereby altering the electrical balance of the catalytic element.

The TLV Sniffer is housed in a sturdy, brushed-aluminum and blue, wrinkle-finished plastic case. An attractively designed carrying handle serves also as an adjustable support stand and shoulder strap holder. Weighing 5- $\frac{1}{2}$ lbs., the compact 8-x6- $\frac{1}{2}$ -x3- $\frac{1}{4}$ -inch instrument is as convenient to carry as a transistor radio. A front panel, easily visible with the instrument in carrying position, contains a meter reading directly in ppm, and control knob for range selection and zero setting of the indicating meter pointer. The side panels of the instrument provide plugs and connectors for an air sample probe, earphones, battery charger, and recorder. Removal of ten screws holding the rugged plastic cover to the rigid aluminum case gives access to batteries and calibration adjustment controls located within the interior of the case.

The portable TLV Sniffer is an extremely sensitive combustible gas and vapor sensing instrument with an overall detecting sensitivity range of from 1 to 10,000 parts of gas or volatile flammable vapor per million parts of air (by volume). The instrument is equipped with an audible (beep) alarm that can be set to sound at any desired level of gas concentration to warn automatically of toxic concentrations of gas.

A

A compact battery charger (230 VAC: #0023-7353; 115 VAC: #0023-7230) with a plug-in connector may be attached to a jack provided in the right side of the instrument case. For stationary testing, the TLV Sniffer may be operated with the charger connected. For portable operations, the charger may be used to rejuvenate batteries within the instrument overnight. The intrinsically safe battery pack may be recharged either in or outside the instrument.

2. Operation

The MODE SELECTOR control knob at lower right on the instrument panel operates a rotating gang switch with an OFF position, a battery test switch, and three range-selector switch positions that allow a choice among three sensitivity ranges for readings of 0 - 100 ppm, 0 - 1000 ppm, or 0 - 10,000 ppm on the meter scale.

1. Turn MODE SELECTOR control knob to BATT TEST position and read condition of battery on meter dial. Install new or recharged batteries if necessary.
2. Turn MODE SELECTOR control to desired operating range, selected in accordance with the Threshold Limit Value for the toxic gas to be monitored (PPM X 1 for TLV from 0 to 100 ppm; PPM X 10 for TLV from 0 to 1000 ppm; PPM X 100 for TLV from 0 to 10,000 ppm).
3. Allow ten-minute warmup period with instrument in same position as it is to be used in service (meter facing up or meter facing to the side).
4. In fresh air before entering monitoring area, turn ZERO ADJUST control knob until meter pointer resets on zero.
5. For monitoring in noisy areas, insert jack of accessory earphone in plug on right side of instrument case.
6. Enter monitoring area and read ppm gas concentrations on meter. Audible warning sounds if gas concentration causes readings at mid-point of scale or above, or if toxic Threshold Limit Value has been exceeded, provided the alarm has been set for this response.

The TLV Sniffer air sampling system consists of a short intake connection leading directly into an interior aluminum air chamber holding the detector, a six-inch length of tubing connecting the chamber and a miniature sample-drawing pump, and a three-inch length of tubing to an exhaust port on the left side of the instrument case.

A meter reading directly in parts per million (ppm) allows instant visual determination of toxicity danger as readings are compared to published standard Threshold Limit Values. The instrument can be calibrated to read directly in parts per million for any one of many kinds of combustible gases.

Other functions provided in the TLV Sniffer circuitry for continuous self-monitoring purposes include a continuous, audible note of warning in response to failing batteries and to excessive negative drift in signal voltage due to malfunctioning detector circuit components. A 45-second time delay circuit is incorporated to prevent the sounding of a false alarm due to temporary voltage imbalances during the brief warmup period after the instrument mode selector switch has been set to operate the instrument.

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

E. CONTINUOUS MONITORING SYSTEM - CALIBRATION AND MAINTENANCE PROCEDURES

1. Calibration:

a. General

The Honeywell continuous monitors are each calibrated and spanned once per week. This is more often than is necessary to retain accuracy based on our experience with the units and based upon our conversations with the equipment manufacturers.

b. Calibration Procedure

1. Pre-calibration equipment checks (information as noted is recorded on "Daily Checklist" at the end of this section).
 - a. Visually check strip chart recorder for proper operation.
 - b. Visually check the control panels for the following settings:
 1. Monitor panel "ON".
 2. Sequence panel in "AUTO" setting.
 3. Amplifier panel in "AUTO" setting.
 4. Dual valve panel in "AUTO" setting.
 5. Dual component panel in "AUTO" setting.
 6. Stream panel showing the proper sequence of stream sampling.
 - c. Record the following data (all recorded on "Daily Checklist").
 1. Air cylinder pressure, high.
 2. Air cylinder pressure, low.
 3. Nitrogen cylinder pressure, high.
 4. Nitrogen cylinder pressure, low.
 5. Hydrogen cylinder pressure, high.
 6. Hydrogen cylinder pressure, low.
 - d. Check air, nitrogen, and hydrogen usage by looking at difference between the previous day's reading and present reading. A large difference indicates possible system leaks which would need correction prior to calibration.
 - e. Insure that pump is operating normally (record on "Daily Checklist").
 - f. Check to see if flame is on (record on "Daily Checklist").
 - g. Check the oven temperature to insure that it is correct. (Record on "Daily Checklist.")
 - h. Make sure that gates 1 through 10 are operating correctly (record on "Daily Checklist").
 - i. Check the oven parameters: temperature, air pressure, air flow.

2. Calibration (record data for each of the four units on "Honeywell Continuous Monitor Calibration Report" at end of this section).
- a. Shut off regular sample flow.
 - b. Open flow line of standard gas until flow meter indicates proper flow rate (5 cc/min.).
 - c. Change the sequencer panel setting from "auto" to "gate".
 - d. After the peaks on the strip chart line out for the standard gas reading, do the following:
 1. change the sequencer panel setting to "spectrum".
 2. change the amplifier panel setting from "auto" to "auto zero" to insure correct timing between peaks.
 3. when peak timing is seen to be stable, do the following on the sequencer panel: set the "auto" and "auto zero" switches to "calib"; also do the following to the dual component panel: change the setting to "calib".
 4. adjust the FID setting and the range setting.
 5. reset the sequencer panel to "auto" and "auto zero".
 6. reset the dual component panel to "auto".
 7. if the resulting peak registers 5 ppm for the 5 ppm standard gas, the calibration is finished;
 8. if the resulting peak does not register 5 ppm, change the sequencer switches from "auto" to "calib" and from "auto zero" to calib; also reset the dual component panel on "calib".
 9. repeat steps (4) through (7) above.
3. Post-Calibration Procedure
- a. Check the panel settings to insure they are as described below:
 1. sequence panel in "auto" setting.
 2. amplifier panel set on "auto".
 3. dual component panel set on "auto".
 - b. Make the following notations on the strip chart as an additional record that calibration has been accomplished:
 1. date
 2. time
 3. calibration span (must be 10 ppm)
 4. calibrator's initials
 - c. Shut off standard gas flow line.
 - d. Open normal sample flow line.

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

E. CONTINUOUS MONITORING SYSTEM - CALIBRATION AND MAINTENANCE PROCEDURES

2. Maintenance

a. Preventive Maintenance Schedule and Procedure

Preventive maintenance includes the following procedure:

1. Check the air flow through the sample lines and the vacuum pump operation.
2. Check the gas bottles for adequate pressure (includes bottles of air, H₂, N₂); make sure backup supply cylinders are always present.
3. Check the pressure in the VCM standard cylinder. Standard is 5 ppm VCM.
4. Check the combustion flame for proper appearance.
5. Make sure oven temperature is correct.
6. Check the air pressure to valves.
7. Examine the recorder to insure that:
 - a. each sample point is represented on the chart;
 - b. cycle times are correct.
8. Check the sample switching valves operation.
9. Check the sampling station lights to insure correct electronic operation of the system.

The preventative maintenance procedure is followed every week day. The attached preventative maintenance checklist is completed at the time of the check.

b. Corrective Maintenance Procedure

When a malfunction occurs, the following troubleshooting procedure is first followed:

1. Check the flame ionization cell for the voltage reading (should be -100 V DC); also check cleanliness of flame tip, and see if igniter is open.
2. Check preamplifier.
3. Check amplifier input and output.
4. Check recorder input and output.
5. Examine power supply.
6. Check sequencer to see if sample streams are being sampled in proper order.
7. Check stream selector to see if sample inlet solenoid valves are operating properly.
8. Check stream selector cards and dual component cards with the test module card, to see if threshold voltage of the IC chip cells is correct.

b. Corrective Maintenance Procedure (Cont.)

If the above procedure fails to pinpoint the cause of the malfunction, a more detailed troubleshooting procedure must be followed. This procedure is now discussed in detail, as is the repair procedure.

The Model 1000 PGC is specifically designed so that significant electrical and electronic levels can be readily monitored at front-panel test points, in the Control Section and in the Analyzer Section. Preamplifier test points, and the preamplifier "BALANCE" adjustment, are accessible by removing the threaded access plate in the front of the Analyzer's explosion-proof electronics housing. If required, the entire front of the housing can be removed to expose the Analyzer terminal strips for measurement of Analyzer input and output levels. The terminal strips and the printed circuit card rack can be removed by turning 1/4 turn fasteners.

An additional maintenance feature is the meter and function-selector switch on the front panel of the Monitor Module. This feature is especially valuable in monitoring the operation of the Chromatograph, and in troubleshooting the equipment.

Inasmuch as possible, the troubleshooting procedures are intended to fully utilize the modular design concept of the Honeywell Model 1000, and the front-panel test points provided in both the Control Section and the Analyzer Section. The primary objective of these procedures is to localize the problem, so that where possible, module substitution can be used to quickly return the equipment to proper operation.

Preliminary Checks

Before attempting to troubleshoot the equipment, make certain that the trouble is not caused by improper control settings or by some external condition. Confirm that all operating parameters are as specified. If a discrepancy is noted, refer to the appropriate troubleshooting chart in this section to further isolate the problem and to implement repairs.

Spectrum Interpretation

Operation of the equipment in the Spectrum mode is an effective means of troubleshooting the unit. Run several analyses in the spectrum mode to establish reproducibility, and interpret the results in accordance with Table 3.

Oven Heating System Troubleshooting

Refer to Table 15 for possible heater malfunctions and probable causes.

Analyzer Leak Check

Leaks in the Analyzer plumbing are a common cause of many operational problems. A leak can cause insufficient sensitivity, poor reproducibility, excessive valve-switching transients, and overall system instability. If the equipment exhibits any of these malfunctions, the Analyzer should be leak checked as follows. If internal valve leakage is suspected, refer to the valve checkout procedures.

1. Apply carrier pressure to the Analyzer.
2. Plug all carrier gas vent lines.
3. Close valve at carrier gas supply and check that pressure drop on the carrier supply gauge is less than 0.5 pounds per hour. If pressure drop exceeds this rate, localize the leak by successively plugging the exit from each valve or column.

Preamplifier Troubleshooting

Check that the preamplifier is operational by observing the preamp meter and varying the setting of the BAL (balance) adjustment potentiometer from side to side. The meter should move in a direction opposite the rotation of the BAL adjustment, and it should be possible to center the meter with this control.

If the meter indicates full-scale in either direction, adjustment can be simplified by placing a meter across the "+ BAL -" test points so that the effect of turning the BAL adjustment can be observed while setting the preamp 1-0-1 volt meter back within full scale. If the bridge will not balance, short out both detectors at the terminal strip on the preamp front panel, and again attempt to center the meter with the BAL adjustment. If the meter can be centered, a defective detector element is indicated.

If the meter cannot be centered, check from the ground test point to the + and - test points for +15 volts and -15 volts, respectively. The regulated +15 volts is produced within the preamplifier from the +20 volts supplied by the Control Section. If the +15 volts is not present, check that the +20 volts is present at the terminal strip in the upper portion of the explosion-proof housing.

Detector Bridge Checkout

Proper operation of the detector bridge can be confirmed by monitoring the bridge current at the R-C-S test points on the preamplifier front panel, or at the R-C-M test points on the Dual Preamplifier. Use a 20,000 ohms per volt meter, or better, and measure from the common (c) test point to the R or M test point, and then the S test point. Each voltage reading, multiplied by three, provides the detector current. This value can be compared with the nominal detector current as stated on the Instrument Operational Parameters sheet. Some variation from the specified value may exist due to temperature variance, however, the two sides of the bridge should be equal.

Detector Bridge Checkout (Cont.)

As a further check, the resistance of each thermistor can be measured by turning the power off at the Control Section, and disconnecting the detector leads from the terminal strip on the front of the preamp. Refer to the Instrument Operational Parameters sheet for the nominal resistance value at 25°C. Again, some variation from this value is acceptable due to temperature variance, however, the two thermistors should read the same.

