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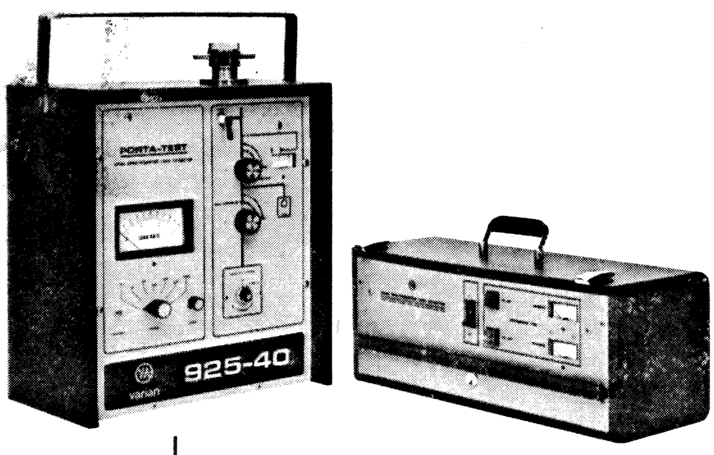
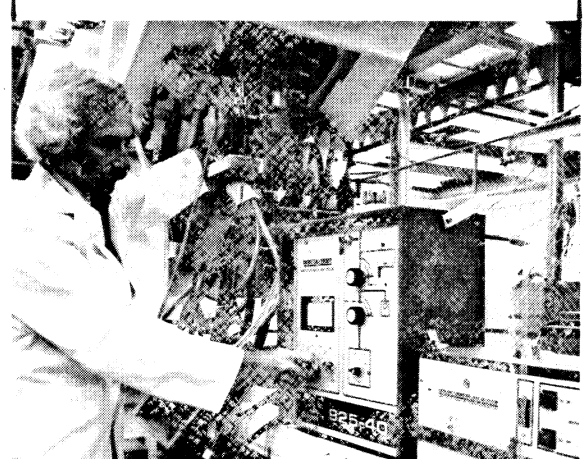



# instruction manual 925-40

# porta-test™ leak detector



# INSTRUCTION MANUAL

## PORTA-TEST

## 925-40

## MASS SPECTROMETER LEAK DETECTOR

varian / lexington vacuum division
121 hartwell avenue / lexington / massachusetts 02173

Part Number
0981-6999-09-400

## NOTE

This manual should be read in its entirety before operation of the 925-40 is attempted.

This manual contains an electrical schematic of the Porta-Test on a fold-out sheet, Figure 20, at the back of the book. An exploded view of the Detector module is also a fold-out sheet, Figure 11.

This manual is designed to fit inside the front cover of the Main Electronic chassis to assure its availability with the unit.

## CUSTOMER DATA SHEET

**Serial Number**

Main Electronics ______________________ Date ______________________

Detector Module ______________________ Initials ______________________

The data recorded in the first column below are readings taken before this unit left the factory. The remaining columns are furnished for the operators' convenience in recording new values, as when the ion source is changed.

| Date | Factory | | | | |
|---|---|---|---|---|---|
| Filament Number | 1 | | | | |
| Ion Dial Setting | | | | | |
| Ion Voltage (TP2)$_{VDC}$ | | | | | |
| Repeller Voltage (TP1)$_{VDC}$ | | | | | |
| Focus Voltage (TP3)$_{VDC}$ | | | | | |
| Emission Switch | High | | | | |
| Emission Reading | | | | | |
| 90 Volt Adjust (TP4)$_{VDC}$ | | | | | |

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# I. INTRODUCTION TO LEAK TESTING

**Leak Testing — Why Is It Needed?**

Even with today's complex technology it is, for all practical purposes, impossible to manufacture a sealed enclosure or system which can be guaranteed leak proof without first being tested. Through the use of modern leak testing techniques, as implemented by the VARIAN NRC 925 — 40 Mass Spectrometer Leak Detector (MSLD), leak rates as small as $10^{-10}$ std. cc/sec. can be reliably detected. The discussion that follows provides a brief summary of specific information pertinent to the overall subject of Leak Detection.

## 1-1 TERMINOLOGY

The following terminology has application throughout this manual:

### 1-1.1 Flow

a) std cc/sec — one cubic centimeter/second of gas at a pressure of one standard atmosphere (760 torr at 0°C).

b) atm cc/sec — one cubic centimeter/second of gas at ambient atmospheric pressure and temperature (used interchangeably with "std cc/scc" because the difference is insignificant for leak testing purposes).

### 1-1.2 Conversions

| | | |
|---|---|---|
| 1 std cc/sec | — | 0.76 torr-liter/sec |
| 1 torr-liter sec | — | 1.3 std cc/sec |
| 1 std cc/sec | — | 9.7 x $10^4$ micron cubic feet per hour<br>practically $10^5\mu$ CFH |
| $1\mu$ CFH | — | practically $10^{-5}$ std cc/sec |

### 1-1.3 Numerical Notation-Exponential System

Most leak rates of commercial significance are very small fractions of a std cc/sec. Therefore minus powers of ten are used as a convenient system of numerical shorthand.

Table 1-1 below shows the relationship of exponents and multipliers (to the base 10) to the arithmetic form, and the equivalent result.

**TABLE 1-1**
**DECIMAL NOTATION**

| Multiplier x $10^N$ | | Arithmetic Form | | Result |
|---|---|---|---|---|
| 1 x $10^2$ | = | 1 x 10 x 10 | = | 100 |
| 1 x $10^1$ | = | 1 x 10 | = | 10 |
| 1 x $10^0$ | = | 1 | = | 1 |
| 1 x $10^{-1}$ | = | 1 x 1/10 | = | .1 |
| 1 x $10^{-2}$ | = | 1 x 1/10 x 1/10 | = | .01 |
| 5 x $10^{-3}$ | = | 5 x 1/10 x 1/10 x 1/10 | = | .005 |
| 1 x $10^{-3}$ | = | 1 x 1/10 x 1/10 x 1/10 | = | .001 |

## 1-2 VARIOUS METHODS OF TESTING FOR LEAKS

There are many methods of testing for leaks in containers. The more commonly used methods along with the range of accuracy provided are listed below:

### 1-2.1 Water Immersion — (Air Bubble Observation)

This method is good to approximately $10^{-3}$ std cc/sec, and sometimes less if internal pressure is increased or vacuum is created above water pressure. This method is limited because of difficulty in differentiating between leakage bubbles and surface desorption bubbles. It is used to test valves, hydraulic components, castings, automotive and air conditioning components.

### 1-2.2 Dye Penetrant

A special dye, applied to one side, works through the leak and appears on the other side. This test method takes about an hour for a $10^{-4}$ std cc/sec leak to show up. This test is expensive and destructive in some applications, and slow.

### 1-2.3 Ultrasonic

This method is good to approximately $10^{-2}$ std cc/sec. This method tests for ultrasonic sounds coming from a gas leak and is used for testing of high pressure lines.

### 1-2.4 Halogen (sensitive to halogen elements or compounds, especially refrigerant gases)

This method is good to approximately $10^{-5}$ std cc/sec in most current applications, but is extendable to $10^{-9}$ std cc/sec under some limited situations. It is critically dependent on operator judgment if leaks are below $10^{-5}$ std cc/sec and requires constant flow of fresh air in test area because of tendency of trace gas to "hang" in an area. This method is sensitive to cigarette smoke and gases from other external sources.

### 1-2.5 Radioisotope

This method is useful for testing hermetically sealed cavities and has approximately same range as the helium method and under some circumstances has the capability of testing to $10^{-11}$ std cc/sec. This method involves an expensive installation (from four to ten times the cost of a helium installation depending on degree of isolation of radiation required.) It also requires a radiation safety officer.

### 1-2.6 Helium Method

This method is good to $10^{-11}$ std cc/sec. and is capable of finding large leaks as well. This method is useful for testing hermetic seals, vacuum enclosures, and vacuum systems, and is the most versatile of industrial and laboratory leak detection testing methods.

## 1-3 HELIUM MASS SPECTROMETER LEAK DETECTION

Helium is an excellent trace gas because it is the lightest of the inert gases and as a consequence readily penetrates small leaks. In addition, its presence in the atmosphere is minute (5 PPM or about 4 microns absolute). Helium is easily detected by a simple mass spectrometer (helium has a mass of 4 so that adjacent "peaks" of 3 and 6 are easily separated by this technique). Also, helium is readily available at reasonable cost ($15 to $20 for a 200 cu. ft. bottle), and is completely non-toxic. The basic principles of the helium MSLD technique are discussed below.

Principles of Mass Spectrometry

The function of a mass spectrometer leak detector is to detect and indicate the rate at which helium passes through a leak in an object under test. Such a leak detector consists basically of an analytical sensing tube (spectrometer tube), electronic circuitry to operate the tube, and a vacuum pumping system to maintain an operating pressure of less than 0.2 micron (millitorr) within the tube.

The spectrometer tube utilizes bombardment by electrons from a hot filament to ionize the gas molecules present, including any helium from a leak. The ions thus formed are accelerated into a magnetic field at a speed which causes the mass 4 (helium) ions to be deflected $90^{\circ}$, while other gas ions are deflected more or less than $90^{\circ}$, depending on their mass. (See Figure 1.) Suitable electrostatic "lenses" are placed along the ion path to maximize the number of helium ions reaching the collector plate.

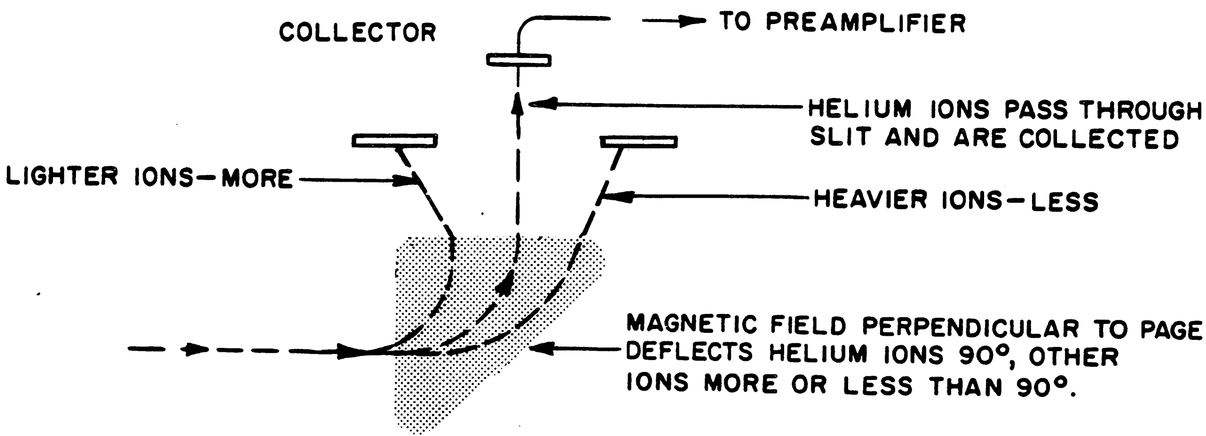



*Figure 1. Helium Ion Separation by Magnetic Field*

Helium ions cause a voltage proportional to the helium leakage rate to build up on the grid of an electrometer tube. An extremely stable DC amplifier feeds back a voltage to the grid resistor which exactly balances the voltage built up by the collection of helium ions. The "feedback" voltage is presented on a panel meter. Since this voltage is directly proportional to the number of helium ions striking the collector per unit time, the panel meter can read directly the concentration of helium in the vacuum system at any time. Since the helium concentration is proportional to the size of the leak, the meter reading is an indication of leak size.

The nature of "Flow" in a Vacuum

It should be noted that the purpose of the vacuum system is to support operation of the detecting spectrometer tube. Helium atoms entering through a leak individually reach the spectrometer tube in a few milliseconds. Helium atoms as well as atoms of other gases are continuously removed by the vacuum system diffusion pump. If helium is continuously applied to a leak, the concentration in the spectrometer tube will rise sharply at first, then it will reach equilibrium since it is being pumped out at the same rate as it is entering. When helium is completely removed from the leak, the input will drop to zero and the residual helium is quickly removed. Thus, a leak is indicated by a rise and fall in output signal of the spectrometer tube.

## 1-4 FACTS ABOUT LEAK RATES

### 1-4.1 Visualizing Leaks in Everyday Terms

| | |
|---|---|
| $10^{-5}$ std cc/sec: | approximately 1 cc/day |
| $10^{-7}$ std cc/sec: | approximately 3 cc/year |

### 1-4.2 Audible or Visual Detection by Observer

a) Bubbles rising in water: $10^{-3}$ std cc/sec. or larger.
b) Audible leaks $10^{-1}$ std cc/sec. or larger.

### 1-4.3 Size of Leaks in Man-Made Joints

Studies indicate that almost all leaks at joints are about $5 \times 10^{-7}$ std cc/sec. (about 1 cc/month) or larger. This is true of ceramic-to-metal, glass to metal, plastic-to-metal seals, welded, soldered and brazed joints. Some long-path leaks may be slightly smaller. Porosity (of glass for helium, steel for hydrogen, for example) is in the $10^{-13}$ std cc/sec range.

### 1-4.4 Variation in Leak Sizes

Leaks unintentionally "built-in" during manufacture will vary from hour to hour and day to day. Breathing on a $10^{-6}$ std cc/sec leak provides enough moisture to close it temporarily; perhaps for several days. Atmospheric particles can close a leak of this size. Never depend on an "accidentally made" leak to remain constant.

# II. DESCRIPTION

## 2-1 GENERAL DESCRIPTION AND APPLICATIONS

The 925-40 consists of a Detector module (including the spectrometer tube, diffusion pump, valves and leak indicator) and a Main Electronics chassis, as well as interconnecting cables.

Figure 2 is a schematic diagram of the Porta-Test showing the relationship of the major components as viewed from the front of the unit. A major innovation with the 925-40 is the interposition of the diffusion pump between the spectrometer tube and the test piece. The spectrometer tube is placed at the inlet (low-pressure) port of the pump, while the unit to be tested is connected to the fore-vacuum (higher pressure) port of the diffusion pump, as is the mechanical vacuum pump. This arrangement assures continuous pumping of the spectrometer tube, while preventing gas and condensible vapors originating at the test piece from reaching the tube. The effectiveness of this arrangement relies on the characteristics of the oil diffusion pump in pumping high molecular weight gases more effectively than those with lower molecular weight. Helium, introduced through a leak in a test piece can diffuse fairly readily through the diffusion pump and reach the spectrometer tube, where it is detected.

Figure 3 illustrates the application of the Porta-Test to testing a typical vacuum system for leaks. The generalized system to be tested includes a vacuum chamber, mechanical and diffusion pumps, valves and a baffle. The mechanical pump of the test system is used to back the diffusion pump of the 925-40, as shown.

Instructions for setting up and operating such an arrangement are given in Section 4-5 of this manual.

Figure 4 shows three approaches to leak-testing enclosures which are not vacuum systems. In each case a suitable auxiliary mechanical vacuum pump must be supplied to back the diffusion pump in the 925-40 and (in some cases) evacuate the test piece. Sketch (a) shows the testing of a piece which can be evacuated. A helium jet is directed at suspected leak sites, or the unit is enclosed with, for example, a plastic bag which is then filled with helium. This will expose all leak sites to helium and an indication of the total leak will be gained.

Sketch (b) shows the testing of a unit which cannot be evacuated. The test piece is filled with a helium-air mixture and sealed. A Super-Probe, connected to the 925-40, is brought close to each suspected leak site, and any helium present will be inducted to the leak detector. The sensitivity of this method is much lower than that of the other approaches shown, but it can be increased by

