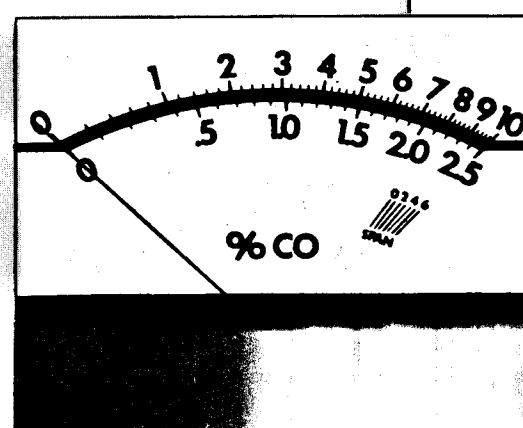
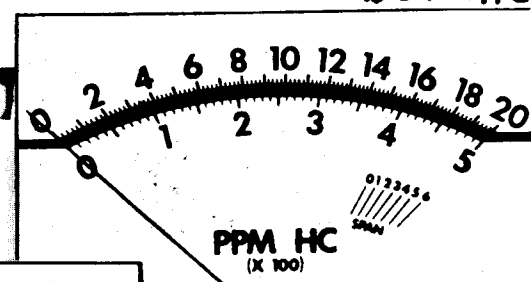


**SUPER** → OLD TYPE ANALYSER  
SERVICE MANUAL UPDATED

→ USE THIS FOR ALL  
CALIBRATION OF OLD TYPES  
WITHOUT HC & CO BENCHES

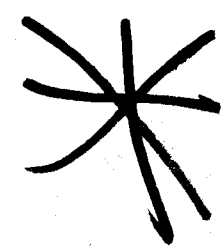
**ALLEN**



**CO/HC  
INFRA-RED  
EMISSION  
ANALYZER**

**23-O60/O70"CA"**

**SERVICE  
MANUAL**



## TABLE OF CONTENTS

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# OPERATION and TEST PROCEDURES

1. Plug power cord in a reliable 110V. wall outlet.

2. Switch power and pump on.

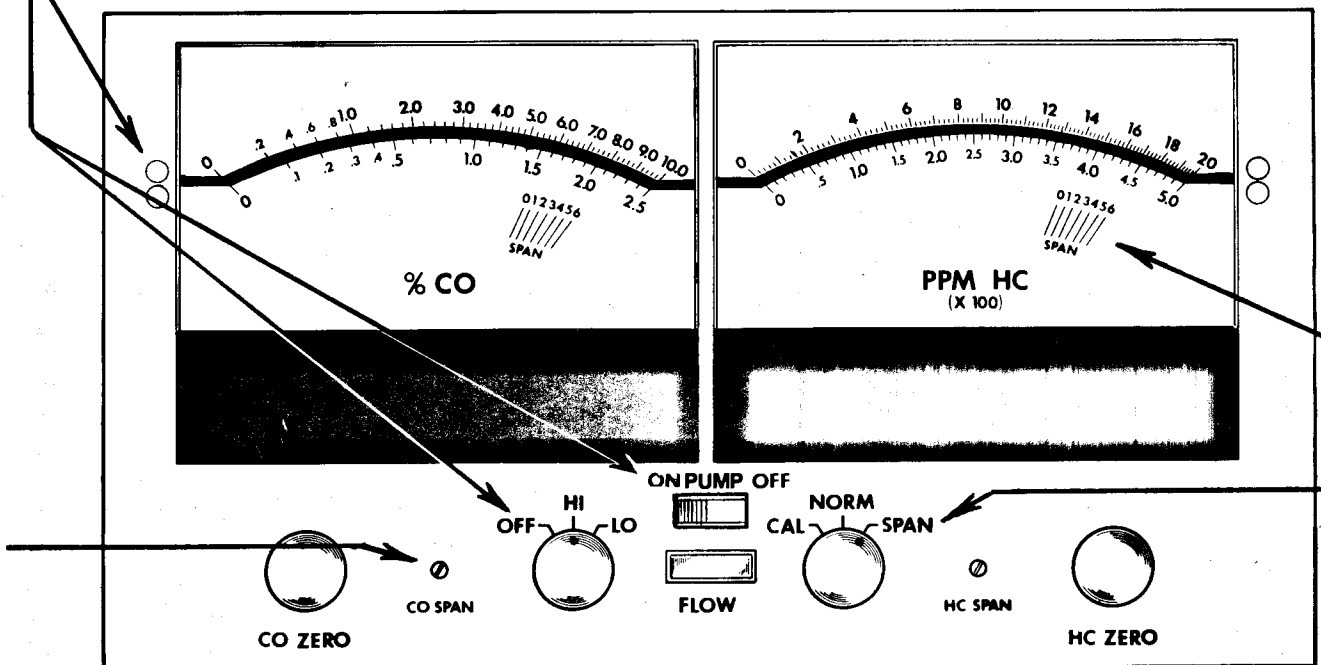
The meter scale indicator light should now be "on" depending on which scale the selector is indicating (HI-LO).

If meter indicator lights do not come on, check 3 amp fuse on the back panel. Do not exceed 3 amp rating. If meter indicator lights flicker or go on and off, double check power outlet or extension cord connections if used.

3. Allow analyzer to stabilize for at least 15 minutes. Needle fluctuations are normal during warm up.  
Flow light should now be on.

If flow light does not come on.

1. Check position of calibration switch which should be in "NORM" position
2. Check flow



CALIBRATION AND PERFORMANCE CHECK. After 15 minutes warm up.

1. With exhaust probe sampling fresh air, zero CO and HC scales with selector in normal position.
2. Turn calibrate knob to "Span" and hold.
3. Verify the span scale to the applicable altitude number below.

## Span Setting

The higher the altitude the lower the density. No calculation is required to compensate since the scale is screened directly on the meter face. Set the span according to altitude per 1000 ft.

Altitude	Setting
0 - 1000 ft.	Between 0 - 1
1000 - 2000 ft.	Between 1 - 2
2000 - 3000 ft.	Between 2 - 3 etc.

If the span reading does not coincide with the numbers above, adjust the CO span and/or HC span with a small screwdriver.

# EMISSION TESTING BOTH PROVIDES POLLUTION CONTROL SERVICE AND AIDS YOU IN PROVIDING HIGHLY PROFITABLE "P·E·P" TUNE-UPS.

## 'PERFORMANCE·ECONOMY·POLLUTION-CONTROL'

### OPERATING THE 23-060 IS SIMPLE AND SPEEDY

HERE'S ALL YOU NEED TO DO TO USE THE ALLEN 23-060 CO/HC EMISSION ANALYZER

- (1) Plug in power cord, switch on. Let analyzer stabilize.
- (2) Zero meter needle in both CO and HC meters.
- (2) Switch to "span" to verify accuracy.
- (4) Insert probe in tailpipe.
- (5) Use CO meter for carburetor diagnosis and adjustments.
- (6) Use HC meter to check hydrocarbon content.

DESIGNED TO CONFORM WITH ALL PERFORMANCE CRITERIA ESTABLISHED BY VARIOUS STATE CONTROL AGENCIES.

#### SPECIFICATIONS: 23-060 PORTABLE EMISSION ANALYZER

**POWER SUPPLY:** 115 Volts, 60 Hz., 450 Watts.

**DIMENSIONS:**

Height (incl. Handle) ..... 41 inches  
Width (incl. Wheels) ..... 22¾ inches  
Depth ..... 17½ inches  
Exhaust Probe ..... 30 feet  
Power Cord Length ..... 25 feet

**METERS:** 8 Inch Mounted on Portable Panel.

**Hi-Scale** = 0 to 10% CO  
              0 to 2000 PPM HC (per N Hexane)

**Lo-Scale** = 0 to 2.5% CO  
              0 to 500 PPM HC (per N Hexane)

**ANALYSIS:** NDIR Method

**ACCURACY:**

**Hi-Scale** = CO within .3% CO  
              HC within 60 PPM

**Lo-Scale** = CO within .075% CO  
              HC within 15 PPM

**RESPONSE:** 90% Reading in Max. 10 Secs.

**WARM UP:** 15 Min. with Ambient Temp. Greater than 60° F.

**ZERO & SPAN DRIFT:** Max. 2% Full Scale.

**CALIBRATION:** Built-in Optical Calibration System Provides Rapid Routine Calibration. Calibration Gas Can Also Be Used.

**OPTICAL SYSTEM:** Dual Beam System.

**CELL WINDOWS:** Fused Silica Windows. Cell Window Deflection Eliminated and Drift is Minimized.

**EXHAUST HANDLING SYSTEM:**

- 30 Ft. Exhaust Probe, Polyurethane Lined Hose with Stainless Steel Tip Provides Ruggedness Required in Garages.
- Teflon Coated Diaphragm Pump for Corrosion Resistance.
- Self-Draining Water Trap System.
- Dual Particulate Filters Insure Greater Protection and Accuracy.
- "Flow Indicator" on Meter Panel.

**SHIPPING WEIGHT** ..... 92 lbs.

# **INTRODUCTION**

## **BASIC OPERATING PRINCIPLE**

The Model 23-060 (23-070, 23-080, 18-090 and 18-150) is a nondispersive Infrared Emission Analyzer (NDIR) capable of measuring the concentration of two specific gas components (Hydrocarbon and Carbon Monoxide). The measurement is accomplished by monitoring the infrared energy absorption of each gas component.

## **THEORY OF OPERATION**

### **What is HC?**

Gasoline is a hydrocarbon consisting of hydrogen and carbon atoms. Unburned gas vapors leaving the combustion chamber results in hydrocarbon contaminants. Hydrocarbon is measured in parts per million (ppm).

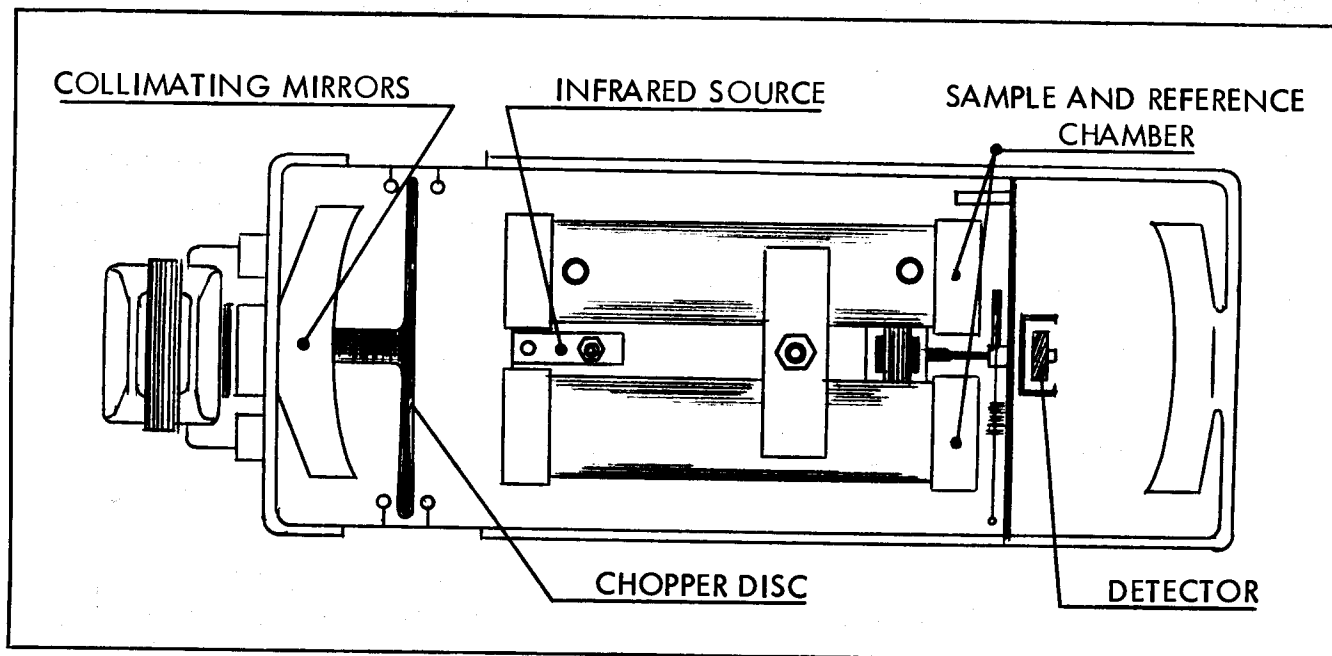
### **What is CO?**

Partially burned gasoline or the incomplete combustion of hydrocarbon results in carbon monoxide contaminants. Carbon monoxide is measured in percent (%) of concentration.

Each gas component has a specific spectral region (a narrow band of infrared energy) that is unique and separate from other gas components. Each Detector Assembly uses a filter or "window" that is highly selective of a particular spectral region, thereby, allowing only the energy levels related to either CO or HC to strike the detector. The infrared energy is directed through a gas Sample Chamber where a portion of the infrared energy is absorbed or attenuated. Therefore, the infrared energy levels detected when the chamber is free of sample gas and the losses of infrared energy levels detected when the chamber contains sample gas, is a measure of the concentration of Hydrocarbon or Carbon Monoxide. In the Models 23-060, 070, 18-090 and 18-150, two detectors are utilized for measuring the Hydrocarbon (HC) and Carbon Monoxide (CO).

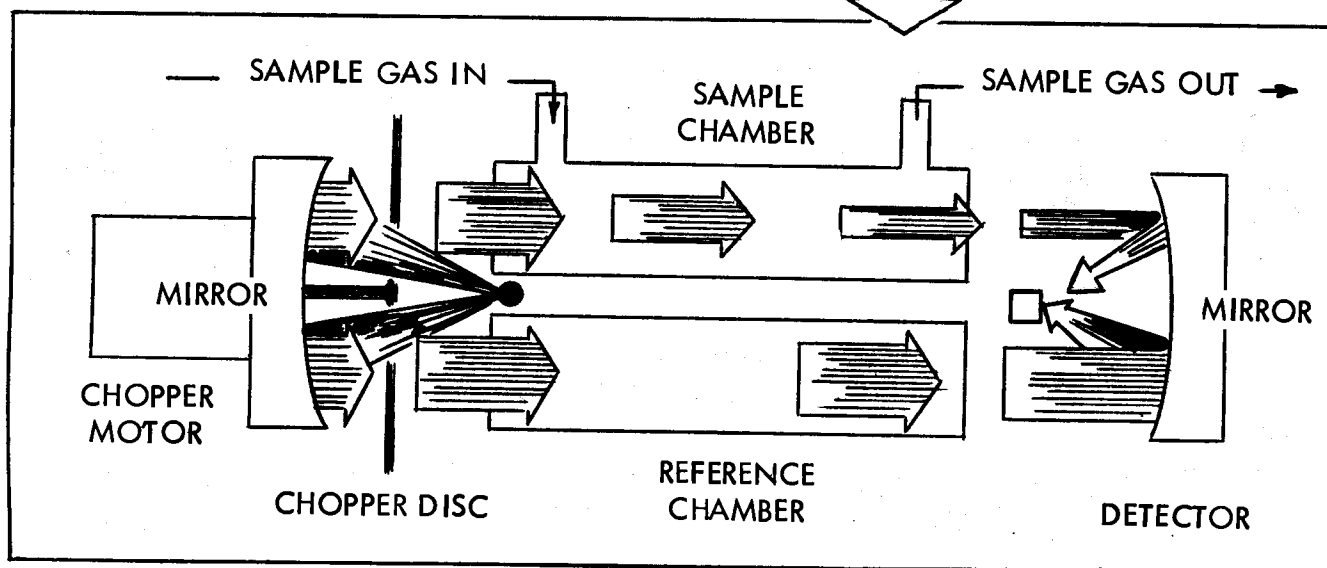
Generally, the systems compare the radiant infrared energy levels of two identical beam paths. One beam path is directed through the Sample Chamber and the other beam path is directed through the Reference Chamber. The difference in energy levels between these paths is then a measure of the infrared absorption. The differences in energy levels are sensed by a Photon Detector where the signal from the detector is processed and used to drive the output meters as a direct measure of unknown gas concentration.

Basically, the gas measuring system consists of an Infrared Source, two Collimating Mirrors, Sample and Reference Chambers, two Detector Assemblies and a Chopper Disc (used for interrupting the infrared beam and directing the beam through either the Sample Chamber or the Reference Chamber).



## Optical Bench Assembly

The Infrared Source is a metal sheathed heater element where it emits infrared energy throughout the infrared spectrum. The emitted energy is directed to the surface of a concave mirror. Since the infrared source is at the focal point of the mirror, the reflected energy leaving the mirror is essentially parallel. The reflected or collimated radiant energy forms two identical infrared beam paths. These beams are interrupted by the Chopper Disc to effect an on-off condition of each beam through each path. (See figure 2.)

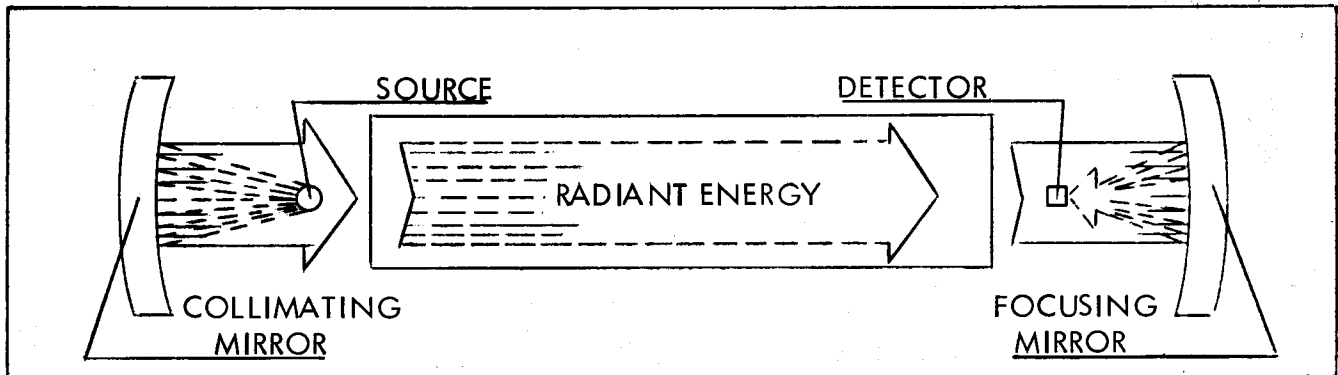


The beams then pass through two parallel chambers which are rigidly mounted to the optical bench. One of the chambers contains the sample or unknown gas, the other chamber contains ambient air at ambient conditions.

## Collimating Mirror

Two identical Collimating Mirrors are located at either end of the Optical Bench.

The purpose of the Collimating Mirrors are to collect infrared energy from the Infrared Source and reflect the energy in a parallel path through the Sample and Reference Chambers and refocus the parallel radiant energy on the Detector Assembly.



Each mirror should be kept clean of finger prints and dirt. (Clean the mirrors with a cotton ball and Isopropyl Alcohol.)

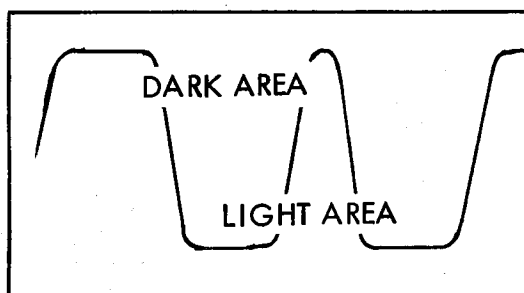
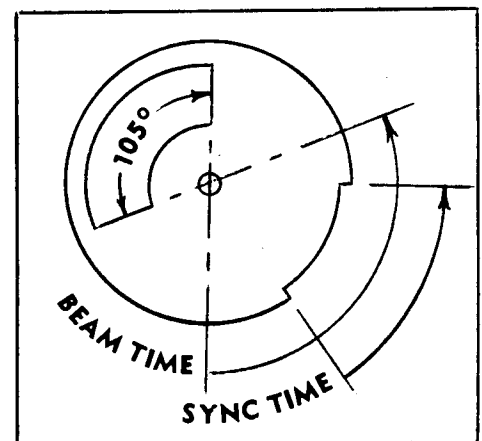
In the event either mirror becomes chipped **REPLACEMENT IS NECESSARY**.

