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SECTION 1

INTRODUCTION

This manual contains important information for understanding, installing, starting, operating, maintaining, troubleshooting, and ordering spare parts for your ULTRATEST® (see table of contents). Appendix F contains the electrical schematics and board component location drawings.

We recommend that you read the yellow sheet in the front of this manual and Sections 2, 3, 4, and 6 before using your ULTRATEST. If you have the optional QUICK-TEST™ you should also read Appendices A-1 through A-3. See Appendix D if your ULTRATEST has the manual gross leak bypass and Appendix E if your ULTRATEST is the US autoranging version.

1-1 DETERMINING THE MODEL AND THE SERIAL NUMBER OF YOUR ULTRATEST

Most ULTRATESTs are wired for 115V and have a D4A backing pump, a LEYBODIFF 180L diffusion pump, and a D16A roughing pump (see Sections 7-6-2-2, 7-6-2-3, and 7-2). You can also order an ULTRATEST with a D8A, D30A, or D60A roughing pump or with a TMP150 turbomolecular pump. The TMP 150 replaces the diffusion pump. See the ID plate on the end of the roughing pump to determine which roughing pump model you have (see Figure 1-1).

The identification label of the ULTRATEST is under the small fold-up work top in the corner near the valve V5 knob (see Figure 1-1). The label contains the following information:

- The 10 digit serial number such as 1179290077.
- The 5 digit catalog number such as 15562.
- The supply voltage such as 115V.
- The power input such as 2700VA (2.7 kilowatt).
- The electrical approval standard VDE 0100. This indicates it is in compliance with West German electrical standards.

1-2 WARNINGS, CAUTIONS, AND NOTES

"WARNING" statements are used in this manual to prevent injury to personnel; "CAUTION" statements are used to prevent damage to equipment; "NOTES" contain helpful information.

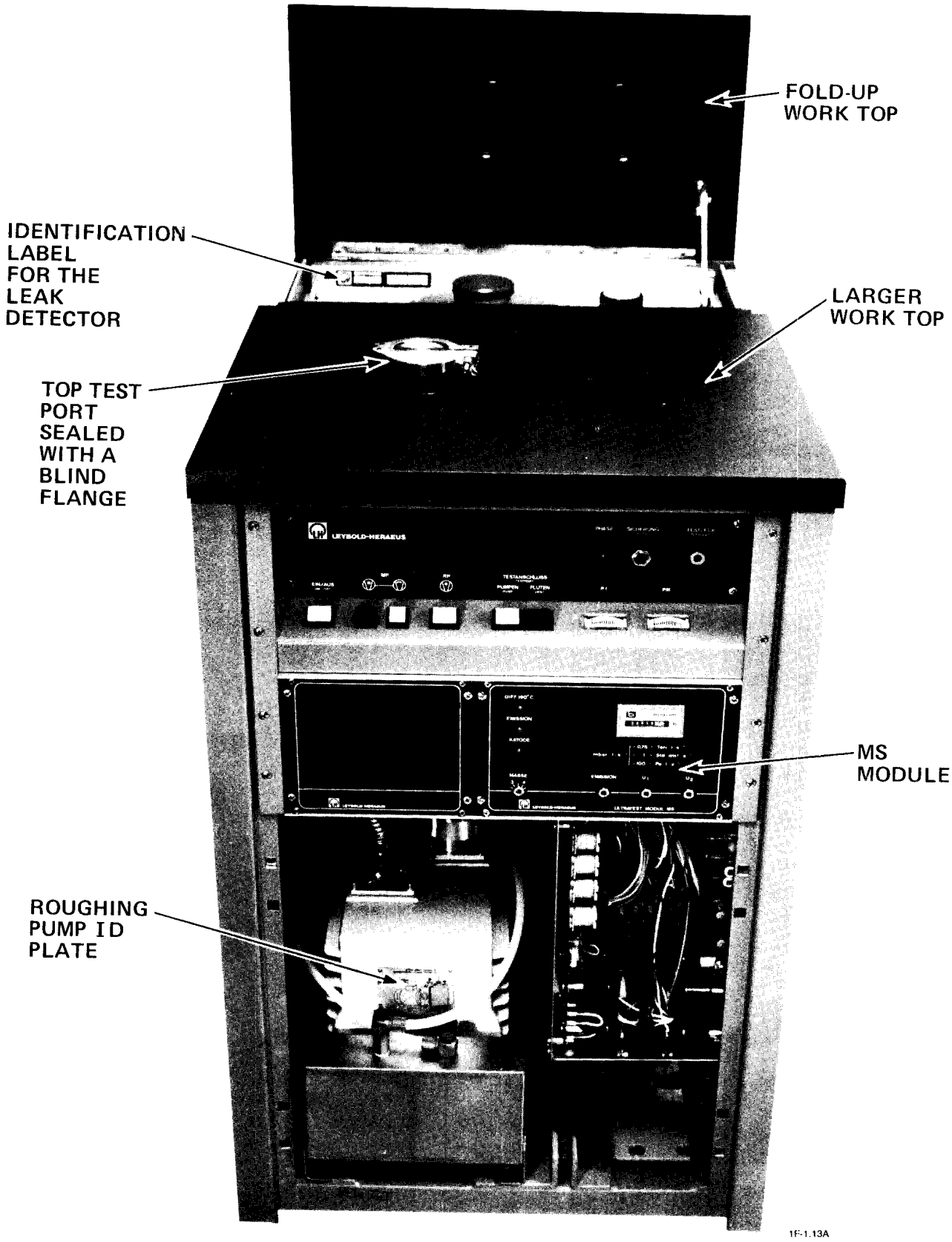


Figure 1-1 - Leak Detector with Lower Front Panel Removed

SECTION 2

RECEIVING AND INSTALLATION

2-1 RECEIVING

Proceed as follows to unpack and check the ULTRATEST for shipping damages as soon as you receive it. Check for damage even if you will not be using your ULTRATEST right away.

1. Inspect the outside of the shipping container for shipping damage. If you will be making a damage claim, keep the shipping container and packing materials.

2. Unpack the ULTRATEST carefully. The ULTRATEST F comes complete with the following:

   - FB module (see Figure 4-3)
   - Leak detector (see Figure 1-1)
   - Connecting cable (1.5 meters long)
   - 1 set of spare gaskets (includes metal gaskets for the vacuum system and O-rings for the vane pump).
   - 1 Tool Kit
   - 1 Dirt screen for test port
   - 2 clamping collars for permanent seal
   - 1 KF®40 to 1-1/8-inch OD tube adapter (P/N 99-138-1402)
   - 1 Spare ion source (P/N 16513)
   - 1 Electrical receptacle to mate with plug
   - 1 receptacle cover
   - 2 bulbs, 24V/50mA
   - 2 fuses T 0.5 B
   - 2 fuses T 1.25 B
   - 2 fuses T 6.3 D
   - Stick-on label containing brief operating instructions

   If you ordered the optional QUICK-TEST it will include the following (See Figure A-10):

   - QUICK-TEST housing
   - Probe with PVC tubing
   - 2 spare safety fuses
   - 3 spare O-rings for the plug connector
   - 1 spare O-ring for the mass separator
   - 1 nose piece for the probe tip
   - 1 set of dust filters
   - 1 drift tool to remove/replace dust filters

3. Remove the side panels from the leak detector and carefully inspect it for damages.

KF is a registered trademark of Leybold-Heraeus.

4. If you find any evidence of damage, proceed as follows:

   a. Save the shipping container, packing material, and damaged part for inspection.

   b. Notify the carrier that made the delivery withing 15 days of delivery in accordance with Interstate Commerce regualtions.

   c. NOTE: Since all equipment is shipped F.O.B. at factory, any damage in transit is the responsibility of the carrier.

      File a claim with the carrier for the damage.

   d. Contact the Leybold-Heraeus Order Services Department to replace the damaged part.

5. Store all parts, particularly the spare ion source, in a dry and dust-free place.

2-2 INSTALLATION

NOTE: See Appendix A-2 for installation instructions for the optional QUICK-TEST.

Install the ULTRATEST F as follows:

1. Stick the English portion of the self-adhesive brief operating instructions (KA 712/2) onto the underside of the fold-up work top (see Figure 1-1).

2. NOTE: You can install as many as three optional 10-meter extension cables (Part No. 15571) between the FB module and the leak detector to use the portable FB module for remote leak checking.

   Connect the female end of the 1.5-meter cable to the Plug FB outlet on the back of the FB module; connect the male end of the cable to its outlet on the back of the leak detector (see Figure 2-1).

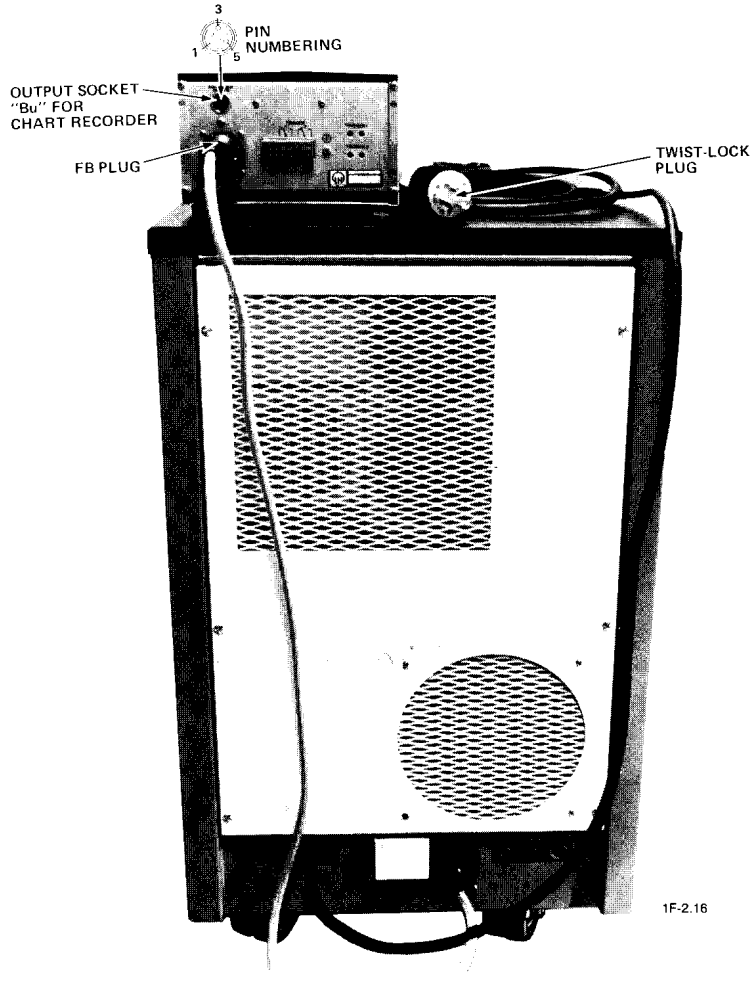


Figure 2-1 - Rear View of the ULTRATEST F

3. Pull open the orange cover below the operating pushbuttons on the front of the leak detector (see Figure 1-1).

4. If not incorporated into the leak detector, install an optional calibrated leak as follows:

   o To temporarily install a calibrated leak, use the KF 40 to 1-1/8-inch adapter (Part No. 99-138-1402) to attach the calibrated leak to the top test port. Calibrated leaks with smooth 1-1/8-inch diameter fittings are available with leak rates that range from 10^{-4} to 10^{-10} atm·cc/sec.

   o To permanently install a 10^{-8} atm.cc/sec calibrated leak, proceed as follows:

   NOTE: We do not recommend permanent installation of a calibrated leak if the ULTRATEST is used mainly for detecting very fine leaks; the valve on the calibrated leak may cause a helium background in the most sensitive range.

   NOTE: For permanent installation, you must use a 10^{-8} atm·cc/sec calibrated leak (P/N 16557).

   a. Remove the KF clamp ring from the top test port and the four allen-head capscrews that secure the larger black work top to the leak detector; lift this work top off of the leak detector (see Figure 1-1).

   b. Remove the clamping collar, support ring, and the sealing disk from the KF10 port on the valve block (see Figure 2-2).

   c. Use a small screwdriver to pry the cap off of the calibrated-leak valve knob.

   d. Loosen the collet screw coupling and remove the valve knob from the calibrated leak.

   e. NOTE: The kit that comes with the ULTRATEST includes a black plastic handwheel with brass nut and bushing, a red plastic cover cap, a drive rod, and a steel sleeve with four setscrews.

      Assemble the extension handwheel as follows:

      (1) Using two of the setscrews, attach the steel sleeve onto the valve spindel of the calibrated leak.

      (2) Using the other two setscrews attach the end of the drive rod that has a flat side to the other end of the steel sleeve.

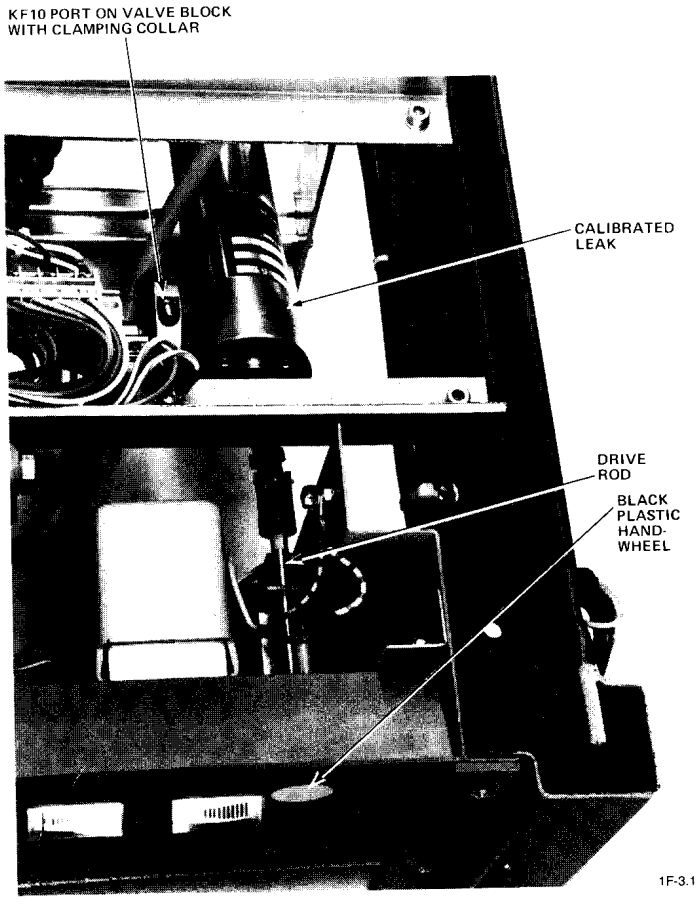


Figure 2-2 - Calibrated Leak Permanently Installed in the Leak Detector

f. Proceed as follows to move control valve SV2 so that the PVC tubing does not interfere with the calibrated leak (see Figure 8-3A).

   (1) Remove the two screws that secure SV2 to the structrual angle iron.

   (2) Shift SV1 along the angle iron toward the center of the machine.

   (3) When the holes are aligned, resecure it with one bolt.

g. Refer to Section 8-9-1 to install the KF10 calibrated leak flange onto the KF10 port of the valve block.

h. Feed the drive rod, which is installed on the calibrated leak, through the "TEST LEAK" hole in the front panel of the leak detector (see Figure 2-2).

i. Fix the black plastic handwheel onto the top end of the drive rod by tightening the collet screw coupling.

j. Snap the red cap into the black handwheel.

k. Place a label near the handwheel indicating the leak rate of the calibrated leak.

5. Check the following electrical cables and connectors to ensure all pins are fully inserted and all connectors are firmly latched.

   - 3 plugs connected to the back of the MS model (see Figure 2-3).
   - 1 plug and several slip-on quick disconnects on pc board LP 11 which is behind the small black front panel that is beside the MS module (see Figures 1-1 and 8-3C).
   - the 6 plugs on the back of the electrics model (see Figure 2-3).

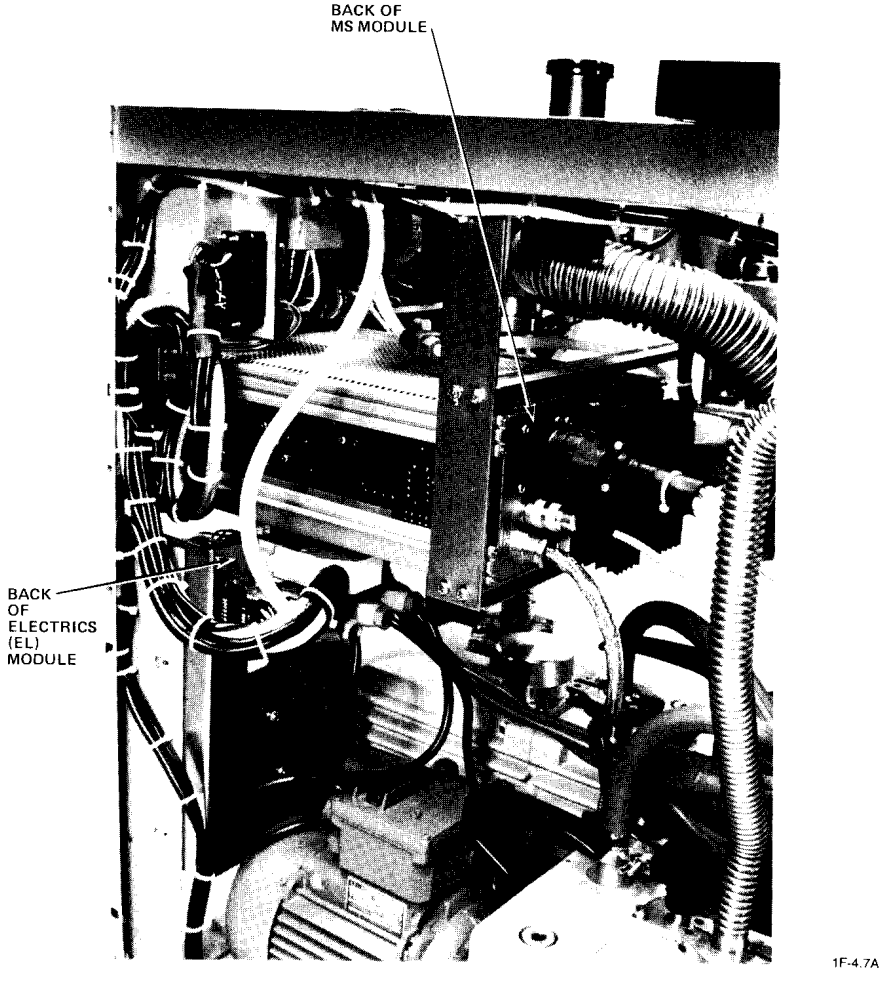


Figure 2-3 - Back of the MS and Electrics (EL) Modules

6. NOTE: Ensure that the power supply meets the power requirements listed on the identification plate of your leak detector (see Figure 1-2).

   NOTE: The internal parts of the ULTRATEST operate at 220 volts. Your leak detector has been fitted with a transformer (located at the rear of the D4A backing pump) to provide this voltage from the line voltage of your plant.

   Install the special twist-lock outlet that came with the ULTRATEST onto a suitable power supply and plug the twist-lock plug of the leak detector into the outlet (see Figure 2-1).

7. If you want to install a chart recorder, connect the plug (P/N 500-17-119) of the recorder onto the 6-pin output socket on the back of the FB module (see Figure 2-1). The function of each lead-out connection is as follows:

   1- Output voltage to match digital display - For example, when the digital display is -8, the pin 1 to 3 output is 8 VDC; when the digital display is blank, the pin 1 to pin 3 output is 0 VDC.
   2- Remote emission ON,
   3- Ground,
   4- Remote emission ON,
   5- Output 0 to 10 VDC for leak in each meter range (10 VDC is full scale deflection of the leak-rate meter,
   6- Not used.

8. See Appendix B to set the triggers to automatically alert the operator when the zero setting or helium background has changed or when the test object should be rejected.

9. If the leak detector will be exposed to higher levels of contaminants, we recommend installing a cold trap or a coaxial trap (Part No. 99-171-164) on the test port of the leak detector.

SECTION 3

BRIEF DESCRIPTION

The purpose of the ULTRATEST F is to find and quantify leaks as small as 2 x 10^{-11} atm.cc/sec. See Table 3-1 for the specifications.

Helium is used as the search gas to penetrate any leaks in the object being tested. The ULTRATEST detects and quantifies any helium leaking through the test object. See Section 5 for information on leak checking techniques.

The heart of the ULTRATEST is the mass spectrometer. The roughing system and the high vacuum system provide the necessary conditions for the mass spectrometer to detect helium.

This section contains a brief description of the vacuum system of the leak detector. See Section 7 for a detailed description and operating principles of the ULTRATEST.

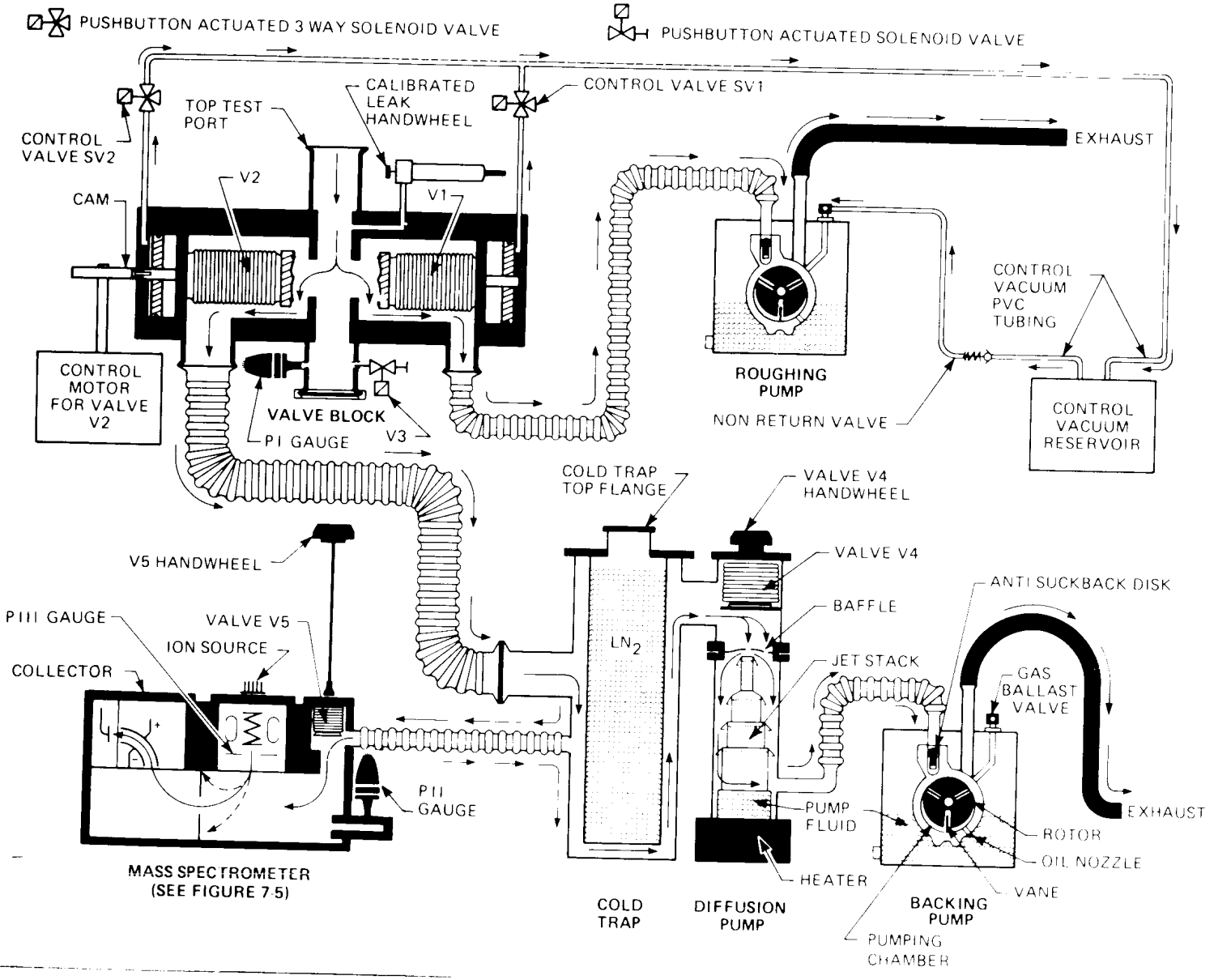
3-1 MASS SPECTROMETER

The ULTRATEST mass spectrometer consists of an ion source, a magnet, a collector, valve V5, and gauges PII and PIII. Gas entering the mass spectrometer is ionized and then separated by its mass/charge ratio so that only helium strikes the collector. A signal proportional to the amount of helium striking the collector registers on the FB module meter as the leak rate.

The EMISSION pushbuttons on the mass spectrometer turn the ion source ON and OFF. The slotted potentiometers "EMISSION", "U1", and U2" on the front of the MS module control the emission current in the ion source, the accelerating voltage of the ions, and the deflection voltage. These potentiometers are used to tune the mass spectrometer so that only helium reaches the collector.

The pressure in the mass spectrometer must be below 1×10^{-2} mbar for the emission to be turned ON and below 2×10^{-4} for the mass spectrometer to function properly. If the mass spectrometer is allowed to operate at pressures above 2×10^{-4} mbar, the leak-rate reading will be inaccurate, the ion source will deterioate rapidly, and the mass spectrometer may become contaminated. Interlocks in the ULTRATEST prevent the mass spectrometer from operating at pressures above 1×10^{-2} mbar.

Gauges PII and PIII monitor the pressure in the mass spectrometer. PII measures from 1000 to 10^{-3} mbar and PIII measures from 10^{-3} to 10^{-6} mbar. PII and PIII can be read from the FB module meter. The EMISSION must be ON to read PIII or to read the emission current (I_E).



NOTE: This Figure shows valve V1 open and valve V2 partially open; the READY lamp would be flashing ON and OFF in this mode of operation

Figure 3-1 - Simplified Cross Section of the ULTRATEST F Vacuum System

Section 3-1 continued

Handwheel valve V5 seals off the mass spectrometer from the rest of the system to prevent it from becoming contaminated when the ULTREATEST is not being used to leak check or when the cold trap defrosts.

3-2 THE ROUGHING SYSTEM

The primary purpose of the roughing system is to quickly reduce the pressure in the test object to 3 x 10^{-2} mbar . The roughing pump can operate from atmospheric pressure with high pumping speed. Once the pressure reaches 3 x 10^{-2} mbar the high vacuum system takes over.

The main components of the roughing system are the roughing pump and valve V1 (see Figure 3-1).

The roughing pump is a TRIVAC® vane pump. The RP pushbutton on the leak detector is used to turn the roughing pump ON and OFF.

When the PUMP pushbutton is pressed, valve V1 opens which allows the roughing pump to evacuate the test object. Gauge PI measures the pressure in the test port. When the pressure reaches 1 mbar, valve V2 begins to open to connect the test object to the high vacuum system. The READY lamp on the front of the FB module begins flashing to indicate that the ULTRATEST is ready to leak check at reduced sensitivity. When pressure PI reaches 3 x 10^{-2} in the test port and PII is below 2 x 10^{-4} in the mass spectrometer, valve V2 opens fully and valve V1 closes. The READY lamp lights with a steady glow to indicate that the ULTRATEST is now ready to leak check at full sensitivity.

Valve V3 is also attached to the test port. It is used to vent the test port and the test object after the test is completed. The test port is vented to allow easy removal of the test object. Vent valve V3 is opened by holding the VENT pushbutton down for two seconds. Tapping the VENT pushbutton closes valves V1 and V2 but does not open vent valve V3.

3-3 HIGH VACUUM SYSTEM

The mass spectrometer has its best sensitivity to helium when the pressure is less than 10^{-5} mbar. The high vacuum system evacuates the mass spectrometer to the required pressure in addition to protecting the mass spectrometer from contamination.

The high vacuum system consists of Valves V2 and V4, the cold trap, and a LEYBODIFF® 180L diffusion pump backed by a TRIVAC® D4A vane pump.

TRIVAC and LEYBODIFF are registered trademarks of Leybold-Heraeus.

Valve V2 is an automatic bellows sealed valve. It begins opening when the pressure in the test port reaches 1 mbar and opens fully when the pressure reaches 3×10^{-2} in the test port and 2×10^{-4} in the mass spectrometer. When V2 is fully open the test object is connected with the mass spectrometer and high vacuum system (see Section 3-2).

When the cold trap is filled with liquid nitrogen (LN_2), water vapor and other contaminants condense and adhere to its cold inner wall. This prevents the contaminants from reaching the mass spectromenter. Contaminants in the mass spectrometer result in reduced sensitivity to helium, high background, and false leak rates. The cold trap must not be allowed to thaw while valve V5 is open because it would release its concentrated contaminants into the mass spectrometer.

The ultimate pressure of the diffusion pump is 10^{-7} mbar, but diffusion pumps cannot exhaust to atmospheric pressure. Thus a backing pump is needed to pump the gas from the diffusion pump exhaust.

When the ON/OFF pushbutton on the front of the leak detector is pressed, the diffusion pump heater and the backing pump start. It takes approximately 20 minutes for the diffusion pump to reach its operating temperature of 190C. When the ON/OFF pushbutton is pressed to turn off the leak detector, the cooling fans and the backing pump continue to run until the diffusion pump cools to 90C.

V4 is a bellows sealed handwheel valve. During shutdown valve V4 is closed to hold the vacuum in the cold trap and prevent backstreaming of oil vapors from the diffusion pump. During operation valve V4 can be partially closed to reduce the pumping speed which increases the sensitivity of the ULTRATEST to helium.

TABLE 3-1 SPECIFICATIONS

TECHNICAL DATA

Minimum Detectable Leak with full pumping speed* with reduced pumping speed*	 2×10^{-11} atm.cc/sec 2×10^{-12} atm.cc/sec
Full Scale Leak-Rate Reading on Least Sensitive Scale	10×10^{-7} atm.cc/sec
Noise Amplitude in the Most Sensitive Range	< 2% of full scale deflection
Response Time	1.5 seconds to reach 63% of final leak reading
Clean-up Time	1.5 sec. for leak reading to drop to 37% of original reading
Amplifier, Drift	< 1% of full scale deflection per hour after warmup
Adjustable Emission Current	0.6 to 5 mAmp
Dectectable Masses	3 and (helium) 4 (selectable)
Total Pressure Reading THERMOVAC (PI & PII) Ionization Gauge (PIII)	 10^{-3} to 1000 mbar 10^{-6} to 10^{-3} mbar
Maximum Safe Continuous Operating Pressure in the Mass Spectrometer	1×10^{-4} mbar
Maximum Gas Flow at Test Port During Test	1×10^{-3} atm.cc/sec
Maximum Admissible Inlet Pressure in Partial Flow (Gross Leak) Operation	1 mbar
Pumping Speed at the Test Port	-for Helium 20 ltr/sec - for air 10 ltr/sec

* 2% of full scale deflection measured according to procedures defined in American Vacuum Society Standard 7.1.

TABLE 3-1 - SPECIFICATIONS continued

HIGH VACUUM PUMPING SYSTEM	
Backing Pump	TRIVAC D4A
Displacement	4.5 CFM (2.1 ltr/sec)
Pump Fluid	HE-200
Diffusion Pump	LEYBOLDIFF 180L
Pumping Speed for air	180 ltr/sec (381 CFM) at 10^{-5} mbar; throttled to approximately 20 ltr/sec.
Pump Fluid, Polyphenolether	HE-300 (50 cc optimum)
Cold Trap	
Capacity	2.4 qts. of liquid Nitrogen (LN_2)
Holding Time	approx. 20 hrs. with one filling
OUTPUTS	
Chart Recorder Socket Bu (see Figure 2-1; Section 2-2, Step 7; and Section 7-7-7-1)	
Pins 5 (+) to Pin 3 (see Figure 2-1)	0 to 10 VDC (10 VDC is full scale deflection of leak-rate meter)
Pins 1 (+) to Pin 3 (see Figure 2-1)	Voltage matches digital display - when digital display is -8, the pin 1 to 3 output is 8 VDC; when digital display is blank, the pin 1 to pin 3 output is 0 VDC
Triggers 1 and 2 (see Appendix B)	6 amp, 220 VAC max. noninductive Form C. (SPDT)
DIMENSIONS	
Leak Detector	29 x 20 x 33 inches
FB Remote Control Module	9.1 x 8.7 and 5.1 inches (4.4 lbs)

TABLE 3-1 Continued

SPECIFICATIONS THAT DEPEND ON THE ROUGHING PUMP

ULTRATEST Model - Specifications	Line Voltage Circuit Breaker (amps)	Displacement of Roughing Pump (CFM)	Pump Down Time		Max Gas Flow at Test Port (Partial Flow)	Weight
			For Sealed Test Port	For 50 ltr. Test Object		
D16A Roughing Pump, 115 Volts, 1 phase	20	14	6 sec.	3.5 minutes	4 atm.cc/sec.	410 lbs.
D16A Roughing Pump, 208 Volts, 1 phase	9	14	6 sec.	3.5 minutes	4 atm.cc/sec.	410 lbs.
D8A Roughing Pump, 115 Volts, 1 phase	18	7				400 lbs.
D8A Roughing Pump, 230 Volts, 1 phase	7	7				400 lbs.
D8A Roughing Pump, 208 Volts, 1 phase	8	7				400 lbs.
D30A Roughing Pump, 230 Volts, 1 phase	9	27	4 sec.	95 sec.	7.5 atm.cc/sec.	490 lbs.
D30A Roughing Pump, 220 Volts, 3 Phase	6	27	4 sec.	95 sec.	7.5 atm.cc/sec.	490 lbs.
D30A Roughing Pump, 208 Volts, 1 phase	10	27	4 sec.	95 sec.	7.5 atm.cc/sec.	490 lbs.

SECTION 4

OPERATION

See Appendix A if you are using the optional QUICK-TEST with your ULTRATEST. See Appendix C if your ULTRATEST has the cold trap vent modification; see Appendix D if it has the manual gross leak bypass modification; see Appendix E if your ULTRATEST is the US autoranging version.

4-1 CONTROLS

4-1-1 Location and Function of Each Control

Figures 4-1, 4-2, and 4-3 show the controls on the leak detector, the MS module, and the FB module respectively, and include a brief explanation of the function of each control.

See Sections 7-7, 7-8, and 7-9 for more detailed information on each control.

See Section 4-1-2 for instructions on how to read the FB module meter.

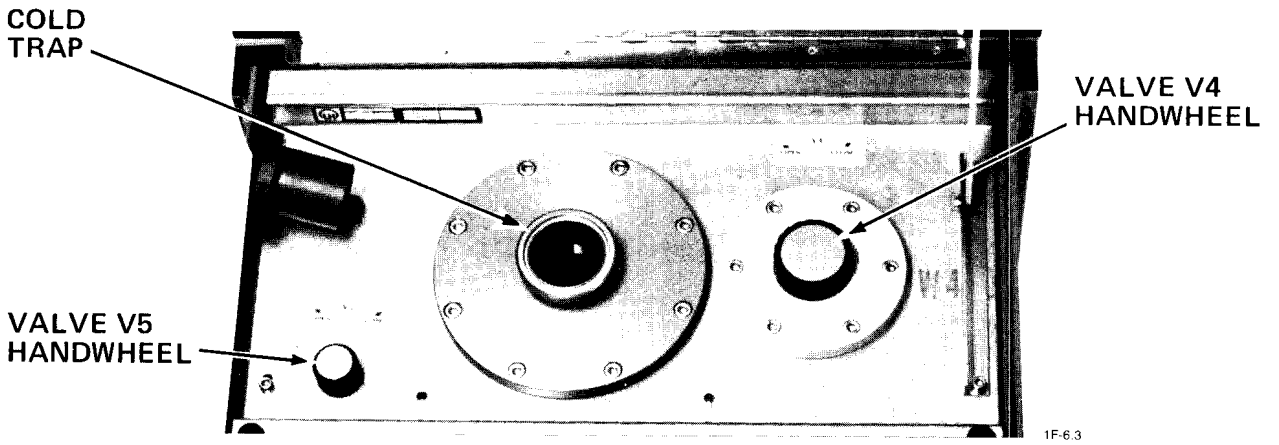


Figure 4-1A - Valve V4 and V5 Handwheels on the Top of the Leak Detector

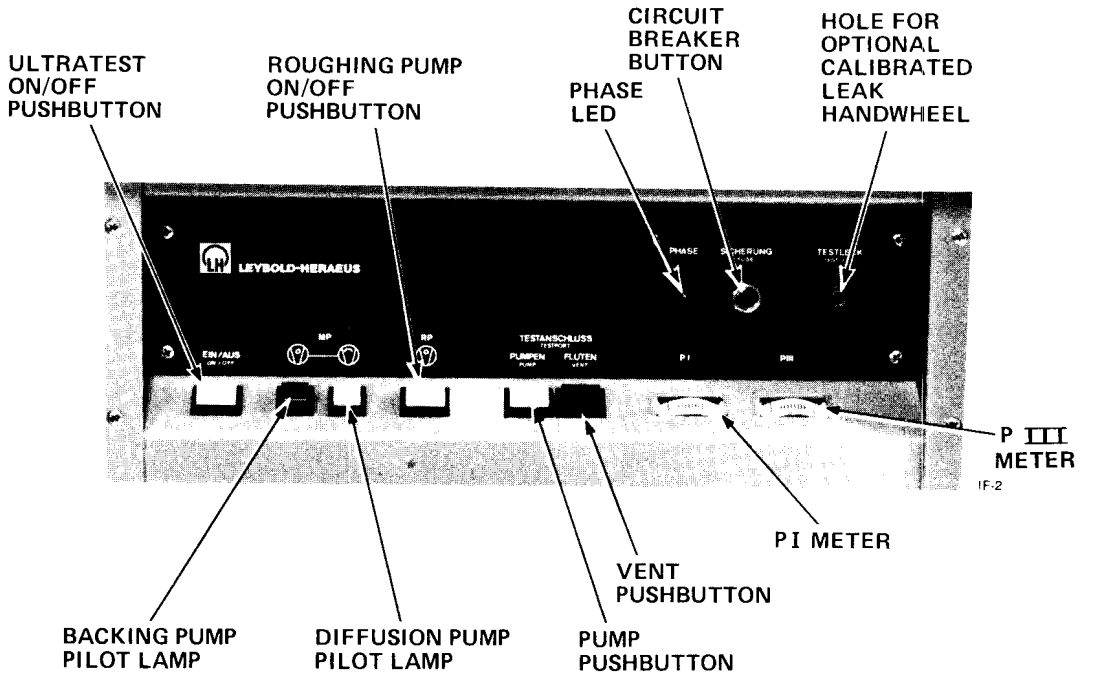


Figure 4-1B - Control Panel on the Front of the Leak Detector

Figure 4-1 - Controls on the Leak Detector
(see Figure 4-2 for the MS Module controls and Appendix D for additional controls for the ULTRATEST with the manual gross leak bypass modification)

Figure 4-1 - Controls on the Leak Detector
(see Figure 4-2 for the MS Module Controls and Appendix D for additional controls for the ULTRATEST with the manual gross leak bypass modification)

Control	Function	Reference Section in Manual
Valve V4 Handwheel	Isolates the high-vacuum pumping system from the cold trap, test port, and mass spectrometer. Allows throttling of pumping speed to increase sensitivity.	Sec. 7-6-2-4 Fig. 3-1
Valve V5 Handwheel	Isolates the mass spectrometer from the leak detector vacuum system.	Sec. 7-6-1-3 Fig. 3-1
"ON/OFF" Pushbutton	Turns power ON and OFF to the ULTRATEST.	Sec. 7-8-1
Pilot Lamp	Lights when the backing pump is operating.	Sec. 7-8-1
Pilot Lamp	Lights when the diffusion pump is at operating temperature.	Sec. 7-8-2
RP Pushbutton	Switches roughing pump ON and OFF.	Sec. 7-8-3
"PUMP" Pushbutton	Evacuates the test object and connects it to the mass spectrometer if the emission and roughing pump are ON.	Sec. 7-8-4
"VENT" Pushbutton	When briefly pressed, it isolates the leak detector from the test object. When depressed for 1.5 seconds, it also vents the test object	Sec. 7-8-5
Phase LED	Warns operator of reverse polarity for leak detectors with 3-phase D30A or D60A roughing pumps.	Sec. 7-8-7
Circuit Breaker Button	Allows resetting of the circuit breaker after a supply surge or short shuts down the ULTRATEST.	Sec. 7-8-8
"TEST LEAK" Handwheel	For opening optional calibrated leak during calibration and closing calibrated leak when leak checking.	Sec. 2-2, Sec. 4-3, Sec. 7-8-9
PIII Meter	Indicates acceptable (green) or unacceptable (red) pressure in the mass spectrometer.	Sec. 7-8-6
PI Meter	Indicates acceptable (green) or unacceptable (red) pressure in the test port.	Sec. 7-8-6

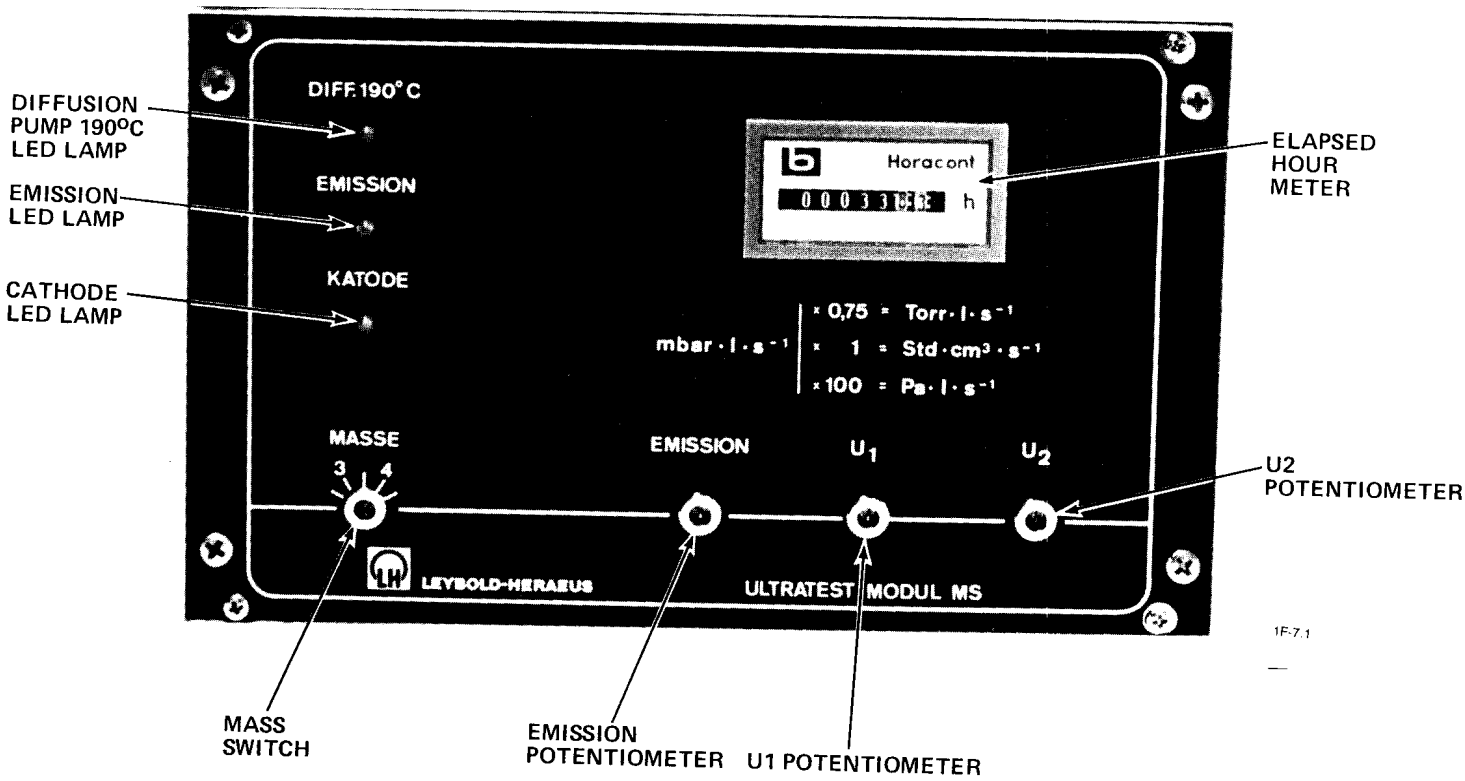


Figure 4-2 - MS Module Controls

Control	Function	Reference Section in Manual
Mass Selector Switch "MASSE"	Sets mass spectrometer from mass 2.5 to mass 4.5.	Sec. 7-9-1
Slotted Potentiometer "EMISSION"	Sets emission current.	Sec. 4-3 Sec. 6-5-1
Slotted Potentiometer "U1"	Sets the accelerating voltage in ion source.	Sec. 7-9-3 Sec. 4-3
Slotted Potentiometer "U2"	Sets voltage applied to deflection plates (i) in the ion collector.	Sec. 7-9-4 Sec. 4-3 Fig. 7-5
"DIFF 190°C" LED	Lights when the diffusion pump is at operating temperature.	Sec. 7-9-6
"EMISSION" LED	Lights when ion source is functioning.	Sec. 6-5-1
"KATODE" LED	Indicates that heating current is passing through cathode filament in the ion source.	
Elapsed Hour Meter	Record the cumulative operating hours of the ULTRATEST (50 Hz. clock - reads 1/6 higher hours)	Sec. 7-9-8

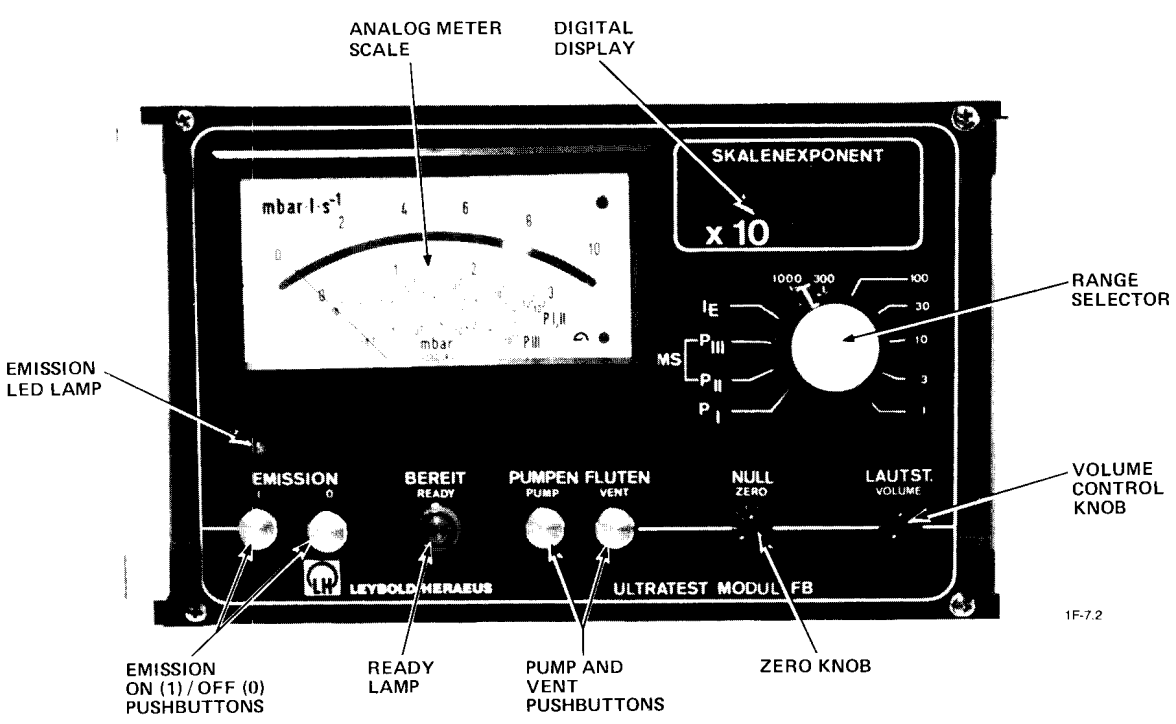


Figure 4-3 - FB MODULE CONTROLS

Control	Function	Reference Section in Manual
Range Selector Switch	Select total pressure (PI, PII, PIII), emission current (I_E), or sensitivity ranges of leak rates for indication on the meter.	Sec. 4-1-2
"EMISSION" Pushbuttons Meter	For switching the emission current in the ion source ON (1) and OFF (0). Provide analog scales for display of pressure, emission current, or leak rates.	Sec. 7-7-1 Sec. 6-5-1 Sec. 4-1-2
Digital Display "ZERO" Knob	Displays exponent for indication of leak rate. For 0 adjustment of amplifier	Sec. 4-1-2 Sec. 4-2 Step. 7e
"VOLUME" Control	To turn up or silence the audible leak-rate signal.	Sec. 7-7-4
"READY" Lamp	A lit READY lamp indicates that the ULTRATEST is ready for leak checking in the most sensitive range. A flashing lamp signals that the ULTRATEST is ready for coarse leak checking.	Sec. 7-7-6
"PUMP" Pushbutton	Evacuates the test object and connects it to the mass spectrometer if the emission and roughing pump are ON.	Sec. 7-8-4
"VENT" Pushbutton	When briefly pressed, it isolates the leak detector from the test object; when depressed for 1.5 seconds, it also vents the test object.	Sec. 7-8-5

4-1-2 Reading the Pressure, Current, and Leak Rate

The meter on the FB module has four scales, as well as a red and green LED lamp. The position of the range selector switch determines which scale you read (see Figure 4-3).

When the range switch is on PI, the PI scale on the meter indicates the total pressure in the test port.

When the range switch is on PII, the PII scale on the meter indicates the total pressure in the mass spectrometer.

The PI/PII scale reads from 10^{3} to 10^{-3} mbar. When valve V5 is closed, the pressure indicated by PII will not decrease because PII is reading the pressure in the mass spectrometer not the pressure in the pumping system.

When the range switch is on PIII, the PIII scale on the meter indicates the total pressure measured in the ion source of the mass spectrometer. The PIII scale reads from 10^{-3} to 10^{-6} mbar. PIII indicates pressure only when the emission is ON.

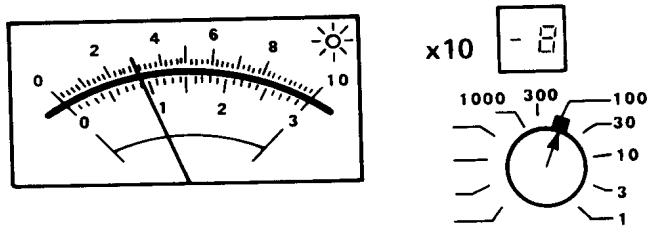
When the range switch is on I_E, the red 0 to 10 scale on the meter indicates the emission current in the ion source in milliamps. An optimal emission reading is between 0.6 and 1.2 milliamps for a new ion source. See Section 6-5 to determine if the ion source needs to be changed. You can read I_E only when the EMISSION is ON.

When the range switch is on 1,000, 300, 100, 30, 10, 3, or 1, the meter displays the leak rate. To choose which leak-rate switch position to use for a particular leak, turn the switch from positon to position (1,000, 300 ... etc.) until you see about a half-scale needle deflection on the meter. If the needle deflection is less than 3 on the 0 to 10 scale, you can turn the switch to the appropriate 3 positon (300, 30, or 3) to read the meter more accurately on the 0 to 3 meter scale. When the switch is on 1,000 100, 10, or 1 position, the red LED lamp on the meter lights to signal that you read from the red 0 to 10 scale. When the switch is on 300, 30 or 3 positions, the green LED lamp lights to signal that you read from the green 0 to 3 scale.

To determine the leak rate, multiply the meter reading by the exponent-reading on the digital display and then subtract the background (see Section 8-2-1). For example, if the switch is on 300, the needle deflection is 1.5 on the 0 to 3 scale, and the exponent is -8; then the leak rate is 1.5×10^{-8} atm.cc/sec (minus the background).

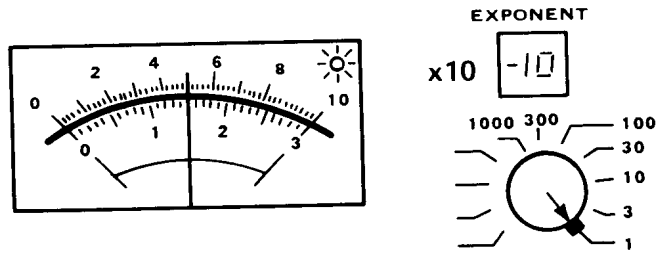
See Figure 4-4 for three additional examples of how to read the leak-rate meter.

Example 1



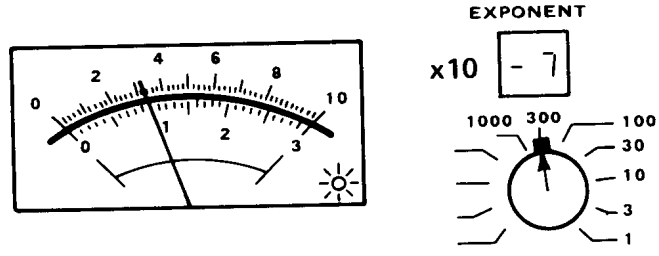
Leak-rate reading of 3×10^{-8} atm·cc/sec* (minus the background)

Example 2



Leak-rate reading of 5×10^{-10} atm·cc/sec* (minus the background)

Example 3



Leak-rate reading of 1×10^{-7} atm·cc/sec* (minus the background)

1F-5.2

* "mbar·l·s^{-1}" is marked on the meter; mbar·l·s^{-1} and atm·cc/sec are equivalent units.