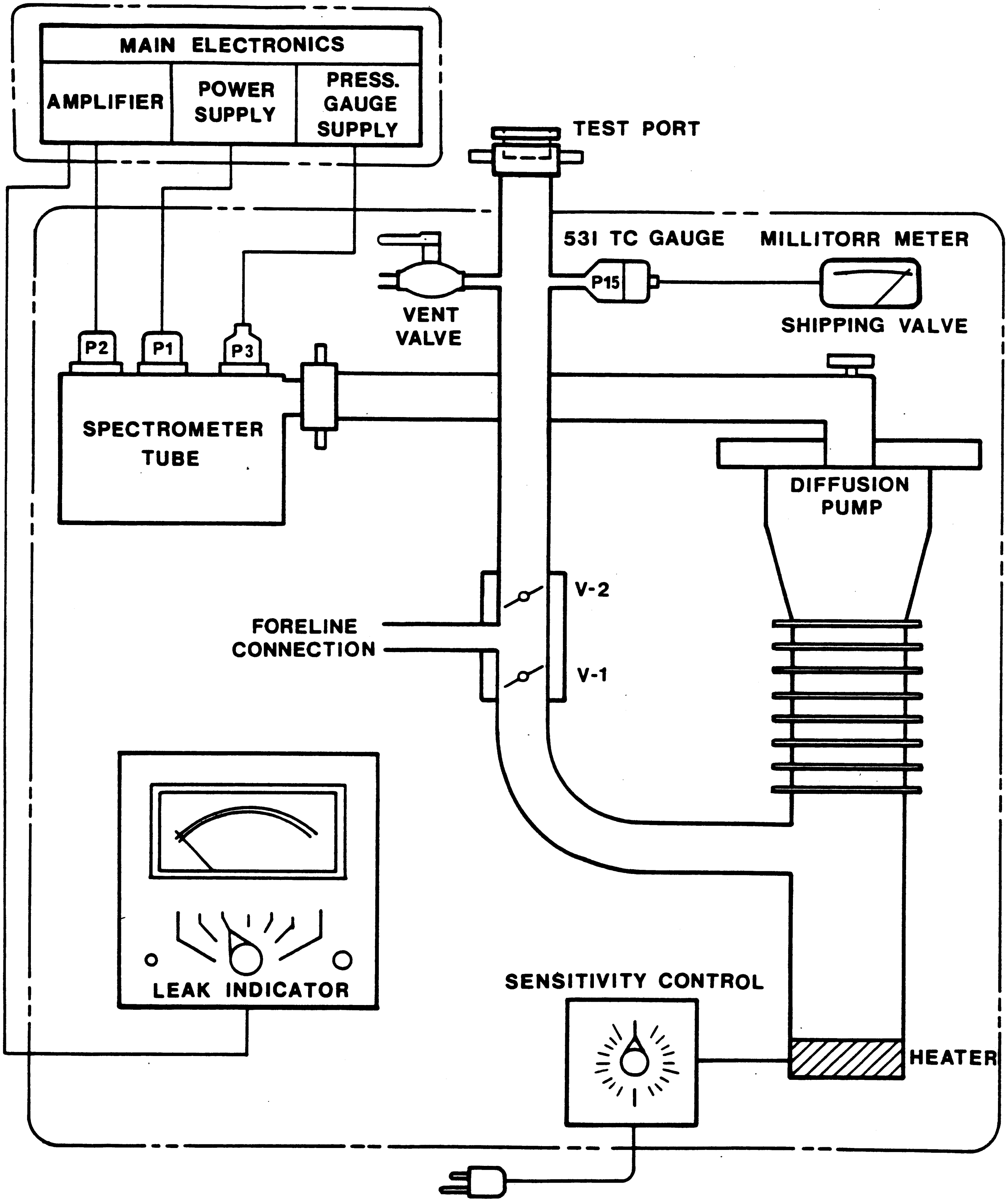



*Figure 2. Schematic Representation of the 925-40 Porta-Test*

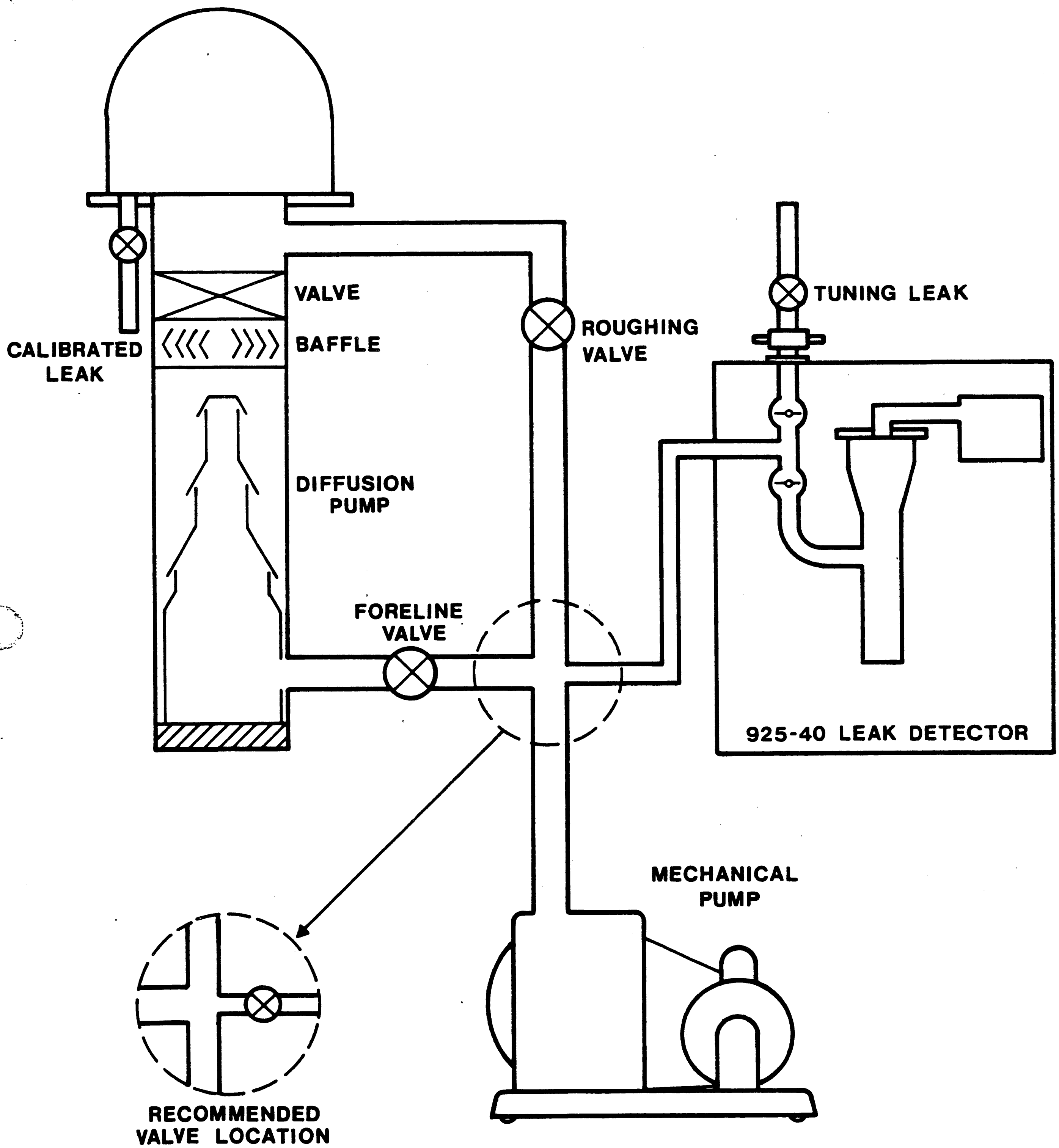
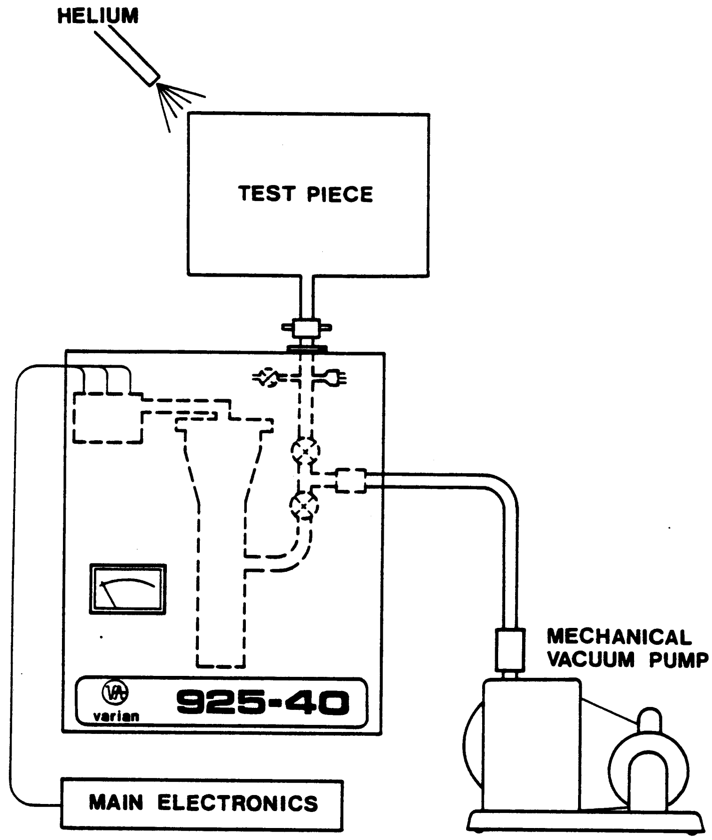
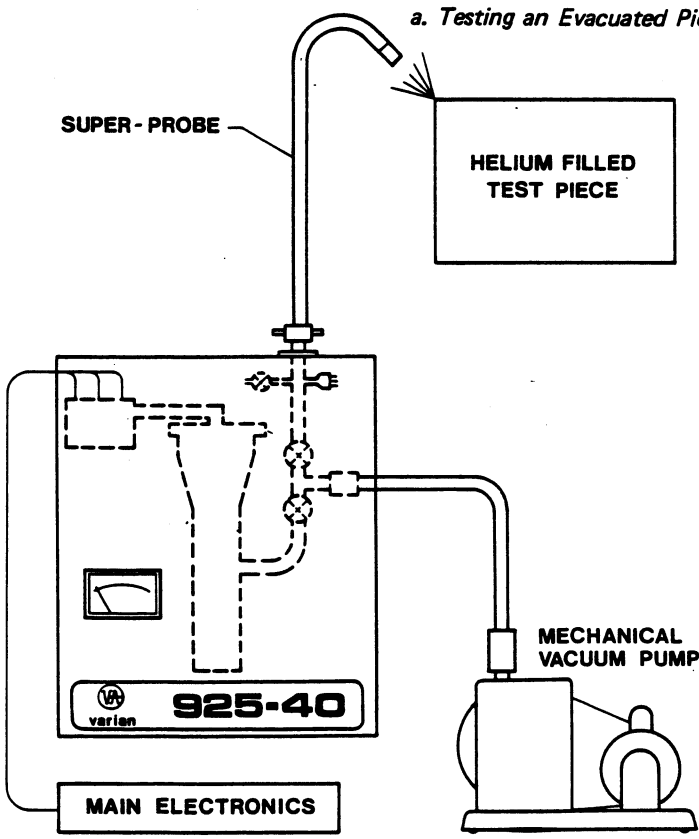


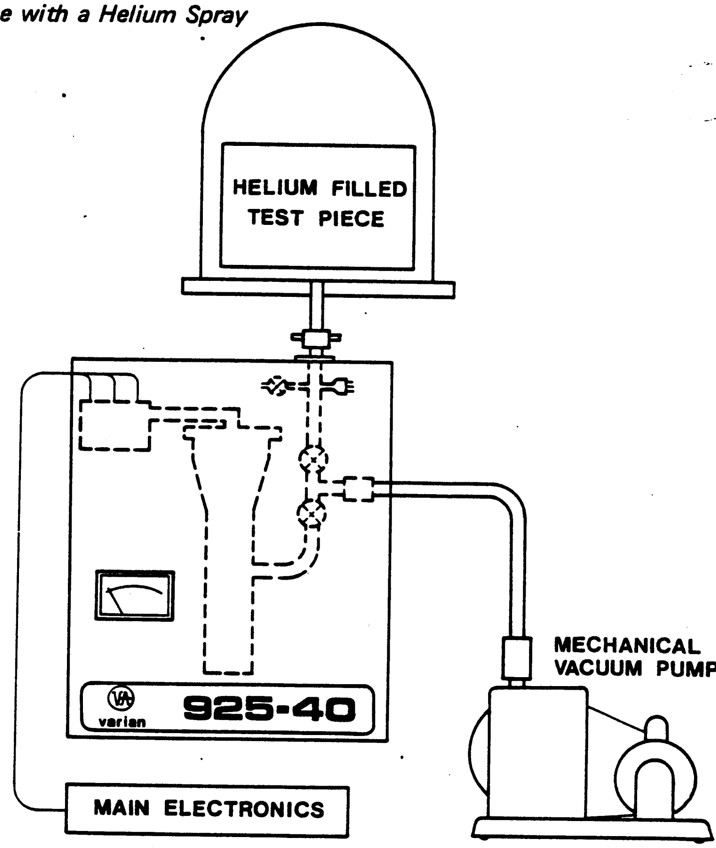

*Figure 3. Testing a Typical Vacuum System*




*a. Testing an Evacuated Piece with a Helium Spray*




*b. Testing a Helium-Filled Piece with a Super-Probe*




*c. Testing a Helium-Filled Piece in a Bell-Jar*

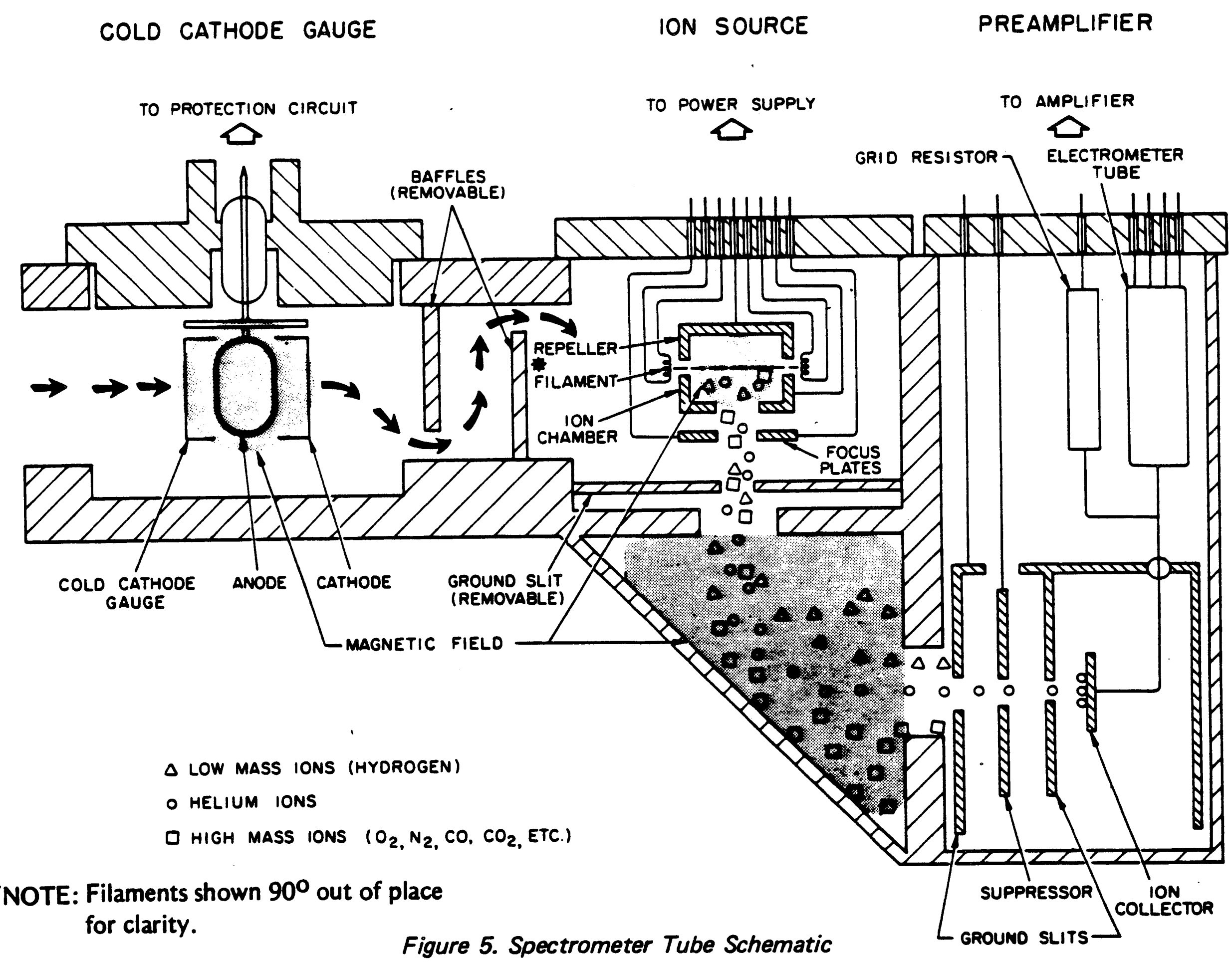
*Figure 4. Three Arrangements for Leak-Testing Pieces*

using a higher concentration of helium in the test piece; by raising the pressure in the test piece; or by collecting any helium evolving from the test piece in a container (e.g., a plastic bag) to integrate the leakage over a time interval.

If a unit which cannot be evacuated is small enough, after it has been filled with helium and sealed it can be placed in an evacuable chamber (as in sketch c). Any helium leaking from the test unit will be able to diffuse to the spectrometer tube.

## 2-2 SPECTROMETER TUBE (Figures 5 and 6)

This is the heart of the leak detector. The main electronics operates the spectrometer tube; the leak indicator provides visual interpretation of the spectrometer tube signal; and the vacuum system provides the low pressure necessary for the spectrometer tube to operate.




*NOTE: Filaments shown 90° out of place for clarity.

*Figure 5. Spectrometer Tube Schematic*

The spectrometer tube is attached by means of an integral O-ring coupling at the inlet of the diffusion pump. It contains an electron source, an ion gun, an ion collector, a pre-amplifier, and a cold cathode vacuum gauge. It is surrounded by a magnetic field provided by two large pole pieces which are fastened to a block of Alnico V.

2-2.1 The ion source is a one-piece expendable unit, consisting of the following parts:

a) Two permanently aligned tungsten filaments which can be used alternately and which provide a source of electrons.
b) An ionization chamber into which electrons are beamed and in which gas molecules are struck by electrons and become positive ions.
c) A repeller electrode which repels the positive ions out through a slit in the ion chamber.
d) Two focus plates which direct the ion beam toward the exit slit, which is at ground potential.

These parts are welded to eight rods which extend through individual glass seals in a round flange to form the male portion of a standard octal connector. A clamp and O-ring are used to seal the assembly into the spectrometer tube. This construction permits easy servicing of the spectrometer tube. The spare filament allows testing to continue after one filament burns out. In addition, no cleaning or disassembly of the source is necessary. It is inexpensively and easily replaced as a unit. All parts of the unit are prealigned, and the unit itself is keyed to the spectrometer tube so that no special skill is required to replace it.

Rotatable external eccentric magnetic pole pieces on each side of the ion source enclosure allow adjustment of the electron beam direction for optimum ionization and sensitivity.

2-2.2 The magnetic field is provided by a block of Alnico V which is mounted permanently between two large rectangular, soft iron pole pieces. Flux-directing inserts conduct the field into two rigidly welded pole pieces which form an integral part of the spectrometer tube housing. The ion beam passes from the ground-potential slit and between the pole pieces. When properly tuned, mass 4 (helium) ion are deflected $90^{\circ}$ through a slit in a baffle plate. Heavier ions are deflected less than $90^{\circ}$, hence separation of helium ions is accomplished.

2-2.3 The preamplifier, consisting of the ion collector, electrometer tube and grid resistor, together with two ground slits and a suppressor slit, is mounted as a unit on eight rods which extend through individual glass seals in a round flange to form the male portion of the preamplifier section connector. This unit is factory prealigned and is of all-welded construction. It is sealed in place with a clamp and O-ring. Removal and replacement, when necessary, is quick and easy.

2-2.4 The cold cathode ionization gauge consists of two pole pieces, a liner which forms the cathode, and a nichrome loop which forms the anode mounted on a single ceramic insulator. A ceramic disc shield prevents sputtered conductive deposits from causing leakage paths across the anode lead-thru insulator. The assembly seals in place with an O-ring. The magnetic field is provided by the common Alnico V magnet.

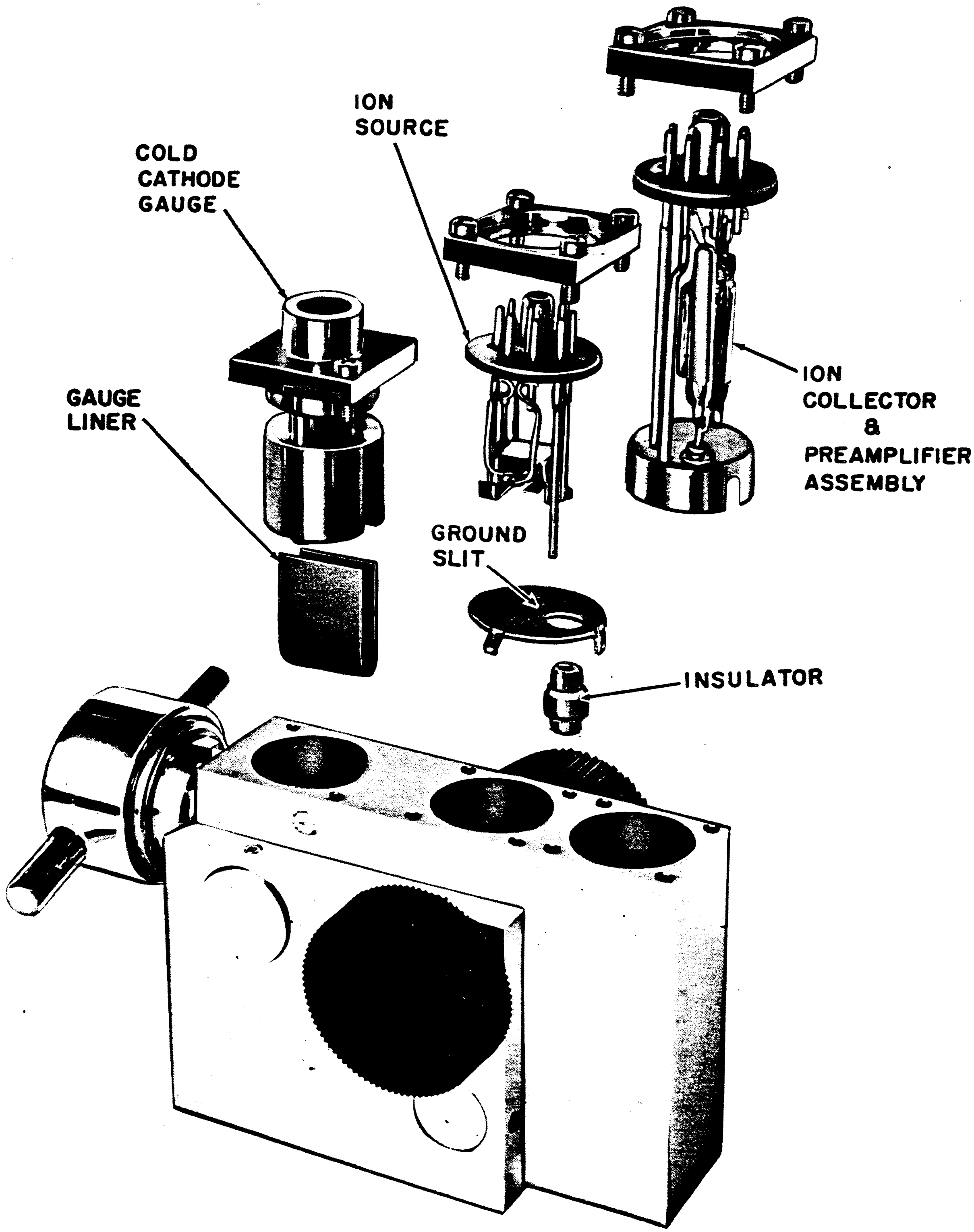



*Figure 6. Spectrometer Tube Exploded View*

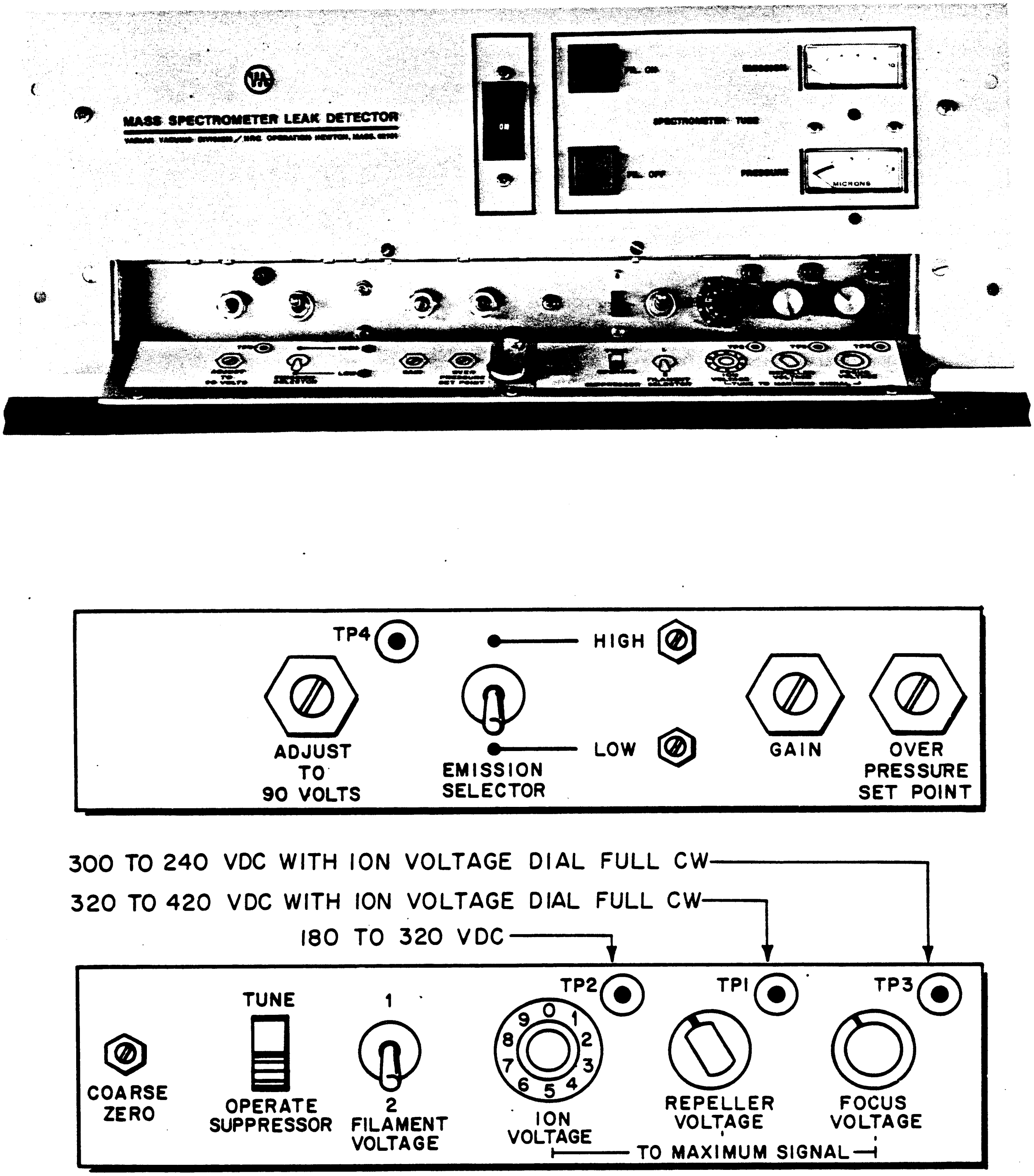



*Figure 7. Tuning Adjustments, Main Electronics*

## 2-3 MAIN ELECTRONICS

The general function of this equipment is to supply the proper operating voltages to the spectrometer tube and to provide electrical signals, denoting quantitatively the presence of helium in the spectrometer tube.