## Chopper Disc & Motor Assembly

The purpose of the Chopper Disc and Motor Assembly is to provide an interruption of the infrared energy leaving the surface of the Collimating Mirrors and directing the energy beam through either the Sample or Reference Chamber.

The Chopper Disc rotates at a rate of 3000 RPM provided by the 110 VAC Synchronous Chopper Motor.

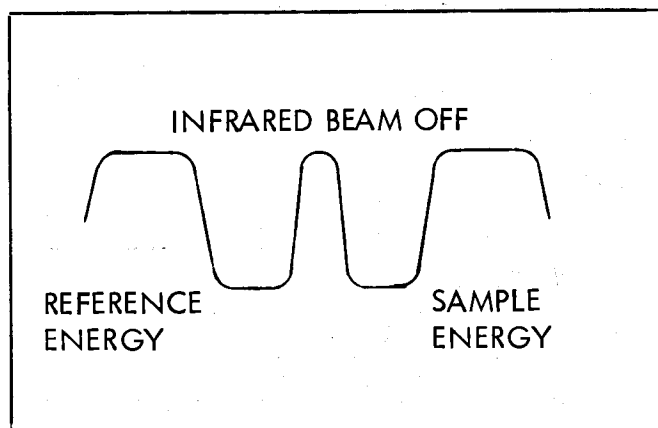
The opening (slot) in the Chopper Disc for the Sample and Reference Chambers is a  $105^\circ$  index opening.



One revolution of the Chopper Disc will provide two infrared beams and two dark areas, (alternately light, dark, light, dark) at the Detector Assembly. One light area will represent the Sample Energy (Sample Signal) and the other light area will represent the Reference Energy (Reference Signal). Therefore, with each revolution of the Chopper Disc, one infrared beam will pass through each chamber. (50 times each second.)

The radiant beams, after passing through the two chambers, are reflected by a second mirror onto two Photon Detectors after first passing through specific optical filters. The optical filters represent the precise "windows" of the absorption bands for Carbon Monoxide (CO) and Hydrocarbon (HC). Energy outside these bands, whether as part of the chopped energy or stray "light" from other sources, are eliminated.

In effect, the system is turned only to see energy in those two unique absorption bands, which represent those two gases. In this way, each detector converts the infrared energy or generates a voltage signal which represents the two energy levels, (Sample Energy and Reference Energy). (See figure 3.) These signals are processed and used to drive the output meters (CO in percent of concentration (%), HC in parts per million (ppm) concentration).



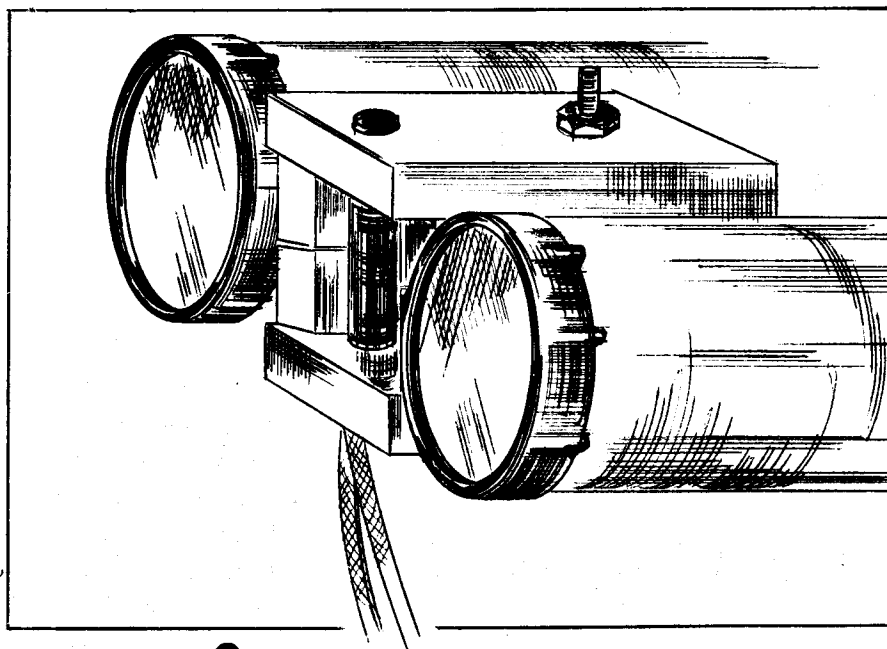
INPUT SIGNAL FROM THE DETECTOR ASSEMBLY  
TO THE PREAMPLIFIER ON THE PROCESSOR PCB

## Infrared Source

The Infrared Source is a metal sheathed heating element operating at a temperature of approximately 750° F (subtle red color) where it emits infrared energy through the spectral region of infrared energy.

The Infrared Source is located at the focal point of the Collimating Mirror and Chopper in a two piece ceramic housing. The two sections are secured to the Optical Bench by means of a single bolt. This permits moderate position of the infrared source for optimum alignment at the focal point of the mirror.

The infrared energy leaving the source is directed back through either the Sample Chamber or Reference Chamber by means of reflection on the face of the Collimating Mirror, where the rays leaving the surface of the Collimating Mirror are essentially parallel. The opening in the Chopper Wheel determines which chamber the beam will be directed through.



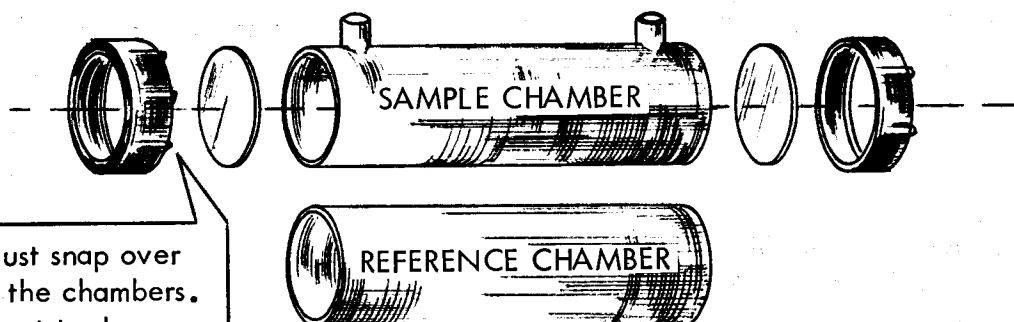


## Sample & Reference Chambers

The Sample and Reference Chambers are located in the center of the Optical Bench and nested in V-Grooves.

The purposes of the Sample and Reference Chambers are to provide a means of confining the sample gases to a given area and a source for continuous referencing to air (ambient conditions).

Each Chamber consists of an eight inch (8") cylindrical tube, two silicon windows and two end caps. The difference between the Sample and Reference Chamber is the Sample Chamber input and output ports.

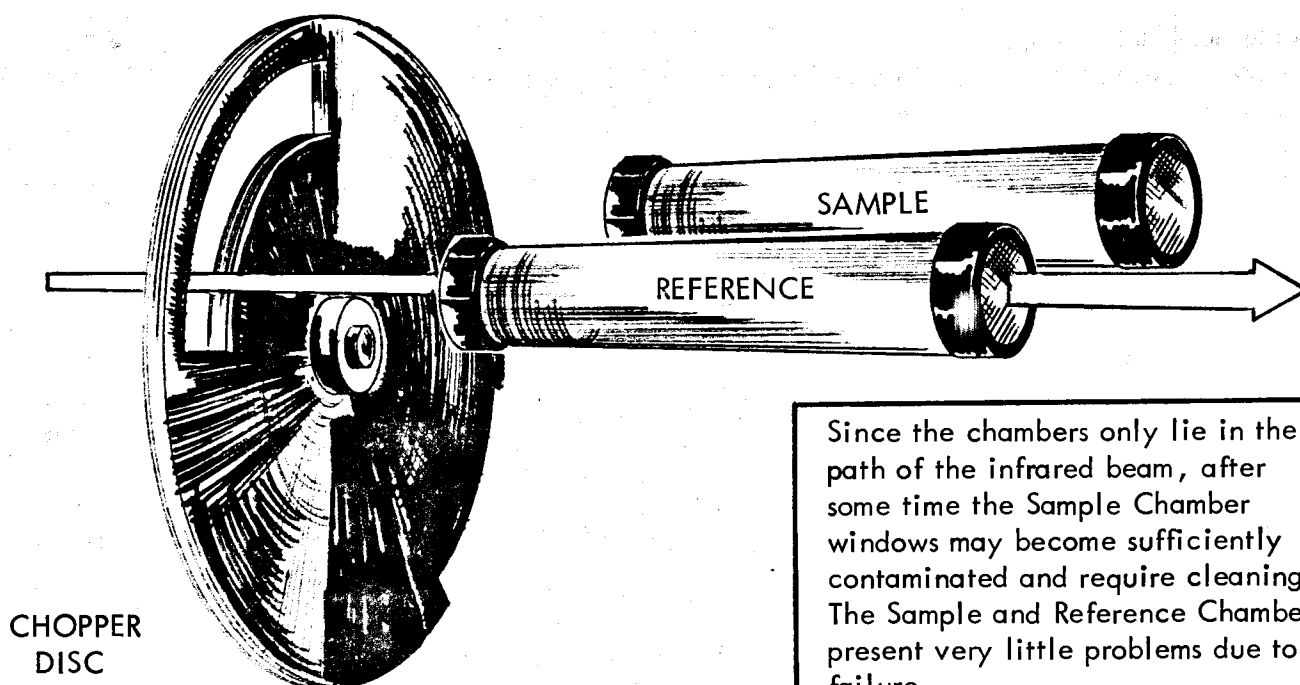


End caps must snap over grooves on the chambers. Be careful not to damage the Silicon windows when removing or reinstalling end caps.

CLEAN SILICON WINDOWS WITH ISOPROPYL ALCOHOL AND COTTON SWAB OR BALL.

The infrared energy is directed through both tubes at separate times, where the collimated energy leaving the surface of the mirrors passes through the opening slot in the Chopper Disc.

When infrared radiant energy is looking through the Sample Chambers and if gases are present in the chamber, an absorption of infrared energy will result where the output energy is attenuated.

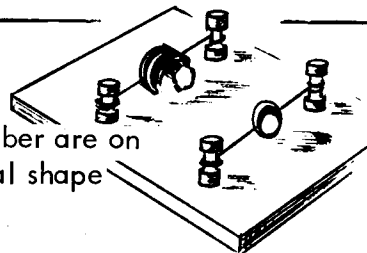


Since the chambers only lie in the path of the infrared beam, after some time the Sample Chamber windows may become sufficiently contaminated and require cleaning. The Sample and Reference Chambers present very little problems due to failure.

The Chopper Disc also provides a Sample and Reference Sync Pulse with each revolution. On one side of the outer edge of the Chopper Disc is a Light Emitting Diode (LED), on the other side of the Chopper Disc is a Photo Transistor. When the opening at the edge of the Chopper Disc passes between the LED and the Photo Transistor, the Photo Transistor conducts.

The result is a pulse occurring during the time the infrared radiant energy is passing through the corresponding chamber.

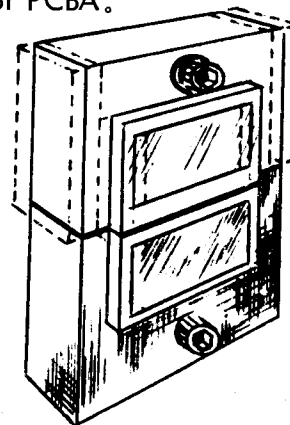
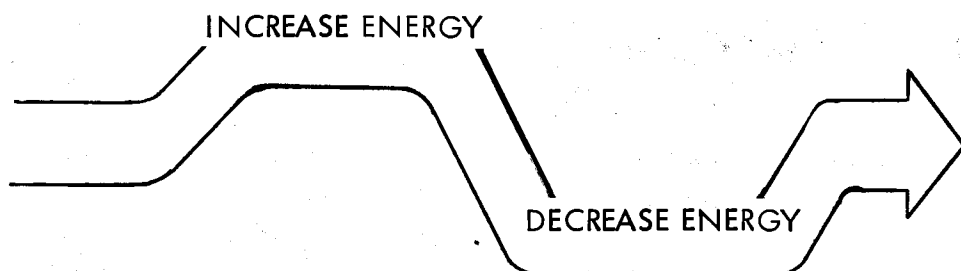
NOTE: The Sample Photo Sync Transistor and the Sample Chamber are on opposite sides of the chopper wheel, due to the physical shape of the Chopper Disc.



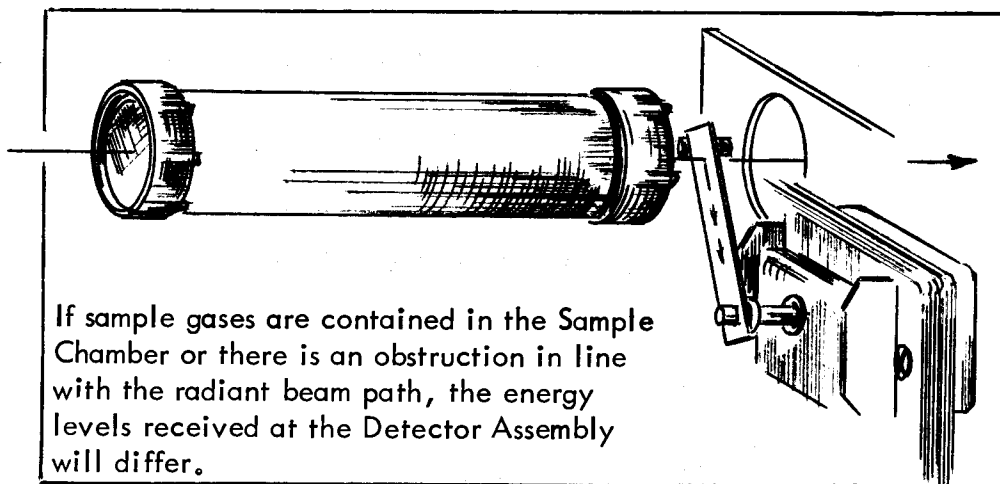
## **Detector Assembly**

The purpose of the Detector Assembly is to screen or block all radiant energies other than the precise band of energy of interest for either CO or HC measurements. Also, the Detector converts the energy levels into voltage signals used in the signal processor PCBA.

The Detector is a photo resistor such that increases in light energy cause decreases in resistance.



The energy received at the Detector Assembly, an alternate on-off sequence, (Reference Energy, No Energy (dark), Sample Energy and No Energy (dark)) is converted into the voltage signal shown above.



If sample gases are contained in the Sample Chamber or there is an obstruction in line with the radiant beam path, the energy levels received at the Detector Assembly will differ.

When the CAL Switch is used, the motor rotates until the CAL Flag hits the stop in this position. The Cal Flag is directly in line with the sample energy where a portion of this energy is absorbed by the Cal Flag. When the CAL Switch is released or returned to NORM, the spring returns the Cal Flag to its original position.

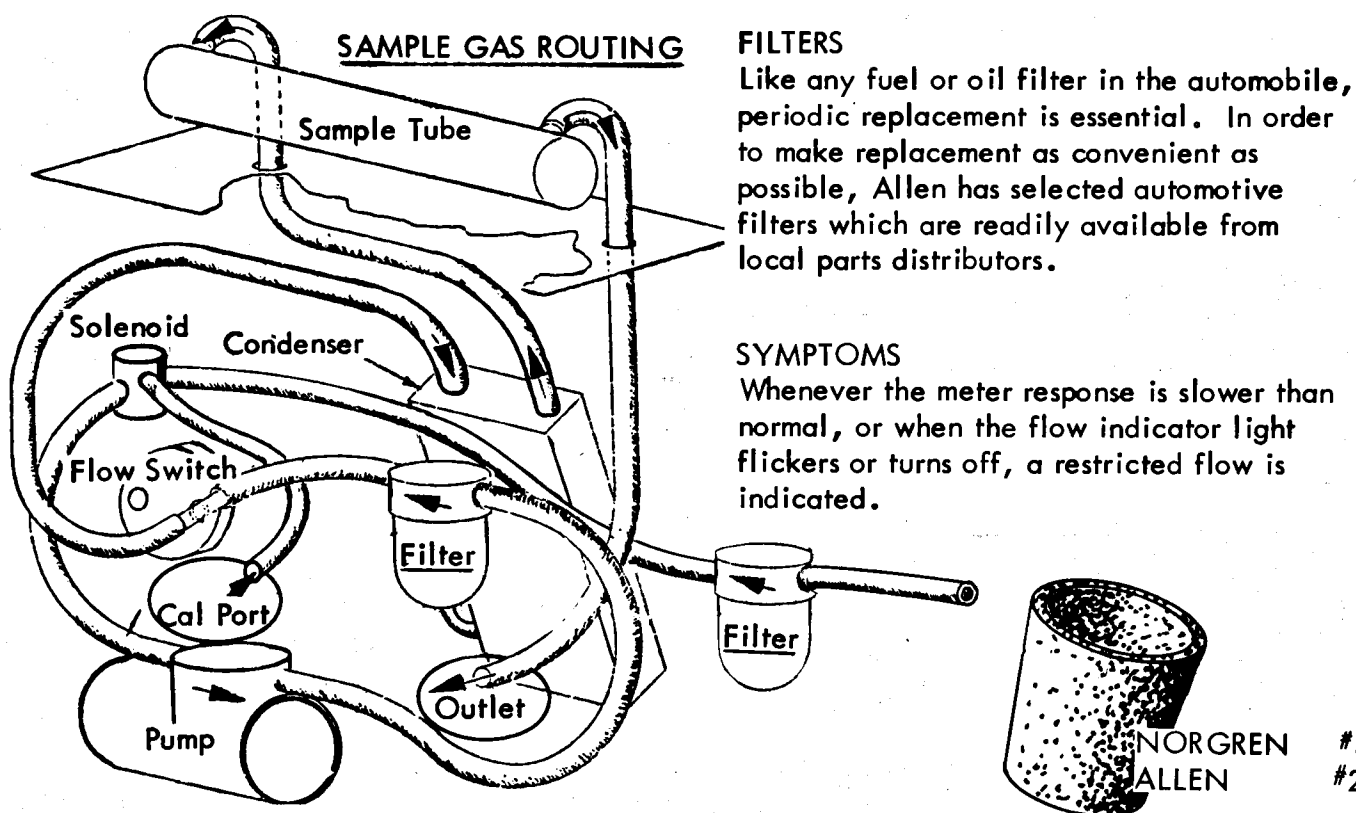
# Exhaust Module System

The Exhaust Module provides the flow and conditioning of the Sample Input.

Since the automotive gas is contaminated with carbon particles and contains water vapors, it is essential that the exhaust system filters out carbon particles, condenses the water vapors and expels them from the system.

If water vapors condense on the Sample Chamber windows (forming water droplets or fogging) erroneous readings can occur since droplets or fogging provide high energy absorption properties. Water vapors that pass through the Sample Chamber provide a negligible absorption property, therefore, it is evident that condensation of water vapors and cooling of the gases is imperative.