Valve Checkout Procedures

1. Standard Valve (External Sample Loop)
 - a. Connect four-way valve to control ports (outer plates), and set air pressure to 32 psig.
 - b. Connect supply gas line to port #1. Use of helium is recommended.
 - c. Connect bubble tubes to ports #2 and #3.
 - d. Plug port #4.
 - e. Submerge bubble tubes in a beaker of water (down about 1/2").
 - f. Set supply gas pressure to 100 psig.
 - g. Port #2 should flow freely with the four-way valve in one position, and should not flow more than one bubble every 30 seconds with the valve in the other position.
 - h. Port 3 should not pass more than one bubble every 30 seconds in either control position, however, momentary flow is permissible during the switching transient.
 - i. Repeat steps 7 and 8 with the supply gas pressure set at 2 psig.
 - j. Connect supply gas line to port #8.
 - k. Connect bubble tubes to ports #6 and #7.
 - l. Plug port #5.
 - m. Submerge bubble tubes in a beaker of water.
 - n. Set the supply gas pressure to 100 psig.
 - o. Port #7 should flow freely with the four-way valve in one position, and should not flow more than one bubble every 30 seconds with the valve in the other position.
 - p. Port #6 should not pass more than one bubble every 30 seconds in either control position, however, momentary flow is permissible during the switching transient.
 - q. Repeat steps 15 and 16 with the supply gas pressure set at 2 psig.
 - r. Check for external leakage by plugging all ports except one and submerging the valve in iso-propyl alcohol with 100 lbs. of helium pressure.
 - s. If the valve fails to meet the above requirements, replace the valve, or recondition the valve.

2. Internal Sample Loop Valve

- a. Connect four-way valve to control ports (outer plates), and set air pressure to 32 psig.
- b. Connect supply gas line to port #1.
- c. Connect bubble tubes to ports #2 and #3.
- d. Plug port #6.
- e. Submerge bubble tubes in a beaker of water (down about 1/2").
- f. Set supply gas pressure to 100 psig.
- g. Port #2 should flow freely with the four-way valve in one position, and should not flow more than one bubble every 30 seconds with the valve in the other position.
- h. Port #3 should not pass more than one bubble every 30 seconds in either control position, however, momentary flow is permissible during the switching transient.
- i. Repeat steps 7 and 8 with the supply gas pressure set at 2 psig.
- j. Connect supply gas line to port #8.
- k. Connect bubble tubes to ports #6 and #7.
- l. Plug port #3.
- m. Submerge bubble tubes in a beaker of water.
- n. Set the supply gas pressure to 100 psig.
- o. Port #17 should flow freely with the four-way valve in one position, and should not flow more than one bubble every 30 seconds with the valve in the other position.
- p. Port #6 should not pass more than one bubble every 30 seconds in either control position, however, momentary flow is permissible during the switching transient.
- q. Repeat steps 15 and 16 with the supply gas pressure set at 2 psig.
- r. Check for external leakage by plugging all ports except one, and submerging the valve in isopropyl alcohol with 100 lbs. of helium pressure.
- s. If the valve fails to meet the above requirements, replace the valve, or recondition the valve.

Repair and Replacement Procedures

Module Replacement

As previously mentioned, module substitution can be effectively used to troubleshoot the equipment, and to quickly return the equipment to proper operation. However, in substituting one module for another, the following points must be considered.

The first three left-hand module positions in the Control Section must always contain the Monitor Module, the Sequencer Module, and the Amplifier Module, in that order. All other modules can be intermixed in the remaining module positions without restriction.

WARNING

Do not install or remove plug-in modules while power is applied to the Control Section. Damage to the module and the Control Section will result.

In replacing a Monitor Module, a Component Module, an Integrator Module, or a Valve Module, the green AUTO ZERO jumper must be moved to either the functional position or the "disabled" position, depending on the requirements of the application. Refer to the Instrument Operational Parameters sheet furnished with the equipment.

In replacing a Component Module, a Dual Component Module, an Integrator Module, or a Ratio Module, the blue GATE jumper (if GATE is used) must be set to coincide with the Component number for which the module is to be used. In Component Modules, the orange MEMORY jumper (if MEMORY output is used) must also be set to coincide with the appropriate Component number. In replacing a Valve Module or a Dual Valve Module, the red VALVE jumper must be set to coincide with the corresponding valve number. Note that the VALVE #1 terminal on the Valve Module and Dual Valve Module printed circuit boards corresponds to the Valve #2 connections on the back of the Analyzer Section. In the Analyzer, Valve #1 is the Sample valve.

In replacing the Sequencer Module, it may be necessary to adjust the CHART ADVANCE potentiometer on the Sequencer printed circuit board to achieve the desired bargraph spacing. In addition, some adjustment of the VALVE DELAY potentiometer may be required to "fine turn" the sample inject duration to coincide with the setting of the previously used module.

In replacing a Stream Selector Module which uses analog stream identification, it may be necessary to adjust trimpot R50 on the analog identification printed circuit card to achieve the desired width of the identification bar.

Detector Replacement

1. Turn detector power and Control Section power off by means of the appropriate switches on the Monitor Module. Shut-off all gas flow through the Analyzer.
2. Remove four screws, and remove the cover from the detector housing.
3. Disconnect four detector leads from the terminal strip inside the housing.
4. Remove two screws and bend the terminal strip up and out of way.
5. Remove the four tubing nuts which connect the detector cell to the feed-thru adapters inside the housing.
6. From outside the housing, disconnect the four tubing leads.
7. Loosen the lock-nut on each tubing adapter, and back out the four adapters as required to obtain clearance for removal of the cell.
8. Remove the detector cell and mount securely in a vise.
9. Remove the two detector hold-down nuts and remove the two detectors. Replace with two detectors obtained from Honeywell Inc. Part Number for 8K Thermistor - 11600228001; for 100K Thermistor - 1160021003.
10. Re-install the detector hold-down nuts and use a box-end wrench to tighten the nuts securely.

Detector Replacement (Cont.)

11. Place the detector cell inside the detector housing, and retighten the four tubing adapters in the housing ends.
12. Re-connect the four tubing leads inside the housing, and tighten the four tubing nuts.
13. Place the terminal strip in position and secure with two screws.
14. Connect the four detector leads to the terminal strip.
15. Install the detector housing cover and secure with four screws.

Valve Overhaul

1. Remove the 3/8-inch bolt through the center of the valve and set aside the bolt, the spring washer, and the bottom plate.
2. Disassemble the valve, being careful not to drop the parts or misplace the two 1/8-inch dowel pins.
3. Remove and discard the rubber diaphragm and the Teflon diaphragm and paper backing.
4. Examine the center plate for evidence of scratches or chemical etching. If defects are noted, replace with P/N 30740489 (internal volume) or P/N 30740483 (external loop) obtained from Honeywell, Inc.
5. Apply one drop of #550 silicone oil to each piston and reinstall in the respective cylinder. Check each piston for proper fit.
6. Re-assemble the valve by first inserting the two 1/8-inch dowel pins into the center plate. These pins will align the remaining parts during reassembly.
7. Install replacement Teflon diaphragms (Honeywell P/N 30740488-2) on each side of the center plate. The smooth side of the diaphragm must be against the center plate.
8. Install the backing paper, the cage, and the pistons and cylinders. Check that the blank cylinders are positioned over the blank areas on the center plate.
9. Install the replacement rubber diaphragms (Honeywell P/N 30740488-1).
10. Install the head plates, making sure that the four holes in the lapped side of each plate are toward the center plate.
11. Install the spring washer and 3/8-inch hex head bolt, and tighten to 10ft.-lbs. of torque.
12. Check the operation of the valve in accordance with the appropriate procedure. In the event that port-to-port leakage occurs following installation of new diaphragms, increase air pressure to approximately 100 psig to "wear in" the Teflon. After the valve has been "worn in" at 100 psig, reduce air pressure to 32 psig and repeat the valve checkout procedure.

Standard Sample Calibration

In order to perform a meaningful calibration, all equipment parameters must be as specified in the Instrument Operational Parameters sheet. In addition, allow at least 30 minutes for the oven temperature and the Control Section electronics to stabilize.

1. Check the preamp balance and adjust as required.
2. Set all front panel controls as specified in the Instrument Operational Parameters sheet and run several bargraph analyses of the sample gas.

- A
3. Observe each component peak and check for improper component levels. To calibrate a specific component, proceed as follows.
 4. Set the Amplifier Module AUTO ZERO/OFF Switch to the centered position. This will hold the baseline at the same position during the calibration.
 5. Set the Sequencer Module MODE switch to MAN to inhibit the timer.
 6. Set all AUTO/OFF/CAL switches to OFF, except for the component of interest. Set this switch to the CAL position.
 7. Set the Amplifier Module AUTO/CAL switch to the CAL position.
 8. Adjust the Amplifier Module RANGE CALIBRATE control to produce the same recorder displacement as the component produced during the previous analyses.
 9. Adjust the RANGE control on the Component Module of interest to achieve the correct percentage of full-scale deflection on the recorder.
 10. Repeat steps 6 through 9 for each remaining component which requires calibration.

Memory Calibration

1. Set all front panel controls as specified in the Instrument Operational Parameters sheet. If desired, calibration time can be substantially shortened by setting the Sequencer Module TIME switches to about 10 seconds, and setting the gate time for the component of interest to about 7 seconds.
2. Set the Sequencer Module sample valve AUTO/MAN switch to the centered (off) position, and the MODE switch to any position except MAN.
3. Set all Component Module AUTO/OFF/CAL switches to OFF, except for the component of interest. Set this switch to the CAL position.
4. Set the Amplifier Module AUTO/MAN switch to AUTO, the AUTO/ZERO/OFF switch to OFF, and the AUTO/CAL switch to CAL.
5. Monitor the amplifier output level by placing a meter across the Amplifier Module GND and OUT test points.
6. Adjust the Amplifier Module RANGE control to produce the desired full-scale output level from the amplifier. Allow the Sequencer to run through several cycles.
7. Measure the output at the GND and OUT test points of the Component Module of interest, and adjust the corresponding MEMORY SPAN control to bring the memory output to the level of the amplifier output, or to the trend recorder full-scale.
8. Place the Amplifier Module AUTO ZERO/OFF switch in the AUTO ZERO position and run several analyses.
9. Again measure the output level at the GND and OUT test points of the Component Module of interest, and adjust the corresponding MEMORY ZERO control to produce a 1 volt (or trend recorder zero) output.
10. Re-set the Amplifier Module AUTO ZERO/OFF switch to OFF, and repeat steps 7, 8, and 9 until the proper zero and full-scale memory outputs are produced.

Chart Advance Adjustment

Bargraph spacing between successive gates and between successive analyses can be adjusted by placing the Sequencer Module on a board extender and adjusting the CHART ADVANCE potentiometer on the printed circuit board. Because analysis spacing is a function of gate spacing, adjustment of CHART ADVANCE effects both functions.

WARNING

Do not install or remove plug-in modules while power is applied to the Control Section. Damage to the module and the Control Section will result.

Sample Valve Duration Adjustment

Sample valve inject duration can be adjusted up to one second beyond the thumbwheel setting by placing the Sequencer Module on a board extender and adjusting the VALVE DELAY potentiometer on the printed circuit board.

WARNING

Do not install or remove plug-in modules while power is applied to the Control Section. Damage to the module and the Control Section will result.

Heater Pressure Switch

The heater air pressure switch is factory set to automatically shut off electrical power to the oven heater in the event that the applied air pressure drops below 15 psig. No further adjustment is required. If defective, order replacement P/N 212-010-0003 from Honeywell, Inc.

Oven Temperature Adjustment

The optimum oven temperature, as stated in the Instrument Operational Parameters sheet, is factory set, and normally should not require re-adjustment. If adjustment is required, remove the threaded access plate on the front of the Analyzer electronics housing, and adjust the TEMP SET control on the front of the temperature controller. Clockwise rotation increases oven temperature, and counterclockwise rotation decreases oven temperature.

NOTE

If the oven operating temperature is to be changed from that specified on the instrument.

Adjustment of Oven Over-Temperature Switch

The oven over-temp switch does not require adjustment, except when the Analyzer is re-configured by installation of new column types which require a change in the oven operating temperature. If adjustment is required, proceed as follows:

1. Remove the threaded access plate on the front of the Analyzer electronics housing so that the indicator on the front of the temperature controller can be seen.
2. Remove four screws on the front of the oven over-temperature switch and remove the cover plate.
3. Set the switch adjustment flush with the front of the setscrew color, then turn the adjustment 3 1/2 turns clockwise.

CAUTION

Do not turn the adjustment fully clockwise.

4. Close the oven door and apply air pressure and electrical power to the Analyzer Section. Adjust the TEMP SET control on the temperature controller as required to stabilize the oven at 10°C above the specified operating temperature for the columns to be used.
5. Open the oven door and rotate the switch adjustment counter-clockwise until the dimly-lit indicator on the controller goes out.
6. Re-adjust the TEMP SET control to stabilize the oven at the proper operating temperature.
7. Re-install the cover over the switch housing, and re-install the threaded access plate.

Adjustment of Heater Barrel Over-Temperature Switch

The heater barrel over-temperature switch does not require adjustment, except following replacement of the heater barrel. To adjust, proceed as follows:

1. Connect a pyrometer to the thermocouple leads which are coiled and stored below the explosion-proof electronics housing in the upper portion of the Analyzer Section.
2. Remove the threaded access plate on the front of the housing so that the indicator on the front of the temperature controller can be seen.
3. Remove the brass plug in the front of the heater housing, and turn the adjustment fully clockwise.
4. Apply power to the Analyzer Section and observe the pyrometer. When the barrel temperature reaches 300-350°C, slowly turn the adjustment counterclockwise until the light on the temperature controller goes out.
5. Disconnect the pyrometer; coil and stow the leads; and install the brass plug and the threaded access plate.

Auto Zero Track and Amplifier Offset Adjustments

The Auto Zero Track and Amplifier Offset adjustments are factory set, and field adjustment is not recommended. If the amplifier fails to meet the performance requirements, the Amplifier Module should be replaced and returned to Honeywell, Inc. for servicing. If field adjustment is to be attempted, the following instructions must be fully understood and precisely implemented.

NOTE

Place the Amplifier Module on a board extender and allow at least one hour for the Control Section electronics to thermally stabilize.