2-3.1 **Power Supplies** – provide regulated voltages to the filament, accelerating and focus plates, ion repeller and amplifier.

2-3.2 **Pressure Gauge Control** – provides the voltage to the cold cathode gauge and indicates its output (spectrometer tube PRESSURE). It also activates a relay which shuts off the filament when the pressure is too high.

2-3.3 **DC Amplifier** – balances the voltages built up across the grid resistor by the collection of helium ions and, therefore, puts out a signal proportional to the concentration of helium in the spectrometer tube.

Behind a door on the front of the electronics unit are controls with which the performance of the spectrometer tube and leak indicator may be optimized. The names of these controls appear in **bold type** where they appear in the operating instructions.

## 2-4 LEAK INDICATOR

The leak indicator utilizes the output signal from the DC amplifier to actuate a LEAK RATE meter. The leak indicator is located on the detector panel.

The LEAK RATE meter is provided with a range selector switch which introduces shunts into the meter circuit. This makes possible the measurement of output currents many times larger than the full scale capacity of the unshunted meter. The meter has two printed scales, marked 0 to 10; and 0 to 3. The position of the range switch determines which scale to read; i.e., if the range switch knob points at any figure starting with 10, read the 0 to 10 scale on the meter; if it points at a figure starting with a 3, read the 0 to 3 scale on the meter.

The sensitivity scale is an arbitrary scale, and the range selector switch permits readings of 10, 30, 100, 300, 3000 and 10,000 major divisions full scale. The amplifier saturates at about 6000 major divisions and no deflection larger than this will occur, regardless of the size of leak.

Since the scale is in arbitrary units, calculations using comparison with a leak of known value will be necessary if the size of a leak must be known. (See Section 4-3.)

# III. RECEIVING AND INSTALLATION

## 3-1 INSPECTION

The model 925-40 Leak Detector has been carefully packed for its protection during shipment. Inspect the contents as soon as possible and report any damage to the carrier without delay. Serial numbers of each unit are on labels at the back of the unit. For convenience, the serial number of the main electronics unit is also engraved on the left-hand side of the chassis, behind the lockable front-panel door. The following items are present:

Detector unit, with spectrometer tube and cable assembly
Main electronics unit

Spare items are located within the Detector module as follows:

a) double filament ion source assembly
b) cold cathode gauge liner and ceramic shield
c) #327 lamps (for FIL-ON, FIL-OFF switch)
d) a tuning screwdriver

Any of the following optional accessories may also be purchased:

Helium Spray Probe Kit
Super-Probe
Calibrated leak
Tuning leak
Audible alarm
Baseplate for inlet port
Bell jar, 12-inch diameter
Isolation valve for inlet port
Inlet adaptor kit (for 12 tubing sizes)
Automatic Zero
Cart, for mounting 925-40 and mechanical pump
Foreline tubing kit.

## 3-2 STORAGE OF LEAK DETECTOR

If the leak detector will not be used immediately, it can be stored after inspection without special precautions. A dry relatively dust-free area is preferable.

## 3-3 UTILITIES

Prior to installation of your 925-40 leak detector, the following should be available at the installation site:

### 3-3.1 Electrical

The 925-40 uses 400 watts of power at the voltage and frequency ordered (normally 115 volts 60 hertz). It must be connected to a grounded receptacle for best operation and safety. An 8-foot cord is provided.

### 3-3.2 Vacuum

Any mechanical vacuum pump capable of achieving a pressure of 50 millitorr or less. (Note: some mechanical pumps exhibit helium sorption characteristics which cause high background and should be avoided. See Varian representative for recommendations.)

### 3-3.3 Tubing

Vacuum hose and metal tubing for connecting pump to leak detector.

### 3-3.4 Helium

A helium supply with pressure regulator and spray jet.

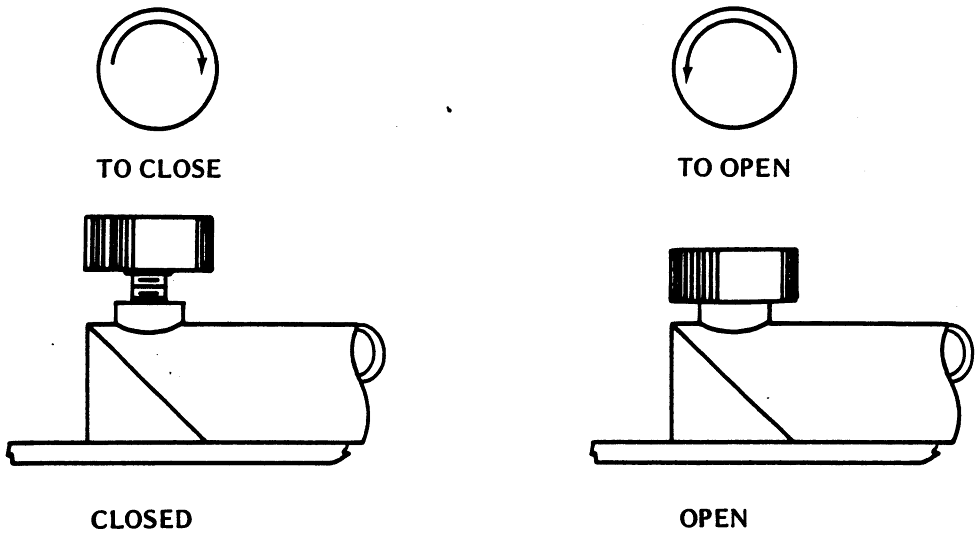
## 3-4 FIELD SERVICE: Installation, Initial Operation & Instruction

The services of a qualified Varian/NRC factory engineer are available on a cost basis. He will operate the leak detector and instruct the user in operation and preventive maintenance. When the leak detector is unpacked and the required facilities are available, contact your nearest Varian/NRC District Office or the plants at Lexington or Palo Alto to arrange for field service if this service has been purchased.

## 3-5 ASSEMBLY

3-5.1 Connect the foreline tubing (7/8" OD copper) at the rear of leak detector to the mechanical pump after locating each unit in the desired position. Copper or stainless tubing should be bent to shape so that one end abutts the inlet port on the mechanical pump and the other end abutts the foreline connection. The joints are made by sliding a piece of vacuum hose over them and clamping so that a minimum of hose is exposed to the vacuum.

3-5.2 After ascertaining that the switch on the Main Electronics panel is Off, connect the Detector module to the Main Electronics unit using the interconnecting cable (multi-terminal connector and red high-voltage lead).




SHIPPING VALVE

3-5.3 Fully open the shipping valve (knurled knob reached through opening at rear of cabinet) Turn counterclockwise until firmly seated.

3-5.4 Connect Leak Detector to the grounded power source.

NOTE

During tuning and operation, should the pressure in the spectrometer tube rise out of the green band, quickly close $V_2$ and open $V_1$ to permit the diffusion pump to recover. When the pressure has returned to the green band, press "FIL ON" button and proceed

# IV. OPERATION

## 4-1 START UP AND TUNING

– PRINCIPLE OF OPERATION –

As previously described, a mass spectrometer leak detector functions because of its ability to sort out helium ions from all other ionized gases and to quantitatively present on the leak rate meter a reading proportional to the number of helium ions per second reaching the ion collector.

For proper performance, it is necessary to adjust the following parameters of the spectrometer tube (see Figures 7 and 8).

| | |
|---|---|
| 1) Electrons Entering Chamber | |
| a) Quantity per unit time entering ionization chamber | **Emission*** control<br>Large black control knobs on the spectrometer tube |
| 2) Ions Leaving Ion Chamber | |
| a) Energy | **Ion Voltage** control |
| b) Quantity per unit time leaving ionization chamber | **Repeller Voltage** control |
| c) Direction | **Focus Voltage** control |

Since the **Ion Voltage** is critical in separating helium from other ions, a ten-turn adjustment with a suitably numbered dial is provided.

Emission can be increased with the **Emission Selector** switch (marked **LOW**, and **HIGH**), with a fine (screwdriver) adjustment for each. The selector switch also inserts appropriate shunts in the Emission meter circuit to correspond with each level.

To operate properly, all of these controls must be "tuned" for maximum response to the presence of helium, with the exception of the **Repeller Voltage** control which is left fully clockwise. Since all of the voltages tend to interact, tuning is a progressive process. The **Ion Voltage** and **Focus Voltage** must be adjusted several times in sequence until the highest possible reading is obtained on the Leak Rate meter while helium is flowing through the leak detector from a constant or standard leak. **Emission** is then adjusted for maximum Leak Rate reading.

*Controls appearing in boldface print are located behind the access panel on the front of the main electronic unit.

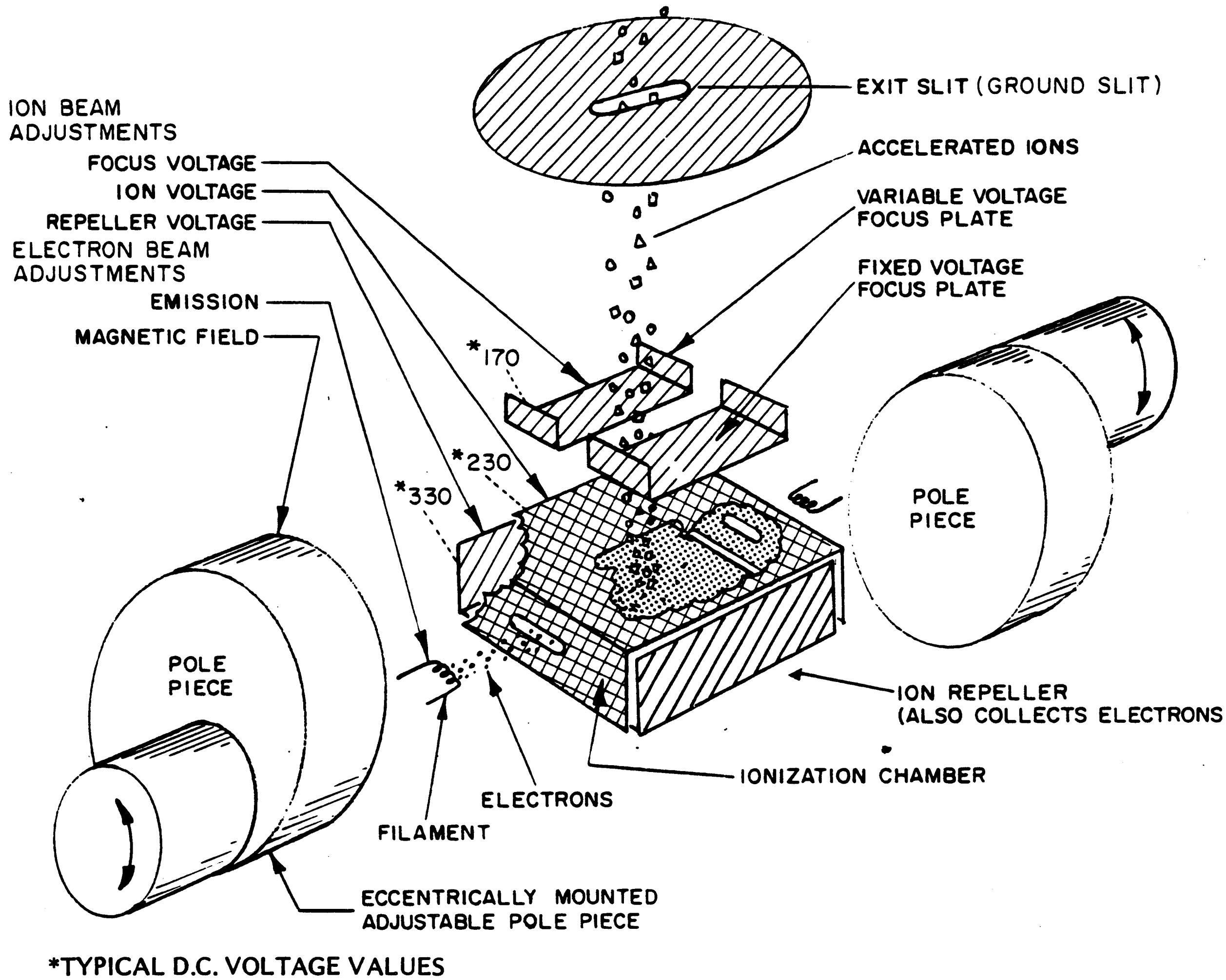



*Figure 8. Details of Ion Source*

As each control is slowly turned, it will be generally noted that the reading rises and then falls. The control should be left in the center of the "peak" and the same thing done to the next control and so on. These steps should be repeated until no further increase is noticed. The source magnet knobs should then be adjusted in the same manner.

## START-UP

### NOTE

Always check to be sure shipping valve is open (P17).

4-1.1 **Turn on the mechanical pump.** This pump must run whenever the diffusion pump is on. Failure of the mechanical pump will damage the diffusion pump and ruin it within a few hours.

With test port plugged, and vent valve closed, open $V_1$ and $V_2$ (these are quarter-turn butterfly valves. They are open when the knob index is vertical. They are closed by firmly seating them at the "3 o'clock" position.)

4-1.2 When pressure is below 50 millitorr, turn SENSITIVITY knob to near Warm Up. (This applies nearly full voltage* to the diffusion pump heater.) Turn on switch on Main Electronics panel. In the following procedure, the electrical controls **should be at settings as recorded at the front of this book.** It is not necessary to change any settings at this time, as any changes necessary will become obvious in the following procedure.

4-1.3 As soon as pressure gauge on Main Electronics panel reaches center of green band or lower (typically 30 minutes) press "FIL ON" button. If filament does not stay on, wait briefly and try again until filament stays on (green FIL ON lamp is lit).

4-1.4 When Filament stays on and pressure drops low in green band, close $V_2$. (Green "FIL ON" lamp and amber "EMISSION" lamp on leak detector should be on.)

### NOTE

Should the pressure rise above the green band, quickly close $V_2$ and open $V_1$ to permit the diffusion pump to recover. When the pressure has returned to the green band, press "FIL ON" button and proceed.

4-1.5 Adjust LEAK RATE meter "ZERO ADJUST" so that meter reads approximately 0 and wait until little or no drift is observed on a sensitive scale. If necessary, use **Coarse Zero** adjustment on the Main Electronics panel. Continue to periodically adjust zero as necessary.

4-1.6 Lift "VENT" Valve handle perpendicular to panel to open, then close valve by returning handle to position parallel with panel.

4-1.7 Loosen test port coupling – remove plug.

## TUNING

4-1.8 Replace test port plug with a test leak; either a standard (calibrated) leak or a tuning (uncalibrated) leak. (If the standard leak has its own valve, leave the valve open.)

*Line voltage should not exceed 115 volts, otherwise sensitivity may be reduced.

4-1.9 Tighten port coupling.

4-1.10 Follow procedure shown graphically on the detector panel, steps 1 through 3.

NOTE

If a Varian tuning leak is used, adjust its knob until the Millitorr meter on the detector unit reads 100 millitorr.

Now continue with step 4. You are now in TEST.

4-1.11 Observe Leak Rate shown on meter. Select range that keeps meter on scale. If there is no meter deflection, skip to 4.1.15 below.

4-1.12 Close $V_2$. If detector is sensing helium in step 4-1.11, meter reading will drop toward zero.

4-1.13 Adjust Leak Rate to zero using ZERO knob on detector module and/or **Coarse Zero** on the main electronics module.

4-1.14 Follow steps 1 through 4 on detector panel. If using a standard (calibrated) leak the Leak rate meter should rise, overshoot, then drop to some value above zero. If a Varian tuning leak is used, reading will rise and stay at some value above zero. This indicates that the Porta-test is sensing helium. Skip to Section 4-1.23 to complete the tuning. If helium is not being sensed (meter does not respond in Section 4-1.12 and 4-1.14) continue to step 4-1.15.

4-1.15 With $V_1$ and $V_2$ still open, turn **Gain** fully counterclockwise. Select **HIGH** Emission, and adjust the associated screwdriver control to achieve an emission meter reading of "5".

4-1.16 Place **Suppressor** switch in **Tune** position. Ignore the immediate fluctuations of the Leak Rate meter. Set **Ion Voltage** knob to "0" (the spectrometer is now tuned on or near mass 6; (Figure 9).

4-1.17 Set **Repeller Voltage** to the position that gives maximum reading on the Leak Rate meter. Measure the Voltage at **TP4** with a D.C. Voltmeter, and set it at 90 volts with the associated control. (This control is factory set and normally does not need adjusting.)

4-1.18 Turn **Focus Voltage** knob slowly until maximum reading is obtained on the Leak Rate meter (change Range switch positions as necessary to keep the meter deflection on scale). Readjust **Repeller Voltage** and focus voltage knob slightly as required to obtain maximum reading.

4-1.19 With a screwdriver, adjust **Emission** control to obtain the greatest Leak Rate indication (change Range switch positions as necessary to keep the meter deflection on scale). The value of emission indicated by the Emission meter is not important at this time. Return **Repeller Voltage** knob to full clockwise position.

**4-1.20** When Leak Rate meter is again steady, turn **Ion Voltage** knob slowly clockwise. The Leak Rate meter reading will drop, then rise, then drop again, somewhat as in Figure 9. Change Range switch position as necessary to keep the meter deflection on scale. Leave the knob set at the top of the rise. This is the "Helium peak"; it may occur anywhere between 2 and 8 on the **Ion Voltage** dial.

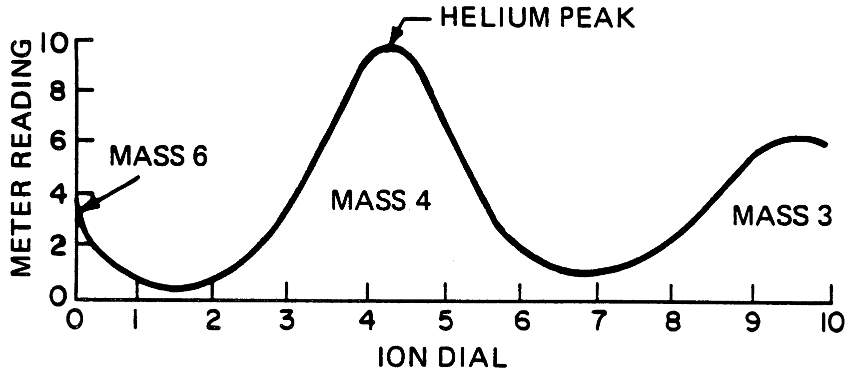



*Figure 9. Tuning the Ion Voltage*

**4-1.21** Return the **Suppressor** switch to Operate position and wait for the meter to become steady again.

**4-1.22** Close $V_2$. Leak Rate meter reading should drop, indicating that Helium is being detected. If it does not drop, turn to Section 5-3 for further procedures. If it does drop, adjust the meter to read "0", using the Zero knob and (if necessary) the **Coarse Zero** adjustment.

**4-1.23** Follow steps 1 through 4 on the detector panel. Adjust the following controls to make sure that each is in the position which yields the highest Leak Rate meter reading. This will assure that the Porta-test is tuned to the center of the Helium peak. Most controls will require very small adjustments at this point: adjust **Focus Voltage, Ion Voltage, Emission,** and the adjustable magnet pole pieces (two black knobs, at the top and bottom of the spectrometer tube). If this tuning is the result of installing a new ion source, be sure to measure the voltages at the four Test Points and record them at the front of the book.

**4-1.24** Follow steps 6 and 7 on detector panel. Remove standard (or tuning) leak.

**4-1.25** Porta-test is now ready for use. Connect test port to device to be leak tested and follow steps numbered on the detector panel. At step 5, zero the Leak Rate meter, then apply helium to suspected leak area on device, while observing Leak Rate meter. Change Range switch positions as necessary to keep the reading on scale. Leaks are located by moving the helium spray to the point giving the highest reading. Leaks giving readings above 6000 can be located by testing with the **Emission Selector** switch in the Low position. See Section 4-2.4.

## 4-2 SENSITIVITY

**4-2.1** The best way to detect changes in the performance of the Porta-test is to make a sensitivity check at the beginning and end of each day's work. This is simply a matter of noting the instruments' response to a standard leak applied at the test port. If a record of these readings is maintained, even gradual changes are readily detected. When making the sensitivity check, the unit should be adjusted to the helium peak, with the **Gain** turned fully counterclockwise and **Emission Selector** on High.

**4-2.2** Use of gain control allows increase of sensitivity (from full counterclockwise to full clockwise) by a factor of 5. Normally gain control should be left full counterclockwise (100% feedback) for maximum electronic stability; however, it may be turned clockwise to gain sensitivity provided the background helium in the system remains constant enough so that the output meter is steady under no-leak conditions.

**4-2.3** Sensitivity can be very markedly increased by rotating the sensitivity control (on detector-panel) clockwise. This lowers the temperature of the diffusion pump boiler and decreases the helium pressure ratio across the diffusion pump to allow more helium to reach the spectrometer tube for a given leak rate. It also lowers the forepressure tolerance of the pump and can be used effectively only when the foreline pressure of approximately 100 millitorr or better is readily achieved during pump down of the device to be tested. The "FIL ON" lamp should stay on when $V_1$ is opened. If it does not stay on, the forepressure tolerance of the pump has been exceeded and a lower test port pressure should be obtained before opening $V_1$ in step 4. For a given set up, the best position of sensitivity control should be determined for desired sensitivity and pump down time. Since these are thermal phenomena, several minutes should be allowed after adjustment to reach stable operating conditions.