Figure 4-4 - Reading the Leak-Rate Meter (3 examples)

When using the optional QUICK-TEST, multiply the leak rate by the correction factor (see Section A-3-1). Using the same example, if the correction factor is 1000 (+3 exponents), the approximate leak rate would be 1.5×10^{-5} when using the QUICK-TEST.

If your ULTRATEST has a change-over switch on the preamplifier, you can turn this switch to shift the measurement range to large leak rates by a factor of 100 (see Section 7-6-1-2).

If your ULTRATEST is the US autoranging version, see Appendix E.

4-2 START-UP

NOTE: See Section 8-16-1 for an electrical description of the power up sequence.

NOTE: Ensure that the test port is closed before following this start-up procedure.

Proceed as follows to start the ULTRATEST after it has been totally shutdown (see Section 4-6-3).

1. Check that the FB meter needle points to 0 on the red 0 to 10 scale, if not turn the screw that is located just below the meter until the needle points to 0 (see Section 7-7-2).

2. Ensure that handwheel valves V5 and V4 are closed (see Figure 4-1A).

3. Press the ON/OFF pushbutton to start the high vacuum pumping system; the lamp in the pushbutton, the backing pump lamp, and the digital display on the FB meter will light (see Figure 4-1B).

4. Press the RP pushbutton to start the roughing pump; the lamp in the RP pushbutton will light. Tap the VENT pushbutton.

5. Turn the range switch on the FB module to PII and read the pressure on the PII scale of the meter (see Section 4-1-2).

   If the PII pressure is greater than 10^{-2}, proceed as follows to bring the pressure in the mass spectrometer to approximately 10^{-2}.

   a. Open handwheel Valve V4 (see Figure 4-1A).

   b. Open handwheel Valve V5 (see Figure 4-1A).

c. NOTE: It normally takes about 1 minute for PII to reach approximately 10^{-2}. However, if the leak detector has been shutdown with valves V5 and V4 open, it may take considerably longer for the pumping system to remove the contaminants and reach 10-2. See Section 8-2-4 for information on contamination and Section 4-6 for the correct shutdown procedure.

Observe PII until it reaches approximately 10^{-2} and then close valves V4 and V5 (see Figure 4-1A).

6. NOTE: When the diffusion pump reaches its operating temperature, the diffusion pump lamp and the "DIFF 190°C" LED on the MS module will light (see Figures 4-1 and 4-2). It generally takes 20 to 30 minutes for the diffusion pump to reach operating temperature.

After the "DIFF 190°C" LED lights, open valve V4 and proceed as follows (see Figures 4-1 and 4-3).

a. NOTE: We recommend adding liquid nitrogen (LN_2) to the cold trap unless you are using the optional QUICK-TEST (see Appendix A). If you are using neither the optional QUICK-TEST nor LN_2, allow the ULTRATEST extra time to pump down to remove water vapor and fingerprint and solvent residues.

WARNING: USE EXTREME CARE WHEN POURING LN_2; SPILLED DROPLETS CAN CAUSE SPOT FROSTBITE.

NOTE: The cold trap capacity is about 2.4 quarts (20 hours) of LN_2.

Carefully pour a small portion of the LN_2 into the filler port on the top of the cold trap (see Figure 4-1A), wait for a minute or two, and then pour the remaining LN_2 into the cold trap unit it is full. Replace the stopper into the filler port.

b. Open valve V5.

c. Set the range switch to PII and wait until the pressure is less than 1×10^{-3} before proceeding (see Section 4-1-2).

d. Press the EMISSION "1" pushbutton on the FB module to turn ON the emission in the ion source (see Figure 4-3); the "KATODE" and EMISSION LEDS on the MS module and the EMISSION LED on the FB module will light.

e. Turn the range switch to PIII and wait until the pressure reaches 5×10^{-5} mbar.

7. Check the calibration of the ULTRATEST as follows:

   a. Open the calibrated leak.

   b. Press the PUMP button; the orange READY lamp on the FB module will flash ON and OFF for about 10 seconds and then it will light with a steady glow.

   c. Shut the calibrated leak.

   d. Once the READY lamp shows a steady glow repeat Step 5e to ensure PIII is at or below 5×10^{-5} mbar.

   e. NOTE: During the first 2 hours of operation, repeat the zero correction several times.

      Zero the FB module meter as follows:

      (1) Push the EMISSION "0" button to switch the emission off.

      (2) Turn the range selector on the FB module fully clockwise to the 10^{-10} atm·cc/sec range.

      (3) Turn the "ZERO" knob until the needle on the meter registers 0 (zeroing the background).

      (4) Push the EMISSION "1" button to switch the emission ON.

   f. Turn the range selector to the leak-rate range marked on the optional calibrated leak (normally 10^{-8} atm·cc/sec).

   g. Open the optional calibrated leak. The FB module meter will overshoot, then settle to a steady value.

   h. Read the leak-rate on the FB module meter. If the ULTRATEST is perfectly calibrated, the meter reading will equal the leak-rate stamped on the calibrated leak.

   i. If the difference between the leak-rate reading and the actual leak rate is unacceptable for your purposes, refer to Section 4-3 to calibrate your ULTRATEST.

   j. Shut the calibrated leak. The leak-rate reading should drop to the left toward 0. With the calibrated leak closed the leak-rate reading is the result of the background (see Section 8-2-1).

8. Tap the VENT pushbutton. If you need to open the test port so that you can connect the test object, hold the VENT pushbutton down for 2 seconds to vent the test port.

4-3 CALIBRATION

NOTE: The calibrated leak allows a constant flow of helium into the leak detector. The flow rate is stamped on the calibrated leak. Each time a calibrated leak is opened, it gives a slight pressure burst before settling down to its flow rate. We recommend using a 10^{-8} atm.cc/sec calibrated leak to calibrate the ULTRATEST.

Check the calibration by opening the calibrated leak once or twice a day during operation. The leak rate indicated on the meter should match the leak rate stamped on the calibrated leak (see Step 7 of Section 4-2). If the difference between the leak-rate reading and the actual leak rate is unacceptable for your process, recalibrate the ULTRATEST as follows:

1. Refer to Section 4-2, Steps 1 through 7 to start the ULTRATEST.

2. Turn the range switch to PIII and wait until PIII reads less than 5 x 10^{-5} and the READY lamp lights with a steady glow (see Section 4-1-2).

3. Ensure that the mass switch is in the 4 position (see Figure 4-2).

4. Open the calibrated leak (see Figure 2-2).

5. Turn the range switch to I_E and adjust the emission potentiometer until the needle points to 1 on the red 0 to 10 scale (see Section 7-9-2).

6. Turn the range switch to the appropriate leak-rate position so that the needle is approximately mid-scale on the meter.

7. Proceed as follows to adjust U_1 and U_2 (see Figure 4-2).

   a. Using a screwdriver, adjust slotted potentiometer U_1 for the highest attainable reading on the meter. Start by slowly turning the U_1 potentiometer clockwise; continue to turn it clockwise as long as the meter reading is increasing. When the meter reading begins to decrease, turn the potentiometer counterclockwise until the needle reaches its peak.

   b. Repeat Step 7a for slotted potentiometer U_2.

   c. Readjust U_1 for maximum meter reading.

8. NOTE: See Section 4-1-2 for instructions on reading the leak rate.

   NOTE: See Section 6-5-1 to determine if the ion source needs to be replaced.

   Adjust the EMISSION potentiometer until the leak-rate indication on the meter matches the leak-rate stamped on he calibrated leak (see Figure 4-2). Be sure you are reading the correct (green 0-3 or red 0-10) scale on the leak-rate meter.

9. Shut the calibrated leak; the meter reading should drop toward 0 (see Figure 2-2). With the calibrated leak closed, the leak-rate reading is the result of the background (see Section 8-2-1).

10. Turn the mass switch to the 4.5 and then to the 3.5 position; the meter reading should drop toward 0 when the switch is on 4.5 or 3.5. If the leak-rate indication does not drop toward 0, it is probably due to contamination (see Section 8-2-4). Return the switch to the 4 position.

4-4 USING THE ULTRATEST F TO EVACUATE AND LEAK CHECK SMALL PARTS

The following is the most commonly used leak checking procedure. See Section 5 for information on other leak checking techniques.

1. NOTE: The ULTRATEST F has two test ports. The top test port (see Figure 6-1) is sealed with a blind flange and KF40 clamp ring. Most customers connect the test object to the top test port. The side test port (see Figure 6-1) is sealed off with an ultra-high vacuum disk and a clamping collar. If you are connecting your test object to the side test port, you may wish to seal the top test port with an ultra-high vacuum disk and the clamping collar (see Section 8-9-1).

   Depress the VENT pushbutton for 2 seconds and then connect the test object to the test port of the leak detector.

2. Set the range switch on the FB module to the range of the leak that you are trying to find, for example 10^{-8} (see Figure 4-3 and Section 4-1-2).

3. Press the PUMP pushbutton (see Figure 4-1B).

4. For coarse leak checking, wait until the orange READY light begins flashing before leak checking.

   For fine leak checking, wait until the READY light shows a steady glow (about 10 seconds for small test pieces) before leak checking.

5. Spray the test object with helium and read the leak rate from the FB module meter (see Section 4-1-2).

6. After the test, depress the VENT pushbutton for 2 seconds (see Figure 4-1B or 4-3).

7. Remove the test object from the test port.

4-5 OPERATING HINTS

(1) See Appendix A if you have the optional QUICK-TEST, Appendix D if you have the ULTRATEST with manual gross leak bypass modification, and Appendix E if you have the US autoranging version.

(2) See Section 5 for leak checking techniques and Section 4-1-2 for instructions on reading the meter.

(3) For remote leak testing, the FB module can be removed from the leak detector. The two units must be connected by an optional extension cable (Part Number 15571) when the FB module is removed.

(4) The pressure in the mass spectrometer must be less than 2×10^{-4} mbar for coarse leak checking. When the pressure is at or below 5×10^{-5} mbar, the ULTRATEST has its best sensitivity.

(5) The EMISSION must be ON before you press the PUMP pushbutton; otherwise, you cannot leak check because valve V2 will not open (see Section 7-8-4). If you press the PUMP pushbutton when the roughing pump is ON and the EMISSION is off, the test object is evacuated but it is not connected to the high vacuum system or to the mass spectrometer. This mode of operation is useful when preparing to test larger volumes before turning the EMISSION ON. However, allowing the leak detector to remain in this operational state results in oil vapor condensing on the valve block surfaces when the roughing pump reaches its ultimate pressure.

(6) Ensure that the optional calibrated leak is closed when leak checking so that you do not get a high background (see Figure 2-2).

(7) Occasionally open the valve on the calibrated leak (see Figure 2-2) and use Step 7 of Section 4-2 to check if the ULTRATEST needs to be calibrated.

(8) Both valves (V4 and V5) should be closed to prevent contamination when the ULTRATEST is not being used for leak checking (see Figure 4-1A). Always turn off the emission before closing V5 to prevent deterioration of the ion source. V5 is always the last valve you open and the first valve you close.

(9) Do not allow all the LN_2 to evaporated from the cold trap when valve V5 is open or when the leak detector is turned OFF [see Item (10)]. When the LN_2 evaporates, the contaminants are released and will enter the mass spectrometer if valve V5 is open. If the high vacuum system is off, the released contaminants will not be removed from the leak detector. See Section 8-2-4 for information on contaminants. See Section 6-4 for information on cleaning the cold trap.

(10) It is best to fill the cold trap with LN_2 once a day before you begin leak checking (see Section 4-2, Step 6a). After you are finished leak checking for the day, tap the VENT button, turn off the roughing pump, and allow the remaining LN_2 to evaporate overnight while the leak detector is running and valve V5 is closed (see Section 4-6-2). This will allow the cold trap to thaw and release the contaminants overnight. The high vacuum system will remove the released contaminants from the leak detector. Because valve V5 is closed, the released contaminants can not enter the mass spectrometer. If you cannot allow overnight self-cleaning because you are running the ULTRATEST for three shifts, remove and clean the cold trap at least once every 2 weeks (see Section 6-4-3).

(11) If you are using neither the optional QUICK-TEST nor LN_2, allow the ULTRATEST extra time to pump down to remove water vapor and fingerprint and solvent residues.

(12) Always turn off the EMISSION, shut valve V5, and turn off the roughing pump before allowing the leak detector to run overnight (see Section 4-6).

4-6 SHUTDOWN

CAUTION: DO NOT UNPLUG THE POWER SUPPLY TO TURN OFF THE ULTRATEST. UNPLUGGING THE POWER SUPPLY WHILE THE DIFFUSION PUMP IS HOT CAN RESULT IN THE DIFFUSION PUMP FLUID BAKING ONTO THE PUMP OR BACKSTREAMING INTO THE MASS SPECTROMETER OR COLD TRAP.

4-6-1 Temporary Shutdown (less than 4 hours)

Do not shut off any of the controls for short breaks from leak checking. Switching off the emission changes the operating temperature which may cause slight variations in the calibration values until the ULTRATEST again reaches operating temperature.

4-6-2 Overnight or Weekend Shutdown

Allowing the high vacuum pumping system to run overnight removes contaminants from the cold trap as the LN_2 boils off and prevents helium and condensation from accumulating in the high vacuum system (see Section 4-5, Items (9) and (10)). Even if LN_2 is not being used, this additional pumping helps reduce contamination.

Shutdown the ULTRATEST overnight as follows:

CAUTION: FAILURE TO TAP THE VENT PUSHBUTTON AND TURN OFF THE ROUGHING PUMP WILL RESULT IN OIL BACKSTREAMING INTO THE VALVE BLOCK AND TEST PORT.

1. Ensure that the PIII pressure is in the mid 10^{-6} mbar range or below before proceeding (see Figure 4-3).
2. Tap the VENT pushbutton.
3. Press the EMISSION "0" button on the FB module to turn off the emission (see Figure 4-3).
4. Shut valve V5 (see Figure 4-1A).
5. Press the RP pushbutton to turn off the roughing pump (see Figure 4-1B).

Do not shutdown the ULTRATEST immediately after a long pumping session. Allowing the leak detector to run for a while permits some self cleaning.

4-6-3 Long-Term Shutdown

If you will not be using the ULTRATEST for more than a week, use the procedure in this section to totally shut it down. Ensure that the cold trap is empty before shutdown (see Step 8). After a long pumping session, allow the leak detector to run for a while to permit self cleaning before shutting it down.

Proceed as follows to shutdown the ULTRATEST for more than a week.

1. Press the VENT pushbutton and hold it down for 2 seconds (see Figures 4-1B or 4-3).

2. Seal the test port with a blind flange (see Figure 1-1).

3. Press the PUMP pushbutton and wait until the "READY" lamp shows a steady glow (see Figure 4-1B or 4-3).

4. Check PIII to ensure that the pressure is in the mid 10^{-6} range or below (see Section 4-1-2).

5. Tap the VENT pushbutton.

6. Switch off the emission (see Figure 4-3).

7. Close valve V5 (see Figure 4-1A).

8. Allow the high vacuum pumping system to run until all the LN_2 boils out of the cold trap. If you can not wait for all the LN_2 to boil off, close valve V4, and empty and clean the cold trap using the instructiions in Section 6-4-3.

9. Close valve V4 (see Figure 4-1A).

10. Press the ON/OFF pushbutton to turn off the ULTRATEST. The vane pump and the fans will continue to operate for 30 to 45 minutes until the pump cools down, then the ULTRATEST will shut off automatically.

If the ULTRATEST has seen hard industrial use and you will be storing it without operation for longer than a month, change the pump fluid in both vane pumps (see Section 6-2) to remove any acid buildup.

SECTION 5

LEAK CHECKING TECHNIQUES

CAUTION: DO NOT EXPOSE THE MASS SPECTROMETER TO PRESSURES GREATER THAN 10^{-4} MBAR OR TO CONTAMINANTS SUCH AS FREON, HALOGENS, WATER VAPOR, OR OIL VAPOR (see Section 8-2).

Refer to Section 4-4 to use the ULTRATEST to evacuate and leak check small parts. See Appendix A-4 for leak checking techniques using the optional QUICK-TEST. See Appendix D if your ULTRATEST has the manual gross leak bypass modification.

The following describes some aditional leak checking techniques that are commonly used with the ULTRATEST.

5-1 SLIPSTREAM OR PARTIAL FLOW LEAK TEST

A system vacuum pump is needed if you want to detect coarse leaks or if the vacuum vessel is very large (see Figure 5-1). A system vacuum pump can also be used to decrease pump down time or to reduce the exposure of the leak detector to contaminants. The sensitivity of the leak detector is reduced when using this partial flow technique. To get full sensitivity, close the throttle valve after the test vessel is evacuated to an acceptable pressure.

CAUTION: IF THE FURNACE OR SYSTEM HAS A DIFFUSION PUMP CONTAINING SILICONE FLUID, IT COULD CONTAMINATE THE ULTRATEST VACUUM SYSTEM. ONCE SILICONE IS BAKED ONTO THE VACUUM SYSTEM, IT MUST BE CLEANED WITH SOAP AND WATER.

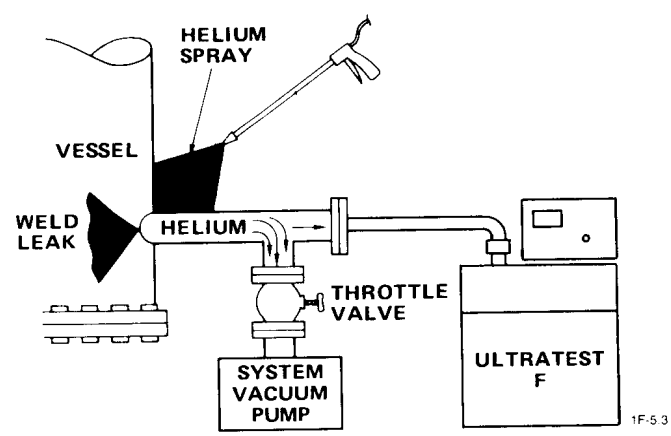


Figure 5-1 - Typical System for Leak Checking Using the Slipstream or Partial Flow Method

Proceed as follows to find leaks using the slipstream or partial flow method (see Figure 5-1).

1. Plumb the leak detector into the vacuum system manifold as shown in Figure 5-1. Be sure to use good vacuum techniques to avoid new leaks; we recommend O-ring-sealed joints and welded tubes.

2. Press the PUMP pushbutton and wait until the READY lamp lights (see Section 7-8-4). It may be necessary to add a throttling valve in the line to the leak detector to enable the READY lamp to come on steady.

3. Working from the top to the bottom, spray helium search gas onto the spots on the test vessel suspected of leaking.

4. The search gas penetrates through the leak, and then travels through the test vessel and connecting tubing to the leak detector. The response time depends on the volumne/pumping speed ratio of the system and on the distance between the leak and the ULTRATEST. Response time must be considered when probing several spots to avoid errors in locating leaks.

5-2 HOOD LEAK TEST

NOTE: A system vacuum pump or roughing pump can also be used with the hood leak test (see Section 5-1).

Proceed as follows to determine the overall leak rate of a test object using the hood test (see Figure 5-2).

1. Press the PUMP pushbutton and wait until the READY lamp lights (see Section 7-8-4).

2. Cover the test object with a hood (i.e. a PVC bag or metal chamber).

3. Fill the hood with helium search gas.

4. The helium search gas enters the test object through any leaks and is drawn through the connecting tubing into the leak detector. The leak rate indicated on the ULTRATEST meter is the total leak rate of the test object. This method can not be used to locate individual leaks.

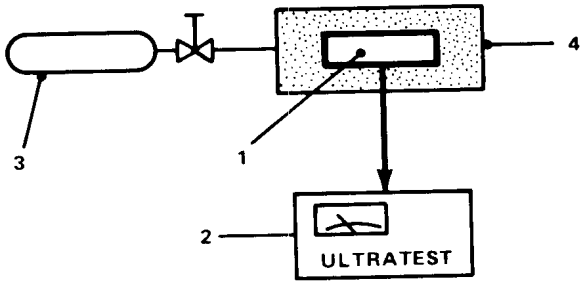


Figure 5-2 - Hood Leak Test Diagram

LEGEND:
1 TEST OBJECT
2 ULTRATEST
3 HELIUM SEARCH GAS CYLINDER
4 TEST ENVELOPE

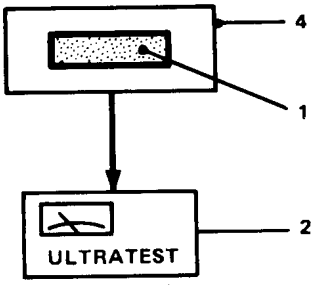


Figure 5-3 - Back Pressurization Leak Test Diagram

1F-5.4

5-3 BACK PRESSURIZING TECHNIQUE (Bombing test)

NOTE: A system vacuum pump or roughing pump can also be used with the back pressurizing techniques (see Section 5-1).

NOTE: This technique is extremely difficult to quantify because the exact amount of helium escaping through a leak depends on many factors including the following:

- o The concentration of helium in the pressurizing gas,
- o The length of time the object was in the pressure tank,
- o The volume of the test object,
- o The external and internal pressure, and
- o The amount of time that elapses between pressurization and testing.

Proceed as follows to use the back pressurizing technique.

1. Place the test object into a pressure tank.
2. Pressurize the pressure tank with helium search gas to allow the search gas to penetrate through any leaks into the test object.
3. Remove the test object from the pressure tank and blow-down the outside of the test object to remove any adsorbed helium.
4. Place the test object into the vacuum vessel connected to the ULTRATEST test port (see Figure 5-3).
5. Press the ULTRATEST PUMP pushbutton and wait until the READY lamp lights (see Section 7-8-4).

6. Search gas in the test object will escape through any leaks and be drawn through the connecting lines into the leak detector. The leak rate indicated on the ULTRATEST meter is due to the total leakage of the test object. This method can not be used to locate individual leaks (see Figure 5-3).

Steps 4 through 6 can also be applied to test objects filled with a high internal pressure of helium search gas. When the helium filling quantity is precisely defined, the leak rate can be quantified.

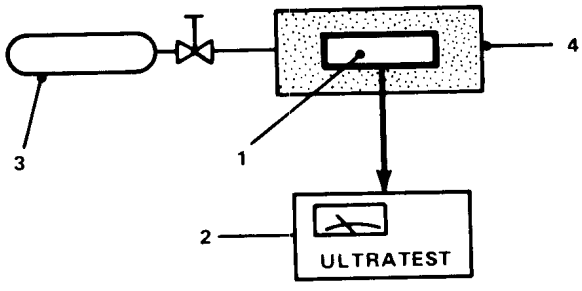


Figure 5-2 - Hood Leak Test Diagram

LEGEND:
1 TEST OBJECT
2 ULTRATEST
3 HELIUM SEARCH GAS CYLINDER
4 TEST ENVELOPE

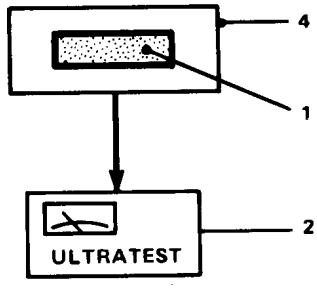


Figure 5-3 - Back Pressurization Leak Test Diagram

1F-5.4

5-3 BACK PRESSURIZING TECHNIQUE (Bombing test)

NOTE: A system vacuum pump or roughing pump can also be used with the back pressurizing techniques (see Section 5-1).

NOTE: This technique is extremely difficult to quantify because the exact amount of helium escaping through a leak depends on many factors including the following:

- o The concentration of helium in the pressurizing gas,
- o The length of time the object was in the pressure tank,
- o The volume of the test object,
- o The external and internal pressure, and
- o The amount of time that elapses between pressurization and testing.

Proceed as follows to use the back pressurizing technique.

1. Place the test object into a pressure tank.
2. Pressurize the pressure tank with helium search gas to allow the search gas to penetrate through any leaks into the test object.
3. Remove the test object from the pressure tank and blow-down the outside of the test object to remove any adsorbed helium.
4. Place the test object into the vacuum vessel connected to the ULTRATEST test port (see Figure 5-3).
5. Press the ULTRATEST PUMP pushbutton and wait until the READY lamp lights (see Section 7-8-4).

6. Search gas in the test object will escape through any leaks and be drawn through the connecting lines into the leak detector. The leak rate indicated on the ULTRATEST meter is due to the total leakage of the test object. This method can not be used to locate individual leaks (see Figure 5-3).

Steps 4 through 6 can also be applied to test objects filled with a high internal pressure of helium search gas. When the helium filling quantity is precisely defined, the leak rate can be quantified.

SECTION 6

MAINTENANCE

See Table 6-1 for the maintenance schedule. The frequencies listed in the Table assume that you are using the ULTRATEST in a relatively clean environment. More frequent maintenance is required under adverse operating conditions. The "Reference Section" columns of the table lists the Section in this manual containing the maintenance instructions. If you have the optional QUICK-TEST, see Appendix A. See Section 8 for troubleshooting and repair.

TABLE 6-1 - MAINTENANCE SCHEDULE

Maintenance	Frequency*					Reference
	Daily	100 Hours	1000 Hours	2000 Hours	As Needed	Section
Check Calibration	X					Sec. 4-2, Step 7
Fill cold trap (20 hour holding capacity)	X					Sec. 4-4, Item (10). Sec. 4-2, Step 6a.
Check vane pump fluid		X				Sec. 6-1
Clean cold trap			X			Sec. 6-4-3
Changing the fluid in the vane pumps					X	Sec. 6-2
Clean the diffusion pump fan and cooling fins			X			Step 2e of Sec. 6-3-2
Change the fluid and clean the diffusion pump				X		Sec. 6-3-2
Drain the pump fluid from the control vacuum reservoir				X		Sec. 6-6
Add pump fluid to the diffusion pump					X	Sec. 6-3-1
Change the ion source					X	Sec. 6-5

* Use the hour counter on the MS module to schedule maintenace intervals. More frequent maintenance is required under adverse operating conditions.

6-1 CHECKING THE LEVEL AND CLEANLINESS OF THE PUMP FLUID IN BOTH VANE PUMPS

Remove the lower panels from both sides of the ULTRATEST in order to see the oil-level sight glass of the roughing pump (see Figure 6-1) and of the backing pump (see Figure 6-2).

6-1-1 Checking the Pump Fluid Level of Both Vane Pumps

Under normal operating conditions the vane pumps use very little pump fluid. However, if you run the D4A backing pump with the gas ballast valve open (see Section 7-6-2-3), the pump fluid consumption of the backing pump increases.

The fluid level should be in the middle to upper third of the sight glass when the vane pump is **not** running. When the vane pump is running, the fluid level should be visible in the sight glass under a layer of bubbles. If the fluid level is in the lower third of the sight glass, proceed as follows to add fluid to the roughing pump or to the backing pump.

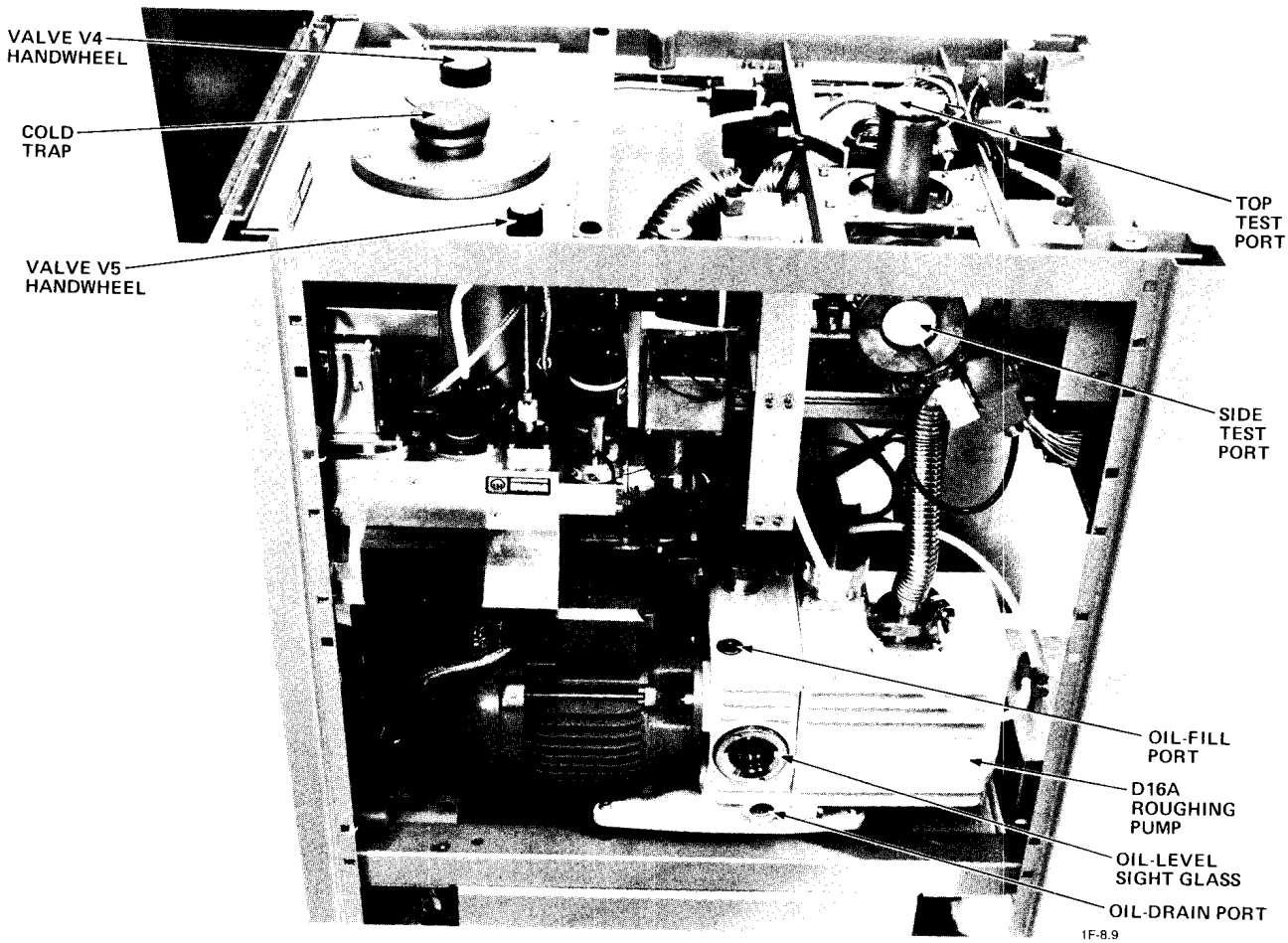


Figure 6-1 - Leak Detector Showing the Roughing Pump, and Valve V4 and V5 Handwheels

1. Refer to Section 4-6-3 to shutdown the ULTRATEST.

2. Using an 8-mm allen wrench, remove the allen-head plugscrew from the oil-fill port in the top of the vane pump (see Figure 6-1 or 6-2).

3. Add HE-200 vacuum pump fluid (see Table 6-2) through th oil-fill port until the fluid level is in the middle to upper third of the sight glass while the ULTRATEST is turned off (see Figure 6-1 or 6-2).

4. Reinstall the plugscrew and the panels.

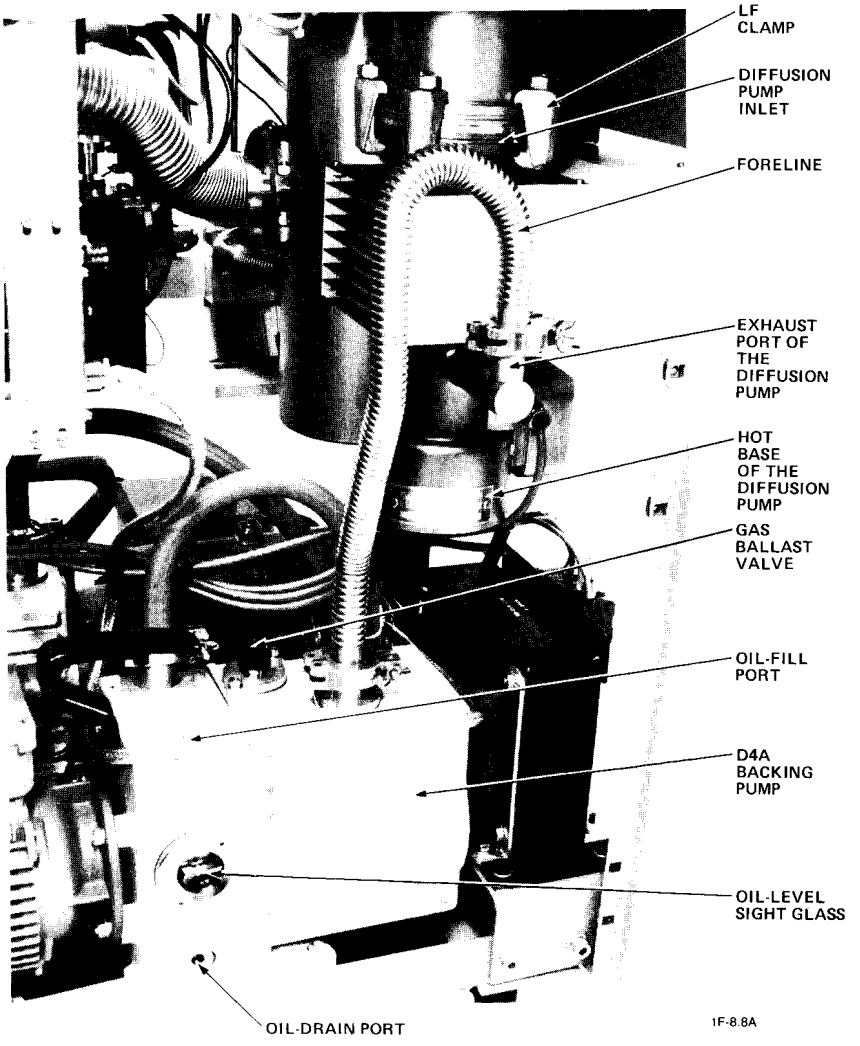


Figure 6-2 - Backing Pump and Diffusion Pump Installed in the Leak Detector

6-1-2 Checking the Cleanliness of the Pump Fluid

NOTE: The fluid in the roughing pump usually needs to be changed more frequently than the fluid in the backing pump.

If the vane pump fluid has an unusual color or odor, is dark, contains particles or flakes, or appears dirty or turbid, change the pump fluid (see Section 6-2). As a general guide, if the pump fluid looks like honey, it does not need to be changed; if it looks like tea, you should probably change it; if it looks like coffee, definitely change it. However, if your pump is exposed to acids, the fluid may look good even though it is contaminated.

If the ULTRATEST is used under very dirty conditions requiring frequent pump fluid changes, periodically change the internal vane pump filter (Part No. 390 26 121 for the D4A and Part No. 390 26 117 for the D16A). Use LN_2 in the cold trap and where applicable add a filter to the test port or a coaxial trap to the roughing line to protect the ULTRATEST vacuum system from contamination.

6-2 CHANGING THE PUMP FLUID IN THE VANE PUMPS

The pump fluid in the roughing pump (see Section 6-2-1) generally needs to be changed more frequently than the pump fluid in the backing pump (see Section 6-2-2).

6-2-1 Changing the Pump Fluid in the Roughing Pump

Change the pump fluid in the roughing pump as follows (see Figure 6-1).

1. If not already done, press the roughing pump pushbutton RP to turn off the roughing pump (see Figure 4-1B).
2. Remove the lower panel from the left side of the leak detector.
3. Using an 8-mm allen wrench, remove the allen-head plugscrew from the oil-fill port in the top of the pump.
4. Place a container under the oil-drain port and remove the allen-head plugscrew from the oil-drain port of the pump to drain the fluid.
5. Use the RP pushbutton (see Figure 4-1B) to jog (switch ON momentarily, and then switch off) the roughing pump several times to drain the remainder of the used fluid.

TABLE 6-2 - RECOMMENDED PUMP FLUIDS AND FILLING CAPACITIES

Pump Model	Recommend Pump Fluid	Pump Fluid Capacity	Catalog No. of Recommended Fluid	
180 L Diffusion Pump	HE-300*	Min: 30cc Opt: 40cc Max: 70cc	98-198-055 for 50cc	98-198-056 for 100cc
D4A Backing Pump	HE-200*	Min: 0.53 qt. Max: 0.74 qt.	98-198-006 for 1 qt.	98-198-007 for 1 gal.
D16A Roughing Pump+	HE-200*	Min: 0.95 qt. Max: 1.37 qt.	98-198-006 for 1 qt.	98-198-007 for 1 gal.
D8A Roughing Pump+	HE-200*	Min: 0.75 qt. Max: 1.2 qt.	98-198-006 for 1 qt.	98-198-007 for 1 gal.
D25B Roughing Pump+	HE-200*	Min: 0.65 qt. Max: 1.15 qt.	98-198-006 for 1 qt	98-198-007 for 1 gal.

* For standard applications
\+ See the identification plate on the end of the roughing-pump oil casing to determine the model of your roughing pump (see Figure 6-1).

6. If the used pump fluid is very dirty, proceed as follows to flush out the vane pump.

   a. Reinstall the plugscrew into the oil-drain port.

   b. Pour the HE-200 pump fluid into the oil-fill port until the vane pump is filled to about one-half capacity (see Table 6-2).

   c. Reinstall the plugscrew into the oil-fill port.

   d. Press the RP pushbutton to start the roughing pump and allow it to run for 5 minutes.

   e. If necessary, repeat Step 1, and Steps 3 through 6 to drain the pump and flush again.

7. Reinstall the plugscrew into the oil-drain port and fill the vane pump to capacity with HE-200 pump fluid (see Table 6-2).

8. Reinstall the plugscrew into the oil-fill port, and reinstall the panel.

6-2-2 Changing the Pump Fluid in the Backing Pump

Change the pump fluid in the D4A backing pump as follows (see Figure 6-2).

1. Refer to Section 4-6-3 to shutdown the ULTRATEST.

2. After the backing pump shuts off, remove the lower panel from the right side of the leak detector.

3. Do Steps 3 through 8 of Section 6-2-1 except use the ON/OFF pushbutton to control the backing pump rather than the RP pushbutton.

6-3 DIFFUSION PUMP MAINTENANCE

If the pressure (PIII) and the leak-rate reading are unstable, it can mean that the pump fluid in the diffusion pump is low or contaminated. Diffusion pump fluid problems can be the result of pumping at too high a pressure, air rushing into the diffusion pump, insufficient cooling, contaminants in the high vacuum system, or from shutting down the leak detector by pulling the plug.

If PIII and the leak-rate reading are unstable, first try adding pump fluid to the diffusion pump (Section 6-3-1); if adding fluid does not remedy the problem, then clean the pump and change the fluid (Section 6-3-2).

6-3-1 Adding Pump Fluid to the Diffusion Pump

Add pump fluid to the diffusion pump as follows:

1. Shutdown the ULTRATEST using the instructions in Section 4-6-3.

2. Remove both panels from the right side of the leak detector.

3. WARNING: DO NOT TOUCH THE DIFFUSION PUMP HEATER
   UNTIL IT HAS COOLED DOWN.

   Wait until the diffusion pump heater cools before proceeding to Step 4 (see Figure 6-2).

4. NOTE: Disconnecting the foreline will vent the diffusion pump.

   Remove the KF clamp and slowly disconnect the foreline from the exhaust port of the diffusion pump (see Figure 6-2).

5. CAUTION: DO NOT USE SILICONE BASED PUMP FLUIDS.

   Pour 10 cc of HE-300 pump fluid (see Table 6-2) into the exhaust port of the diffusion pump (see Figure 6-2).

6. Reassemble the foreline to the exhaust port of the diffusion pump and reinstall the side panels.

7. Start and calibrate the ULTRATEST using the instructions in Section 4-2 and 4-3.

8. If the symptoms remain, it may be necessary to service the diffusion pump (see Section 6-3-2).

6-3-2 Cleaning the Diffusion Pump and Changing the Pump Fluid

NOTE: Decomposition of pump fluid can result from inrushes of air, insufficient cooling, contaminants (see Section 8-2-4), excessive exposure of hot diffusion pump fluid to atmospheric pressure, or from shutting down the leak detector by pulling the plug.

Proceed as follows to remove, disassemble, clean, assemble, and add clean pump fluid to the diffusion pump.

1. Do Steps 1 through 4 of Section 6-3-1.

2. Remove the diffusion pump as follows:

   a. Depress the clips and unplug diffusion-pump plug "H" from the back of the EL module (see Figure 8-18).

   b. Unplug the ULTRATEST from the wall outlet or power source.

   c. Using a 17mm wrench, loosen and remove the four LF clamps from the diffusion pump inlet (see Figure 6-2).

   d. Remove the diffusion pump from the leak detector.

   e. Use compressed air to blow any dirt off of the exterior cooling fins and the fan of the diffusion pump.

3. Disassemble the diffusion pump as follows (see Figure 6-3).

   (1) Remove the orifice plate (baffle) from the top of the pump.

Section 6-3-2, Step 3 continued

(2) WARNING: DO NOT TOUCH THE JET ASSEMBLY UNTIL IT HAS COOLED.

Pull up the jet assembly far enough to allow the pump fluid to drain into the pump housing before removing the assembly from the pump housing.

(3) NOTE: Normally the diffusion pump fluid can be reused unless it looks or smells bad.

Pour the used pump fluid out of the pump housing.

4. CAUTION: DO NOT USE FREON OR HALOGEN SOLVENTS TO CLEAN THE DIFFUSION PUMP.

CAUTION: DO NOT CRUSH OR BEND THE MATING EDGES OF EACH SEGMENT ON THE JET STACK.

NOTE: Cracking of the pump fluid results is brown stains on the jet assembly. If the stains are light and are on the bottom half of the jet assembly, they have little effect on the operation of the pump. If the stains are dark and are on the upper portion of the jet assembly, they cause the leak rate reading to be unstable. Exposing the diffusion pump to atmospheric pressure results in stains on the top portion of the jet assembly.

Proceed as follows to clean the diffusion pump.

a. CAUTION: BE VERY CAREFUL WITH THE JET ASSEMBLY PARTS; THEY ARE ALUMINUM AND BEND OUT OF SHAPE EASILY.

Unscrew the small hex nut from the bottom of the center rod to disassemble the jet assembly (Part No. 410-11-410).

b. Thoroughly clean the jet assembly and pumping chamber with acetone or trichloroethylene.

c. If deposits are baked onto the diffusion pump, remove them with fine grained detergents and Scotch Brite or emery. Deposits will affect the heat transfer characteristics of the pump.

d. CAUTION: DO NOT HANDLE THE JET ASSEMBLY WITH BARE HANDS AFTER CLEANING.

Rinse the jet assembly and pumping chamber with methanol and then dry with warm air.

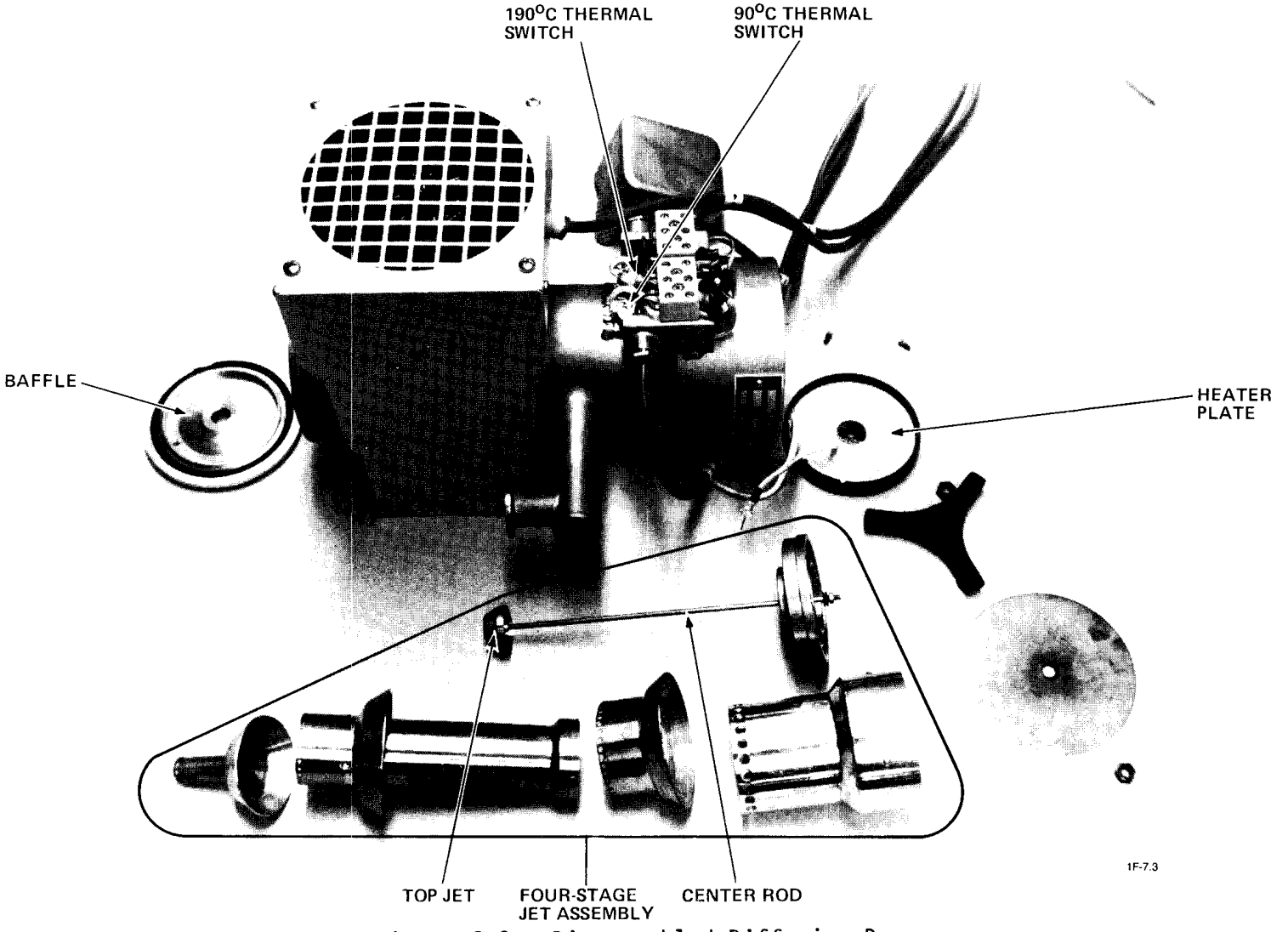


Figure 6-3 - Disassembled Diffusion Pump

5. Reassemble and install the diffusion pump as follows:

   a. CAUTION: DO NOT TURN THE JET ATTACHED TO THE TOP OF THE CENTER ROD TO TIGHTEN THE JET ASSEMBLY. IF YOU TIGHTEN THE JET ASSEMBLY IN THIS MANNER, YOU COULD TWIST THE TOP OF THE JET OFF OF THE CENTER ROD.

      Reassemble the jet assembly ensuring that the parts are seated concentrically, and that there are no gaps between the stages; tighten the small hex nut and washers onto the bottom of the center rod (see Figure 6-3).

   b. Pour 50 cc of clear, clean HE-300 pump fluid into the top of the pumping chamber.

   c. Place the jet assembly into the pumping chamber ensuring that it is firmly and correctly positioned. All pieces of the jet assembly must be straight and the assembly must sit perpendicular to the bottom of the pumping chamber.

Section 6-3-2, Step 5 continued

d. Ensure that the baffle, O-ring, and difffusion pump inlet are clean and then place the baffle onto the diffusion pump inlet flange so that the convex side faces up (see Figure 6-3).

e. Look through the hole in the baffle to ensure that the jet stack is centered in the diffusion pump housing and is not tilted to one side.

f. Open the gas ballast valve on the backing pump (see Section 7-6-2-3 and Figure 6-2).

g. Reinstall the diffusion pump into the leak detector (see Figure 6-2). Be sure to gradually tighten the LF clamps crosswise so that the O-ring is sealed evenly.

h. Plug the leak detector into a suitable electrical outlet and use Section 4-2 to start the ULTRATEST.

i. After running the leak detector for about 1/2 hour to remove any residual solvents from the diffusion pump, close the gas ballast valve on the backing pump and reinstall the panels onto the leak detector.

j. Use Section 4-3 to recalibrate the ULTRATEST.

6-4 COLD TRAP MAINTENANCE

Contaminants adhere to the cold inner wall of the cold trap when it contains LN_2. If the cold trap is always filled with LN_2, the layers of contaminants will build up until they insulate the cold trap and cause thawing and release of contaminants. This release of contaminants can cause the pressure or background leak rate in the leak detector to be unacceptable. See Section 6-4-1 to prevent the build-up of contaminants and Section 6-4-2 and 6-4-3 to remove contaminant build-up.

6-4-1 Recommended Operation

See Item (10) of Section 4-5 for the method of operation we recommend to prevent buildup of contaminants on the cold trap.

6-4-2 Defrosting the Cold Trap

The easiest way to remove the contaminants from the cold trap is as follows:

1. Tap the VENT pushbutton (see Figure 6-5).

2. Shut the valve V5 handwheel (see Figure 6-1).

3. Ensure that the valve V4 handwheel is open (see Figure 6-1).

4. Press the RP pushbutton to turn off the roughing pump.

5. Allow all the LN_2 to boil out of the cold trap while the high vacuum pumping system is operating.

If you do not have time to wait for all the LN_2 to boil off or if pressure PIII and the background remain high after following the above procedure, refer to Section 6-4-3 to clean the cold trap.

6-4-3 Removing and Cleaning the Cold Trap

WARNING: FAILURE TO USE EXTREME CARE WHEN HANDLING THE COLD TRAP AND POURING LN_2 COULD RESULT IN FROSTBITE.

NOTE: Ensure that you have a new gasket on hand before removing the cold trap (see Section 8-9-2).

1. Ensure that there is a good vacuum in the mass spectrometer (PIII), turn off the emission, shut valve V5, and then shut valve V4 (see Section 4-1).

2. Press the ON/OFF pushbutton to shutdown the ULTRATEST (see Figure 6-5).

3. CAUTION: DO NOT NICK OR DENT THE COLD TRAP.

   NOTE: When the cold trap is sealed with a metal seal, it will vent itself when the screws are loosened. If the metal seal has been replaced with an O-ring, you must vent the cold trap or the vacuum will prevent you from pulling it out of the leak detector. See Appendix C for information on the cold trap rough/vent modification.

   Remove the allen-head cap screws and carefully pull the cold trap out of the top of the leak detector (see Figure 6-1).

4. Carefully empty the remaining LN_2 from the cold trap.

5. If necessary, carefully defrost the cold trap with a heat gun or hot water.

6. CAUTION: DO NOT USE HALOGENS OR FREON TO CLEAN THE COLD TRAP.

   Clean the cold trap with acetone and then rinse with methanol. Also clean everything you can reach inside the cold trap housing in the top of the leak detector.

7. Dry the cold trap thoroughly with a heat gun.

8. NOTE: If you clean the cold trap frequently, you can replace the metal seal with a VITON O-ring (Part No. 239-70-404). An O-ring is not as vacuum tight as a metal seal, but it can be reused (see Appendix C).

   CAUTION: DO NOT CLEAN THE METAL GASKET CHEMICALLY.

   Using fine steel wool, carefully remove the oxide film from the new metal gasket, rinse with methanol to remove oil or dust, and substitute the new gasket for the used one (see Section 8-9-2).

9. Reinstall the cold trap (see Section 8-9-2).

10. Press the ON/OFF pushbutton to start-up the ULTRATEST (see Figure 6-5).

11. Partially open valve V4, wait for a minute, and then fully open the valve (see Figure 6-1).

6-5 ION SOURCE

The ion source has two cathodes that are selectively operated. Use Section 6-5-1 to determine if the cathode being used needs to be changed; if necessary, use Section 6-5-2 to switch the cathodes. If both cathodes are bad, use Section 6-5-3 to install a new ion source.

6-5-1 Determining If The Ion Source Should Be Changed

If during operation, the EMISSION LEDs go out while the EMISSION "1" button is ON and PII is less than 10^{-2} mbar, adjust the EMISSION potentiometer and check if the EMISSION LEDs light. If they light, it means that the ion source is getting weak and needs to be changed (see Section 6-5-2); if the LEDs do not light when you adjust the potentiometer, it means that relay 252 (Part No. 590-22-252) on the LP2 board is bad (see Figure F-LP2).

Many times the EMISSION LEDs stay lit even though the ion source is bad. If the sensitivity of the ULTRATEST to helium is deteriorating, check the ion source as follows:

1. Proceed as follows to check the I_E range (see Section 4-1-2).

   a. Set the range switch to I_E.

   b. While watching the meter, turn the EMISSION potentiometer fully clockwise and then fully counterclockwise. The normal meter reading for a good ion source ranges from 0.5 to 5 as you turn the potentiometer.

   c. If the maximum I_E reading is much less than 5, the ion source is beginning to deteriorate and you should be sure to have a spare ion source on hand.

2. Proceed as follows to check the calibrated I_E reading:

   a. Use Section 4-3 to calibrate the ULTRATEST.

   b. Set the range switch to I_E. The optimal calibrated I_E reading is between 0.5 and 1.2.

   c. If the I_E reading is greater than 1.2, the ion source is starting to deteriorate and you should order a spare. If the reading is greater than 1.5, switch the cathodes or change the ion source.