1. Disconnect the preamplifier signal leads at the rear of the Control Section and short the amplifier input.
2. Set the Sequencer Module sample valve AUTO/MAN switch to the centered (off) position, and the MODE switch to SPEC. Set the TIME selector switches to 02 seconds and the DURATION switches to 01 seconds.
3. Set the Valve Module AUTO/OFF/MAN switches to OFF.
4. Set the Monitor Module Auto Zero COARSE time selector switches to 01 seconds. This will cause the auto zero function to be repetitively fired during the adjustments.
5. Set the Amplifier Module AUTO/MAN switch to the MAN position and set the MANUAL RANGE selector to the "1000" position.
6. Set the Amplifier Module AUTO/CAL switch to AUTO and the AUTO ZERO/OFF switch to OFF.
7. Center the Amplifier Module AMPLIFIER ZERO control to produce zero volts at the wiper arm of the potentiometer.
8. Place a meter across the Amplifier Module GND and OUT test points, and adjust trimpot R42 on the printed circuit board to produce zero volts out.
9. Set the Amplifier Module AUTO/CAL switch to the CAL position, and adjust the RANGE CALIBRATE control to produce one or two volts (positive or negative) at the amplifier output.
10. Place the Amplifier Module AUTO ZERO/OFF switch in the AUTO ZERO position and allow the Sequencer to cycle three or four times.
11. Measure the voltage level at the amplifier output and adjust trimpot R18 on the printed circuit board to produce zero volts.
12. Turn the Amplifier Module AMPLIFIER ZERO control fully to one end, and allow the sequencer to cycle three or four times.
13. Measure the amplifier output level and note any variance from zero volts.
14. Adjust trimpot R18 to remove one-half of the error, and adjust trimpot R28 to remove the remaining error.

15. Turn the Amplifier Module AMPLIFIER ZERO control fully in the opposite direction.
16. Measure the amplifier output level and adjust R18 to remove one-half the error, and then adjust R28 to remove the remaining error.
17. Repeat steps 13, 14, and 15 until the Auto Zero circuitry tracks as close to zero as possible. Any error present must be the same at both extremes of the AMPLIFIER ZERO control.
18. Adjust trimpot R42 on the Amplifier Module printed circuit board to reduce any offset of the amplifier output to zero.
19. Perform the Auto Zero Tracking and Amplifier Offset Checks and "fine tune" R18 to compensate for any negative baseline shift of the component with the highest gain setting.
20. Remove the short at the amplifier input and re-connect the preamplifier leads.

Stream Selector Analog Identification Adjustments

1. Set the analysis times as specified in the Instrument Operational Parameters sheet. If desired, the times may be set proportionally shorter to speedup the adjustment procedure. Set all Component and Valve modules to OFF.
2. Place the Stream Selector Module on an extender board, apply power to the Control Section, and allow 30 minutes for warmup.
3. Set the Sequencer Module sample valve AUTO/MAN switch to the centered position, and the MODE switch to SPEC.
4. Set all "stream-select" switches to the ON position.
5. Depress the Stream Selector RESET switch, and then the Sequencer Module SEQ. RESET switch.
6. Center the zero adjustment (R73) and the span adjustment (R78). Observe the recorder or use a meter at TP2, and adjust R78 to produce a 1-volt difference between each successive output as the Stream Selector cycles.
7. Adjust R73 to produce a 5-volt output when Stream 5 is selected. The resultant output for each of the other stream selections should be nominally: Stream 1 = 1 volt, Stream 2 = 2 volts, etc. Alternately adjust R73 and R78 to produce a readily identifiable output for each stream selected. Precise adjustment is not required.
8. Adjust R50 on the analog identification printed circuit board to vary the width of the identifying bar on the recorder.

Integrator Module Adjustments

1. Place the Integrator Module on an extender board and apply power to the Control Section. Allow 30 minutes for warmup.
2. Set the Sequencer TIME switches to produce a 15-second analysis, and set the sample valve AUTO/MAN switch to the centered (off) position. Set MODE to any position except MAN.
3. Set the Integrator COARSE switches to produce an integrator gate which is ON at 05 seconds and is OFF at 10 seconds.
4. Short the Integrator input at pins 36 and 37 on the integrator printed circuit board. Adjust offset potentiometer R19 to produce 0 volts out of TP2.

5. Adjust R38 on the integrator printed circuit board so that the voltage at pin 2 of Q4 is equal to the voltage at pin 6 of Q4. On some models, R38 is a fixed resistor, and must be selected to produce the desired voltage at pin 2.
6. Monitor the front-panel GND and OUT test jacks, and adjust the front-panel ZERO control to produce 1-volt out after the integrator gate is closed.
7. Remove the short at the Integrator input.
8. Adjust the SPAN control, as required to produce an optimum output waveshape for the peak(s) being integrated.

Ratio Module Adjustments

The five trimpots associated with the ratio circuitry of A1 and IC5 (R42, R44, R45, R48, R49) should not be adjusted in the field. These adjustments effect the operation of the ratio elements of the circuit, and specialized equipment is required for calibration and adjustment. Instead, adjust the input memories and the output memory as follows:

1. Place the Ratio Module on an extender board and apply power to the Control Section. Allow 30 minutes for warmup.
2. Set the Sequencer TIME switches to 60 seconds and set the sample valve AUTO/MAN switch to the centered (off) position.
3. Set one component gate of interest to be ON for 10 seconds duration, starting at 05 seconds into the analysis. Set the other component gate of interest to be ON for 10 seconds duration, starting at 25 seconds into the analysis.
4. Set the Ratio Module COARSE switch to 40 seconds.
5. Set all AUTO/OFF/CAL switches to OFF, except for the two components of interest and the Ratio Module. Set these switches to AUTO.
6. Set the Amplifier Module AUTO ZERO/OFF switch to AUTO ZERO, and the AUTO/CAL switch to CAL.
7. Adjust the Amplifier Module RANGE CALIBRATE control to produce 5 volts out of the Amplifier Module GND and OUT test jacks during the gate associated with relays K1 and K2 in the Ratio Module.
8. Adjust zero control R22 on the Ratio Module printed circuit board to produce 1 volt at TP6 during the Auto Zero which occurs coincident with the gate opening. Adjust span control R31 to produce 5 volts at TP6 after the Auto Zero is completed.
9. Adjust the RANGE control on the Component Module associated with relays K3 and K4 in the Ratio Module, to produce 5 volts out of the Amplifier Module GND and OUT test jacks during the associated component gate.
10. Adjust zero control R26 on the Ratio Module printed circuit board to produce 1 volt at TP5 during the Auto Zero which occurs coincident with the gate opening. Adjust span control R37 to produce 5 volts at TP5 after the Auto Zero is completed.
11. Allow the Sequencer to complete several cycles. Adjust the Ratio Module front-panel ZERO control to produce a 1-volt output at TP9.

12. Adjust the RANGE control on the Component Module associated with relays K3 and K4 in the Ratio Module, to produce 0 volts out of the Amplifier Module GND and OUT test jacks during the associated component gate.
13. Allow the Sequencer to complete several cycles. Adjust the Ratio Module front-panel SPAN control to produce a 5-volt output at TP9.
14. Re-calibrate the Component Module associated with relays K3 and K4 in the Ratio Module.

Re-Application Data

The preamplifier gain can be increased or decreased by changing the values of resistors R15 and R17 in the Preamplifier Module. The preamp gain is normally a function of the intended application and is thus pre-set at the factory. In the event of reapplication in the field, the following factors should be considered.

Resistors R15 and R17 are a precisely matched pair of high-quality wirewound resistors. If the preamp gain is to be changed, refer to Table 8 and order the appropriate matched pair from Honeywell, Inc. The gain of the preamp should be selected so that the largest anticipated peak will not drive the amplifier to saturation. Maximum peak output should be 5 to 6 volts.

In installing the replacement resistors, exercise extreme care in soldering the leads in place. Do not apply prolonged excessive heat which could change the resistance of the components.

Component Module or Integrator Module Gain Change

The gain range of a Component Module or Integrator Module can be increased or decreased by changing the value of resistor R65 on the printed circuit card. Refer to Table 9 and select a resistor value which will produce a slightly less than full-scale output and will allow final full-scale adjustment by means of the Component Module or Integrator Module RANGE Control.

Installation of New Column Types

In the event that field re-application involves installation of columns which differ from those previously used, special attention must be given to establishing the proper oven temperature.



TABLE 14

SPECTRUM ANALYSIS TROUBLESHOOTING CHART

<u>Indication</u>	<u>Possible Cause or Solution</u>
Baseline drift in one direction	1. Analyzer oven not stabilized at proper temperature. 2. Incorrect column or reference flow. 3. Check for column leak, or uneven column bleeding in two-column system. 4. Check the sample for materials which may be entering the column as a liquid. 5. Check detector bridge current. 6. Replace supply gas cylinder(s). 7. Replace supply gas drier(s).
Wavy or sine-wave baseline	1. Analyzer oven temperature cycling. 2. Check the recorder. 3. Check stability of column flow. 4. Check carrier pressure and leak check carrier flow system. 5. Check sample gas for leakage into carrier gas.
Noisy or erratic baseline	1. Defective Preamplifier Module. 2. Replace Amplifier Module. 3. Excessive power supply ripple. Monitor power supply output with an oscilloscope at the rear of the Control Section. 4. Check for loose leads, bad ground connection or dirty switch contacts. 5. Check for carrier gas leak. 6. Replace or recondition contaminated column.
Improper elution times	1. Check that the Analyzer oven has stabilized at the proper temperature. 2. Check the column flow rates. 3. Replace or recondition the columns.
Incorrect component readout	1. Check that the Analyzer oven has stabilized at the proper temperature. 2. Calibrate the Control Section. 3. Check the column flow-rates. 4. Check for proper valve switch timing. 5. Check for foreign components in the sample.
Baseline shift at Auto Zero times	1. Auto Zero circuitry defective or improperly adjusted.

TABLE 14 (Cont.)

<u>Indication</u>	<u>Possible Cause or Solution</u>
No peaks	1. Check that the Monitor Module DET (detector) power switch is on. 2. Check for proper flow rates and air pressure settings. 3. Check valve switch timing. See Instrument Operations Parameters sheet. 4. Check for defective sample inject valve. 5. Check preamp and detector bridge. 6. Check for defective column-switching valve.
Poor Sensitivity	1. Check for improper MANUAL RANGE setting. 2. Check that the Analyzer oven has stabilized at the proper temperature. 3. Check for insufficient sample size or partially blocked sample volume chamber. 4. Check for extreme preamplifier imbalance.
Steady baseline drift in one direction, then in the other direction.	1. Check for cycling oven temperature. 2. Check for contaminated carrier or drier.
"Stairstep" baseline	1. Check recorder for proper operation. Check ground connections.
Inverted peaks	1. Check for reversed recorder leads at the rear of the Control Section.
Incorrect trend output	1. Memory circuitry defective or improperly adjusted.
Auto Zero not functioning	1. Check that Amplifier Module AUTO ZERO/OFF switch is set to AUTO ZERO position. 2. Check that the corresponding Auto Zero jumper (green) is set to the functional position.
Column-switching valve not functioning	1. Check for proper air pressure. Adjust as required. 2. Check that the corresponding valve switch on the Solenoid Driver Card is in the AUTO position. 3. Check that the Valve Module VALVE jumper (red) is set to the proper position.
Memory (trend output inoperative)	1. Check that the Component Module MEMORY jumper (orange) is set to the proper position.

TABLE 14 (Cont.)

<u>Indication</u>	<u>Possible Cause or Solution</u>
Incorrect Ratio Output	1. Ratio memory circuits defective or improperly adjusted.
Incorrect Integrator Output	1. Integrator module defective or integrator memory circuits improperly adjusted.
Incorrect Analog Stream Identification	1. Stream Selector analog identification circuit defective or improperly adjusted.
Stream Selector Inoperative	1. Stream 1 ON-OFF switch is not set to the ON position.

TABLE 15

OVEN HEATING SYSTEM TROUBLESHOOTING CHART

<u>Indication</u>	<u>Possible Cause or Solution</u>
No heating	1. Check AC power to Analyzer Section at terminal strip inside explosion-proof electronics housing. 2. Check fuse on front of temperature controller module. 3. Check that sufficient air pressure (34 psig is applied, and that the heater air shut-off valve is open. 4. Check for 115 VAC across the heating element. 5. Check for AC power to and through the contacts of the oven over-temperature switch, the low-pressure shut-off switch the heater barrel over-temp switch.
Oven stabilizes at incorrect temperature	1. Temperature Controller Module defective or improperly set. 2. Oven over-temp switch defective or set below the specified operating temperature. 3. Check for leaks around oven door seals.
Oven temperature will not stabilize	1. Check operation of Temperature Controller Module. 2. Check for leaks around oven door. 3. Check for air flow obstructions in the oven 4. Heater barrel over-temp switch or oven over-temp switch defective.

HONEYWELL VALVE OVERHAUL

Procedure: Disassembly

1. Place the valve into a vise allowing only the mounting fixture to remain in the jaws of the vise.
2. Loosen the 3/8 inch bolt by turning in a counter clockwise direction.
3. Remove entire valve from vise and prepare for disassembly in a clean area.
4. Remove 3/8" bolt, belleville washers and force washer from valve head plate and set aside.
5. Carefully slide remaining portion of valve from mounting fixture.
6. Place the valve on clean tissue paper with port number 8 toward you and at the lower right hand corner.
7. Remove head plate from top portion of valve and inspect surface for scratches.
8. Leave both dowel pins in place until disassembly leaves only the center plate.
9. Remove the actuating diaphragm and discard.
10. Remove cylinder plate and inspect cylinder walls for wear and galling.
11. Remove pistons, cylinders and cylinder blank from valve and check each piston and cylinder for ease of movement. This is done by gently tapping the bottom of the piston with the finger and observing the free movement of the piston within the cylinder. If the piston does not move freely, check to determine if piston or cylinder is the cause, and replace as necessary.
12. Remove sealing diaphragm and discard.
13. Taking remaining portion of valve, turn it over and repeat above operation.