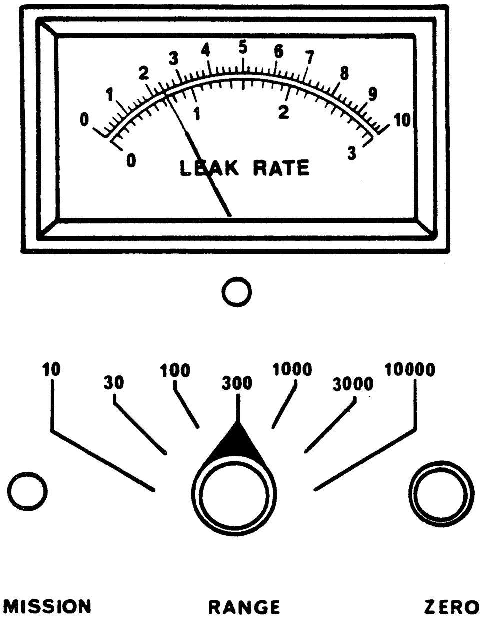
**4-2.4** Sensitivity can be decreased by switching to "**Emission Low.**" After switching to the "Low" position, the unit must be retuned: Place a test leak into the test port and tighten port coupling.

Follow steps 1 through 4 on detector module. You are now in test.

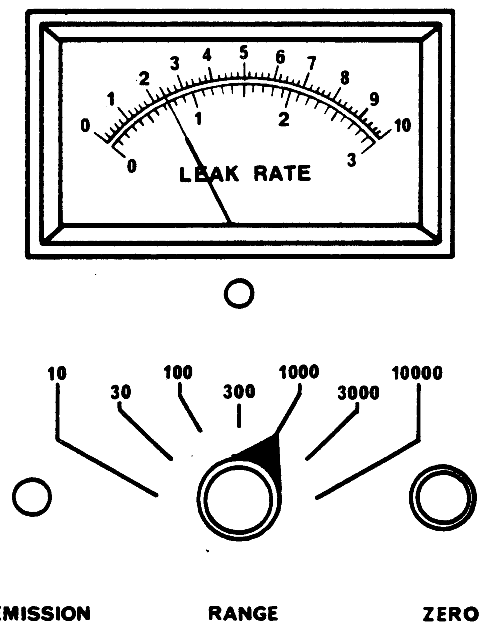
Adjust the following controls to make sure each is tuned to the center of the helium peak. (Maximum reading on Leak Rate Meter): **Focus Voltage; Ion Voltage; Repeller Voltage.**

**Gain** control should be fully counterclockwise. Operate with the Sensitivity control in warm-up position for reduced sensitivity.

If a further reduction in sensitivity is desired, the **Emission Low** screwdriver adjustment may be turned to lower the emission.




*Reading is 75 major divisions since full scale is 300. Use 0 to 3 meter scale as range switch is on a range beginning with 3.*




*Reading is 240 major divisions since full scale is 1000. Use 0 to 10 meter scale as range switch is on a range beginning with 10.*

*Figure 10. Two Examples of the Use of the Leak Rate Scales*

## 4-3 READING THE OUTPUT (LEAK RATE) SIGNAL (Figure 10)

The scale of the Leak Rate meter on the Leak Detector is an arbitrary linear scale. It is calibrated in major divisions (numbered meter divisions). The selector switch position shows the full scale major divisions of the range chosen. If the selector switch is on the 10 range and the meter reads 10, the meter will read 1 when switched to either the 30 or 100 scale and 0.1 on the 300 or 1000 scale.

To ascertain the approximate leak rate of an unknown leak it is first necessary to test a known leak.

For instance, if a known leak of $4 \times 10^{-6}$ std cc/sec. of helium reads 6 on the 1000 range with $V_2$ open and 0 with $V_2$ closed this would represent a meter excursion of 600 major divisions for the $4 \times 10^{-6}$ std cc/sec. leak. An excursion of 1 major division with the leak detector adjusted to these same conditions would indicate a $6.7 \times 10^{-9}$ std cc/sec. leak $(\frac{4 \times 10^{-6}}{600})$. Should you test a piece and obtain a reading of 1200 major divisions (1.2 on 3000 range), this would be caused by a leak of $8 \times 10^{-6}$ std cc/sec. $(\frac{1200}{600} \times 4 \times 10^{-6})$. Another way of determining the leak size is to multiply the value of one major division by the total number of major division in your reading ($1200 \times 6.7 \times 10^{-9} = 8 \times 10^{-6}$ std cc/sec.).

In general practice it is only desirable that leaks above a certain value be located; however, reasonably accurate values can be assigned to unknown leaks by use of the above method provided 100% He at atmospheric pressure is applied to the unknown leak; that the "unknown" leak is clean, dry and stable; and that the "known" leak is indeed accurate.

## 4-4 SHUTDOWN PROCEDURE

Stability and start-up time are optimized by leaving the leak detector fully operational with $V_2$ and $V_1$ in the position marked "S" which stands for start, stop and standby ($V_2$ closed, $V_1$ open), with mechanical pump, diffusion pump, and filament on.

If the system is to be shut down:

4-4.1 Turn Sensitivity control to "OFF". This will allow the diffusion pump to cool. Press "FIL OFF" switch on Main Electronics.

4-4.2 After 15 minutes close $V_1$ and shut off main electronics.

4-4.3 Turn off mechanical pump. To vent mechanical pump, open $V_2$ and Vent valve.

4-4.4 If unit is to be transported, close the shipping valve (knurled knob reached through opening at the rear of the cabinet). Turn clockwise until firm. Uncouple the mechanical pump from the foreline connection; disconnect the cable from the main electronics unit; disconnect power cord; and store the cable and power cord in the back of the detector cabinet.

4-4.5 The 925-40 can be shut down temporarily (for periods up to about 10 minutes) as might be necessary to move to an adjacent room, etc. Close $V_1$, then proceed to turn off the mechanical pump and disconnect the foreline tubing. Unplug the power cord from its receptacle and carry the two modules to the new location. Plug in the power cord, connect the foreline tubing to the mechanical pump and turn it on. When the millitorr meter reaches 100 millitorr, open $V_1$. The Porta-Test is now ready for operation.

# 4-5 USE OF THE 925-40 TO TEST A VACUUM SYSTEM

4-5.1 Refer to Figure 3 of this Manual.

4-5.2 It will be necessary to provide a leak check port in the roughing line of the vacuum system, between the foreline valve, the roughing valve, and the mechanical pump.

4-5.3 Connect the 925-40 foreline connection to the leak check port discussed above. Plug the 925-40 Test Port with a tuning leak or a port plug.

4-5.4 Open $V_1$ and $V_2$ and proceed to pump down the vacuum system as usual. When the millitorr meter on the 925-40 indicates 100 or lower, turn the sensitivity control to the Warm-Up position and turn on the Main Electronics. If in the course of the pumping cycle the mechanical pump pressure will rise above 100 millitorr, have $V_1$ closed at that time. When the vacuum system has stabilized near its lowest pressure, and the 925-40 diffusion pump has been on for 30 minutes or more (Spectrometer tube pressure in Green Band) turn on Filament and tests can begin. Refer to Section 4-1.

NOTE

Leaving $V_1$ closed, or allowing the forepressure to remain above 200 millitorr for long periods will expose the diffusion pump to serious damage.

4-5.5 The leak check port, as discussed in Section 4-5.2 above, should be provided with a valve so that Porta-Test can be disconnected from it for normal use. (See inset, Figure 3.) When this is the case, the Porta-Test can be connected to the vacuum system while the system is evacuated and the pump running:

4-5.6 Connect the foreline port of 925-40 to the leak check port discussed above. With the Test Port suitably plugged, and $V_1$ and $V_2$ open, close both the roughing valve and the foreline valve of the vacuum system. Open the valve on the leak check port to evacuate the line to the Porta-Test.

4-5.7 When the millitorr meter reads 100 or lower, turn the sensitivity control to Warm-Up and turn on the switch on the Main Electronics. Open either the roughing valve or the foreline valve to restore the vacuum system to its previous operation.

4-5.8 After a 30-minute warm-up period, proceed with testing. Refer to Section 4-1.

4-5.9 If a pressure of 100 millitorr or less cannot be maintained, it will be necessary to decrease the load on the mechanical pump by throttling either the high-vacuum valve, the roughing valve, or the foreline valve of the vacuum system, as appropriate to keep the pressure in the 925-40 at 100 millitorr.

4-5.10 A tuning or standard leak placed in the test port of the 925-40 will be adequate for tuning and adjusting the unit for optimum operation. However, if it is necessary to make quantitative measurement of the leaks in a system (see Section 4-3), a standard leak should be located at or near the point in the system farthest from the leak detector.

# V. MAINTENANCE

Maintenance of the 925-40 is simplified if a sensitivity check is made each day before the unit is used. A record of tuning voltages can be kept in the front of this book and will be useful in the event that retuning becomes necessary.

The cabinet of the leak detector can be lifted off after removal of four screws at the rear of the cabinet, and two on each side of the front panel. The "nuts" on the inlet port must also be removed.

**CAUTION**

Hazardous voltages are present within the cabinet. Exercise caution when the cover is not in place.

The screws fastening the cover should always be secure as even slight movement of the mild steel cover will affect the output of the spectrometer tube.

**NOTE**

The shipping valve at the top of the diffusion pump is vacuum sealed only when fully open or fully closed. Do not, therefore, operate this valve while the diffusion pump is hot. It is provided only to assure that the diffusion pump oil is not sloshed into the spectrometer tube during shipping and handling.

## 5-1 MECHANICAL SERVICING

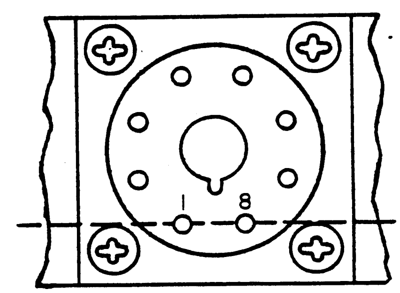
### 5-1.1 Ion Source (Figure 12)

The ion source has two filaments. The spare is turned on by the FILAMENT SELECTOR switch behind the locked access panel (Figure 7). Slight retuning may be desirable to obtain maximum sensitivity; however, the filaments are usually close to the same adjustment.

Although the filaments have long life, it is impossible to predict just when failure will occur. If failure of the spare filament may upset critical testing, the ion source should be replaced as soon as convenient after the spare filament has been put into use (takes about 20 minutes). Otherwise, just use the spare as long as it lasts.

Removal and Replacement

1. Refer to Section 4-4 for shutting down the leak detector.
2. Disconnect ion source plug (center plug) from spectrometer tube, remove four screws and take out ion source.
3. Before installing new ion source, be sure that ground slit (at the bottom of the hole) is clean and firmly in place. Be sure it is 90° to side of tube body; adjust with thin screwdriver, if necessary.
4. Place new ion source in cavity so that locating pin enters ceramic bushing freely. For maximum sensitivity, adjust ion source so that pins 1 and 8 are aligned parallel to edge of tube body. Use a new O-ring; wipe it and mating surfaces with clean cloth. Tighten screws evenly and firmly. Reconnect plug.




NOTE

This is a good opportunity to see if cold cathode gauge (Section 5-1.2) is clean.

5. Restart and retune as in Section 4-1.

### 5-1.2 Cold Cathode Gauge: Removal, Cleaning and Re-installation (Figure 12)

1. Refer to Section 4-4 for shutting down the leak detector.
2. With power off, disconnect red connection (P-3) and remove cold cathode gauge.
3. Slip out cathode liner. If dirty, gently spread and clean with emery cloth and wipe with soft cloth, or replace. To dismantle gauge (rarely necessary), see Figure 12.
4. Inspect vacuum side of high voltage feedthrough to be sure the lead is not shorted to ground. If it is, it will give false full-scale signal. Clean ceramic insulator carefully with emery cloth and wipe with soft cloth.
5. Re-install cold cathode gauge, using new O-ring. Wipe O-ring and mating surface with clean cloth. Tighten screws evenly and firmly. Raise dust cap, insert high voltage lead onto pointed terminal and then slide dust cap over rim. Make sure high voltage does not short to ground. Restart as in Section 4-1.

### 5-1.3 Spectrometer Tube Servicing (Figure 12)

1. Shut down leak detector (Section 4-4), remove cover (Section V).
2. Disconnect the three connectors on the spectrometer tube. Loosen the vacuum compression coupling. Remove screws holding the aluminum channel to the front and rear panels. Detach tube, together with channel and take it to a convenient work surface.
3. Remove cold cathode gauge, ion source and preamplifier. Remove compression fittings.
4. Slip out baffle between cold cathode gauge and ion source cavities. Remove ground slit and ceramic bushing from ion source cavity.
5. Remove the four Phillips mounting screws and take-off the magnet assembly. DO NOT DISASSEMBLE THE MAGNET.
6. Using fine abrasive paper, remove heavy deposits from spectrometer tube body, ground slit plate, cold cathode liner and baffle.
7. Spectrometer tube body together with ground slit plate, baffle, liner and ceramic insulator may now be boiled in hot Alconox solution, rinsed with hot water and then with alcohol. Baking in a vacuum oven to 150°C is desirable, but not necessary. DO NOT USE ACETONE.
8. Reassemble spectrometer tube (see 5-1.1.3 & 4; 5-1.2.3 & 4 & 5). Be sure to remove any magnetic material clinging to the assembly. Install and restart leak detector (Section 4-1).

### 5-1.4 Diffusion Pump Oil (Figure 11)

The diffusion pump in the 925-40 is designed for use with Santovac 5 (polyphenyl ether). Use of any other pump fluid will have adverse effects on the performance of the unit.

If the pump oil is found to be darkened or if it has been spilled, (or every year of continuous service), the pump should be cleaned and recharged. Proceed as follows:

With the system shut down, remove the spectrometer tube (see Section 5-1.3), and set it aside. Remove hose from foreline connection. Remove knobs from $V_1$ and $V_2$. Remove the two screws securing the pump top flange to the front and rear panels. Now the pump and foreline stack can be pivoted and slipped out the side of the cabinet. Be sure to disconnect the pump power cord. Remove the three long screws which hold the foreline stack, and carefully set aside the test port manifold, $V_2$, the pump fitting and $V_1$ as well as the four O-rings.

Remove the three 10-32 Phillips screws from the top flange assembly, and lift it off. Remove the jet retaining spring and lift out the jet. Pour the oil into a suitable container.

Examination of the oil may help determine if the cleaning interval is too long or too short, or if the oil was contaminated.

Using a clean soft lint-free cloth, wipe $V_1$ and $V_2$ to remove oil and any foreign matter. Set them aside to await reassembly. Wipe oil from pump, jets, pump fitting and top flange and valve assembly. Wash with alcohol or triclorethelene to dissolve oil and remove foreign matter. Dry thoroughly, heating if possible.

Reassemble, making sure that the clips on the diffusion pump jet assembly straddle the foreline opening, and that the jet assembly is resting on the boiler. Before assembling the top flange assembly, add 65 cc (2 fluid oz.) of Santovac 5 pump oil.

In assembling the O-rings, lubricate sparingly with water, then install. Assemble the foreline stack carefully, making sure that the valve stems all point in the proper direction for installation to the front panel. Tighten the three long 1/4-inch screws for metal-to-metal contact on the whole foreline stack. Assemble the top flange and valve assembly to the diffusion pump, making sure that the spring is over the top jet and in the recess of the shipping valve plate. Orient the tubing correctly; install the three 10-32 Phillips head screws and tighten them eveniy and firmly.

Slide the diffusion pump assembly into the cabinet, plugging in the power cord, and rotate it so that all three valves protrude through the front panel. Locate the base of the pump between the retaining stops and install the two screws, with nuts on the front and rear panels. Tighten securely. Install the knobs on $V_1$ and $V_2$, orienting the index appropriately.

Restart as in Section 4-1.1.

If possible, operate the unit for the first hour or two with the cover off. As the new oil is heated, it will outgas, preventing the pump from reaching a good ultimate pressure at first. When the spectrometer tube can be turned on, tune for helium (Section 4-1) and check for leaks at all joints in the pump and foreline assembly. Then install cover, tighten screws, and retune to the helium peak.

### 5-1.5 Diffusion Pump Heater (Figure 11)

When the diffusion pump heater is known to have failed, it may not be possible to withdraw it from the heater block. After removing pump and foreline stack from cabinet (Section 5-1.4), cut the wires as short as possible. Remove the aluminum reflector from the bottom of the pump, and remove the heater block from the two studs. Drive the heater back out of the hole with a drift or blunt pin. If this is not effective, the heater can be removed from the block by drilling. (Drill through with a 19/32" drill, and ream the hole to 0.624", +0.000" - 0.001" 2" deep. This will assure a suitable fit for the new cartridge.) It may be found to be convenient to order a new heater block to install with the new heater cartridge. (Heater cartridge order number 0181-6473-01-100, Heater block order number 0181-82247-001). Before installing the new heater cartridge, assemble the heater block with the counter bores facing the boiler of the diffusion pump. Secure the heater block using both pairs of nuts. Install reflector to the pump using remaining pair of nuts. Slide the heater into the heater block, fastening it in with the clip provided.

### 5-1.6 Shipping Valve (Figure 11)

If the shipping valve knob is removed, it should be re-installed as follows: After setting the O-ring and the knob over the shaft, with the valve in a partly or entirely closed position, press down firmly on the knob, while tightening both set screws firmly. After a few minutes, retighten both set screws.

### 5-1.7 Vent Valve (Figure 11)

If the vent valve is to be replaced: Remove valve from its fitting; clean the glyptal off the threads of the fitting; recoat the threads with fresh glyptal and screw new valve into the fitting until the distance from the elbow centerline and the valve stem centerline is 1.38 inches, as shown in Figure 11.

### 5-1.8 $V_1$ and $V_2$ (Figure 11)

If a butterfly valve, $V_1$ or $V_2$, is leaking, the "O" rings should be replaced. Disassembly of the valve is straightforward: First remove the valve from the "pump stack" or vacuum assembly.

**Do not loosen the set screws holding the cam to the shaft.** Open the valve slightly, then remove the two screws holding the flapper to the shaft, lifting off the backing plate. Manually displace the flapper enough to permit removal of the shaft. Pull the shaft straight out after clearing the flapper, and lift the flapper out the large end of valve.

Remove all three O-rings carefully, clean the shaft, flapper, and body completely. Install the three new O-rings, applying a thin coat of Apiezon "L" vacuum grease to each just before installation. Place the flapper part way into the open end of the valve, with the screw holes up and generally aligned with the shaft direction. Now apply Apiezon "L" vacuum grease liberally to the area between the two O-rings on the shaft and install the shaft with the machined flat facing the flapper. Be sure that this will orient the cam so that it will not interfere with the pin on the valve body. If there is interference, the flapper should be placed on the other side of the shaft. Slide the shaft home, and turn it to the nearly closed position, moving the flapper manually to match, while aligning the screw holes in the two pieces. Put a drop of Loctite™ sealant on the threads of each screw. Now assemble the backing plate with the two screws to the shaft and take up (but do not tighten) the screws. Close the valve fully, and tighten the screws firmly. This completes the assembly.

If the shaft cam has come loose from the shaft, or if the valve does not "seat" in the closed position because the cam limits the shaft rotation improperly, it will be necessary to relocate the cam. This can best be done (after the cam set screws are loosened), by placing the shaft so that the flapper is a few degrees past (clockwise) the ideal seated position. Now locate the cam with the pin in contact with the left-hand face. Tighten both set screws, then cycle the valve several times. It should seat positively. If not, make very small adjustments in the cam position until a satisfactory action is obtained. Finally, tighten the set screws firmly.

## 5-2 ELECTRONIC SYSTEM

### 5-2.1 Units and Modules

To simplify maintenance, the complete electronic system is divided into three physically separate units, each with a block of numbers for components part identification:

| | |
|---|---|
| Spectrometer tube | 0 – 9 |
| Leak Indicator | 10 – 99 |
| Main Electronics units | 400 – 499 |

The system schematic is numbered to correspond with these blocks. For example, V-405 is the fifth vacuum tube in the main electronics unit.

To speed up troubleshooting and restoration of normal operation, the main electronics are equipped with plug-in amplifier and power supply printed circuit cards. These are clearly shown on the system schematic.