6-5-2 Switching the Ion Source Cathodes

Proceed as follows to switch the cathodes:

1. Remove the panels from the left side of the leak detector.

2. Disconnect the ion source plug IQ, turn it 180°, and firmly reinsert it (see Figure 6-4).

3. Switch ON the emission (see Figure 4-3). The emission control may cut out again because of degassing the new filament. If so, switch it ON again.

4. If the EMISSION LED lights, use Section 4-3 to recalibrate the ULTRATEST.

   If the emission continues to cut out after several tries at switching it ON, it means that both cathodes are bad. When both cathodes are bad, use Section 6-5-3 to replace the ion source.

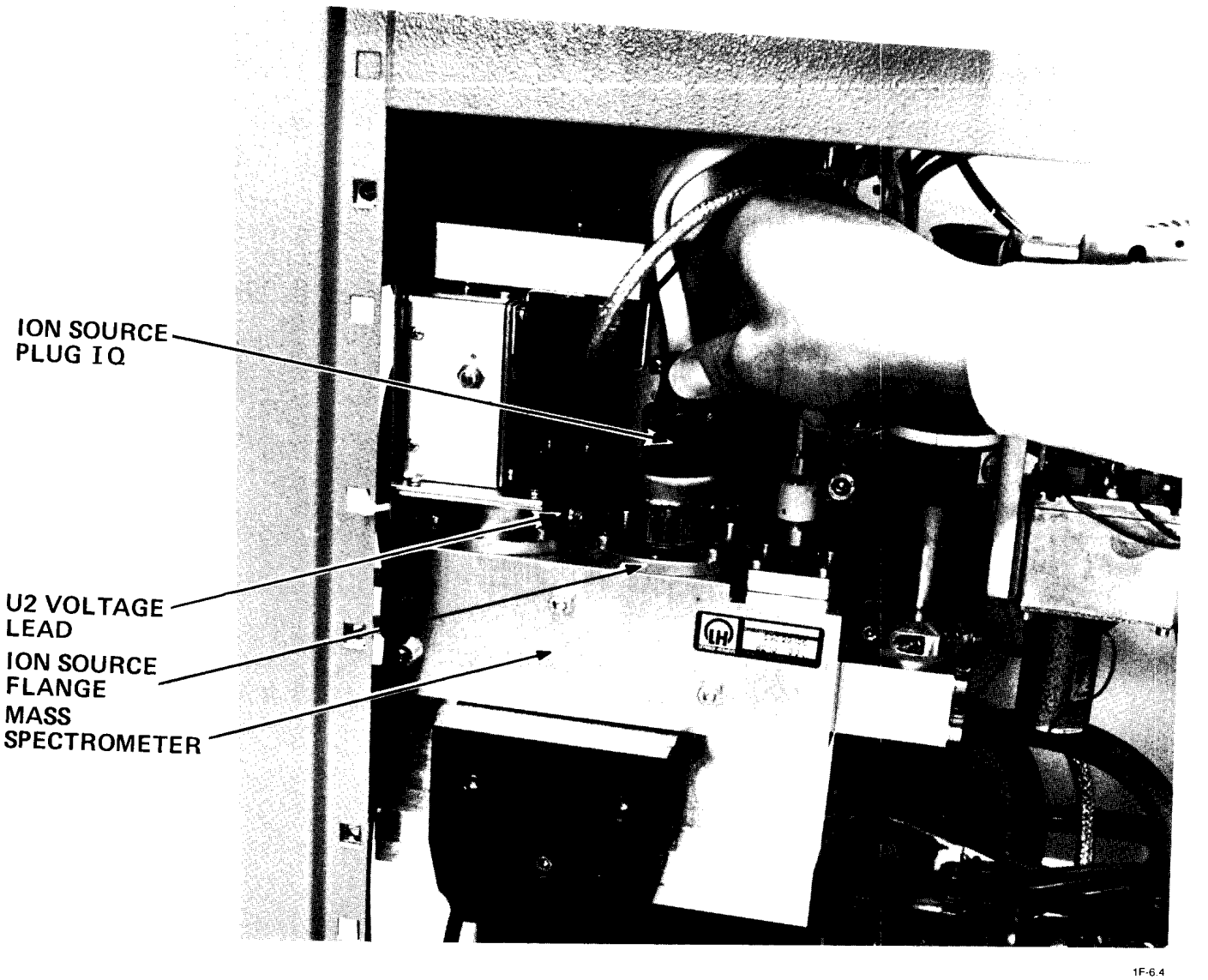


Figure 6-4 - Turning the Ion Source Plug to Switch the Cathodes

6-5-3 Installing the New Ion Source

NOTE: Before replacing the ion source, ensue that a new ion source (Part No. 165 13) and a new metal gasket (see Section 8-9-2) are available.

CAUTION: DO NOT STRAIGHTEN BENT CATHODES ON THE ION SOURCE. THE CATHODE WAS INTENTIONALLY BENT AS PART OF THE FACTORY ALIGNMENT PROCEDURE.

NOTE: You can install a new ion source while the ULTRATEST is ON.

Proceed as follows to install a new ion source.

1. Tap the VENT pushbutton to close valves V1 and V2 (see Figure 6-5).

2. Turn off the EMISSION (see Figure 6-5).

3. Shut the valve V5 handwheel (see Figure 6-1).

4. Remove the panels from the left side of the leak detector.

5. Unplug the ion source plug IQ (see Figure 6-4).

6. Remove the brass plug for the U2 voltage lead from the collector to allow you more room to work (see Figure 6-4).

7. Remove the four allen-head cap screws attaching the ion-source flange to the mass spectrometer (see Figure 6-4).

8. Screw one of the allen-head cap screws into the jack screw hole in the ion source flange to remove the old ion source (see Figure 6-4).

9. CAUTION: DO NOT USE SOLVENTS TO REMOVE THE OXIDE COAT FROM THE METAL GASKET.

   NOTE: If the metal gasket (P/N 235-51-133) is not available, you can use an O-ring (P/N 704-01-921) to seal the ion source. However, using an O-ring will increase the background leak rate and decrease sensitivity of the ULTRATEST.

   Discard the old metal gasket, polish the new metal gasket with fine steel wool or fine Scotch Brite, and rinse with methanol to remove any oil or dust (see Section 8-9-2).

10. CAUTION: DO NOT SCRATCH THE FLANGE SURFACE (see Section 8-9-2).

    CAUTION: DO NOT TOUCH THE VACUUM AREA OF THE ION SOURCE WITH YOUR BARE HANDS; A FINGERPRINT CAN CAUSE PROBLEMS. ALWAYS HANDLE THE ION SOURCE BY ITS FLANGE.

    Using a new metal gasket, place the new ion source into the mass spectrometer (see Figure 6-4); install the cap screws finger-tight, then make 5 to 10 rounds to tighten them sequentially around the flange (see Section 8-9-2).

11. Plug the ion source plug IQ firmly onto the pins of the ion source (see Figure 6-4) and reconnect the brass plug for the U_2 lead to the collector.

12. Reinstall the side panel.

13. Slowly open vlave V5, monitor PII until it drops to 10^{-3}, and switch ON the emission (see Figure 6-5). The emission control may cut out again because of degassing the filament. If so, switch it ON again.

14. Leak check the ion source flange.

15. Use Section 4-3 to recalibrate the ULTRATEST.

6-6 DRAINING THE CONTROL VACUUM RESERVOIR

A slight pump fluid mist from the gas ballast valve of the roughing pump sometimes collects in the control vacuum reservoir. If the control vacuum reservoir fills with pump fluid, valves V_1 and V_2 will not open properly.

Under normal operating conditions, drain the pump fluid from the vacuum reservoir once every 2000 operating hours. If the leak detector is cycled frequently from high to low pressures, the vacuum reservoir must be drained more frequently.

Drain the pump fluid from the control vacuum reservoir as follows (see Figure 6-5).

1. Press the RP pushbutton to shutdown the roughing pump.

2. Remove the lower gray front panel from the leak detector.

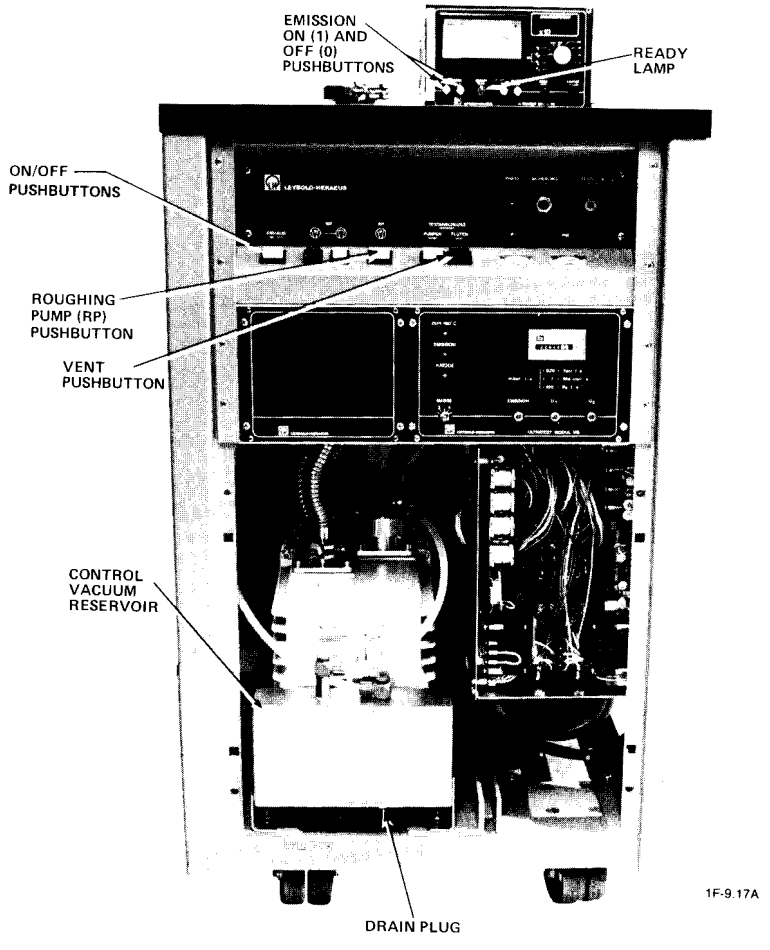


Figure 6-5 - Front View of Leak Detector Showing the Control Vacuum Reservoir

3. Unscrew and remove one of the nuts that secure the legs of the vacuum reservoir to the frame of the leak detector.

4. Swing the vacuum reservoir out from the leak detector so that you have easy access to the drain plug on the bottom of the vacuum reservoir.

5. Remove the drain plug from the bottom of the vacuum reservoir and allow any pump fluid to drain into a suitable container.

6. Reassemble the leak detector.

MAINTENANCE RECORD

Date	Maintenance

SECTION 7

DETAILED DESCRIPTION AND PRINCIPLES OF OPERATION

The purpose of the ULTRATEST is to find and quantify leaks as small as 2 x 10^{-11} atm.cc/sec. See Section 3 for a brief description and the specifications for the ULTRATEST. See Appendix A for information on the optional QUICK-TEST.

7-1 OVERVIEW

The ULTRATEST F consists of the leak detector and an FB module. The FB module attaches magnetically to the top of the leak detector (see Figure 6-5). The FB module contains all the measuring and control elements for operating the leak detector. The leak detector includes the mass spectrometer, the electronics that support the mass spectrometer and automatic valves, and the vacuum system including pumps, valves, and the cold trap (see Figure 7-1, 7-2, and 7-3).

The roughing pump in the leak detector evacates the test object until gauge PI reads 1 mbar; then valve V2 slowly opens to allow part of the gas coming from the test object to enter the high vacuum system (see Figure 7-2 and 7-3). When gauge PII reaches 3 x 10^{-2} mbar and gauge PIII is below 2 x 10^{-4} mbar, valve V2 opens fully and then valve V1 closes. With V2 fully open and V1 closed, all of the gas coming from the test object goes into the high vacuum system.

The gas enters the cold trap where condensable vapors condense and adhere to the cold inner walls. The noncondensable gas entering the mass spectrometer is separated according to mass; only the helium 4 molecules strike the collector. A signal proportional to the number of helium molecules striking the collector causes a deflection of the meter needle and an audible sound in the FB module. The high vacuum pumping system maintains the required vacuum in the mass spectrometer and removes the helium so that is does not accumulate and cause a false leak reading. The pressure readings from gauges PII and PIII show the pressure in the mass spectrometer. The valves (V4 and V5) protect the mass spectrometer. Valves V4 and V5 protect the mass spectroveter from contamination when the ULTRATEST is not being used to leak check, and allow maintenance without totally shutting down the leak detector. The MS module contains the electronics that support the mass spectrometer (see Figure 7-1B).

Sections 7-2 through 7-9 describe each major component and explain its function.

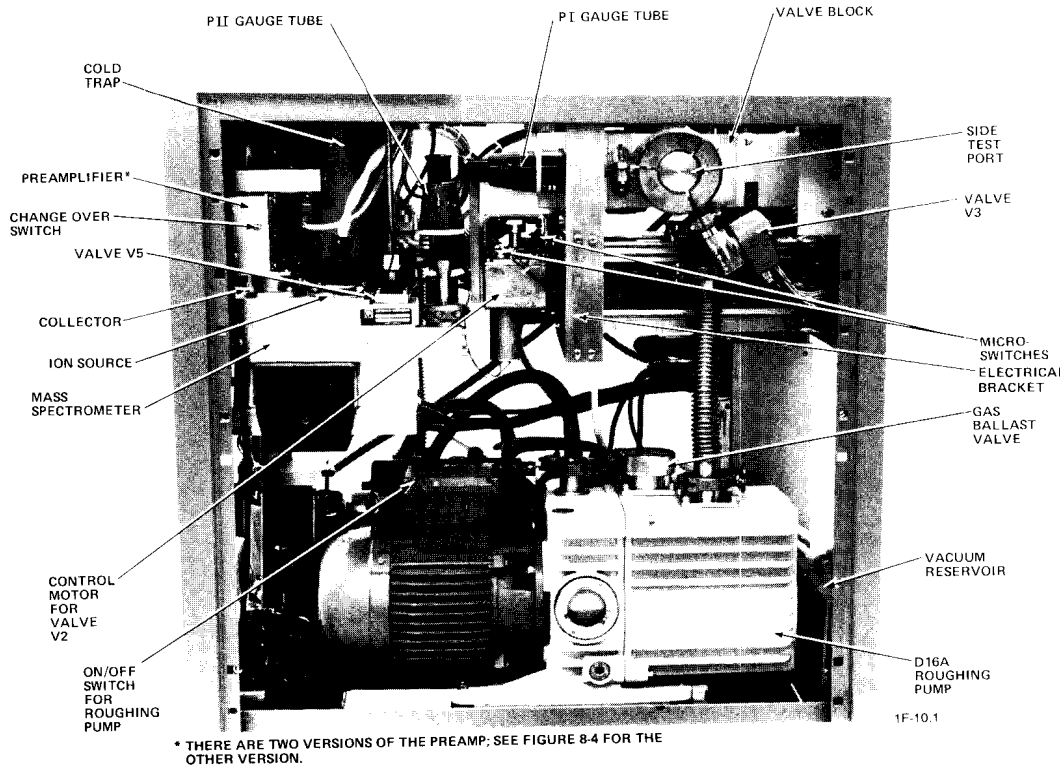


Figure 7-1A - Left Side of the Leak Detector with the Panels Removed

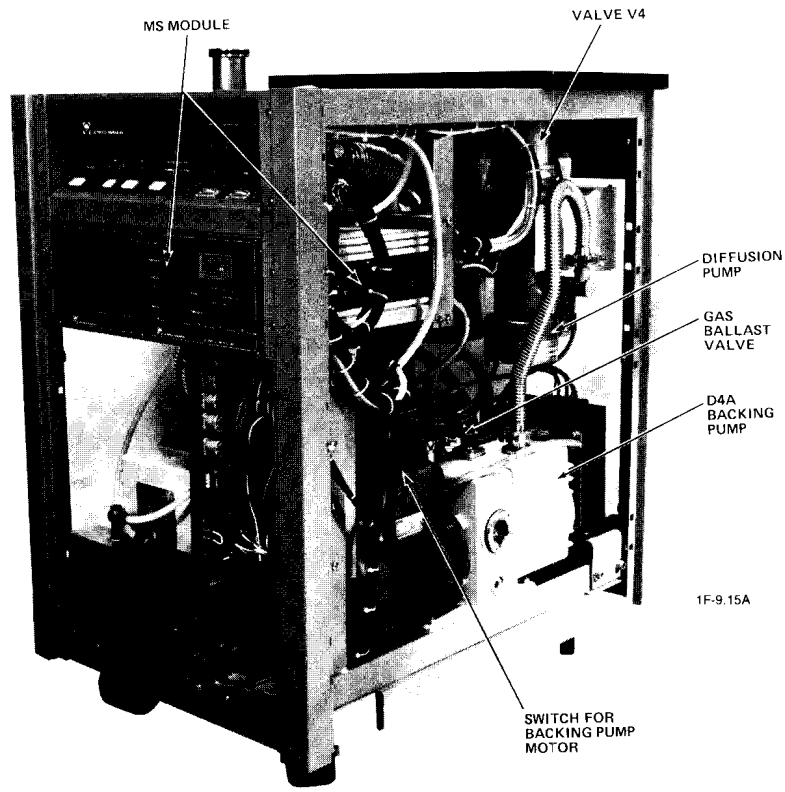
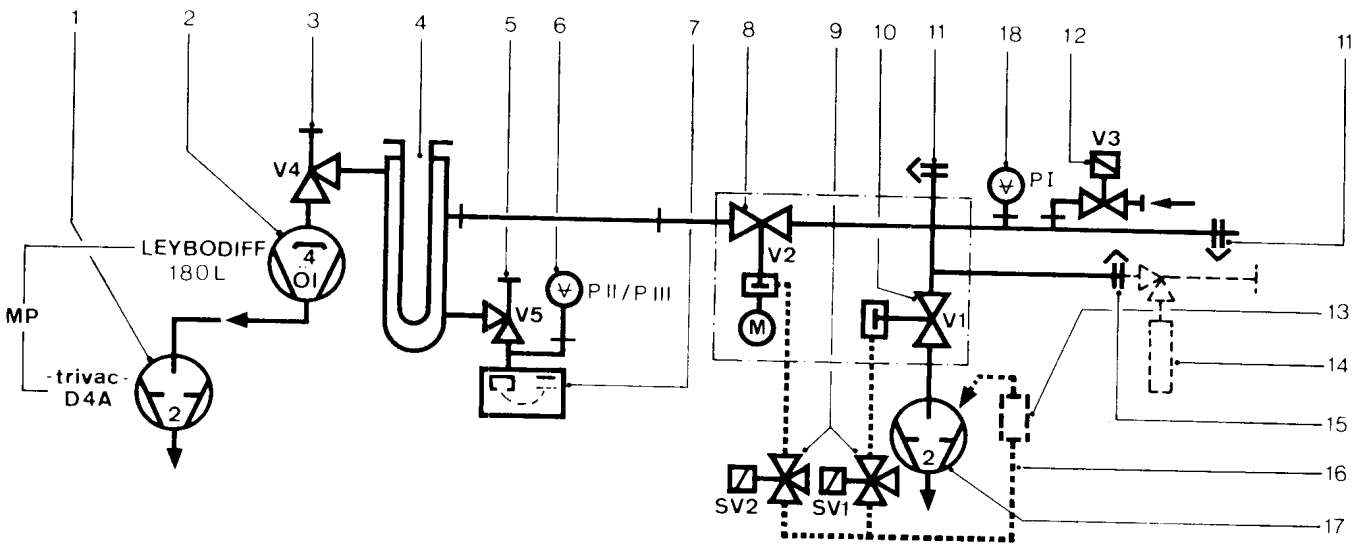


Figure 7-1B - Right Side of the Leak Detector with the Panels Removed



1 Backing pump
2 Diffusion pump
3 Handwheel valve V 4
4 LN_2 cold trap
5 Handwheel valve V 5
6 THERMOVAC TR 201 gauge head (P II)
7 Mass spectrometer (P III)
8 Inlet valve V 2
9 Control valves SV 1 and SV 2
10 Roughing valve V 1 (valves V 2 and V 1 in one block assembly)
11 Inlet test ports - NW 40 KF
12 Venting valve V 3
13 Control vacuum reservoir
14 Helium calibrated leak
15 Connecting port, e.g. for calibrated leak
16 Control vacuum PVC tubing
17 Roughing pump
18 THERMOVAC TR 201 gauge head (P I)

1F-5.5

Figure 7-2 - Operation Flow Diagram for the ULTRATEST F

7-2 ROUGHING PUMP (see Figure 7-1A and 7-3)

The roughing pump reduces the pressure in the test object. It is a dual stage vane pump. Most ULTRATEST F's have a D16A roughing pump which has a displacement of 14.1 CFM. The ULTRATEST F can also be ordered with TRIVAC roughing pumps ranging from 7 to 27 CFM displacement (see Table 3-1).

A rotor is mounted eccentrically in the vane pump stator housing so that there is a crescent-shaped pumping chamber between the rotor and the stator housing (see Figure 7-3). The pumping chamber is divided by three vanes that fit into slots in the rotor. The vanes are drawn out against the inner wall of the stator housing by centrifugal force as the rotor rotates. A thin film of pump fluid seals the clearance between the vanes and the stator housing.

One pumping cycle proceeds as follows (see Figure 7-3).

1. Gas is drawn into an increasingly large vacuum-tight chamber in the vane pump.

2. The rotation increases the size of the chamber until it is sealed off by a second vane.

3. Further rotation decreases the chamber size and compresses the gas.

4. The gas is forced out through an opening in the center plate and into the second stage of the pumping chamber.

5. The gas is compressed to atmospheric pressure in the second stage and forced out through the pump exhaust valve.

The gas ballast valve (see Section 7-6-2-3) is not adjustable on the roughing pump because it is used to provide the vacuum to operate valves V_1 and V_2 (see Section 7-3).

See the manual in the back of this binder for detailed information on the TRIVAC vane pumps.

7-3 VALVE BLOCK

The valve block includes valves V1 and V2, two KF40 test ports, and three KF10 ports (see Figures 7-1A and 7-4). The PI pressure gauge attaches to one of the KF10 ports; the venting valve V3 attaches to another KF10 port; and the third KF10 port is for permanently attaching a calibrated leak.

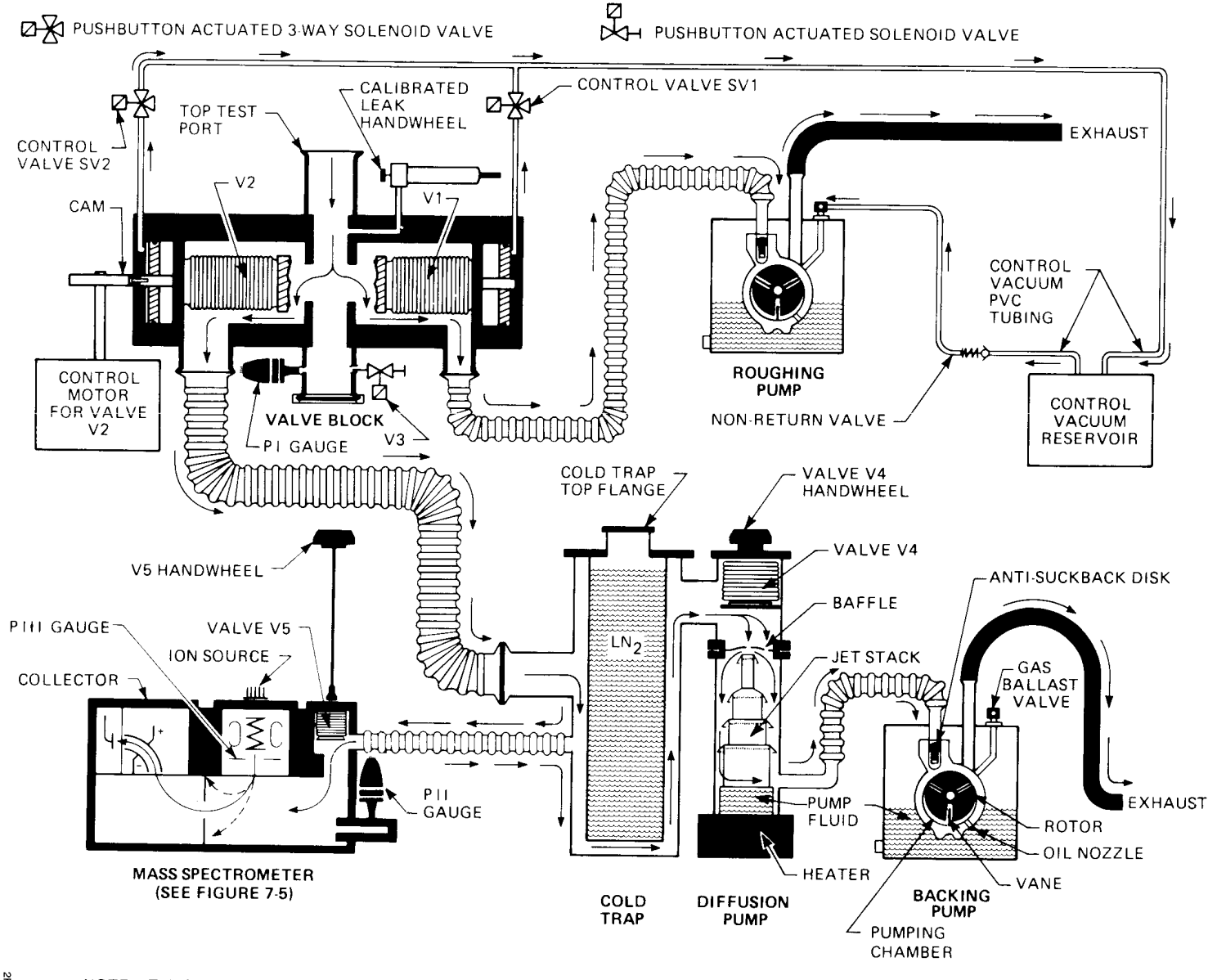
The valve block is made of aluminum; both valves V1 and V2 have stainless steel bellows-sealed stems.

7-3-1 Valves V1 and V2

Roughing valve V1 is located between the test ports and the roughing pump (see Figure 7-2). When the PUMP pushbutton is pressed, V1 opens immediately allowing the roughing pump to evacuate the test object.

Inlet valve V2 is located between the test ports and the high vacuum system. When V2 is open, it allows gas from the test object to enter the high vacuum system where its helium content is measured (see Section 7-6).

V1 and V2 are vacuum actuated valves which are closed by springs when not commanded open. The vacuum to operate both valves comes from the gas ballast valve of the roughing pump. PVC tubing connects the gas ballast valve to a control vacuum reservoir (see Figures 7-1A and 7-3). The control vacuum reservoir prevents surges and collects any oil mist coming from the gas ballast valve of the roughing pump. PVC tubing leading from the control vacuum reservoir splits at a Tee. One branch of the Tee leads to the control valve (SV1) for valve V1; the other branch leads to the control valve (SV2) for valve V2 (see Figures 7-3 and 7-4). Both control valves (SV1 and SV2) open when you press the "PUMP" pushbutton, and close when you press the "VENT" pushbutton (see Sections 7-8-4 and 7-8-5).



2F-5-1

NOTE: This Figure shows valve V1 open and valve V2 partially open; the READY lamp would be flashing ON and OFF in this mode of operation.

Figure 7-3 - Simplified Cross Section of the ULTRATEST F Vacuum System

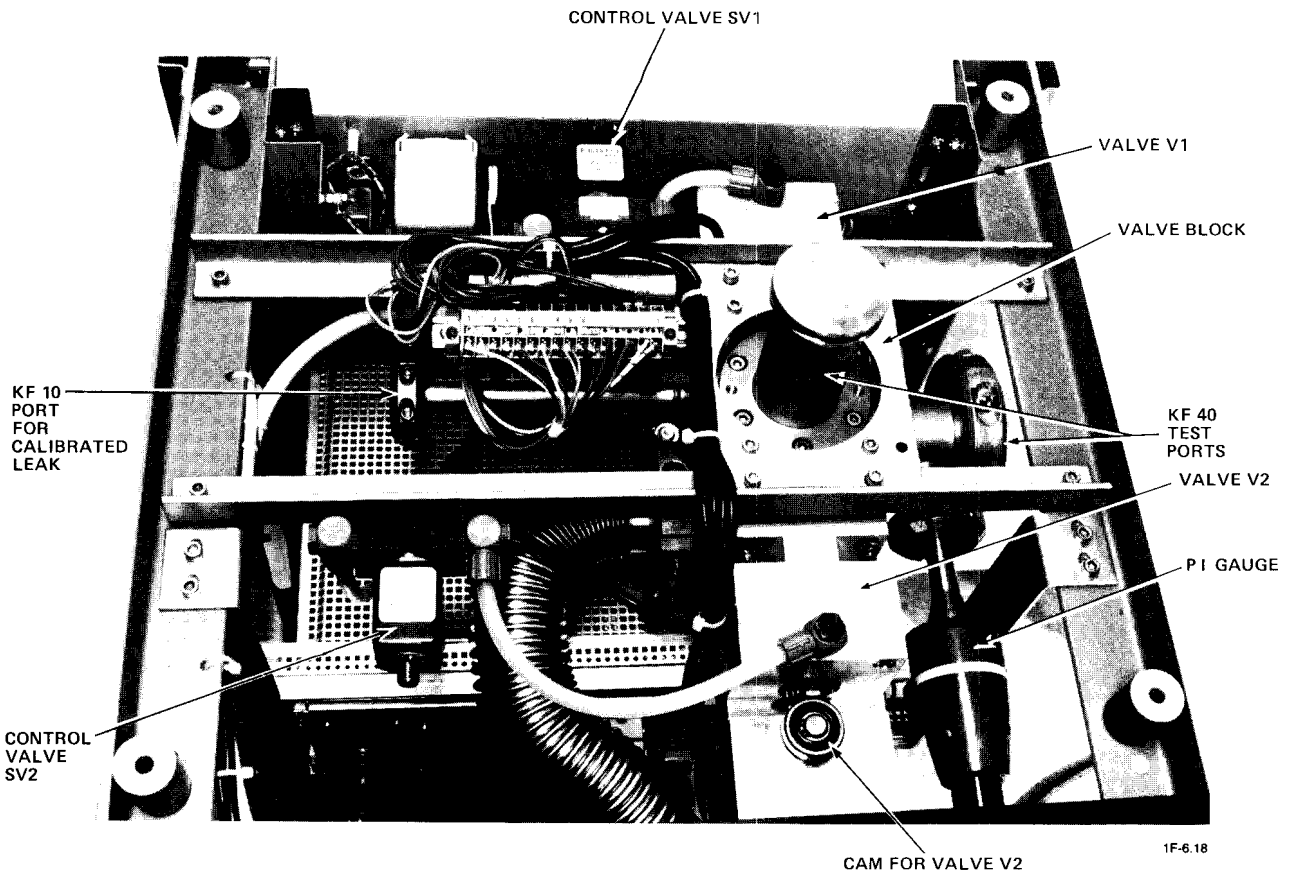


Figure 7-4 - Top of the Leak Detector Showing the Valve Block

When control valve SV1 opens, the chamber above the valve V1 piston is evacuated through the PVC tubing (see Figure 7-3). The vacuum in this chamber pulls the valve V1 piston and holds it in the open position. Valve V1 remains open until control valve SV1 shuts and vents the chamber above the piston. The piston springs shut when the chamber above it is vented.

Valve V1 opens immediately when control valve SV1 opens. Valve V2 and control valve SV2 would work the same way except that V2 is held closed by a cam. When control valve SV2 is open and there is vacuum in the chamber above the V2 piston, the piston can not open if the cam is all the way down. If the cam is halfway down, V2 will open halfway etc. The position of the cam is determined by a control motor which is in turn controlled by pressure gauges PI and PIII (see Figures 7-1A and 7-3). If the EMISSION is off, the PIII signal will be missing, and thus control valve SV2 will not open. The loss of power to SV2 immediately closes valve V2. See Section 7-8-4 for an explanation of how PI, PIII, V2, and the controls interact.

See Appendicies C and D for information on valve operation for leak detectors that have the cold trap vent or manual gross leak bypass modifications.

7-4 PRESSURE GAUGE PI

Gauge PI measures the pressure in the test port (see Figure 7-3).

PI and PII (see Section 7-6-1-4) are THERMOVAC® TR201 gauges that measure pressure from 1,000 to 10-3 mbar.

7-5 VENT VALVE V3

Valve V3 is a solenoid valve that vents the test object to atmospheric pressure when the VENT pushbutton is held down for 1.5 seconds (see Figures 7-1A and 7-3). V3 remains open until you press the PUMP pushbutton. Pressing the PUMP pushbutton immediately closes the vent valve unless the vent button is held down.

7-6 MASS SPECTROMETER AND HIGH VACUUM PUMPING SYSTEM

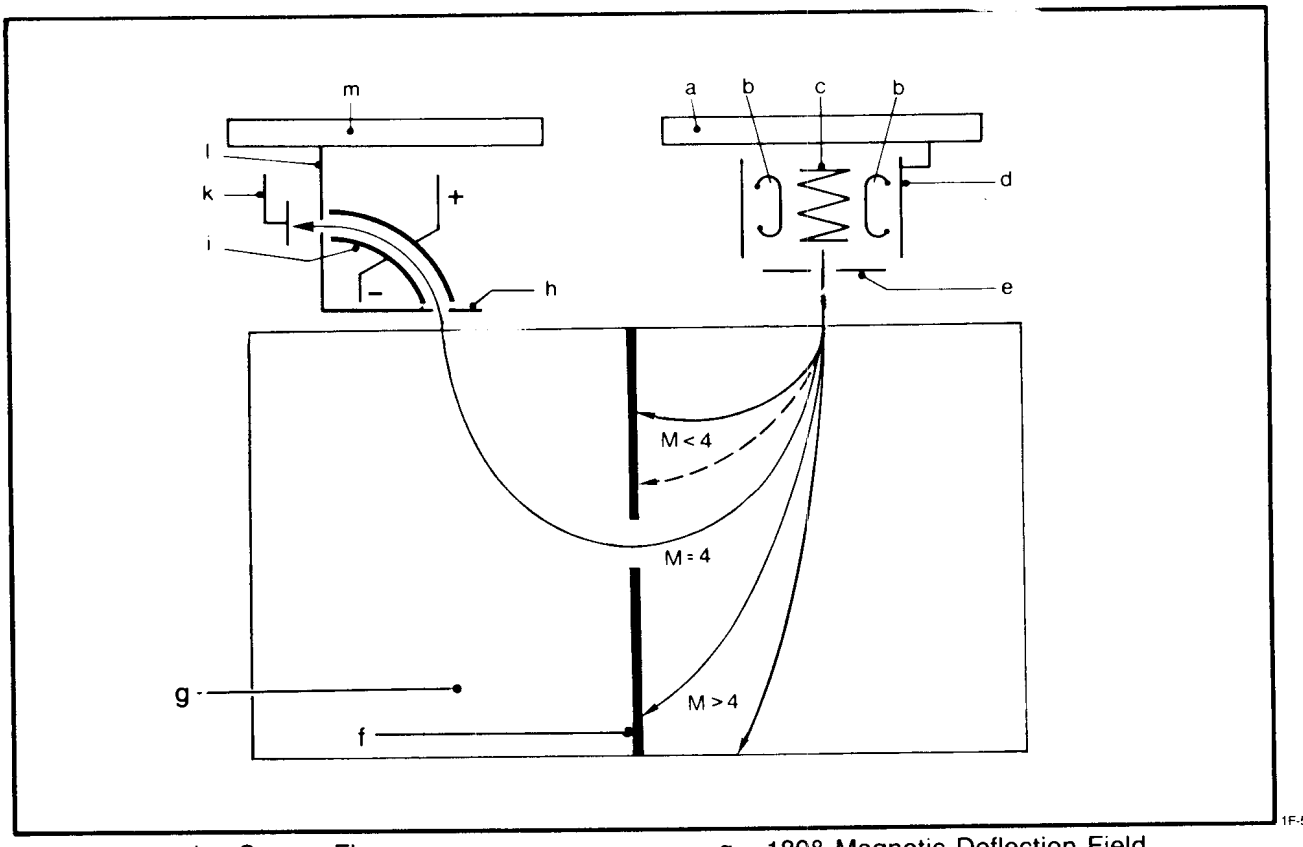
7-6-1 Mass Spectrometer with Ion Source, Collector, Preamp, Valve V5, and Gauges PII and PIII

The neutral gas molecules in the mass spectrometer (see Figure 7-5) are bombarded with electrons from the cathode (b) to form positive ions. The path of each ion through the magnetic field (g) and then through the electostatic field depends on its mass/charge ratio (see Figure 7-5). The slot in the intermediate slit (f) and the opening in the electrostatic deflection plates (i) are positioned so that only singularly ionized molecules with mass 4 (helium) are deflected through to the ion collector (k) (see Figure 7-5). Lighter and heavier ions collide with the intermediate slit (f) or with the walls of the mass spectrometer.

7-6-1-1 Ion source - The ion source has two cathodes (b) (see Figure 7-1A and 7-5). Because of their thoria coating, these iridium filaments (b) operate at a much lower temperature than tungsten filaments, improving their resistance to embrittlement, oxygen, water vapor, and hydrocarbons. However, in the presence of halogens (chlorine, bromine, iodine, and fluorine) and halogenated hydrocarbons (Freon, Frigen, Kaltron, etc.) the thoria coat wears off and causes a loss of emission current. See Section 6-5-1 to determine if the ion source needs to be changed. If one of the cathodes (b) is malfunctioning, disconnect the ion-source plug IQ, turn it 180^{0}, and reinsert it to use the other cathode (b) (see Section 6-5-2).

The original ion source is guaranteed against burnout during the first year of operation.

THERMOVAC is a registered trademark of Leybold-Heraeus.



a — Ion-Source Flange
b — Cathodes (thoriated iridium)
c — Anode (heated)
d — Ground Shield
e — Extractor Plate and Ion Collector for Pressure Measurement (PIII)
f — Intermediate Slit
g — 180° Magnetic Deflection Field
h — Inlet Slit to 90° Electrostatic Field
i — Electrostatic Deflection Plates
k — Ion Collector
l — Ground Slit
m — Ion Collector Flange

Figure 7-5 - Diagram of the Mass Spectrometer

7-6-1-2 **Ion Collector and Preamplifier** - The deflection plates (i)/ion collector (k) assembly is flange-mounted (m) onto the mass spectrometer (see Figure 7-1A and 7-5). The positive helium ions striking the ion collector (k) cause it to have a positive charge. Negative electrons flowing toward this positive-charge collector (k) constitute a minute current. This current is proportional to the number of positive ions striking the collector (k). The current is amplified in the preamplifier and the signal appears on the meter as the leak rate (see Section 4-1-2).

The changeover switch on the preamplifier allows for quantitative measurement of larger leaks. Turning the changeover switch reduces the sensitivity of the preamplifier by a factor of 100 which extends the effective range to 1 x 10^{-4} atm.cc/sec. The digital display for the leak-rate meter is automatically corrected.

7-6-1-3 Isolation Valve V_5 - V_5 is a manually-operated bellows-sealed valve used to isolate the mass spectrometer from the rest of the system (see Figure 7-1A and 7-3). Shut V5 when cleaning the cold trap and before shutting down the system to hold the vacuum in the mass spectrometer and to prevent contamination and loss of sensitivity. Shutting V5 also allows you to install a new ion source during operation.

During start-up and shut-down, V5 should always be the last valve you open, and the first you close. See Section 7-6-2-4 for information on valve V4.

7-6-1-4 Pressure Gauges PII and PIII - There are two gauges that measure the total pressure in the mass spectrometer. PII measures the pressure from 1,000 to 10^{-3} mbar, and PIII measures the pressure from 10^{-3} to 10^{-6} mbar.

When valve V4 or V5 is closed, the pressures indicated by PII will not decrease because PII is measuring the pressure in the mass spectrometer which is not being pumped.

PII is attached directly to the mass spectrometer. It is a Leybold-Heraeus THERMOVAC TR201 (see Figures 7-1A and 7-3).

If the pressure in the mass spectrometer is high, the large quantity of ions produced will interfere with each other and hinder the separation of ions according to the mass/charge ratio. For this reason PII is interlocked with the emission and will not allow ion production until the pressure PII is less than 10^{-2} mbar. This PII/emission interlock also protects the ion source from burning out.

PIII is an ionization gauge. It is operational only when the ion source (emission) is turned ON. It measures the current at the extractor plate (e) in the ion source (see Figure 7-5). PIII is used to control the opening of valve V2 during the valve transfer process.

7-6-2 High Vacuum System

The mass spectrometer maximum operation pressure is 2 x 10^{-4} mbar. To get the best sensitivity, the pressure should be below 5 x 10^{-5} mbar.

The high vacuum system meets the operating pressure requirements of the mass spectrometer and removes helium from the mass spectrometer so that it does not accumulate and give inaccurate leak readings. This pumping system can also be used to remove contaminants (see Section 8-2-4-3).

The high vacuum system consists of a cold trap, and a LEYBODIFF 180L four-stage stainless steel diffusion pump backed by a TRIVAC D4A vane pump (see Figures 7-1B and 7-3). When the cold trap contains liquid nitrogen, it removes contaminants and improves the pumping speed and ultimate pressure of the system.

The ultimate pressure of the backing pump is 3×10^{-4} mbar, thus it must be used with a diffusion pump to meet the optimal operating pressure of the mass spectrometer. The ultimate pressure of the diffusion pump is 10^{-7} mbar but is must be backed by a vane pump because diffusion pumps are unable to compress gas sufficiently to discharge it against atmospheric pressure.

During start-up, first the backing pump starts and power is applied to the diffusion pump heater. Shortly after the diffusion pump reaches 190C, the high vacuum pumping system is ready for operation as indicated by PIII. It generally takes 20 to 30 minutes for the high vacuum pumping system to warm up.

7-6-2-1 Cold Trap

When the cold trap contains liquid nitrogen (LN_2), it has high pumping speed for condensable vapors and improves the ultimate pressure by removing the partial pressure of water vapor (see Figures 7-1A and 7-3). Its main purpose, however, is to prevent contaminants, oil, and water vapors from entering the mass spectrometer. See Section 8-2-4-1 for information on the problems caused by contamination.

The cold trap consists of an inner housing and an outer housing. The inner housing can be easily removed for cleaning (see Section 6-4-3). To make the cold trap operational, pour (LN_2) into the trap's inner housing through the filler port (see Section 4-2 and Figure 4-1A). The trap holds 2.4 quarts of LN_2 which lasts approximately 20 hours.

When the cold trap contains LN_2, unwanted vapors entering the trap condense on and adhere to the cold wall of the inner housing. The unwanted vapors either enter the cold trap through the test port or migrate from the diffusion pump (see Figure 7-3).

If you allow all of the LN_2 to evaporate, the contaminants on the inner housing wall will thaw and be released. See Sections 4-2, 4-6, and 6-4 for the correct filling, shutdown, and cleaning precedures for the cold trap.

Generally, LN_2 is not added to the cold trap if you are using the optional QUICK-TEST (see Appendix A).

7-6-2-2 LEYBODIFF 180L Diffusion Pump

The LEYBODIFF 180L is an air cooled four-stage diffusion pump with a pumping speed of 180 liters/second (see Figure 7-1B and 7-3).

An orifice baffle plate on the diffusion pump inlet reduces the pumping speed to increase the sensitivity of the leak detector.

Careful design of the jets and the baffle reduces backstreaming of pump fluid vapors to a negligible level (see Figure 7-3). Backstreaming and pump fluid deterioration is also minimized by using HE-300 polyphenol diffusion pump fluid. HE-300 has a vapor pressure of 5×10^{-6} Torr at 100C and is oxidation resistant.

The heater at the base of the diffusion pump heats the pump fluid causing vapors to rise through the center of the jet stack (see Figure 7-3). At each stack segment opening, jets deflect the pump fluid vapor outward and downward toward the outside wall. The oil condenses on the air-cooled outside wall and drains down to the oil reservoir. The pumping action occurs when gas entering the top of the diffusion pump is compressed by collisions with the pump fluid molecules and is driven toward the base of the pump.

7-6-2-3 TRIVAC D4A Backing Pump

The TRIVAC D4A is a dual-stage direct-drive vane pump (see Figures 7-1B and 7-3). The TRIVAC uses HE-200 pump fluid which is a double-distilled hydrocarbon fluid that is resistant to contaminants. See Section 7-2 for an explanation of the operating principles of TRIVAC vane pumps; see the manual in the back of this binder for detailed information of the TRIVAC vane pumps.

The TRIVAC D4A backing pump has a gas ballast valve (see Figures 7-1B and 7-3). When the valve is opened, it allows a controlled amount of air into the second stage pumping chamber just before the exhaust valve. (The gas ballast valve is inoperative on the TRIVAC roughing pump (see Section 7-2)).

An open gas ballast valve increases the operating temperature of the pump which vaporizes any liquid contaminants from the pump fluid. Unwanted vapors are removed from the backing pump because an open gas ballast valve forces the exhaust valve to open before the vapors condense. However, running the backing pump with the gas ballast valve open also results in high pressures and higher pump fluid consumption.

The gas ballast valve should be opened if you suspect the pump fluid in the vane pump is contaminated or if the leak detector is exposed to high levels of water vapors or other contaminants (see Section 8-2-4-3).

To open the gas ballast valve, turn the black plastic cap until one of the holes on the side of the cap is aligned with the hole in the side of the metal cylinder.

7-6-2-4 Diffusion Pump Valve V4

V4 is a manually operated valve used to isolate the diffusion and backing pumps from the rest of the leak detector (see Figure 7-1B and 7-3). Partially closing V4 throttles the pumping speed and thus increases the sensitivity and the response time of the ULTRATEST. Shut V4 when removing the cold trap for cleaning, and before shutting down the system to hold vacuum in the cold trap. When the cold trap is at atmospheric pressure, always open valve V4 slightly until you hear the first inrush of air; then wait for a few minutes before fully opening the valve.

See Section 7-6-1-3 for information on valve V5.

7-7 FB REMOTE CONTROL MODULE

The FB module has all the measuring and control elements required for operating the leak detector (see Figure 7-6). See Table 8-2 for a list of PC boards and Section 8-13 for instructions for replacing the boards or the FB module. See Appendix E if your ULTRATEST is the US autoranging version.

The FB module can be removed from the leak detector. With an optional extension cord (30 meter maximum length), you can easily carry the FB module with you when you are leak checking.

See Section 4-1-2 for a description of how the controls and meter on the front panel of the FB module are used to read the pressure, emission current, and leak rate (see Figure 7-6).

The following describes each control on the front panel of the FB module.

7-7-1 "EMISSION" Pushbutton

Press the "1" pushbutton to turn ON the emission and the "0" button to turn it OFF (see Figure 7-6). The "EMISSION" and "KATODE" LEDs on the MS module light when the emission is ON and functioning. See Section 6-5-1 to determine if the ion source needs to be changed.

The emission can not be switched ON unless the total pressure measured at PII is below 1×10^{-2} mbar and the diffusion pump has reached its operating temperature (see "DIFF 190°C" LED). The emission switches off if one of these conditions is not met; it must be manually switched ON again.

The emission should be ON only when valve V5 is open. If the emission is ON and valve V5 is closed, the pressure in the mass spectrometer will rise and automatically shut off the emission.

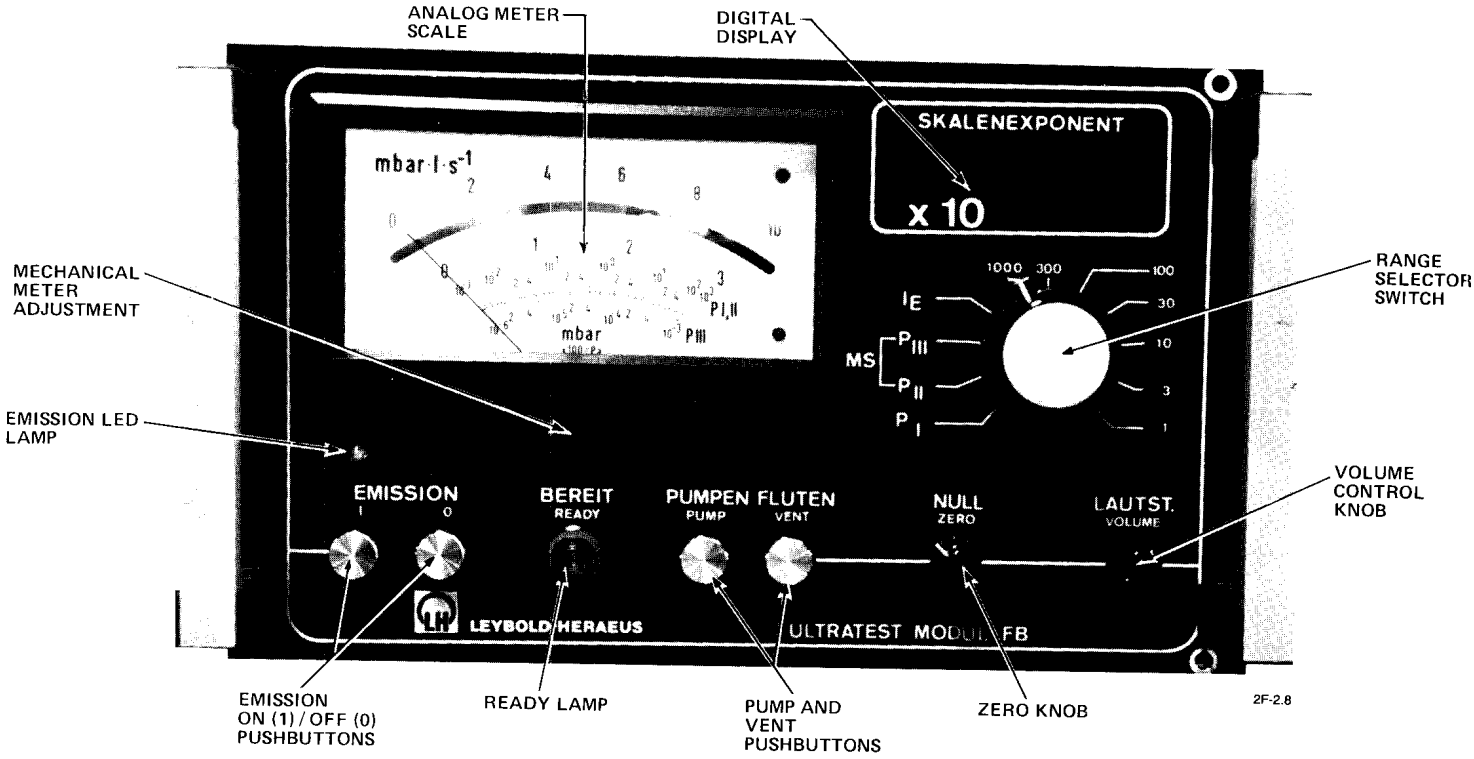


Figure 7-6 - FB Module Front Controls

7-7-2 Mechanical Meter Adjustment

After the FB module has been shipped or if it has been jarred, check the mechanical meter adjustment (see Figure 7-6). With the ULTRATEST turned off, turn the screw until the needle is on "0".

7-7-3 "ZERO" Rotary Knob

This knob is used for zero adjustment of the amplifier (see Figure 7-6). To zero the amplifier 1) Tap the VENT pushbutton, 2) switch off the emission (see Figure 7-6), 3) close the calibrated leak, (see Figure 2-2), 4) turn the range switch to the "1" leak-rate position (see Figure 7-6), and 5) turn the "Zero" knob until the red 0 to 10 scale reads 0.

If you are using the optional QUICK-TEST, the meter should read approximately 5 to 20% of full scale on the most sensitive range when you switch on the emission due to the naturally occurring helium in the air. If the meter reading with the QUICK-TEST is greater than 9 x 10^{-8}, it means a) that the calibrated leak is open, b) that the

mass spectrometer is contaminated or contains some residual gas, or c) that the area around the probe tip has a higher than normal helium content. You can compensate for moderate background readings by using this rotary knob to zero the meter while the EMISSION is ON and the calibrated leak is closed. See Section 8-2 for additional information on helium background.

7-7-4 "VOLUME" Control

This rotary knob controls the volume of the audible leak signal (see Figure 7-6). The larger the meter deflection, the higher is the pitch of the audible signal. The audibility threshold is at 10% of fullscale meter deflection. If you wish to silence the signal, turn it all the way counterclockwise.

7-7-5 PUMP and VENT Pushbuttons

The PUMP and VENT buttons on the FB module can be used instead of the corresponding pushbuttons on the leak detector (see Figures 7-6 and 7-7).

See Sections 7-8-4 and 7-8-5 for a description of the function of these pushbuttons.

7-7-6 "READY" Pilot Lamp

The orange "READY" lamp lights to indicate that the "ULTRATEST" is ready for leak checking the test object (see Figure 7-6). The READY lamp lights with a steady glow only if the inlet valve V2 is fully open. If the READY lamp is flashing, it means that roughing valve V1 is fully open and inlet valve V2 is partially open. You can leak check at reduced sensitivity when the READY lamp is flashing because part of the gas from the test object is entering the mass spectrometer. When the READY lamp is not lit it means that valve V2 is closed.

7-7-7 Rear of FB Module (see Figure 2-1)

7-7-7-1 6-pin Recorder Plug Bu

This plug provides outputs in parallel with the leak-rate meter. The outputs are detailed in Table 3-1 and in Section 2-2, Step 7. In addition, momentarily shorting pins 2 and 4 will turn ON the emission if pressure PII is less than 1×10^{-2}.