HONEYWELL VALVE OVERHAUL

Procedure: Assembly

1. Place a clean, lapped and de-burred center plate upon a clean tissue.
2. Having carefully inspected the above plate for scratches, insert two dowel pins on either side of the center plate.
3. Turn the center plate such that port 8 will be at the lower right hand corner facing you.
4. Take one sealing diaphragm and inspect both sides for scratches, cuts, etc.
5. Place over dowel pins and onto center plate such that the dull side faces the center plate and slide down onto the center plate.
6. Slide a clean cylinder plate over dowel pins onto the sealing diaphragm. Cylinder plate must be free of scratches on inside walls that house piston and cylinder assembly.
7. Pistons and cylinder assemblies, and cylinder blanks must be thoroughly cleaned with freon, and cylinder and cylinder and piston land areas inspected for scratches, etc. Each outside wall of cylinders must be inspected for evidence of binding in the cylinder plate.
8. Each piston and cylinder assembly must move freely without any binding.
9. Place the cylinder blank and piston and cylinder assembly into their respective positions and be sure that the vent hole faces the vent area in the cylinder plate.
10. If the valve is to be used in a dual column mode, place a small viton o-ring 1/32" thick over the piston which controls flow to port #2. Check assembly drawing. Do not insert plug into port #2 until valve test is complete.
11. Place clean actuating diaphragm over dowel pins and onto top of cylinder plate housing piston-cylinder assemblies.
12. Place top head plate over dowel pins making sure exit holes are down. The actuating air connection port is on the side with ports #6 and #7 for 8 port valves, and on the same side as ports #3 and #6 for 6 port valves. Plug air ports not used with 1/8" s.s. ball bearing and seal with screw socket.
13. Turn the valve over and repeat above procedure exactly except replace step 10 with step 14.
14. If the valve is to be used in the dual column mode, place a small viton o-ring 1/32" thick over the piston controlling flow to port #7. Check assembly drawing. Do not insert plug into port #7 until valve test is complete.
15. Having completed the above, turn the partially assembled valve right side up and place upon the mounting fixture.

Procedure: Assembly (Cont.)

16. Slide the belleville washer stack onto the bolt. Check assembly drawing to be sure the belleville washers have been stacked properly.
17. Slide the force washer onto the bolt below the belleville washer. Stack and insert through the center of the valve and thread hand tight into the mounting fixture.
18. Grasp mounting fixture only in a holding device and with a torque wrench and 9/16" socket, tighten to 110 inch pounds.
19. The valve should be re-torqued after 24 hours and stored in a protective enclosure when not in use.

VALVE TEST PROCEDURE

- Check torque to be sure it is 110 inch/pounds.
- Check that ports in manifold plates which are not being used are plugged. The actuating air line from each manifold must be connected to a four way actuating valve - or to two two-ways.
- Set actuating pressure to 50 PSIG.
- Actuate the valve 20 times, allowing 5 seconds between actuations.

Flow Rate Test

- Set supply gas (carrier) pressure to 1.0 PSIG and connect to ports as below. A flow rate of at least 300 ml/min should be measured out of the appropriate port. Should proper flows not be obtained, disassemble valve and inspect center section for restricted passage.

(A) Standard 8 Port Valve

<u>Supply Gas</u>	<u>Flow Meter</u>	<u>Manifold Pressurized</u>
#1	#2	Bottom
#1	#4	Top
#3	#4	Top
#5	#6	Top
#5	#8	Bottom
#7	#8	Top

(B) Internal Loop Sampling Valve

<u>Supply Gas</u>	<u>Flow Meter</u>	<u>Manifold Pressurized</u>
#1	#2	Bottom
#1	#6	Top
#3	#8	Bottom
#7	#8	

(C) Dual Column Valve Applications

<u>Supply Gas</u>	<u>Flow Meter</u>	<u>Manifold Pressurized</u>
#5	#6	Top
#5	#8	Bottom
#1	#4	Top
#3	#4	Bottom

(D) Backflush Valve Applications

<u>Supply Gas</u>	<u>Flow Meter</u>	<u>Manifold Pressurized</u>
#1	#2	Bottom
#1	#4	Top
#3	#4	Bottom
#5	#6	Top
#5	#8	Bottom

PRESSURE TEST

- Set supply gas pressure at 110 PSIG. For carrier pressures in excess of 110 PSIG, consult Table 1 for the proper air actuation pressure.
- Connect supply gas, plugs, and bubble tube to appropriate ports as described below. When properly connected, no flow must be observed through the bubble tube.
- If gas flow is observed, disassemble the valve and inspect for foreign matter in the sealing area. Also, inspect the center section, cylinder lands, piston lands for surface f.

(A) Standard 8 Port Valve

<u>Supply Gas</u>	<u>Bubble Tube</u>	<u>Plugged Ports</u>	<u>Manifold Pressurized</u>
#1	#2	#3, #4	Top
#1	#2	#4	Top
#1	#4	#2, #3	Bottom
#8	#6	#5, #7	Bottom
#8	#7	#5	Bottom
#8	#5	#6, #7	Top

- Connect jumper tube between ports #4 and #5 for external sampling application. Plug port
- Connect 110 PSIG supply gas to port #3.
- Connect bubble tubes to ports #6 and #2.
- Apply actuation pressure to top manifold and note momentary bubble of gas out of port #6.
- Apply actuation pressure to bottom manifold. No bubble must be observed at port #6 or #2.

(B) Internal Loop Sampling Valve 6 Port

<u>Supply Gas</u>	<u>Bubble Tube</u>	<u>Plugged Ports</u>	<u>Manifold Pressurized</u>
#1	#2	#3, #6, #7, #8	Top
#1	#3	#2, #6, #7, #8	Bottom
#3	#1	#6, #7, #8	Top
#3	#6	#7, #8	Bottom
#7	#6	#8, #1	Top
#7	#8	#3	Bottom

- Connect 110 PSIG supply gas to port #3.
- Connect bubble tubes to port #6 and #2. Plug port #8.
- Apply acutation pressure to top manifold and note momentary bubble out of port #6.
- Apply actuation pressure to bottom manifold. No bubble must be observed at port #6 or #

(C) Dual Column Valve Application

<u>Supply Gas</u>	<u>Bubble Tube</u>	<u>Plugged Ports</u>	<u>Manifold Pressurized</u>
#1	#2	#3, #4	Bottom
#1	#4	#3	Bottom
#1	#3	#4	Top
#8	#7	#5, #6	Top
#8	#5	#6	Top
#8	#6	#5	Bottom

- Ports #2 and #7 should now be plugged.

(D) Backflush Valve Application

<u>Supply Gas</u>	<u>Bubble Tube</u>	<u>Plugged Ports</u>	<u>Manifold Pressurized</u>
#1	#2	#3, #4	Top
#1	#3	#4	Top
#1	#4	#2, #3	Bottom
#8	#7	#5, #6	Bottom
#8	#6	#5	Bottom
#8	#6	#5, #7	Top

- Port #7 should now be plugged.

c. Electronic Zero Periodic Verification Procedure

The following procedure is followed at the same time it is calibrated.

1. Set the Sequencer Module sample valve AUTO/MAN switch to the centered position, and the MODE switch to SPEC.
2. Set the Amplifier Module AUTO/MAN switch to MAN, and the MANUAL RANGE selector to "1000". Place the AUTO ZERO/OFF switch to OFF.
3. Place the Amplifier Module AUTO/CAL switch in the CAL position, and adjust the RANGE CALIBRATE control to produce one or two volts at the amplifier output.
4. Place the Amplifier Module AUTO/MAN switch to AUTO, and the AUTO ZERO/OFF switch to AUTO ZERO.
5. Observe the baseline and check for any excessive baseline shift during the gate openings. If excessive baseline shift is noted, the Amplifier Module should be replaced and returned to Honeywell for service.

DAILY CHECK LIST

HONEYWELL

LOCATION _____

AIR PRESSURE HIGH A

RECORD #/in² HIGH B

LOW A

LOW B

NITROGEN PRESSURE HIGH A

RECORD #/in² HIGH B

LOW A

LOW B

HYDROGEN PRESSURE HIGH A

RECORD #/in² HIGH B

LOW A

LOW B

STANDARD GAS #/in² HIGH

PUMP RUNNING

FLAME ON

OVEN TEMPERATURE °C

CHECK GATE AND ADJ. AS NEEDED

check sample flow on #1

#2

#3

#4

#5

#6

#7

#8

#9

#10

MON.

TUES.

WED.

THURS.

FRI.

SAT.

SUN.

7/17/79

VAB.0001172593

HONEYWELL CONTINUOUS MONITOR CALIBRATION REPORT

Date_____

Gas Chromatograph Location	Range PPM	Calibration Gas Concentration (PPM) and Cylinder Number	Reading With Span Gas Prior to Calibration (ppm)	Reading With Span Gas After Calibration (ppm)	Calibration Checked by	Comments
	1._____ 2._____					
	1._____ 2._____					
	1._____ 2._____					
	1._____ 2._____					

Cylinder Pressure	
Nitrogen	1.
	2.
Hydrogen	1.
	2.
Air	1.
	2.
STD	1.

CALIBRATION

1. Close sample valve and open standard gas valve.
2. Run STANDARD Gas until reading stablizes-4 to 5 analysis.
3. If STANDARD is reading incorrectly record and adjust as follows.
4. Set the Amplifier Module **Auto zero/off** switch to the centered position.
5. Set sequencer Module **MODE** switch to **MAN**.
6. Set **Auto/off/cal** switch on component module to **CAL**.
7. Set amplifier module **Auto/Cal** switch to **CAL**.
8. Adjust amplifier **Range Calibrate** control to produce the same recorder reading as the standard produced on the last analysis.
9. Adjust the **Range** control screws on the component module to make the recorder out put read the correct valve for the standard.
10. Return all switches to their normal auto position and run the standard gas. Record the STD reading.

7/17/79

VAB.0081172594

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

F. HNU PORTABLE HYDROCARBON DETECTOR - CALIBRATION AND MAINTENANCE PROCEDURES

1. Calibration

There are eight HNU portable hydrocarbon detectors in the plant. One is kept at the control room to locate potential leak sources indicated by the continuous monitoring system. Once every two weeks, each HNU portable hydrocarbon detector is checked and calibrated. The HNU portable hydrocarbon detectors are also used for routine leak patrols.

The first step in the calibration procedure for the portable hydrocarbon detector is to turn the instrument to the standby position and adjust the electronic zero. A pressurized container of a calibration gas is connected directly to the 8" extension to the photoionization probe (see figure 6). The valve on the pressurized container is opened and the instrument draws in the volume of sample required for detection. Now the span pot is adjusted so that the instrument is reading the exact value of the calibration gas. (If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted, if necessary.)

The calibration gas is traceable to the National Bureau of Standards.

A calibration form is attached.

2. Maintenance

If problems occur while using the photoionization analyzer, it is recommended that the following troubleshooting guide be followed before consulting the factory.

General Aid to Fault Determination

Check battery condition. Recharge if necessary. Turn the instrument on. Look into the Sample Inlet of the probe unit. A violet colored glow from the UV light source should be observed in all positions of the mode switch except the standby position. If unstable readings are obtained, a faulty probe cable or electrical connection could be the problem. To check, hold the probe normally and flex the cable firmly. Watch the meter for fluctuations as the cable is stressed. Individual wires in the readout can be checked in a similar way. Check the coaxial connector on the amplifier board in the probe.

In the more sensitive ranges, a fluctuation in the reading may be noted if hand or other large object is placed in very close proximity to the probe. This is normal for the instrument and will not result in an error in the measurement as long as the probe is held stationary while the measurement is being taken.

If the probe is held close to AC power lines or power transformers an error may be observed. If measurements are to be made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

Disassembly of Instrument

PROBE - Turn the function switch to the OFF position and disconnect the probe connector from the readout unit. Remove the exhaust screw found near the base of the probe (see Figure 7). Grasp the end cap in one hand and the probe shell in the other, and gently pull to separate the end cap and lamp housing from the shell. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing. Care must be taken so that the ion chamber doesn't fall out of the end and the lamp doesn't slide out of the lamp housing. Turn the end cap over in your hand and tap on the top of it; the ion chamber should fall out in your hand. Place one hand over the top of the lamp housing and tilt slightly; the light source will slide out of the housing. The amplifier board can be removed from the lamp housing assembly by unsnapping the coaxial connection and then removing the retaining screw.

To reassemble this unit, first slide the lamp back into the lamp housing. Place the ion chamber on top of the lamp housing, checking to make sure that the contacts are

properly aligned. Place the end cap on top of the ion chamber and replace the two screws. The screws should be tightened only enough to seal the "O" ring. DO NOT OVERTIGHTEN. Line up the pins on the base of the lamp housing with the pins inside the probe shell. Gently slide the housing assembly into the probe shell. DO NOT FORCE the assembly into the shell as it only fits one way.