The Exhaust Module System, consisting of Sample Probe and Extension Hose, Primary Filters, Solenoid, Pump, Secondary Filters and Condenser Unit operates at a lower temperature than the Optical Bench. Therefore, any remaining water vapor in the gases from the condenser unit to the Sample Chamber will be placed in a higher temperature environment where further condensation will not occur.



## Sample Probe and Extension Hose

1. The purpose of the Sample Probe and Extension Hose is to draw the sample gas from the automobile tailpipe to the unit.

## **Primary Filter**

2. The Primary Filter provides a filtering of particles of dirt and carbon that are larger than 50 microns. Also, condensation will take place in the Filter Assembly and water will collect in the Bowl Assembly.

## **Solenoid Assembly**

3. The Solenoid Assembly is a three (3) way valve used for directing the flow through either the Exhaust Input or the Cal Input. When the Selector Switch is in the NORM position, the solenoid is not actuated and the flow is through the Exhaust Input. When the Selector Switch is in the SPAN or CAL position, the solenoid is actuated and the flow is through the Cal Input.

## **Pump Assembly**

4. The Pump Assembly provides a means of drawing the sample through either the Exhaust Post or Cal Port. The input side of the pump should produce 17" to 20" of vacuum, where the output side of the pump will produce a pressure and force the gases through the system.

## **Flow Switch (Pressure)**

5. The Flow Switch (Pressure Switch) monitors the condition of the flow rate. When the Exhaust System is unrestricted at the input and the pump is operating at an efficient level, the Flow Switch completes a circuit for the flow lamp, thereby, indicating a sufficient volume of gas flow.

## **Secondary Filter**

6. The Secondary Filter is used to further trap carbon particles and condense and expel water vapors into the Plenum Chamber of the Condenser Unit. The Secondary Filter also contains a 50 micron filter element.

## **Condenser Assembly**

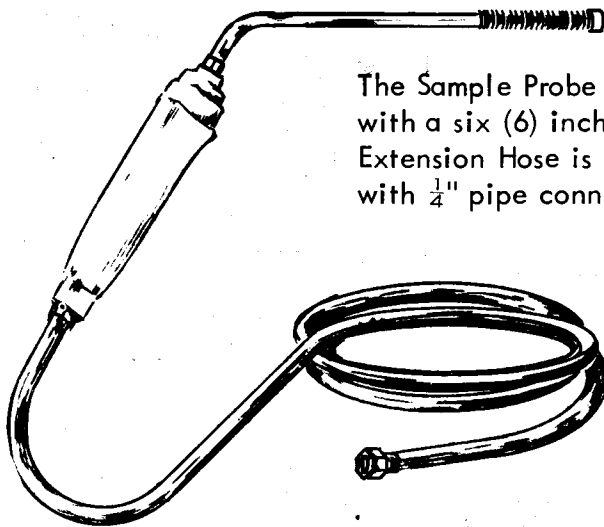
7. The Condenser Unit cools the gases and condenses most of the water vapors in the sample gas. The condensation or water is drained into the Plenum Chamber where the pressure in the chamber forces the water and dirt particles out through the Drain Port.

## **Sample Chamber**

8. The Sample Chambers (CO and HC) contain a volume of gas where the infrared beam passes through that gas. The absorbed energy is then a measure of CO or HC concentration.

## Sample Probe and Extension Hose

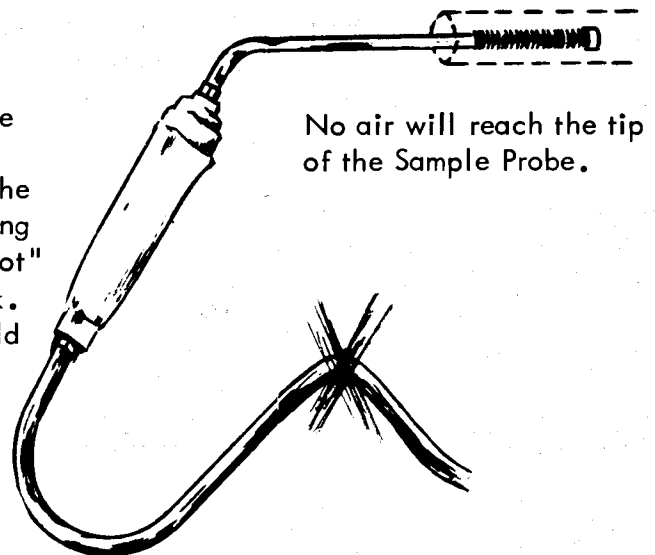
The purpose of the Sample Probe and Extension Hose is to provide a means of drawing exhaust gases from the automobile to the unit and isolating the exhaust gases from ambient conditions.



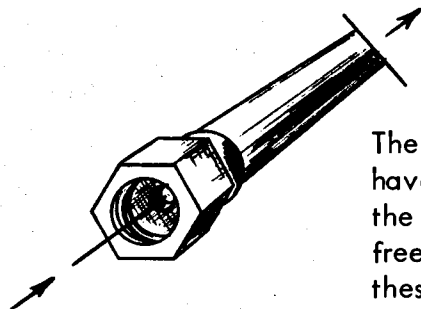
The Sample Probe is constructed of stainless steel with a six (6) inch metal flex tube at the tip. The Extension Hose is Dacron reinforced poly-urethane with  $\frac{1}{4}$ " pipe connectors.

For proper sampling, the Sample Probe is inserted 6" to 12" into the tailpipe of the automobile. This provides a means of drawing only exhaust gases into the unit.

The Sample Probe and Extension Hose should be periodically inspected for bends and kinks. A "kink" in the hose will cause a restriction in the flow line where the velocity of hot gases passing that point increases. This can cause a "hot spot" in the hose and may eventually develop a leak. A Hose or Sample Probe in this condition should be replaced.



No air will reach the tip of the Sample Probe.



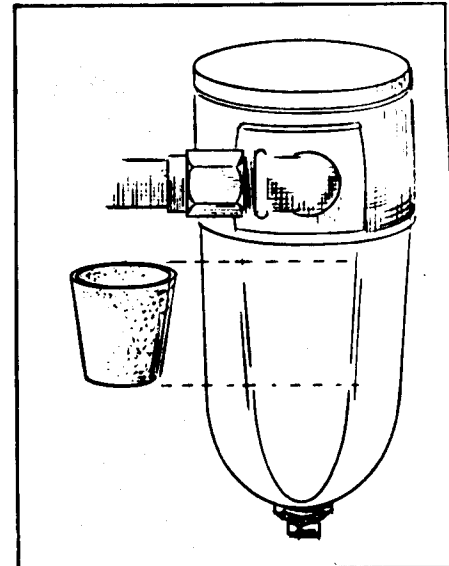
The  $\frac{1}{4}$ " pipe connectors on the Extension Hose have small ports compared to the diameter of the sample probe tubing. Be sure the Hose is free of large particles of dirt or gravel, since these particles could lodge in the connector ports and restrict the flow of sample gas.

## Primary Filter

The purpose of the Primary Filter Assembly is to provide protection for the Pump Assembly by trapping dirt and carbon particles larger than 50 micron.

The Filter Assembly contains a 50 micron filter element enclosed in a transparent bowl.

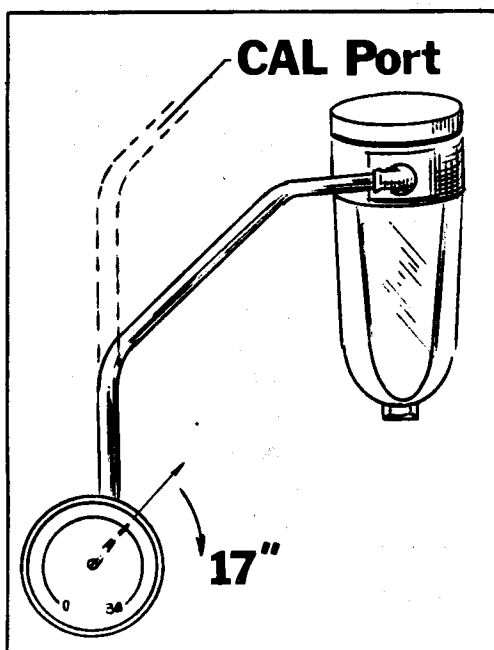
✓	<b>Leaks in input</b>
✓	<b>Cracks in bowl</b>
✓	<b>Plugging of filter</b>



The Filter Assembly will also condense and trap water vapors. Water will collect in the filter bowl and remain in the bottom, eventually, enough water will have accumulated where the level has reached the bottom of the filter element. Although, water passing through the Primary Filter will be expelled by the Secondary Filter and Condenser Assembly, it is recommended to remove the filter bowl and dump the water. This of course, is to prevent the oil and contaminants from the automobile gas which foul the water from prematurely clogging the filter element.

Since the Primary Filter is on the input side of the Pump Assembly (vacuum side) it is important that the Filter Assembly does not leak.

Leaks can be caused by a cross-threaded filter bowl or filter bowl stop, torn or missing bowl gaskets, cracks in the filter bowl, etc.



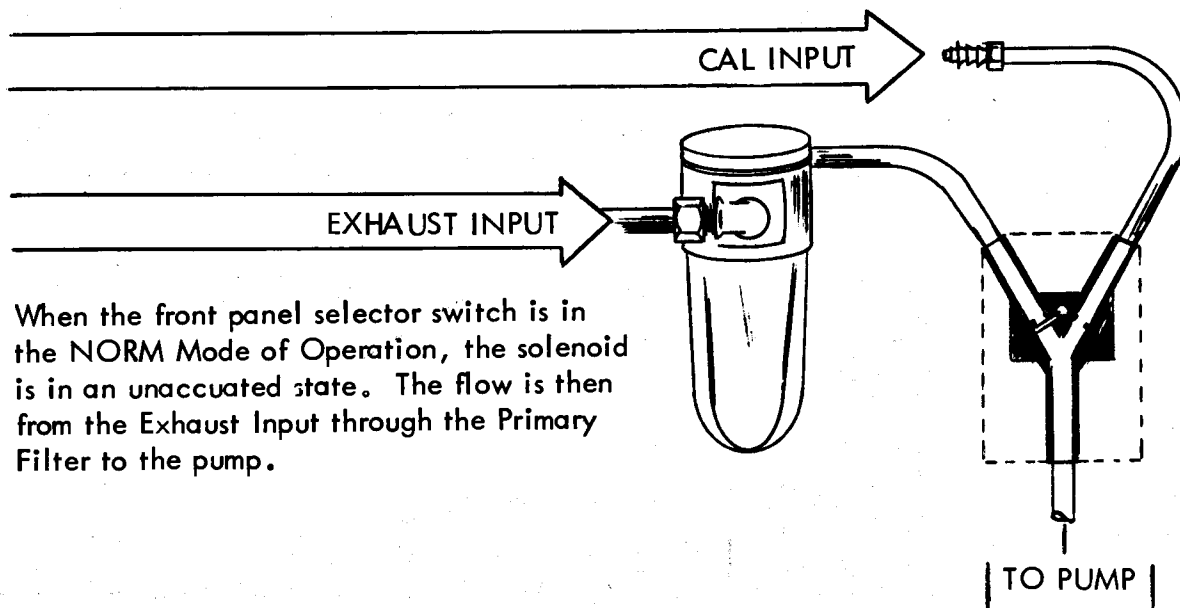
Test the Bowl Assembly for leaks with the following procedure:

1. Connect a Vacuum Gauge to the input of the Filter Bowl Assembly allowing the gauge to fully restrict the input. Note the vacuum reading when the unit is in the NORM Mode of Operation.
2. Connect the Vacuum Gauge to the "Cal Port" allowing the vacuum gauge to fully restrict the input. Note the vacuum readings with the unit in the CAL Mode of Operation.

If the filter input vacuum reading is lower, it is likely that the Primary Filter Assembly is leaking.

## Solenoid Assembly

The purpose of the Solenoid Assembly is to provide a sample input source through either the Exhaust Hose or the "Cal Port". Essentially, the solenoid is a three (3) way valve with two inputs and one output.



When the front panel selector switch is in the NORM Mode of Operation, the solenoid is in an unaccuated state. The flow is then from the Exhaust Input through the Primary Filter to the pump.

However, when the front panel selector switch is in the SPAN or CAL Mode of Operation, the flow is through the "Cal Port" and to the pump. In either of these modes, the Solenoid is in an accuated state, (for longivite of the Solenoid, it is recommended that the unit is left in the NORM position while not in use).

### Checking the Solenoid

- 1** Listen for the sound of the relay when the selector switch is switched to the CAL position from the NORM position. If the sound is not evident, the solenoid is probably defective. (NOTE: Be sure 110 VAC is available at the solenoid.)

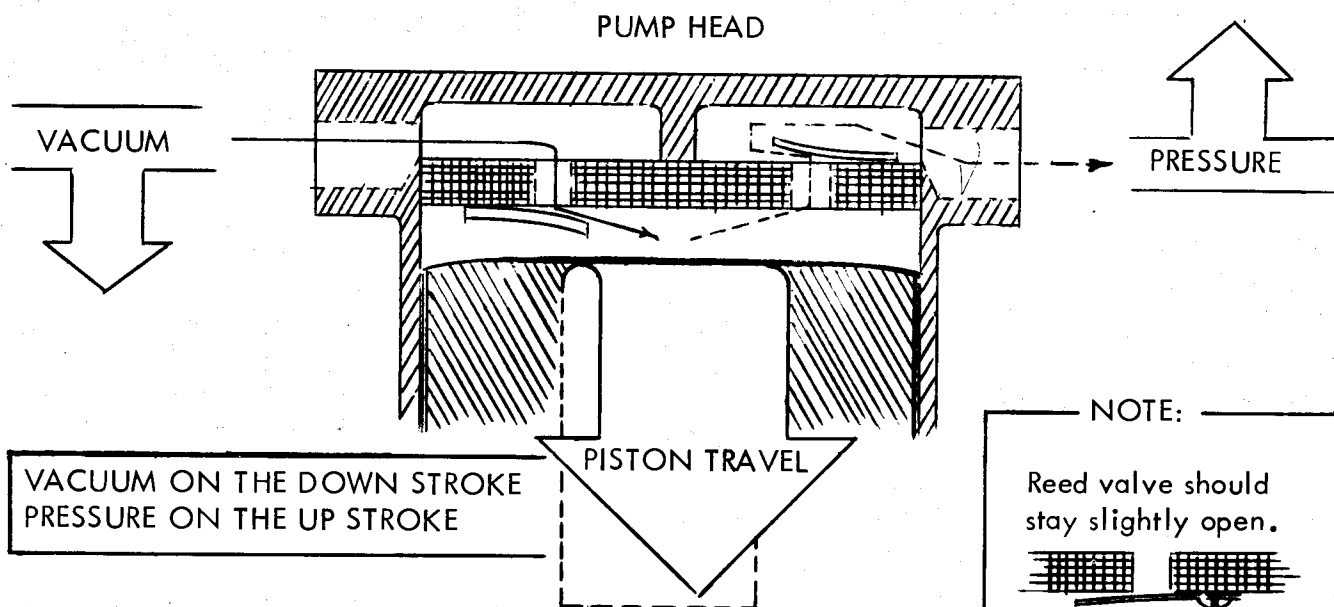
- 2** Monitor the input vacuum at the Exhaust Port and Cal Port with the front panel switch in the NORM and CAL positions respectively. Equal vacuum readings should be noted at each input.

## Pump Assembly

The purpose of the Pump Assembly is to draw the sample input into the system and force the sample gas through the system (provide a rate of flow).

The input side of the pump is a vacuum and the output side of the pump is a pressure.

To determine the efficiency of the Pump Assembly, connect a vacuum gauge to the input. The pump should be capable of producing 17" to 20" of mercury when fully restricted.

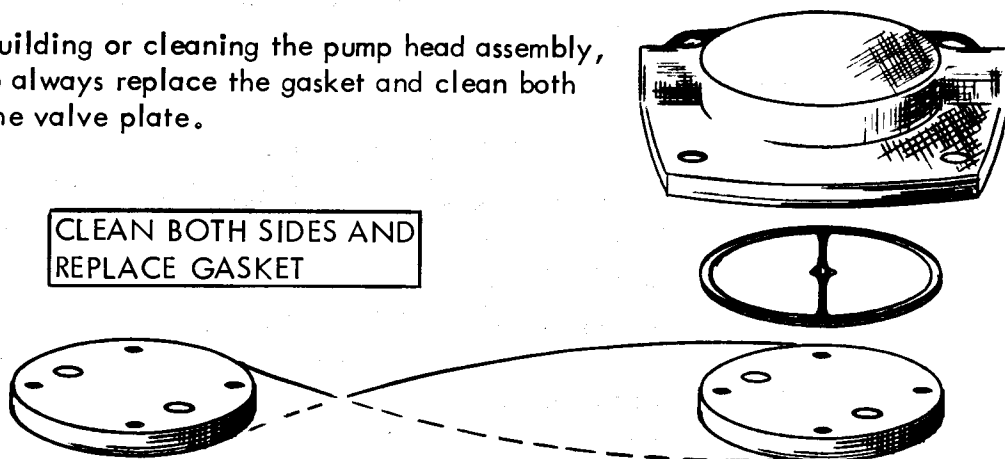


Inefficient pump operation is generally characterized by insufficient vacuum. Usually, problems of this nature are corrected by cleaning the valve plate and reed valves.

Inspect the pump head for carbon particle build-up and reed valve condition.

When rebuilding or cleaning the pump head assembly, be sure to always replace the gasket and clean both sides of the valve plate.

CLEAN BOTH SIDES AND  
REPLACE GASKET





## Secondary Filter

The purpose of the Secondary Filter Assembly is to condense and trap water vapors and provide additional particulate filtering.

Since the Secondary Filter Assembly is on the output (pressure side) of the Pump Assembly, any condensation in the filter bowl is forced out of the filter bowl and expelled into the Plenum Chamber of the Condenser Unit.

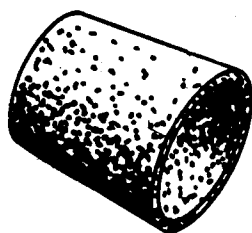
This Filter is an automatic drain source for water and carbon particles that pass through the input filter and Pump Assembly.

Generally, this filter requires little maintenance. However, it is recommended that the filter element is periodically cleaned to insure a free flow of sample gases.

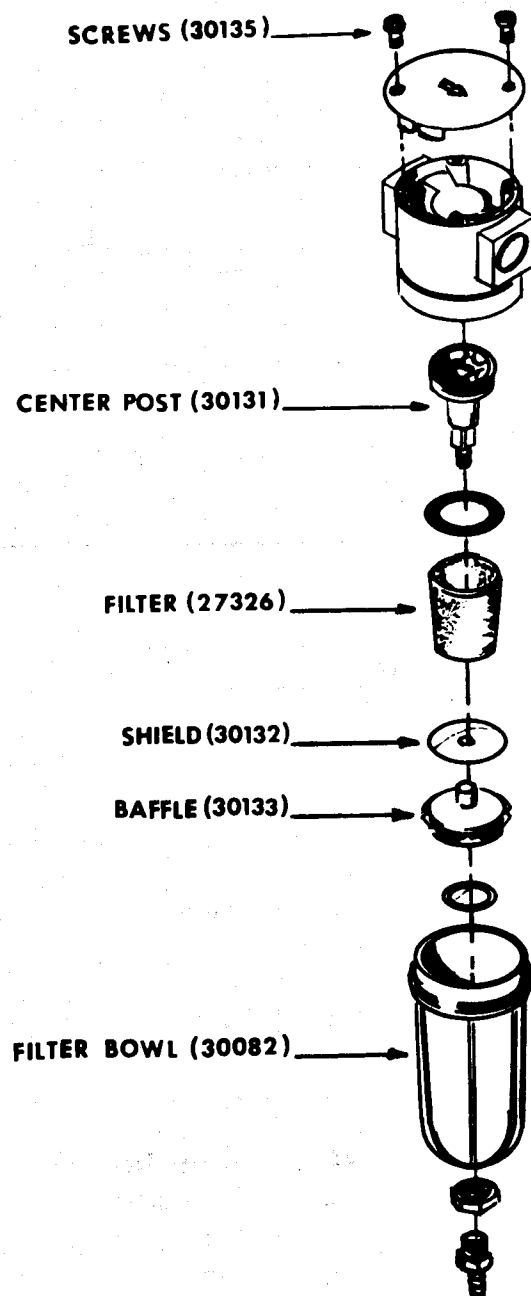
When replacing the filter element, be careful that the center post threads are not cracked or broken by over torqueing. Replacement of the filter element should be "just snug", not tight.