7-7-7-2 Terminal Block, Potentiometers, and LEDs for Trigger 1 and 2 Relay Outputs

The rectangular terminal block provides access to the Trigger 1 and Trigger 2 relays. The potentiometers are used to set the triggers. The LEDs light to alert the operator when the zero setting or helium background has changed, or when the test object should be rejected. See Appendix B for information on the function and use of the triggers.

7-7-7-3 AR/man./AR+U Switch

If this three position rotary switch is present, the machine is an autoranging unit with calibrated gross-leak bypass valve (ULTRATEST F SOAG). Request instruction set GA 712/3 from the factory.

7-8 CONTROLS AND LAMPS ON THE FRONT OF THE LEAK DETECTOR (see Figure 7-7).

NOTE: See Section 7-9 for the MS module controls, and Appendix D if your ULTRATEST has the manual gross leak bypass modification.

7-8-1 ON/OFF Pushbutton and Backing Pump Lamp 

Pressing the ON/OFF pushbutton during startup starts the backing pump and the diffusion pump heater. This pushbutton and the backing lamp will immediately light when you press the ON/OFF pushbutton to turn ON the ULTRATEST.

When switched OFF the pushbutton lamp goes out, but the backing pump and the diffusion pump cooling fans continue to operate until the diffusion pump has cooled.

7-8-2 Diffusion Pump Lamp 

It takes approximately 20 minutes after the ULTRATEST is switched ON for the diffusion pump to reach operating temperature. When the diffusion pump reaches operating temperature, the diffusion pump lamp lights. The "DIFF 190°C" LED on the MS module also lights at this time.

7-8-3 Roughing Pump Pushbutton

The illuminated pushbutton RP is used for separate ON and OFF switching of the roughing pump (see Figure 7-7). Pushing the RP button starts the roughing pump. However, the roughing pump can not evacuate the test object until valve V1 is opened by pressing the PUMP pushbutton.

7-8-4 PUMP Pushbutton

NOTE: The FB module also contains a PUMP and a VENT button (see Section 7-7-5).

The emission and the roughing pump must be switched ON before pushing the PUMP button.

Pushing the PUMP button initiates the following sequence to evacuate the test object and connect it to the mass spectrometer (see Figure 7-3 and 7-7).

(1) Venting valve V3 is closed and roughing pump valve V1 opens.

(2) When the test port pressure PI falls below 1 mbar, inlet valve V2 begins "stepping" open and the READY light flashes (see Section 7-3).

(3) Signals from gauges PI (test port pressure) and PIII (mass spectrometer pressure) control the control motor which gradually opens valve V2 so that the mass spectrometer pressure does not exceed 1×10^{-4} mbar. When PI falls below 5×10^{-2} mbar, the control motor opens valve V2 all the way which changes the state of the S1 microswitch.

(4) Valve V1 closes as soon as valve V2 is fully opened.

(5) The orange "READY" lamps stops flashing and changes to a steady glow. Now the test object is connected to the mass spectrometer at full detection sensitivity.

If the test port pressure PI can not be reduced below, for instance 0.5 mbar, inlet valve V2 will remain partially open. Part of the gas from the test object will be pumped by the roughing pump through open valve V1 and part will be pumped by the high vacuum system through partially open valve V2. The portion of the gas that enters the mass spectrometer makes leak checking with reduced sensitvity possible.

If outgassing causes the pressure at PII to exceed 1×10^{-2} mbar valve V2 closes instantly. To start leak checking again, tap the "VENT" button (see Section 7-8-5) and then press the PUMP button.

If outgassing causes the pressure to rise above 2×10^{-4} but not exceed 1×10^{-2}, you can continue to leak check; however, sensitivity is greatly reduced, and the ion source filament will deterioate rapidly when leak checking in this pressure range.

If you press the PUMP button when the emission is OFF, the test object is evacuated, but it is not connected to the high vacuum system or the mass spectrometer. Allowing the leak detector to remain in this operational state results in oil vapor condensing on the valve block when the roughing pump reaches its ultimate pressure. Under normal operating conditions, the gas flow in the system prevents such backstreaming of oil vapor.

If you press the PUMP button when the roughing pump is not running, neither valve V1 nor valve V2 will open (see Figure 7-3).

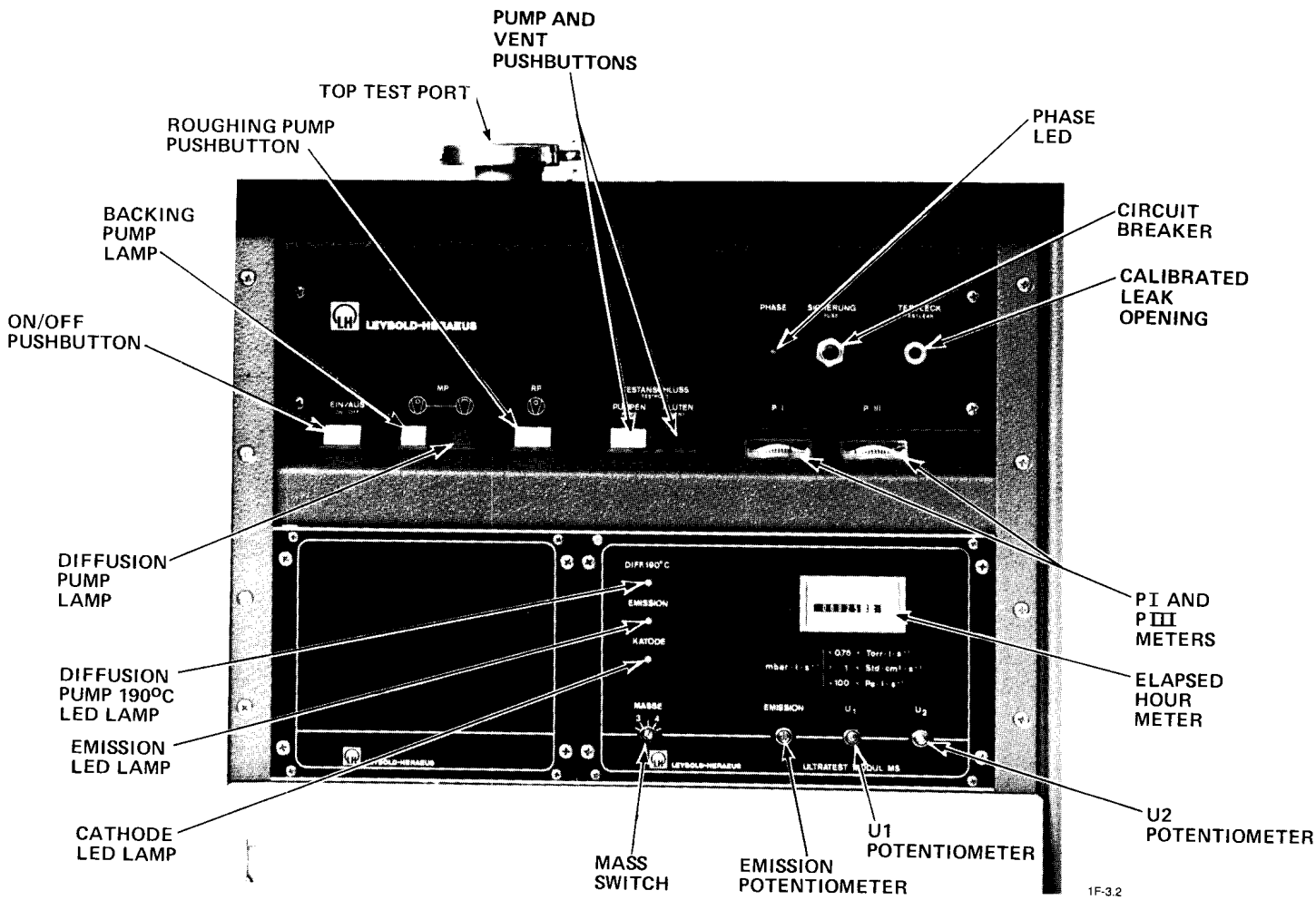


Figure 7-7 - Front Panel and MS Module Controls

7-8-5 "VENT" Pushbutton

NOTE: The FB module also contains a PUMP and a VENT button (see Section 7-7-5).

The VENT button is used in two ways (see Figures 7-3 and 7-7).

(1) Briefly tapping the VENT button stops the pump-down or leak checking process by instantly closing valves V1 and V2. This isolates the test object from the roughing pump and from the high vacuum system.

(2) When depressing the button and holding it down, valves V1 and V2 close immediately and after 1.5 seconds, valve V3 opens and vents the test object to atmospheric pressure. Valve V3 remains open until the PUMP button is pressed to start a new test cycle.

7-8-6 Meters PI And PIII

The PI and PIII meters monitor the pressure at the test port and in the mass spectrometer and indicate these pressures in parallel to the FB module meter (see Figures 7-6 and 7-7). Unlike the FB meter, the PI and PIII meters indicate continuously and independently of the position of the range switch (see Section 4-1-2). Instead of the graduated scales, the PI and PIII meters have green and red markings indicating whether the pressure is acceptable or too high.

If the PI meter is in the red range, the PI pressure is too high for leak checking. If PIII is in the red range, you can not precisely measure the leak rate.

7-8-7 Phase LED

The phase LED is operational only if the roughing pump has a 3-phase motor. The D30A and D60A are the only roughing pumps which are available with 3-phase motors. If the phase LED lights, it means that the polarity is reversed. Reverse two of the input leads on the roughing pump to correct the polarity.

7-8-8 Fuse

The "FUSE" pushbutton is a circuit breaker (see Figure 7-7). A supply surge can cuase the circuit breaker to open. Push in the FUSE button to reset the breaker. If the circuit breaker continues to open, it ususally means there is a short in the ULTRATEST electronics.

7-8-9 Test Leak

If the optional calibrated leak is permanently installed on your ULTRATEST, the knob will extend out the TEST LEAK hole in the front panel (see Figure 7-7). The calibrated leak is used for calibrating the ULTRATEST (see Section 4-3). See Section 2-2 for instructions for permanently installing the optional test leak.

7-9 MS MASS SPECTROMETER POWER SUPPLY MODULE

The MS module contains the electronics that support the mass spectrometer (see Figure 7-1B). See Table 8-2 for a list of PC boards in the MS module and Section 8-12 for instructions for replacing the PC boards.

The following describes each item on the front panel of the MS module (see Figure 7-7).

7-9-1 Mass Selector Switch "MASSE"

This switch is a slotted potentiometer which is set to the mass (3 or 4) of the search gas used for leak testing. Most of our customers use helium 4 so the slot should be turned to the 4 position. If you use a mass 3 search gas, tun the slot to 3 and recalibrate the leak detector (see Section 4-3).

7-9-2 Slotted Potentiometer "EMISSION"

This potentiometer is used for adjusting the emission current in the ion source. It is used in calibrating the leak detector (see Section 4-3).

7-9-3 Slotted Potentiometer "U1"

This potentiometer controls the accelerating voltage of the ions and thus defines the injection speed of the ions into the magnetic field (see Section 4-3). Adjustment of U_1 sweeps the path of the search gas ions back and forth past the exit from the magnetic deflection section.

7-9-4 Slotted Potentiometer "U2"

This potentiometer adjusts the voltage applied to the deflection plates (i) in the ion collector (see Figure 7-5). It tunes the electrostatic field to allow the search gas being used to pass through the plates (i). U_2 changes proportional to U_1 (see Section 4-3).

7-9-5 LED Pilot Lamp "DIFF. 190°C"

This light is lit when the diffusion pump reaches its operating temperature.

7-9-6 LED Pilot Lamp "EMISSION"

This LED lights when the emission is ON and functioning. See Section 6-5-1 to determine if the ion source needs to be changed.

7-9-7 LED Pilot Lamp "KATODE"

This LED indicates that heater current is passing properly through the cathode filament (b) in the ion source (see Figure 7-5).

7-9-8 Elapsed Hour Meter

This meter records the cumulative operating hours of the leak detector. The meter is actuated when the illuminated "ON/OFF" push button is ON. Use the hour meter to determine the maintenance intervals for your leak detector.

SECTION 8

TROUBLESHOOTING AND REPAIR

8-1 TROUBLESHOOTING

NOTE: A diagnostic test kit (Catalog Number 99-077-078) is available that functionally checks the FB and MS module and all of the PC boards except for the preamp (LP5).

Use Table 8-1 and Sections 8-2 through 8-2-5 to troubleshoot the ULTRATEST. See Appendix A-6 for additonal troubleshooting information if you have the optional QUICK-TEST.

To use the troubleshooting chart, first observe the symptom, do the observation or check, and perform the recommended corrective action. The "Reference Sections" column list Sections, Steps, or Figures in the manual that are helpful in correcting the problem.

See Section 9 for the spare parts list and Appendix F for schematics and board component location drawings.

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TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
1. ON/OFF pushbutton does not light.	a. Backing pump lamp is lit. Backing pump and elapsed hours meter are running.	Bulb is burnt out.	Replace bulb.	8-15-1
	b. Backing and diffusion pumps are not running.	Connectors N,M,or D.	Ensure that the connectors are plugged in tightly.	Figure 8-18
		Circuit breaker is open due to a short or high power requirements caused by low ambient temperature. Unit is not getting power.	Reset circuit breaker. Find short or increase ambient temperature as necessary. Check if circuit has power.	Fig. 4-1 Fig. 7-8-3
			Check if power cord is plugged into electrical outlet.	
2. Backing pump is inoperative.	a. D4A backing pump is silent (while roughing pump is not running); motor fan does not draw in air.	Switch on top of D4A pump motor is in the OFF position.	Switch motor to ON position.	Figure 7-1B
		Plugs L,D, or M.	Check Plugs.	Figure 8-18
		Thermal switch (internal) to pump motor has cut out because: - Ambient temperature is too high.	Reduce ambient temperature or improve cooling.	
		- Pump or motor is faulty.	Remove motor and turn D4A pump shaft by hand. If it is too stiff, repair or replace D4A pump.	TRIVAC manual in back of this binder
		- Main supply overvoltage or undervoltage exceeds 10%.	Equalize potential using a transformer or voltage stabilizer.	
	b. Relay C1 is buzzing. Fan on diffusion pump may not be running.	Relay C1	Check continuity/wiring or relay C1*.	

* Always disconnect the power to the ULTRATEST before checking continuity to avoid damage to your meter.

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
3. The diffusion pump lamp does not light. NOTE: This lamp should light approximately 20 minutes after pressing the ON/OFF pushbutton.	a. "DIFF 190°C" LED is lit.	The bulb is burned out.	Replace the bulb in the diffusion pump lamp.	Sec. 8-12-2
	b. Exhaust air from diffusion pump fan is cool.	Heater is malfunctioning.	Check heater for continuity*. Heating element resistance should be approximately 100 ohms. If it is shorted or has an open circuit, replace the heater plate (Part No. 401-55-639).	Sec. 8-6-2 Figure 8-9
		ON/OFF switch, second level.	If relay d1 is not energized, check ON/OFF switch.	Sec. 8-15-2 Figure F-LP10
	c. Exhaust air from the diffusion pump fan is warm.	Thermal switch 190C is defective.	Remove plug H when the diffusion pump is hot and check continuity* between contacts V and X. If necessary, replace thermal switch 190C (Part No. 590-47-208).	Sec. 8-6-1 Fig. 8-9
		Poor heat transfer from heater to base of pump.	Clean pump bottom and heater plate, scour the bottom and apply a thermal compound, if necessary. Ensure that heater fits tightly against base of pump.	Sec. 8-6
	d. Very little or no exhaust air is flowing from the diffusion pump fan.	Clogged cooling fan and air grates.	Clean cooling fan and and air grates.	Fig. 8-10
		The motor on the cooling fan is malfunctioning.	Install a new cooling fan (Part No. 380-93-103).	Fig. 8-10

* Always disconnect the power to the ULTRATEST before checking continuity to avoid damage to your meter.

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
4. Pressure reading PII_2 does not reach $1x10^{-2}$ mbar.	a. "DIFF 190°C" LED on MS module is lit and and test port is sealed off.	Valve V4 is partially closed.	Open valve V4 fully.	Fig. 8-3A
		Valve V5 is partially closed.	Open valve V5 fully.	Fig. 8-3A
		Poor forevacuum. Pump fluid in backing pump is contaminated.	Test vacuum directly at inlet port of backing pump. Change pump fluid as necessary.	Sec. 6-1 & 6-2-2
		Leak in vacuum systems of ULTRATEST.	Find and seal leak.	Sec. 8-2-3
		Diffusion pump fluid is cracked.	Disassemble, clean, and change the fluid in the diffusion pump.	Sec. 6-3-2
		Cold trap is contaminated.	Defrost and clean cold trap. Clean connecting lines as necessary.	Sec. 6-4
		TR201 gauge (PII) is malfunctioning.	Check with T200 gauge test tube. Replace sensing tube (Part No. 16209) as necessary.	Sec. 8-10
		The jet assembly in the diffusion pump is dirty or incorrectly mounted.	Disassemble, clean and carefully reassemble jet assembly in diffusion pump. Pay attention to concentric seating of the jet assembly.	Sec. 6-3-2
		Mass spectrometer is contaminated.	Clean mass spectrometer. Do not use silicone-based pump fluid.	Sec. 8-3
5. Pressure PII shows a full deflection to the left or to the right off of the meter scale.	Zero setting procedure on TR201 guage head is unsuccessful.	Sensing tube is malfunctioning.	Replace sensing tube.	Sec. 8-10-4
		PII gauge head plug TM2, or PC board LP3 is malfunctioning.	Check connector. Replace as necessary.	Fig. 8-3-C Fig. 8-17 Sec. 8-12-5

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
6. EMISSION pushbutton on FB module has no effect	a. "EMISSION" and "KATODE" LEDs on MS module and the "EMISSION" LED on the FB module do not light.	PII is greater than 10^{-2} mbar.	Wait for diffusion pump to warm (approximately 20 minutes). See Symptom 3.	
		Cathode failure.	Check ion source plug IQ and plug A. Rotate ion source plug 180° to actuate second cathode. If no emission, replace ion source.	Fig. 7-18 Sec. 6-5
		Plug FB or plug contact b12 on PC board LP6, ion source plug IQ.	Check connectors	Fig. 8-18 Fig. F-LP6
		6.3 fuse Si2MS is blown.	Problem is likely on Board LP2. Replace fuse.	Figs. 8-17 & 9-6 Sec. 8-12-1 Sec. 8-12-4
		EMISSION switch is defective.	Disconnect plug FB. There should be continuity* between contacts FB13 and FB33 when the EMISSION is switched ON.	Fig. 7-18
		Supply voltage +15 V not available because board LP1 is defective (MS module).	Voltage between pins 4 and 8/34 on LP1 should be +15 V when switched ON. Replace LP1 if necessary.	Fig. F-LP1 Sec. 8-12-1 Sec. 8-12-3
		PC board LP2 or LP3 is defective (MS module).	Replace LP2 or LP3 as necessary.	Sec. 8-12-1 Sec. 8-12-4 Sec. 8-12-5
	b. EMISSION LED on FB and MS module does not light; "KATODE" LED on MS module lights. Emission current (I_E) indicates zero.	Malfunctioning ion source.	Replace ion source.	Sec. 6-5

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
6. EMISSION pushbutton on FB module has no effect (continued).	c. EMISSION LED on FB and MS module does not light; "KATODE" LED on MS module lights; meter indic-cates emission in selector position IE.	"KATODE" LED is burned out.	Replace "KATODE" LED.	Sec. 8-12-2
		PC board LP2 is mal-functioning (MS-unit).	Replace LP2 if necessary.	Sec. 8-12-1 Sec. 8-12-4
		Darlington transistor T254 on rear of MS module.	Replace T254 (MJ4034) (Part No. 533-21-213)	Fig. 9-6
	d. EMISSION LED on FB module does not light; "KATHODE" LED on MS module lights; meter indic-ated a negative emission current.	Cathode is shorted to another ion source element.	Inspect the ion source and remove the short; then rotate the ion source plug IQ 180°, or if necessary, replace the ion source.	Sec. 6-5
	e. EMISSION LED lights briefly after push-ing EMISSION "1" button on FB module.	Heavy degassing from cathode.	Repeat switch-on attempts several times.	Sec. 6-5
		Short circuit after warm up.	Rotate the ion-source plug IQ 180° or if necessary, replace ion source.+	Sec. 6-5
		PII set point for cathode protecting circuit needs readjusted.	Adjust the set point to 10^{-2} mbar by adjusting potentiometer P 308 on board LP3.	Fig. F-LP3 Sec. 8-12-5
			Rotate ion source plug IQ 180° because one cathode is probably malfunctioning.	Sec. 6-5
		Valve V5 is closed.	Open valve V5.	Fig. 8-3A
	f. EMISSION LEDs go out while EMISSION is ON and PII is $<10^{-2}$. Adjust EMISSION potentiometer to see if LEDs light.	If EMISSION LEDs light when you adjust potentiometer, it means the ion source is weak.	Switch cathodes of ion source or install new ion source.	Sec. 6-5
		If EMISSION LEDs do not light when you adjust potentiometer it means relay 252 is bad.	Replace relay 252 or replace PC board LP2.	Sec. 8-12-4 Fig F-LP2 Sec. 8-12-1

+ Failure of the ion source can result from contamination (see Section 8-2-4-1).

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
6. Emission pushbutton on FB module has no effect (continued).	g. EMISSION LED lights. Pressure PIII is indicated on meter.	Plug FB or plug contact b11 on PC board LP6.	Check connectors	Fig. 8-18 Fig. F-LP6
		Emission OFF switch (S4) is defective.	Disconnect plug FB when switch is depressed. There should be continuity between contacts FB14 and FB33.	Fig. 8-18
		Supply voltage +15V is not available because PC board LP1 is defective.	When switch is depressed there should be +15V between pins 5 and 8/34. If not, replace LP1 board.	Fig. F-LP1 Fig. 8-17 Sec. 8-12-3 Sec. 8-12-1
7. "KATODE" LED on MS module does not light.	a. EMISSION LEDs do not light.	Relay 251 circuitry on PC Board LP2 in the MS unit is malfunctioning.	Repair relay 251 circuitry or replace board LP2.	Sec. 8-12-4 Fig. F-LP2 Sec. 8-12-1
	b. All lights on MS and and FB module are out.	1.25 fuse located on rear of MS module is blown.	Check if transformer TR1MS is shorted. Replace fuse.	Fig. 8-17
8. Pressure PIII reading shows full deflection to the right or to the left, off of the scale.	a. EMISSION is ON.	Ion source or connector.	Check connector IQ, rotate the ion source plug IQ 180°, or if necessary, replace the ion source.	Fig. 8-3C Sec. 6-5
		If deflection is full scale to the right, it usually means that the vacuum in the mass spectrometer is poor.	See Symptom 10.	
	b. EMISSION is OFF.	PC board LP1 in the MS unit.	Repair or replace PC board LP1.	Sec. 8-12-1 Sec. 8-12-3
9. Pressure PIII exceeds 10^{-4} mbar.	a. EMISSION can be switched ON; high helium background.	Leak in the ULTRATEST vacuum system.	Locate and seal leak.	Sec. 8-2-3
	b. See Symptom 3b.	See Symptom 3b.	See Symptom 3b.	
	c. Cold trap is defrosting.	Liquid nitrogen has evaporated.	Replenish liquid nitrogen.	Sec. 4-2, Step 6a.
	d. See Symptom 4.	See Symptom 4.	See Symptom 4.	

* Always disconnect the power to the ULTRATEST before checking continuity to avoid damage to your meter.

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
10. Pressure PIII is unstable.	a. Reading fluctuates between higher and lower pressures.	Pump fluid level in diffusion pump is low.	Add 10 cc of HE-300 to diffusion pump.	Sec. 6-3
		Too much pump fluid in diffusion pump.	Drain and clean pump and charge it with 50 cc of HE-300.	Sec. 6-3-2
		Outgassing bursts from inner surfaces due to contamination from test equipment.	Run ULTRATEST with test port sealed off and EMISSION OFF for several hours. If necessary, remove inner housing of cold trap and clean cold trap and/or diffusion pump.	Sec. 8-2-4 Sec. 6-4
		PC board LP9	Repair or replace LP9	Sec. 8-16-2
11. Meter indicates negative leak rate.	a. Full left deflection on meter scale cannot be corrected with zero setting.	Preamplifier, or main amplifier in FB module	Remove plug EMV on preamplifier. If zero can now be set, preamplifier is malfunctioning and should be replaced. If zero can not be set, check IC601 and replace, if necessary.	Sec. 4-2, Step 7. Sec. 8-13 Fig. 9-3
		Excessive humidity reduces insulation on feedthrough for ion current and in preamplifier.	Remove preamp and ion current feedthrough and carefully dry with hot air blower. If instrument is transferred from one ambient temperature to another, allow adequate acclimatization.	
	b. Full left deflection on meter scale cannot be corrected with zero setting with EMISSION switched ON; however, zero can be corrected with EMISSION switched OFF.	PIII is greater than 10^{-4} mbar. High density of molecules causes charge transfer effects.	Wait until pressure PIII falls below 10^{-4} mbar. See Symptom 12.	
		Mass spectrometer is contaminated.	Clean mass spectrometer.	Sec. 8-3

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
12. Full right deflection off scale of leak-rate meter.	Deflection cannot be corrected with "ZERO" potentiometer with EMISSION OFF.	Preamplifier, main amplifier or IC 601 in FB module.	See Symptom 11a.	
		Collector is shorted.	Install new collector	Sec. 8-3, Steps 3a & 3b. Fig. 9-8
		LP2 board.	Replace PC board LP2.	Sec. 8-12-4
13. Leak-rate meter is unstable (see Section 8-2).	a. EMISSION is ON. Calibrated leak rate in the 10^{-8} atm.cc/sec. range.	Diffusion pump.	Throttle valve V4 until meter reading is approximately 10^{-9} atm.cc/sec; if meter reading becomes more stable, it means that diffusion pump is the problem.	Sec. 8-2
		Insufficient pump fluid in diffusion pump.	Pour 10 cc of HE-300 into exhaust port of the diffusion pump.	Sec. 6-3
		Too much pump fluid in diffusion pump.	Drain and clean pump and charge it with 50cc of HE-300.	Sec. 6-3
		Jet assemblies of diffusion pump.	Remove diffusion pump and check jet assembly for correct mounting and stability.	Sec. 6-3
	b. EMISSION is off. Calibrated leak is isolated.	Supply voltage is noisy or subject to intermittent spikes.	Locate and eliminate source of spiking (noise). Install separate power line for ULTRATEST.	
		Contamination of vacuum system.	Clean vacuum system.	Sec. 8-2-4
14. Calibration with calibrated leak is not possible.	a. Slotted potentiometer U1 is on end stop.	Trimmer potentiometer on PC board LP2 needs to be adjusted.	Set slotted potentiometer U1 to center. Using trimmer potentiometer P 203 on LP2, adjust peak to maximum.	Fig. F-LP2 Sec. 8-12-4
		If both U1 and U2 calibrate at or near their end stops, mass spectrometer is contaminated.	Clean mass spectrometer.	Sec. 8-3
	b. Calibration using Section 4-3 is unsuccessful.	Deflection voltage U2.	Check connectors A,M and plug U2 at collector.	Fig. 8-18 Fig. 8-3C
		Accelerating voltage U1.	Check connectors A, M, and ion source plug IQ.	Fig. 8-18 Fig. 8-3C

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
14. Calibration with calibrated lead is not possible (continued).	b. Calibration using Section 4-3 is unsuccessful (continued).	Calibrated leak is defective.	Trap a hair between the O-ring and a blank flange on the test port. Spray this intentional leak with helium. If the meter deflects, it means the calibrated leak is defective.	
		Mass switch is not in correct position.	Turn mass switch to 4.	Sec. 7-9-1
		If the emission current is greater than 1.5, it means the ion source is deteriorating.	Rotate the ion-source plug IQ 180^0, or if necessary, replace the ion source.	Sec.6-5
		PC board LP2 in the MS-module is malfunctioning.	Repair or replace LP2.	Sec. 8-12-4 Sec. 8-12-1
15. Digital display on FB module is dimly lit or gives wrong display.	Analog display on meter is OK.	PC board LP8 or LP6 in FB-module is malfunctioning.	Check if plug e in FB modules and all connecting wires are tight.	Fig. 8-18
			Replace PC borad LP8, LP6, or the FB module.	Sec. 8-13 Fig. F-LP8
16. No audible leak signal.	Leak-reate meter deflection is greater than 10% of full scale.	Speaker is malfunctioning.	Check speaker and replace as necessary.	Fig. 8-19
		Room is too noisy to hear audible leak signal.	Adjust volume control knob.	Sec. 7-7-4
			Use optional extension cables to move FB module to a quieter location.	Sec. 2-2, Step 2
		PC board LP6 in FB module.	Replace PC board LP6 or FB module.	Sec. 8-13
17. Automatic shutdown is malfunctioning.	a. After pressing the OFF pushbutton, the vane pump continues to run beyond the diffusion pump cool-down period (approx. 30 min.).	Thermal switch 90C is malfunctioning.	After the diffusion pump has cooled, pull plug * H and check continuity between pins T and W The contacts should be open at room temperature. If not, replace the switch.	Figs. 8-18 & 8-9 Sec. 8-6-1

* Always disconnect the power to the ULTRATEST before checking continuity to avoid damage to your meter.

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
17. Automatic shutdown is malfunctioning. (continued).	b. The backing pump stops immediately when the OFF push-button is pressed.	Thermal switch 90C is malfunctioning.	Remove Plug H while the diffusion pump is still hot and check continuity between pins T and W. The contacts should be closed, If not, replace the switch.	Figs. 8-18 & 8-9 Sec. 8-6-1
18. Elapsed hour counter is not working.	a. Fuse Sil (1.25) on rear panel of MS-unit is defective.	Tranformer TR1MS is shorted.	Check transformer; replace fuse.	Figs. 8-18, 9-5, & 9-6.
	b. Plug A or plug on mother board of MS module.	Connectors are loose.	Check connectors. Ensure that two wires coming off of the hour counter are connected tightly on both ends.	Fig. 8-18
	c. Counter is defective.		Replace counter.	Fig. 9-4
19. Background leak rate is high (see Section 8-2).	a. Check if optional calibrated leak is open.	Calibrated leak is open.	Close calibrated leak. Remove calibrated leak for operating in most sensitive range.	Sec. 2-2, Step 4.
		Condensation in backing pump.	Run backing pump with gas ballast valve open for 20 minutes to 1 hour. Change pump fluid as necessary.	Sec. 7-6-2-3 Sec. 6-2-2
		Contamination in vacuum system.	Change pump fluid in vane pumps. Clean cold trap. Service diffusion pump. Clean valve block and mass spectrometer as necessary.	Sec. 6-2 Sec. 6-4 Sec. 8-2-4 Sec. 8-4 Sec. 8-3 Sec. 6-3
		Leaks in ULTRATEST vacuum system.	Leakcheck the ULTRATEST.	Sec. 8-2-3
		Ion source.	Switch cathodes or replace ion source as necessary.	Sec. 6-5
	b. See Section 8-2.	See Section 8-2	See Section 8-2	See Sec. 8-2

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
20. ULTRATEST has poor sensitivity to helium.	a. Check if mass switch is in correct position.	Mass switch set on wrong mass.	Set mass switch on 4.	Sec. 7-9-1
	b. Open calibrated leak and turn mass switch to 3.5 and then 4.5.	If the leak-rate meter reading does not decrease toward 0 when mass is set to 3.5 or 4.5, calibration is off.	Recalibrate ULTRATEST.	Sec. 4-3
	c. Check helium background (see Section 8-2).	Contamination.	Seal test port and run ULTRATEST or clean ULTRATEST vacuum system.	Sec. 8-2-4
		O-ring is permeated with helium.	Run ULTRATEST or replace O-ring.	Sec. 8-2-5
		Leak	Find and eliminate leak.	Sec. 8-2-3
	d. Check PIII pressure in mass spectrometer.	PIII pressure is greater than 2×10^{-4} mbar.	See Symptom 10. Do not use silicone-base pump fluid in vacuum pumps.	
	e. Check emission current (I_E) reading and range.	Ion source is deteriorating.	Switch cathodes in ion source or if necessary, install new ion source.	Sec. 6-5
21. "READY" light on FB module does not flash.	Ensure that PI is less than 1 mbar.	Control valve SV1 (controls valve V1).	Chech fuses Si2 and Si3 on EL module.	Figs. 8-20 & 9-1
			Check power supply.	
			Check control vacuum.	Sec. 8-8
			Drain oil from control vacuum reservoir.	Sec. 6-6
		No control vacuum.	Check gas ballast valve of roughing pump. Drain oil from control vacuum reservoir.	Sec. 8-8 Sec. 7-2 Sec. 6-6
		No emission.	Press EMISSION "1" pushbutton.	Fig. 7-6
		Valve position switch.	Close contacts by hand several times. Exchange micro-switch as necessary.	Fig. 7-1A Sec. 7-3-1 Fig. 9-7
		Plugs A or M.	Check connectors.	Fig 8-18
		PC board LP9 in EL unit.	Repair or replace PC board LP9.	Sec. 8-16-2

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
22. "READY" light on FB module does not change to a continuous glow.		PI is greater than $5x10^{-2}$ mbar.	See Symptom 23.	
		No control signal that inlet valve V2 is open.	Operate microswitch several times by hand. Replace if necessary.	Fig. 7-1A Fig. 9-7
		PC board LP9 in EL unit.	Repair or replace PC board	Sec. 8-16-2
		Pressure in test object is too high for fine leak testing.	Perform coarse leak testing.	Sec. 4-4, Step 4.
23. Total pressure PI does not reach $5x10^{-2}$ mbar but halts at a higher valve.	a. Check pressure PI with blanked off test port.	Pump fluid is contaminated.	Check ultimate pressure directly over backing pump flange. Change pump fluid as necessary.	Sec. 6-1 & Sec. 6-2-2.
		See Symptom 24.	See Symptom 24.	
		Venting valve V3 is not closing properly.	Check sealing of valve V3.	Fig. 7-1A,
		Leak in roughing pump system or valve block.	If PI is < 1 mbar, leak check the roughing system and valve block.	Sec. 8-2-3-3 Sec. 8-2-3-4
		Valve block is contaminated.	Clean valve block.	Sec. 8-4-3
	b. Check PI	See Section 8-10.	See Section 8-10.	
24. Total pressure PI shows full deflection left off scale.	a. No indication with T200 simulator head.	Gauge head plug TM1, plug B, or PC board LP4.	Check connectors.	Fig. 8-18
	b. Correct indication with T200 simulator head.	PI sensing tube.	Carry out zero setting procedure on PI gauge tube. Replace sensing tube if unsucessful.	Sec. 8-10
25. Total pressure PI shows full deflection off scale to the right.	a. No indication with T200 simulator head.	Gauge head plug TM1, plug B, or PC board LP4.	Check connectors.	Sec. 8-18
	b. Correct indication with T200 simulator head.	PI sensing tube.	Carry out full-scale deflection procedure on PI guage tube. Replace sensing tube if un-successful.	Sec. 8-10

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
26. Total pressure PI remains at 1000 mbar.	Check PI pressure with blanked off test port. Ensure that roughing pump is running.	Control valve SV1 or roughing valve V1 is defective.	Check fuses Si2 and Si3 (T 0.5B) on EL unit and power supply SV1. Check control vacuum.	Fig. 8-20 Fig. 9-1 Sec. 8-8
		No vacuum available for valve operation.	Check gas ballast valve on roughing pump. Check control vacuum. Drail oil from control vacuum reservior.	Sec. 8-8 Sec. 6-6
		PC board LP9.	Repair or replace LP9.	Sec. 8-16-2
27. Roughing pump "RP" pushbutton does not light.	ON/OFF pushbutton is lit and roughing pump is running.	Bulb is burned out.	Replace RP pushbutton bulb.	Sec. 8-15-1
		Connectos D or M.	Check connectors D or M.	Fig. 8-18
27a. ON/OFF pushbutton is is lit but roughing pump is not running.		Switch on top of the roughing pump motor is in the OFF position.	Switch motor to ON position.	Fig. 7-1A
		Connectors K, D, or M.	Check connectors and cables.	Fig. 8-18
		Thermal switch (internal to pump motor) has cut out because:		
		- Ambient temperature is too high.	Reduce ambient temperature or improve cooling.	
		- Pump or motor is faulty.	Remove motor and rotate roughing pump shaft by hand. If it is too stiff, repair or replace pump.	See TRIVAC manual in the back of this binder.
		- Mains supply overvoltage or undervoltage exceeds 10%.	Equalize potential using a transformer or voltage stabilizer.	
		Thermal overload el in EL module has cut out.	Check operating voltage and correct setting if necessary.	Fig. 8-20. Sec. 8-16.
		Contactor C2.	Replace contactor C2.	Fig. 8-20 Sec. 8-16

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
28. Pressing PUMP pushbutton has no effect.	a. PUMP pushbutton bulb does not light. PI stays at 1000 mbar. "READY" lamp lights.	Roughing pump is not running.	Switch ON roughing pump. See symptom 27a.	Fig. 7-1A
		Connector D or M.	Check connectors.	Fig. 8-18
		Bulb in "PUMP" pushbutton is burned out.	Replace bulb.	Sec. 8-15-1
	b. Bulb in pushbutton lights. PI stays at 1000 mbar.	Control valve SV1, fuse Si2 or Si3 (T 0.5B) in EL unit.	Check fuses in EL unit.	Fig. 8-20 Fig. 9-1
		Roughing pump is not running.	See Symptom 27a.	
		A hissing sound is heard because venting valve V3 did not close or there is a large leak in the valve block.	Check if air is being sucked into the venting valve. Check for other leaks in the valve block.	Fig. 8-3C Sec. 8-2-3-3
		Roughing valve V1 did not open.	Control valve SV1 did not open.	Sec. 8-8-3 Sec. 8-8
			Control vacuum is inadequate (>320 mbar).	Sec. 8-8
			Drain oil from control vacuum reservior.	Sec. 6-6
			Valve V1 fault.	Sec. 8-4
29. VENT pushbutton has no effect.	Venting valve V3 does not open. Gentle clicking from relay on LP11.	Fuses Si2 or Si3 (T 0.5B) on EL unit.	Check fuses in EL unit.	Fig. 8-20 Fig. 9-1
		Connector D or M.	Check connectors.	Fig. 8-18
		PC board LP9 is defective.	Replace or repair PC board LP9.	Sec. 8-16-2
30. PUMP and VENT button on FB module are inoperative.	PUMP and VENT pushbuttons on leak detector are OK.	Connector F	Check Connector F on board LP11.	Fig. 8-18
		PC board LP11.	Check LP11	Sec. 8-15-3
		PUMP and VENT buttons.	Check PUMP and VENT buttons on leak detector.	Sec. 8-15-2
31. Recorder output on socket Bu on rear of FB module is defective.	Analog display is OK.	Overload of output by wrong input impedance in recorder etc, used.	Check output with high resistance voltmeter.	TABLE 3-1 Fig. 2-1 Sec. 2-2 Step 7
		PC board LP6 in FB unit.	Repair of replace LP6 or replace FB module.	Sec. 8-13

TABLE 8-1 - TROUBLESHOOTING CHART FOR THE ULTRATEST F continued

Symptoms	Observation or Check	Probable Cause	Recommend Corrective Action	Reference Section
32. Trigger 1 or 2 on back of the FB module does not operate.	Trigger LEDs do not light.	Relay contacts overloads.	Check that the load connected does not exceed the values given in the specifications.	TABLE 3-1 APPENDIX B
		PC board LP7 in FB module.	Check connectors on LP7. Repair or replace LP7 as necessary.	Fig. F-LP7 Sec. 8-13-4

8-2 HELIUM BACKGROUND, CONTAMINATION, OR LEAKS IN THE ULTRATEST

A high background leak-rate reading or an unstable meter reading can be caused by contamination, leaks, electronic problems, or helium permeation in the leak detector. In addition, high background can result from the calibrated leak being open or the electrical zero drifting. The procedures in this section can be used to troubleshoot either high background or unstable-meter problems since both problems have similar causes.

8-2-1 Determining the Background and Meter Stability and Isolating the Location of the Problem

NOTE: Ensure that the emission has been ON for at least 15 minutes before proceeding.

Proceed as follows to determine the background level and to find which section of the ULTRATEST contains the source of the problem.

1. NOTE: If you are testing for very fine leaks, the optional calibrated leak should not be permanently mounted on the ULTRATEST during leak checking or when determining the helium background.

   Ensure that the optional calibrated leak is closed tightly and is not the source of the background.

2. NOTE: If you usually use LN_2 in the cold trap, be sure the cold trap is filled with LN_2 before determining the background (see Section 4-2, Step 6a). If you normally run the leak detector without LN_2, do not add LN_2 as this time.

   Determine the background level as follows (see Figure 7-6).

   a. Press and hold down the VENT pushbutton for 2 seconds to vent the test port.

   b. Seal the test port with a blind flange.

   c. Refer to Section 4-3 to calibrate the ULTRATEST.

   d. Turn the range selector on the FB module all the way clockwise to the finest leak position.

   e. Turn off the EMISSION and use the ZERO knob to set the meter reading to 0; wait a minute or two to be sure the needle does not drift.

   f. Turn ON the EMISSION.

Section 8-2-1, Step 2 continued

g. Press the PUMP pushbutton and wait until the orange READY lamp shows a steady glow.

h. Read the background from the FB module meter. The background should be less than 2×10^{-10} if you plan on checking for very fine leaks.

i. Make a note of the background for future reference.

3. Check the meter stability as follows:

a. Fill the cold trap with LN_2 (see Section 4-2, Step 6a).

b. Refer to Section 4-3 to calibrate the ULTRATEST.

c. Open the calibrated leak.

d. Observe or use a chart recorder to record the leak-rate reading for 10 minutes. The stability is adequate if

- o Brief meter fluxuations remain with $\pm$2% of full scale deflection.
- o There were three or less brief larger deflections, and
- o Any slow change in leak-rate indication was less than $\pm$20%.

4. Proceed as follows to determine if high background or meter instability is due to the electronics (see Figure 7-6).

a. Turn off the EMISSION.

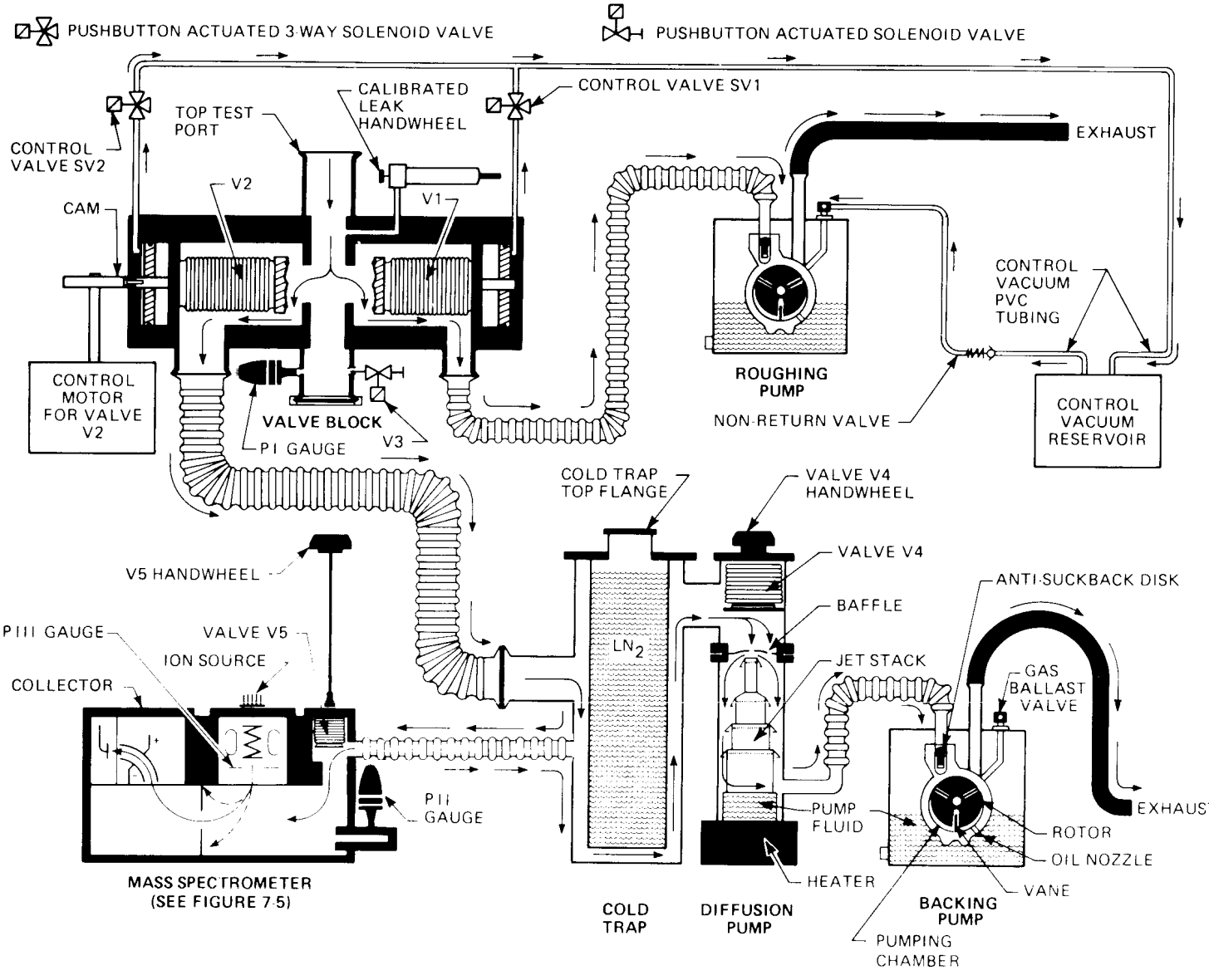
b. Observe the meter. If the high background continues, the problem is in the electronics.

c. Turn the ZERO knob so the FB module meter reading is the same as it was with the emission ON and repeat Step 3d. If the meter instability continues, the problem is in the electronics.

d. If the high background or meter instability is at an acceptable level when the EMISSION is off, proceed to Step 5.

5. Proceed as follows to determine which section of the leak detector contains the source of the problem.

a. Turn ON the EMISSION.



2F-5-1

NOTE: This Figure shows valve V1 open and valve V2 partially open; the READY lamp would be flashing ON and OFF in this mode of operation

Figure 8-1 - Simplified Cross Section of the ULTRATEST F Vacuum System

Section 8-2-1, Step 5 continued

b. Watch the meter on the FB module as you tap the VENT pushbutton. If the problem stays the same or increases, the source of the problem is in the high vacuum system (see Figure 8-1).

   If the problem diminished when you tap the VENT button, the source of the problem is likely in the valve block/test port area (inlet system).

c. If the problem is coming from the high vacuum system, proceed as follows to further isolate the location.

   (1) If not already done, refer to Section 4-2 Step 6a to add LN_2 to the cold trap.

   (2) Turn off the EMISSION and use the ZERO knob to set the meter needle to 0.

   (3) Turn ON the EMISSION.

   (4) Using valve V4, throttle the pumping speed until the calibrated leak indication increases by exactly a factor of 10. For example, if your calibrated leak is 10^{-8}, throttle valve V4 until the leak-rate meter reads 10^{-7}.

   (5) If the problem with your ULTRATEST is high background, close the calibrated leak and repeat Steps 2c through 2i to check the background with vavle V4 throttled.

   (6) If the meter stability improves or if the background does not change significantly after V4 is throttled, the problem is coming from the backing pump or from the diffusion pump. See Section 6-2-2 to change the backing pump fluid. If necessary, change the O-rings on the diffusion pump flanges and see Section 6-3 to service the diffusion pump and Section 8-6-2 to replace the heater plate.

   If the meter stability does not change significantly or the background gets worse after valve V4 is throttled, then the problem is contamination or small leaks in mass spectrometer, cold trap, or connecting lines (see Section 8-2-2).

8-2-2 Determining if the Source of the Problem is Helium Background, Contamination, or Leaks

If the background leak indicator on the meter is steady and pressure PIII is low, the background is due to helium. Refer to Section 8-2-5 to eliminate helium.

If the background leak indication on the meter is unstable, it is usually due to a leak in the ULTRATEST or contamination (see Section 8-2-3 and 8-2-4). The PIII pressure will be high if the problem is contamination or large leaks(s). See Section 8-2-3 to do an overall leak check of the ULTRATEST.

If you determined in Step 5 of Section 8-2-1 that the source of the meter instability is in the mass spectrometer/cold trap section of the leak detector, proceed as follows to decide whether the problem is a result of contamination or leaks.

1. Tap the VENT pushbutton (see Figure 8-3A).

2. Turn off the EMISSION (see Figure 7-6).

3. Close valve V4 (see Figure 8-3A).

4. Plot pressure PII vs time until a trend is apparent.

5. Compare your graph to the graphs in Figure 8-2 to determine if the problem is contamination or leaks. See Section 8-2-4 to eliminate contamination or Section 8-2-3 to leak check the mass spectrometer/cold trap section of the leak detector.

If you determine in Step 5 of Section 8-2-1 that the source of the meter instability is in the valve block/test port, proceed as follows to decide whether the problem is a result of contamination or leaks.

1. Press and hold down the VENT pushbutton for 2 seconds (see Figure 8-3A).

2. Seal off the test port with a blind flange.

3. Press the PUMP pushbutton and wait until the READY lamp lights with a steady glow (see Figure 7-6).

4. Tap the VENT button (see Figure 8-3A).

5. Plot pressure PI vs time until a trend is apparent.

6. Compare your graph to the graph in Figure 8-2 to determine if the meter instability is contamination or leaks. See Section 8-2-4 to eliminate contamination or Section 8-2-3-3 to leak check the valve block.

1 – Pressure rise resulting from a leak

2 – Pressure rise resulting from outgassing from the vessel walls

3 – Pressure rise resulting from both effects

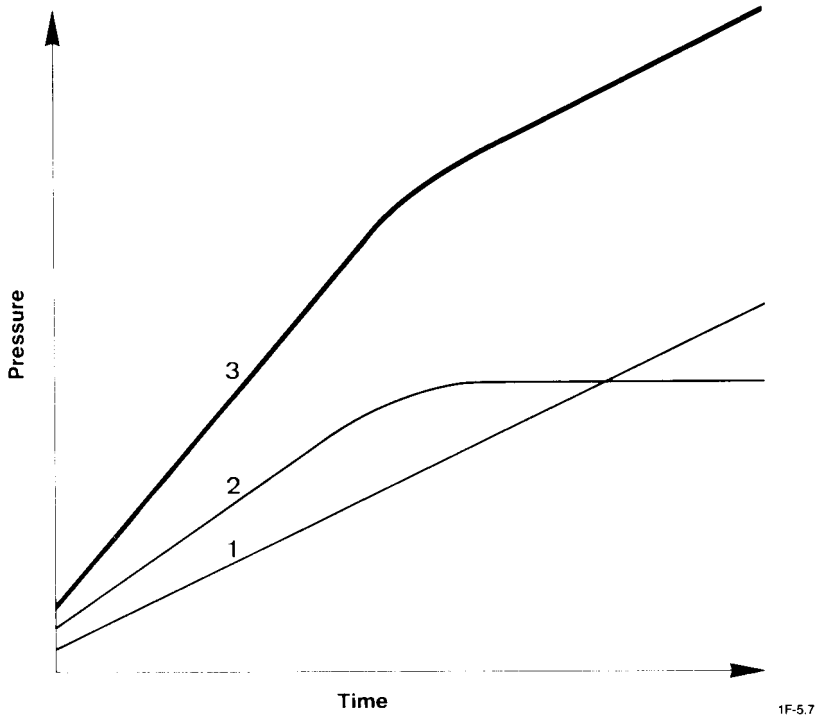


Figure 8-2 - Graph of Pressure Rise Vs. Time from Leaks and/or Outgassing

8-2-3 Checking the ULTRATEST for Leaks

NOTE: Leaks in the ULTRATEST may or may not cause a noticeable increase in pressure depending on the size and location of the leak.

8-2-3-1 Overall Leak Check of the ULTRATEST

Determine the overall leak-rate of the ULTRATEST as follows:

1. Remove the front, back, and side panels and the larger black work top from the leak detector.

2. Do Steps 2a through 2g of Section 8-2-1 so that the test port is sealed off and the READY light is ON.

3. Fit the plastic cover that came with the ULTRATEST over the leak detector.

4. CAUTION: DO NOT ALLOW THE LEAK DETECTOR TO REMAIN IN THE HELIUM BLANKET FOR MORE THAN 3 MINUTES OR THE O-RINGS, VENT VALVE V3, AND VANE PUMP MAY BECOME PERMEATED WITH HELIUM AND THE LEAK DETECTOR MAY OVERHEAT.

   Fill the plastic cover with helium and read the leak-rate from the FB module meter. The overall leak-rate should increase by less than 2×10^{-9}. If it changes by less than 2×10^{-9}, the high background is probably the result of contamination (see Section 8-2-4).

5. Immediately remove the plastic cover and flush away the helium with compressed air.

6. If the overall leak-rate increases by more than 2×10^{-9}, proceed to Section 8-2-3-2 or 8-2-3-3 to find the leaks.

   NOTE: See Step 5 of Section 8-2-1 to help determine which section of the ULTRATEST has a leak.