READOUT UNIT - Turn the function switch to the OFF position and disconnect the probe from the readout unit before disassembly is conducted (see Figure 9). Remove the accessory power jack plug. Loosen the screw on the bottom of the case and, holding the instrument by the bezel, remove the case. The power supply board and control panel can be removed by unscrewing two screws and two nuts. The entire panel, including the function switch, zero and span pots is removed in this operation. Electrically disconnecting this module is simple, since all connections are made with Molex connectors.

HNU PORTABLE HYDROCARBON DETECTOR

CALIBRATION REPORT

PORTABLE DETECTOR NUMBER	CALIBRATION GAS CYLINDER NUMBER	DATE	CALIBRATION GAS CONCENTRATION (PPM)	READING WITH CALIBRATION GAS BEFORE CALIBRATION (PPM)	READING WITH CALIBRATION GAS AFTER CALIBRATION (PPM)	CALIBRATION CHECKED BY	COMMENTS

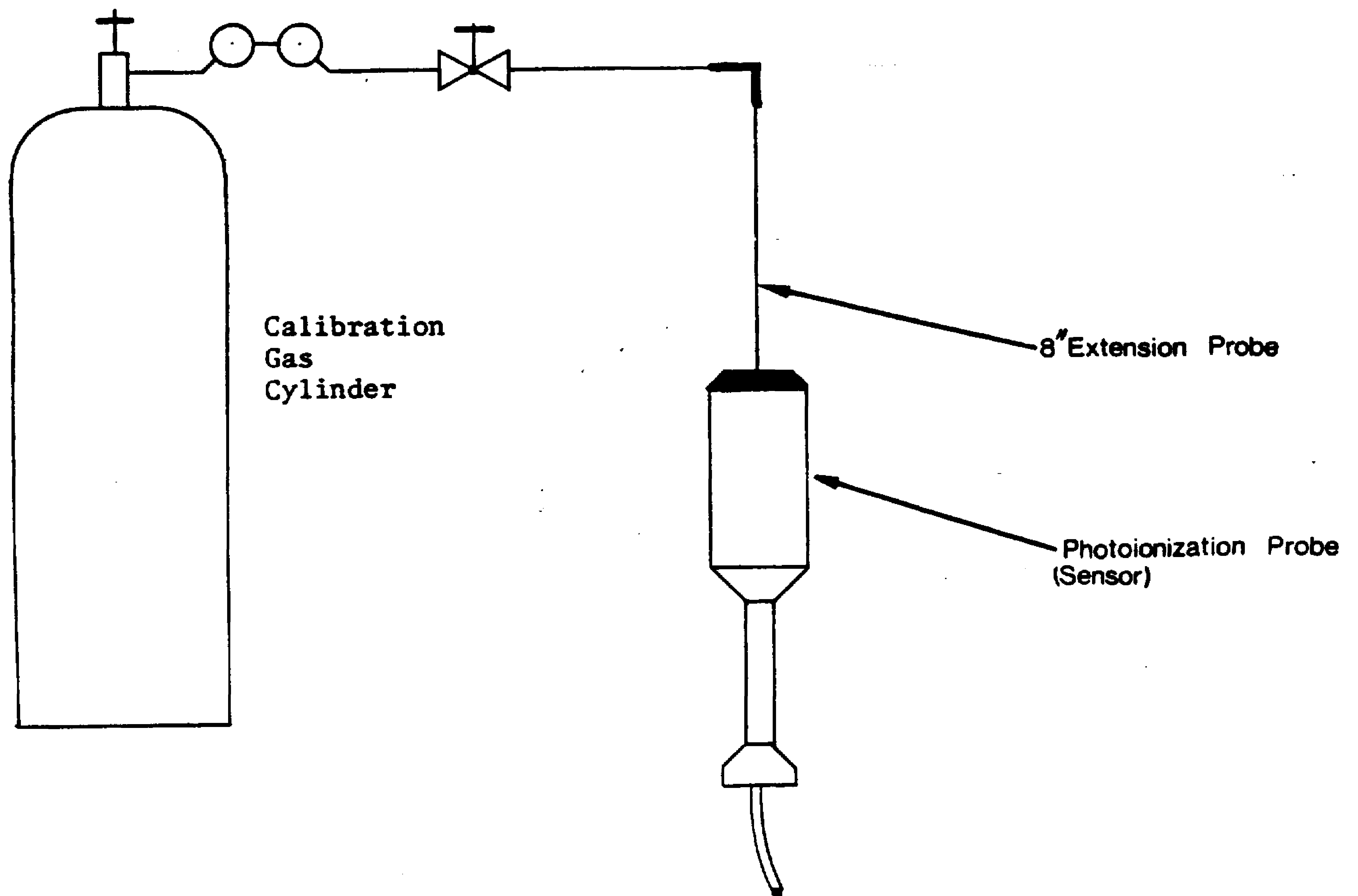


Figure 6

Calibration Procedure for Photoionization Analyzer

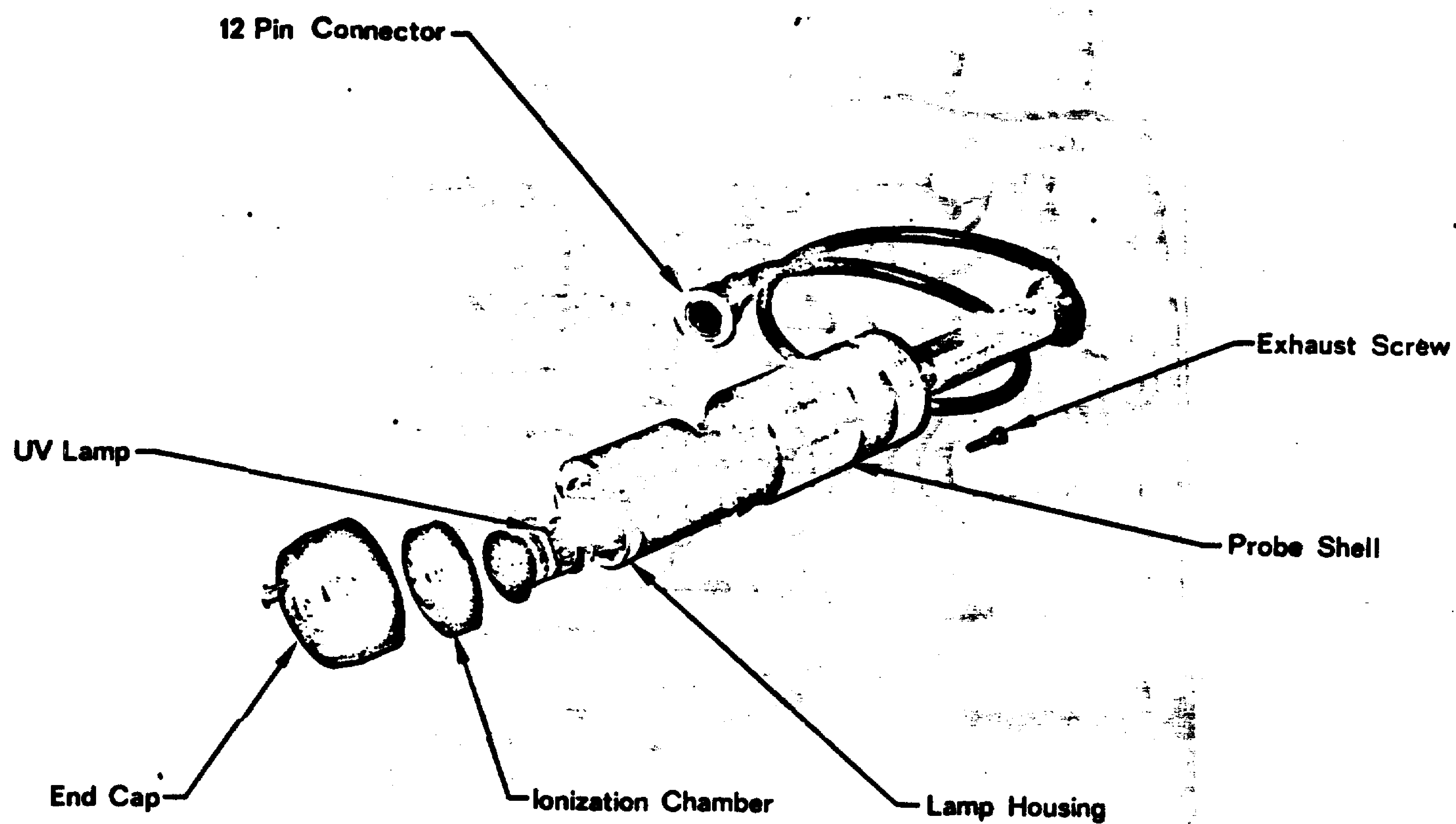


Figure 7 Component Parts of Probe

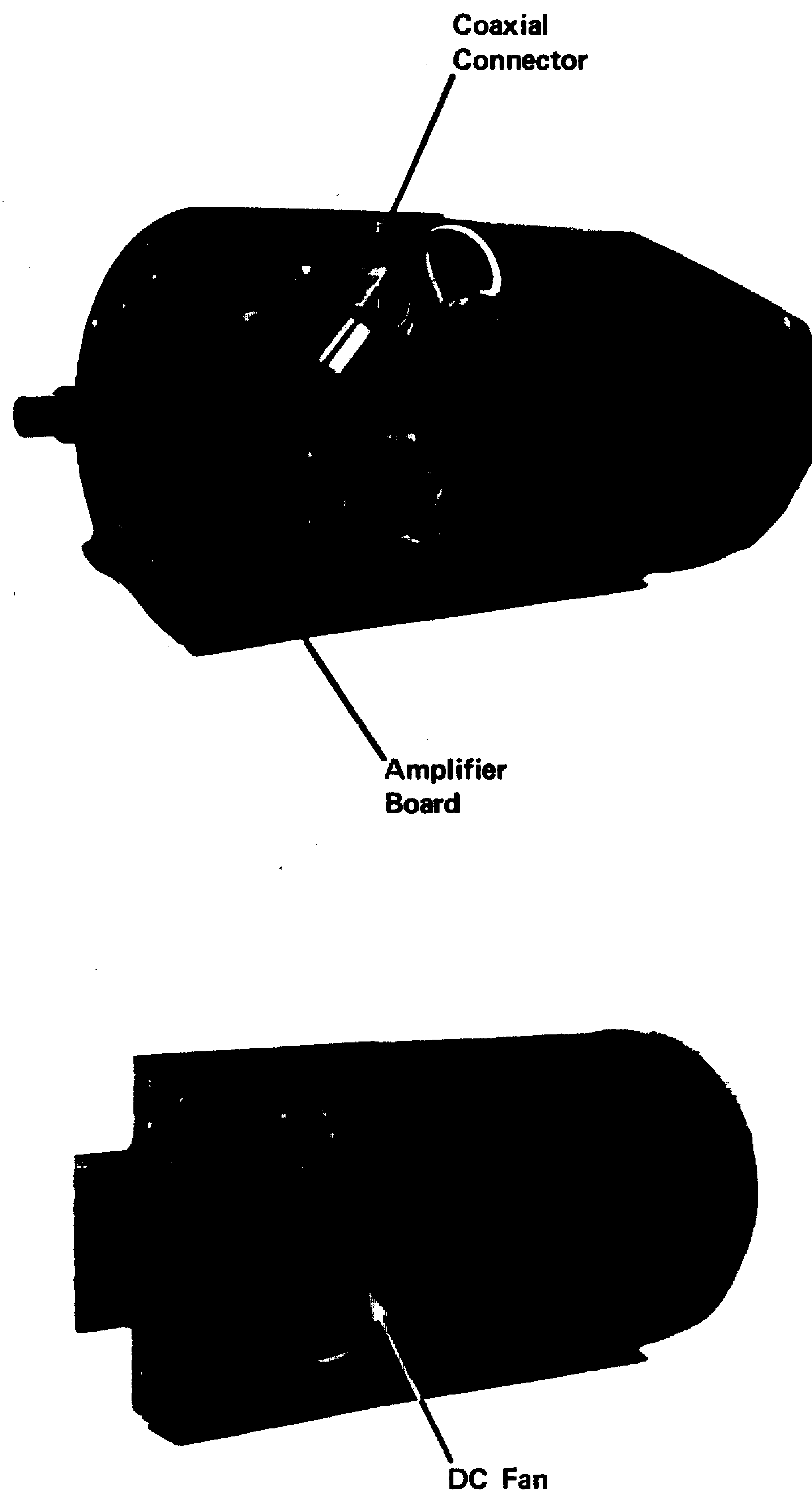


Figure 8 Component Parts of Lamp Housing.

Specific Faults

1. No meter response in any switch position (including BATT CHK)
 - A. Broken meter movement
 - (1) Tip instrument rapidly from side to side. Meter needle should move freely, and return to zero.
 - B. Electrical connection to meter is broken
 - (1) Check all wires leading to meter and clean the contacts of quick-disconnects.
 - C. Battery is completely dead
 - (1) Disconnect battery and check voltage with a volt-ohm meter.
 - D. Check 2 amp fuse
 - E. If none of the above solves the problem, consult the factory.
2. Meter responds in BATT CHK position, but reads zero or near zero for all others
 - A. Power supply defective
 - (1) Check power supply voltages per Figure 10. If any voltage is out of specification, consult the factory.
 - B. Input transistor or amplifier has failed
 - (1) Rotate zero control; meter should deflect up/down as control is turned.
 - (2) Open probe. Both transistors should be fully seated in sockets
 - C. Input signal connection broken in probe or readout
 - (1) Check input connector on printed circuit board. Should be firmly pressed down.
 - (2) Check components on back side of printed circuit board. All connections should be solid, and no wires should touch any other object.
 - (3) Check all wires in readout for solid connections.