### 5-2.2 Circuits

The electronics system is divided into seven circuits for description purposes:

Spectrometer tube
Electrometer amplifier
Overpressure protection
Spectrometer power supply
Emission regulator
Thermocouple gauge
Indicator lights

**PARTS LIST OF ACCOMPANY Figure 11**

| Item | Part Description | VARIAN Part Number |
|---|---|---|
| 1 | Knob, Shipping Valve | 0981-K0451-006 |
| 2 | O-ring, Parker No. 2-108, Buna-N | |
| 3 | O-ring, Parker No. 2-222, Buna-N | |
| 4 | Disc and Shaft assembly, Shipping Valve | 0981-K-1114-301 |
| 5 | O-ring, Parker No. 2-237, Buna-N | |
| 6 | Spring, Pump jet retaining | 0981-6602-85-290 |
| 7 | Diffusion pump jet assembly | 0181-85485-301 |
| 8 | Diffusion pump, complete | 0981-K0449-301 |
| 9 | Heater Block | 0181-82247-001 |
| 10 | Heater, Cartridge, 115V, 350W | 0181-6473-01-100 |
| 11 | O-ring, Parker No. 2-130, Buna-N | |
| 12 | Butterfly Valve | 0981-K0459-301 |
| 13 | O-ring, Parker No. 2-9, Viton | |
| 14 | O-ring, Beemer 568-214, Viton 9009-75 | 0981-6608-98-075 |
| 15 | Valve knob | 0981-6602-51-014 |
| 16 | Pump fitting | 0981-K0452-301 |
| 17 | Test Port Manifold | 0981-K0453-301 |
| 18 | Toggle Valve | 0981-6266-31-008 |
| 19 | Thermocouple Gauge | 0531-F0472-301 |
| 20 | Test Port Nut | 0981-83488-001 |
| 21 | Screw 1/4 D X 5" long, 20 t.p.i. | |
| 22 | Inlet screen, 50 mesh | 0981-87626-302 |
| 23 | O-ring, Parker No. 2-216, Buna-N | |
| 24 | O-ring follower | 0981-82848-001 |
| 25 | Compression Cap | 0981-82847-301 |
| 26 | Spectrometer Tube Assembly | 0981-82837-301 |
| 27 | Top Flange and Valve Assembly includes items 1, 2, 3, 4 | 0981-K0451-301 |
| 28 | Screw, 10-32 | |
| 29 | Silicone Gasket | 0181-84687-001 |
| 30 | Washer, split lock, No. 10 | |
| 31 | Nut, Hex, No. 10 X 24 t.p.i. | |
| 32 | Reflector | 0181-85254-301 |
| 33 | Nut, Acorn, No. 10 X 24 t.p.i. | |
| 34 | Clip, Heater retaining | |
| 35 | Washer, External tooth lock, No. 4 | |
| 36 | Screw, No. 4 X 40 t.p.i. X 3/16 inch long | |
| | Diffusion pump oil, Santovac 5, 500cc bottle | 5000-6954-05-005 |
| | Diffusion pump oil, Santovac 5, 65cc bottle | 0981-6954-05-002 |
| | Spare O-ring Kit | 0981-K1668-301 |
| | Pilot Light | 0981-6510-13-013 |
| | Meter (Millitorr) | 0881-6522-08-125 |
| | Meter (Leak Rate) | 0981-84398-301 |
| | Manual for 925-40 Porta-Test | 0981-6999-09-400 |

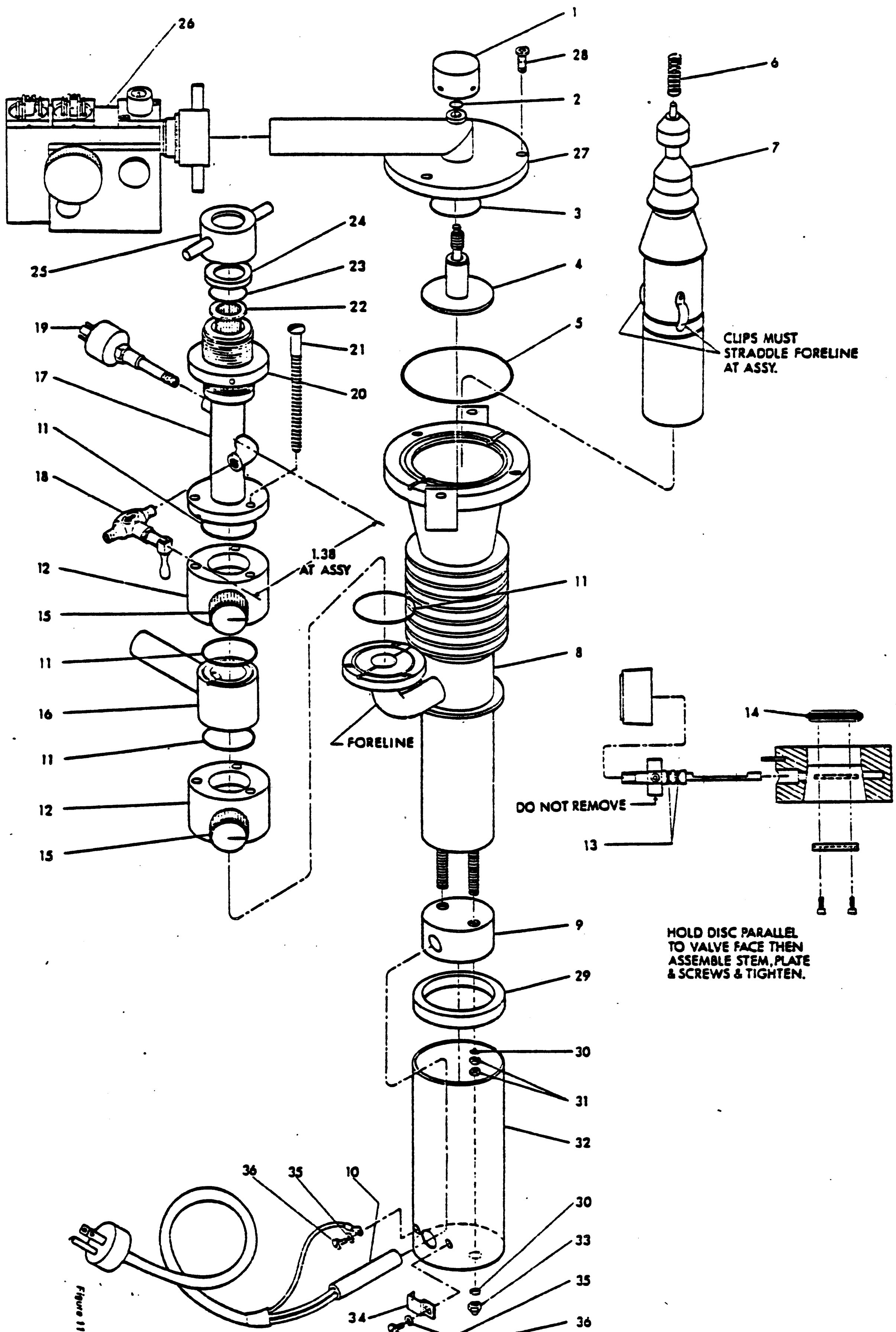



Figure 11. 925-40 Vacuum System, Exploded View

Portions of these circuits may be located in more than one unit. For example, the complete electrometer amplifier starts in the spectrometer tube (preamplifier), continues in the main electronics unit, and ends in the detector unit (LEAK RATE meter). Consequently, in the simplified schematic, there are corresponding part numbers in the 0 – 9, 400 – 499, and 10 – 99 blocks. In reading the sections below, it may be desirable to fold out Figure 20 for reference.

### 5-2.3 Spectrometer Tube (Figures 5 and 20)

As described in detail in Section 2-2, this is the heart of the system. All external circuits either contribute to its operation or gather information from it. From the electronic viewpoint, there are three essential assemblies served by the external circuits:

1. The cold cathode gauge, which measures the total pressure within the spectrometer tube.
2. The ion source, which ionizes the gas molecules and shapes and directs the ion beam into the magnetic field. (The magnetic field then separates the helium ions from other ions in the ion beam and directs them to the collector.)
3. The preamplifier assembly, which collects and amplifies the small helium ion current so that it may be sent through the interconnect cable.

### 5-2.4 Electrometer Amplifier (Schematic: Figures 18 and 20) (PC Board: Figure 17)

The output of the preamplifier is fed into an additional two stages of amplification. A cathode follower output is used to isolate the electrometer circuit from the load on the output. The output of the cathode follower is read on the LEAK RATE meter.

Negative feedback is used for stability. The feedback is variable from 20% to 100% by adjusting the GAIN potentiometer. The amplifier has a COARSE ZERO adjustment in addition to the normal ZERO adjustment.

Much of the amplifier circuit is incorporated in a plug-in printed circuit card. The card contains the second and third stages of amplification and the cathode follower with associated plate and bias resistors.

The power supply for electrometer amplifier circuit is also on a p-c card. The voltages supplied are a positive 100 volts DC ± 10% and a negative 100 volts DC ± 10%, both regulated by zener diodes.

The 90-volt DC adjust, R-447, with observation of voltage at test-point-4, is used to set the DC filament voltage of the electrometer tubes.

### 5-2.5 Overpressure Protection (Schematic: Figure 20) (PC Board: Figure 15)

The protection circuit depends upon information received from the cold cathode gauge, which senses pressure in the spectrometer tube. (Note: When tube pressure is above 1/3 atmosphere, the discharge may extinguish. There is then no protection for the filament.)

If the tube pressure rises above 0.2 micron, the filament will be turned off automatically. (FIL. OFF lamp will light.)

The OVER-PRESSURE SET POINT adjustment fixes the pressure point for protection of the filament. It is factory preset for green-band operation (actuates just above 0.2 micron). However, it may be adjusted to any point in the range of the SPECTROMETER TUBE PRESSURE meter. (Operation of the filament at higher pressures will shorten filament life.)

### 5-2.6 Spectrometer Power Supply (Schematic: Figure 20) (PC Board: Figure 16)

The power supply is on a p-c card with multiple outputs, each regulated by zener diodes. The power supply has a total span of 430 volts DC ± 10% and a variable ground potential. Power is supplied to the emission regulating circuit and voltages are supplied to the ion source elements and to the suppressor slit. This is a relatively high impedance supply, and is not damaged by elements in the ion source which become shorted to ground. Such shorts will, however, grossly affect one or more supply voltages as indicated at the several test points enumerated below. This provides a handy diagnostic tool for locating faults.

The ION VOLTAGE adjustment varies the voltage of the ion box with respect to ground. The REPELLER VOLTAGE adjustment varies the voltage on the ion repeller and the FOCUS VOLTAGE adjustment varies the voltage on the variable voltage focus plate.

TP-1 is a test point for measuring REPELLER VOLTAGE,
TP-2 is a test point for measuring ION VOLTAGE, and
TP-3 is a test point for measuring FOCUS VOLTAGE.

Periodic measurement and recording of the voltages at these points can make it easier to tune the leak detector. Measurements should be made with a meter having 20,000Ω/v or higher impedance.

### 5-2.7 Emission Regulator (Schematic: Figures 19 and 20) (PC Board: Figure 16)

The emission regulator circuit can be subdivided into:

emission regulator module
saturable reactor and filament transformer
meter circuit
power supply

The emission regulator circuit uses negative feedback to provide continuous correction of the emission current. The amplifier controls the impedance of the saturable reactor to maintain the proper voltage on the filament to regulate its emission.

Two ranges of emission are available. In the HIGH position, the leak detector provides maximum sensitivity. To decrease sensitivity, the emission switch may be turned to LOW position (tenfold reduction in sensitivity). A screwdriver adjustment is provided for each level. The effective sensitivity of the emission meter is also changed with the emission switch, assuring full utilization of the meter on both ranges.

The amplifier of the emission regulator is a plug-in module for ease of maintenance. Power for the emission regulator is supplied by the spectrometer power supply, on the same p-c card.

### 5-2.8 Thermocouple Gauge (Schematic: Figure 20)

The "millitorr" meter on the front panel of the detector unit responds to the power generated by a thermocouple (in the inlet port) which is being heated by a constant current. The temperature of the thermocouple junction (and therefore the power generated by it) is a function of the gas density present in the system. The meter displays this gas density in standard pressure units. The thermocouple gauge tube (a Varian/NRC model 531) is replaceable.

**5-2.9 Indicator Lamps (Figure 20)**

Power to the main electronics is indicated by either the FIL ON or FIL OFF lamps.

The FIL ON lamp indicates that voltage is supplied to the filament. The EMISSION lamp on the detector unit indicates that current is flowing through the filament. The FIL ON lamp cannot be energized unless the pointer is in the green band of the pressure meter.

NOTE

> If the pressure in the spectrometer tube is above 1/3 atmosphere (250 torr) the FIL ON lamp *can* be energized and the filament will be destroyed. (See Section 5-2.5.) This is not normally a problem, because one usually observes the spectrometer tube pressure gauge displaying the reduction of pressure in the spectrometer tube toward the green band, assuring that the pressure is sufficiently low.

The FIL ON lamp also cannot be energized until the main electronics has been on for several seconds. This protects the filament.

# 5-3 TROUBLE SHOOTING

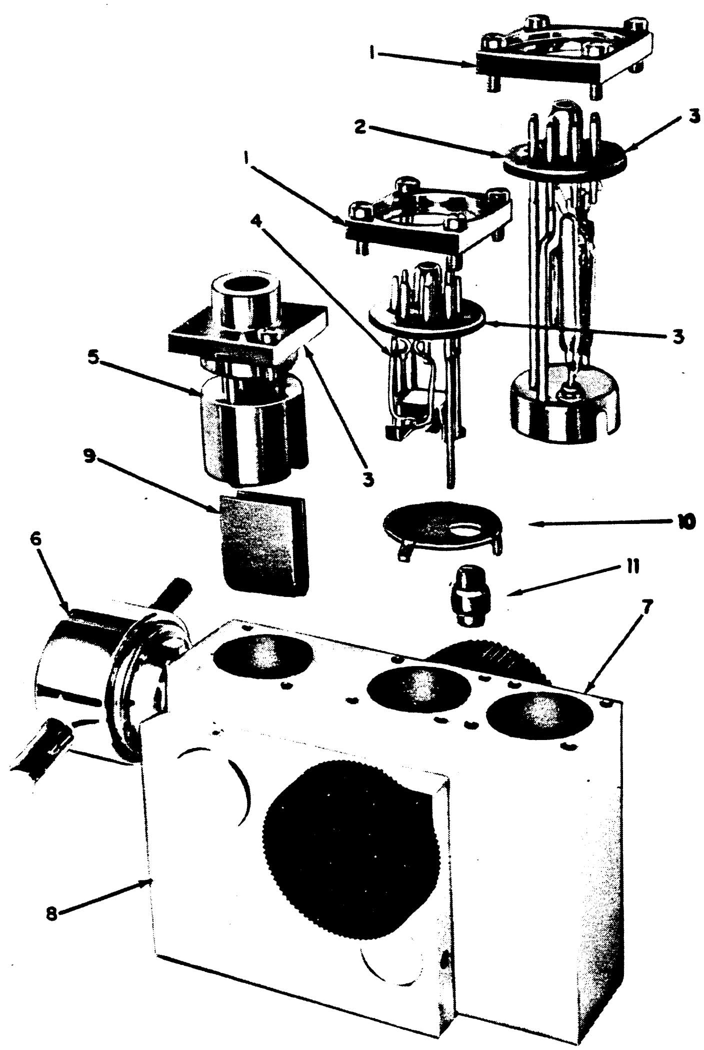
| Symptom | What to Do |
| --- | --- |
| 5-3.1 Cannot obtain helium signal on LEAK RATE meter. Filament is ON. Emission is normal. Helium is being applied by the calibrated leak. | 1. Check LEAK RATE meter by turning ZERO knob to determine that needle responds to electrical signal. Then reset zero.<br>2. Be sure $V_1$, $V_2$ and leak valve are open.<br>3. Measure voltage at the ION, REPELLER, and FOCUS test points and adjust to previous settings. (Factory settings are recorded in front of this book. New settings should be noted after installation and tuning of a new ion source.)<br>4. Slowly turn ION VOLTAGE knob approximately one full turn in each direction to locate helium peak. Monitor voltage to be sure it is changing. If peak is not located, return knob to original setting.<br>5. Repeat step 4 for FOCUS VOLTAGE.<br>6. Make sure that the Repeller voltage knob is turned fully clockwise.<br>7. If no signal is obtained, replace calibrated leak to determine whether it is plugged. |

| Symptom | What To Do |
| --- | --- |
| 5-3.1 Cont'd | 8. The above steps should produce a helium signal. If so, tune for maximum response. Turn off leak to be certain that signal is helium. If signal does not drop, peak is probably mass 6. Measure ion voltage, multiply by 1.5 and reset. This should be helium. Tune to peak. |
| | 9. If helium has not been located, remove J-1 and check voltages at each pin. Also check pin 1 of J-2 for suppressor voltage. It should be same as ION VOLTAGE at TP-2. |
| | 10. If any of the voltages is abnormal, use the normal troubleshooting techniques, referring to the system schematic. |
| | 11. If all voltages appear normal, remove ion source as in Section 5-1.1. Inspect tube body for contamination and clean, if needed, as in Section 5-1.3. NOTE: Inspect magnet assembly for stray pieces of iron which may have been inadvertently attracted to it. |
| 5-3.2 LEAK RATE meter reads above mid-scale with the RANGE SELECTOR turned fully clockwise, filament OFF. | 1. Check TP-4 to see if it is 90 volts. If it is not, try adjusting. If voltage will not change, the filament circuit for V-1 and V-403 is open. Replace either electrometer amplifier module in main electronics unit or the preamp in the mass spectrometer tube, whichever is defective. |
| | 2. If the voltage at TP-4 measures 0 volts, change the electrometer power supply module. |
| 5-3.3 LEAK RATE meter reads below zero and cannot be zeroed. | 1. Pull plug P-2 off preamplifier. If LEAK RATE meter stays negative, replace electrometer amplifier module in the main electronics unit. |
| 5-3.4 EMISSION meter pegs full scale. Filament is ON. Emission current cannot be adjusted. EMISSION light ON. | 1. Switch filaments. |
| | 2. If symptom does not change, remove connector P-1 from the spectrometer tube. If emission goes to zero, replace ion source. |
| | 3. If symptom remains the same, reconnect P-1 to J-1. Replace the emission regulator module. |

| | Symptom | What To Do |
|---|---|---|
| 5-3.5 | EMISSION meter reads zero<br><br>FILAMENT is ON<br><br>EMISSION lamp is OFF<br><br>Adjustments for emission | 1. Switch filaments<br><br>2. Switch the EMISSION selector through HIGH and LOW positions and check for emission.<br><br>3. Check continuity of filaments with an ohmmeter, referring to system schematic.<br><br>4. If one or both of the filaments is continuous check the EMISSION meter with an ohmmeter. (It should exhibit finite resistance and the needle should move up or down scale.)<br><br>5. Turn the ION VOLTAGE knob fully counterclockwise and measure the ion voltage at TP-2. If it is not 160 volts DC $\pm$ 10%, remove P1 and P2. If the voltage rises to 160 volts DC, replace the ion source or preamplifier. If the ion voltage is unaffected, replace the spectrometer power supply module.<br><br>6. If the ion voltage and filaments are good, replace the emission regulator module.<br><br>7. If emission remains at zero, replace the ion source. |
| 5-3.6 | PRESSURE meter is pegged full scale, but spectrometer tube pressure is known otherwise to be well below 1 millitorr. | 1. Disconnect P-3 from cold cathode gauge.<br>NOTE: THIS WIRE CARRIES 2000 VOLTS DC EXERCISE CAUTION.<br><br>2. If meter indication drops to zero, clean or replace the cold cathode gauge.<br><br>3. If meter remains pegged, check for short in high voltage cable or high voltage power supply. |
| 5-3.7 | PRESSURE meter reads zero.<br><br>While spectrometer tube pressure is rising, PRESSURE meter remains at zero. | 1. Remove P-3 and short the high voltage lead to the Chassis.<br>NOTE: THIS WIRE CARRIES 2000 VOLTS DC EXERCISE CAUTION.<br>If meter pegs full scale, clean or replace the cold cathode gauge liner and anode loop. |

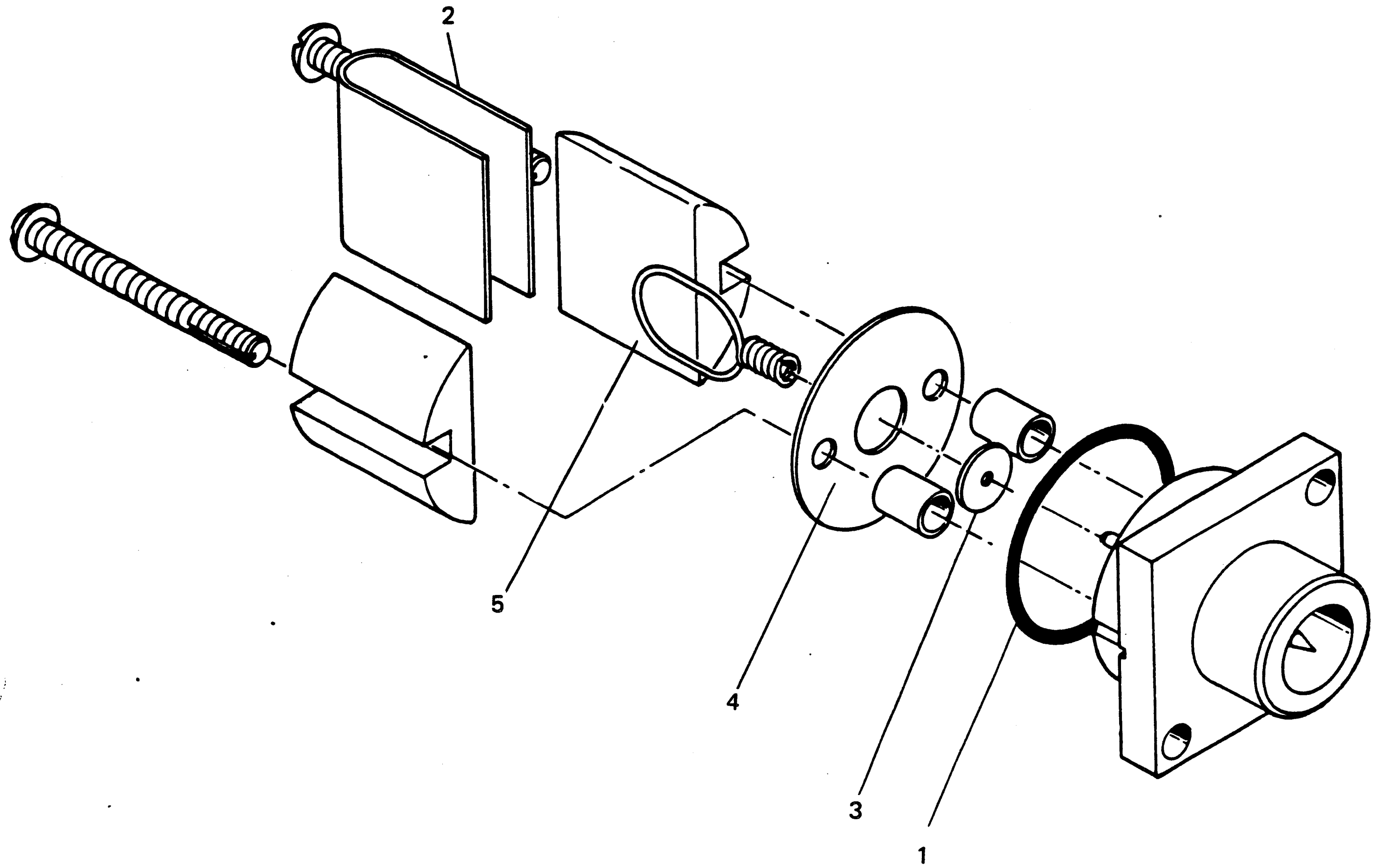
| Symptom | | What To Do |
|---|---|---|
| 5-3.8 | Millitorr meter reads "ATM" when test port pressure is known to be below 100 millitorr. | 1. Measure voltage at J15 PIN 1 to PIN 3. If not above 0.2 volts, check TC supply.<br>2. Measure resistance on TC gauge, PIN 1 to PIN 3. If open, replace TC gauge. Nominal resistance is 1.4 ohm. |
| 5-3.9 | Millitorr meter never nears "0" reading, despite otherwise known good vacuum. | 1. When TC gauge is known to be at below 5 millitorr, adjust R TC2 so that meter reads known pressure. |
| 5-3.10 | LEAK RATE meter fluctuates randomly with amplitudes exceeding 2 major divisions.<br><br>$V_1$ OPEN<br>$V_2$ CLOSED | 1. Check cold cathode gauge for cleanliness. |