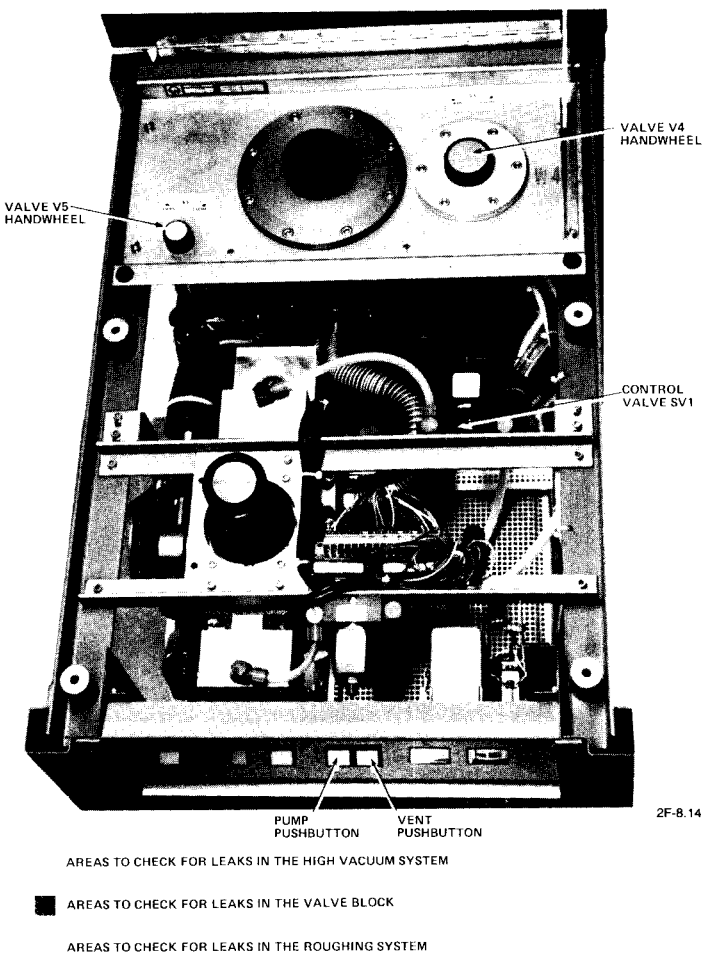


Figure 8-3A - Checking for Leaks in the Leak Detector, Top View

8-2-3-2 Leak Checking the High Vacuum System

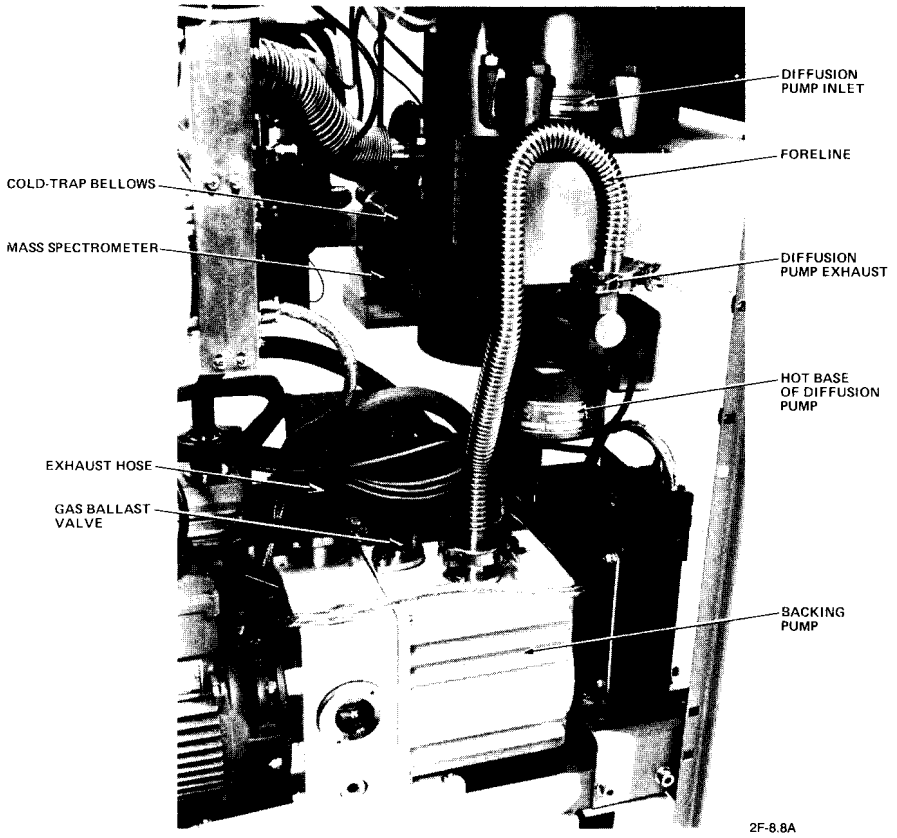
NOTE: Any leak greater than 2×10^{-9} in the high vacuum system is unacceptable.

Proceed as follows if you suspect that there is a leak in the high vacuum system (see Section 8-2-1, Step 5).

1. Tap the VENT pushbutton to close valves V1 and V2.

2. CAUTION: DO NOT SPRAY HELIUM INTO THE EXHAUST OR INTO THE GAS BALLAST VALVE ON THE BACKING PUMP (See Figure 8-3B).

   Spray the flanges, high vacuum line (KF 40 metal bellows tubing), the drive side of the valve V2, and the fore-vacuum line sparing with helium (see the areas shown in yellow Figures 8-3A, 8-3B, and 8-3C).



AREAS TO CHECK FOR LEAKS IN THE HIGH VACUUM SYSTEM

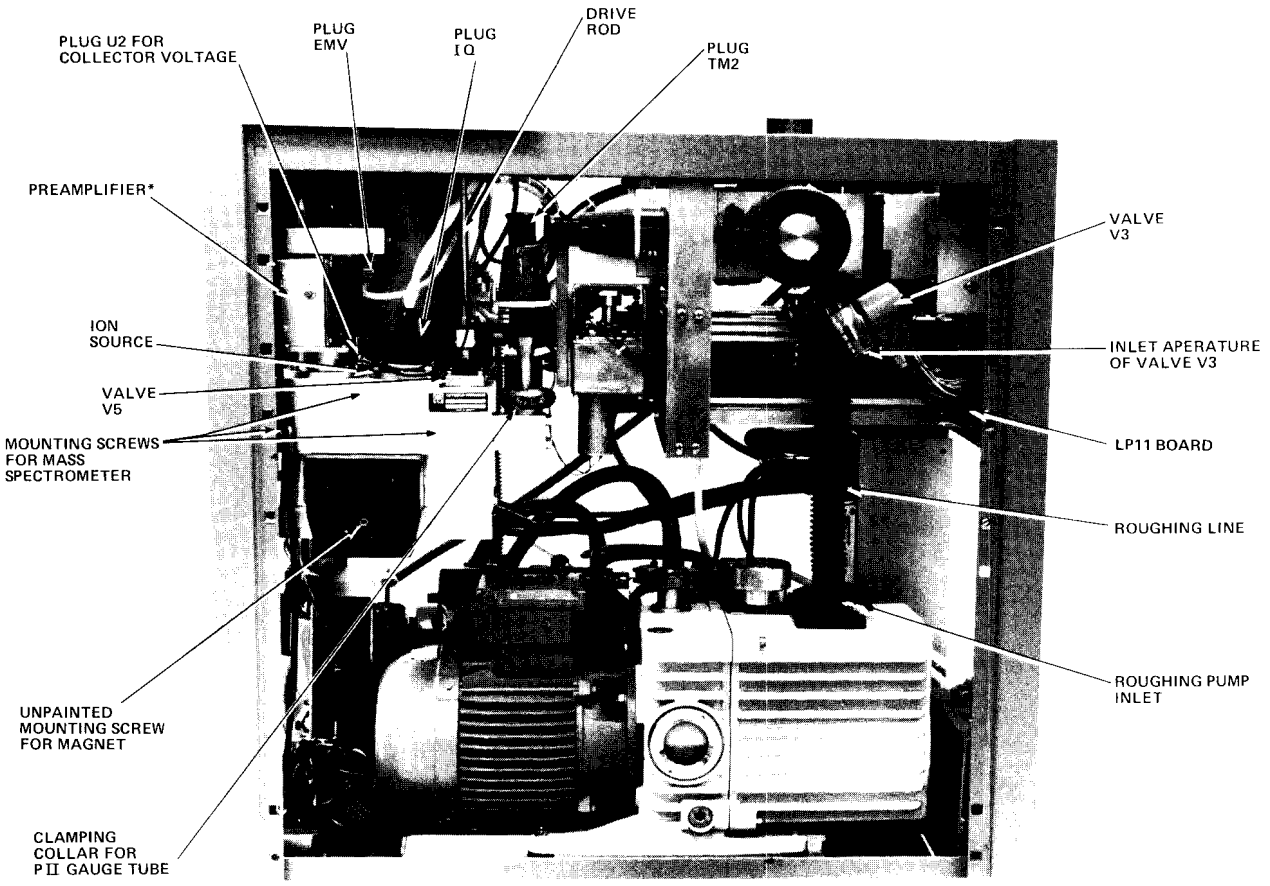
Figure 8-3B - Checking for Leaks in the Leak Detector, Right Side View

3. After spraying each component, allow the helium to "soak in" for 1 or 2 seconds while checking the leak-rate meter (see Section 4-1-2).

4. Flush away the helium with air.

5. If you find a leak in a metal seal, carefully tighten the flange. If tightening does not eliminate the leak, replace the seal (see Section 8-9).

6. If you find a leak in an O-ring, shutdown the leak detector (see Section 4-6-3) and carefully check the O-ring and the sealing surface for dirt or particles. If you find cracks when you stretch the O-ring, replace it with a new clean O-ring. Do not grease the O-ring.



* THERE ARE TWO VERSIONS OF THE PREAMPLIFIER. SEE FIGURE 8-4 FOR A PHOTOGRAPH OF THE OTHER VERSION.

Figure 8-3C - Checking for Leaks in the Leak Detector, Left Side View

8-2-3-3 Leak Checking the Inlet System (Valve Block)

NOTE: Any leak greater than 10^{-9} in the inlet system is unacceptable.

CAUTION: DO NOT DIRECTLY EXPOSE THE RUBBER GASKETS WHICH SEAL THE TEST PORT TO HELIUM.

If you suspect that there is a leak in the inlet system (see Section 4-2-1, Step 5), leak check the inlet system as follows:

1. Press the PUMP pushbutton and wait until the READY lamp shows a steady glow.

2. Cover the air inlet opening in the venting valve V3 to avoid contacting the valve gaskets with helium (see Figure 8-3C). Check valve V3 with a brief squirt of helium and then flush it away by pumping and venting alternately several times (see Figure 8-3C).

3. Repeat Step 1.

4. Spray the PI, calibrated leak, and test port flanges sparingly with helium (see the areas outlined in red in Figures 8-3A and 8-3C).

5. Repeat Steps 3 through 6 of Section 8-2-3-2 to read the meter and repair any leaks.

8-2-3-4 Leak Checking the Roughing System

NOTE: The leak-rate in the roughing line section including the drive of valve V1 must be less than 1×10^{-8}.

Leak check the roughing system as follows (see Figure 8-3A and 8-3C).

1. Tap the VENT pushbutton to shut valve V1.

2. Disconnect the roughing line from the roughing pump inlet and connect the line to an independent leak detector.

3. Spray helium sparingly onto valve V1 and on the roughing line (see the areas outlined in blue in Figures 8-3A and 8-3C).

4. Repeat Setps 3 through 6 of Section 8-2-3-2 to read the leak-rate meter and repair any leaks.

8-2-4 Removing Contaminants from the Leak Detector

8-2-4-1 Contamination

Contaminants adsorb helium and then later release it causing a false leak-rate and an unstable background. Outgassing from contaminants result in higher pressures in the leak detector.

In addition to causing an unstable background leak-rate and increasing the pressure, contaminants can cause the following problems:

- o Contamination from halogens (chlorine, bromine, iodine, and fluorine) and halogenated hydrocarbons (Freon, Frigen, Kaltron, etc.) results in failure of the emission circuitry and deterioration of the cathodes in the ion source.
- o Contamination of the PI and PII gauge heads results in reduced accuracy of the pressure measurement.
- o Contamination of the pump fluid can result in failure of the vane pumps.

When the cold trap is filled with LN_2, it prevents contaminants from entering the mass spectrometer, the diffusion pump, and the backing pump. However, if all LN_2 evaporates from the cold trap or if the layers of the trapped contaminants on the cold trap become very thick, the temperature of the cold trap rises and results in the release of the contaminants.

8-2-4-2 Preventing Contamination

If contaminants have been causing problems in your leak detector, we recommend installing a cold trap on the test port to prevent comtaminants from entering the leak detector. Using the optional QUICK-TEST containing a clean filter in the probe tip and a clean mass separator will also prevent most contaminants from entering the leak detector (see Appendix A). A coaxial trap (Part No. 99-171-164) in the roughing line prevents most hydrocarbon backstreaming from the roughing pump into the valve block.

See Item (10) of Section 4-5 for the recommended method of operation to keep the cold trap in the leak detector clean.

See Section 4-6 for the recommended shutdown procedures which help remove contaminants and prevent them from entering the leak detector during shutdown.

8-2-4-3 Removing Contaminants from the Leak Detector

The easiest way to eliminate contamination is as follows:

1. Refer to Section 8-2-1 to seal off the test port and determine which section of the leak detector is contaminated.

2. If you suspect the contamination is in the roughing system, change the pump fluid in the roughing pump (see Section 6-2-1).

3. Refer to Section 6-4 to clean the cold trap.

4. Refer to Section 4-2, Step 6a to fill the cold trap with LN_2.

5. NOTE: If you suspect that the contamination is in the inlet section, skip Step 5 and proceed to Step 6.

   Proceed as follows only if the comtamination is in the high vacuum system (see Section 8-2-1, Step 5).

   a. Tap the VENT pushbutton to close the inlet valve V2.

   b. Turn off the EMISSION.

   c. Close valve V5.

6. Open the gas ballast valve on the backing pump (see Section 7-6-2-3).

7. Allow the ULTRATEST to run until the unstable backgound and pressure decrease to an acceptable level.

8. If the background has not decreased after 16 hours, try changing the pump fluid in the backing pump (see Section 6-2-2).

9. If the problem continues, clean the contaminated section of the leak detector. The following lists the Sections in this manual containing cleaning instructions.

Section Title	Section No.
Cleaning the Cold Trap	6-4
Cleaning the Valve Block	8-4-3
Servicing the Diffusion Pump	6-3
Cleaning the Mass Spectrometer	8-3

8-2-5 Helium Background

The background problem is from helium if pressure PIII is low and the background leak-rate is steady. The helium background can be the result of an O-ring becoming permeated with helium or a fine leak which allows atmospheric helium into the system. Helium background is undesirable because it reduces the sensitivity of the ULTRATEST to fine leaks.

Proceed as follows if you have a helium background problem.

1. Refer to Section 8-2-1 to determine the helium background and isolate the section of your ULTRATEST that contains the source of the background.

2. Proceed as follows if the problem is in the test port/valve block assembly.

   a. Determine if the venting valve V3 is the source of the background as follows (see Figure 8-3C).

      (1) Ensure that the test port is sealed off and the READY lamp is lit.

      (2) Connect the venting valve V3 to a vacuum pump and evacuate it.

      (3) If the background decreases, valve V3 is the source of the background.

   b. If time permits, run the ULTRATEST with the test port sealed off and the READY lamp ON until the helium is pumped out of the valve block.

   c. Refer to Section 8-2-3-3 to leak check the valve block assembly.

   d. If there is an O-ring on the test port flange, replace it with a new O-ring.

   e. Refer to Steps 1 and 2 of Section 8-2-1 to see if the helium background has now been reduced to an acceptable level.

   f. If the helium background is still too high, change the pump fluid in the roughing pump and clean the roughing line with acetone and rinse wih methanol (see Figure 8-3C).

   g. If the problem still exists, refer to Section 8-4 to replace the O-rings in the valve block.

4. If the helium background is coming from the high vacuum pumping system (see Section 8-2-1, Step 5), proceed as follows:

   a. Change the pump fluid in the backing pump (see Section 6-2-2).

   b. If necessary, replace the O-ring seals on the inlet and exhaust of the diffusion pump and on the inlet port of the backing pump (see Figure 8-3B).

   c. If the problem still persists the internal O-rings of the backing pump are probably permeated with helium. This helium can be removed by running the pump until all the helium is pumped off, or by rebuilding the vane pump using new seals (see the TRIVAC manual in the back of this binder).

5. If the helium background is in the cold trap/mass spectrometer area, refer to Section 8-2-3 to leak check the applicable flanges and metal bellows vacuum lines.

8-3 CLEANING THE MASS SPECTROMETER

Do not disassemble the mass spectrometer as part of routine maintenance. The mass spectrometer should only be disassembled if you have good reason to suspect that it is the source of a problem (see Section 8-2-1).

Proceed as follows to disassemble and clean the mass spectrometer:

1. Remove the grey side panels from the left side of the leak detector.

2. Remove the mass spectrometer as follows:

   a. CAUTION: USE CARE TO AVOID DAMAGING THE SMALL METAL BELLOWS WELDED TO THE COLD TRAP.

      Remove the four allen-head capscrews securing the cold trap bellows to the back of the mass spectrometer and carefully remove the cold-trap bellows from the mass spectrometer (see Figure 8-3B).

   b. Loosen the clamp and then disconnect plug EMV from the preamp (see Figure 8-3C).

   c. Unplug the plugs from the ion source (IQ) and PII gauge head (TM2) (see Figure 8-3C).

   d. Remove the brass coaxial plug U2 from the collector (see Figure 8-3C).

Section 8-3, Step 2 continued

e. Loosen the setscrew securing the V5 valve stem to the valve V5 drive rod (see Figure 8-3C).

f. Unscrew the mounting capscrews securing the mass spectrometer to the brackets and remove the mass spectrometer (see Figure 8-3C).

3. Disassemble the mass spectrometer as follows:

a. CAUTION: FAILURE TO PULL THE PREAMP STRAIGHT STRAIGHT UP WHEN REMOVING IT FORM THE COLLECTOR COULD RESULT IN DAMAGE TO THE CERAMIC FEEDTHROUGH ON THE BOTTOM OF THE PREAMP.

CAUTION: FAILURE TO KEEP THE PREAMP GROUNDED COULD RESULT IN DAMAGE TO THE PREAMP.

Remove the four screws holding the preamplifier onto the collector and remove the preamp by pulling it straight up from the collector (see Figures 8-3C and 8-4).

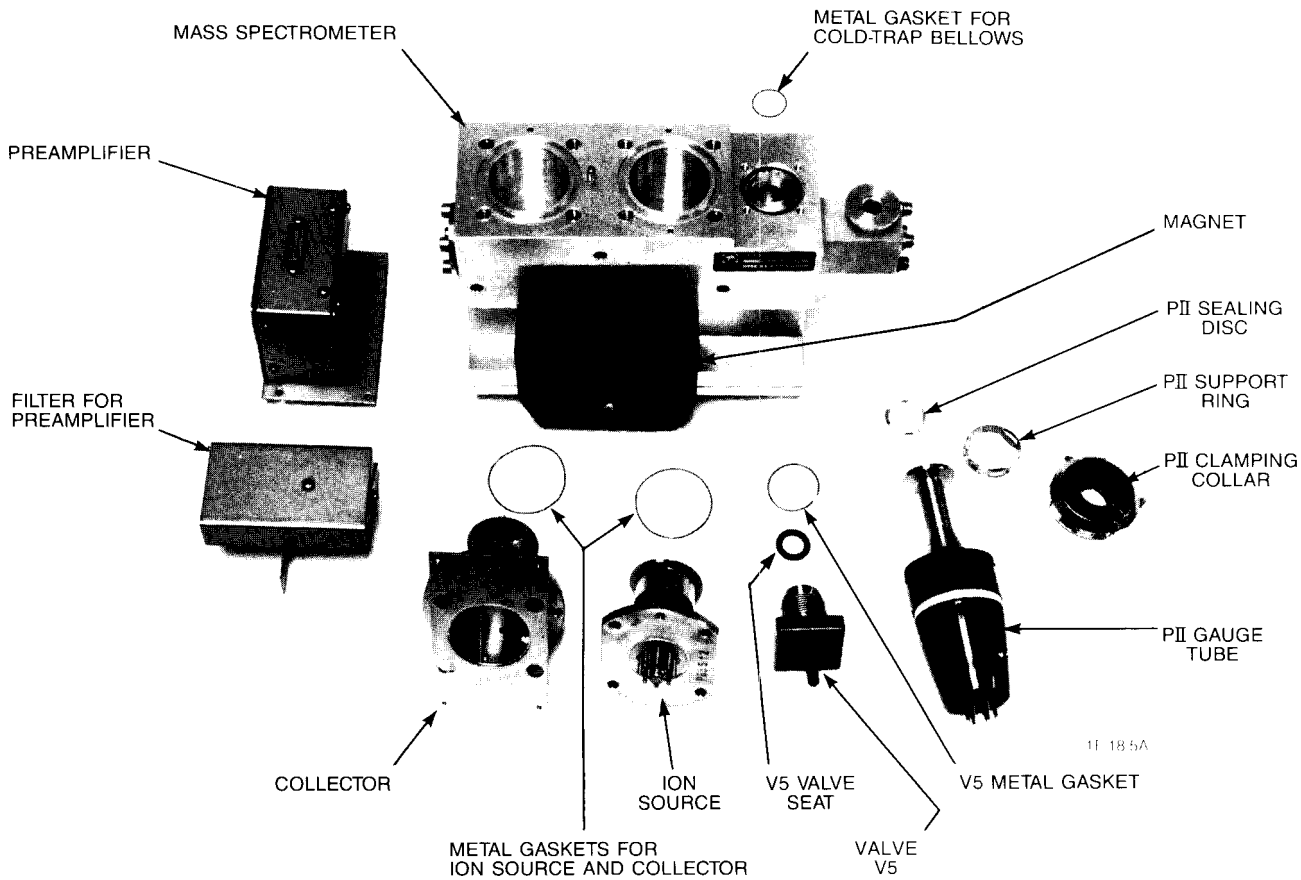


Figure 8-4 - Disassembled Mass Spectrometer

Section 8-3, Step 3 continued

b. CAUTION: DO NO TOUCH THE VACUUM AREAS OF THE COLLECTOR; FINGERPRINTS CAN CAUSE PROBLEMS. ALWAYS HANDLE THE COLLECTOR BY ITS FLANGE.

Remove the four recessed allen-head capscrews attaching the collector to the mass spectrometer and remove the collector (see Figure 8-4).

c. Remove the ion source as follows:

1) Remove the four allen-head capscrews attaching the ion-source flange to the mass spectrometer (see Figures 8-3C and 8-4).

2) CAUTION: DO NO TOUCH THE VACUUM AREAS OF THE ION SOURCE; FINGERPRINTS CAN CAUSE PROBLEMS. ALWAYS HANDLE THE ION SOURCE BY ITS FLANGE.

If necessary, screw one of the allen-head capscrews into the jack screw hole in the ion-source flange to remove the ion source (see Figure 6-4).

d. Remove the four allen-head capscrews securing valve V5 to the mass spectrometer and remove valve V5 (see Figures 8-3C and 8-4).

e. Remove the clamping collar, support ring, vacuum sealing disk, and PII gauge tube from the mass spectrometer (see Figures 8-3C and 8-4).

f. If necessary, clean the PII pressure gauge using the instructions in Section 8-10.

g. Remove the bottom plate from the mass spectrometer as follows:

1) CAUTION: THE STRONG MAGNETIC FIELD FROM THE MASS SPECTROMETER MAGNET CAN DAMAGE WATCHES, BANK CARDS ETC.

CAUTION: SET THE MAGNET ON NON-METALLIC SURFACES ONLY.

Remove the unpainted allen-head capscrews from each side of the magnet and slide the black magnet assembly from the mass spectrometer (see Figure 8-3C).

2) Remove the 14 allen-head capscrews securing the bottom plate to the mass spectrometer; screw one of the capscrews into the jackscrew hole to remove the bottom plate from the mass spectrometer. Also remove the thin metal spacer.

3) Remove the 3 screws attaching the intermediate slit plate to the bottom plate.

4. CAUTION: USING SCOTCH BRIGHT OR ANY SIMILAR ABRASIVE TO CLEAN THE MASS SPECTROMETER RESULTS IN DAMAGE TO ITS FINISH AND POOR OPERATION OF THE MASS SPECTROMETER.

Inspect and clean the mass spectrometer as follows:

a. Inspect the intermediate slit plate. Ion burning on the plate is normal, but it will affect the sensitivity of the leak detector if it builds up. Use an ink eraser to remove any ion burns (blue marks with a halo) from the plate.

b. Inspect the ion source penetration in the mass spectrometer. A light brown discoloration is normal. A heavy brown discoloration indicates hydrocarbon contamination; a dark blueish discoloration indicates a vacuum leak in the mass spectrometer.

c. Clean the collector and the mass spectrometer parts in an ultrasonic medium, rinse with alcohol, and dry with a heat gun. Ensure that all sealing surfaces are clean, that all ion burns are removed, and that the feedthrough on the collector is thoroughly dry and restored to full isolation capacity.

d. CAUTION: DO NOT CLEAN O-RINGS WITH ACETONE. ACETONE WILL RESULT IN CRACKING OF THE O-RING.

Remove the O-ring valve seat from valve V5 and clean it with methanol or install a new O-ring as necessary.

6. Replace the metal gaskets on valve V5, the ion source, the collector, the bottom plate, and the cold-trap bellows connection with new metal gasket (see Section 8-9 and Figure 8-4).

7. Refer to Section 8-9-1 to use the clamping collar, support ring, and vacuum sealing disk to attach the PII gauge tube to the mass spectrometer.

8. CAUTION: FAILURE TO ENSURE THAT ALL FLANGES AND THE BOTTOM PLATE ARE CLEAN AND TIGHTENED EVENLY COULD RESULT IN A VACUUM LEAK (see Section 8-9).

   CAUTION: THE HALF OF THE MAGNET WITH THE "N" STAMPED ON IT MUST BE INSTALLED ON THE SIDE OF THE MASS SPECTROMETER THAT WILL FACE THE COLD TRAP.

   NOTE: When installing the bottom plate onto the mass spectrometer, align the jackscrew hole in the plate with the jackscrew mark on the bottom of the mass spectrometer. Start by tightening the screws in the middle and work your way out; then tighten sequentially around the flange.

   Reassemble and install the mass spectrometer (see Figures 8-3C and 8-4).

9. Check for leaks (see Section 8-2-3-2).

8-4 SERVICING THE VALVE BLOCK ASSEMBLY

Valves V1 and V2 are mounted in a valve block which is fixed to a cross member. Also mounted on the valve block are control valves SV1 and SV2, venting valve V3, the PI gauge head, the control motor for valve V2, and the optional calibrated leak (see Figure 8-5 and 8-6). The wiring for the valves connects plug G to a terminal strip attached to the cross member (see Figures 8-5 and 8-18).

The valve block should not be disassembled for routine maintenance. It should only be disassembled if you have good reason to suspect that the valve block is the source of the problem (see Section 8-2-1). Refer to Section 8-4-2-1 to install a new O-ring on the valve seat, Section 8-4-2-2 to replace the piston seals, and Section 8-4-3 to clean the valve block.

8-4-1 Removing the Valve Block Assembly

NOTE: It is not necessary to remove the valve block from the leak detector to clean the test ports (see Section 8-4-3).

Remove the valve block assembly from the leak detector as follows:

1. Remove the larger work-top and the side panels from the leak detector (see Figure 8-3C).

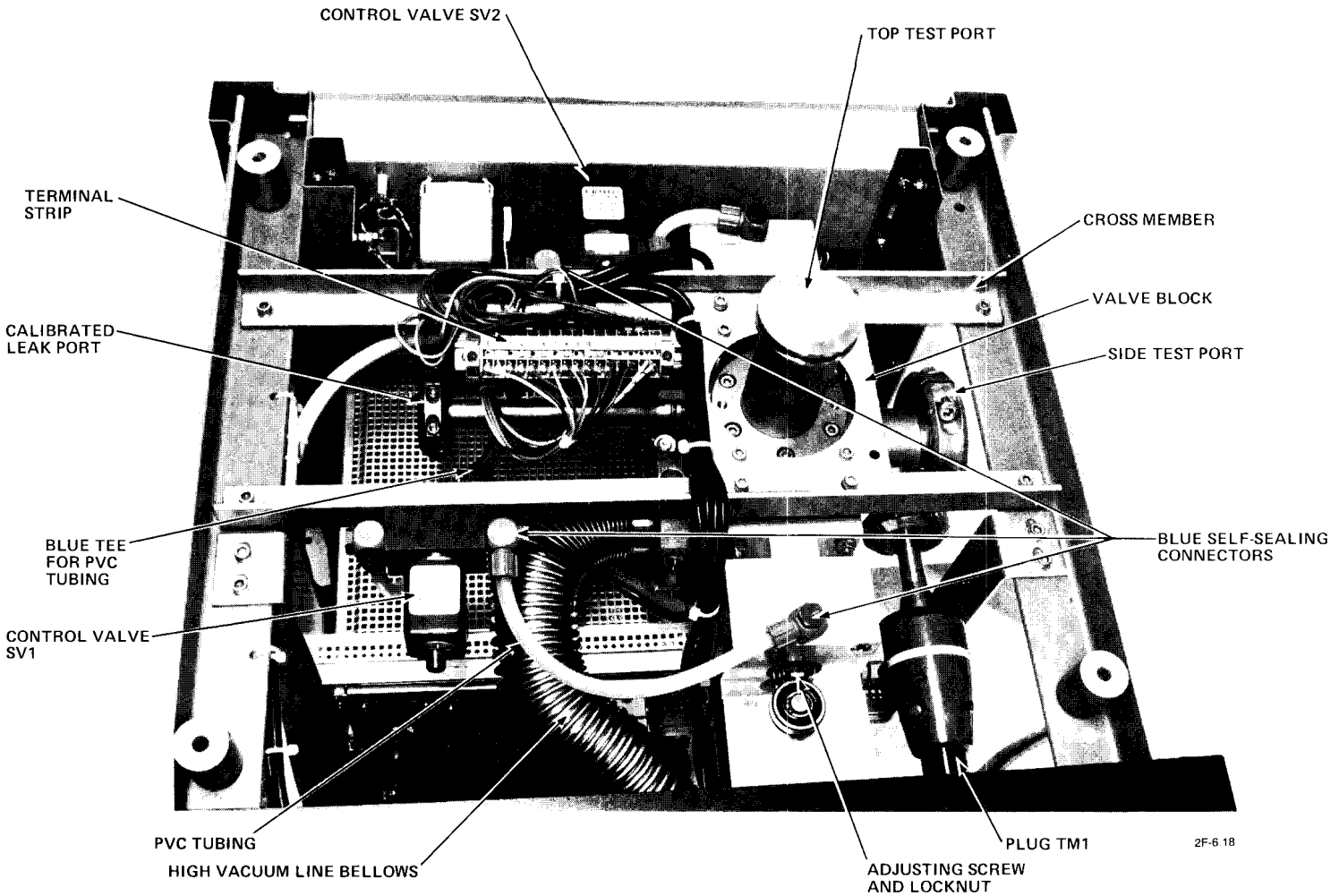


Figure 8-5 - Top of Leak Detector with Larger Work Top Removed

2. Remove plug TM1 from the PI gauge tube (see Figure 8-5) and plug G from the back of the EL module (see Figure 8-18).

3. Disconnect the roughing line from the valve block; remove it by compressing it slightly downward so that it does not scratch the mounting flange (see Figure 8-3C).

4. Disconnect the high vacuum-line bellows to the cold trap directly as the flange of the valve block (see Figure 8-5).

5. Remove the white PVC tube from the stem of the blue tee by unscrewing the nut and pulling the PVC tubing out (see Figure 8-5).

6. If the optional calibrated leak is permanently installed, disconnect the steel sleeve from the drive rod (see Figure 2-2).

7. Remove the four allen-head capscrews securing the cross members to the top of the leak detector frame (see Figure 8-5).

8. Withdraw the cross member/valve block assembly from the leak detector.

8-4-2 Repairing the Valve Block

CAUTION: DO NOT REMOVE THE VALVE-BLOCK PORTS THAT CONNECT TO THE ROUGHING LINE, TO THE HIGH VACUUM LINE, OR TO THE CALIBRATED LEAK. THESE PORTS ARE SCREWED INTO THE BLOCK AND SEALED BY A METAL GASKET AND AN EPOXY-RESIN CEMENT.

NOTE: The instructions in Sections 8-4-2-1 and 8-4-2-2 can be used for valve V1 and valve V2.

Refer to Section 8-4-1 to remove the valve block assembly from the leak detector before repairing the valves.

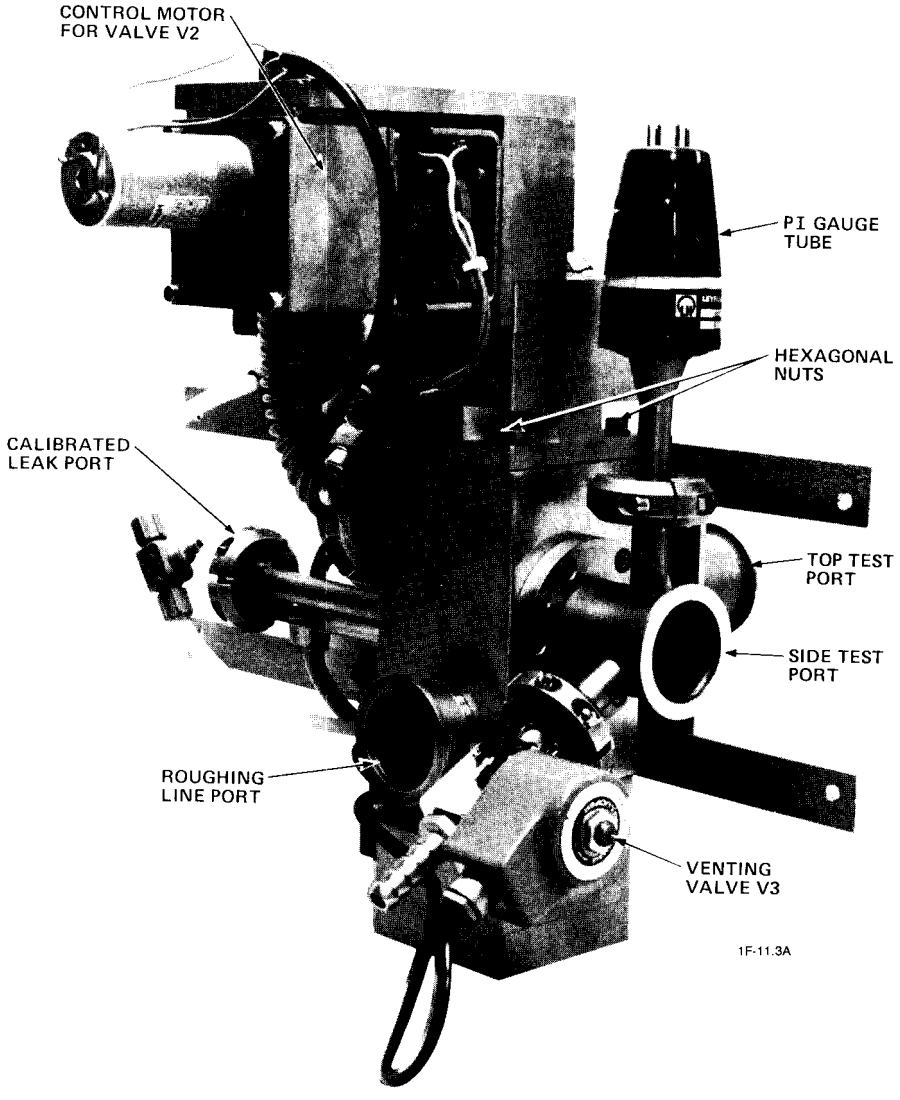
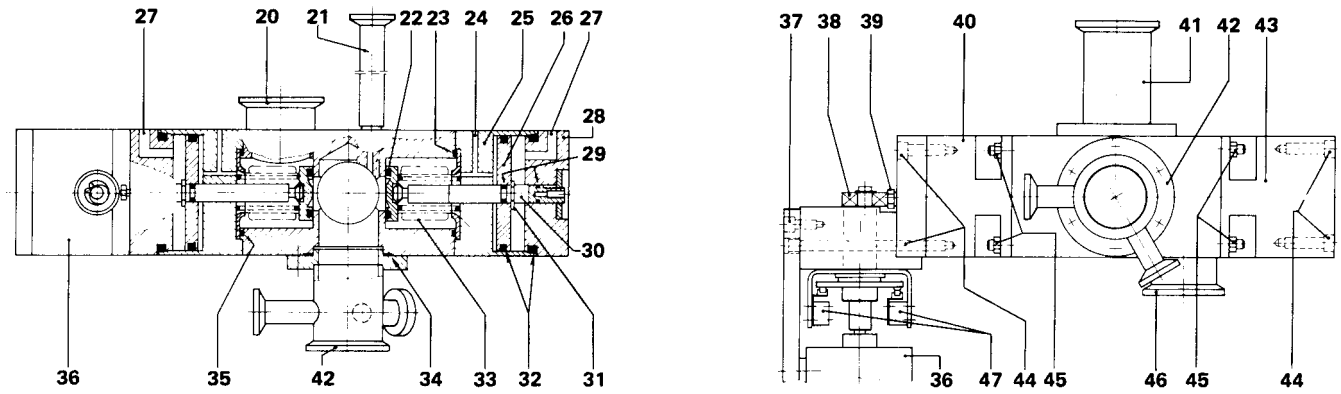


Figure 8-6 - Valve Block Removed from the Leak Detector



KEY TO FIGURE 8-7

20 High vacuum connection
21 Connection for calibrated leak
22 Valve seat O-ring gasket (22 x 5)
23 O-ring gasket (50 x 3)
24 Equalization channel
25 Cylinder
26 Piston
27 Connection for control vacuum
28 Bonnet
29 O-ring gasket (9.25 x 1.8)
30 Valve stem
31 Circlip
32 O-ring gasket (65 x 5)
33 Valve Belows
34 Metal gasket
35 Helicoflex gasket (See Figure 8-13)
36 Control motor
37 Socket hex head screw
38 Ball bearing cam
39 Adjusting screw
40 Valve V2
41 Top test port
42 Side test port
43 Valve V1
44 Socket hex head screw
45 Hexagonal nut
46 Connection to roughing pump
47 Microswitch

1F-5.8

Figure 8-7 - Cross Sectional and Side View of the Valve Block

8-4-2-1 Renewing the Valve-Seat O-ring

NOTE: It is not necessary to remove the control motor from valve V2 to replace the valve seat (see Figure 8-6).

Install a new valve seat as follows (see Figures 8-6 and 8-7).

1. Remove the four hexagon nuts (45) that secure the valve to the block and remove the valve assembly from the block.

2. Remove the old valve seat O-ring (22) from the groove in the end on the bellows (see Figures 8-7 and 8-8).

3. Ensure that the valve seat and the new O-ring is clean and free of particles.

4. Install the new O-ring (22) into the groove in the valve seat as follows (see Figures 8-7 and 8-8).

   a. Apply a thin film of high-vacuum grease to the O-ring (22).

   b. Press the O-ring into its groove, ensuring that the fine seam on the O-ring is not facing the sealing surface.

   c. Verify that the sealing surface is even by pressing a glass or plexiglass plate onto the O-ring installed in the valve seat.

5. Install a new seal for the drive mechanism before reassembling the valve block (see Figures 8-7 and 8-8). Valve V1 uses an O-ring seal (23). Be sure to gradually tighten the four nuts crosswise so that the O-ring is sealed evenly. We recommended helicoflex metal gasket (Part No. 230-05-105) for valve V2. See Section 8-9-2-3 for instructions for installing helocoflex gaskets (35).

6. Reinstall the valve block assembly into the leak detector ensuring that the high vacuum line, the roughing line, and the PVC tubing connections are vacuum tight (see Section 8-9 and Figures 8-3C and 8-5). Be sure to connect plug G to its outlet on the back of the EL module and plug TM1 onto the PI gauge tube (see Figures 8-18 and 8-5).

8-4-2-2 Renewing the Piston Seal

CAUTION: Do not wipe the graphite from the piston chamber. If you must clean this chamber, be sure to place MOLYKOTE G RAPID PLUS GRAPHITE lubricant on the piston chamber walls before reassembly. MOLYKOTE G is a Dow-Corning lubricant.

Install a new piston seal as follows:

1. For valve V2 only, remove the V2 control motor and adjusting screw as follows:

   a. Remove the two M6 x 80mm capscrews that secure the V2 control motor to the valve block (see Figure 8-7).

   b. Measure the distance between the hex head of the adjusting screw and the locknut so that you can maintain the spacing during reassembly (see Figure 8-5).

   c. Remove the adjusting screw with locknut (see Figures 8-5).

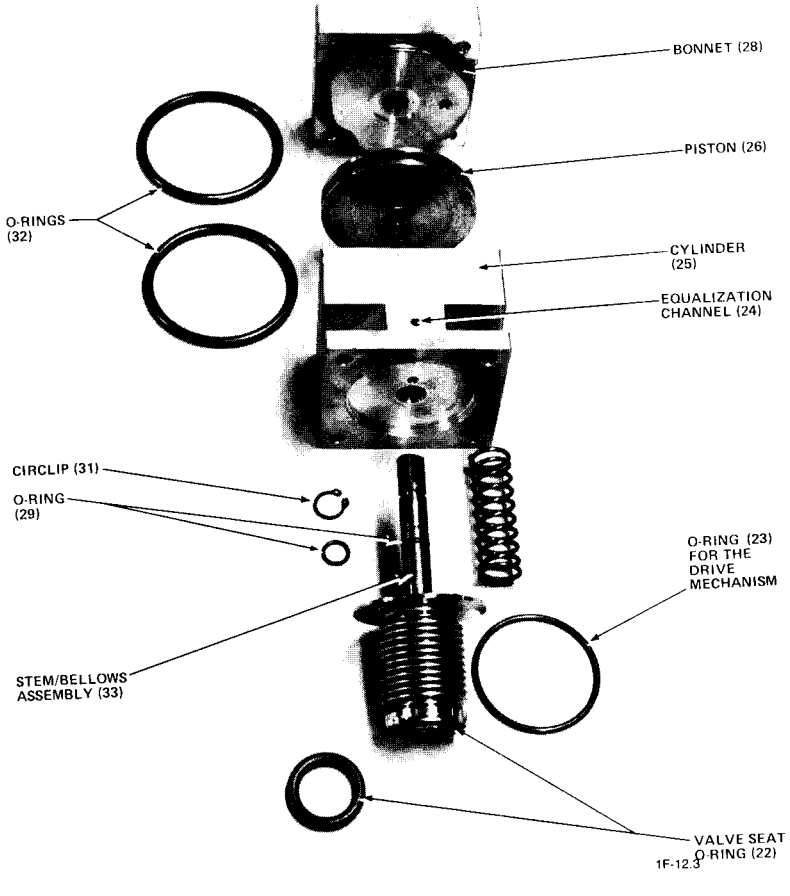


Figure 8-8 - Disassembled Valve V1

2. Remove the allen-head capscrews (44) from the bonnet and withdraw the bonnet (28) from the connecting rod (30) (see Figures 8-7 and 8-8).

3. Remove the two O-rings (29) and the circlip (31) from the connecting rod (30) (see Figure 8-7 and 8-8).

4. Using compressed air or helium in the equalization channel (24), carefully blow the piston (26) out of the cylinder (25) (see Figure 8-8).

5. Install new O-rings (29 and 32) and carefully assemble the valve block (see Figure 8-6, 8-7, and 8-8).

6. Refer to Step 6 of Section 8-4-2-1 to install the valve block assembly onto the leak detector.

8-4-3 Cleaning the Valve Block

NOTE: See Sections 8-2-1 and 8-2-2 to determine if contamination of the valve block is the source of your problem.

If contamination in the valve block is causing high pressure and an unstable background leak-rate, first try cleaning the test ports while the valve block is installed in the leak detector (see Step 1); if cleaning the test ports does not remedy the problem, remove, disassemble, and clean the valve block (Steps 2 through 10).

1. Proceed as follows to clean the test ports while the valve block is installed in the leak detector (see Figure 8-5).

   a. Remove the blind flange or system tubing from the top and the side test ports.

   b. Swab all accessible internal surfaces with acetone.

   c. Rinse with methanol.

   d. Reconnect the blind flange or system tubing to the top and side test ports.

   e. Allow the ULTRATEST to run overnight with the READY light ON to remove any residual solvents from the valve block.

   f. Check the PIII pressure and the background leak-rate to see if cleaning the test ports remedied the problem (see Section 8-2-1). If not, proceed to Steps 2 through 10 to disassemble and clean the valve block.

2. Refer to Section 8-4-1 to remove the valve block assembly from the leak detector.

A detailed manual (Part No. 99-800-005) is included in this binder to help you repair the vane pump. If you are replacing the vane pump motor, be sure to order the correct AEG motor. If you must replace the coupling connecting the pump shaft to the motor shaft, order the couplings that fit on AEG motors.

See Section 7-2 of this manual for a description of the vane pump and Sections 6-1 and 6-2 for maintenance information.

8-6 LEYBODIFF 180L DIFFUSION PUMP

CAUTION: DO NOT USE SILICONE-BASED PUMP FLUID IN THE DIFFUSION PUMP. USE ONLY HE-300 POLYPHENOL PUMP FLUID IN THE DIFFUSION PUMP.

WARNING: DO NOT TOUCH THE BASE OF THE DIFFUSION PUMP IF IT IS STILL HOT FROM OPERATION (see Figure 8-3B).

The following list the sections in the manual containing information on the diffusion pump.

SECTION:	CONTENT:
7-6-2-2	Description
6-3	Removing, Cleaning, and Changing Pump Fluid
Table 8-1; Symptoms 3, 4, 10, 13a, 17, and 19a. Section 8-6.	Troubleshooting
Figures 8-1, 8-3B, and 8-10.	Illustrations
Figures 9-12 and 9-11	Spare Parts

8-6-1 Checking the 90C and 190C Thermal Switches

NOTE: The 90C switch is the one with "77" marked on it; the 190C switch is the one with "177" marked on it.

The 190C thermal switch is closed when its temperature is above approximately 190C. The "DIFF 190°C" LED is lit and an EMISSION interlock is cleared when the 190C switch is closed.

The 90C thermal switch turns off the diffusion pump fan when the diffusion pump cools to approximately 90C during shutdown.

The 90C and 190C thermal switches are normally open at room temperature and are closed at approximately 90C (194F) and 190C (374F) respectively.

1. NOTE: Both thermal switches should be open when the leak detector is at room temperature.

   Check if the thermal switches open properly as follows:

   a. Disconnect Plug H while the leak detector is at room temperature (see Figure 8-18).

   b. Check for continuity for the 90C switch between pins T and W (see Figure 8-9).

   c. Check for continuity for the 190C switch between pins V and X (see Figure 8-9).

   d. Reconnect Plug H.

2. NOTE: You can also check if the thermal switches close properly by using a heat gun to apply heat to these switches (see Figure 8-10).

   Check if the thermal switches close properly as follows:

   a. Turn ON the ULTRATEST and allow it to run for 25 minutes.

   b. CAUTION: FAILURE TO CHECK THE CONTINUITY QUICKLY COULD RESULT IN OVERHEATING BECAUSE THE FANS ARE SHUT DOWN WHEN PLUG H IS DISCONNECTED.

      Disconnect Plug H and quickly check for continuity between pins V and X (190C Switch) and then between pins T and W (90C Switch) (see Figure 8-9).

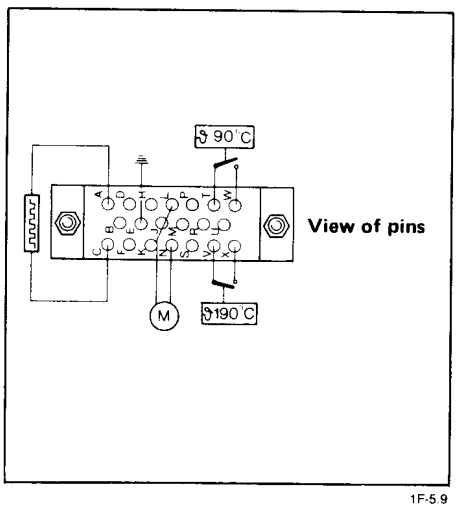


Figure 8-9 - Wiring Diagram for Diffusion Pump Plug H

8-6-2 Replacing the Heater Plate

Proceed as follows to replace a malfunctioning heater on the diffusion pump (see Figure 8-10).

1. Use Section 6-3-2, Steps 1 and 2 to remove the diffusion pump for the leak detector.

2. Ensure that Plug H is disconnected (see Figure 8-18), and then unscrew the nut from the bottom of the diffusion pump and remove the heater shield.

3. After unscrewing the next nut, remove the cast iron bracket.

4. Remove the terminal box cover and disconnect the two wires that connect the terminals to the heater plate.

5. Remove the heater plate from the diffusion pump.

6. Clean the base of the diffusion pump. This is important because dirt or scale result in poor heat transfer and lead to overheating the new plate.

7. Install the new heater plate ensuring that the heater plate and pump base are perfectly flush and that the heater plate fits tightly.

8. Reconnect the heater plate wires to the terminals and reassemble the diffusion pump.

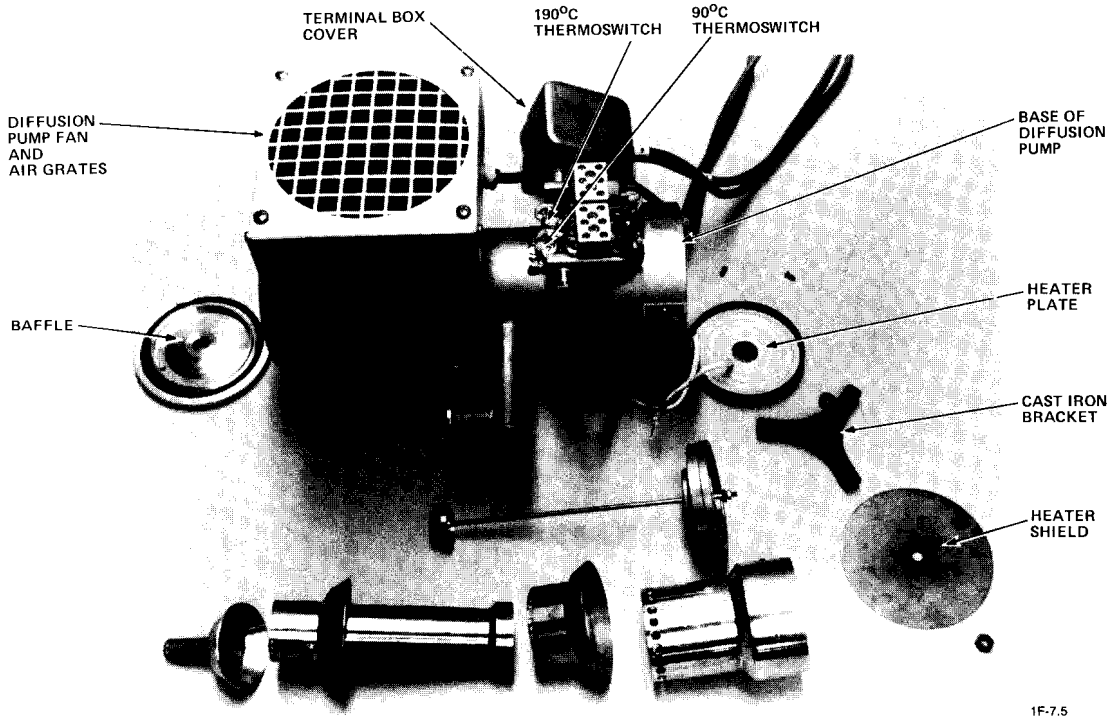


Figure 8-10 - Diffusion Pump with Heater Plate Removed

8-7 VALVES V3, V4, AND V5

8-7-1 Valve V3

CAUTION: DO NOT REMOVE THE SOLENOID FROM VALVE V3 WHILE POWER IS APPLIED SINCE THIS WILL CAUSE IT TO BURN OUT.

NOTE: See Section 8-2-3-3 for information on leak checking valve V3.

The venting valve V3 (see Figure 8-3C) is operated by a 220 VAC relay supplied from the EL module. Holding the VENT pushbutton down for 1.5 seconds energizes the relay which opens valve V3. Pressing the PUMP button de-energizes the relay allowing V3 to close.

Proceed as follows if you suspect that V3 is malfunctioning:

1. Check the operation of V3 as follows:

   a. Refer to Section 4-2 to start the leak detector.

   b. Press the PUMP button (see Figure 8-12).

   c. Check pressure PI. If PI is near atmospheric pressure, and the pressure decreases when you place your finger over the V3 venting port, it means that either valve V3 or its control logic circuit is malfunctioning.

2. Determine the source of the valve V3 problem as follows:

   a. WARNING: THE TERMINAL STRIP CONTAINS 220V.

      Remove the larger work top from the leak detector (see Figure 8-5).

   b. If not already done, press the PUMP button (see Figure 8-12).

   c. Check the voltage across contacts 5 and 6 of the terminal strip (see Figure 8-11).

   d. If there is still power between contacts 5 and 6, the problem is in the control logic circuitry.

   e. If no voltage is present between contacts 5 and 6, then there is a mechanical fault in valve V3. In this case, replace valve V3 with a new valve.