- A
3. Instrument responds correctly in BATT CHK, and STBY, but not in measuring mode.
 - A. Check to see that light source is on (See General Faults section.)
 - (1) Check high voltage power supply (see Figure 10).
 - (2) Open end of probe, remove lamp and check high voltage on lamp contact ring.
 - (3) If high voltage is present at all above points, light source has most likely failed. Consult the factory.
 4. Instrument responds correctly in all positions, but signal is lower than expected.
 - A. Check span setting for correct value.
 - B. Clean window of light source
 - C. Double check preparation of standards
 - D. Check power supply 180 V output. See Figure 10.
 - E. Check for proper fan operation. Check fan voltage. See Figure 10.
 - F. Rotate span setting. Response should change if span pot is working properly.
 5. Instrument responds in all switch positions, but is noisy (erratic meter movement).
 - A. Open circuit in feed back circuit. Consult the factory.
 - B. Open circuit in cable shield or probe shield. Consult the factory.
 6. Instrument response is slow and/or irreproducible.
 - A. Fan operating improperly. Check fan voltage. See Figure 10.
 - B. Check calibration and operation.
 7. Low Battery indicator.
 - A. Indicator comes on if battery charge is low.
 - B. Indicator also comes on if ionization voltage is too high.

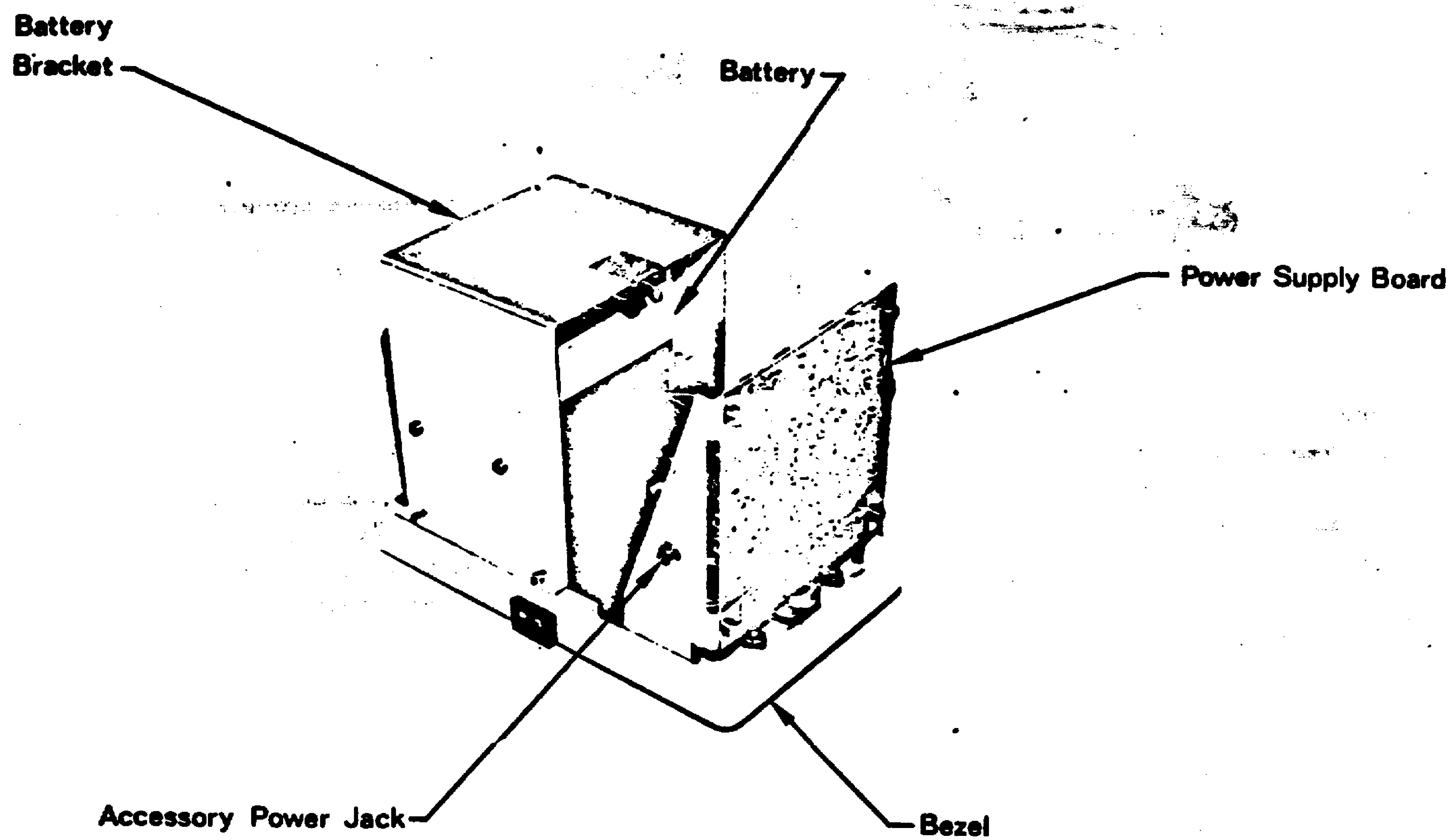
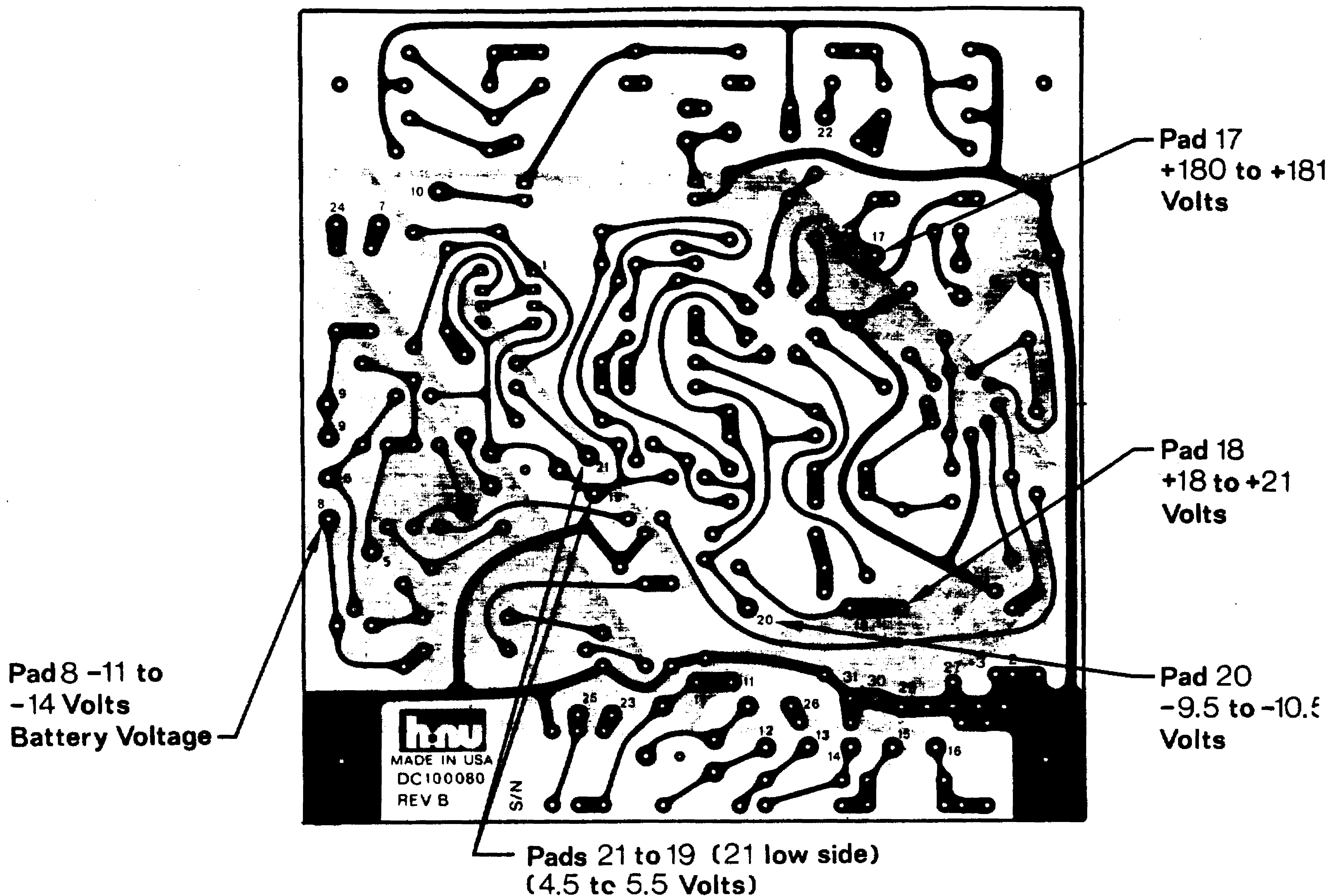


Figure 9 **Component Parts Of Readout Unit.**

1. All voltages measured with probe connected and instrument mode switch in BATT CHK position.
2. All measurements referred to ground (pads 2,3 and 27) except pad 21 measured to pad 19 and pad 8 to pad 11.



All Voltages Respect to Ground							
pads	voltage	pads	voltage	pads	voltage	pads	voltage
1	- 5.7V	9	- 12.2V	17	180V	25	0
2	GRD	10	- 12.1V	18	- 19.4V	26	0
3	GRD	11	0	19	- 10.6V	27	GRD
4	- 10.7V	12	0	20	- 9.7V	28	0
5	- 11.3V	13	0	21	- 14.5V	29	GRD
6	- 12.1V	14	0	22	- 400V	30	GRD
7	0	15	0	23	0	31	GRD
8	- 12.2V	16	0	24	0		

Figure 10 Power Supply PC Board

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

G. TLV PORTABLE HYDROCARBON DETECTOR - CALIBRATION AND MAINTENANCE PROCEDURE

1. Calibrations and Adjustments

There are four TLV portable hydrocarbon detectors in the plant. These will be calibrated before use on each day of its use. Prepare the TLV Sniffer for operation in accordance with the following steps and Section 61.245(b) of Subpart V of the NESHAP regulations. A calibration form is attached.

BATTERY TEST

Test battery as follows: Turn MODE SELECTOR knob from OFF position to BATT TEST position. Meter pointer should come to rest in BATTERY GOOD range of meter scale. (Both a meter reading below BATTERY GOOD range and an audible signal warn of batteries too weak to sustain normal operation.)

SETTING METER POINTER TO ZERO

Set pointer to meter zero as follows:

1. Attach air sampling probe connector to instrument intake on left side of case by pulling back spring collar of connector, pressing connector over intake, and releasing spring collar.
2. Place TLV Sniffer in position in which meter indications will be read (usually in meter-up position).

NOTE: Heat distribution from active and reference filaments of the detector sensor changes from vertical to horizontal position. The resulting change in electrical balance between elements causes a shift in pointer zero from one position to the other.

3. Set MODE SELECTOR switch to PPM X 100 and operate instrument for 10 minutes to allow circuits to stabilize.
4. Set ZERO ADJUST knob at midpoint (five full turns from either extreme position). Introduce zero gas (air, less than 10 ppm of volatile organic compounds) into the sniffer intake.

SETTING METER POINTER TO ZERO - Continued

5. Turn coarse adjustment screw, located under ZERO ADJUST knob, to move meter pointer to zero on the meter scale.
6. Turn MODE SELECTOR to PPM X 10 position and turn ZERO ADJUST knob to set pointer to zero.
7. Turn MODE SELECTOR TO PPM X 1 position and turn ZERO ADJUST knob to set pointer to zero.

SETTING METER POINTER DEFLECTION

To calibrate the instrument, proceed as follows:

1. Remove case cover for access to internal adjustments.
2. Turn FINE ZERO ADJUST (pot) full clockwise and then five turns counterclockwise to mid-range. Then turn COARSE ADJUST (pot) full clockwise and then ten turns counterclockwise to mid-range.
3. Turn MODE SECLECTOR TO BATT. TEST position. The meter pointer must indicate within BATTERY GOOD range, if not recharge.
4. After allowing for five-minute warm-up, introduce known zero gas into sniffer intake. Turn MODE SELECTOR switch to PPMX100 position and adjust R-13 (see Figure 11) for meter pointer indication of scale zero.
5. Turn MODE SELECTOR switch to PPMX10 position and adjust COARSE ADJUST for meter pointer indication of scale zero. Readjust per Steps 4 and 5 until meter pointer indicates a relatively constant scale zero when MODE SELECTOR is switched between PPMX10 and PPMX100 range.
6. Turn MODE SELECTOR switch to PPMX100 position. Connect a pressurized container of a calibration gas (less than 10,000 ppm) directly to the probe extension.
7. Open the vlave on the pressurized container. The instrument will then draw in the volume of sample required for detection.
8. Allow one minute for meter pointer to achieve maximum indication. Adjust the X100 span adjuster, R4 (see figure 11), until the meter pointer indicates the same amount of the calibration gas.

A

SETTING METER POINTER DEFLECTION - Continued

9. Close valve on the pressurized container. Remove the pressurized container of calibration gas from the probe extension. Allow two minutes for meter pointer to return to zero.
10. Turn MODE SELECT switch to PPMX10 position. Then turn the FINE ZERO ADJUST until meter pointer indicates full scale 1000 ppm. Turn MODE SELECT switch to PPMX100 position and adjust R4 the X100 Span Adjuster until meter pointer indicates (10) or 1000 ppm. Turn FINE ZERO ADJUST until meter pointer indicates scale zero.
11. Turn MODE SELECT switch to PPMX10 position, then turn FINE ZERO ADJUST until meter pointer indicates 10 on the scale or 100 ppm.
12. Turn MODE SELECT switch to PPMX1 position and adjust the X1 Span Adjuster until meter pointer indicates 100 (full scale) or 100 ppm.
13. Turn FINE ZERO ADJUST until meter pointer indicates scale zero.