Soak the filter element in a carburetor cleaner solution for approximately 5 minutes.

✓	<b>Leaks in input</b>
✓	<b>Cracks in bowl</b>
✓	<b>Plugging of filter</b>

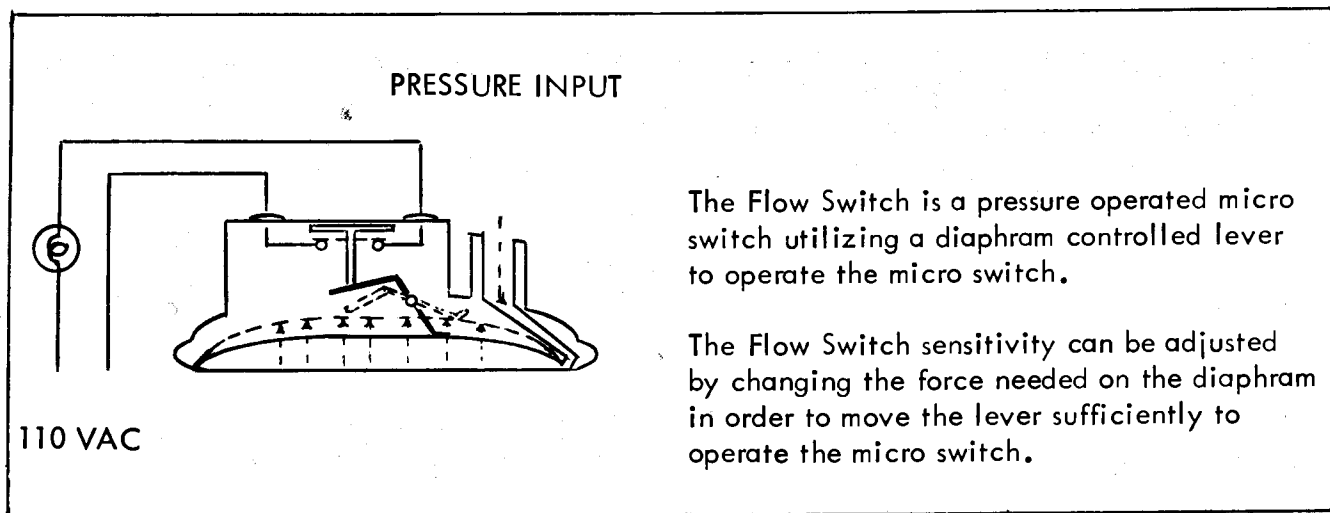


BLOW THE ELEMENT CLEAN WITH AN AIR HOSE FROM THE INSIDE OF THE FILTER ELEMENT.

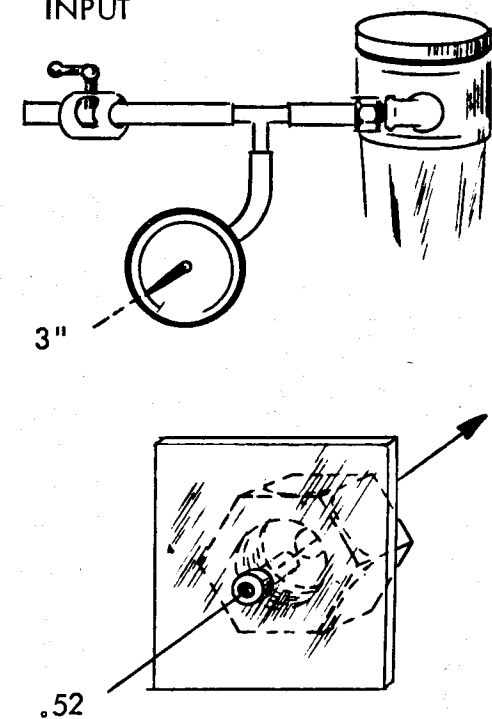


## Flow Switch (Pressure)

The purpose of the Flow Switch is to monitor the flow of the Exhaust Module System and provide and indication of sufficient flow by controlling the flow lamp.



Adjusting the Flow Switch can be accomplished in the following three (3) ways:

<b>A</b>	<ol style="list-style-type: none"> <li>1. With the front panel selector switch in the NORM position, connect a vacuum gauge to the Exhaust Port as illustrated.</li> <li>2. Adjust the Flow Switch until the flow indicator lamp is "just on".</li> </ol>	<p style="text-align: center;">RESTRICT THE INPUT</p> 
<b>B</b>	<ol style="list-style-type: none"> <li>1. With the units front panel switch in the CAL position, place an orifice (.52) over the input port and adjust the Flow Switch until the flow indicator is "just on".</li> </ol>	
<b>C</b>	<ol style="list-style-type: none"> <li>1. Monitor the input flow rate with a Standard Cubic Foot per Hour gauge. Adjust the flow rate to 25 CFH and adjust the Flow Switch until the flow indicator is "just on".</li> </ol>	

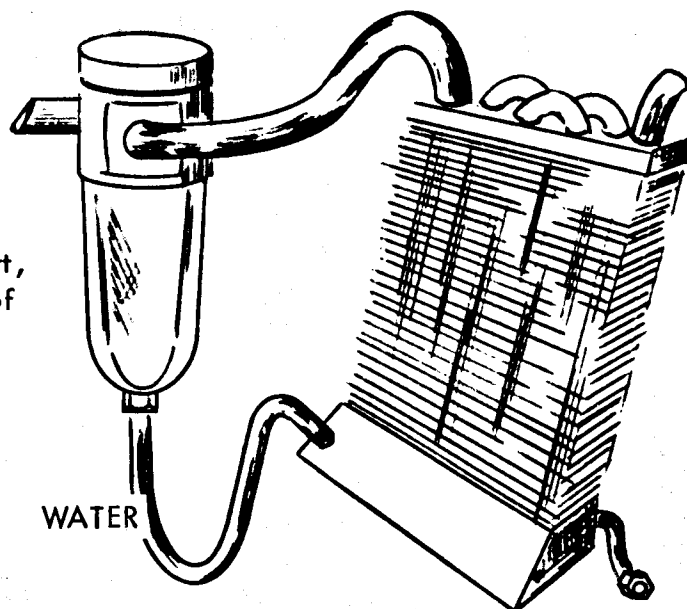
## Condenser Assembly

The purpose of the Condenser Assembly is to cool the gases, condense water vapors, expel excess water and dirt or carbon particles through the drain.

Since the Condenser Assembly is on the pressure side of the Pump Assembly, condensed water vapors and carbon particles are forced out of the Plenum Chamber through the drain opening.

GAS FLOW  
(from pump)

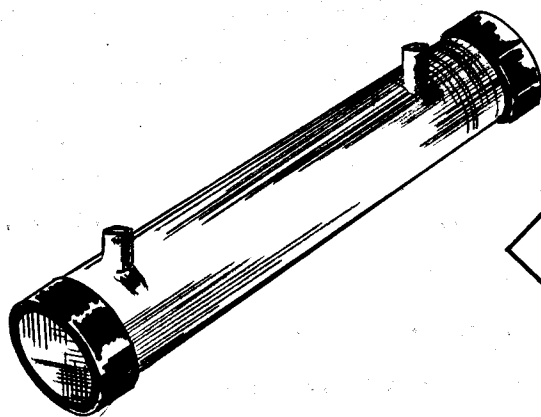
The input and output ports of the Condenser Unit are large in comparison to the drain port, therefore, the sample gas passes in and out of the Condenser Assembly. Since the Plenum Chamber is under a higher pressure, little if any gas is expelled through the drain port.



The gases leaving the Condenser Assembly may still contain water vapor, however, the Sample Chamber is operating at a higher temperature than the Condenser, therefore, no further condensation of gases should occur in the Sample Chamber.

Plugging is the only likely problem of the Condenser Assembly.

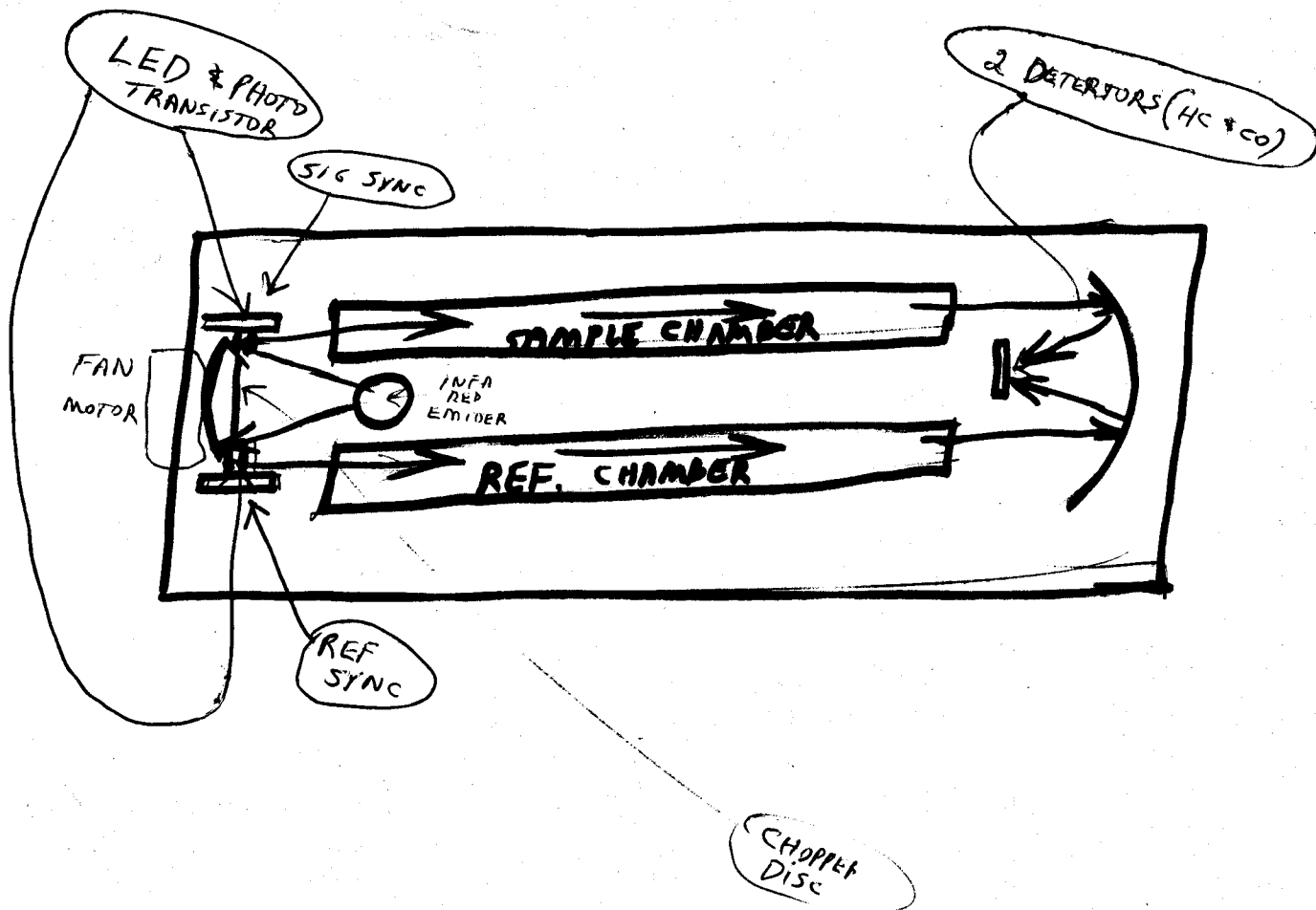
## Sample Chamber



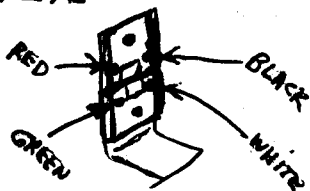
The Sample Chamber is located in the Optical Bench Assembly, connected to the exhaust at the output of the Condenser Unit.

(FOR MORE DETAILS ON THE SAMPLE CHAMBER → REFER TO PAGE 5.)

# Notes:



DETECTORS: CO & HC DETECTORS ARE THE SAME EXCEPT GLASS FILTER IN FRONT OF EACH IS DIFFERENT. GREEN LENS FACES OUT ON CO, RED FACES OUT ON HC. THE LENS ARE THE SAME - JUST INSTALLED IN REVERSE. DETECTORS ARE NOTHING MORE THAN A LIGHT SENSITIVE VALISTER.



# SYSTEMS THEORY OF OPERATION

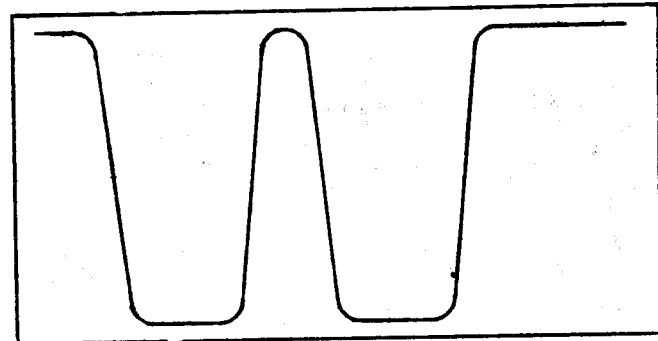
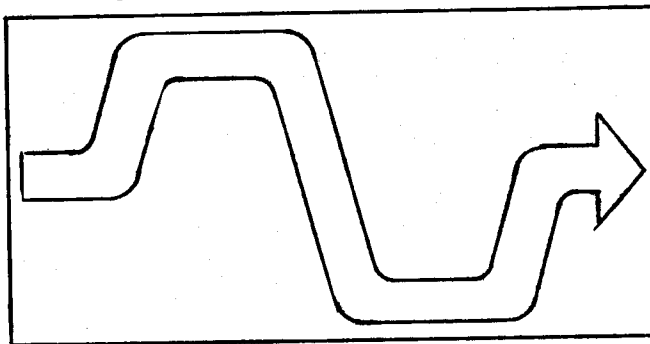
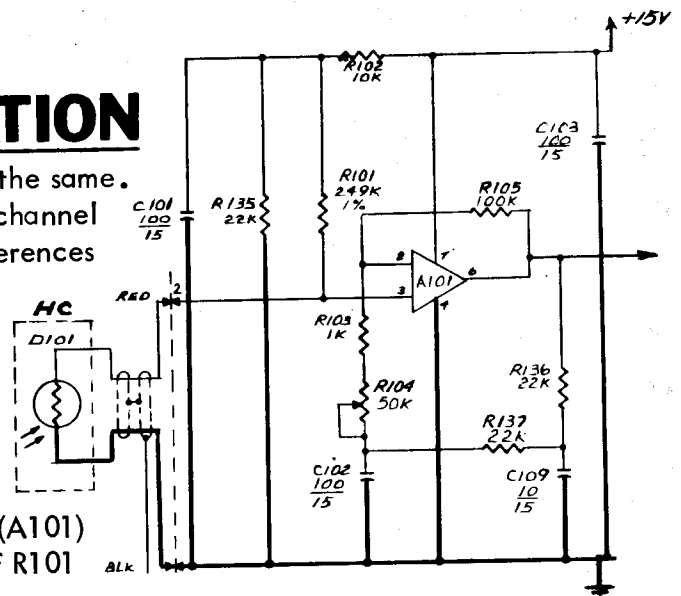
The circuits for each channel are essentially the same. The circuit description is given for only one channel (HC) and where differences occur, these differences are noted.

The Detector Assembly (D101) is a light sensitive varistor where increases in light energy cause decreases in resistance within the Detector.

The input signal at pin 3 of the Preamplifier (A101) is formed by the voltage divider consisting of R101 and the Detector (D101).

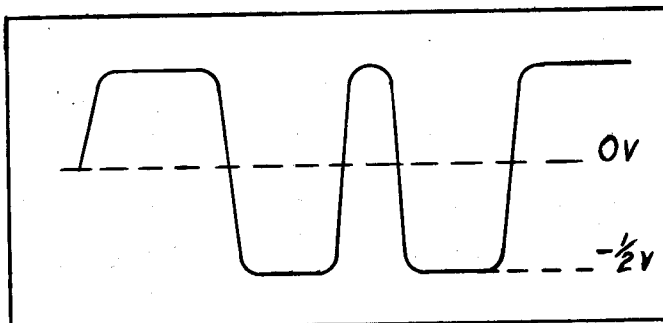
As Infrared Energy (light energy) increases in the Detector Assembly, the Detector resistance decreases resulting in a voltage decrease at pin 3 of the Preamplifier (A101). As Infrared Energy decreases in the Detector Assembly (infrared beam blocked by the Chopper Disc) the resistance of the Detector increases, resulting in an increase of voltage at pin 3 of A101.

## Detector / Preamplifier



The input voltage signal at pin 3 of A101 is applied to the non-inverting pin of the Preamplifier where the signal output (pin 6) has the same time and phase as its' input. The closed loop feedback circuit, consisting of R105, R103, R104 and C102, provides a gain characteristic of 6X to 100X for the HC Channel (R205, R203, R204 and C202) for the CO Channel provides a gain of characteristic of 17X to 470X.

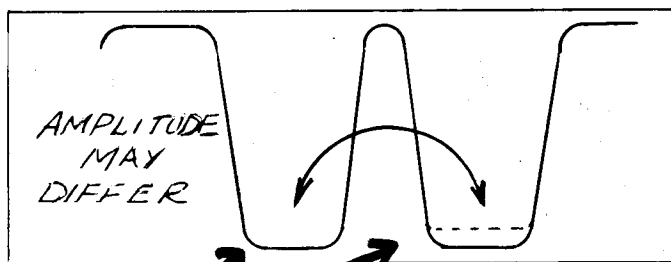
Since the gain of the Preamplifier is adjustable by R104 (204), the desired gain is adjusted to a peak output level of one volt peak to peak (1 v/pp  $\pm$  250 millivolts) as measured at TP101.



Since the Chopper Disc is rotating and therefore providing energy to the Detector at an alternate ON-OFF sequence and since the Chopper Disc is directing energy through the Reference Chamber, then OFF, through the Sample Chamber, then OFF and again through the Reference Chamber. The resulting output signal of the Preamplifier (A101, TP101) will be as shown below:

#1 CHECK

19 #1 CHECK

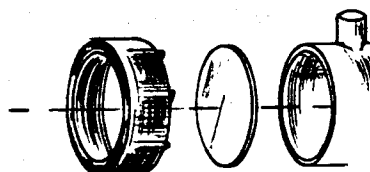


With no gas present in the Sample Chamber, ideally the reference energy levels and the sample energy levels will be equal in amplitude. However, due to component tolerances and Sample Chamber "window" contamination, it is likely that the signal amplitude will differ.