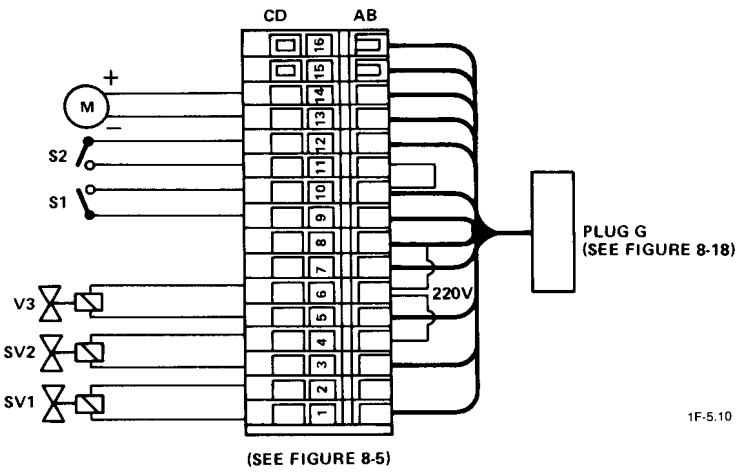


Figure 8-11 - Wiring Diagram for the Terminal Strip

8-7-2 Valves V4 and V5

NOTE: Be sure to have a new metal gasket before removing the central section of valve V4 or V5 (see Section 8-9).

If valve V5 develops a mechanical fault or the O-ring on the valve seat needs to be replaced, proceed as follows to remove the inner section of the valve (see Figure 8-3C and 8-4). The procedure for repairing valve V4 is similar (see Figure 8-3A and 9-14).

1. Close valve V4 before repairing valve V5. Close valve V5 and turn OFF the ULTRATEST (see Section 4-6-3) before repairing valve V4.

2. Remove the allen-head capscrews from the valve flange.

3. For valve V5 only, loosen the set screw on the jointed drive rod (see Figure 8-3C).

4. Withdraw the inner section of the valve (see Figure 8-4 or 9-14).

5. Remove the old O-ring valve seat, ensure that the groove is clean, and install the new O-ring into the groove ensuring that the fine seam on the O-ring does not face a sealing surface.

6. Reassemble the valve using a new metal gasket (see Section 8-9-2).

8-8 CONTROL VACUUM

NOTE: See Section 7-3 for more information on the function of the control vacuum.

Control valves SV1 and SV2 are electromagnet three-way valves. When the "PUMP" button is not depressed, control valves SV1 and SV2 close the vacuum tubing coming from the control vacuum reservoir and open the venting aperature (see Figure 8-1 and 8-5). When you depress the "PUMP" button, SV1 and SV2 close the venting aperture and connect the control vacuum reservoir to the piston chambers of valves V1 and V2. The control vacuum should be below 320 mbar to ensure positive operation of valves V1 and V2.

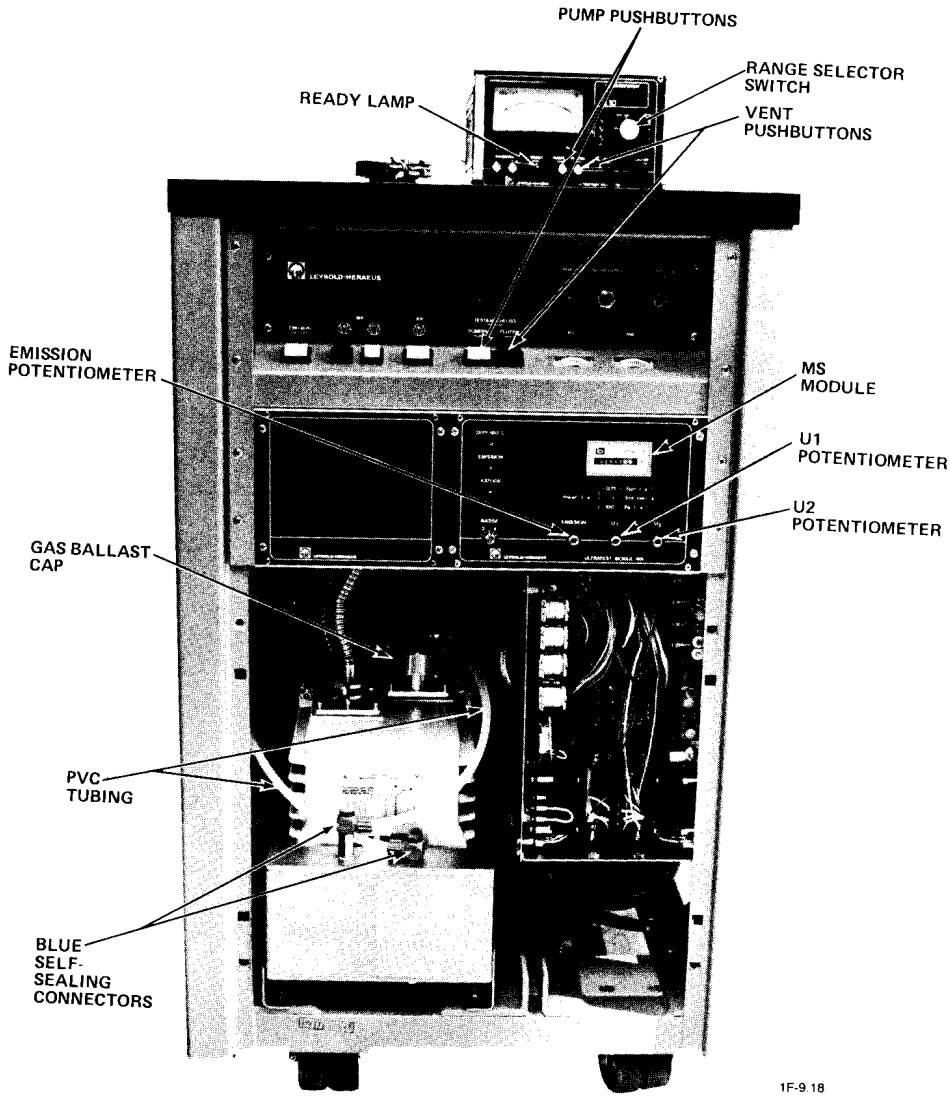


Figure 8-12 - Front of Leak Detector with Panel Removed

8-8-1 Control Vacuum Leaks

When both valves V1 and V2 are not operating properly, it means that the control vacuum is inadequate. Check the blue connectors on the white PVC tubing and the O-ring on the gas ballast valve cap of the roughing pump (see Figure 8-12 and 8-5). Carefully tighten the blue self-sealing connectors and where necessary replace the O-ring on the gas ballast cap of the roughing pump.

8-8-2 Faulty Control Valves

Check the control valves as follows (see Figure 8-5).

1. WARNING: REMOVING THE WORK TOP EXPOSES 220 VOLTS.

   Remove the larger black work top from the leak detector and listen for the switching sound from the control valves SV1 and SV2 as you depress the "PUMP" button (see Figures 8-5 and 8-12).

2. If you do not hear the clicks, check the supply voltage (220 VAC) between contacts 1 and 2 and between 3 and 4 on the terminal strip (see Figures 8-5 and 8-11).

3. If the supply voltage is present, replace the faulty control valve.

   If there is no voltage, check the LP9 board (see Section 8-16-2).

8-8-3 Valve V1 or V2 is Faulty

If both control valves work perfectly but valve V1 or V2 does not open, the problem is in valve V1 or V2 (see Section 8-4).

8-9 METAL GASKETS

NOTE: See Figure 8-13 for a photograph of the different types of seals in the ULTRATEST F.

NOTE: A set of spare metal gaskets comes with the ULTRATEST.

NOTE: See Table 9-1 for part numbers for ordering additonal spare metal gaskets.

Most of the seals in the leak detector are metal-wire gaskets (see Section 8-9-2) or ultra-high vacuum sealing disks (see Section 8-9-1). The piston flange on valve V2 is sealed with a helicoflex metal gasket (see Section 8-9-2-3).

It is worth taking the extra time and care to install metal gaskets correctly; otherwise, you may have problems locating and repairing a leaky gasket.

8-9-1 Ultra High Vacuum Sealing Disks

Vacuum disks can be reused three or four times, however to be safe we recommend using a new one every time. Each time the gasket is reused, it must be deformed further by increasing the torque. When the sealing surface reaches 1mm (0.039 inch) across, the disk must be replace with a new disk (see Figure 8-14). When in doubt about the width of the wear surface, use a new sealing disk. If the used disk has any crosswise scratches, use a new disk.

The support ring that is used with each sealing disk is reusable.

Proceed as follows to install a vacuum disk.

1. Place the support ring onto the flange and insert the sealing disk inside of the support ring (see Figure 8-13).

2. Ensure that each screw on the clamping collar has a washer (see Figure 8-13).

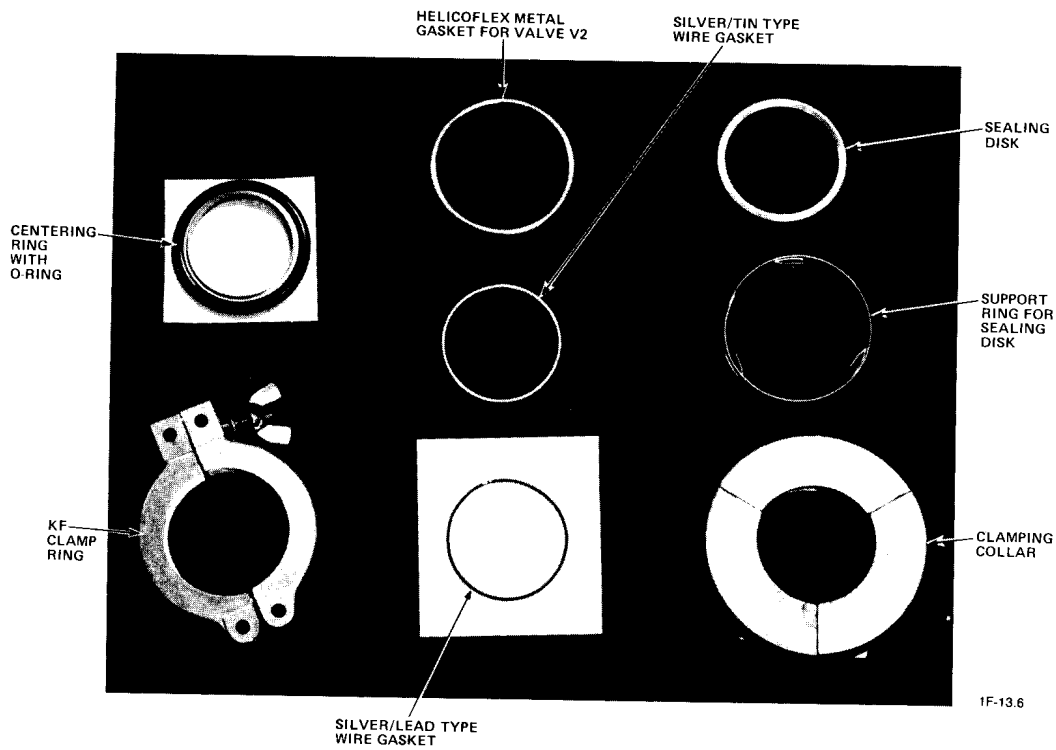


Figure 8-13 - Clamp and Seal Types Used in the Leak Detector

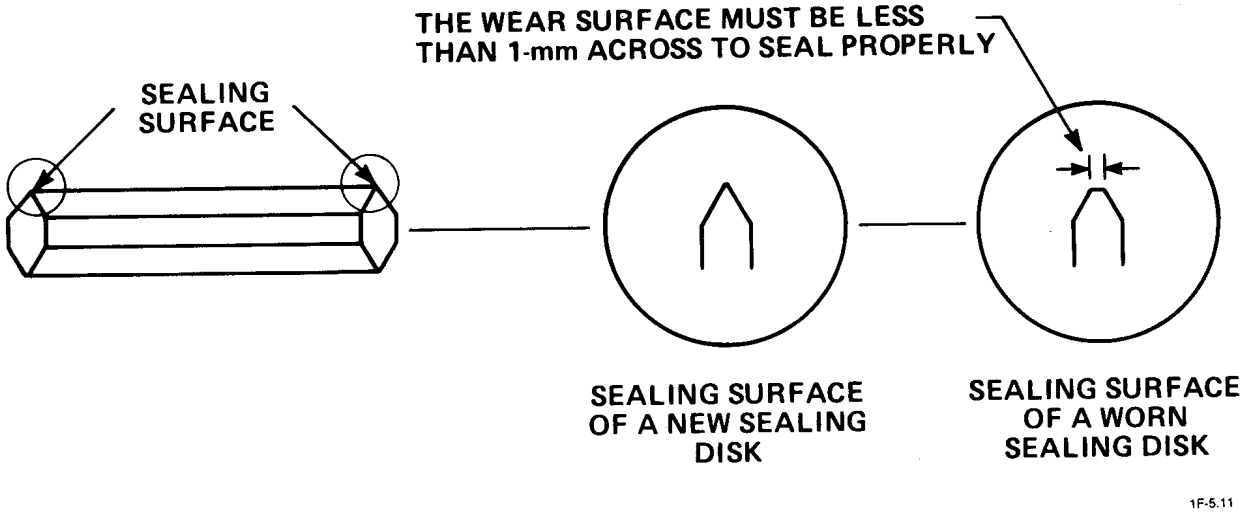


Figure 8-14 - Cross Section of a High Vacuum Sealing Disk Showing Wear on the Sealing Surface

3. Place the three segments of the clamping collar over the flanges and disk.

4. NOTE: Be sure to maintain even spacing between the three segments of the clamping collar.

   Screw the three segments of the clamping collar together finger-tight.

5. Tighten the screws sequentially around the clamping collar about one turn with each pass until the torque is 9cmkg (0.65 ft-lb.) for KF16 flanges and 45 cmkg (3.25 ft-lb) for KF40 flanges. These torque values are for new sealing disks. The torque must be increased each time the disk is reused.

8-9-2 Metal-Wire Gaskets

The cold trap, cold trap/mass spectrometer flange, mass spectrometer bottom plate, ion source, collector, and valves V4 and V5 are sealed with wire gaskets. Metal-wire gaskets are more vacuum tight and helium proof than O-ring gaskets; however, metal-wire gaskets cannot be reused.

We recommend using silver/tin alloy wire gaskets rather than using the silver/lead gaskets (see Figure 8-13). The silver/tin gaskets are 1/16 inch thick which is about twice as thick as the silver/lead gaskets; thus the silver/tin gaskets produce a more reliable seal. Section 8-9-2-1 describes how to make and/or install silver/lead alloy wire gaskets; Section 8-9-2-2 describes how to install the silver/lead alloy gaskets.

8-9-2-1 Making and/or Installing Silver/Tin Gaskets

NOTE: A one pound spool of silver/tin alloy wire for making wire gaskets is available under Part No. 98-181-0027.

NOTE: A set of silver/tin alloy metal gaskets is available under Part Number 98-181-0029. This set include the following wire gaskets:

- o 2 for the PII block/mass spec flange.
- o 4 for cold trap
- o 2 for valve V4
- o 2 for valve V2
- o 5 for ion source
- o 2 for valve V5
- o 2 for the mass spec/cold trap flange

1. Proceed as follows to make silver/tin gaskets:

   a. Roll the gasket wire around the flange of the fixture (ion source, cold trap, etc.) and cut the wire to fit.

   b. Straighten out any dips in the wire so the two ends of the gasket butt together on the same plane on a flat surface.

   c. Cut a second piece a few inches long from the spool to use as filler material for soldering.

   d. Clean the two cut pieces with fine emery cloth or Scotch Brite.

   e. Secure the gasket piece on a nonmetalic work surface so that the ends butt.

   f. Use a 25 or 40W soldering pencil and the piece of filler material (see Step c) to solder the ends of the wire piece together to form the gasket.

   g. Use a fine file to file the soldered joint flat.

   h. Using fine emery cloth of Scotch Brite, polish the wire gasket ensuring that all crosswise scratches are sanded smooth.

2. Install the gasket as follows:

   a. Use fine emery cloth or Scotch Brite to remove any oxide film or crosswise scratches from the new gasket just before installing it. Ensure that the soldered joint is smooth.

   b. Rinse the wire-gasket with methanol to remove any oil or dust.

   c. After ensuring that all sealing surfaces are clean, shape the gasket to fit the sealing surface.

   d. Place the gasket on the flange so that the joint will be under a mounting screw and install the flange screws finger tight.

   e. Make 3 or 4 rounds to evenly tighten the screw sequentially around the bolt circle until they are all tight. Tighten the screws about a quarter turn with each pass.

      NOTE: After tightening, there will be a small gap between the flanges if you are using the thicker silver/tin alloy wire gaskets.

   f. Leak check the new seal.

   g. After a settling time of 2 or 3 days, make 2 rounds to retighten the screws.

8-9-2-2 Installing Silver-Lead Gaskets

Refer to Step 2 of Section 8-9-2-1 to install silver-lead gaskets.

8-9-2-3 Installing Helicoflex Metal Gaskets

The only flange in the leak detector using a helicoflex gasket (Part No. 230-05-105) is in valve V2 (see Figure 8-7 and 8-13). An O-ring (Part No. 239-50-146) can be used in place of this helicoflex gasket. However, O-rings can absorb and later release helium causing a high background leak rate. O-rings are not as vacuum tight as metal gaskets. Helicoflex gaskets can be used only once; they can not be reused.

Install the helicoflex metal gasket as follows:

1. Rinse the gasket with methanol to remove any oil or dust (see Figure 8-13).

2. Insert the gasket into its groove in the valve block (see Figure 8-7).

3. Insert the valve V2 assembly in place.

4. Install the four hex nuts finger-tight (see Figure 8-7).

5. Evenly tighten the hex nuts about a quarter turn every pass until all nuts are tight.

8-10 PI AND PII PRESSURE GAUGES (THERMOVAC TR 201)

If the PI or PII pressure gauge is malfunctioning, first try calibrating the TR201 gauge (see Section 8-10-1). If you can not calibrate the gauge, proceed to Section 8-10-2 to isolate the source of the problem.

8-10-1 Calibrating the TR201 Pressure Gauges

1. Calibrate the PI pressure gauge as follows:

   a. When the ULTRATEST is operating, press the VENT pushbutton and hold it down for 2 seconds (see Figure 8-12).

   b. Turn the range selector on the FB module to PI (see Figure 8-12).

   c. Set the 100% potentiometer on the TR201 gauge tube of PI to 10^{-3} mbar (see Figure 8-15 and 8-16).

   d. Press the "PUMP" pushbutton and wait for the READY lamp to light with a steady glow (see Figure 8-12).

   e. Turn the range switch to PIII and wait until the pressure reading is less than 10^{-5} mbar.

   f. Turn the range switch back to PI and set the "0" potentiometer on the PI gauge head so that the needle is on the 10^{-3} position on the PI scale of the meter (see Figures 8-15 and 8-16).

   g. Repeat Steps 1a and 1b and recheck the 100% adjustment. Use Step 1c to correct any deviation.

   h. If you corrected the 100% adjustment in Step g, repeat Steps d through f to readjust the 0 potentiometer.

2. NOTE: It is not neceassry to adjust the 100% potentiometer on the PII gauge because the mass spectrometer never reaches atmospheric pressure during operation.

Calibrate the PII pressure gauge as follows:

a. Turn the range switch to PIII and wait until the pressure reading is less than 10^{-5} mbar (see Figure 8-12).

b. Turn the range switch to PII and set the "0" potentiometer on the PII gauge head so that the needle is on the 10^{-3} position on the PII scale of the meter (see Figure 8-15 and 8-16).

8-10-2 Isolating the Source of the TR201 Gauge Problem

If you could not calibrate the PI or PII gauge in Section 8-10-1, proceed as follows to check out the malfunctioning gauge.

1. NOTE: See Step 2 if you are having problems with PII.

If PI is malfunctioning, proceed as follows:

a. Ensure that pressure PIII is less than 10^{-5} mbar.

b. Remove the plugs from the top of the PI and PII gauge heads.

c. Connect the PI plug onto the PII gauge head (see Figure 8-15).

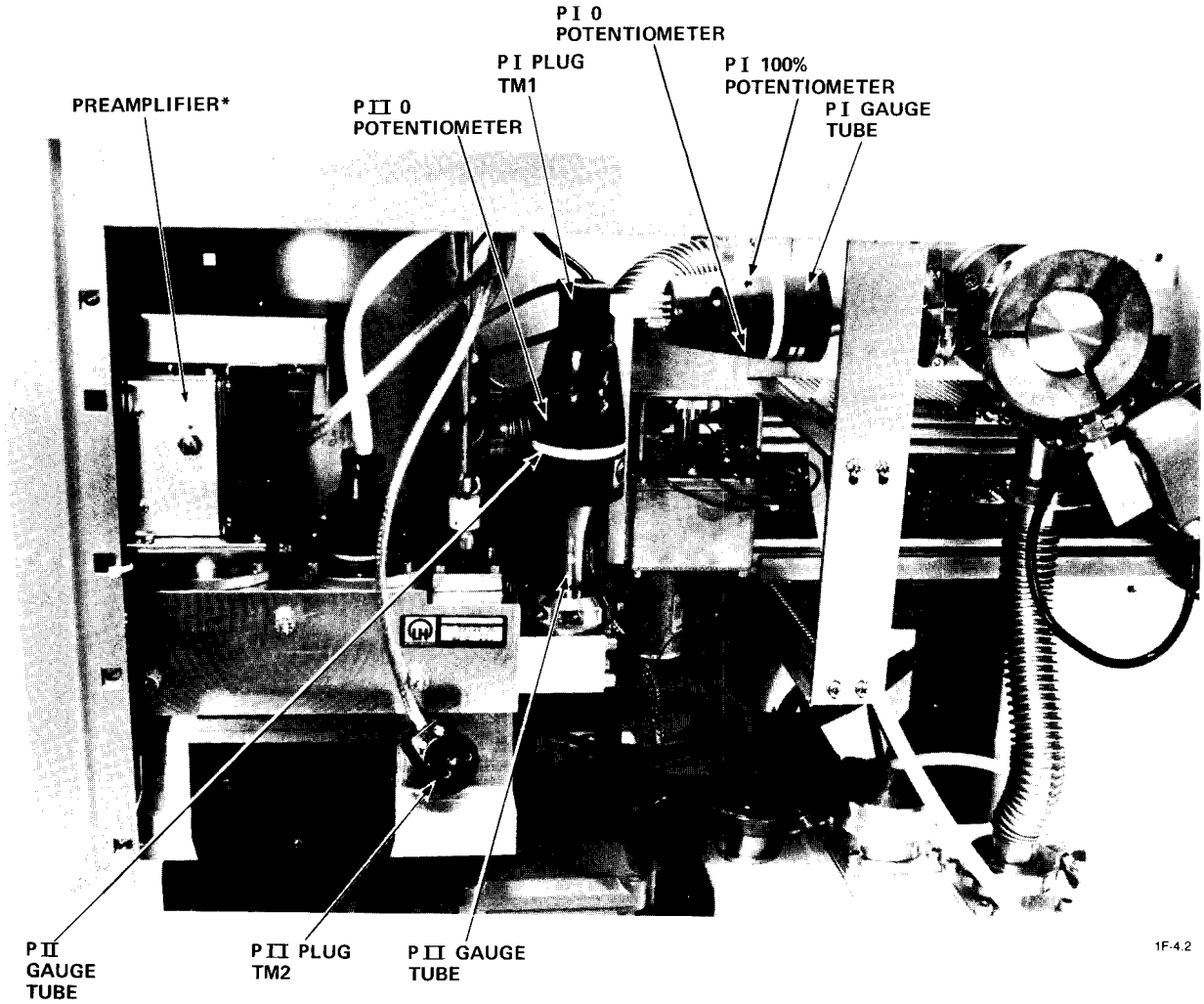
d. Turn the range switch to PI and try to set the 0 potentiometer on the PII gauge head so that the needle is on the 10^{-3} position on the PI scale of the FB module meter (see Figures 8-15 and 8-16).

e. If you can not set the needle to 10^{-3} in Step d, it means that the problem is in the electronics (see Section 8-12-6). If you can set the needle to 10^{-3} in Step d, it means the problem is in the PI gauge tube (see Section 8-10-3).

f. If the PI 100% potentiometer could not be set correctly in Section 8-10-1, proceed as follows:

(1) Refer to Section 4-6-3 to shutdown the ULTRATEST.

(2) After the backing pump and fans shut off, open handwheel valves V4 and V5.



* THERE ARE TWO VERSIONS OF THE PREAMPLIFIER. SEE FIGURE 8-4 FOR A PHOTOGRAPH OF THE OTHER VERSION.

Figure 8-15 - PI Plug Installed on the PII Gauge Tube to Troubleshoot the Gauges

Section 8-10-2, Step 1f continued

(3) Remove the PII gauge tube from the mass spectrometer to vent the mass spectrometer(see Figure 8-15).

(4) Close handwheel valve V5.

(5) Reconnect the PII gauge tube (see Section 8-9-1).

(6) Turn ON the ULTRATEST and set the range selector to PI.

(7) Try to set the 100% potentiometer on the PII gauge head so that the meter needle is on the 10^{3} position on PI/PII scale.

(8) If you can set the needle to 10^{3} in Step (7), the problem is in the electronics (see Section 8-12-6).

If you can not set the needle to 10^{3} in Step (7), the problem is in the PI gauge tube (see Section 8-10-3).

g. Be sure to connect plug TM1 to the PI gauge tube and plug TM2 to the PII gauge tube when reassembling the leak detector.

2. If PII is malfunctioning, proceed as follows:

a. Repeat Steps 1a through 1d of Section 8-10-2.

b. If you can not set the needle to 10^{-3} in Step 1d, it means that the problem is in the PII gauge tube (see Section 8-10-3).

If you can set the needle to 10^{-3} in Step 1d, the problem is in the electronics (see Section 8-12-5).

c. Be sure to connect plug TM2 to the PII gauge tube and plug TM1 to the PI gauge tube when reassembling the leak detector.

8-10-3 Cleaning the Malfunctioning Sensing Tube

NOTE: It is not necessary to remove the sensing tube from the gauge head to clean it.

Proceed as follows to clean the sensing tube (see Figure 8-16).

1. Remove the malfunctioning gauge tube from the leak detector.

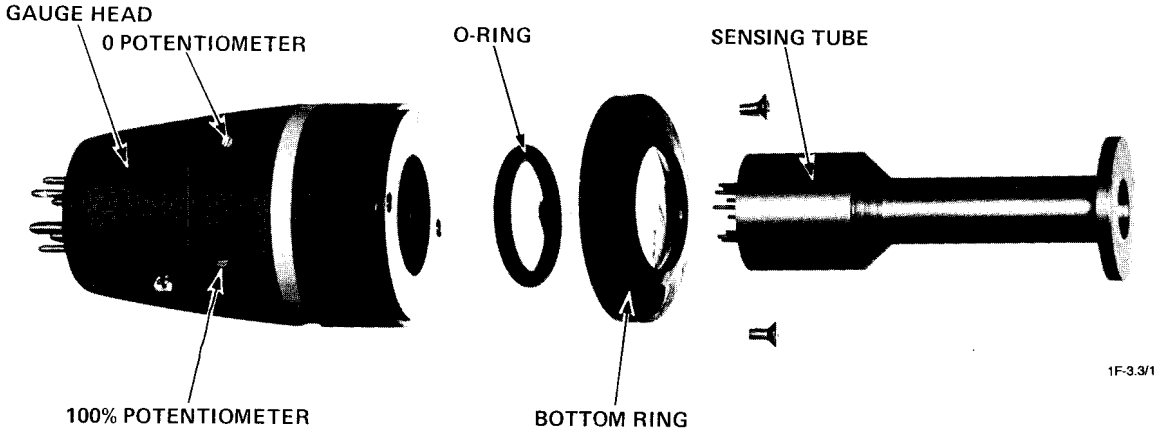


Figure 8-16 - Disassembled TR201 Gauge Tube (PI and PII)

2. CAUTION: DO NOT SHAKE THE SENSING TUBE OR CLEAN IT MECHANICALLY. SHAKING OR BRUSHING THE SENSING TUBE WILL DAMAGE THE SENSING FILAMENT.

   CAUTION: DO NOT USE FREON.

   Using a syringe, carefully fill the sensing tube with an organic solvent (acetone, ether, carbon tetrachloride, etc.).

3. After a few minutes drain the solvent from the tube and then rinse the tube with methanol.

4. Repeat Steps 2 and 3.

5. Dry and evacuate the sensing tube to ensure that is is free of residual solvent.

6. Reinstall the gauge tube into the leak detector.

7. Start the ULTRATEST and allow it to run for 30 to 60 minutes with the READY lamp lit to clean up any outgassing.

8. Refer to Section 8-10-1 to calibrate the gauge.

9. If cleaning did not remedy the problem, refer to Section 8-10-4 to change the sensing tube.

8-10-4 Replacing the Sensing Tube

Proceed as follows to install a new sensing tube (see Figure 8-16).

1. Remove the gauge tube from the leak detector.

2. Remove the two screws attaching the black bottom ring to the blue gauge head.

3. CAUTION: DO NOT TWIST THE SENSING TUBE WHEN UNPLUGGING IT FROM THE GAUGE HEAD.

   Pull the old sensing tube straight out from its base in the gauge head.

4. Plug the new sensing tube with O-ring into the gauge head and reinstall the bottom ring.

5. Reinstall the gauge tube into the leak detector and calibrate the gauge using the instructions in Section 8-10-1.

8-10-5 Adjusting the Electronics for the TR201 Gauges

NOTE: The T200 is a gauge test tube which is used for testing and calibrating gauge control units, gauge cables, and simulation of the entire measuring range. It is available under part number 15708.

Step 1 is for the PII gauge and Step 2 is for the PI gauge.

1. Proceed as follows to check the PII meter display and trigger setting.

   a. Replace the PII gauge head with the optional T200 gauge test tube and turn the range switch on FB module to PII .

   b. WARNING: USE STANDARD PRECAUTIONS WHEN WORKING ON THE MS MODULE ELECTRONICS. BE PARTICULARLY CAREFUL OF THE TRANSFORMER (220VAC) AND THE LP2 BOARD (460VDC).

      Pull the MS module out of the leak detector and remove the cover grill from the top of the module. Do not disconnect Plug A from the back of the MS module (See Figure 8-18).

   c. Start the ULTRATEST (see Section 4-2) and turn the range switch to PII.

   d. Check the PII meter display as follows:

      (1) Turn the knob on the T200 fully clockwise. If the meter does not read 10^{-3}, adjust trimmer potentiometer P305 (see Figure F-LP3) until the meter reads 10^{-3}.

      (2) Turn the T200 knob fully counterclockwise. If the meter does not read 10^{-3} mbar, adjust trimmer potentiometer P304 (see Figure 8-17) until the meter reads 10^{-3}.

   e. Check the PII setting for emission shut-off as follows:

      (1) Set PII to less than 10^{-2} mbar by turning the knob on the T200.

      (2) Check the voltage between pins 29 (+) and 30 (-) on LP3 (see Figure F-LP3). The voltage should be approximately 21V.

Section 8-10-5, Step 1e continued

(3) NOTE: You should be able to hear the relay click when the voltage drops from 21 to 0 V.

Turn the T200 knob so that PII is greater than 10^{-2} mbar. The voltage between pin 29 and 30 should drop to 0 when PII exceeds 10^{-2}. If necessary, adjust P306 (see Figure 8-17) until the switching point from 21V to 0V is at 10^{-2} mbar.

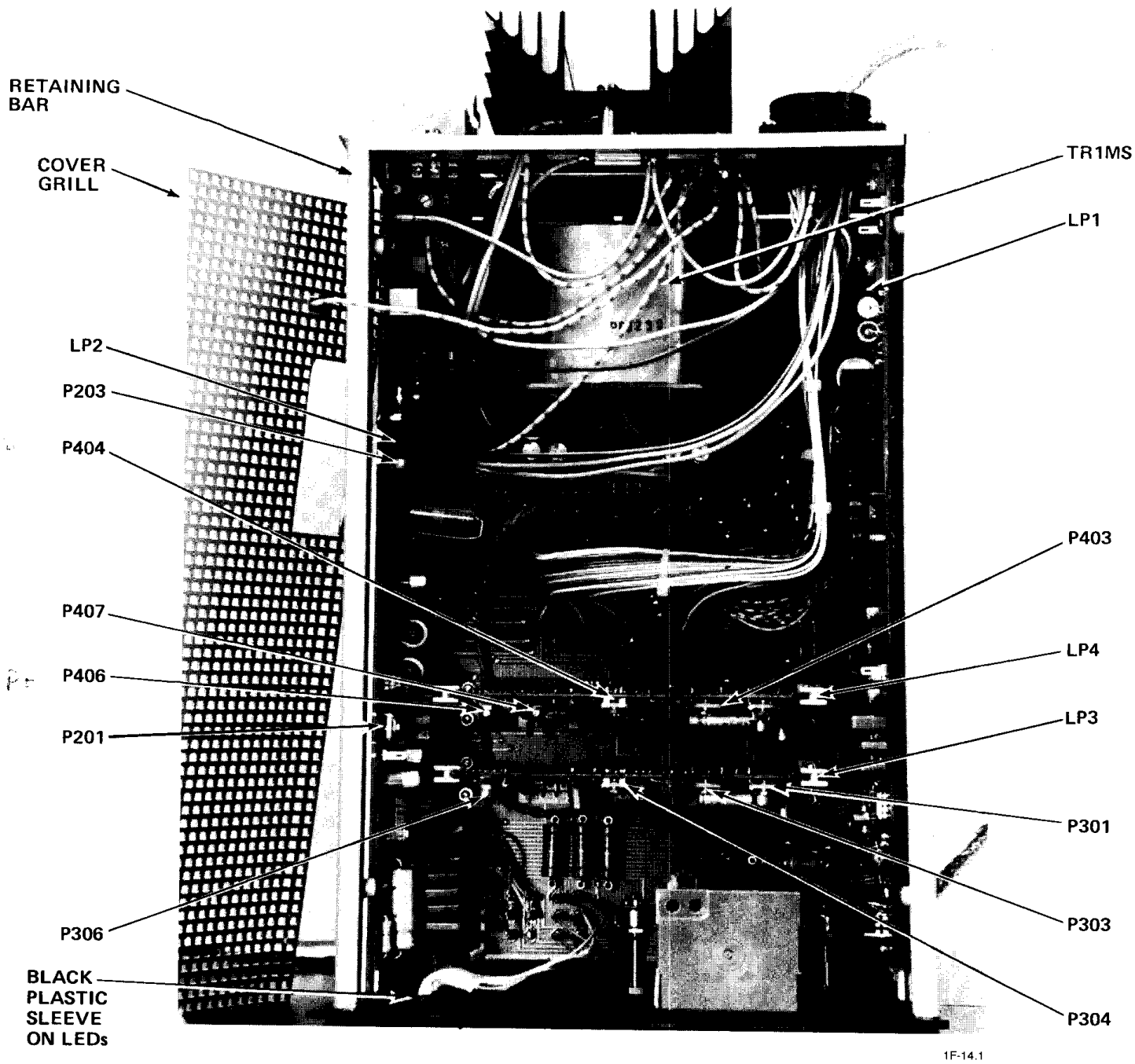


Figure 8-17 - Top of MS Module Showing the PC Boards

2. Proceed as follows to check the PI meter display and trigger settings.

   a. Replace the PI gauge head with the optional T200 gauge test tube and turn the range switch to PI.

   b. Repeat Steps 1b and 1c.

   c. Check the PI meter display by turning the knob on the T200 fully clockwise. If the meter does not read 10^{3}, adjust trimmer potentiometer P405 (see Figure F-LP4) until the meter reads 10^{3}.

   d. Turn the T200 knob fully counterclockwise. If the meter does not read 10^{-3} mbar, adjust trimmer potentiometer P404 (see Figure 8-17) until the meter reads 10^{-3} mbar.

   e. Check the PI 1 mbar trigger as follows:

      (1) Set the PI pressure at greater than 1 mbar using the optional T200 gauge test tube.

      (2) Check the voltage between pins 27 (+) and 30 (-) of LP4. It should be 0V (see Figure F-LP4).

      (3) NOTE: You should be able to hear the relay click when the voltage jumps from 0 to 22 volts.

      Turn the T200 knob to move the pressure indicator from higher to lower pressure. The indicated voltage between pins 27 and 30 should jump to 22V at 1 mbar.

      (4) Correct the trigger point as necessary using potentiometer P406 (see Figure 8-17).

   f. Refer to Step e to check the PI 10^{-2} mbar trigger. The indicated voltage between pins 27 and 30 should jump from 0 to 22V at 3 x 10^{-2} mbar. If not, use potentiometer P407 to correct the trigger setting (see Figure 8-17).

8-11 KEY TO PRINTED CIRCUIT (PC) BOARDS

The replaceable Printed Circuit boards (PC boards) are referred to by various names and numbers as listed in Table 8-2. In this manual the PC boards are always referred to by the short designation, such as LP1.

TABLE 8-2 - PC BOARD FUNCTION, DESIGNATION, AND PART NUMBER

Function	Short Desgination	Part No. +++	Module Unit	Board Component Location-Drawing
DC power supply for +15V,-15V, -24V, +24 and -120V; total pressure amplifier "PIII" emission safety cut-out circuit, first part of emission ON-OFF circuit.	LP1	400-78-163	MS*	F-LP1
Emission current regulation, cathode heating, anode voltage, anode heating, acceleration and deflection voltage supply, second part of emission ON-OFF circuit	LP2	400-78-138	MS*	F-LP2
Total pressure measurement "PII" guage head supplies, signal amplifier, and level trigger for emission current safety cut-out.	LP3	400-78-140	MS*	F-LP3
PI pressure measurement, gauge head supplies, signal amplifier, trigger circuit 1 mbar for automatic partial flow start, and trigger circuit inlet pressure.	LP4	400-78-139	MS*	F-LP4
Main amplifier (leak-rate signal), voltage divider network for range switching, generation of the digital exponent display, generation of the step voltage for range recognition, generation of the acoustic leak-rate signal.	LP6	701-50-169	FB+	F-LP6
Trigger 1 (zero monitor) and 2 (leak rate monitor) with relay contacts and LED displays (see Appendix B).	LP7	400-78-143	FB+	F-LP7
Digital display of the leak-rate decade range.	LP8	400-78-159	FB+	F-LP8
15V and 220V power supply; control logic for automatic valve operation and automatic partial flow system using digital circuitry; gear motor control.	LP9	400-78-145	EL++	F-LP9
Relay circuit for pump power supply and mass spectrometer unit; power supply for relays; polarity safety circuit (3-phase supply).	LP10	400-78-144	EL++	F-LP10
Power unit for the power supply to the valve V2 control gear motor, relay with transistor energizing circuit for the PUMP and VENT pushbuttons.	LP11	400-78-158	**	F-LP11
Physical support and interconnections for the components that attach to the board (see Figure 9-1)	EL Motherboard	400-76-555	EL++	F-EL

* See Figure 8-17 for the location of this PC board.
\+ See Figure 8-19 for the location of this PC board.
** See Figure 8-3C for the location of this PC board.
++See Figure 8-20 for the location of this PC board.
+++ Do not use the part number printed on the board for ordering; in most cases, the number on the board is for a bare board without components.

8-12 MS MODULE

NOTE: See Schematic MS in the back of this binder for the electrical schematics for the MS module.

The 1.25 amp (top) fuse (Si1) on the back of the MS module is to the primary of transformer TR1MS. If this fuse fails the PII and leak rate exponent display on the FB module will not be available. The 6.3 amp (bottom) fuse (Si2MS) in the collector supply voltage circuit is for the T254 transistor on the heat sink (see Figure 9-6). The T254 transistor powers the cathode power supply. If the emission does not come on, check this 6.3 amp fuse and T254.

8-12-1 Replacing the PC Boards in the MS Module

NOTE: See Appendix F for the board component location drawing for each PC board and for the electrical schematics.

WARNING: DISCONNECT PLUG "A" FROM THE REAR OF THE MS MODULE BEFORE REMOVING OR INSTALLING THE PC BOARDS. PC BOARDS LP1 AND LP2 HAVE HIGH DC VOLTAGES (SEE FIGURES 8-17 AND 8-18).

Proceed as follows to replace a PC board in the MS module (see Figure 8-17).

1. Remove the MS module from the leak detector as follows:

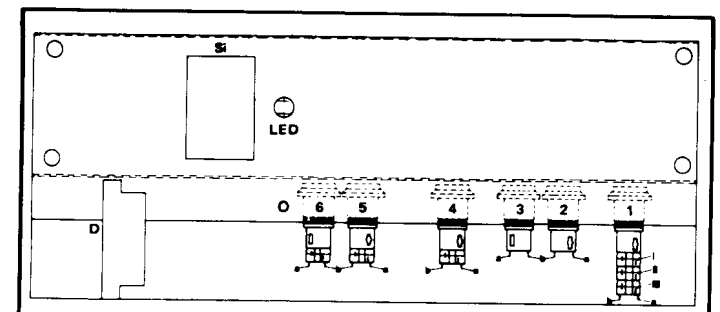
   a. Unplug the A, B, and C plugs from the back of the MS module (see Figure 8-18).

   b. Disconnect the plug from the end of the cable that leads from the back of the MS module. This plug is located at the back of the leak detector near the bottom.

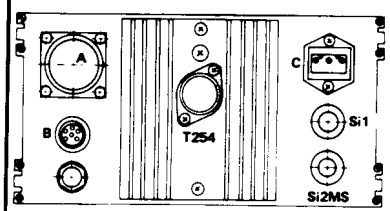
   c. Remove the four small outside screws from the front of the MS module (see Figure 8-12).

   d. Pull the MS module out of the leak detector.

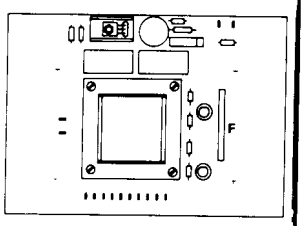
2. Loosen one of the top retaining bars on the MS module by removing the phillips screw from one of the top corners of the front panel and removing the two slotted screws from the corresponding top corner on the rear panel. The retaining bar remains fixed to the PC board but you can pull the retaining bar outward slightly to remove the cover grill (see Figure 8-17).



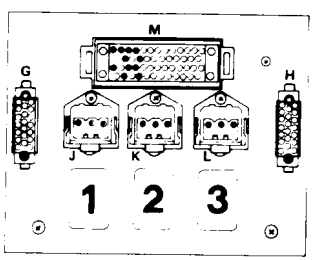
Back of Pushbutton Control Panel



Back of MS Module

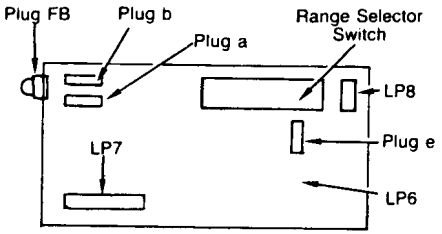


LP 11

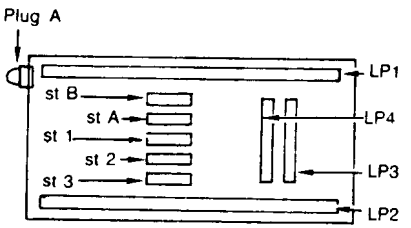


Back of EL Module

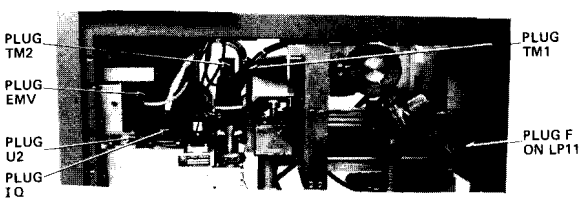
View of leak detector looking toward back of the front panels



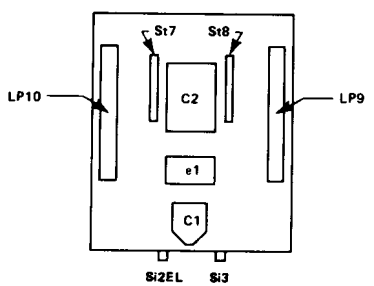
FB Module (Top View)



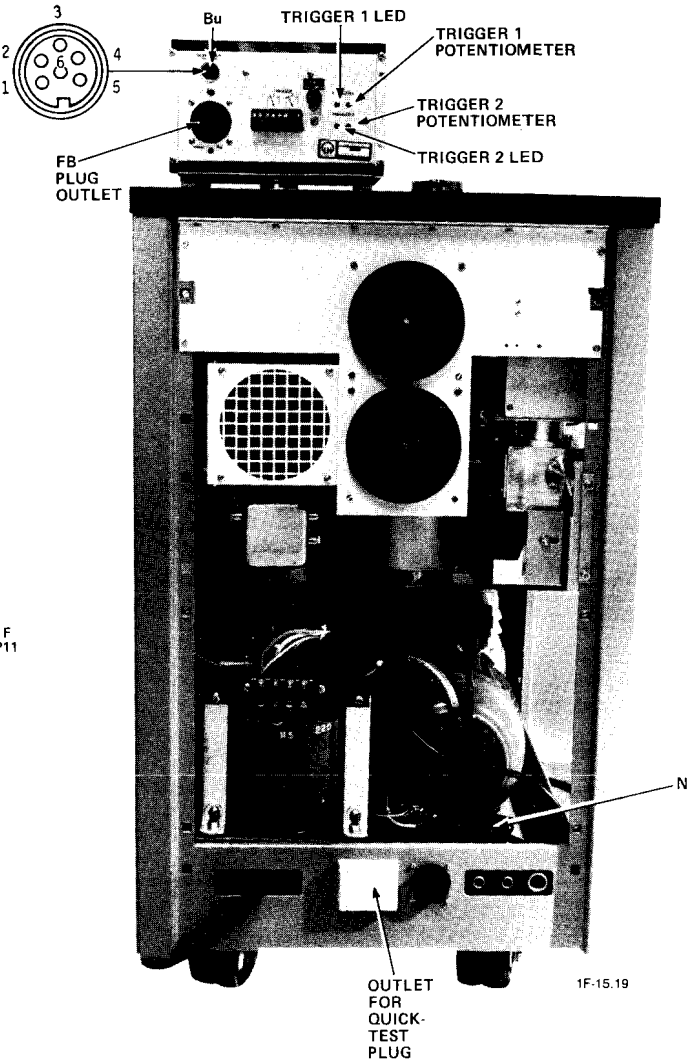
MS Module (Top View)



Left side of leak detector 1F-10.0A



Front of EL Module (see Figure 8-20)



Rear of leak detector

1F-5.12

NOTE: See Figures F-LP1 through F-EL for the location of all the pins and tabs.

Figure 8-18 - Plug and PC Board Locations for the ULTRATEST F

3. Remove the cover grill from the top of the MS module after disconnecting the ground (green/yellow) lead. (See Figure 8-17).

4. Remove the malfunctioning PC board. To remove boards LP1 and LP2, first remove the screws attaching them to the retaining bar.

5. Install the new board and reassemble the MS module.

6. When reinstalling the MS module, ensure that the gray cord that comes from the back of the module is installed so that it can not touch the hot base of the diffusion pump (see Figure 8-3B).

8-12-2 Replacing the Light Emitting Diodes (LEDs) in the MS Module

Proceed as follows to replace the "DIFF 190^{o}C", "EMISSION", or "KATODE" LED on the MS module.

1. Repeat Steps 1, 2, and 3 of Section 8-12-1.

2. Pull the black plastic sleeve from around the back of the LED on the back side of the MS-module front plate (see Figure 8-17).

3. Pull the LED out of its hole and detach the LED from the wires.

4. Solder a new LED onto the wires and reinstall the LED and sleeve.

8-12-3 Printed Circuit Board LP1

8-12-3-1 Function - LP1 provides the DC power supply for +15V, -15V, -24V, +24V, and -120V; it also contains the total pressure amplifier "PIII" emission safety cut-out circuit and the first part of the emission ON-OFF circuit.

8-12-4 Printed Circuit Board LP2

8-12-4-1 Function - LP2 regulates the emission current, contains the second half of the emission ON-OFF circuit, and supplies the voltage for cathode heating, anode heating, the anode, and acceleration and deflection.

8-12-4-2 Checking the Accelerating Voltage "U1".

NOTE: See Table 8-3 for the correct voltages for each position of the mass switch.

Check the accelerating voltage as follows:

1. Set mass switch to 4 (see Table 8-3).

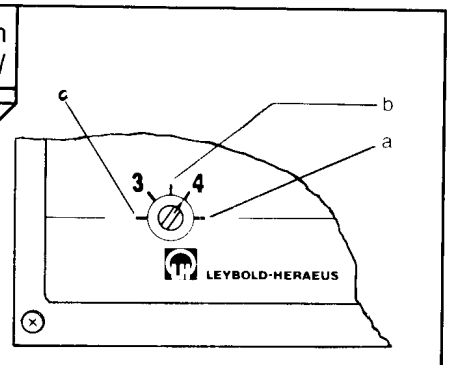
2. Turn slotted potentiometer, "U_1" and "U_2" fully clockwise (see Figure 8-12).

3. Connect the test prods between point B and 0V on LP1 (see Figure F-LP1).

4. In case of deviation, correct the trimmer potentiometer P203 to approximately +90VDC (see Figure F-LP2). If the "U1" peak can not be adjusted (see Section 4-3, Step 7a and Figure 8-17), clean the mass spectrometer (see Section 8-3).

TABLE 8-3 - CORRECT VOLTAGES FOR THE MASS SWITCH

Switch setting	Pot. "U_1" setting	Voltage between point B and 0 V
a	clockwise	70V
a	counterclockwise	106V
4	clockwise	90V
4	counterclockwise	134V
b	clockwise	108V
b	counterclockwise	164V
3	clockwise	148V
3	counterclockwise	225V
c	clockwise	174
c	counterclockwise	260V



MS Module Mass Switch (see Fig. 8-20)

8-12-4-3 Checking the Deflection Voltage "U2".

Check the U_2 voltage as follows:

1. Ensure that the U1 and U2 potentiometers are turned fully clockwise and that the mass switch is set to 4 (see TABLE 8-3 and Figure 8-20).

2. Place the test prods between studs A(+) and B(-) (see Figures 8-17 and F-LP2).

3. NOTE: P201 is a single turn potentiometer.

   Adjust P201 to +120V (see Figure F-LP2).

8-12-4-4 Cathode Voltage

The cathode voltage is 11V.

8-12-5 Printed Circuit Board LP3 (see Figure F-LP3)

8-12-5-1 Function - PII pressure measurement gauge head supplies signal amplifier, and level trigger for emission current safety cutout.

8-12-5-2 Checking 13.0V Supply - Connect the test prods between pin 31 (+) and pin 30 (-). In case of deviation, set trimmer potentiometer P301 to 13.0 volts.

8-12-5-3 Checking the -3.5V Supply - Connect the test prods between pin 30 (+) and the plug end of resistor R307 (2.7 kohms); the correct valve is -3.5V.

8-12-5-4 Checking the Offset Voltage of IC 302 - Check the IC 302 offset voltage as follows (see Figure F-LP3).

1. Ensure that trimmer potentiometer P303 (cable length compensation) is set fully clockwise.
2. Connect the test prods between pins 2 and 3 of IC 302 (MA 741).
3. Using a high-resistance voltmeter, check the voltage.
4. In case of deviation, correct trimmer potentiometer P302 to 2 mV.

8-12-5-5 Checking the PII Meter Display and Trigger Setting

Refer to Section 8-10-5 to check the PII meter display and the emission shut-off trigger.

8-12-6 Printed Circuit Board LP4 (See Figure F-LP4)

8-12-6-1 Function - PI pressure measurement, gauge head supplies, signal amplifier, trigger circuit 1 mbar for automatic partial flow start, and trigger circuit inlet pressure.

8-12-6-2 Checking the 13.0V supply - Connect the test prods between pins 31 (+) and pin 30 (-). In case of deviation, set trimmer potentiometer P404 to 13 volts (see Figure F-LP4).

8-12-6-3 Checking the -3.5V Supply - Connect the test prods between pin 30 and the end of resistor R407 which points downward; the correct voltage is -3.5 volts.

8-12-6-4 Checking the Offset Voltage of IC 402 - Check the IC 402 offset voltage as follows (see Figure F-LP4).

1. Ensure that trimmer potentiometer P 403 (cable length compensation) is set fully clockwise.

2. Connect the test prods between pins 2 and 3 of IC 402 (MA 741).

3. Using a high-resistance voltmeter, check the voltage.

4. In case of deviation, correct trimmer potentiometer P402 to 2mV.

8-12-6-5 Checking the PI Meter Display and Trigger Settings

Refer to Section 8-10-5, Step 2 to check the PI meter display and the 1 mbar and 10^{-2} mbar triggers.

8-13 FB MODULE (Remote Control Unit)

NOTE: See Appendix F for the schematic and the board component location drawings. See Appendix E if your ULTRATEST F is the US autoranging version.

8-13-1 Replacing the PC Boards in the FB Module

Proceed as follows to replace a PC board (see Figure 8-19).

1. Unplug the connecting cable (FB plug) from the rear of the FB module (see Figure 8-18).

2. Remove the top and bottom slotted screws attaching each side panel to the back of the FB module (see Figure 8-18).

3. Pull the side panels out of the FB module (see Figure 8-19).

4. Slide the top cover off of the FB module.

5. To remove LP8, remove the plug e from LP6 and the two phillips screws securing LP8 to the front cover. (see Figure 8-19).