# VI. SCHEMATICS



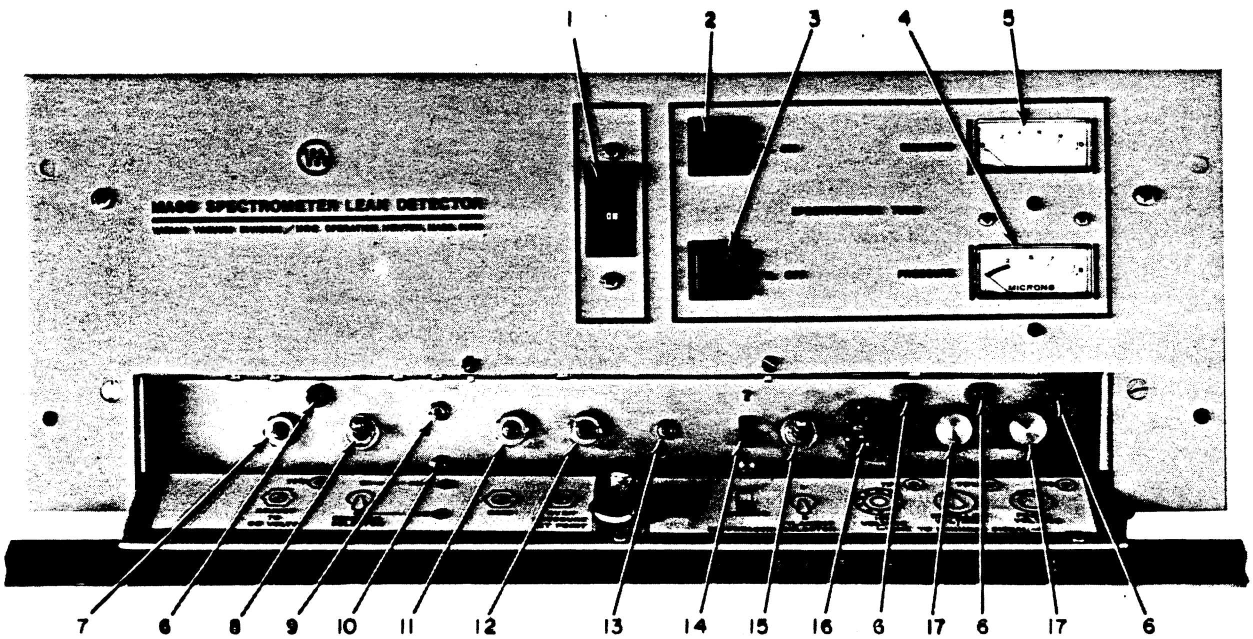

| Item | Description | VARIAN Part No. |
|---|---|---|
| 1 | Flange Cap | 0981-82852-001 |
| 2 | Preamplifier Ass'y | 0981-87849-301 |
| 3 | O-Ring, Buna | Parker No. 2-25 |
| 4 | Ion Source Ass'y | 0981-82850-301 |
| 5 | Cold Cathode Gauge Ass'y | 0981-82849-301 |
| 6 | Cap Ass'y | 0981-82847-301 |
| 7 | Body Ass'y | 0981-82838-301 |
| 8 | Magnet Ass'y | 0981-82842-301 |
| 9 | Cathode Liner | 0981-82849-008 |
| 10 | Ground Slit Plate | 0981-82854-001 |
| 11 | Ceramic Insulator | 0981-82853-001 |
| | Baffle (not shown) | 0981-83834-301 |

*Figure 12a. Mass spectrometer tube*



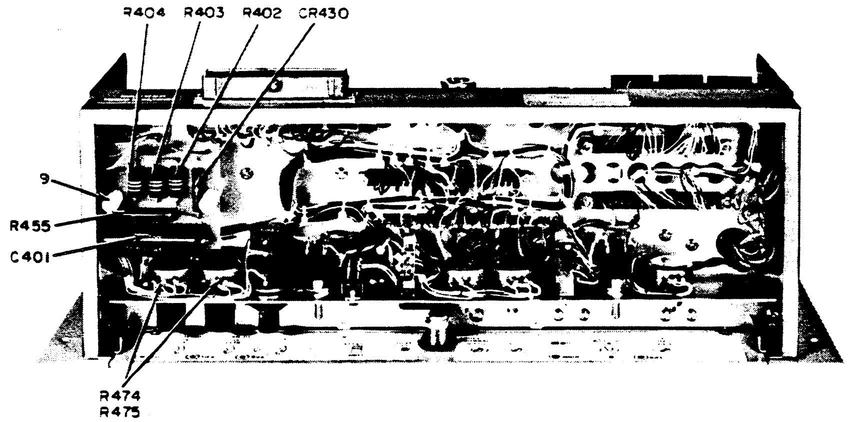

| Item | Description | VARIAN Part No. |
|---|---|---|
| 1 | O-Ring, Buna-N | Parker No. 2-25 |
| 2 | Cathode Liner | 0981-82849-008 |
| 3 | Ceramic Shield | 0981-6480-45-015 |
| 4 | Shield | 0981-82849-005 |
| 5 | Anode | 0981-82849-006 |
| | Complete CC Gauge | 0981-82849-301 |

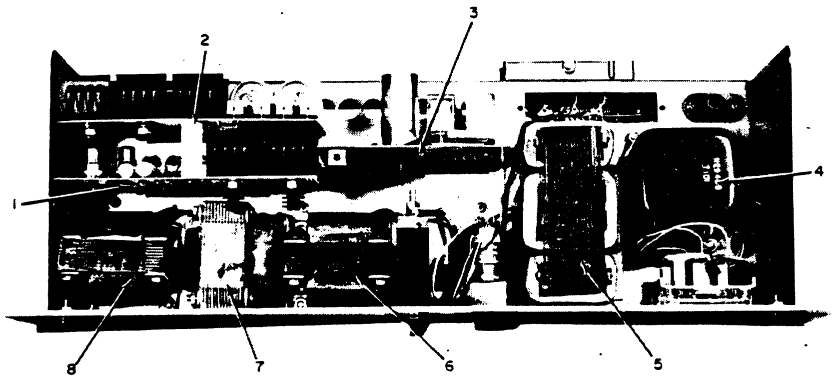
*Figure 12b. Cold Cathode Gauge*




| Item | Schematic Symbol | Description | VARIAN Part No. |
|---|---|---|---|
| 1 | CB401 | Circuit Breaker | 0981-6431-02-004 |
| 2,3 | S401, S402 | Micro-Switch | 0981-6421-02-005 |
| | | Lamp, GE No. 327 | 0981-6510-09-025 |
| | | Lens (Red) | 0981-6421-02-003 |
| | | Lens (Green) | 0981-6480-73-012 |
| 4 | M401 | Pressure Meter | 0981-F5252-001 |
| 5 | M402 | Emission Meter | 0981-F5251-001 |
| 6 | TP4, TP2, TP1, TP3 | Phone Tip Jack, E.F. Johnson No. 105-602 | 0981-6480-73-080 |
| 7 | R447 | Potentiometer, Ohmite Type AB – Type CLU-2521 | 0981-6545-12-025 |
| 8 | S403 | Switch, Toggle, Arrow-Hart No. 81027-CE | |
| 9 | R439 | Potentiometer, Allen Bradley Type RK253U | 0981-6545-09-020 |
| 10 | R438 | Potentiometer, Allen Bradley Type RK254U | 0981-6545-09-030 |
| 11 | R442 | Potentiometer, Ohmite Type AB – Type CLU-2531 | 0981-6545-12-015 |
| 12 | R406 | Potentiometer, Ohmite Type AB – Type CLU-1031 | 0981-6545-12-005 |
| 13 | R450 | Potentiometer, Allen Bradley Type RK103U | 0981-6545-12-035 |
| 14 | S405 | Switch, Slide, Stackpole No. SS-50 | 0981-6421-10-010 |
| 15 | S404 | Switch, Toggle, Arrow-Hart No. 81027-CE | |
| 16 | R433 | Potentiometer, 10 Turn 100K Helipot (less knob). | 0981-6545-12-045 |
| 17 | R434, R431 | Potentiometer, Ohmite Type AB – Type CMU-1541 | |
| Not Shown | | Cabinet Assembly | 0981-K0778-301 |

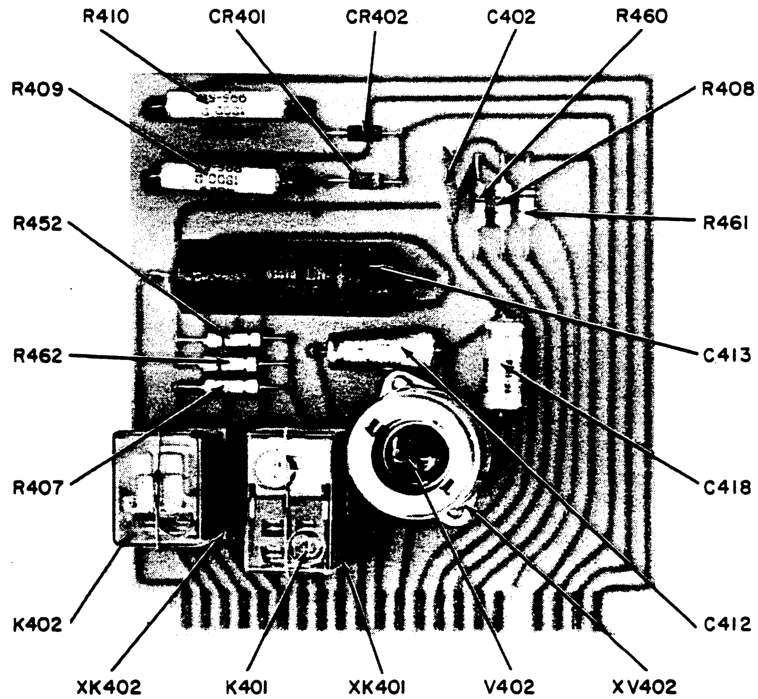
*Figure 13. Main Electronics Assembly, Front*



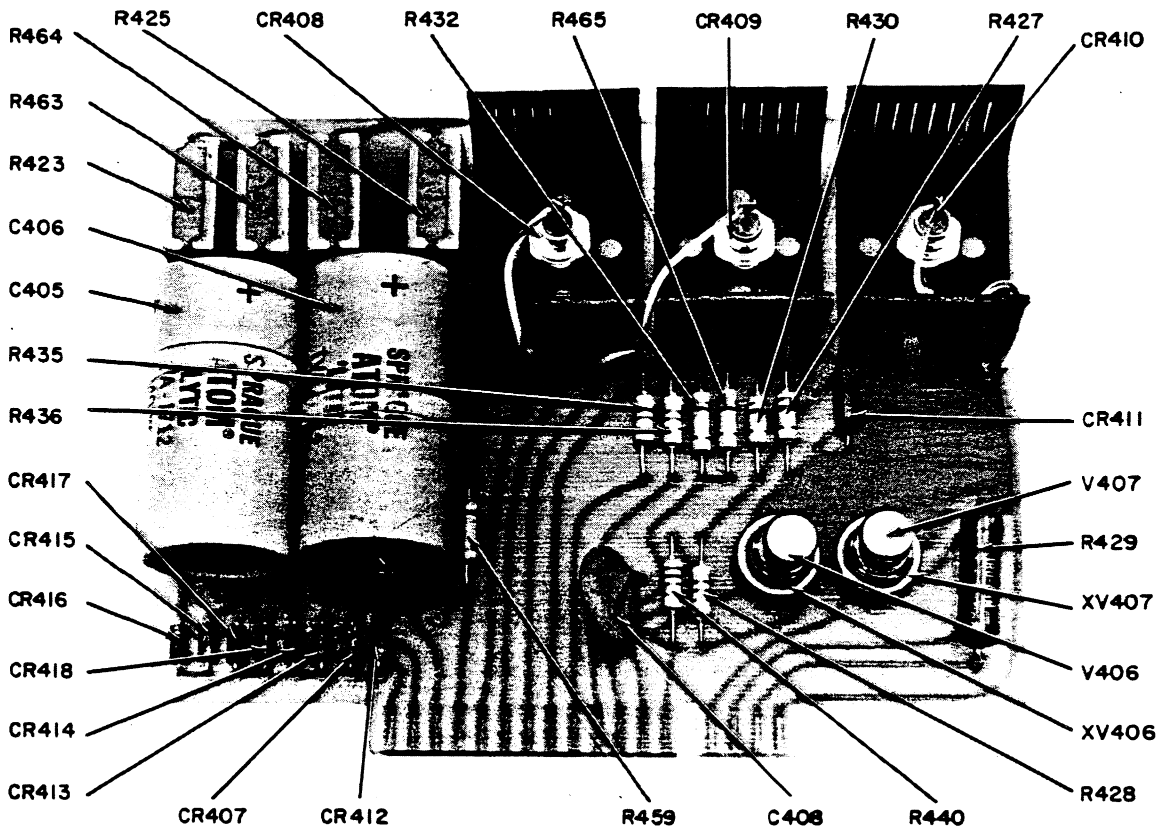

| Item | Schematic Symbol | Description | VARIAN Part No. |
|---|---|---|---|
| 1 | – | Electrometer & Electrometer Power Supply Printed Wiring Board Ass'y | 0981-F5258-301 |
| 2 | – | Spectrometer Power Supply & Emission Regulator Printed Wiring Board Ass'y | 0981-F5255-301 |
| 3 | – | Overpressure Printed Wiring Board Ass'y | 0981-F5261-301 |
| 4 | T401 | Transformer | 0981-87783-001 |
| 5 | T403 | Saturable Reactor | 0981-6584-00-005 |
| 6 | T405 | Transformer | 0981-6581-00-165 |
| 7 | T404 | Transformer | 0981-6581-00-160 |
| 8 | T402 | Transformer | 0981-6581-00-170 |
| 9 | – | High Voltage P/C Board Complete | 0981-F5311-301 |
| | C401 | • Capacitor, .001 $\mu$f, 6 KV, Sprague No. 130P102060 | 0981-6449-10-012 |
| | CR430 | • Diode, EDI Type RHC 25-8 | 0981-6491-10-005 |
| | R402-R404 | • Resistor, 27 M ±10%, 2 W, Ohmite Little Devil | |
| | R455 | • Resistor, 100 M ±15%, 1 W, Victoreen Type BAKW | |
| | R474 | • Resistor, Carbon Deposit, 1/2 W, 5%, 47K | |
| | R475 | • Resistor, Carbon Deposit, 1/2 W, 5% 220K | |

*Figure 14. Main Electronics Assembly, Back*



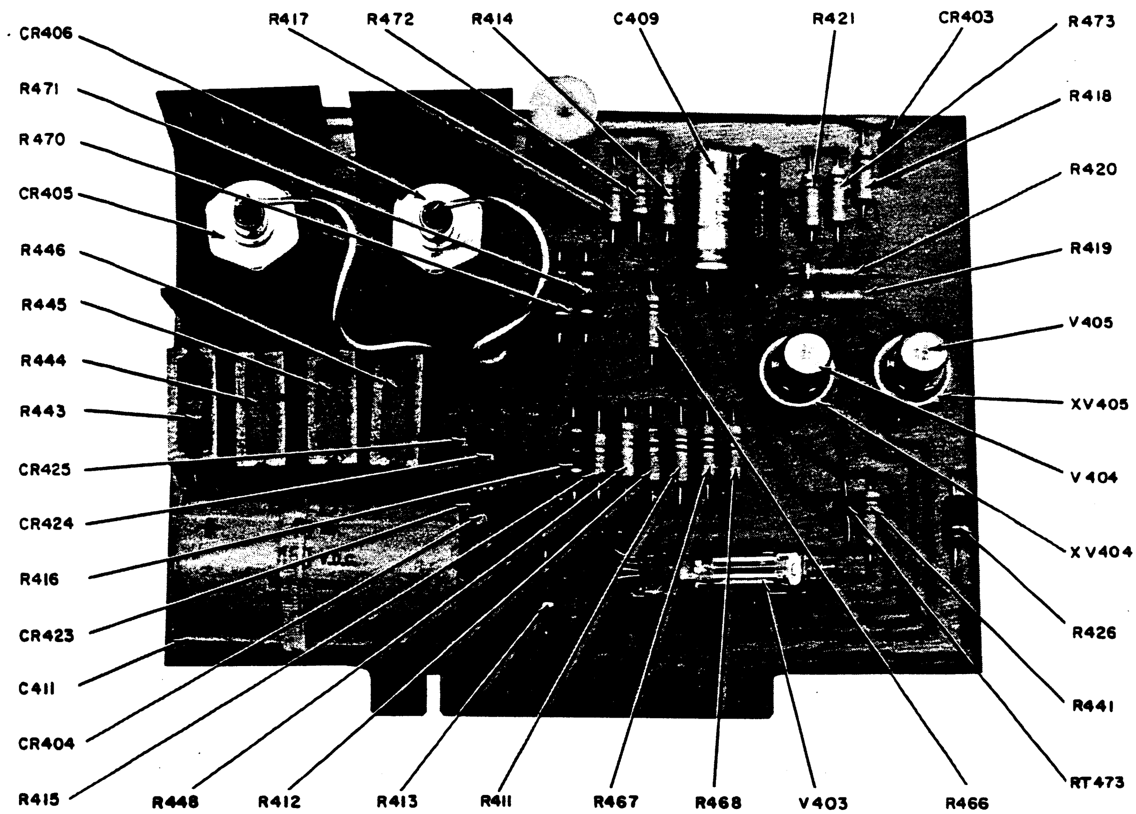

| Schematic Symbol | Description |
|---|---|
| C402 | Capacitor, .1$\mu$f, 100 V, Sprague No. TGP-10 |
| C412 | Capacitor, 4$\mu$f, 150 V, Sprague No. TE-1503 |
| C413 | Capacitor, .47$\mu$f, 400 V, Sprague No. 4TM-P47 |
| C418 | Capacitor, 10$\mu$f, 50 V, Sprague No. TE-1304 |
| CR401, CR402 | Diode, Sarkes-Tarzian No. E6 |
| K401 | Relay, 4 Pole, Double-Throw, 15 K, 115 VDC, 5A Contacts, Allied No. TF154-4C |
| K402 | Relay, 2 Pole, Double-Throw, 115 VAC, 60 Hz, 5A Contacts, 115 VAC Res., Allied No. TF-255-2C |
| R407 | Resistor, Carbon Deposit, 33 K ±5%, 1/2 W |
| R408 | Resistor, Carbon Deposit, 3 K ±5%, 1/2 W |
| R409, R410 | Resistor, 1.8K ±10%, 5 W, IRC Type PW5A |
| R452, R462 | Resistor, Carbon Deposit, 300 K ±5%, 1/2 W |
| R460 | Resistor, Carbon Deposit, 4.7 K ±5%, 1/2 W |
| R461 | Resistor, Carbon Deposit, 10 K ±5%, 1/2 W |
| V402 | Tube, GE Type 6EW6 |
| XK401 | Socket, 4 Pole, PC Mounting, Allied No. 30055-4 .1 Grid |
| XK402 | Socket, 2 Pole, PC Mounting, Allied No. 30054-3 .1 Grid |
| XV402 | Socket, Tube, Cinch-Jones No. 7PC-M2 |