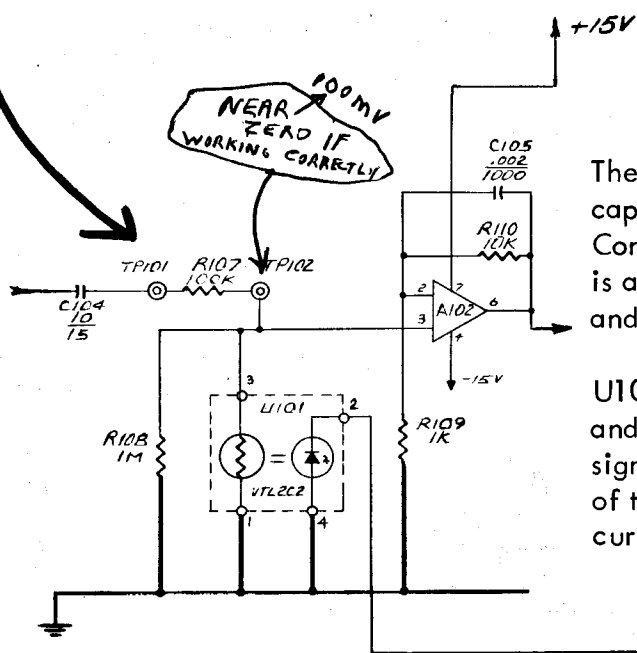
\* The Signal Symmetry can be adjusted by positioning the Detector Assembly in the focal plane of the Focusing Mirror such that the signal amplitude is within 100 millivolts.

(Refer to Calibration Procedure for Signal Symmetry Adjustments.)

NOTE: If Signal Symmetry cannot be adjusted, the most likely cause of difference will be due to Sample Chamber "window" contamination. Remove both end caps and clean with Isopropol Alcohol and cotton.



## #2 CHECK

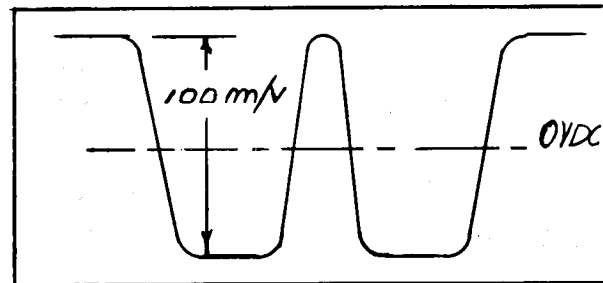


The input signal from the Preamplifier (A101) is capacitively coupled by C104 to the Signal Gain Control Amplifier (102). The input signal at TP102 is attenuated by the voltage divider R107, R108 and U101.

U101 consists of a Light Sensitive Varistor (LSV) and a Light Emitting Diode (LED). The input signal at TP102 depends largely upon the resistance of the varistor which in turn depends upon the current through the LED.

The current through the LED depends upon the AGC feedback voltage from the AGC Amplifier circuit. Normally, the signal is attenuated approximately 11X and thereby providing a peak voltage signal at TP102 of approximately 100 millivolts.

Any changes in input amplitude should produce corresponding changes in AGC feedback voltage and therefore change the current through the LED in U101 and consequently, the ratio of attenuation resulting in a CONSTANT amplitude signal at the input to the Gain Control Amplifier (A102).



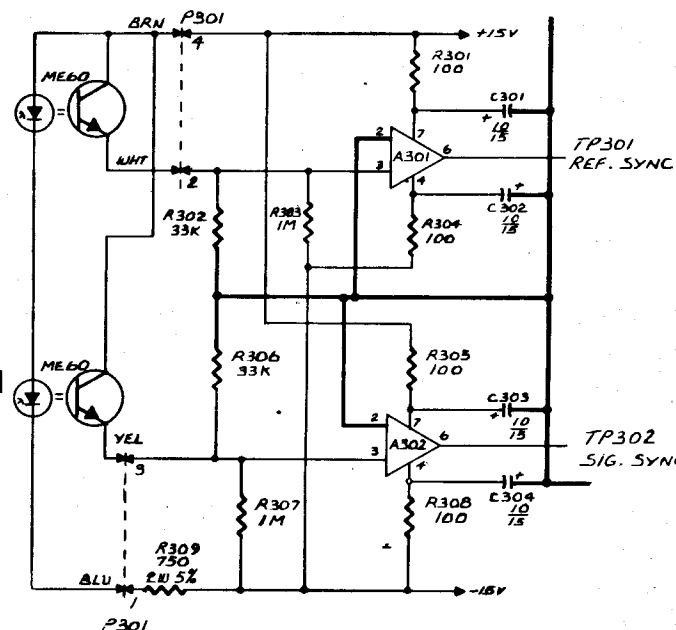
This signal is applied to the non-inverting pin (3) of the Gain Control Amplifier (A102) where the output signal has the same time and phase at its' input. The closed loop feedback circuit consisting of R110 and R109 provides gain characteristics of approximately 11X and thereby provides an output signal of CONSTANT gain of one volt peak to peak (1 v/pp  $\pm$  100 millivolts).

Since the input signal amplitude is controlled by the AGC feedback voltage to U101, the output signal at pin 6 of A102 will always be a CONSTANT one volt peak to peak signal. **TP 101**  
REFER TO AGC DEMODULATOR/AMPLIFIER

As the Chopper Disc rotates between the Light Emitting Diode and the Photo Transistor, a light pulse is generated from the LED to the base of the Photo Transistor each time the opening (slot) on the outer edge of the Chopper Disc passes between the components.

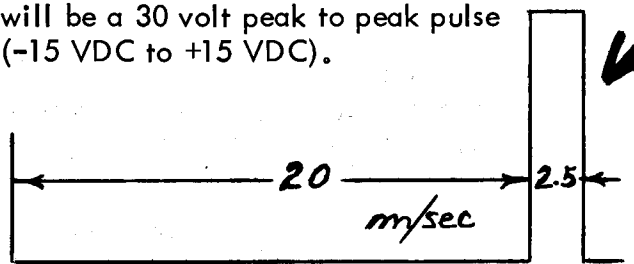
At this time, the current is increased through the Photo Transistor, raising pin 3 of A301/302 to some slight positive value. The output of the operational amplifier will pulse to +15 VDC voltage level at this time.

**NOTE:** The input pulse to A301/302 at pin 3 cannot be observed or measured at that point.



As the Chopper Disc further rotates to a point where the outer edge of the Chopper Disc interrupts the Light Transmittance of the LED to the base of the Photo Transistor, the Photo Transistor will cut-off, creating a slight negative voltage at pin 3 of A301/302. Consequently, the amplifier output will pulse to the -15 VDC level during that time.

The output signal as measured at TP301/302 will be a 30 volt peak to peak pulse (-15 VDC to +15 VDC).

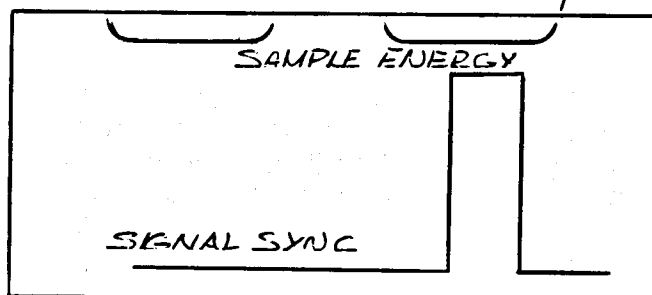
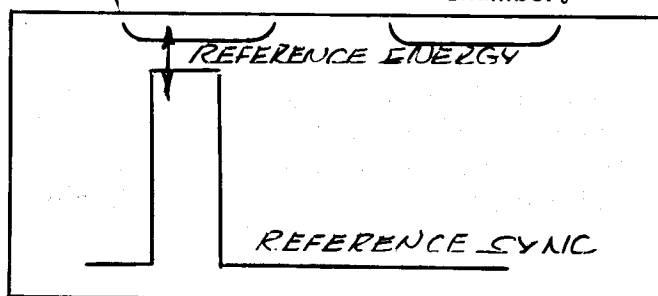


**#3 CHECK**

The speed of the Chopper Disc set the time the output pulse is positive and the time the output pulse is negative. At 3000 RPM the +15 VDC pulse will have a duration of 2.5 milliseconds and the -15 VDC will have a duration of 20 milliseconds.

Also, since the physical shape of the Chopper Disc dictates when the Sync Pulse occurs, when the infrared beam occurs and which chamber the infrared beam is directed through, the demand of signal time and relationship is shown below:

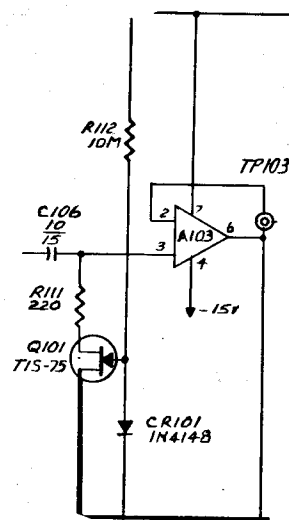
NOTE: The Reference Sync occurs during the time the infrared beam is directed through the Reference Chamber. The Signal Sync occurs during the time the infrared beam is directed through the Sample Chamber.



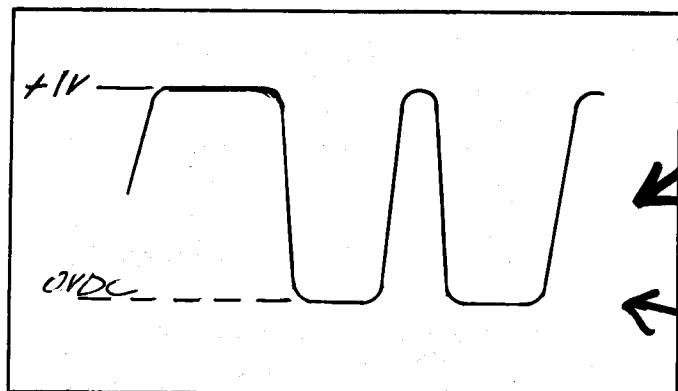
The input signal to the Reference Clamp Amplifier is capacitively coupled by C106 to the non-inverting pin (3) of the amplifier (A103).

During the time the infrared beam is directed through the Reference Chamber, the +15 VDC reference pulse is applied to the GATE of the FET (Q101). At this time, the FET is on and pin 3 of A103 is referenced to ground through R111.

The Reference Clamp Amplifier is connected as a voltage follower, therefore, the output signal at TP103 will be the same amplitude as the input (1 v/pp). However, the signal reference energy is now referenced to ground.



Since the input signal from the Detector is not ideally symmetrical, the sample energy level may be above ground reference or below ground reference. At this time (generally above ground reference). However, the reference energy level will be constantly referenced to ground.

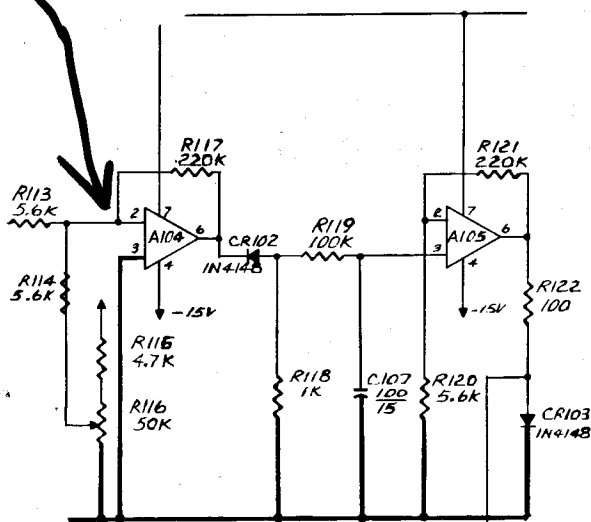


#4 CHECK  
TP 103 & 203

The signal measured or observed at TP103 will have a CONSTANT GAIN of 1 volt and a CONSTANT REFERENCE to ground at this time.

SCOPE IN DC MODE  
REF. AT GROUND (0 LINE)

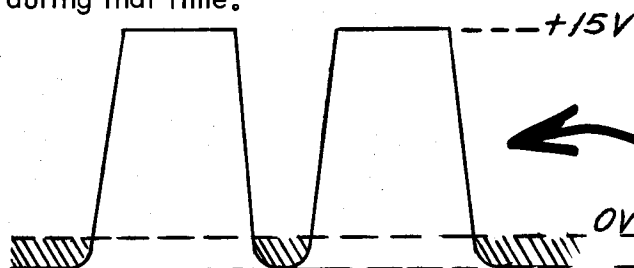
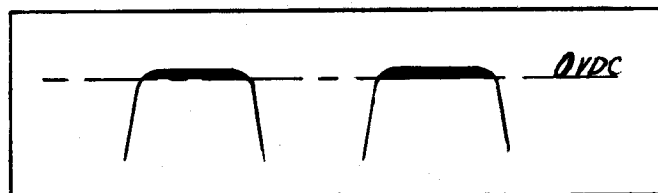




The input signal from TP103 is applied to the inverting pin (2) of the Demodulator (A104) through R113. The AGC level adjustment will change the input reference to some negative value (approximately -1 VDC) due to the resistive circuit consisting of R113, R114, R115, R116 and the -15 VDC Power Supply R116 sets the reference level of the input signal in such a way that the Preamplifier (A104) can monitor the amplitude between the light area and the dark area.

With the input signal to pin (2) of the Demodulator effectively referenced to approximately -1 VDC by R116, the amplifier can monitor any change in total amplitude and generate an AGC feedback voltage to suppress any amplitude changes. (Refer below.)

That portion of the signal below ground level will be amplified and inverted approximately 40X. Since the Power Supply limit is +15 VDC the output signal of A104 will be +15 VDC during that time.



That portion of the signal just slightly above ground will also be amplified and inverted approximately 40X resulting in a negative voltage level during that time.

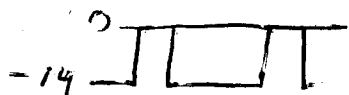
Since CR102 is reversed biased when the Amplifier output is +15 VDC, no charge or discharge takes place in the RC circuit consisting of R119 and C107. When the output condition of the amplifier is negative, CR102 becomes forward biased and C107, with charge to the peak value of the negative signal through R119 and the diode CR102, C107, will remain charged to that level providing no changes in input amplitude occurs. Therefore, a constant negative DC voltage level is felt at the non-inverting pin of A105. When changes in input signal amplitude occurs, the charge level of C107 will change accordingly, thereby, changing the -DC level present at pin 3 of A105.

The amplifier A105 will amplify its' input and provide a negative DC voltage level at its' output to be used as the AGC feedback voltage to U101, consequently, providing a CONSTANT gain output of A102.

The output signal as measured at TP103 has, therefore, a CONSTANT GAIN and a CONSTANT REFERENCE.

**#5 CHECK**  
PIN 6  
A104 +  
A204

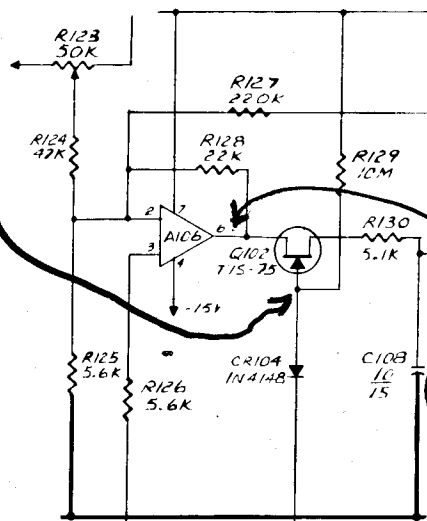
## #6 CHECK



GATE OF Q102 (Q202)  
SHOULD HAVE SIGNAL  
APPROX 1/2 OF SIGNAL  
AT TP 301  
(14 VOLTS)  
(14 VDC)

The input signal to the Demodulator Amplifier (A106) is provided by the Reference Clamp output (A103) TP103 through R126. This input signal is a CONSTANT GAIN (1 v/pp) and a CONSTANT REFERENCE (ground during the reference energy level).

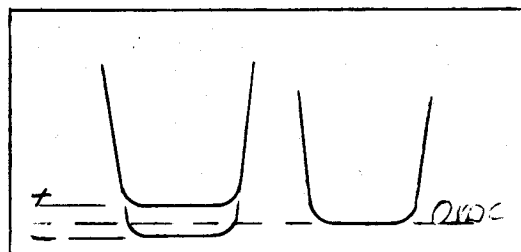
The circuit's objective is to amplify the difference in Sample Energy when no gases are contained in the Sample Chamber and when gases are contained in the Sample Chamber.



+5V SHOULD BE  
Pin 6 of A106  
should be  
+2 VOLTS same  
as 2410 pots set  
to ZERO

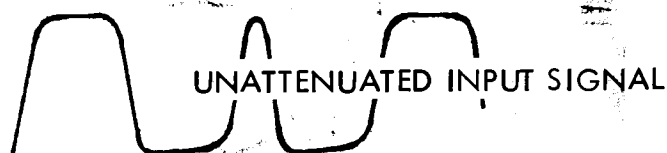
The Coarse Zero Control (R123) and the Front Panel Zero Control are tied across the -15 VDC and +15 VDC power sources, therefore, the "wiper arm" can be positioned at some positive or some negative voltage level. The output offset condition for the signal will then be some positive or negative voltage level depending on what is needed to effectively place the Sample Energy level at ground potential (see below).

NOTE: There will exist a Signal Symmetry disparity, therefore, in order to establish a zero offset condition for the Sample Energy, it is necessary to reference the output of A106 at some positive or some negative voltage level.

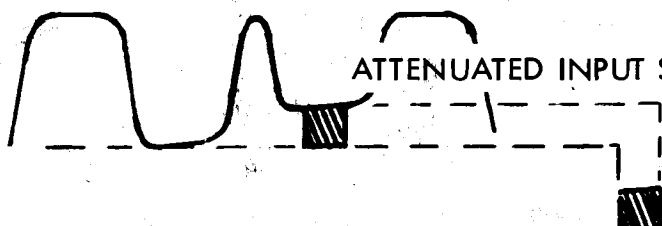


In this manner, when the signal sync pulse is positive at the GATE of the FET, the FET is on where the capacitor (C108) will charge to the voltage condition existing at the output of the operational amplifier (A106). If the output reference voltage places the Sample Energy effectively at zero volts, the charge of C108 will be nulled. The input, therefore, to the Final Amplifier (A107) will be zero volts.

When sample gases are in the Sample Chamber, the Sample Energy level is attenuated where the output condition at pin 6 of A106 will be decreased to some positive voltage level.



UNATTENUATED INPUT SIGNAL



ATTENUATED INPUT SIGNAL (SAMPLE GAS IN SAMPLE CHAMBER)

AREA OF OFFSET VOLTAGE INTERGRATION

The Charge level of C108 will be null with no gases contained in the Sample Chamber providing the Front Panel Zero Adjust has been positioned in such a manner that the output condition of A106 places the Sample Energy level at zero volts.

During the time the Sample Chamber contains gas, the amplitude of the Sample Energy level is offset in the positive direction, therefore, the charge level of C108 will be the peak value of the offset amplitude. This positive DC level is applied to the input pin of the Final Amplifier (A107) as a measure of unknown gas concentration.

PIN #3 OF A207 SHOULD HAVE ABOUT .4 OR .5 V POS DC FROM ZERO REF. (GRD) WHEN SPAN SW ON. (CO SECTION)

PIN #6 OF A207 SHOULD BE 1X TO 3X INPUT AT PIN #3.