6. LP6 has extensive internal connections. Use the electrical schematic in Appendix F and note the location of each plug and wire before removing LP6.

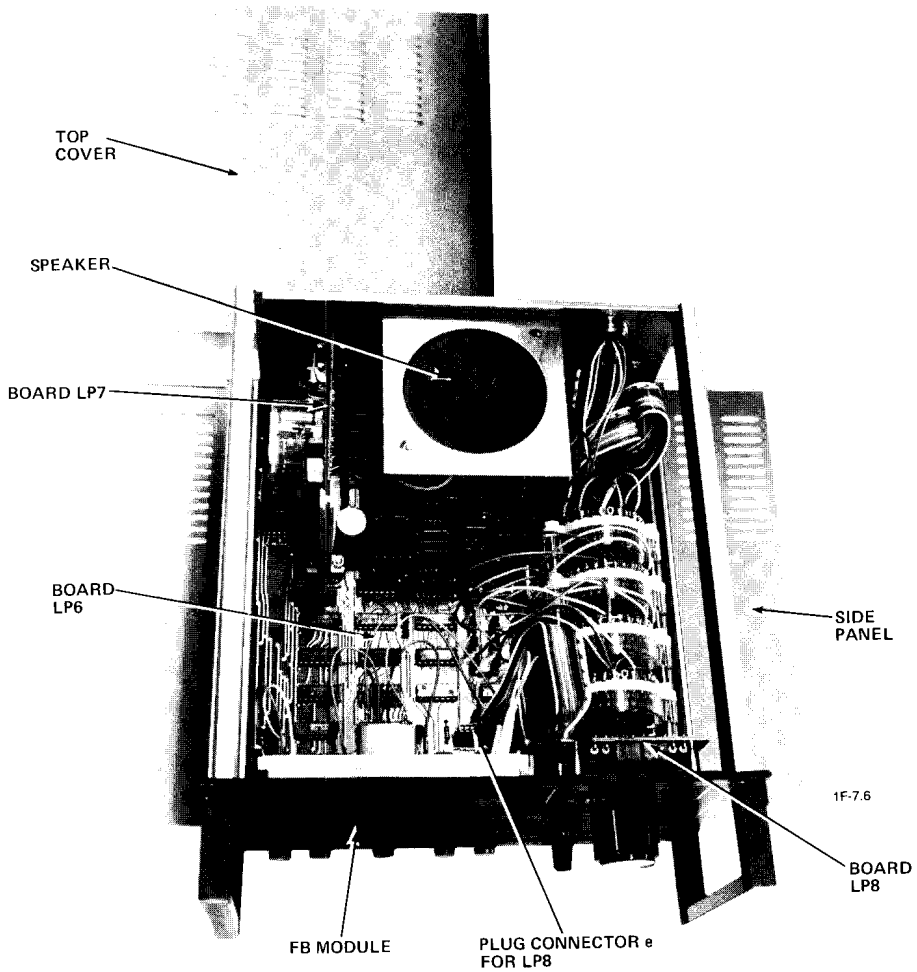


Figure 8-19 - Top of FB Module Showing PC Boards

8-13-2 Replacing the EMISSION LED and the READY Bulb in the FB Module

Proceed as follows to replace the LED and bulb:

1. Do Steps 1,2,3, and 4 of Section 8-13-1.

2. Do Steps 2,3, and 4 of Section 8-12-2 except replace the EMISSION LED in the FB module front cover.

3. Proceed as follows to replace the READY lamp (see Figure 8-12).

   a. Pry the translucent yellow cap off of the front cover of the FB module.

   b. Using shrink tubing or tygon, pull the bulb straight out of its socket.

   c. Install a new bulb and reinstall the yellow cap.

8-13-3 Printed Circuit Board LP6

8-13-3-1 Function - Main amplifier (leak rate signal), voltage divider network for range switching, and generation of the digital exponent display, the step voltage for range recognition, and the acoustic leak rate signal.

8-13-3-2 Checking the Threshold for the Acoustic Signal

1. Set the range switch to 10 x 10^{-9} range.

2. Using the ZERO knob begin increasing the leak-rate signal on the FB module meter. As the needle passes 1 on the 10 scale, you should hear the acoustic leak signal.

3. If the acoustic leak signal is not set properly, use trimmer potentiometer P603, to correct it (see Figure C -LP6).

8-13-3-3 Checking the Step Voltage

1. Connect your test prods to sockets 1(+) and 3 (-) on the recorder output socket Bu on the back of the FB module (see Figures 8-18).

2. Turn the range switch from one leak rate position to another while reading the voltage. The voltage should increase by one volt steps as you change the range.

3. If necessary, use trimmer potentiometer P651 to correct (see Figure F-LP6).

8-13-3-4 Checking the Recorder Output

1. Connect the test prods to sockets 5 (+) and 3 (-) on the recorder output socket Bu on the back of the FB module (see Figure 8-18).

2. Set the range switch to 10 x 10^{-9} at full scale.

3. Use the ZERO knob to set the leak-rate meter to 10 (full scale).

4. Check that 10 V is displayed on the test voltmeter.

8-13-4 Printed Circuit Board LP7

8-13-4-1 Function - Trigger 1 (zero monitor) with relay contacts and LED display; trigger 2 (leak rate monitor) with relay contacts and LED display.

8-13-4-2 Checking Power Supply Voltages

The following are the correct voltages for the LP7 board (see Figure F-LP7).

Test Prods on (+)	(-)	Correct Reading	Supplied To
Pin 6	Pin 3	18 V	Relay
Pin 5	Pin 3	15 V	IC's
Pin 4	Pin 3	-15 V	IC's

Refer to the instructions in Appendix B-2 to set trigger 1 (P701) and trigger 2 (P703). You can vary the width of the trigger 1 "switching window" (hysteresis) using trimmer potentiometer P702 (See Figure F-LP7).

8-13-5 Printed Circuit Board LP8

LP8 displays the leak-rate decade range.

If one of the digits fails, replace the malfunctioning digit; if necessary replace PC board LP8 (see Figures 8-19 and F-LP8). If both of the digits are not functioning, the fault lies in PC boards LP 6 (see Figure 8-19 and F-LP6).

8-14 PREAMPLIFIER AND COLLECTOR

The preamplifier is a highly sensitive electrometer circuit which amplifies leak-rate signals as small as 10^{-13} amp (see Figure 8-15).

Do not open the preamplifier or collector housing or attempt to repair these units. Opening the housing results in degradation from dust and moisture. Specialized equipment and techniques are required to repair the units.

Do not use contact or similar sprays near the preamplifier and ion source feedthrough.

There are two versions of the preamplifier and collector. The version shown in Figure 9-7 provides a sensitivity of 2×10^{-11} or 2×10^{-9} atm.cc/sec depending on the position of its changeover switch. The version shown in Figure 9-8 provides a sensitivity of 2×10^{-10} atm.cc/sec. The preamp (P/N 330-25-144) and collector (P/N 590-29-111) shown in Figure 9-8 are interchangeable with the preamp (P/N 330-25-133) and collector (P/N 590-59-107) shown in Figure 9-7. However, if you replace one of these parts, you must replace both parts because the interconnections between the different styles are incompatible.

8-15 FRONT PANEL CONTROLS

See Appendix F for the electrical schematic.

8-15-1 Replacing Bulbs in the Front Panel

Proceed as follows to replace bulb(s) (Part No. 530-31-246) in the illuminated pushbuttons (see Figure 9-1).

1. Use a blunt screwdriver to pry the colored cap(s) off of the pushbutton(s).

2. Use a piece of insulation or shrink tubing (tygon) to carefully pull the small bulb straight out of its socket.

3. Insert a new bulb into the socket ensuring that the contacts are oriented correctly.

8-15-2 Replacing the Pushbutton(s) or Indicator Lamp(s) in the Front Panel

Replace a defective pushbutton or lamp as follows (see Figure 8-1).

1. Unscrew the plastic nut (behind the front panel) from the rear of the lamp or pushbutton .

2. Pull the lamp or pushbutton out of the front of the leak detector so that you can work on it.

3. Break the soldered connections to the lamp or switch.

4. Solder a new lamp or switch to the appropriate wires and reinstall it into the leak detector.

8-15-3 Printed Circuit board LP11

PC board LP11 is the power unit for the power supply to the control motor for valve V2. It also includes a relay with transistor energizing circuit for the PUMP and VENT pushbuttons.

It is located behind the small front panel beside the MS module (see Figures 9-1 and 8-3C). To remove LP11, first unplug the three connectors from the board, then remove the four small retaining screws that hold the small panel to the leak detector. Remove the screws holding LP11 to the small panel.

8-16 EL MODULE

WARNING: DO NOT TOUCH THE EL MODULE UNLESS THE POWER SUPPLY TO THE LEAK DETECTOR HAS BEEN UNPLUGGED. SWITCH OFF THE ULTRATEST AND WAIT UNTIL THE BACKING PUMP AND ALL FANS AUTOMATICALLY STOP BEFORE DISCONNECTING THE POWER PLUG.

8-16-1 Description

The electrics (EL) module contains PC boards LP9 and LP10, contactor C1 and C2, thermal overload e1, and fuses Si2EL and Si3 (See Figure 8-20). Fuses Si2EL and Si3 protect LP9 and LP10 and the valve block wiring.

When the ON/OFF pushbutton is pressed, contactor C1 and relays d1 and d4* on LP10 energize. Contactor C1 starts the backing pump, the diffusion pump fan, and establishes nominal +24VD/C power through transformer TR10 and diode bridge GL1 on LP10 as long as the normally closed thermal switch at the backing pump motor is closed. Thermal overload e1 opens the roughing pump circuit and protects contactor C1 if the current exceeds the preset maximum.

Relay d1 supplies power to the diffusion pump heater, the hour counter, and the isolation transformer TR1MS. TR1MS supplies power for the FB and MS module electronics, and for the emission, deflection, acceleration voltages and anode and cathode heater supplies in the mass spectrometer.

When the diffusion pump reaches its operating temperature of 190C, a normally open thermal switch in the diffusion pump energizes relay d2 on LP10. Relay d2 lights the "DIFF 190°C" LED and clears an emission interlock. Relay d2 contacts pick up and send a +24 DC signal to the electronics.

When the RP (roughing pump) pushbutton is depressed, relay d5 on LP10 is energized which lights the RP light, sends a signal to the electronics and energizes contactor C2. Contactor C2 supplies power to the roughing pump motor.

Table 8-2 describes the function of LP9 and LP10. Appendix F has the board component location drawing and the electrical schematics.

When installing LP9 and LP10 into the EL unit, ensure that the transformer on both boards faces the bottom of the EL module (see Figure 8-20).

* For 3-phase power, relay d4 will not energize and the phase LED will light if the phase rotation sequence is other than A-B-C.

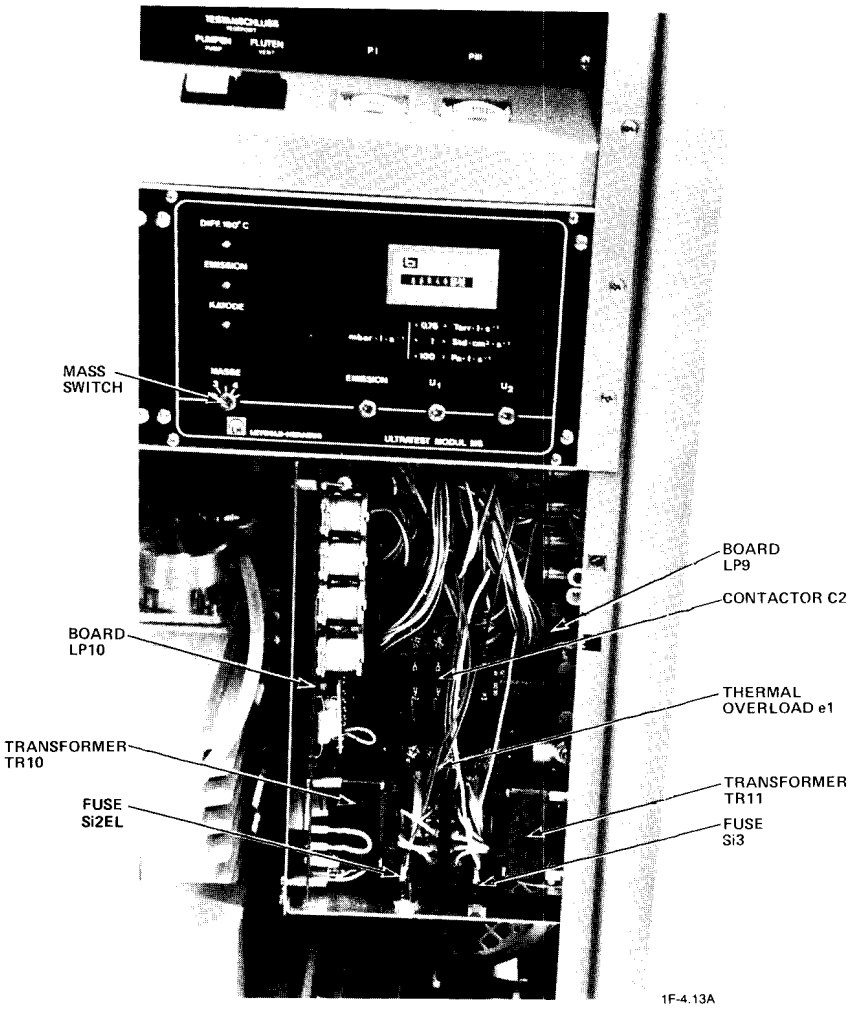


Figure 8-20 - Electrics (EL) Module Showing the Pc Boards and Major Components

8-16-2 Printed Circuit Board LP9

8-16-2-1 Function

15V and 220V power supply, control logic for automatic valve operation and automatic partial flow system using digital circuitry, gear motor control.

8-16-2-2 Checking the Operation of LP9

NOTE: The special extension board can also be used to check PC boards LP3, LP4, and LP10.

Use the special extension board (Part No. 400-76-244) on the 31-pole plug connector to check LP9 for faulty operation (see Figure F-LP9). Refer to the electrical schematic to check the input and output signals.

8-16-2-3 Replacing LP9

LP9 is aligned before it leaves the factory so that you do not need to adjust it after exchanging PC boards.

Remove the EL module from the leak detector before removing LP9. The EL module is attached to the orange frame of the leak dectector by four phillips screws.

8-16-3 Printed Circuit Board LP10

8-16-3-1 Function - Provide the relay circuit for the pump power supply and mass sepctrometer unit, power supply for relays and the polarity safety circuit (used if the roughing pump requires a 3-phase supply).

8-16-3-2 Checking the Operation of LP10

NOTE: The special extention board can also be used to check PC boards LP3, LP4, and LP9.

There are no adjustments to make on LP10. To check for faulty operation, use the special extension board (Part No. 400-76-244) to check the input and output voltage against the electrical schematic (see F-LP10).

SECTION 9

PARTS LIST

Table 9-1 "Recommended Spare Parts" lists items that you may want to keep on hand for routine repair of your ULTRATEST F. Figures 9-1 through 9-15 list part numbers for replacement parts.

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TABLE 9-1 - RECOMMENDED SPARE PARTS*

Item No.	Description	Location	Recommended Quantity	Part Number
A	Maintenance Kit+		1	99-077-071
B	Spare Parts Kit**		1	087-26-110
C	Oil for Standard Applications			
	o HE-200 Vane Pump Oil	See Section 6-2	1 gallon	98-198-007
	o HE-300 Diffusion Pump Oil	See Section 6-3	50cc	98-198-055
D	"READY" Lamp Bulb - 24v, 50mA	See Figure 4-3	2	530-31-246
E	Bulb for Illuminated Pushbuttons - 24v, 50mA	See Figure 4-1	6	530-31-246
F	Fuses Si2EL and Si3 (0.5A)	See Figure 8-20	2	520-25-312
G	Fuse Si1 (1.25A, 250V)	See Figure 9-6	2	520-25-316
H	Fuse Si2MS (6.3A, 250V)	See Figure 9-6	2	520-25-321
I	Set of 19 Silver/Tin Wire Seals	See Section 8-9-2-1	1	98-181-0029
J	Spool of Silver/Tin Alloy Wire for Fabricating Metal-Wire Gaskets	See Section 8-9-2-1	1 lb.	98-181-0027
K	Set of 11 Silver/Lead Wire Seals, Sealing Disks, and O-Rings	See Section 8-9	1	15570
L	Rebuild Kit for D4A Backing Pump	See manual in the	1	10167-K
M	Rebuild Kit for D16A Roughing Pump	back of this binder	1	10169-K
N	Ion Source	See Figure 8-4	1	16513
O	KF10/16 High Vacuum Sealing Disk (set of 3)	See Section 8-9-1	2	88373
P	KF32/40 High Vacuum Sealing Disk (set of 3)	See Section 8-9-1	2	88377
Q	Maintenance Kit* for Optional QUICK-TEST	See Figure A-10	1	99-077-074
R	PVC Tubing for Optional QUICK-TEST	See Figure A-10		99-262-2002

* See Section 2-2 for a list of spare parts that comes with the ULTRATEST.
+ Includes Items B,C,D,F,G,H,L,M, and N in addition to hardware and a recorder plug.
** Inclues Items D,F,G,H, and N in addition to a tool kit, an O-ring set, and the Helicoflex gasket.

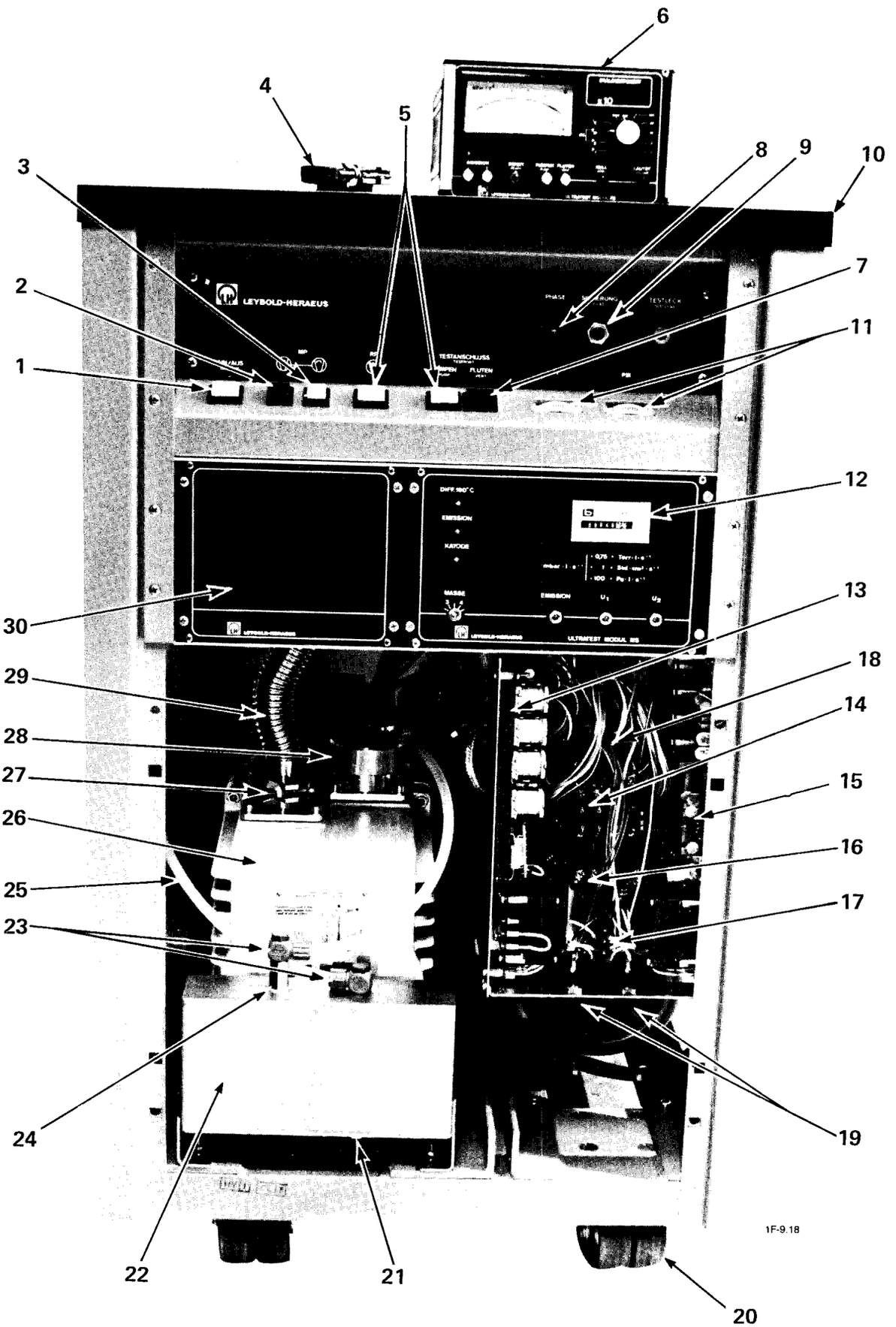

Figure 9-1 - Front of the ULTRATEST F

Figure 9-1 - Front of ULTRATEST F continued

Item No.	Description	Part No.	Remarks
1	ON/OFF Illuminated Pushbutton	570-10-453	White
	Bulb for Pushbutton	530-31-246	24V,50mA
2	MP Backing Pump Lamp	528-27-128	Green
	Bulb for Lamp	530-31-246	24V,50mA
3	MP Diffusion Pump Lamp	528-27-129	Yellow
	Bulb for Lamp	530-31-246	24V,50mA
4	Clamp Ring	18343	KF40
	Blind Flange	88438	KF40
	Centering Ring with Buna-N O-ring	183 28	KF40
	Test Port Flange	200-29-234	KF40
5	RP and PUMP Illuminated Pushbuttons	570-10-452	White
	Bulb for Pushbutton	530-31-246	24V,50mA
6	FB Module Complete	899415	
7	VENT Illuminated Pushbutton	570-10-451	Red
	Bulb for Pushbutton	530-31-246	24V,50mA
8	PHASE LED	510-43-131	MV 5021
9	Circuit Breaker	520-31-234	380V,6A
10	Table Top	443-52-125	
11	PI and PIII Meters	590-36-290	
12	MS Module, complete	330-25-148	See Fig. 9-4
13	Printed Circuit Board LP10	400-78-144	See Fig.F-LP10
14	Contactor C2	590-19-214	For rouging pump
15	Printed Circuit Board LP9	400-78-145	See Fig.F-LP9
16	Thermal Overload e1	590-22-307	
17	Contact Relay C1	590-19-207	3TG210D,220V
18	EL Motherboard (bare board without components)	400-76-555	
19	Fuses Si2EL and Si3	520-25-312	0.5A
	Fuse Holders	528-28-103	
	Fuse Caps	528-28-104	
20	Caster Wheel	251-62-202	

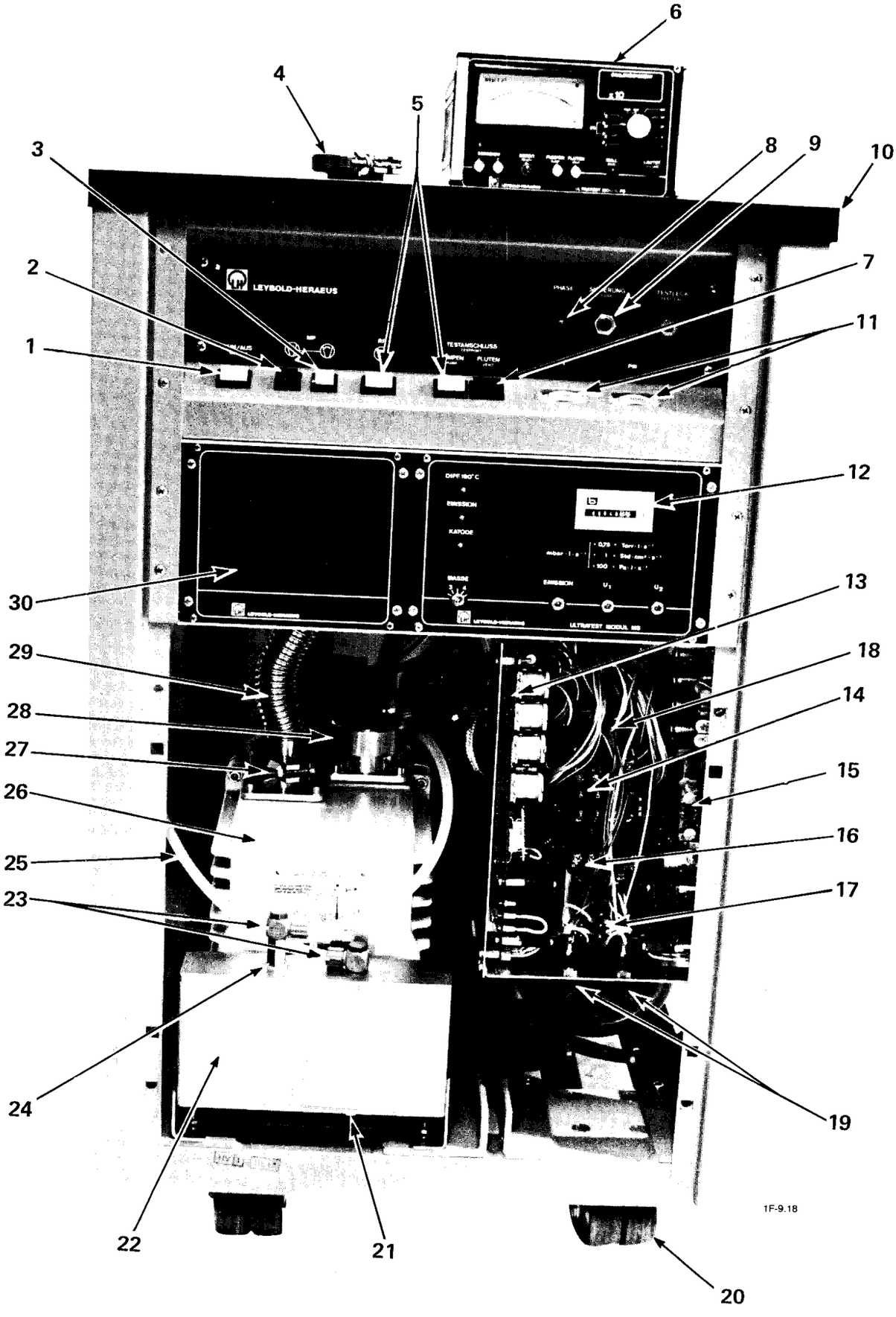

Figure 9-1 - Front of the ULTRATEST F

Figure 9-1 - Front of the ULTRATEST F (continued)

Item No.	Description	Part No.	Remarks
21	Drain Plug	201-12-102	
	Gasket	230-01-107	
22	Vacuum Reservoir	330-50-129	
23	Quick-Screw Coupling	351-78-112	Blue
24	Nonreturn Valve	350-20-156	
25	PVC Tubing	128-02-198	
26	TRIVAC D16A Roughing Pump	720-25-202	See ID plate on roughing pump to determine which model you have.
	TRIVAC D8A Roughing Pump	Contact factory	
	TRIVAC D25B Roughing Pump		
27	KF25 Clamp Ring	18342*	
	KF25 Centering Ring with Buna-N O-ring	18327*	
	Replacement O-ring KF25*	239-50-113	* Buna-N
	KF40 Clamp Ring	18343+	
	KF40 Centering Ring with Viton O-ring	88348+	
28	Gas Ballast Valve Cap	500-20-415	Aluminum
	O-ring for Cap	239-50-129	Buna-N 40x2.5
29	Stainless Steel Bellows Tubing (KF25)	86783*	250mm Lg.
	Stainless Steel Bellows Tubing (KF40)	87245+	
30	Panel Only	443-15-471	
	Printed Circuit Board LP11 Only	400-78-158	Fig. F-LP11

*For ULTRATEST F models with D16A or D8A roughing pumps (see the ID plate on the roughing pump).
+For ULTRATEST F models with D25B roughing pumps (see the ID plate on the roughing pump).

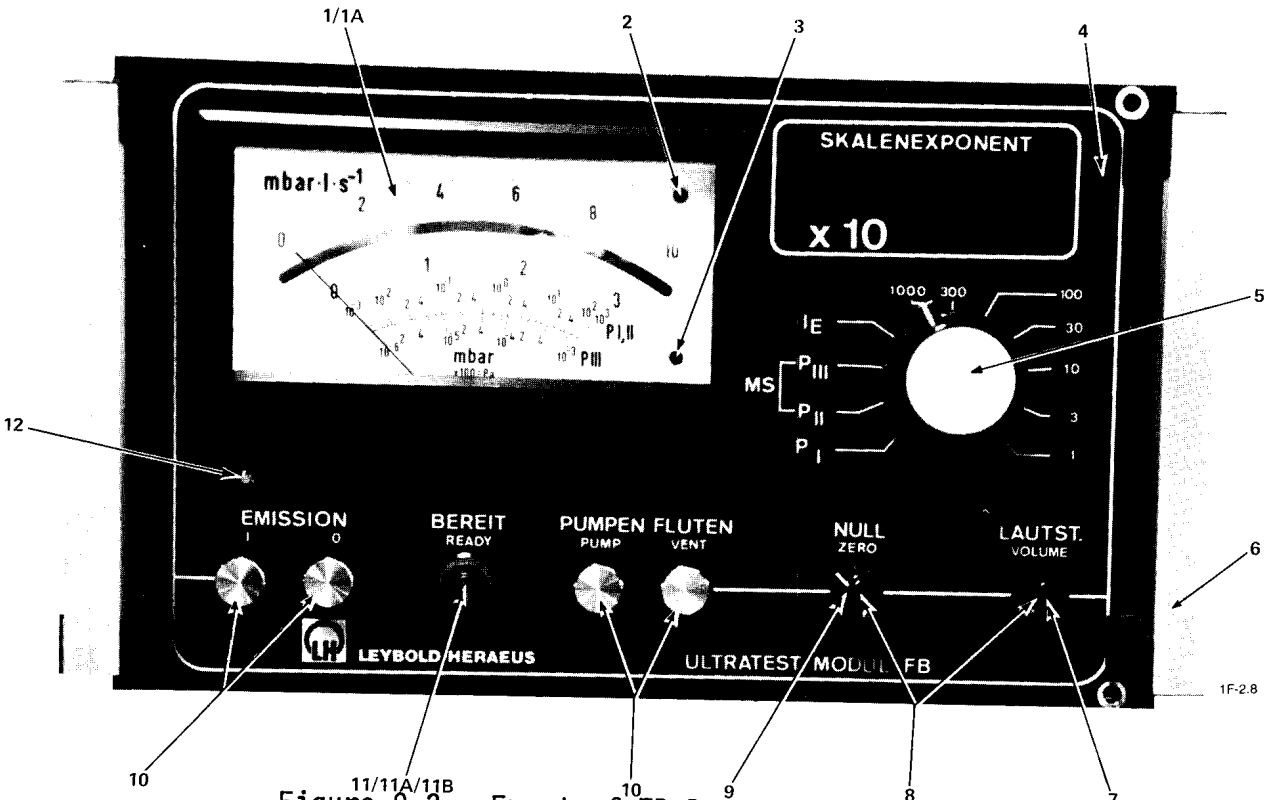

Figure 9-2 - Front of FB Remote Control Module
(Catalog No. 899415)

Item No.	Description	Part No.	Remarks
1	Meter	590-36-285	
1A	Metal Scale for Meter	590-40-319	
2	Red LED	510-43-333	
3	Green LED	510-43-332	
4	Front Plate	443-15-469	
5	Range Selector Knob	288-29-120 & 288-29-506	
6	Handles	331-22-214 & 331-22-259	
7	Volume Potentiometer	420-37-125	
8	Volume and Zero Knobs	288-29-114 (2 required) 288-29-214 (2 required)	
9	Zero Potentiometer	420-47-124	
10	Pushbuttons	500-36-189	
11	READY Bulb	530-31-246	See Section 8-13-2
11A	Yellow Cap	528-50-110	
11B	Bulb Holder	478-29-112	
12	EMISSION LED	510-43-333	See Section 8-13-2

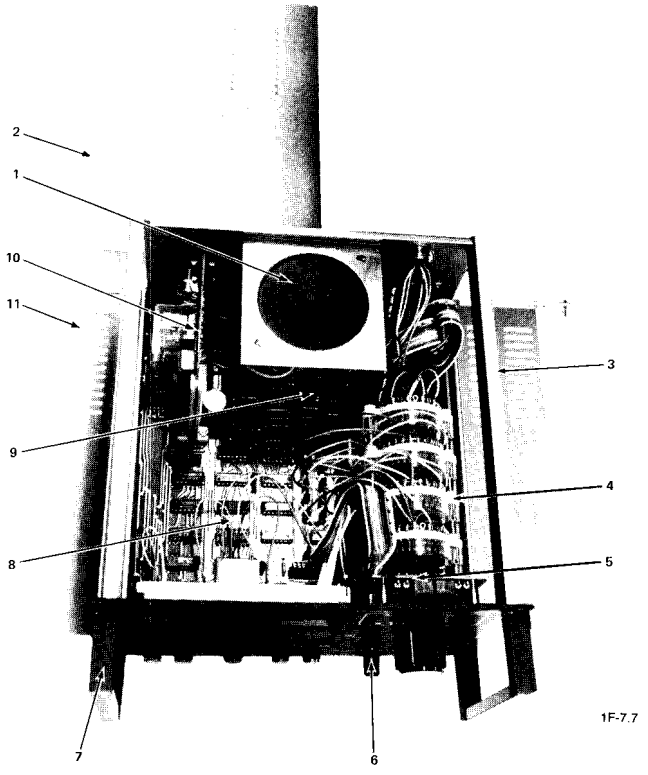

Figure 9-3 - Top of FB Remote Control Module (Part Number 899415)

Item No.	Description	Part No.	Remarks
1	Speaker LSP601	590-14-401	
2	Top and bottom cover (2 req'd)	331-22-238	
3	Retaining Bar (2 required)	331-22-202	
4	Range Selector Switch Assembly	500-62-156	
5	LP8 Digital Control Card	400-78-159	See Sec. 8-13-5
6	Zero and Volume Knobs	288-29-114 (2 req'd) 228-29-214 (2 req'd)	
7	Handles	331-22-214 & 331-22-259	
8	LP6 Board	701-50-169	See Sec. 8-13-3
9	IC 601 (8007)	533-21-190	
10	LP7 Trigger 1 and 2 Board	400-78-143	See Sec. 8-13-4
11	Side Cover (2 Required)	331-22-237	
Not Shown	Magnet for the Bottom Cover	591-81-208	
Not Shown	Chart Recorder Plug to connect to socket Bu on the rear of the FB module	500-17-119	See Figure 8-18

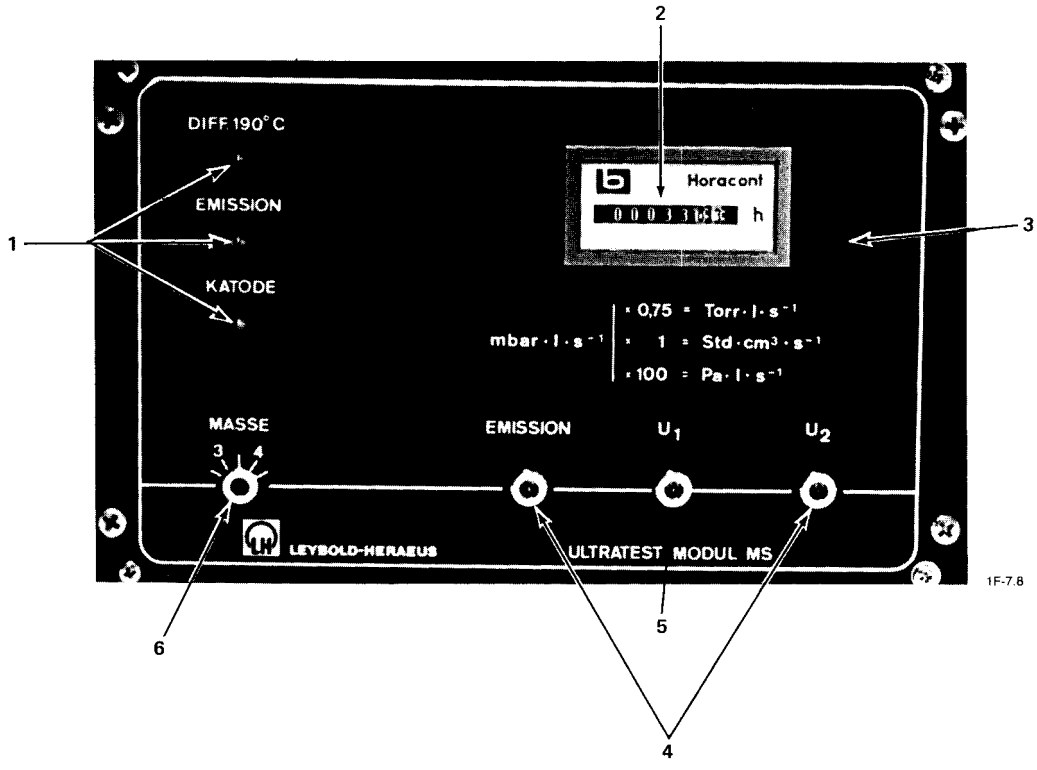

Figure 9-4 - Front of MS Module
(Catalog Number 330-25-148)

Item No.	Description	Part No.	Remarks
1	LEDs	510-43-131	See Section 8-12-2
2	Elapsed Hour Meter	590-05-127	
3	Front Plate	443-15-468	
4	EMISSION and U_2 Potentiometers	420-37-146	
5	U_1 Potentiometer	420-37-145	
6	Mass Switch	500-36-113	Reference 330-25-148-2.4 for slot modification

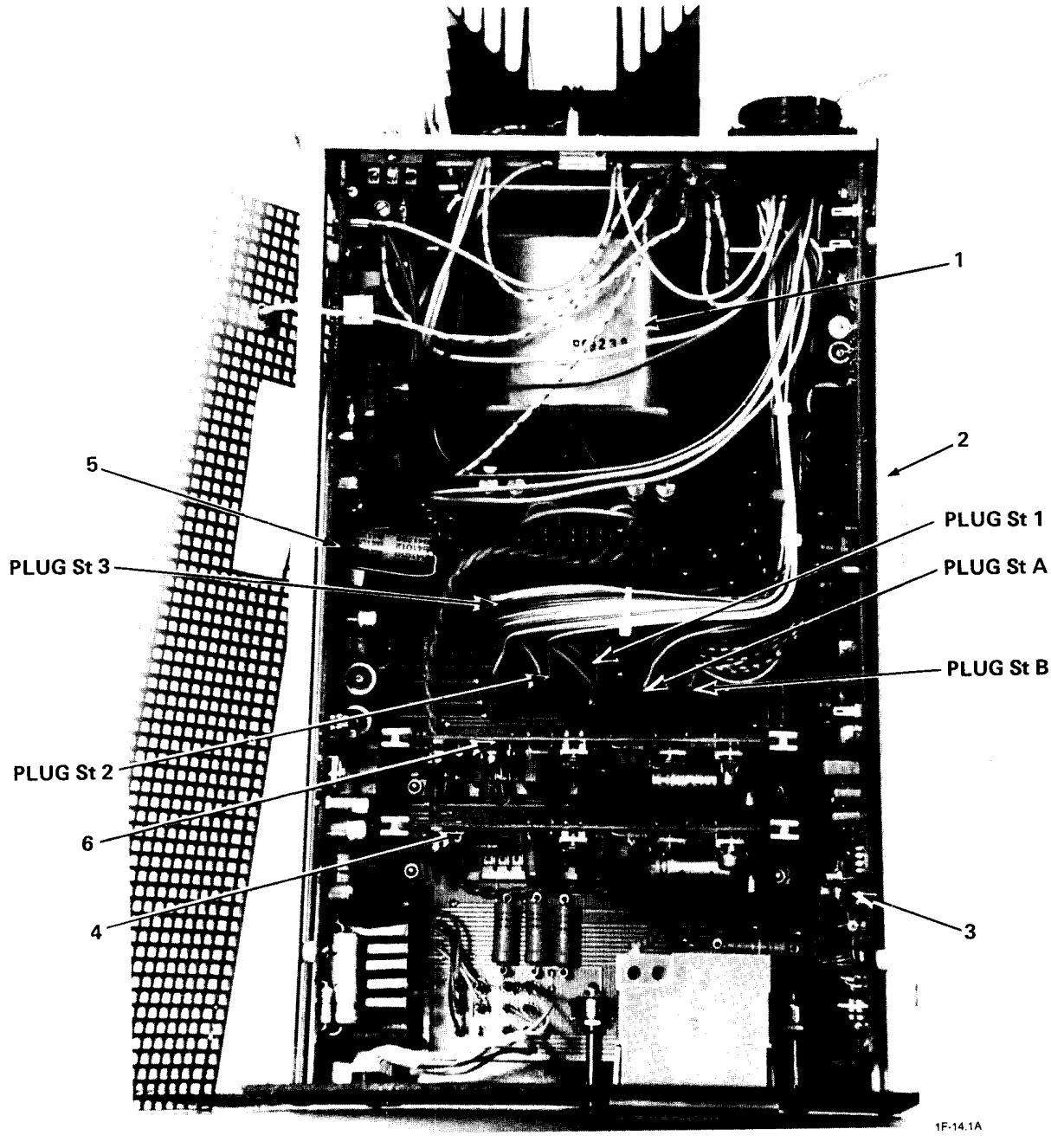

Figure 9-5 - MS Module Electronics

Item No.	Description	Part No.	Remarks 1 Assembly 1/99
1	Transformer TR1MS	510-32-456	$280.00
2	Retaining Bar (2 required)	331-22-204	
3	LP1 Printed Circuit Board	400-78-163	See Section 8-12-3
4	LP3 Printed Circuit Board	400-78-140	See Section 8-12-5
5	LP2 Printed Circuit Board	400-78-138	See Section 8-12-4
6	LP4 Printed Circuit Board	400-78-139	See Section 8-12-6

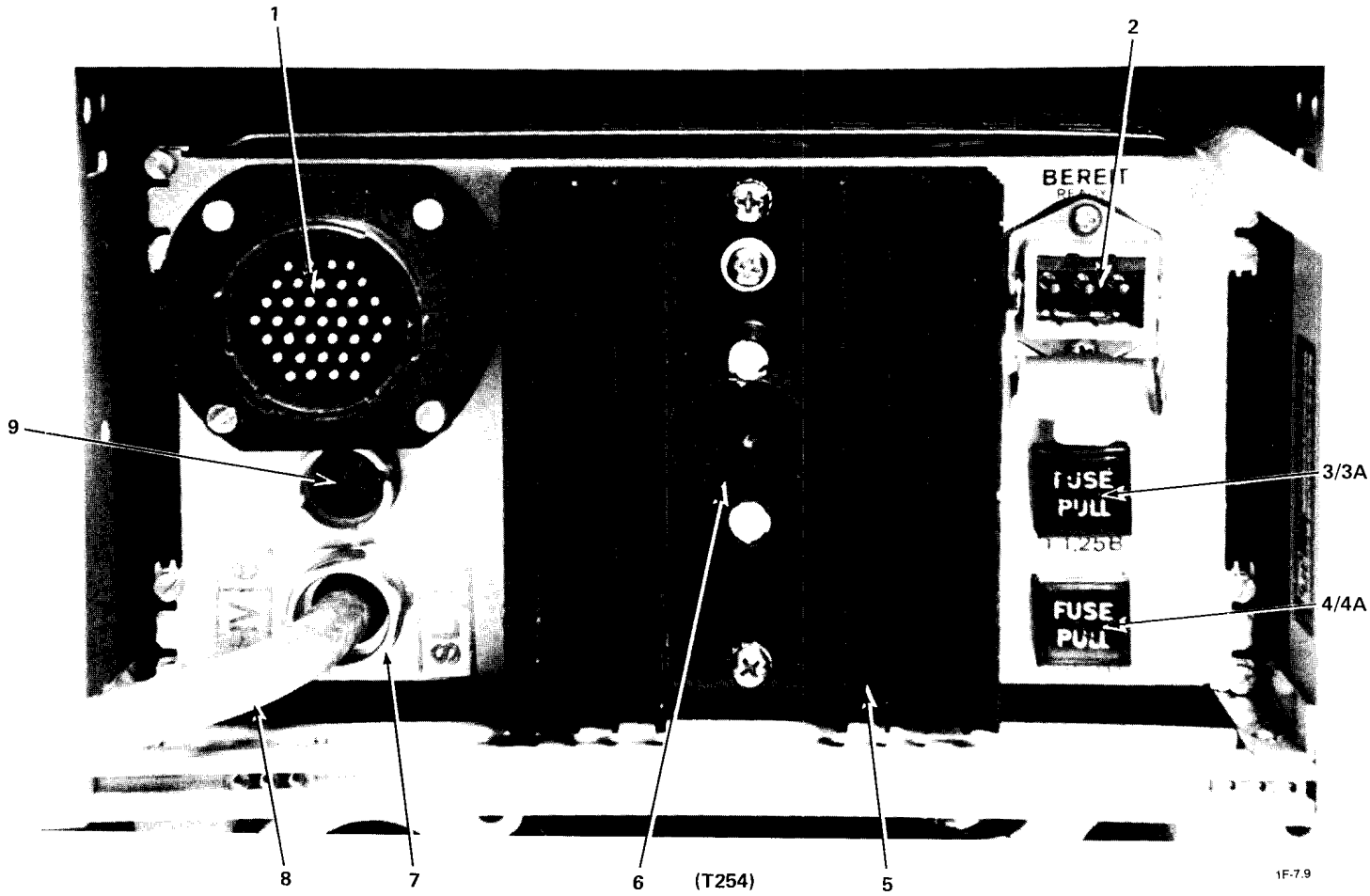

Figure 9-6 - Back of MS Module

Item No.	Description	Part No.	Remarks
1	Male Plug Outlet A	500-11-212	This No. is for the pins. 37 are required.
		500-17-244 500-17-238	
2	Male Outlet C	540-22-326	
2A	Mating Plug for Outlet C	500-17-146	
3	Fuse Si1 (1.25 A, 250V)	520-25-316	
3A	Round Fuse Holder	528-28-111*	
4	Fuse Si2MS (6.3A, 250V)	520-25-321	
4A	Round Fuse Holder	528-28-111*	
5	Heat Sink	533-21-212	
6	Transistor T254	533-21-213	MJ4034
7	Outside Nut Cylinder with Gasket	432-02-100	
7A	Inside Hex Nut	212-07-205	
8	Cable	310-05-108	
9	Plug Outlet B for PI Gauge	500-17-127	
Not Shown	Recorder Plug PI for PI Gauge	500-17-119	

*This fuse holder requires soldering on installation.

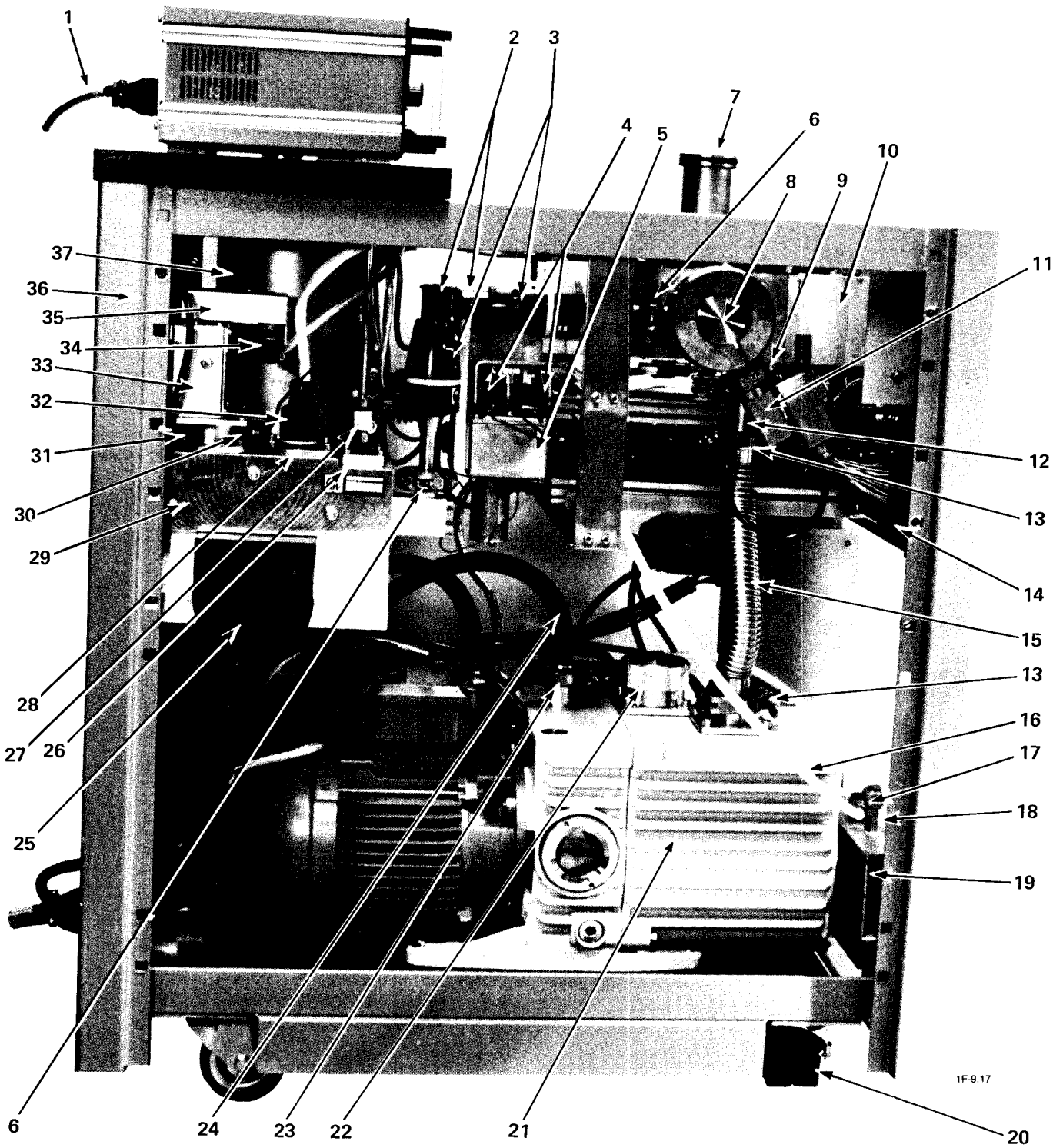

Figure 9-7 - Left Side of ULTRATEST with the Panels Removed

Figure 9-7 - Left Side of ULTRATEST with the Panels Removed

Item No.	Description	Part No.	Remarks
1	Cable Assembly	310-75-135	
2	Plugs TM2 and TM1 for TR201 Gauge Heads	540-18-101	PI and PII
3	TR201 Gauge Tubes	16202	
4	Microswitches for Valve V2 Control Motor	500-36-220	
5	Control Motor for Valve V2	380-26-146	
6	Clamping Collar	88275	KF10/16
	Sealing Disk (set of 3)	88373	KF10/16
	Support Ring for Sealing Disk	88374	KF10/16
7	Blind Flange	88438	KF40
	Test Port	200-29-234	KF40
8	Clamping Collar	88278	KF40
	Blind Flange	88438	KF40
	Sealing Disk (set of 3)	88377	KF40
	Support Ring for Sealing Disk	88378	
	Side Test Port	200-29-235	KF40
9	Clamping Collar	88275	KF10/16
	Sealing Disk (set of 3)	88373	KF10/16
	Support Ring for Sealing Disk	88374	
10	Valve Block Assembly	350-20-161	See Fig. 9-15
11	Valve V3 Complete	200-29-049	
12	KF40 to KF25 Reducer*	88516*	
	KF40 30° Elbow+	98-278-0451+	
13	Clamping Ring*	18342	
	Spare O-Ring*	239-50-113*	Buna-N
	Centering Ring with Buna-N O-ring*	18327*	KF25
	KF40 Clamping Ring+	18343+	
	KF40 Centering Ring+	88348+	Viton
14	Printed Circuit Board LP11	400-78-158	
15	KF25 Bellows Tubing*	86783*	10-inches lg.
	KF40 Bellows Tubing+	87245+	
16	PVC Tubing	128-02-198	
17	Quick-Screw Coupling	351-78-112	Blue
18	Nonreturn Valve	350-20-156	
19	Vacuum Reservoir	330-50-129	
20	Caster Wheel	251-62-202	

* For ULTRATEST F Models with D16A or D8A roughing pumps (see the ID plate on the roughing pump).
+ For ULTRATEST F Models with D25B roughing pumps (see the ID plate on the roughing pump).