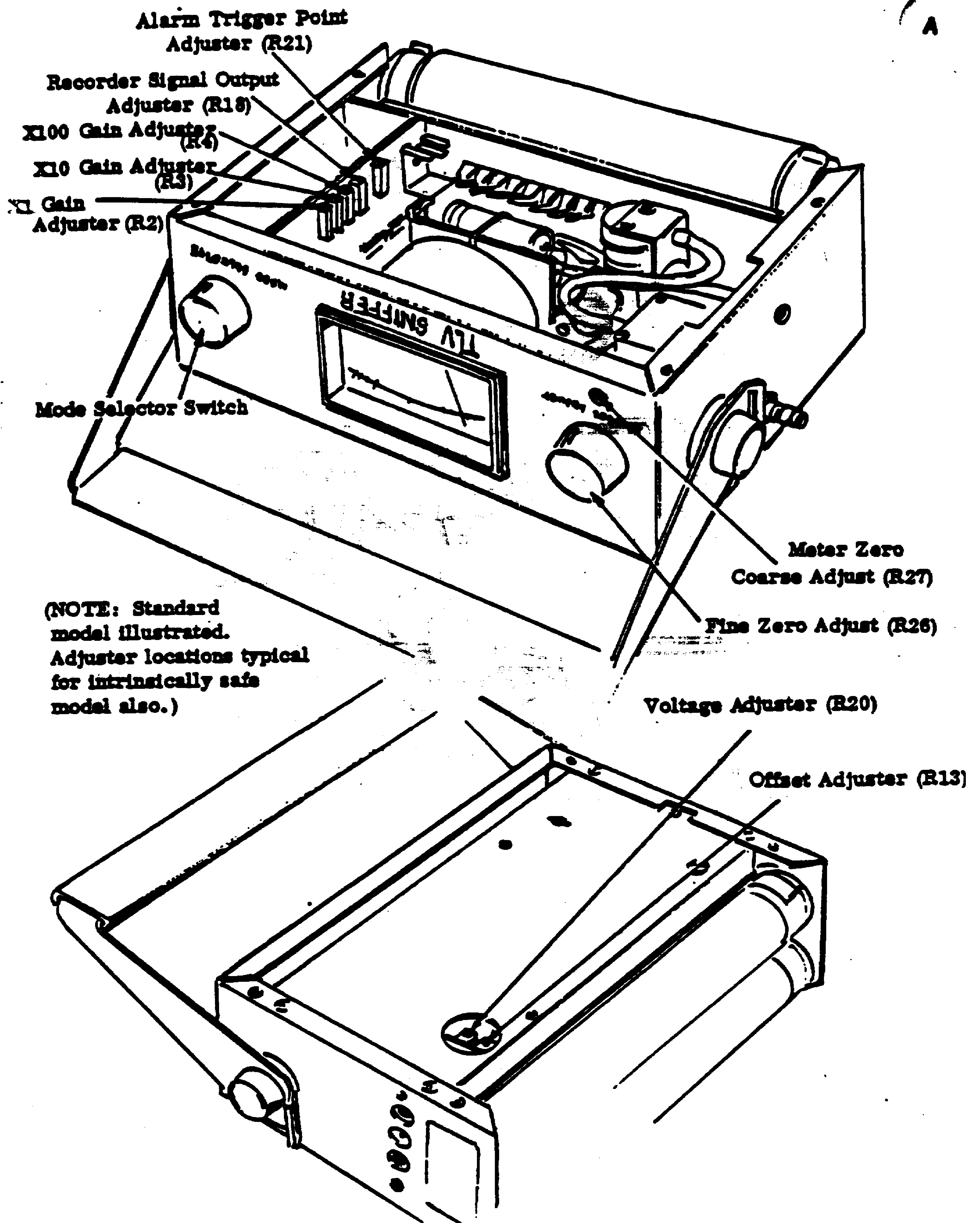


FIGURE 11. TLV Circuitry Adjustment Potentiometer Locations.

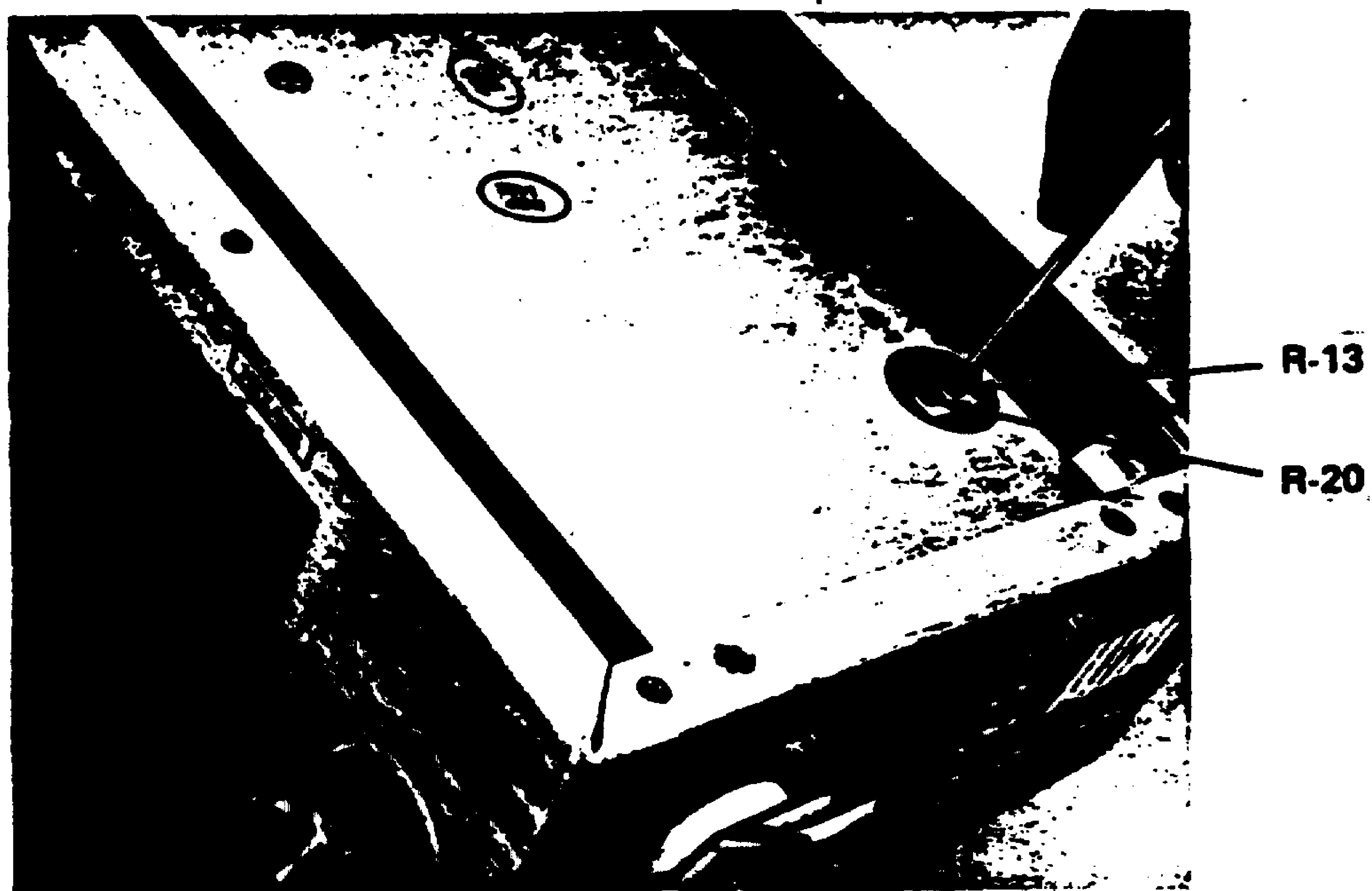


FIGURE 12. Locating and adjusting R-13 on PPMX100 position for meter pointer indication of scale zero.

2. MAINTENANCE

SYMPTOMS AND REMEDIES

Gradual exhaustion of the detector element, eventual wearing of air-sample pump parts, battery recharging or replacement, etc., require an amount of maintenance and repair work over an extended period of time. The following table describes symptoms, possible causes, and remedial actions relating to conditions requiring maintenance and repairs.

TABLE 16

TROUBLESHOOTING PROCEDURES

SYMPTOM	POSSIBLE CAUSE	REMEDY
Meter pointer drifts from zero.	Traces of combustible gas in air sample thought to be pure.	Adjust pointer to zero in fresh air. Use Bacharach Kit 51-7199 if fresh air is otherwise unavailable.
	Change of position of instrument from upright to horizontal or vice versa, thus redistributing heat between active and reference elements of the detector.	Keep instrument consistently in either vertical or horizontal position while in use.
	Insufficient warmup period.	Allow 10-minute warmup period before zeroing meter pointer.
	Erratic monolithic chip.	Consult factory or replace circuit board.
	Erratic sensing element.	Replace detector.

TABLE 18 (continued)

SYMPTOM	POSSIBLE CAUSE	REMEDY
No audible alarm in presence of strong concentration of combustible gas.	Operation of 45-second delay circuit after turning MODE SELECTOR control to operate instrument.	Wait approximately 45 seconds for delay period to expire.
	Improper setting of alarm response level.	Reset alarm to desired level.
	Faulty monolithic chip.	Consult factory or replace circuit board.
	Loose lead to speaker; damaged speaker.	Inspect for loose leads. Using 0-15V range voltmeter, check for excitation voltage across speaker terminals while meter indicates in alarm zone.
	Dead batteries.	Confirm battery exhaustion at meter with MODE SELECTOR switch in BATT TEST position. Recharge or replace batteries if necessary.

Replacing Batteries

Replace batteries, if necessary, as follows:

1. Remove ten screws used to hold cover to case and remove cover.
2. Standard model: Remove two battery assemblies (three batteries in each of two cardboard tubes) from spring clips in back of case.

Intrinsically safe model: Replace entire sealed battery pack. The following steps 3 and 4 do not apply.

3. Standard Model: Remove old batteries from tubes and replace with new batteries. Orient plus and minus battery terminals as indicated by arrows with polarity signs on battery mounting panel.
4. Standard model: Snap replacement batteries with tubes into battery holding clips. Spring terminals at one end may be held back with a small screwdriver or similar tool to facilitate insertion of battery assemblies in clips.
5. Replace cover and attach with ten screws.

Replacing Detector

Replace detector when necessary as follows:

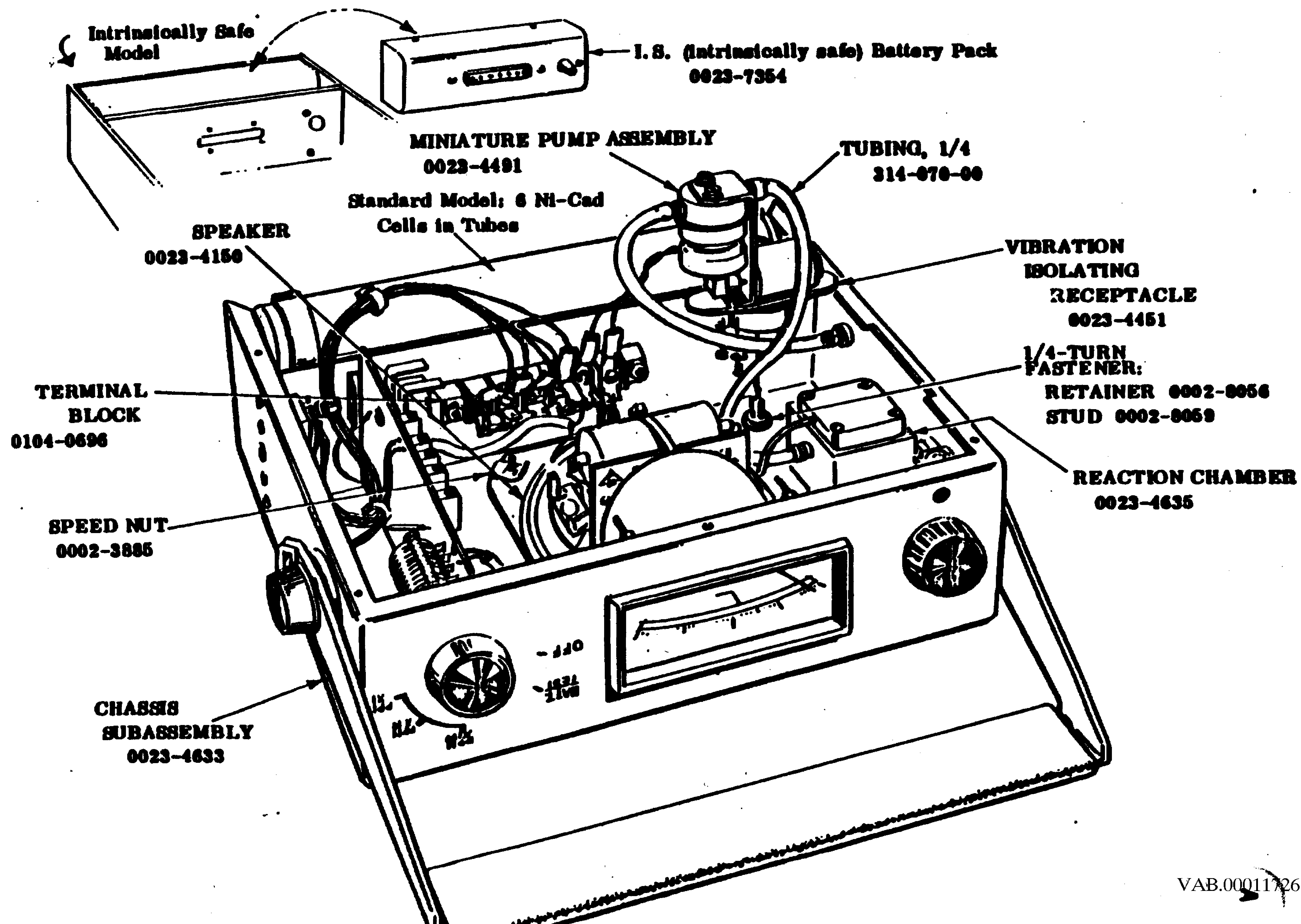
1. Remove instrument case cover to gain access to detector housing.
2. With instrument in speaker-down position, remove four screws used to attach detector socket assembly to cubical aluminum air sample chamber.
3. Lift detector socket assembly from air chamber block.
4. Unplug old detector from socket assembly.
5. Insert new detector in socket. New detector part number should correspond to that listed on label affixed to cover of instrument (#800-080.90).
6. Reinstall socket assembly with new detector in air chamber and replace instrument cover. Tighten screws uniformly and snugly.