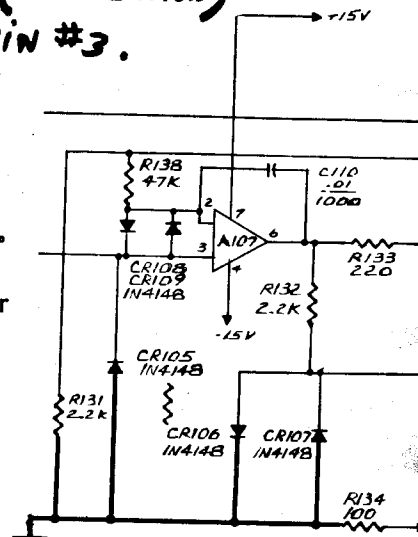
PIN #3 OF A107 SHOULD HAVE ABOUT +1.7VDC FROM ZERO

## Final Amplifier

REF. (GRD) WHEN SPAN SW. ON (HC SECTION)

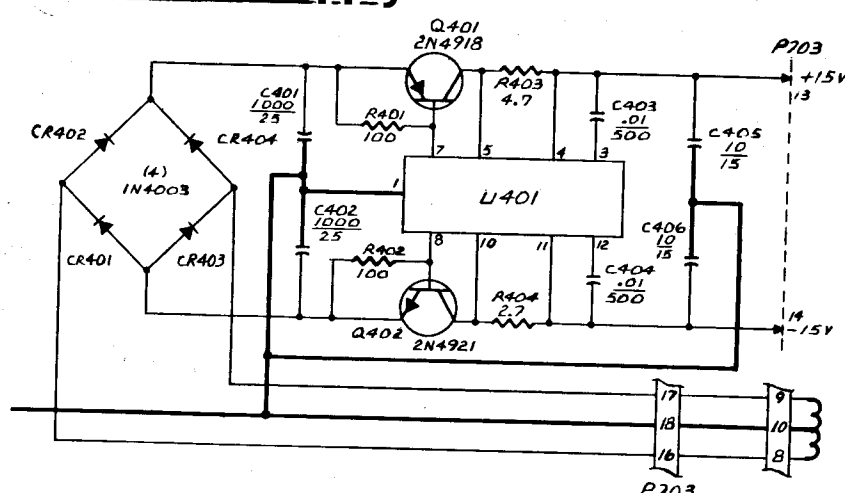
PIN #6 OF A107 SHOULD BE 1X TO 3X INPUT AT PIN #3

The positive DC voltage level at the input pin (3) of the Final Amplifier is a measure of the unknown gas concentration. The gain of the Final Amplifier (A107) is fixed by the Front Panel SPAN Control, thereby, always returning the gain factor of A107 to the same gain ratio as when set to KNOWN gas concentrations. (Providing the span control is returned to the correct altitude span setting.)



In this manner, the output gain is constant with a known gas concentration. Consequently, output meter circuit displays the exact amount of gas components contained in the Sample Chamber.

## Power Supply



The 110 VAC input voltage is applied to the full wave Bridge Rectifier consisting of CR401, CR402, CR403 and CR404. Pins 7 and 8 regulate the base voltage of Q401 and Q402 for output voltages of +15 VDC and -15 VDC respectively.

Positive and negative 15 VDC are the only voltage developed in the Power Supply Circuit.

## Summary

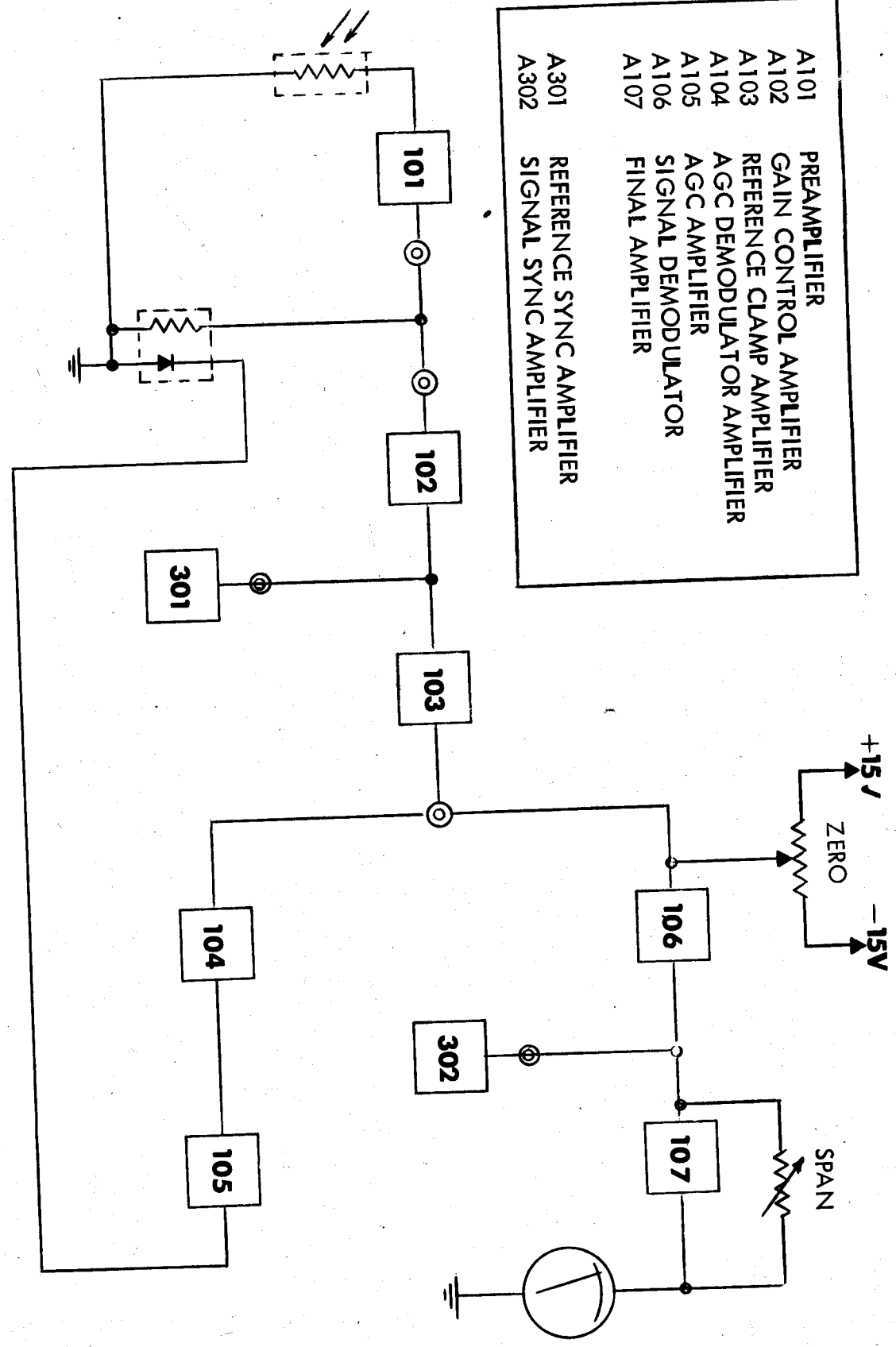
The input signal from the Detector Amplifier is received and applied to the low noise, high gain amplifier where the output is capacitively coupled to the Gain Control Amplifier (A102). At the output of the Gain Control Amplifier (A102), the signal has a CONSTANT GAIN of 1 v/pp, controlled by the AGC feedback voltage and the voltage divider consisting of R107 and U101. The input to the Reference Clamp Amplifier is REFERENCED to ground through R111 and Q101 during the time the Reference Sync Pulse is present at the GATE of Q101 (Reference Energy). The output signal is therefore a CONSTANT GAIN and CONSTANT REFERENCE signal of 1 v/pp. This signal is applied to the input of the Demodulator Amplifier where the Sample Energy is referenced to zero volts by the Front Panel Zero Control to obtain a zero meter reading. During the time the Signal Sync Pulse is present at the GATE of Q102, capacitor C108 will charge to the voltage difference of the Sample Energy and ground. The DC voltage is applied to the input of the Final Amplifier (A107) where the gain of the final amp is set by the Front Panel Span Control. The output of the Final Amplifier is used to drive the meter as a measure of unknown gas concentration.

HECK

R129  
10M  
R130  
5.1K  
C108  
1K  
15  
-15V D  
positive  
some p  
ple Ener

ET is on  
the op  
vely at  
ifier (A  
ted wh  
be nu  
ole Ch  
, Adj  
ner the  
es the  
E CHA  
E INTER  
nergy  
eak v  
Ampli

- A101 PREAMPLIFIER
- A102 GAIN CONTROL AMPLIFIER
- A103 REFERENCE CLAMP AMPLIFIER
- A104 AGC DEMODULATOR AMPLIFIER
- A105 AGC AMPLIFIER
- A106 SIGNAL DEMODULATOR
- A107 FINAL AMPLIFIER
- A301 REFERENCE SYNC AMPLIFIER
- A302 SIGNAL SYNC AMPLIFIER



ZERO  
R501  
SPAN  
R503

SPAN  
R503

M501+

M501-

ie  
ber.

iced  
rence  
(107)

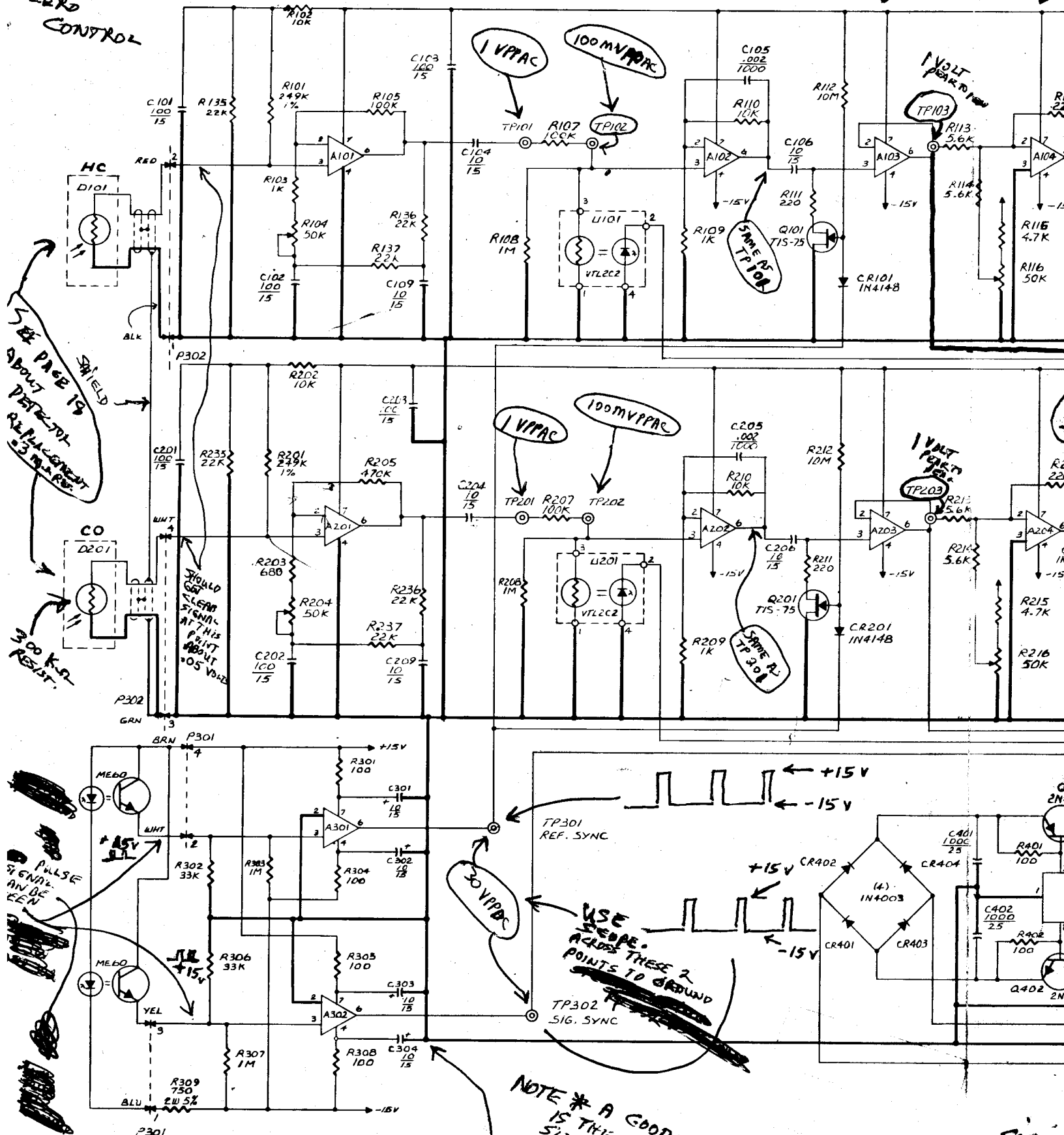
NOTE \*  
CR 105 &  
CR 205 IF  
SHORTED  
CAUSES NO  
ZERO  
CONTROL

PIN 3  
NON-INVERTING  
↓

NON-INVERTING  
PIN 3  
↓

PIN 3  
CATHODE-FOLLOWER  
NON-INVERTING  
↓

DE  
IN  
PIN  
↓



P 26 P 1

Similar  
ATLA

DEMOMULATOR  
INERTING  
PIN 2

CW UPSHALE

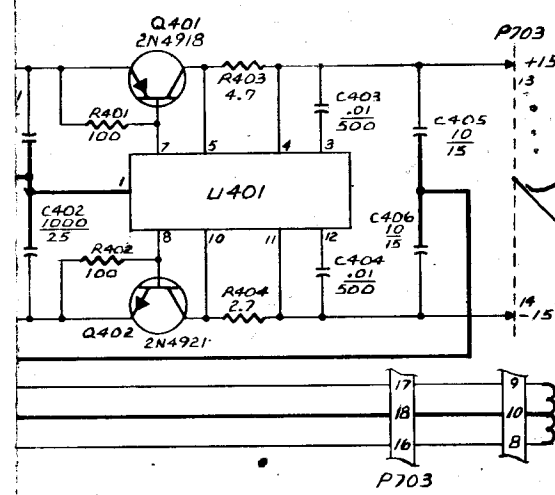
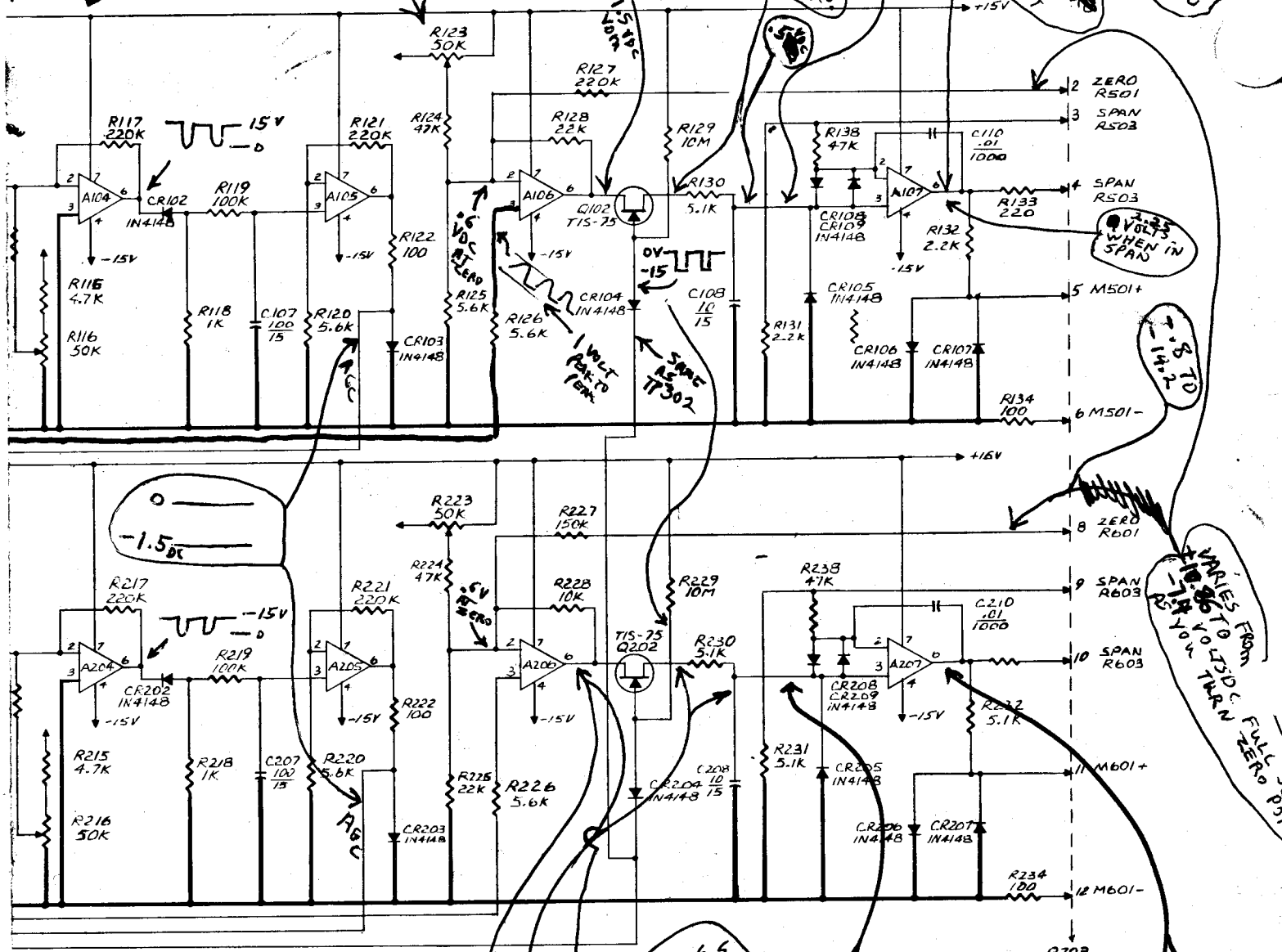
0V - 3V  
NORM POS.

SPAN AT 600 FEET  
ELEVATION

6 VDC. NORM POS.  
WITH ZERO POT  
FULL SCALE

5 VDC. NORM POS.  
SPAN WITH ZERO  
POT BACK ON ZERO

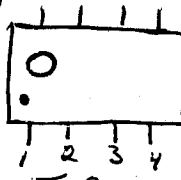
WITH ZERO POT SPAN  
SET TO 600 FEET  
SWITCH ON



26

SIMILAR TO  
ATLAS AEM 330

P. 26 P2.



I.C.

WHEN IN NORM. DC  
VOLTAGE WILL VARY  
FROM 0 TO APPROX. +6  
AS YOU TURN ZERO POT

6 VDC. NORM POS.  
WITH ZERO POT ADJ.  
FULL SCALE

.4 OR .5 VDC  
WHEN IN SPAN  
WITH ZERO POT  
BACK ON ZERO

WHEN IN NORM.  
VOLTAGE WILL VARY  
FROM 0 TO APPROX. +1.2 VDC  
AS YOU TURN  
ZERO POT

GAIN SHOULD  
BE 1X TO 3X  
IN PNT AT PIN 3



# Calibration Procedure

In order to thoroughly calibrate the Exhaust Analyzer, it is necessary that both an Electrical Alignment and Gas Span procedure is performed.

*SIGNAL SHOULD  
BE AT BOTH - IF  
NOT, IC IS BAD*

## Electronic Alignment

Check TP301 and TP302 for 30 v/pp DC sync pulses. ~~TP301 and TP302~~

\*Connect the Test Probe to TP101 and adjust R104 for a 1 v/pp signal  $\pm 250$  millivolts. \* **.4 VOLT**

\*Connect the Test Probe to TP201 and adjust R204 for a 1 v/pp signal  $\pm 250$  millivolts. \* **.4 VOLT**

Check TP102/TP202 for a .1 v/pp signal.