*Figure 15. Overpressure Protection Board*
*Main Electronics Unit*




| Schematic Symbol | Description |
|---|---|
| C405, C406 | Capacitor, 40$\mu$f, 450 V, Sprague No. TVA-1712 |
| C408 | Capacitor, .01$\mu$f, 1 KV, Sprague No. 5GA-S10 |
| CR407, CR412-CR418 | Diode, Sarkes-Tarzian No. E6 |
| CR408 | Diode, Zener, 100 V, Motorola or G.E. No. 1N3005A |
| CR409, CR410 | Diode, Zener, 160 V, Motorola or G.E. No. 1N3012A |
| CR411 | Diode, Zener, 50 V, Motorola MZ 1000-30 |
| R423, R425 R463, R464 | Resistor, 4 K ±10%, 5 W, IRC Type PW5A |
| R427, R430 | Resistor, Carbon Deposit, 100 K ±5%, 1/2 W |
| R428, R436 | Resistor, Carbon Deposit, 4.7 K ±5%, 1/2 W |
| R429 | Resistor, 10 K ±10%, 5 W, IRC Type PW5A |
| R432 | Resistor, Carbon Deposit, 20 K ±5%, 1/2 W |
| R435 | Resistor, Carbon Deposit, 270 ohms ±5%, 1/2 W |
| R440 | Resistor, Carbon Deposit, 1 K ±5%, 1/2 W |
| R459 | Resistor, Carbon Deposit, 68 K ±5%, 1/2 W |
| R465 | Resistor, Carbon Deposit, 30 K ±5%, 1/2 W |
| V406, V407 | Tube, Nuvistor, RCA No. 7586, P/N 0981-6551-00-125 |
| XV406, XV407 | Socket, Nuvistor, Cinch-Jones No. 5NS-2 |

*Figure 16. Spectrometer Power Supply and Emission Regulator Board. Main Electronics Unit*




| Schematic Symbol | Description |
|---|---|
| C403 | Capacitor, .1$\mu$f, 200 V, Sprague No. 155P .1-200 |
| C409 | Capacitor, 50$\mu$f, 50 V, Sprague No. TE-1307 |
| C411 | Capacitor, 40$\mu$f, 450 V, Sprague No. TVA-1712 |
| CR403 | Diode, Zener, 51 V Motorola MZ1000-30 |
| CR404, CR423 | Diode, Sarkes-Tarzian No. E6 |
| CR424, CR425 | |
| CR405, CR406 | Diode, Zener, 100 V, Motorola or GE No. 1N3005A |
| R411, R417 | Resistor, Carbon Deposit, 10 M ±10%, 1/2 W |
| R467, R468 | |
| R412 | Resistor, Carbon Deposit, 6.8 M ±5%, 1/2 W |
| R413 | Resistor, Carbon Deposit, 1.6 K ±5%, 1/2 W |
| R414 | Resistor, Carbon Deposit, 5.6 M ±5%, 1/2 W |
| R415 | Resistor, Carbon Deposit, 470 ohms ±5%, 1/2 W |
| R416, R470 | Resistor, Carbon Deposit, 3 K ±5%, 1/2 W |
| R471 | |
| R418 | Resistor, Carbon Deposit, 270 K ±5%, 1/2 W |
| R419 | Resistor, Carbon Deposit, 3 M ±5%, 1/2 W |
| R420, R472 | Resistor, Carbon Deposit, 4.7 M ±5%, 1/2 W |
| R421, R466 | Resistor, Carbon Deposit, 22 K ±5%, 1/2 W |
| R473 | |
| R426 | Resistor, Carbon Deposit, 2 M ±5%, 1/2 W |
| R441 | Resistor, Carbon Deposit, 6.8 K ±5%, 1/2 W |
| R443-R446 | Resistor, 1.3 K ±10%, 5 W, IRC Type PW5A |
| R448 | Resistor, Carbon Deposit, 33 K ±5%, 1/2 W |
| RT473 | Thermistor, Fenwal No. KB22L2 |
| V404, V405 | Tube, Nuvistor, RCA No. 7586 |
| V403 | Tube, Raytheon Type CK5886 |
| XV404, XV405 | Socket, Nuvistor, Cinch-Jones |

*Figure 17. Electrometer and Electrometer Power Supply Board, Main Electronics Unit*

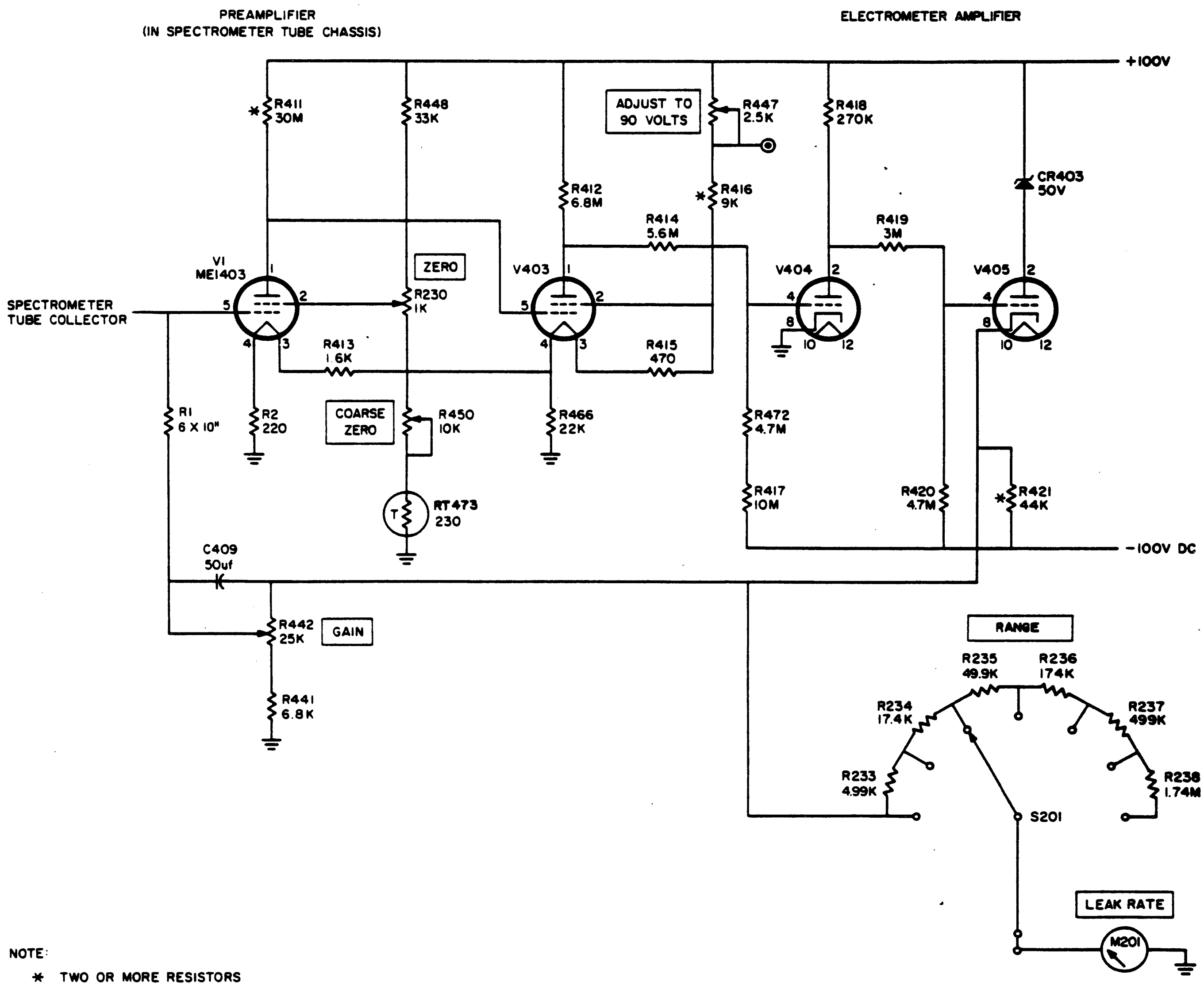



*Figure 18. Electrometer Amplifier Simplified Schematic*

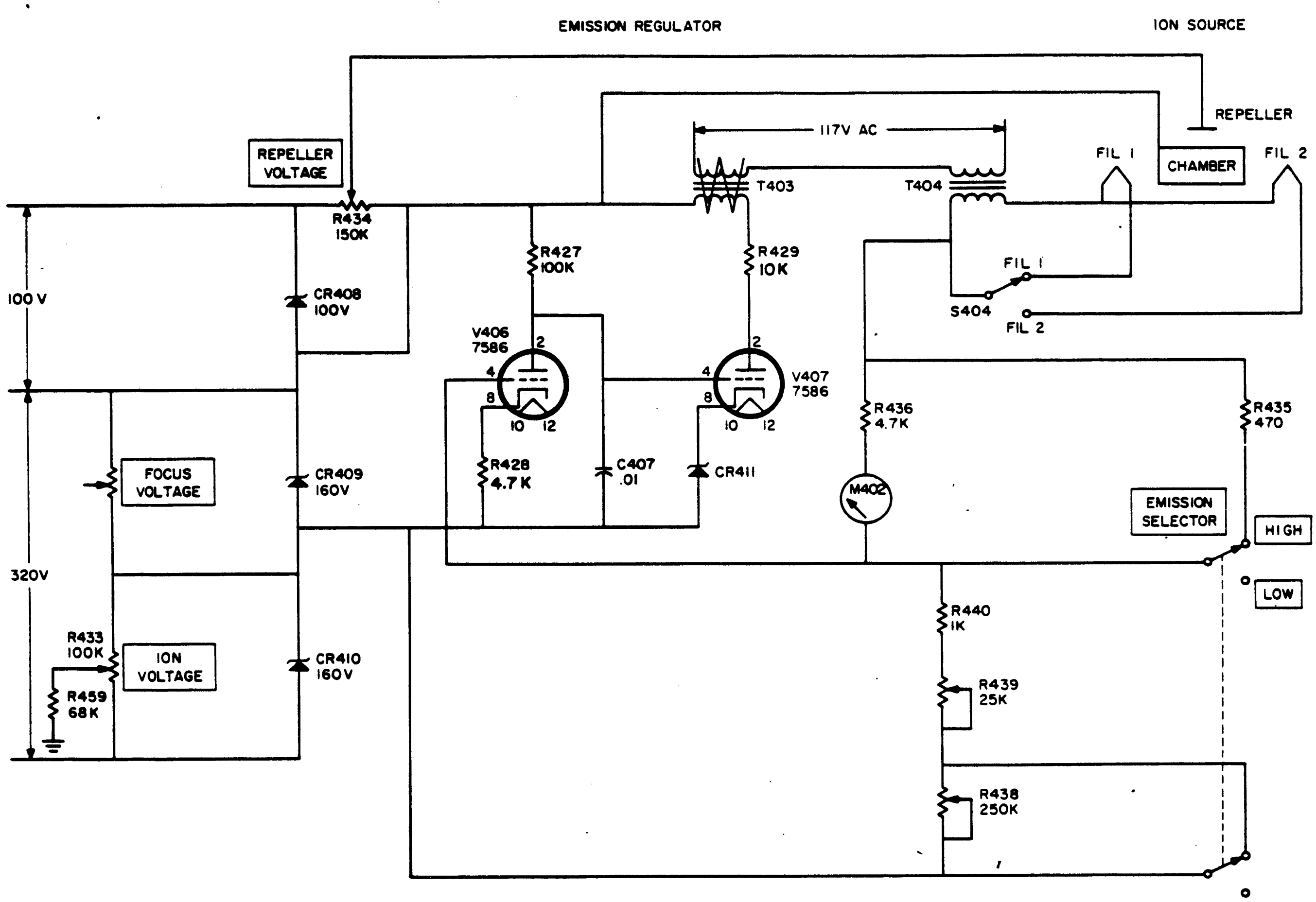



*Figure 19. Emission regulator simplified schematic*

**PARTS LIST OF ACCOMPANY Figure 20**

| Item | Part Description | |
|---|---|---|
| C1 | $0.01\mu f$ capacitor | |
| TC C1 | $2\mu f$, 200V, TRW, X663F | |
| C11 | $0.001\mu f$, 1000 VDC, Ceramic Disc Sprague No. 1075-D10 | |
| C417 | $0.1\mu f$ capacitor | |
| C416 | $0.1\mu f$ capacitor | |
| R1 | $6 \times 10^{11} \pm 10\%$, Victoreen "hi-Meg" | |
| R2 | 221 ohms, 1/4 Watt | |
| TCR1 | 33 ohms ±5%, Carbon | |
| TCRT1 | 1 ohm Thermistor, Fenwal LDO1K3 | |
| TCR2 | 200 ohms Potentiometer, 200 ohms 2W Wirt E860PCAB | |
| R11 | 1K ohm 1-1/2 W Potentiometer 10 turn Beckman Helipot Model 7216 | |
| R12 | 6.8 K ±5%, 1/2 W dep. carbon | |
| R13 | 4.99 K ±2%, Dale type DCF | |
| R14 | 17.4 K ±2%, Dale type DCF | |
| R15 | 49.9 K ±2%, Dale type DCF | |
| R16 | 174 K ±2%, Dale type DCF | |
| R17 | 499 K ±2%, Dale type DCF | |
| R18 | 1.74 M ±2%, Dale type DCF | |
| TCCR1 | 6.8 V Zener diode, Schauer SZ6.8 | |
| TCCR2 | 6.8 V Zener diode, Schauer SZ6.8 | |
| CR11 | 6.8 V Zener diode, Schauer SZ6.8 | |
| DS11 | Pilot light, Leecraft No. 36 EN2113 (amber) | |
| TC T1 | Transformer | 7560-87430-001 |
| M11 | Meter, Leak Rate | 0981-84398-301 |
| TC M12 | Meter, Millitorr | 0981-6522-08-125 |
| S11 | Switch, Range, Centralab No. 2502, 1 pole, 7 pos, $30^{\circ}$ | |
| V1 | Vacuum tube, Mullard ME-1403 | |
| | Sensitivity Control: Lutron "Fandial" FS-5, 5 amp | 0981-6589-39-005 |
| | Interconnect cable | 0981-K0779-301 |

# VII. ACCESSORIES

## 7-1 AUDIBLE ALARM (0991-K1336-301)

### 7-1.1 General

The Audible Alarm circuit has two functions: to furnish an audible signal with pitch proportional to the Leak Rate meter deflection, and to furnish relay contacts which open or close at an adjustable point within the meter range.

The Audible Alarm module has two controls, one for volume and one to adjust the set point which controls both the relay and the initiation of the audible pitch.

### 7-1.2 Circuit description (Fig. 21)

The audible pitch is generated by a linear timer (A-1) which generates pulses at a repetition rate which varies as a function of the current supplied to it. These pulses are amplified by Q7 and Q8 to drive the speaker. Volume is controlled by varying the width of the pulses with R8.

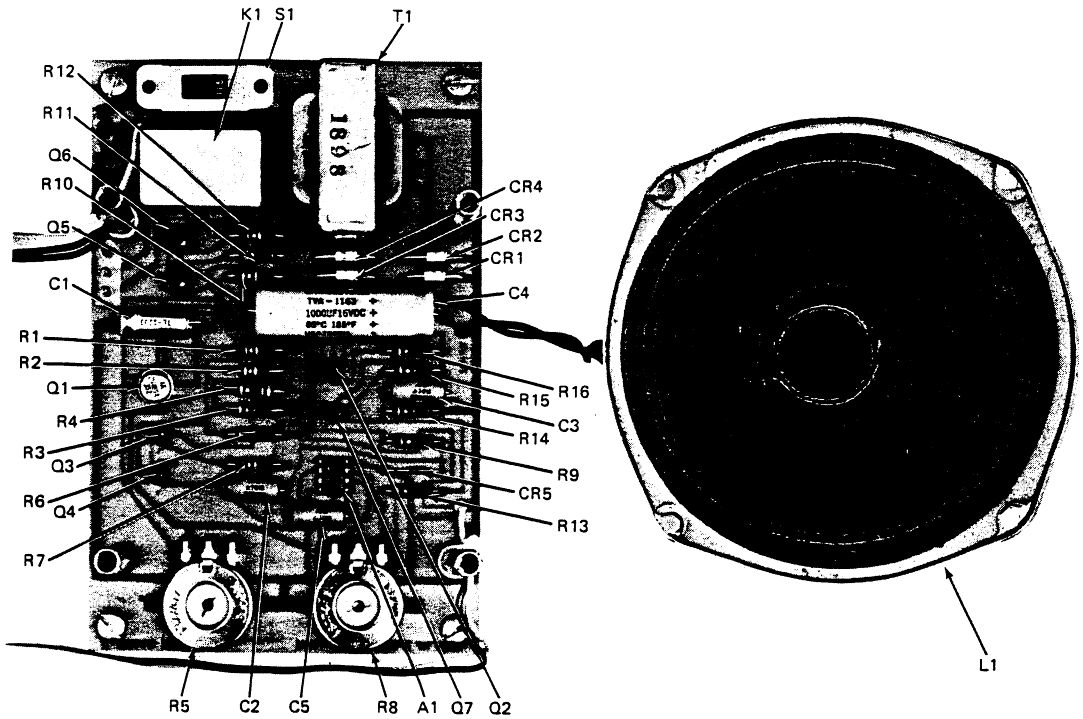
The basic elements in the circuit are Q1-b, which generates the necessary exponential response to the linear signal shown on the Leak Rate meter, and the bridge Q2-Q3 which furnishes current to either an inverter which powers the relay coil or to the timer to generate the pulse train. The input signal level at which the bridge rebalances is adjusted with R5 (set point).

The circuit, which can operate on either 110 volts or 220 volts, 50/60 hertz, draws about 5 watts of power. The relay contacts are form C, rated at 5 amps, 125 volts.

## 7-2 SUPER PROBE (See page 53 for Parts Numbers)

### 7-2.1 General (Fig. 23)

The Super-Probe is an accessory for the Varian 925-40 Porta-Test Leak Detector. It is a sniffer probe designed to find leaks in containers pressurized internally with helium or helium-air mixtures.




| Schematic Symbol | Description |
|---|---|
| A1 | Int. Circ. Signetics NE555V |
| C1 | Capacitor 50$\mu$ f 12V |
| C2, C3, C5 | Capacitor .047$\mu$ f 200V |
| C4 | Capacitor 1000$\mu$ f 12V |
| CR1, CR2, CR3, CR4 | Diode Sarkes Tarzian E-6 |
| CR5 | Diode, Zener Schauer SZ 6.8 |
| K1 | Relay - RBM/ESSEX MS 64-902 0981-6570-09-040 |
| L1 | Loudspeaker, Utah SP5D 3-4$\Omega$ |
| Q1 | Transistor 2N4854 |
| Q2, Q3, Q7 | Transistor 2N4248 |
| Q5, Q6 | Transistor 2N5735 |
| Q8 | Transistor MPS 6560 |
| R1, R7, R10, R12 | Resistor, Carbon Deposit, 1/2 W 10K |
| R2 | Resistor, Carbon Deposit, 1/2 W 68K |
| R3, R13, R14 | Resistor, Carbon Deposit, 1/2 W 1K |
| R4 | Resistor, Carbon Deposit, 1/2 W 3.3K |
| R5 | Resistor, Variable, 100$\Omega$, CTS 450-U-100-1" |
| R6 | Resistor, Carbon Deposit 1/2W 1 M |
| R8 | Resistor Variable 2500$\Omega$ CTS-450-U-2500-1" |
| R9, R11, R15, R16 | Resistor Carbon Deposit 100 |
| S1 | Switch, Slide, DPDT Switchcraft 46206LF |
| T1 | Transformer, Quality # 305-K-41 |