Replacing Printed Circuit Board

Replace printed circuit board, when necessary, as follows:

1. Remove instrument case cover to gain access to printed circuit board.
2. Using Allen wrench, remove two small setscrews used to hold MODE SELECTOR knob to shaft and remove knob from shaft.
3. Remove hex head nut used to hold MODE SELECTOR switch shaft to instrument panel.

Figure 13. TLV Sniffer Chassis Subassembly Showing Miniature Pump Assembly in Disassembled Position.



TLV PORTABLE HYDROCARBON DETECTOR

CALIBRATION REPORT

PORTABLE DETECTOR NUMBER	CALIBRATION GAS CYLINDER NUMBER	DATE	CALIBRATION GAS CONCENTRATION (PPM)	READING WITH CALIBRATION GAS BEFORE CALIBRATION (PPM)	READING WITH CALIBRATION GAS AFTER CALIBRATION (PPM)	READING WITH ZERO AIR BEFORE CALIBRATION (PPM)	READING WITH ZERO AIR AFTER CALIBRATION (PPM)	CALIBRATION CHECKED BY	COMMENTS

LEAK DETECTION AND ELIMINATION PROGRAMABERDEEN CHEMICAL PLANTH. ROUTINE LEAK PATROL-DATA RECORDING AND HANDLING

There are five different leak patrols conducted at various intervals during the year. If a leak is detected (as identified in Section K), the Action Plan for Leak Elimination (Section J) must be initiated and the leak recorded on the Leak Detection Reporting Form. The five leak patrols are as follows:

1. Daily Leak Patrol- Check each pump and compressor on the attached "PUMP AND COMPRESSOR SURVEY" form for sensor or visual evidence of a leak. File the form in the Operations Supervisor's office.
2. Weekly Leak Patrol- Check each location on the attached list and complete the attached "WEEKLY LEAK PATROL SURVEY" form once per week. The HNU portable hydrocarbon detector will be used for this patrol. The inspector is to record the concentration at each point monitored. If there is a reading where the HNU reads full scale (2000 p.p.m.), the TLV must be used to determine if it is a leak as defined in Section K. The pumps in VCM service must also be checked visually once per week. This form will be filed in the Environmental Director's office.
3. Monthly Leak Patrol- Check each item on the attached "Monthly Patrol Survey" form. The HNU portable hydrocarbon detector will be used for this patrol. The inspector is to record the concentration at each point monitored. If there is a reading where the HNU reads full scale (2000 PPM), the TLV must be used to determine if it is a leak as defined in section K. This form will be filed in the Environmental Director's office.
4. Yearly Random Valve Survey- At the direction of the Director of Environmental Control, 200 valves in VDC service chosen at random will be tested in accordance with Section 61.65(b)(8)ii of the NESHAP regulations. File the documentation in the Engineering Files.
5. Yearly Closed Vent Piping Survey- At the direction of the Director of Environmental Control, the closed vent piping and valves from the Old Module VCM receivers to the incinerator firing chamber will be tested in accordance with Section 61.242-11 of Subpart V of the NESHAP regulations.

LEAK DETECTION AND ELIMINATION PROGRAM

ABERDEEN CHEMICAL PLANT

PUMP AND COMPRESSOR SURVEY

-Daily check each pump and compressor listed below and initial below if there is no evidence of a leak by visual or sensor check. If there is evidence of a leak, go to the Action Plan for Leak Elimination and follow procedures.

Date:

1. Emission Recovery System

a. East Vacuum Pump

b. West Vacuum Pump

c. East Compressor

d. West Compressor

2. Old Module Recovery System

a. East Vacuum Pump

b. West Vacuum Pump

c. East Compressor

d. West Compressor

3. New Module Recovery System

a. North Vacuum Pump

b. South Vacuum Pump

c. North Compressor

d. South Compressor

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WEEKLY LEAK PATROL SURVEY

I. NEW MODULE

A. Reactor Area-Third Level

- 1.741 Lenape Seal
- 2.741 Condenser Bottom Seal
- 3.741 Rinse Water Valve
- 4.742 Lenape Seal
- 5.742 Condenser Bottom Seal
- 6.742 Rinse Water Valve
- 7.743 Lenape Seal
- 8.743 Condenser Bottom Seal
- 9.743 Rinse Water Valve
- 10.744 Lenape Seal
- 11.744 Condenser Bottom Seal
- 12.744 Rinse Water Valve
- 13.745 Lenape Seal
- 14.745 Condenser Bottom Seal
- 15.745 Rinse Water Valve

B. Reactor Area-Condenser Level

- 1.741 Condenser Top Seal
- 2.741 Recovery Valve
- 3.742 Condenser Top Seal
- 4.742 Recovery Valve
- 5.743 Condenser Top Seal
- 6.743 Recovery Valve
- 7.744 Condenser Top Seal
- 8.744 Recovery Valve
- 9.745 Condenser Top Seal
- 10.745 Recovery Valve

C. Charge Pumps and Filters

- 1.East Rec. VCM Charge Pump Seal
- 2.East Rec. VCM Charge Pump Valves
- 3.West Rec. VCM Charge Pump Seal
- 4.West Rec. VCM Charge Pump Valves
- 5.Rec. VCM Filter Pack Head
- 6.East VCM Charge Pump Seal
- 7.East VCM Charge Pump Seal
- 8.West VCM Charge Pump Seal
- 9.West VCM Charge Pump Seal
- 10.North VCM Filter Pack Head
- 11.South VCM Filter Pack Head

(A)

Weekly Leak Patrol Survey

II. Old Module

A. Reactor Area-Third Level

- 1.300 Lenape Seal
- 2.300 Condenser Bottom Seal
- 3.300 Rinse Water Valve
- 4.400 Lenape Seal
- 5.400 Condenser Bottom Seal
- 6.400 Rinse Water Valve
- 7.500 Lenape Seal
- 8.500 Condenser Bottom Seal
- 9.500 Rinse Water Valve
- 10.600 Lenape Seal
- 11.600 Condenser Bottom Seal
- 12.600 Rinse Water Valve
- 13.700 Lenape Seal
- 14.700 Condenser Bottom Seal
- 15.700 Rinse Water Valve

B. Reactor Area-Condenser Level

- 1.300 Condenser Top Seal
- 2.300 Recovery Valve
- 3.400 Condenser Top Seal
- 4.400 Recovery Valve
- 5.500 Condenser Top Seal
- 6.500 Recovery Valve
- 7.600 Condenser Top Seal
- 8.600 Recovery Valve
- 9.700 Condenser Top Seal
- 10.700 Recovery Valve

C. Charge Pumps and Filters

1. Rec. VCM Transfer Pump Seal
2. East VCM Charge Pump Seal
3. West VCM Charge Pump Seal
4. Rec. VCM Filter Pack Head
5. North VCM Filter Pack Head
6. South VCM Filter Pack Head
7. West VCM Return Pump Seal
8. East VCM Return Pump Seal

III. VCM Tank Farm

A. Compressor Shed

1. #1 Compressor
2. #2 Compressor
3. #3 Compressor
4. #4 Compressor
5. #5 Compressor

B. Transfer Pumps

1. North Transfer Pump
2. South Transfer Pump

Monthly Leak Patrol Survey

I. New Module

A. Reactor Area-Ground Level

- 1.741 Charge Valves
- 2.Directly Under 741
- 3.742 Charge Valves
- 4.Directly Under 742
- 5.743 Charge Valves
- 6.Directly Under 743
- 7.744 Charge Valves
- 8.Directly Under 744
- 9.745 Charge Valves
- 10.Directly Under 745

B. Recovery Area

Ground Level

- 1.East VCM Storage Tank Bottom (Area)
- 2.East VCM Storage Tank Top (Area)
- 3.Middle VCM Storage Tank Bottom (Area)
- 4.Middle VCM Storage Tank Top (Area)
- 5.West VCM Storage Tank Bottom (Area)
- 6.West VCM Storage Tank Top (Area)
- 7.South Seal Water Separator Pump Seal
- 8.North Seal Water Separator Pump Seal

Second Level

- 1.901 South Vacuum Pump Seal
- 2.902 North Vacuum Pump Seal
- 3.903 Recovery Compressor Seal
- 4.904 Recovery Compressor Seal
- 5.905 Recovery Compressor Seal
- 6.Recovery Condenser Area

II. Old Module

A. Reactor Area-Ground Level

- 1.300 Charge Valves
- 2.Directly Under 300
- 3.400 Charge Valves
- 4.Directly Under 400
- 5.500 Charge Valves
- 6.Directly Under 500
- 7.600 Charge Valves
- 8.Directly Under 600
- 9.700 Charge Valves
- 10.Directly Under 700

Monthly Leak Patrol Survey

II. Old Module (cont.)

B. Recovery Area

V-11 Building Second Level

1. East Vacuum Pump Seal
2. West Vacuum Pump Seal
3. East Recovery Compressor Seal
4. West Recovery Compressor Seal
5. Recovery Condenser Area

Area West of V-11 Building

1. South VCM Receiver Bottom Area
2. South VCM Receiver Top Area
3. Middle VCM Receiver Bottom Area
4. Middle VCM Receiver Top Area
5. North VCM Receiver Bottom Area
6. North VCM Receiver Top Area
7. VCM Collect Tank Area
8. Batch Water Stripper Top Area

III. VCM Tank Area

1. Railcar Connection #1 (North)
2. Railcar Connection #2
3. Railcar Connection #3
4. Railcar Connection #4 (South)
5. Sphere Bottom Area
6. Sphere Top Area

A

LEAK DETECTION AND ELIMINATION PROGRAM

LOCATION OF CONTINUOUS MONITORING POINTS

I. LOCATION OF CONTINUOUS MONITORING POINTS

The plant has four Honeywell Model 1000 Process Gas Chromatographs. Each instrument monitors 10 locations for the presence of vinyl chloride. Thus a total of forty points are monitored.

The continuous vinyl chloride monitoring system serves two primary purposes.

1. Monitoring of plant process equipment to detect potential vinyl chloride leaks.
2. Protection of Employees from exposure to vinyl chloride.

Changing process conditions or newly identified needs may suggest moving the monitoring points. The system used is adaptable to such changes. The plant reserves the right to modify the location of the forty points. The locations will be changed and the location records revised only as desired to optimize the needs of the two defined functions.

The precise location of the forty points is shown on the attached Table 17. The location is also indicated on the attached Plot Plan Layout drawing.

TABLE 17
FIXED POINT MONITORING SYSTEM
SAMPLING LOCATIONS
ABERDEEN CHEMICAL PLANT

GC No. 1 - Tank Farm

1. VCM Railcar Unloading Compressor Shed
2. North VCM Railcar Unloading Station
3. North Middle VCM Railcar Unloading Station
4. South Middle VCM Railcar Unloading Station
5. South VCM Railcar Unloading Station
6. VCM Storage Sphere
7. Emission Recovery System, Upstairs
8. Emission Recovery System, Downstairs
9. No. 6 Dryer Blend Tanks
10. Process Control Room

GC No. 2 - Old Reactor Module

1. Fresh VCM Receiver
2. North RVCM Receiver
3. Large Recovery System, Downstairs
4. Large Recovery System, Upstairs
5. Reactor Dump Sweco
6. Bottom of D-300 Reactor
7. Top of D-400 Reactor
8. Bottom of D-500 Reactor
9. Top of D-600 Reactor
10. Bottom of D-700 Reactor

GC No. 3 - New Reactor Module

1. Bottom of 741 Reactor
2. Top of 742 Reactor
3. Bottom of 743 Reactor
4. Top of 744 Reactor
5. Bottom of 745 Reactor
6. Reactor Dump Sweco
7. Recovery System, Downstairs
8. Middle VCM Receiver
9. Blowdown Tank
10. Recovery System, Upstairs

GC No. 4 - Lab

1. Front Guard House
2. Maintenance Shop
3. No. 1 Dryer Blend Tanks
4. Quality Control Lab
5. GC Lab
6. South of Plasticizer Building
7. Compound Line I
8. Old Module D-700 Dump System
9. New Module 745 Dump System
10. Plant Breathing Air