\*Connect a Test Probe to TP103 and adjust R116 for a 1 v/pp signal  $\pm 100$  millivolts. \* **.5 VOLT**

\*Connect a Test Probe to TP203 and adjust R216 for a 1 v/pp signal  $\pm 100$  millivolts. \* **.5 VOLT**

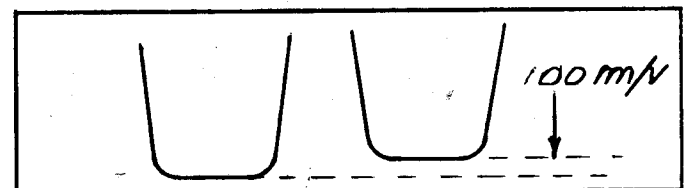
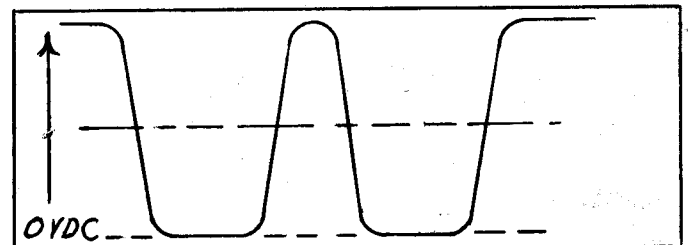
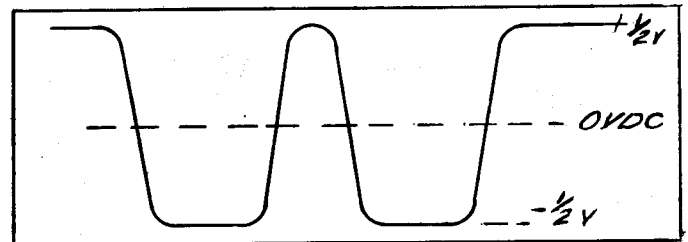
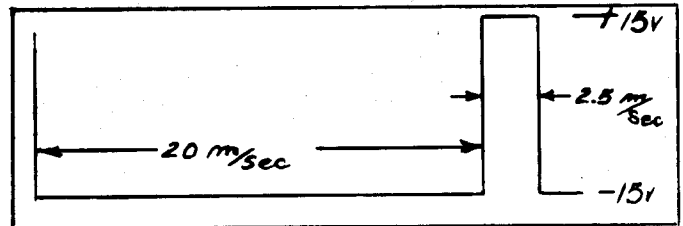
**\* SET TO THESE FIGURES IF IN  
FIELD AND YOU HAVE NO SCOPE**  
**Verify the Signal Symmetry**

Using TP103 and TP203, verify the Signal Symmetry of the Reference and Sample Energy levels. The Signal Symmetry should be within 100 millivolts.

If the Signal Symmetry is greater than 100 millivolts, loosen the Detector Assembly filters (allen screw) and reposition them (slide back and forth) until the amplitude symmetry is within tolerance.

NOTE: When tightening the detector filters, be sure the Signal Symmetry is maintained.

The Signal Symmetry adjustment should be made with the pump motor running and no gases applied to the unit.

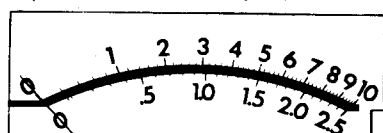


## Zero Centering

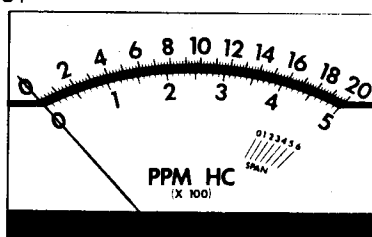
Rotate the CO and HC Zero Controls on the front panel to their full clockwise position. (Return each Zero Control  $2\frac{1}{2}$  turns to midpoint.)

NOTE: The Zero Controls are 5 turn multislip-clutch design. Rotate clockwise until the clutch action is felt.

With the pump motor running and the selector switch in the NORM position.



adjust R223 for an CO Zero Meter Reading



adjust R123 for and HC Zero Meter Reading

## Span Gas Adjustment

Purge the system (with no gases applied to the unit, allow the pump motor to operate in the NORM position).

Select HI Scale operation with the switch on the front panel. Zero both CO and HC Meters with the front panel Zero Control.

Select the CAL position with the selector switch on the front panel and turn the pump switch off.

Insert the Calibration Gas Hose into the Cal inlet port and adjust the rate of flow to 4 CFH.

With the front panel SPAN adjustment screws, set the CO and HC Meters to read the certified gas concentration as indicated on the gas bottle.

NOTE: Multiplication factor on back panel, this factor is to be used as a multiplier times the propane gas concentration.

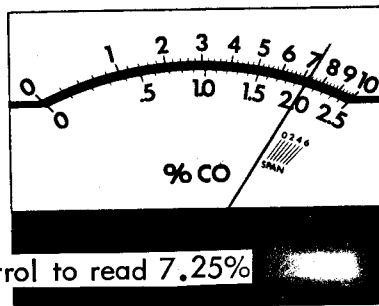


Calculate the HC values as follows:

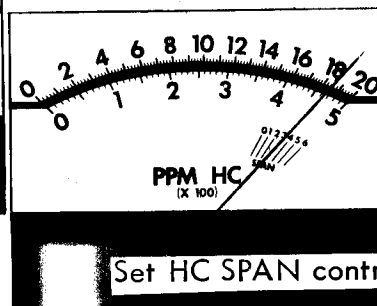
EXAMPLE

Propane on tank	=	3570
HC calibration factor	=	.52
(on back panel of unit		
Meter should read		1856





Set CO SPAN control to read 7.25%



Set HC SPAN control to read 1856 ppm

Return the selector switch to the NORM position and turn the pump switch on. Allow the meters to return to zero and stabilize.

NOTE: If either meter is more than  $\frac{1}{2}$  division off zero, reset zero and repeat span gas calibration.

DO NOT MOVE SPAN CONTROL UNTIL THE CALIBRATION IS COMPLETE.

## HI-LO Scale Adjustment

With the selector switch in the NORM position (HI-LO switch in the HI position) and the pump motor operating, set the CO Meter for a reading of 2% with the front panel Zero Control.

Set the HC Meter for a reading of 500 ppm with the front panel Zero Control.

Select the LO position with the HI-LO Switch and adjust LO-CO for a reading of 2% on the Low Scale. Adjust LO-HC for a reading of 500 ppm (full scale) on the Low Scale.

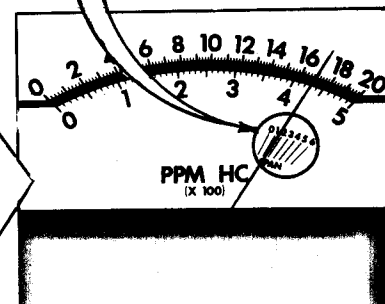
Return the HI-LO Switch to HI Scale operation with the front panel Zero Control and set each meter at zero.

Select the SPAN position with the selector switch and adjust:

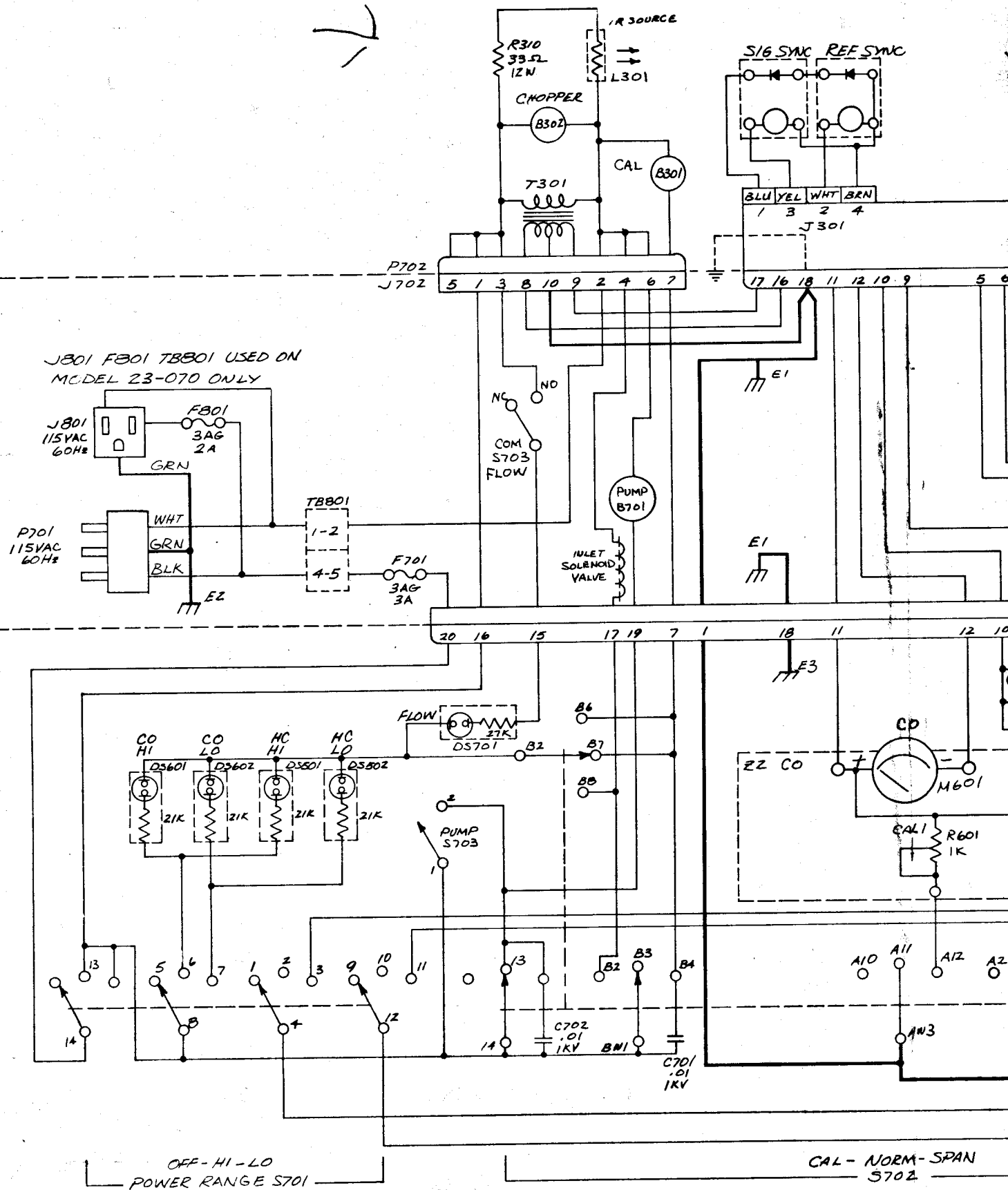
CAL 1 (CO) for the proper altitude reading in your area.  
CAL 1 (HC) for the proper altitude reading in your area.

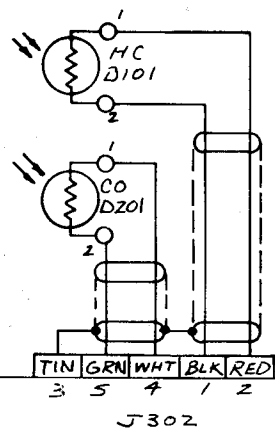
### ALTITUDE SETTING

- 0 - 1000 Feet = 0-1 setting
- 1000 - 2000 Feet = 1-2 setting
- 2000 - 3000 Feet = 2-3 setting
- 3000 - 4000 Feet = 3-4 setting
- 4000 - 5000 Feet = 4-5 setting
- 5000 - 6000 Feet = 5-6 setting

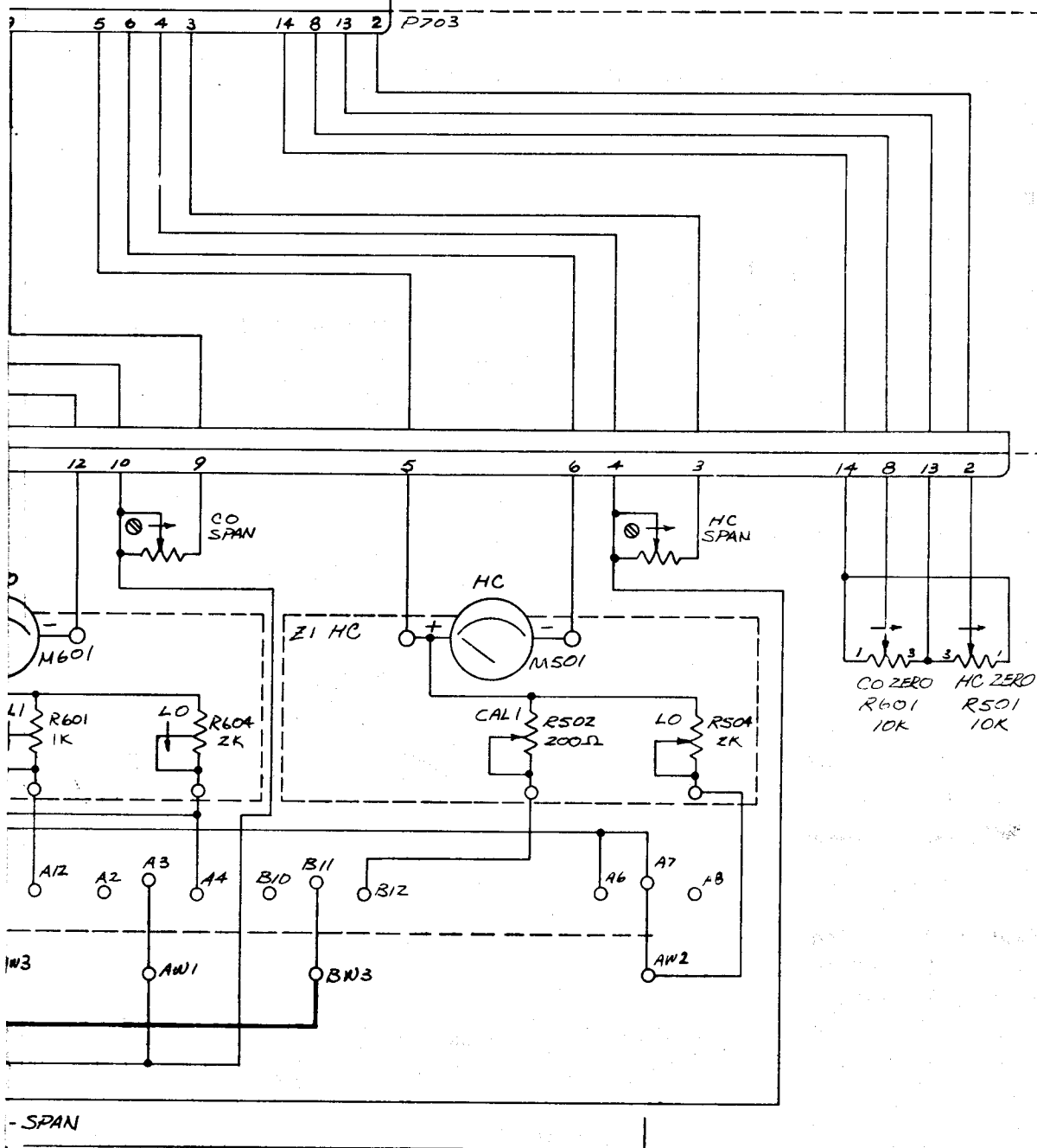


Return selector switch for NORM. CALIBRATION IS COMPLETED.





← P. 2. →



# TROUBLE SHOOTING

## BY SYMPTOMS


### Unit Check-out

✓	Check for leaks or cracks in Filter Bowl Assembly.
✓	Check for plugging of Filter Element.
✓	Check for input vacuum efficiency. (should be 17" or greater fully restricted.)
✓	Check flow light adjustment (3" vacuum drop).
✓	Check for clogging of drain outlet.
✓	Check for contamination of Sample Chamber "window".
✓	Check for zeroing of both Meters.
✓	Check for span of both Meters.
✓	Check calibration of unit.

### Trouble Shooting Chart

SYMPTOM	CORRECTIVE ACTION
Vacuum OK. No exhaust at exit port.	Check plumbing Check filter bowl.
Vacuum slowly creeping up pump laboring.	(a) Restricted plumbing. (b) Check filter.
Severe oscillations on the vacuum gauge and low reading.	Clean pump
Flow light going off when sample probe is connected.	(a) Restricted probe. (b) Improper filter used.

SYMPTOM	CORRECTIVE ACTION
A. Power does not turn ON when actuating power switch.	<p>(a) Check for blown fuse. Replace with exact duplicate, 3 ampere, 3AG.</p> <p>(b) Check AC voltage at outlet for correct voltage. Reset breaker or switch to supply power to receptacle.</p> <p>(c) Check power to terminal board (TB70) located inside cabinet. CAUTION: terminal board contains 115 volt line voltage which can be hazardous. Check for loose terminal to one of the terminal board lugs, replace as required.</p> <p>(d) Check that chopper motor is energized. If energized, check wiring to pilot light located on control panel.</p>
B. Meter Pointer at Zero, No Zero Control	<p>(a) Check that Power is ON and chopper motor energized.</p> <p>(b) Check that sync assembly connector (P301) is properly and securely mated. Reconnect. (P.C.B.A.)</p> <p>(c) Where only one meter does not move check for broken lead to meter. Correct wiring as required.</p> <p>(d) Check output of preamplifier (TP101/TP201). Peak to Peak voltage should be 1 volt. Adjust gain of preamp (R104 and R204) for one volt output.</p> <p>(e) Check input to preamp with high impedance oscilloscope. Voltage swing should be about 100 millivolts for HC and 10 millivolts for CO channel. Replace detector assembly where either signal is absent.</p> <p>(f) Check for open diode CR104 (CR204). Replace if open.</p>
C. Meter Pointer Below Zero.	<p>(a) Adjust Zero panel control.</p> <p>(b) With Zero panel control centered adjust coarse zero (R123 HC and R223 CO).</p>