*Figure 21. Audible Alarm Unit*

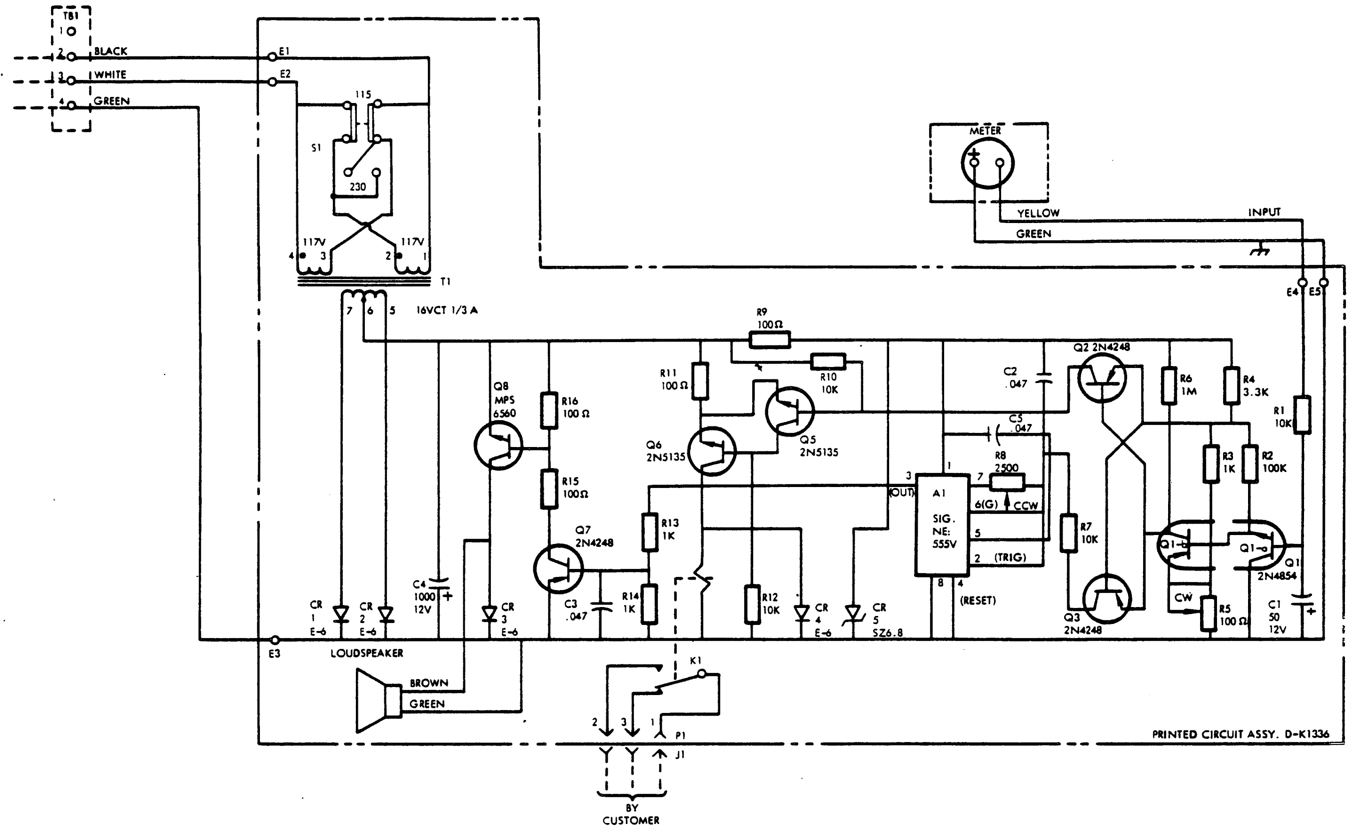



*Figure 22. Schematic, Audible Alarm*

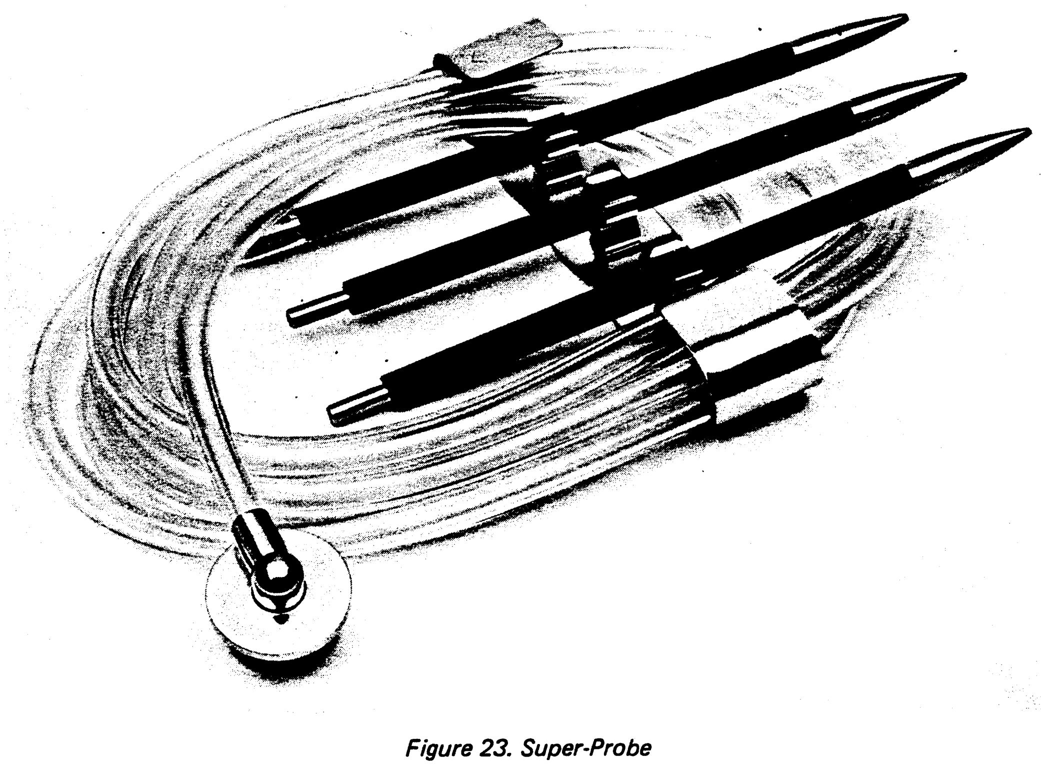


*Figure 23. Super-Probe*

The Super-Probe requires no adjustment. It has a fixed conductance which permits the mechanical pump with the Porta-Test to maintain approximately 100 millitorr foreline pressure. This conductance is sufficient to capture significantly more of the helium coming out of a leak than would be possible with a conventional probe-leak detector combination.

### 7-2.2 Application and Operation

The test port adaptor which is assembled to the clear plastic tubing of the Super-Probe is designed to fit directly into the test port of the 925-40 Porta-Test. Pumping out the Super-Probe the first time, and any time after it has been out of use will be fairly slow, perhaps requiring five minutes to reach 100 millitorr. This is because of outgassing from the walls of the plastic tubing, which is slowed by air being drawn in at the probe tip. The process can be hastened by pinching off the plastic tube near the probe body until the foreline pressure gauge drops below 50 millitorr, at which time the tube should be opened and a pressure of about 150 millitorr will be obtained. If your Porta-Test is operating with full heater voltage (sensitivity control at WARM-UP) you can now open $V_2$ and proceed to use the probe. If your Porta-Test has the sensitivity control turned clockwise from the warm-up position, wait until the foreline pressure reaches nearly 100 millitorr, then open $V_2$ and proceed with testing.

The response time of the probe is between 1 and 3 seconds depending on the mechanical pump; a reasonable traverse speed for the probe along a potentially leaky seam depends on the size leak suspected, and will be quickly developed by the operator. When looking for a large leak the traverse speed can be faster than when a very small leak is suspected. Faster response can be obtained by shortening the tubing connecting the probe with the Porta-Test.

The Super-Probe, in drawing in room air, will also draw in helium which is present at about five parts per million of air. This will constitute a background signal equivalent to a leak the size of which depends on the speed of the mechanical pump (see table below). If this signal is relatively constant, it can be "zeroed out" by suitable adjustment of the **zero** and **coarse zero** controls to permit using the Porta-Test on a more sensitive scale. If this background wanders or drifts enough to preclude testing at the desired sensitivity, the use of an Automatic Zeroing circuit is suggested. Such a circuit, developed specifically for the 925-40 is described in Sect. 7-3 and can be ordered from Varian.

In use, it is advisable to keep the tip of the Super-Probe very slightly removed from the surface of the test piece to avoid sucking in dust, condensation or other materials clinging to the surface. The Super-Probe is resistant to plugging in normal use, but direct exposure to liquids will plug it, at least temporarily. Shaking the probe or tapping the side of it on a hard surface will frequently clear such a stoppage, but continued abuse of this nature will soon make the probe unrepairable. Changing the probe is simple - after closing $V_2$, just cut the clear plastic tubing at the end of the stainless probe and push onover the new probe, working the clear tubing right up to the black plastic. Replacement probes can be ordered from Varian.

### 7-2.3 Characteristics of probes for different mechanical pumps

| Mechanical pump speed | Nominal response time | Nominal equivalent leak | Super-Probe assembly part number | Replacement probes part number |
|---|---|---|---|---|
| 1 cfm | 3 sec. | $3 \times 10^{-7}$ std. cc/sec. | 0991-K1889-301 | 0991-K2132-301 |
| 5.6 cfm | 2 sec. | $1 \times 10^{-6}$ std. cc/sec. | 0991-K1889-305 | 0991-K2132-305 |
| 10.6 cfm | 1 sec. | $3 \times 10^{-6}$ std. cc/sec. | 0991-K1889-310 | 0991-K2132-310 |

## 7-3 AUTOMATIC ZERO (0991-K2525-302)

### 7-3.1 General

The automatic zero feature, an optional accessory for the Varian 925-40 Porta-Test, is designed to prevent slowly varying signals from being displayed on the leak-rate meter. Only rapidly changing signals produce a movement of the meter needle, which otherwise remains at the zero mark.

The "Auto Zero" is located at the lower back of the detector module. The three controls are accessible from outside the back of the detector module, while the printed circuit board comprising the unit is inside. The "on-off" switch brings the circuit into and out of effect. The "zero" adjustment sets the position at which the leak-rate meter needle rests, and the "rate" control adjusts the speed with which the needle recovers to the zero setting.

### 7-3.2 Use

After the Porta-Test has been properly tuned and zeroed (see Section 4-1) with the Auto-Zero **off**, the circuit can be turned **on**. After an initial meter deflection, the "zero" control should be adjusted (with the tuning screwdriver) to set the leak-rate meter again at zero. The "rate" control can also be set (though for a given type of testing this should be a one-time adjustment). Probably the most effective way to set the "rate" control is with a simulated (or real) leaky part, in the mode in which it will be tested. The "rate" control should be set as slow as will still compensate for unwanted fluctuations. As the rate of zeroing is increased, the possibility of seeing the full magnitude of a leak is decreased. If a leaky part is not available, it can be simulated (roughly) by the use of a calibrated leak installed in the test port. Manipulation of the valve of the calibrated leak can produce a rapidly rising signal, and the "rate" control can be adjusted to make the leak-rate meter recover from this signal at the desired rate.

### 7-3.3 Circuit description (Fig. 25)

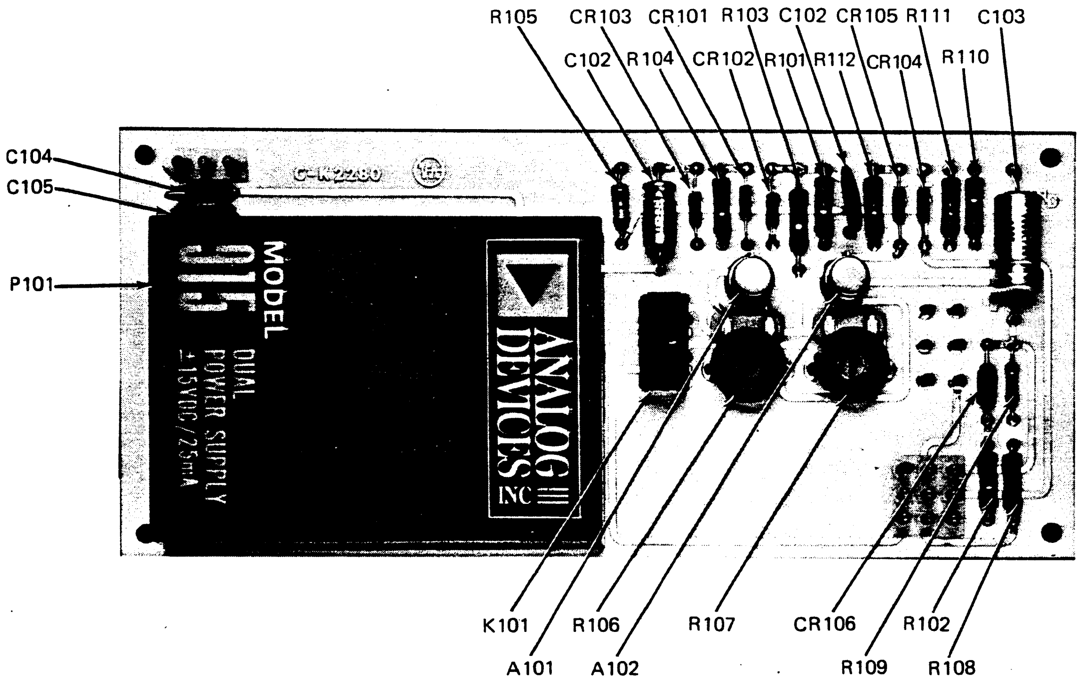
Voltage appearing at the negative terminal of the meter is sensed by the amplifier (A101) at pin 2 (which is protected from voltages of greater than 0.6 volts) and a stable output signal is produced at pin 6. The level of this signal can be adjusted to generate a rest (or zero) position of the meter by adjustment of the variable resistor (R106). The output of A101 is fed through a (rate-control) resistor (R107) to the input of amplifier A102. The output of A102 is used to bias the screen grid of the preamplifier (ME1403) tube of the Leak Detector.

## 7-4 TUNING LEAK (0991-K1608-301)

### 7-4.1 General description (Fig. 26)

The Varian Tuning Leak is an uncalibrated source of helium designed to furnish an ample leak Rate signal for tuning the 925-40 Porta-Test leak detector. The Tuning Leak is adjustable to furnish approximately the same signal for the Porta-Test regardless of the size of the mechanical pump or system being used to furnish the backing vacuum for the Porta-Test.

The Helium used by the Tuning Leak is the naturally occuring Helium in the air, which is normally present at a concentration of about 5 parts per million. The Tuning Leak admits a small amount of air into the Leak Detector, where the trace of Helium is separated and identified. No separate source of Helium is necessary for use with this leak.




| Schematic Symbol | Description |
|---|---|
| A101, A102 | Int. Circ. Analog Devices AD741K |
| C101, C104, C105 | Capacitor .01$\mu$ f 1KV |
| C102 | Capacitor 1$\mu$ f 50V |
| C103 | Capacitor 1000$\mu$ f 10V |
| CR101, CR105 | Diode, IN457A |
| CR106 | Diode, Zener, 10V |
| K101 | Relay-Struthers-Dunn # MRR1ADS-5V (not used) |
| R101, 104 | Resistor, Carbon Deposit 1/2W 22K |
| R102 | Resistor, Carbon Despoit 1/2W 2.2K |
| R103 | Resistor, Carbon Deposit 3/4W 10M |
| R105 | Resistor, Carbon Deposit 1/2W 1K |
| R106 | Resistor Variable 1/4W 10K CTS Type U201R 103B |
| R107 | Resistor Variable, 1/4W 100K CTS Type U201R 104B |
| R108, R111, R112 | Resistor Carbon Deposit 1/2W 10K |
| R109 | Resistor Carbon Deposit 1/2W 33K |
| R110 | Resistor Carbon Deposit 1/2W 100K |
| S101 | Switch, DPDT Slide Stackpole # SS-50/±C/ 1/2 inch |
| P101 | Power Supply, ±15 VDC Analog Devices 915 |

*Figure 24. Automatic-Zero*

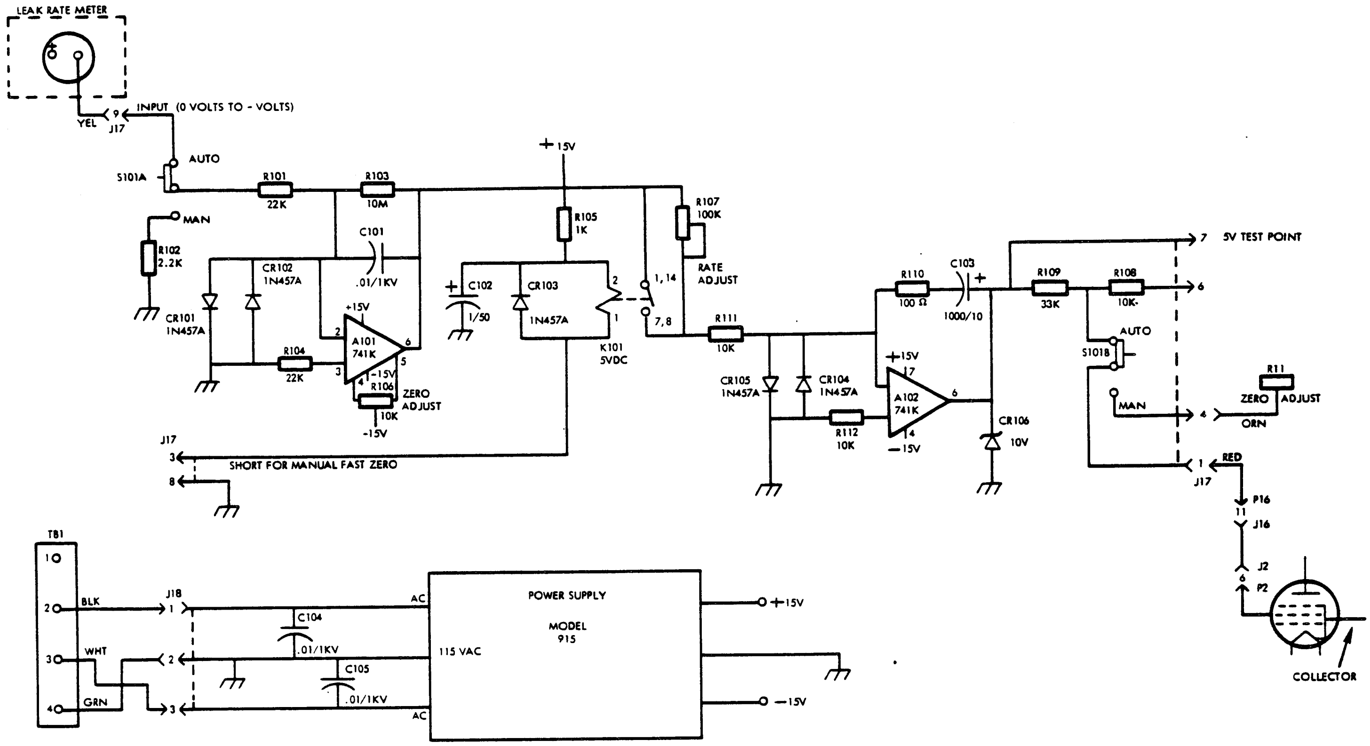



*Figure 25. Schematic, Automatic-Zero*

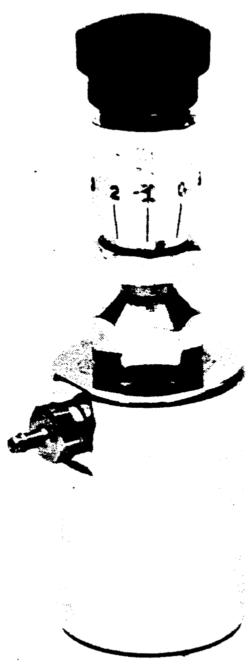


*Figure 26. Tuning Leak*
(Part Number-0991-K1608-301)

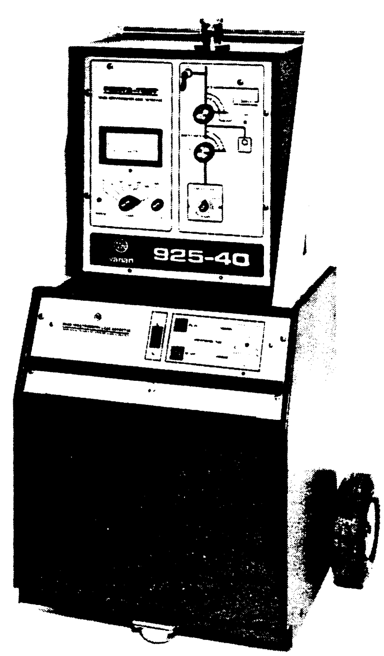



*Figure 27. Cart*

### 7-4.2 Application and Operation

The use of the Tuning Leak is described in section 4 of the Porta-Test manual. Basically; with the Tuning Leak installed in the test port, proceed with steps 1 through 3 as shown on the front panel. Now slowly open or close the valve on the Tuning Leak to achieve a stable pressure of 100 millitorr on the front-panel pressure gauge. Now proceed with step 4 and 5, permitting the 100 millitorr pressure to be applied to the foreline of the diffusion pump. Now continue with normal tuning procedures, as listed in the manual, section 4-1.11.

If the air in the vicinity of the Tuning Leak has a varying helium content, as might be the case if helium were being released nearby, the Leak Rate signal will not be stable. Variations in needle position as drafts blow different helium concentrations past the Tuning Leak will make it difficult or impossible to tune the Porta-Test. One solution to this is to run a piece of tubing from the fitting on the side of the Tuning Leak to an area of stable helium concentration - perhaps out a window or through the roof. This should provide a steady meter deflection to use in tuning the Porta-Test.

The Tuning Leak should be closed gently when necessary, as excess force will damage the valve seat. Do not attempt to use the Tuning Leak in a classical leak detector (Varian 925, Veeco, etc.) which requires test port pressures near $10^{-4}$, as it will only work on the Varian 925-40 Porta-Test.

## 7-5 CART

### 7-5.1 General description (Fig. 27)

A specially designed cart, available for use with the 925-40 Porta-Test, provides space for the Detector Module, the Main Electronics, and a mechanical vacuum pump. Two large semi-pneumatic wheels make the unit easy to roll around, and a front ball-caster helps maneuver in close quarters.

The cart measures 20 3/8" wide and 16 1/2" deep, and the wheels add to both dimensions to make the overall size 26 1/2" wide by 19 1/2" deep. The test port is the highest part of the assembly at 46 1/2" from the floor. The unit has a single, 15 foot, power cord and is equipped with a duplex receptacle to connect the mechanical pump and leak detector. Ventilating areas on the sides of the cart provide handy visual access to check the level of the mechanical pump oil. The unit can be purchased alone or complete with a choice of three sizes of Welch pumps and manifolds to connect to your Porta-Test.

### 7-5.2 Service

To remove the rear door of the cart, loosen the four quarter-turn fasteners, then lift the door off. This provides access to check the tension on the mechanical pump belt, disconnect the main electronics, power cords, or pump manifold.

NOTE

Check the condition of the belt regularly. Failure of this belt, if undetected (as at night) will damage or ruin the diffusion pump.

To gain complete access to the pump in order to replace it or change oil, etc., first remove the rear door. Disconnect the pump power cord, remove the rubber exhaust hose, and loosen the hose clamp on the clear plastic tubing connecting the foreline to the mechanical pump inlet. Separate the foreline from the pump inlet. Now remove the nine philips-head screws around the base of the cart. The entire cart structure can now be lifted off by two people and set aside, leaving the pump fully exposed on the wheeled base plate. The detector module, main electronics, foreline, etc. all will lift off without being disconnected.

### 7-5.3 Order Numbers

| | |
|---|---|
| Cart without pump or manifold | 0991-K1874-301 |
| Cart with 0.9 cfm pump (1400) & manifold | 0991-K1874-302 |
| Cart with 5.6 cfm pump (1402B) & manifold | 0991-K1874-302 |
| Cart with 10.6 cfm pump (1376B) & manifold | 0991-K1874-303 |

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