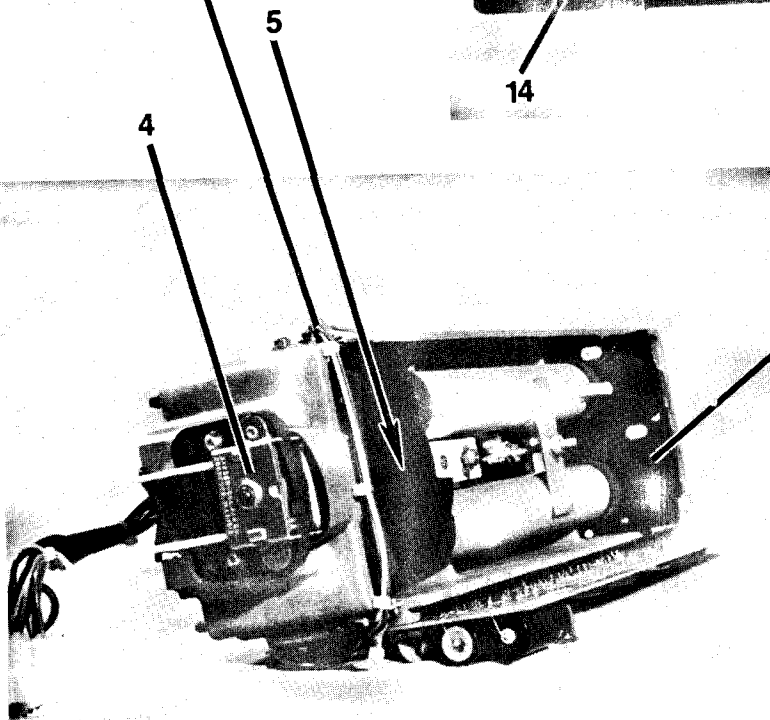
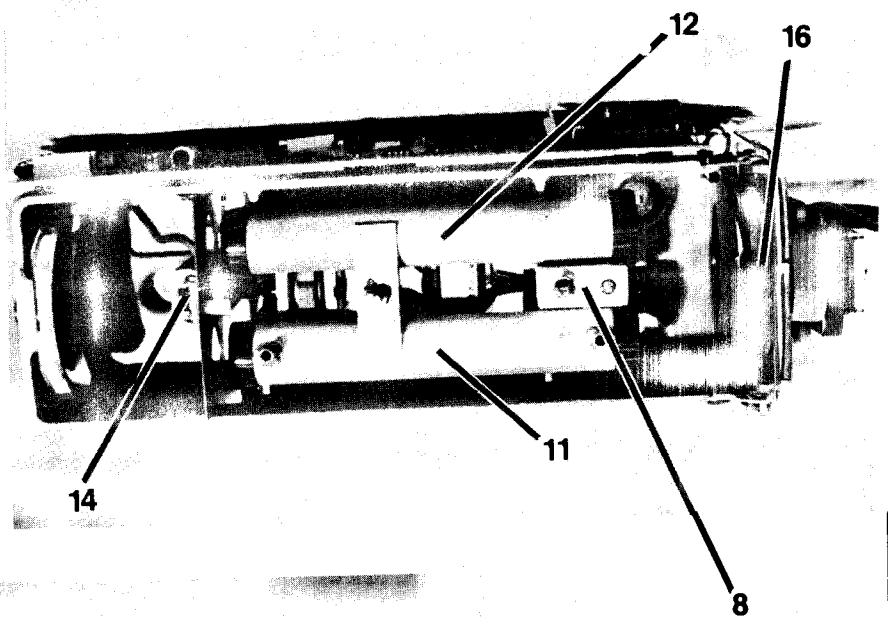
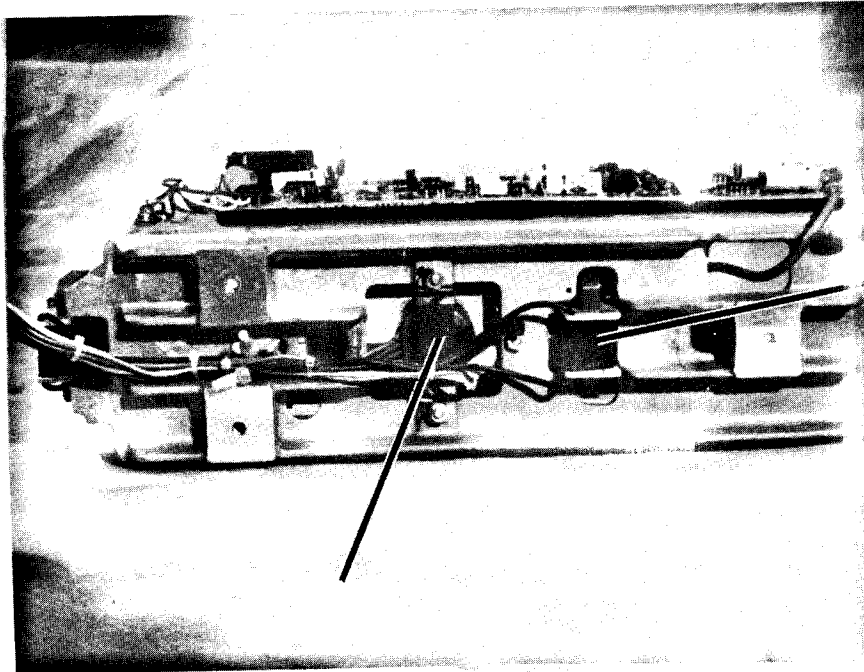
SYMPTOM	CORRECTIVE ACTION
	<p>(c) Check that infrared radiant source (L301) is glowing a dull orange color. Replace if burned out.</p>
D. Meter Pointer Up Scale	<p>(a) Check zero controls. Adjust to bring pointer to zero.</p> <p>(b) Check for obstruction in sample beam path. Check that CAL FLAG does not obscure path. Remove foreign object.</p> <p>(c) Check for excessive moisture in plumbing and sample tube. Clean and/or replace sample tube. Check plugged filter/watertap.</p>
E. Insufficient Span Control.	<p>(a) Check that CAL Flag is operated and nested against rubber stopper. Check electrical circuit and power to CAL FLAG motor. Repair as required.</p> <p>Check for shorted clipping diode CR 105 (CR205). Replace if shorted.</p> <p> Check gain of last amplifier stage (A107, A207). Gain variation should be from 1x to 3x. Check for shorted Span potentiometer. Replace operational amplifier (A107, A207) if defective.</p> <p><i>ONE SIDE OF SYNC &amp; REF. ASSY BURNED OUT.</i></p>
F. Noisy or Erratic Operation	<p>(a) Reduced output of infrared source.</p> <p>(b) Noisy motor.</p> <p>(c) Noisy detector.</p> <p>(d) Correct grounding of printed circuit board.</p> <p>(e) Optical bench not grounded to cabinet.</p> <p>(f) Detector cable not secured to cable clamp at plug.</p> <p>(g) Faulty preamplifier.</p> <p>(h) Connector to control panel not properly mated.</p>

SYMPTOM	CORRECTIVE ACTION
G. Flow Light Erractic or Off.	(a) Check vacuum at inlet. (b) If vacuum is over 15", check flowlight adjustment. (c) If vacuum is under 15", check motor operation and/or clean pump. (d) Check nylon tubing and plumbing for loose connections. (e) Check proper seating of filter bowl, missing gasket, etc.
H. Erratic Needle Movement on one Scale Only.	(a) Check connector for open or pushed out pins. (b) Check Signal Reference at TP103/203 for Zero Volt Reference.
J. <del>Meters</del> <sup>METERS</sup> drifting at or near zero while sampling no exhaust.	(a) Check AGC level. If too high and cannot be corrected, replace P.C.B.A. and recalibrate.
K. Meters not responding at all.	(a) Absence of flow. Check vacuum. Check exhaust port for flow. If no exhaust, check for open plumbing.

Troubleshooting by symptoms depends entirely upon a thorough understanding of the system and its theory of operation.

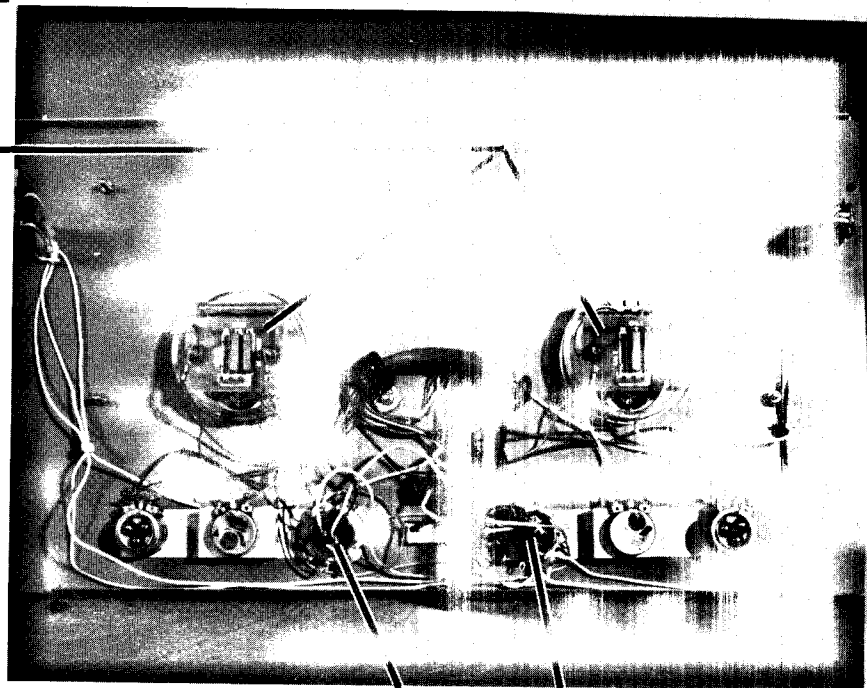
The relationship between the meter indications and signals at TP's 101, 102, 103 (TP's 201, 202, 203) TP301 and TP302 are the determining factors in quick and efficient troubleshooting.

TP101/201	One volt peak to peak energy signal. (checks the detector and preamplifier)
TP102/202	Approximately .1 volt peak to peak. (checks the AGC circuit, provides CONSTANT GAIN)
TP103/203	One volt positive peak to peak. (checks the Reference Clamp Circuit)
TP301	30 volt peak to peak pulse. (occurs during the Reference Energy Signal time and provides the unit with a CONSTANT REFERENCE)
TP302	30 volt peak to peak pulse. (occurs during the Sample Energy Signal time and provides signal to final stage amplifier for meter indications)



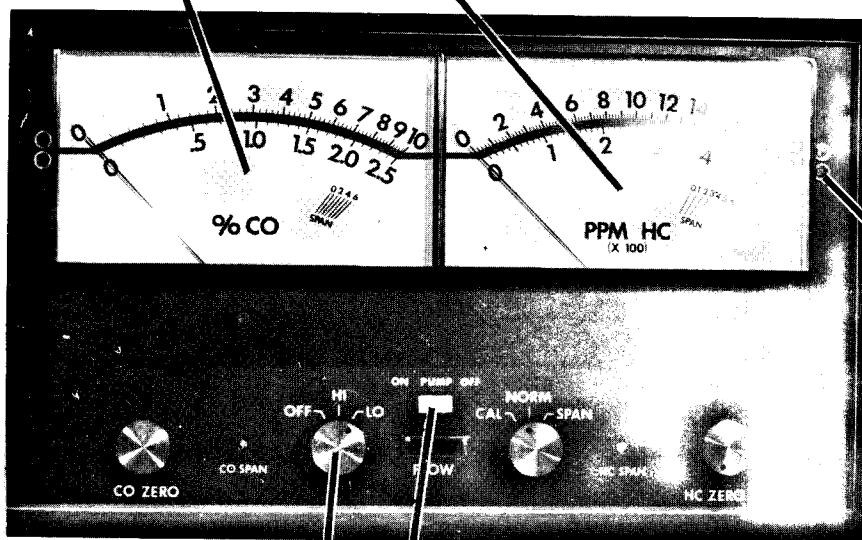


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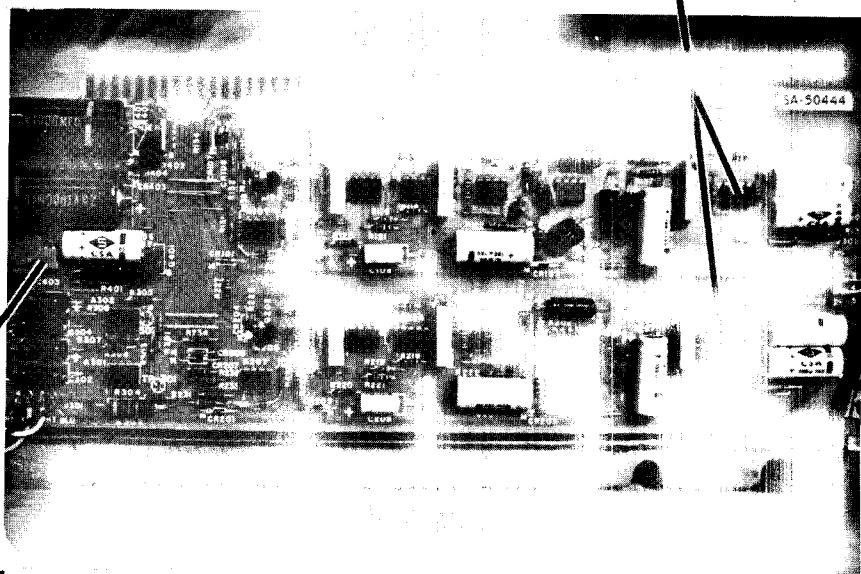
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## EMISSION ANALYZER

MODEL 23-060 "CA"

KEY	DESCRIPTION	PART NO.				
1	CO/HC Module Assy (Complete)	BA27944				
2	Optical Bench Assy (Complete)	CA27938				
3	Optical Bench	30137				
4	Motor, AC Chopper	30075				
5	Chopper Disc	30076				
6	Motor, AC Cal	30075				
7	Cal Flag Assy	30077				
8	Source, Infrared	30051	54.50			
9	Mount, Source	30092				
10	Transformer, Input	30045				
11	Sample Tube Assy	30096	112.50			
12	Reference Tube Assy	30097	104.50			
13	End Cap	30078				
14	Detector Assy	30079				
15	Sync & Reference Wiring Assy	30094				
16	Mirror (2)	30084				
17	Mirror Hub (2)	30085				
18	Ring, Mirror Retaining	30090				
19	PCBA	30154				
20	Amplifier, Operational (2)	30000				
21	Amplifier, Operational (14)	30001				
22	Regulator, Dual Voltage	30043				
23	Transistor, Photo (2)	30042				
24	Transistor, Field Effect (4)	30011				
25	Transistor, 2N4918	30012				
26	Transistor, 2N4921	30013				
27	Isolator, Photo VTL2C2 (2)	30044				
28	Potentiometer Trimits 10K (4)	30041				
29	Potentiometer 50K (4)	30017				
30	Resistor, 499K 1% (2)	30014				
31	Resistor, 10K 5% (10)	30015				
32	Resistor, 1K 5% (7)	30016				
33	Resistor, 100K 5% (5)	30018				
34	Resistor, 220 ohm 5% (4)	30019				
35	Resistor, 1 Meg 5% (4)	30020				
36	Resistor, 10 Meg 5% (4)	30021				
37	Resistor, 5.6K 5% (8)	30022				
38	Resistor, 4.7K 5% (3)	30023				
39	Resistor, 220K 5% (3)	30024				
40	Resistor, 100 ohm 5% (10)	30025				
41	Resistor, 47K 5% (2)	30026				
42	Resistor, 150K 5% (2)	30027				
43	Resistor, 5.1K 5% (2)	30028				

EMISSION ANALYZER						
MODEL 23-060 "CA"						
KEY	DESCRIPTION	PART NO.				
44	Resistor, 560 ohm 5% (2)	30029				
45	Resistor, 22K 5% (6)	30030				
46	Resistor, 680 ohm 5%	30031				
47	Resistor, 33K 5%	30032				
48	Resistor, 1K 2W 5%	30034				
49	Resistor, 33 ohm 12W	30035				
50	Diode, Infrared Emitter (2)	30009				
51	Diode, 1N4148 (14)	30007	← ALS 238.53			
52	Diode, 1N4003 (4)	30010				
53	Capacitor, 100 mfd, 15V (8)	30002				
54	Capacitor, 10 mfd, 15V (13)	30003				
55	Capacitor, .002 mfd, 1000V (2)	30004				
56	Capacitor, 1000 mfd, 25V (2)	30005				
57	Capacitor, .01mfd 500V (2)	30006				
58	Fuse, 3 amp	30053				
59	Fuse, 2 amp	15880-7				
60	Holder, Fuse (2)	26388				
61	Cord, AC Power	A27937				
62	Accessory Harness Assy	A27097				
63	PCBA Conn. Harness Assy (18 pin)	DA27911				
64	Strain Relief	8892-3				
65	Spacer, Mtg (3)	27908				
66	Grommet .75 I.D. (3)	27897				
67	Grommet (3)	6723				
68	Terminal Blk	24234				
69	Module Assy (Exhaust, Complete)	CA27943				
70	Module, Welded	CA27623				
71	Panel, Right Rear	BA27971				
72	Panel, Left Rear	B27928				
73	Condenser Assy	BA27948				
74	Solenoid Assy	27932				
75	Flow Switch	30073				
76	Pump Assy	30074				
77	Diaphragm	30087				
78	Head	30124				
79	Gasket	30123				
80	Valve Plate	30122				
81	Valve Keeper (2)	30121				
82	Valve (2)	30120				
83	Screw, Valve					
84	Screw Keeper					
85	Screw, Head					
86	Filter Bowl Assy	30150				
87	Bowl, Transparent	30082				

## EMISSION ANALYZER

MODEL 23-060 "CA"

KEY	DESCRIPTION	PART NO.				
88	Gasket	30134				
89	Center Post	30131				
90	Filter	27326				
91	Elbow 3/8 ID x 3/8 ID (Hose to Hose) (8)	27769				
92	Elbow 1/8 Male x 3/8 ID Hose (3)	27770				
93	Elbow 1/8 Male x 3/16 ID Hose	27952				
94	Elbow 1/4 Male x 3/8 ID Hose	27771				
95	Tee 3/8 ID x 3/8 ID	27772				
96	Filter, Bulkhead	30099				
97	Adapter, Male 3/8 Hose x 1/4 NPT (4)	30102				
98	Adapter, Male 3/8 Hose x 9/16-18 thread	30103				
99	Clamp, Hose (4)	27774				
100	Spacer, Mtg. (3)	27908				
101	Grommet (3)	6723				
102	Nut, Jam	87930				
103	Tubing 1 1/2" lg. (5)	27773-1				
104	Tubing 3" lg. (2)	27773-2				
105	Tubing 9" lg. (2)	27773-5				
106	Tubing 10" lg.	27773-7				
107	Tubing 2" lg.	27773-10				
108	Tubing 12" lg.	27773-11				
109	Tubing 13" lg.	27773-12				
110	Tubing 6" lg.	27947-1				
111	Tubing 11" lg.	27947-4				
112	Cabinet Screened	A28036				
113	Panel, Back, Screened	A28035				
114	Wheel (2)	13761-1				
115	Hub (2)	17461				
116	Axle	B26370				
117	Bracket, Cord	B26369				
118	Bracket, Meter	B26373				
119	Handle	C26378				
120	H.C. Cal Factor Tag	27958				
121	Meter Housing Assy	BA28034				
122	Meter Housing, Welded	BA27702				
123	Meter Panel Assy	CA28033				
124	Meter Panel Screened	A27720				
125	Meter, HC	C20707				
126	Meter, CO	C20708				
127	Cover, Meter (2)	20481				
128	HC PCB Assy	5000527				
129	CO PCB Assy	5000528				
130	Knob (4)	23936				

# EMISSION ANALYZER

MODEL 23-060 "CA"

KEY

DESCRIPTION

PART NO.

131	Lamp, HI-LO (4)	27279
132	Bracket, Pot Mtg. (2)	27711
133	Lamp, Flow Indicator	27960
134	Switch, Pump ON/OFF	27933
135	Mtr Panel Harness Assy	DA27959
136	Switch, OFF HI-LO	27278
137	Switch, CAL-NORM-SPAN	B27689
138	Potentiometer, 10K (4)	27982
139	Conn. 20 pin	30065
140	Conn. 3 pin (2)	24207
141	Conn. 1 pin (4)	24206
142	Capacitor, .01 mf (2)	24151
143	Cable, Extender	CA28230
144	Grommet	23775-1
145	Pin, Connector Male	27909
146	Filter Kit Assy	A28225
147	Elbow, Street	28254
148	Nipple, 2"	28255
149	Plug, Hex Head	28285
150	Bracket, Clamp	BA28277
151	Sample Probe	CA27914
152	Sample Hose	A27920

CABINET PARTS are replaced by the 23-160 parts, therefore the Exhaust Module Housing must be used in order to mount the Exhaust components.

23-070 EMISSION ANALYZER

153	Exhaust Module, Welded	CA28353
154	Cabinet	DA28399
155	Handle	B26850
156	Spacer	23441-1
157	Cap	23440
158	Caster W/lock	23646
159	Caster	23647

$$\begin{array}{r}
 3020 \\
 12080 \\
 15100 \\
 163080
 \end{array}$$

$$\begin{array}{r}
 3530 \\
 3530 \\
 14120 \\
 144730
 \end{array}$$


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**ALLEN  
GROUP**

TESTPRODUCTS DIVISION