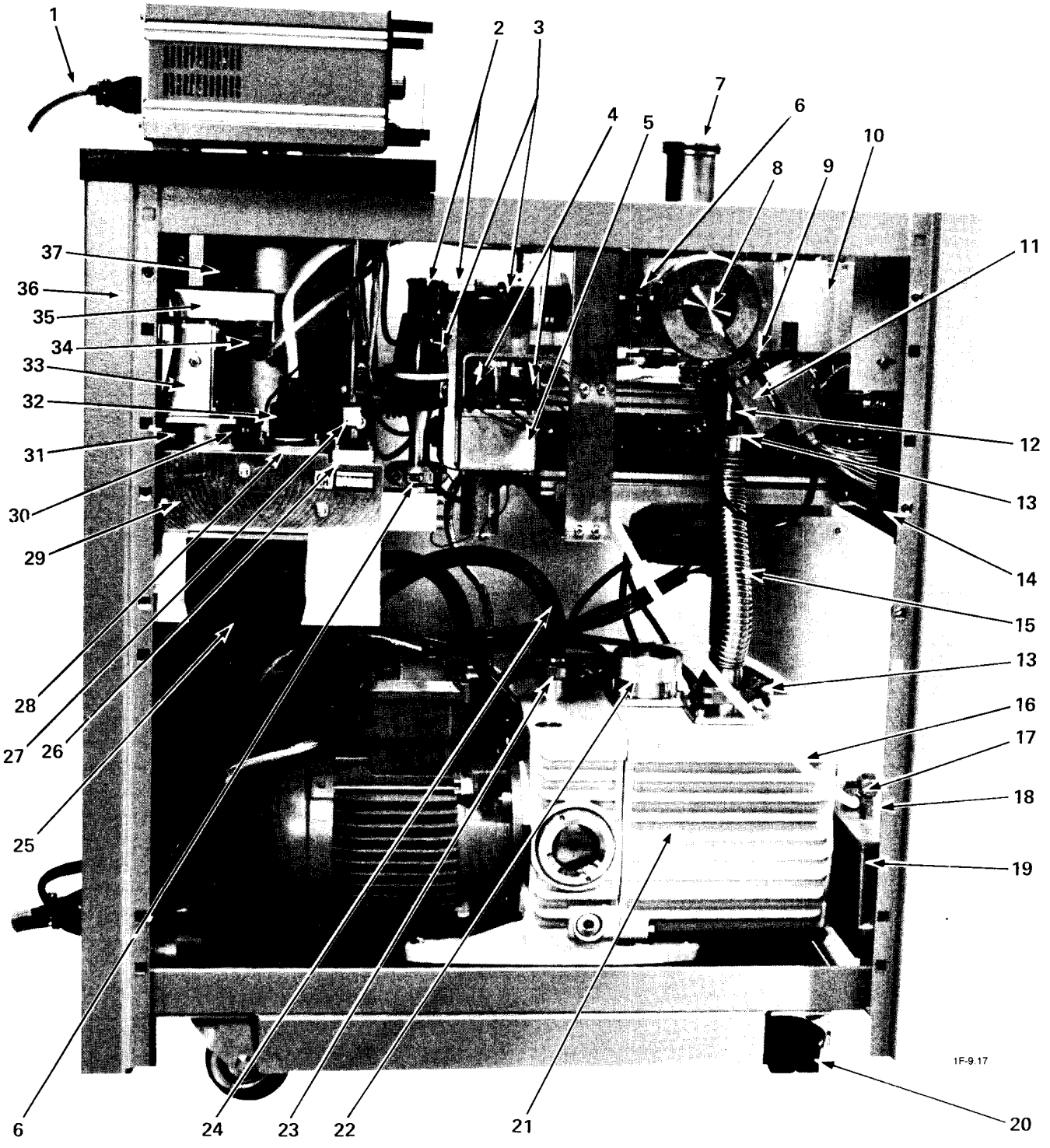

Figure 9-7 - Left Side of ULTRATEST with the Panels Removed

Figure 9-7 - Left Side of ULTRATEST with the Panels Removed (continued)

Item No.	Description	Part No.	Remarks
21	TRIVAC D16A Roughing Pump	720-25-202	See ID plate on roughing pump to determine which model you have.
	TRIVAC D8A Roughing Pump	Contact factory.	
	TRIVAC D25B Roughing Pump		
22	Cap for Gas Ballast Valve	500-20-415	Aluminum
	O-ring for Cap	239-50-129	Buna-N,40x25
23	Hose Nipple*	18291*	KF25
	Hose Clamp	571-26-129	
	Hose Nipple+	18292+	KF40 to 1/2"
24	Exhaust Hose	129-04-158	
25	Magnet	590-29-104	
26	Valve V5 Inner Part	301-66-139	
27	Coupling for Valve V5	570-42-127	
28	Ion Source	16513	
29	Mass Spectrometer	590-29-113	
30	Brass Connector U2 for Collector	500-17-151	
31	Collector	590-29-107	$ 1,900
32	Plug IQ for Ion Source	540-21-108	
33	Preamplifier	330-25-133	$3,000
34	Female Plug EMV on Preamp	500-20-416	15 pol Sub-D connector
	Mating Male Connector on Filter	500-20-417	
35	Filter for preamp	510-22-510	
36	Support	330-50-126	
37	Outer Housing of Cold Trap	330-50-131	

* For ULTRATEST F Models with D16A or D8A roughing pumps (see the ID plate on the roughing pump).

\+ For ULTRATEST F Models with a D25B roughing pump (see the ID plate on the roughing pump).

Test Box

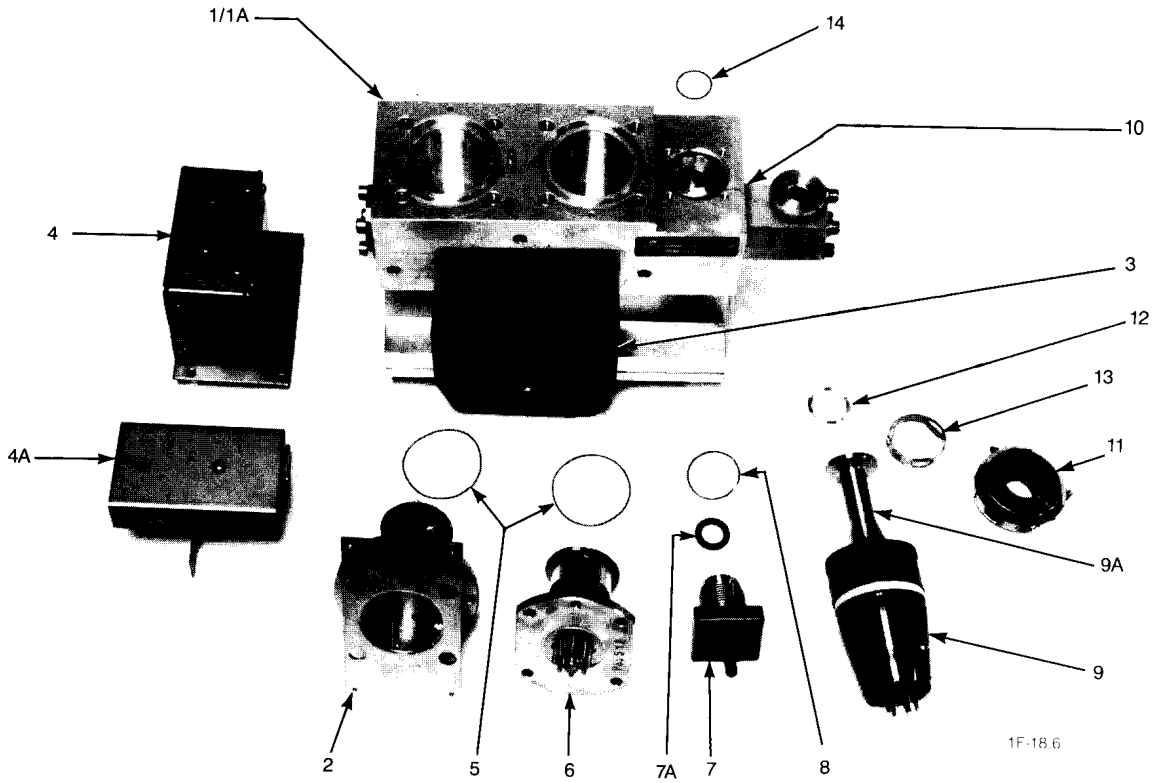

Figure 9-8 - Disassembled Mass Spectrometer

Item No.	Description	Part No.	Remarks
1	Mass Spectrometer, complete	590-29-113	See Sec. 7-6 & 8-3
1A	Gasket for Mass Spectrometer Bottom Plate	200-27-107	See Sec. 8-9-2
2	Collector	590-29-107	See Sec. 7-6-1-2 & 8-3.
3	Magnet	590-29-104	See Sec. 8-3
4	Preamplifier	330-25-133	See Sec. 8-14
4A	Filter for Preamplifier	510-22-510	
5	Metal-Wire Gasket for Ion Source and Collector	235-51-133+	See Sec. 8-9-2
6	Ion Source	16513	See Sec. 6-5
7	Valve V5	301-66-139	See Sec. 8-7-2
7A	O-Ring Valve Seat for Valve V5	239-50-147	See Sec. 8-7-2
8	Metal Gasket for Valve V5 Flange	235-51-132	See Sec. 8-9-2
9	TR201 Gauge Tube, complete	16202	See Sec. 8-10
9A	Sensing Tube	16209	See Sec. 8-10
10	Metal-Wire Gasket	235-51-130	See Sec. 8-9-2
11	Clamping Collar	88275	See Fig. 9-7
12	Sealing Disk (set of 3)	88373	See Fig. 8-13
13	Support Ring for Sealing Disk	88374	See Fig. 8-13
14	Metal gasket for Sealing Cold Trap Bellows to Mass Spectrometer	235-51-131	See Sec. 8-9-2

+ An O-ring (P/N 704-01-921) can be used in place of this metal gasket; however, using an O-ring will reduce the sensitivity of the ULTRATEST.

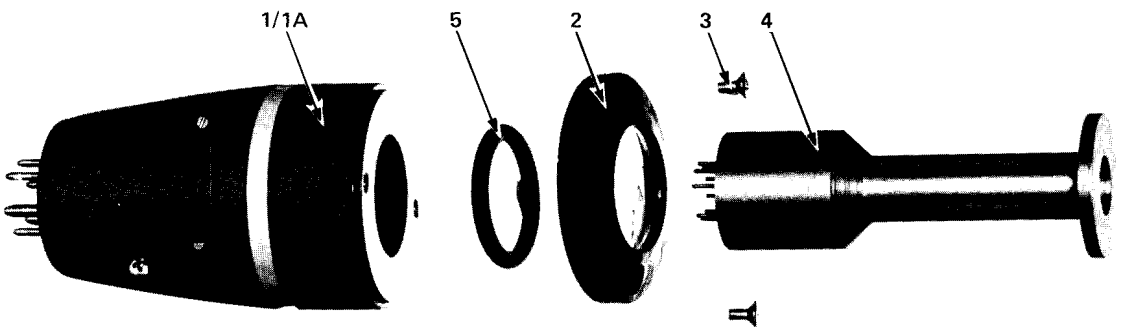

Figure 9-9 - Disassembled TR201 Gauge Tube
(Catalog No. 16202)

Item No.	Description	Part No.	Remarks
1	Plastic Housing (2 required)	548-74-105	
1A	Gauge Head, complete	530-43-127	Includes plastic housing
2	Bottom Ring	238-88-101	
3	Screws (2 required)	202-03-160	M3x8,DIN964
4	Sensing Tube	16209	See Section 8-10
5	O-ring	239-50-191	23x4

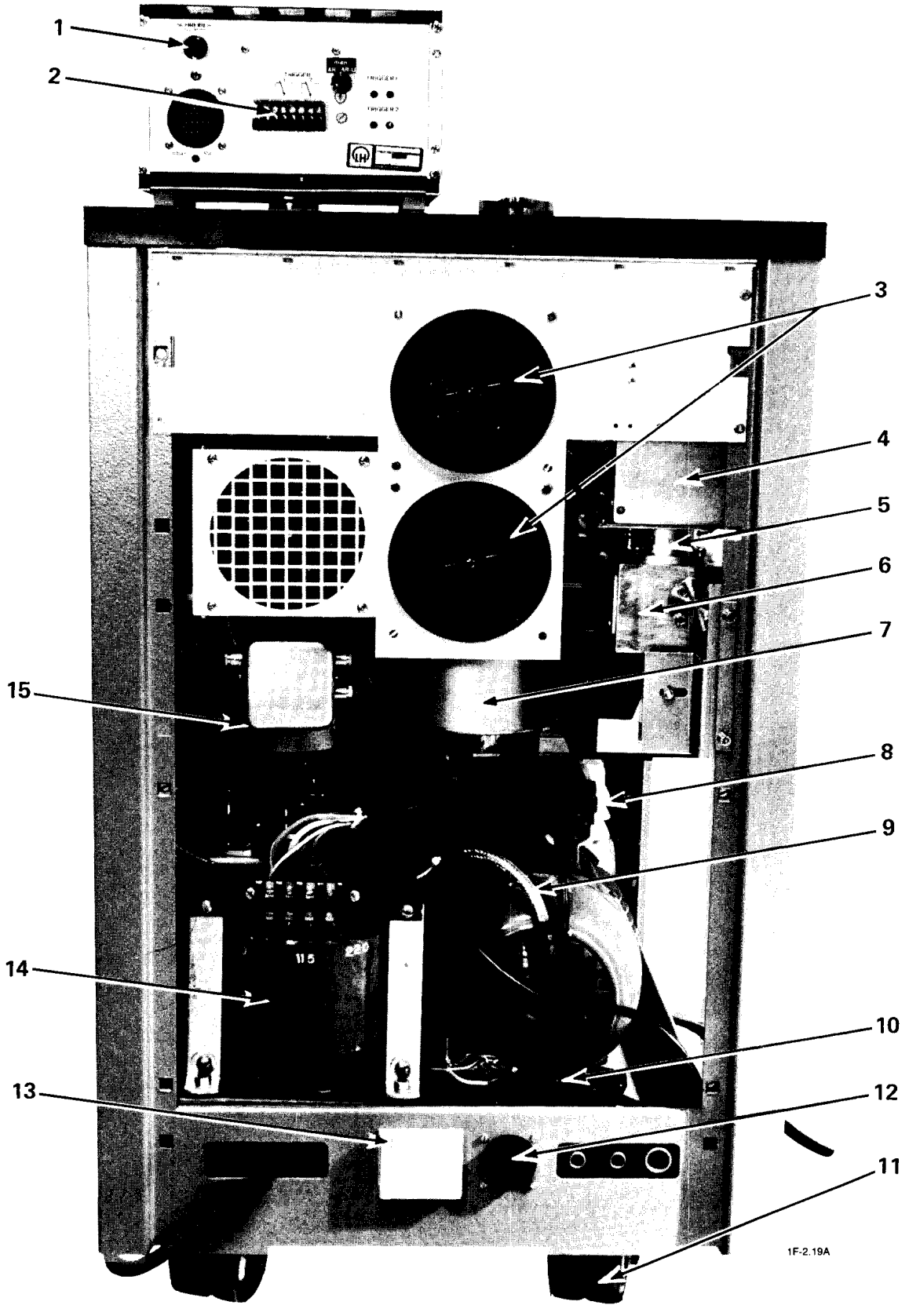

Figure 9-10 - Rear View of ULTRATEST with the Panels Removed

Figure 9-10 - Rear View of ULTRATEST with the Panels Removed

Item No.	Description	Part No.	Remarks
1	Recorder Socket Bu	500-17-127	Shown
	Recorder Plug	500-17-119	Not Shown
2	Terminal Block for Trigger Relay Outputs	570-03-113	8 required
3	Fan	380-93-103	
4	Preamplifier	330-25-133	
5	Collector	590-29-107	
6	Mass Spectrometer	590-29-113	
7	Cold Trap Outer Housing	330-50-131	
8	TRIVAC D16A Roughing Pump	720-25-202	See ID plate on roughing pump to determine which roughing pump you have.
	TRIVAC D8A Roughing Pump	Contact factory	
	TRIVAC D25B Roughing Pump		
9	Cable	310-05-108	
10	Plug	500-20-481	
	Socket	500-20-482	
	Tension Relief Piece	500-20-483	
11	Caster Wheel	251-62-202	
12	Socket	310-04-158	
13	Socket for Quick-Test	540-26-110	220V,10A
14	Transformer Tr2	99-254-038	
15	LEYBODIFF 180L Diffusion Pump	219-45-1	

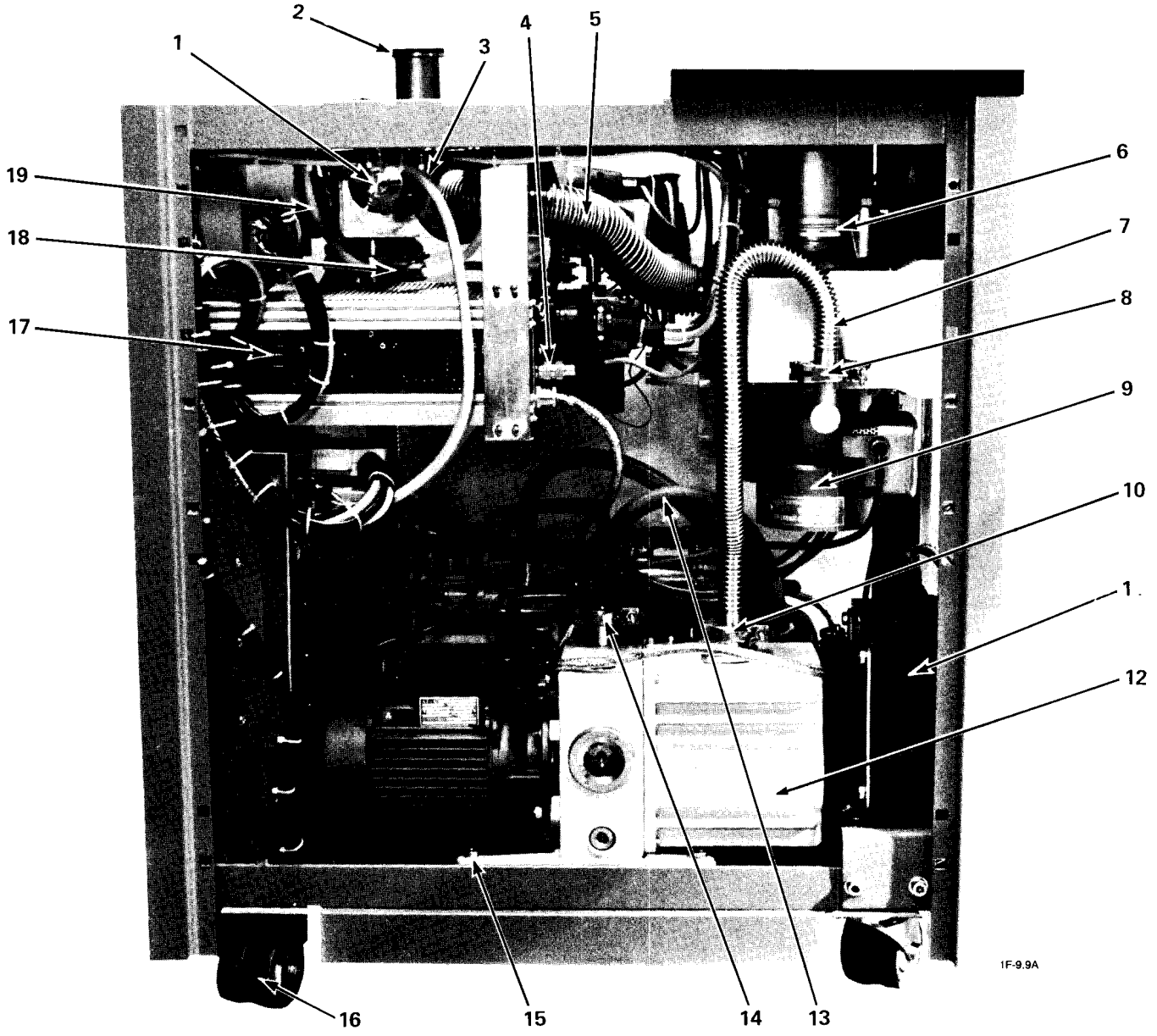

Figure 9-11 - Right Side of the Leak Detector with the Panels Removed

Figure 9-11 - Right Side of the Leak Detector with the Panels Removed

Item No.	Description	Part No.	Remarks
1	Clamping Collar	88275	KF10/16
	Blind Flange	88441	
	Sealing Disk	88373	KF10/16
	Support Ring for Sealing Disk	88374	
2	Test Port Flange	200-29-234	KF40
3	Clamping Collar	88278	KF32/40
	Sealing Disk	88377	KF32/40
	Support Ring for Sealing Disk	88378	
4	PI Plug for TR201 Gauge	500-17-119	
	Cable for PI Plug	110-21-132	
5	Bellows Tubing	86795	KF40,20-inches Long
6	LF Clamps (set of 4)	26701	
	Baffle	720-54-039	
	Baffle O-ring	239-50-207	Buna-N
7	Bellows Tubing Foreline	86791	KF16,20-inches Long
8	Clamp Ring	18341	KF16
	Centering Ring with Buna-N O-ring	18326	KF16
9	LEYBODIFF 180L Diffusion Pump	21945-1	See Fig. 9-12
10	Clamp Ring	18341	KF16
11	Transformer TR2	99-254-038	
12	D4A TRIVAC Backing Pump	720-25-201	
13	Exhaust Hose	129-04-158	KF16
14	Hose Clamps (2 required)	571-26-129	
	Hose Nipple	182 90	KF16
15	Vibration Absorber (4 required)	370-51-125	
16	Caster Wheel	251-62-202	
17	MS Module, complete	330-25-148	See Fig. 9-4
18	Quick-Screw Tee	351-78-115	Blue
19	PVC Tubing	128-02-198	

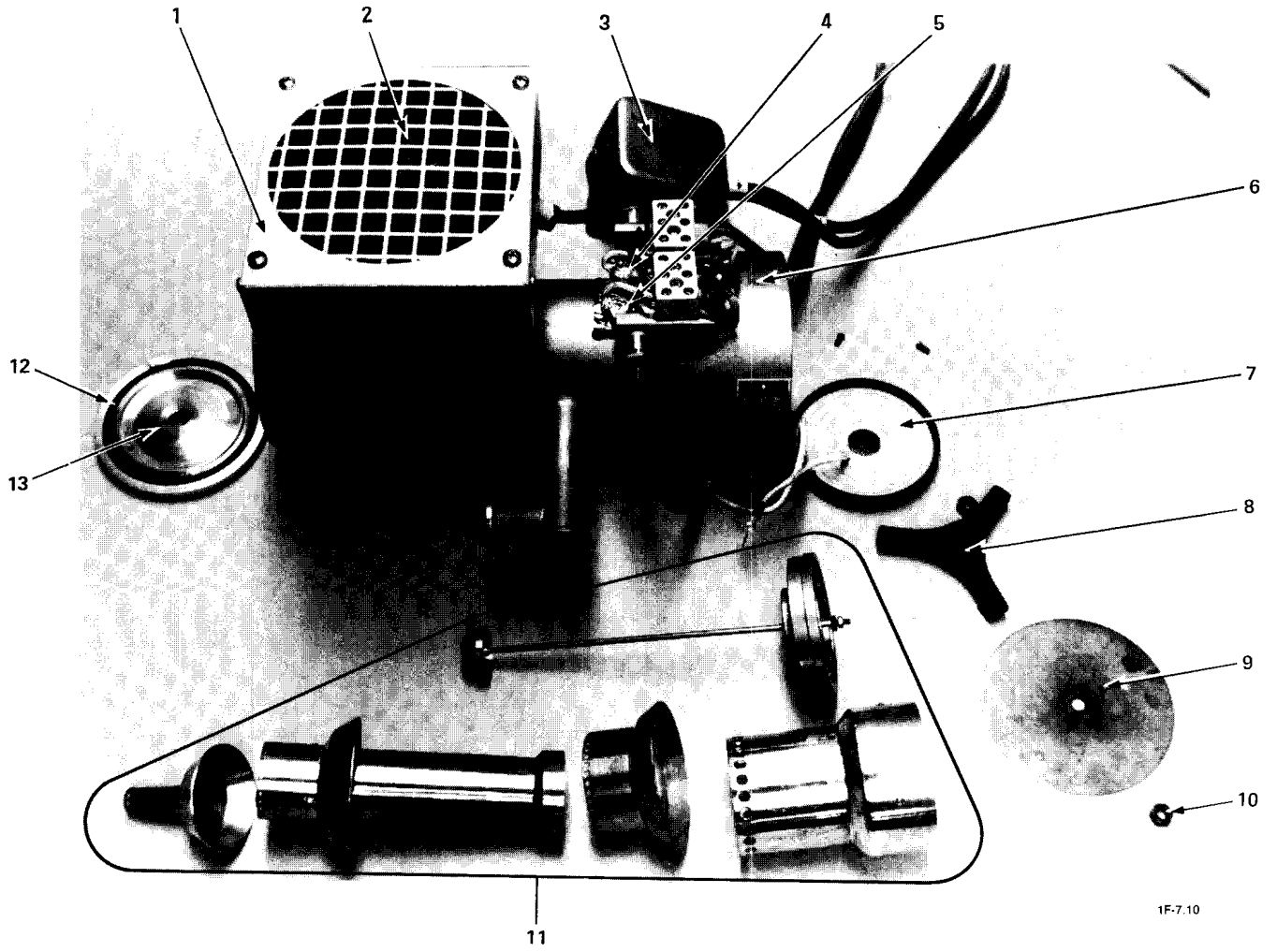

Figure 9-12 - Disassembled LEYBODIFF 180L Diffusion Pump (Catalog No. 21945-1)

Item No.	Description	Part No.	Remarks
1	Fan Housing	331-68-244	
2	Diffusion Pump Fan	380-93-103	
3	Terminal Cover	331-68-056	
4	190C Thermoswitch	590-47-208	See Section 8-6-1
5	90C Thermoswitch	590-47-214	See Section 8-6-1
6	Diffusion Pump Housing	301-58-447	
7	Heater Plate	401-55-639	See Section 8-6-2
8	Cast Iron Bracket	481-52-105	See Section 8-6-2
9	Bottom Cover Plate	221-01-209	
10	Nut (2 required)	211-01-109	
11	Jet Stack, complete	410-11-410	See Section 6-3-2
12	Baffle O-Ring (BUNA-N)	239-50-207	
13	Baffle	720-54-039	See Section 7-6-2-2
	Pump Fluid for Diffusion Pump		See Table 6-2

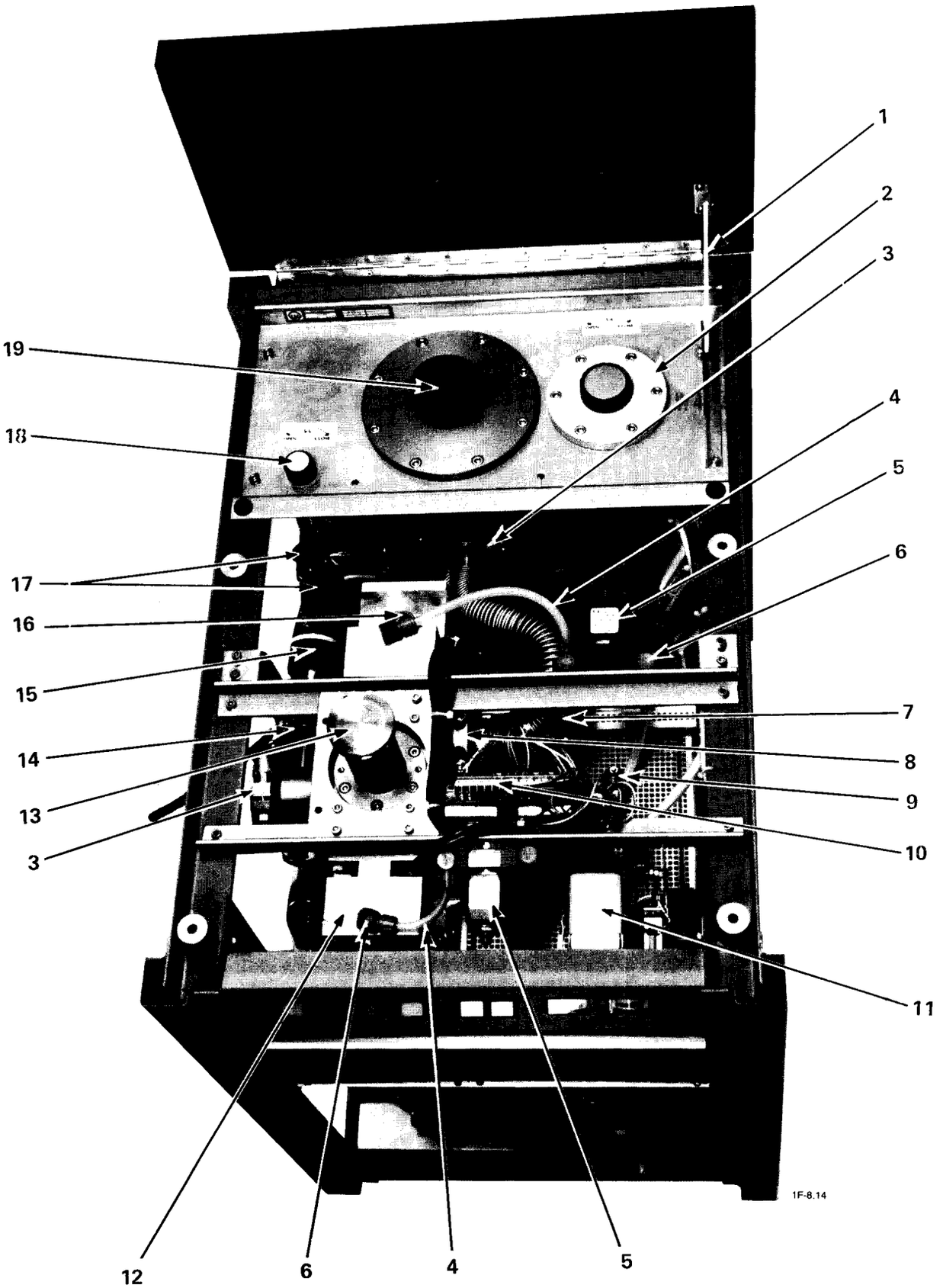

Figure 9-13 - Top View of Leak Detector with the Larger Work Top Removed

Figure 9-13 - Top View of Leak Detector with the Larger Work Top Removed

Item No.	Description	Part No.	Remarks
1	Arm	261-76-108	
2	Valve V4 Assembly	301-66-171	See Fig. 9-14
3	Clamping Collar	88278	KF40
	Sealing Disk (set of 3)	88377	KF40
	Support Ring for Sealing Disk	88378	KF40
4	PVC Tubing	128-02-198	
5	Control Valve	350-20-152	
6	Quick-Screw Coupling	351-78-112	Blue
7	Bellows Tubing	86795	KF40,20-inches Long
8	Clamping Collar	88278	KF40
	Sealing Disk (set of 3)	88377	KF40
	Support Ring for Sealing Disk	88378	KF40
	Side Test Port	200-29-235	KF40
9	Clamping Collar	88275	KF10/16
	Blind Flange	88441	
	Sealing Disk	88373	KF10/16
	Support Ring for Sealing Disk	88374	
10	Terminal Block	570-20-316	
	Overvoltage Damping Capacitor	510-22-509	2 required
11	Circuit Breaker	520-31-234	380V,6A
12	Valve Block Assembly	350-20-161	
13	Blind Flange	88438	
	Centering Ring with Buna-N O-ring	18328	KF40
	Test Port Flange	200-29-234	KF40
14	Clamping Collar	88275	KF10/16
	Sealing Disk	88373	KF10/16
	Support Ring for Sealing Disk	88374	
15	TR201 Gauge Tube	16202	PI (see Fig. 9-9)
16	Bearing for Valve V2 Stop	261-03-212	
17	Plugs TM2 and TM1 for TR201 Gauge Heads	540-18-101	PI and PII
18	Black Plastic Handwheel	288-29-504	Valve V5
	Red Plastic Cap for Handwheel	288-29-506	Valve V5
19	Stopper for Cold Trap	328-25-106	
	Cold Trap Inner Housing	200-29-277	
	Metal Gasket for Cold Trap	235-51-136*	

* An O-Ring (Part No. 239-70-404) can be used in place of the metal gasket (see Appendix C).

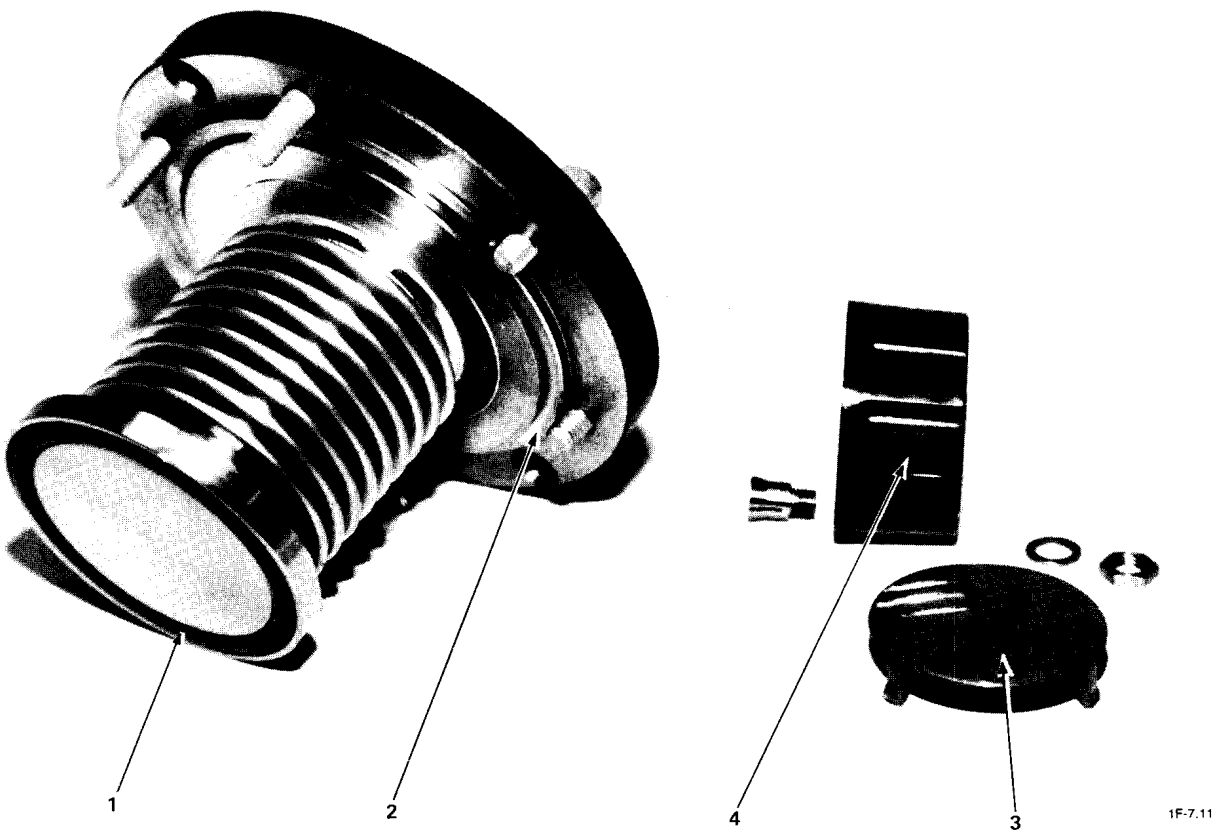

Figure 9-14 - Disassembled Valve V4

Item No.	Description	Part No.	Remarks
	Valve V4 Assembly	301-66-171	See Section 8-7-2
1	O-Ring	239-70-118	See Section 8-7-2
2	Metal-Wire Gasket	235-51-135	See Section 8-9-2
3	Red Plastic Cap	288-29-521	
4	Black Plastic Handwheel	288-29-520	

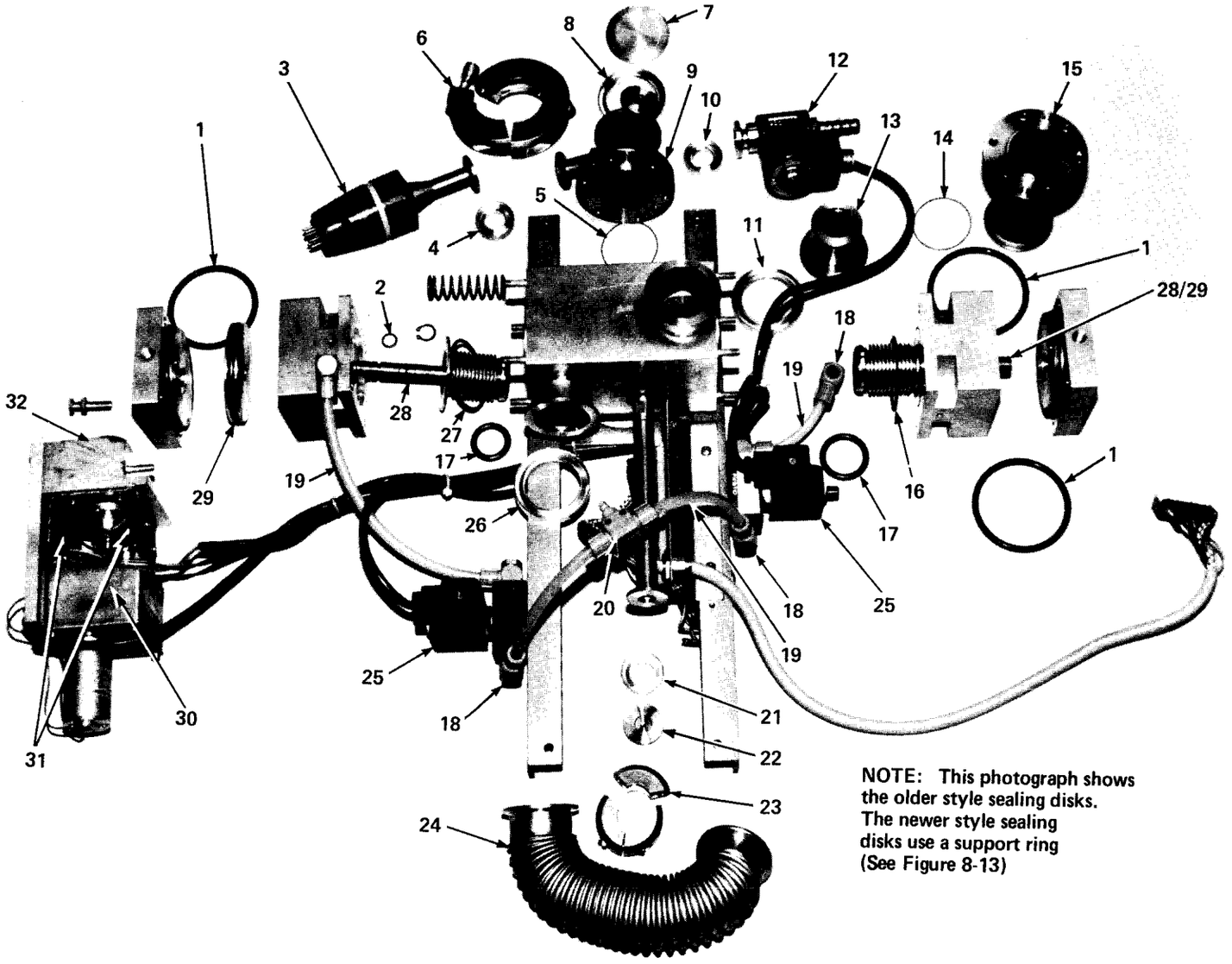

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Figure 9-15 - Disassembled Valve Block, Bottom View

Figure 9-15 - Disassembled Valve Block, Bottom View

Item No.	Description	Part No.	Remarks
1	O-Ring for Piston and for Valve Top (V1 and V2)	239-50-109	65x5(2 required for each valve)
2	O-Rings for Valve Shafts	239-70-179	9.25x1.78 (2 required for each valve stem)
3	TR201 Gauge Tube for PI	16202	See Fig. 9-9.
4	Sealing Disk for PI Flange	88373	Set of 3
	Support Ring for the Sealing Disk	88374	Not Shown
5	Metal-Wire Gasket (see Section 8-9-2)	235-51-134	Seals the flange between the side test port and the valve block.
6	KF40 Clamping Collar	88278	Seals side test port
7	Blind Flange	88438	
8	KF40 Sealing Disk (set of 3)	88377	
	Support Ring for the Sealing Disk	88378	Not shown
9	Side Test Port	200-29-235	KF40
10	KF10/16 Sealing Disk	88373	Seals valve V3/side test port flange
	Support Ring for Sealing Disk (Not Shown)	88374	
11	KF40 Sealing Disk (set of 3)	88377	Seals the reducer flange (13) to the test port
	Support Ring for Sealing Disk (Not Shown)	88378	
12	Valve V3, complete	200-29-049	
13	KF40 to KF25 Reducer	88516	
14	Metal-Wire Gasket (see Section 8-9-2)	235-51-134	Seals top test port to valve block
15	Top Test Port	200-29-234	
16	O-Ring (48.9 x 2.62)	239-50-146	Seals valve V1 to the valve block
17	O-Ring (22 x 5)	239-50-194	Valve seat for valves V1 and V2
18	Quick-Screw Coupling	351-78-112	Blue
19	PVC Tubing	128-02-198	
20	Quick-Screw Tee	351-78-115	Blue
21	Sealing Disk (KF10/16) (set of 3)	88373	For calibrated leak port.
	Support Ring for Sealing Disk (Not Shown)	88374	

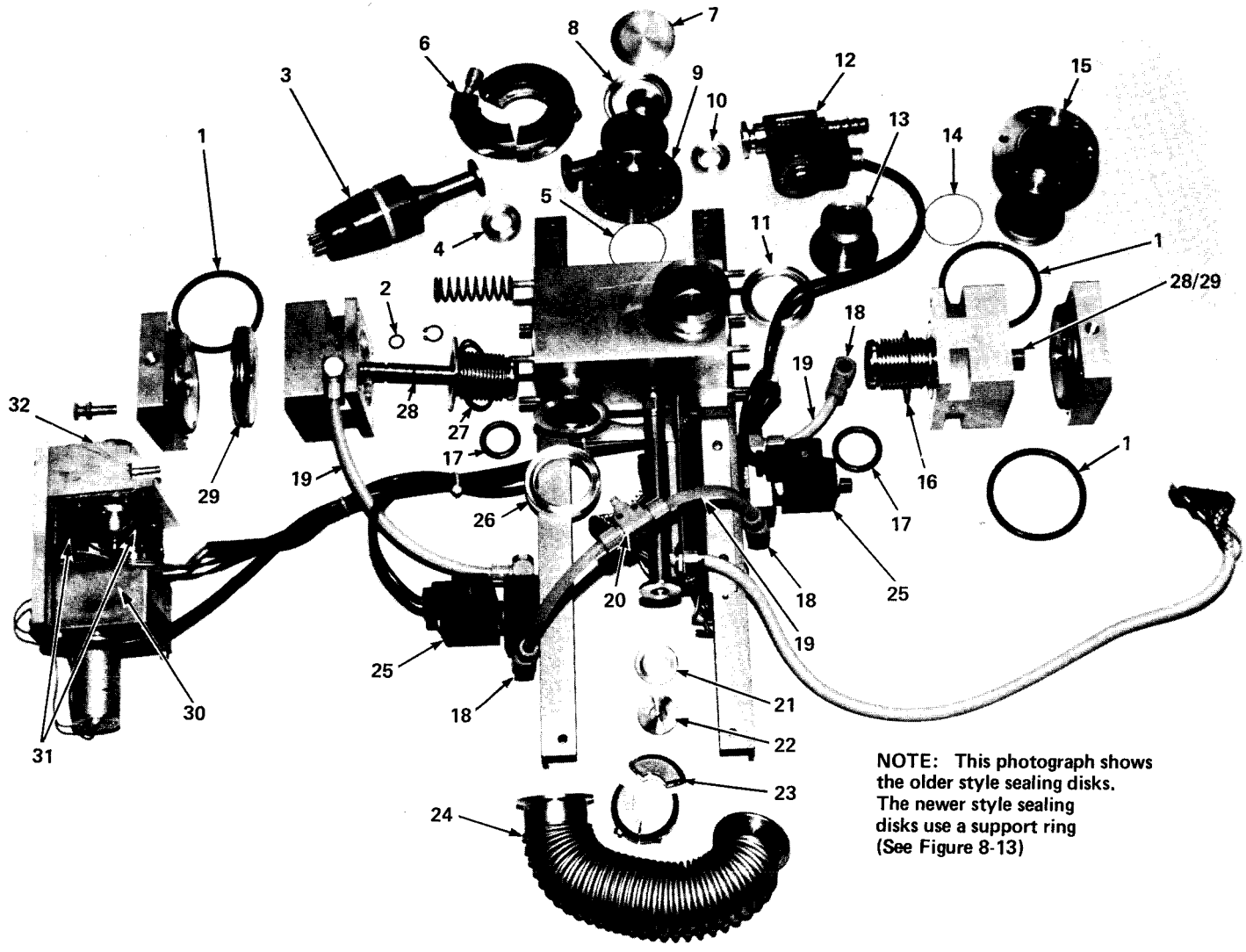

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Figure 9-15 - Disassembled Valve Block, Bottom View

Figure 9-15 - Disassembled Valve Block, Bottom View (continued)

Item No.	Description	Part No.	Remarks
22	Blind Flange	88441	
23	Clamping Collar (KF10/16)	88275	
24	Bellows Tubing	86795	KF40,20-inches long
25	Control Valve	350-20-152	
26	KF40 Sealing Disk (set of 3)	88377	Seals the bellows tubing (24) to the valve block
	Support Ring for the Sealing Disk (Not Shown)	88378	
27	Helicoflex Metal Gasket (see Section 8-9-2-3)	230-05-105	An O-Ring (Item No. 16) can be substituted for this metal gasket
28	Valve V1 and V2 Stem/Bellows/Seal Assembly	350-01-172	Does not include O-Ring seat
29	Piston for Valve V1 and V2	403-03-126	
30	Drive Motor	380-26-146	For Valve V2
31	Microswitches for Drive Motor	500-36-220	
32	Bearing for Valve V2 Stop	261-03-212	Not Shown
	Shaft bushing for Drive Motor	270-27-105	

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APPENDIX A

OPTIONAL QUICK-TEST HELIUM SAMPLING PROBE

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A-1 DESCRIPTION AND PRICIPLES OF OPERATION

NOTE: See Table A-1 for the specifications for the QUICK-TEST.

NOTE: The ULTRATEST does not come standard-equipped with a QUICK-TEST. The QUICK-TEST must be purchased separately.

NOTE: LN_2 is not normally added to the ULTRATEST cold trap when the optional QUICK-TEST is being used.

When attached to the test port of the leak detector, the QUICK-TEST allows you to locate leaks by the "sniffing" or the "vacuum pump exhaust" technique. "Sniffing" refers to using the QUICK-TEST probe to scan a vessel filled with helium for leaks (see Section A-4-1). "Vacuum pump exhaust" refers to spraying a vessel with helium and inserting the QUICK-TEST probe into the exhaust of the vacuum pump that is evacuating the vessel (see Section A-4-2). If there is a leak in the vessel, the helium will be drawn into the vessel and exhausted by the vacuum pump. Some of the helium in the vacuum pump exhaust stream is drawn into the leak detector through the QUICK-TEST probe.

The housing of the QUICK-TEST contains a diaphragm pump, a fuse, a switch, and three connecting ports. The NW40 flange is for connecting the QUICK-TEST to the ULTRATEST test port; the NW10 flange is for connecting the calibrated leak to the QUICK-TEST; the socket is for connecting the QUICK-TEST PVC tubing and probe to the QUICK-TEST housing.

The sample gas flows through the QUICK-TEST as follows (see Figure A-1).

1. Approximately 90 atm.cc/minute of gas is drawn in through the 0.01-inch (0.25 mm) I.D. capillary tube on the end of the probe. The probe tube has a filter to remove dirt.

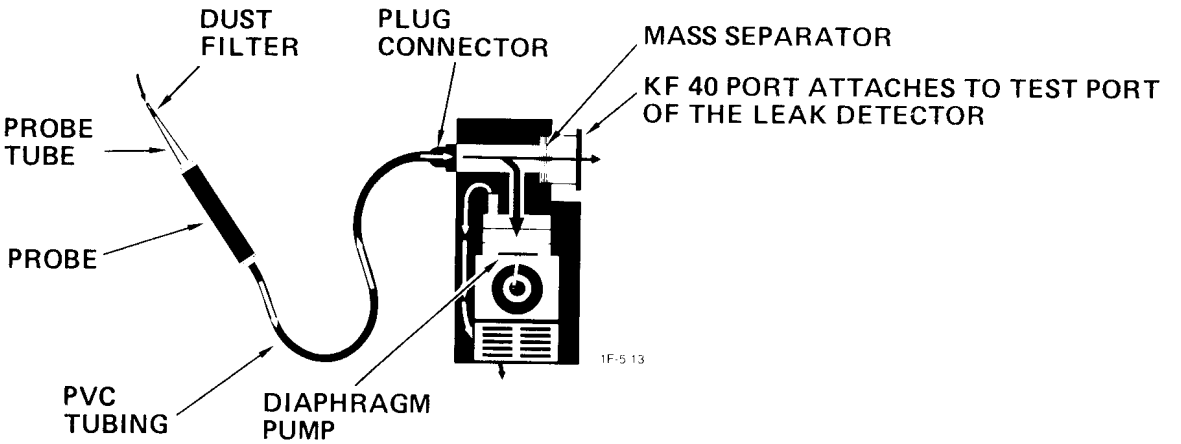

Figure A-1 - Simplified Diagram of the QUICK-TEST

2. The gas flows through the PVC tubing and into the QUICK-TEST housing. The diaphragm pump (see Item 4 below) maintains gas flow in the PVC tubing.

3. A gas permeable membrane inside the NW40 port of the QUICK-TEST housing allows only 10^{-3} atm·cc/sec. to pass through it and into the ULTRATEST test port. This membrane, called the mass separator, is permeable by helium but not by gases with larger molecules. The mass separator prevents most undesirable gases from entering the leak detector, thus protecting the mass spectrometer and pumping system from contamination (see Section 8-2-4). Because the mass separator protects the high vacuum system of the leak detector from most contaminants, it is not necessary to add LN_2 to the cold trap.

4. The diaphragm pump inside of the QUICK-TEST housing exhausts the gas that does not pass through the permeable membrane.

TABLE A-1 - SPECIFICATIONS FOR QUICK-TEST

Smallest Detectable Leakrate	10^{-7} atm.cc/sec with ULTRATEST F
Gas Throughput in Probe	Approx. 90 atm.cc/minute
Sampled Gas Inlet to Leak Detector	Approx. 10^{-3} atm.cc/sec.
Connecting Flange	NW40KF
Connecting Flange for Calibrated Leak	NW10KF
Line Voltage	60 Hz, 220V
Dimensions of Housing	8.4x6x3.2 inches
Weight of Housing	5.5 lbs
Probe PVC Tubing Length	15 ft. standard, up to 100 ft. optional
Response time for 15 ft. tubing*	less than 2 seconds
Weight of 15 ft. of tubing	1.1 lbs.
Capillary	0.01 inch (0.25 mm) ID

* If you ordered the optional longer tubing, the response time will be greater.

The QUICK-TEST is excellent for pinpointing leaks. However, a precise reading of the leak rate is not possible with a helium sampling probe because of the following:

- The mixture of ambient air with the helium streaming out of the leak can not be controlled.
- Only a portion of the gas entering the probe flows into the mass spectrometer.

See Section A-3 to obtain an approximate leak rate when using the QUICK-TEST.

The switch on the QUICK-TEST must be ON when leak checking.

When scanning a vessel with the QUICK-TEST probe, hold the tip of the probe tube no more than 5 mm (3/16 inch) away from the vessel surface, and do not move the probe faster than 3/4 inch/second (see Section A-4).

A-2 INSTALLATION

Install the QUICK-TEST onto the leak detector as follows (see Figure A-2).

1. Refer to Section 4-2 to start the ULTRATEST.

2. Press the "VENT" pushbutton and hold it down for 2 seconds to vent the test port.

3. If not already done, remove the KF clamp from the top test port of the leak detector.

4. Remove the plastic cover from the flanges on the QUICK-TEST housing.

5. CAUTION: DO NOT SCRATCH THE ALUMINUM FLANGES ON THE QUICK-TEST OR THE TEST PORT FLANGE ON THE LEAK DETECTOR. ENSURE THAT THE FLANGES ARE CLEAN.

   Use the KF clamp ring and the centering ring with clean O-ring to attach the larger QUICK-TEST flange to the top test-port flange on the leak detector.

   NOTE: The QUICK-TEST can also be permanently mounted on the side test port using the KF40 extension that came with the ULTRATEST and a KF40 gate valve (Part No. 99-269-062). This arrangement allows you to use the top test port when you need to quantify fine leaks, and use the QUICK-TEST mounted on the side test port when you need to sniff for leaks.

6. Lift the lid on the white plastic outlet which is located at the bottom of the rear side of the leak detector, and plug the 2-pronged QUICK-TEST plug into the plastic outlet (see Figure 9-10).

7. NOTE: You can use a maximum of 100 feet of optional PVC tubing (Part Number 99-262-2003) on the helium sampling probe for remote leak checking.

   CAUTION: DO NOT STRIP THE ALUMINUM THREADS IN THE QUICK-TEST CONNECTOR SOCKET WHEN ATTACHING THE TUBING/PROBE ASSEMBLY.

   NOTE: Be sure that the small O-ring inside of the plug connector is in place.

   Screw the plug connector that is on the end of the PVC tubing into its socket on the front of the QUICK-TEST (see Figure A-2).

8. Use a KF clamp ring and centering ring with clean O-ring to attach an optional calibrated leak to the KF-10 flange on the side of the QUICK-TEST (see Figure A-2).

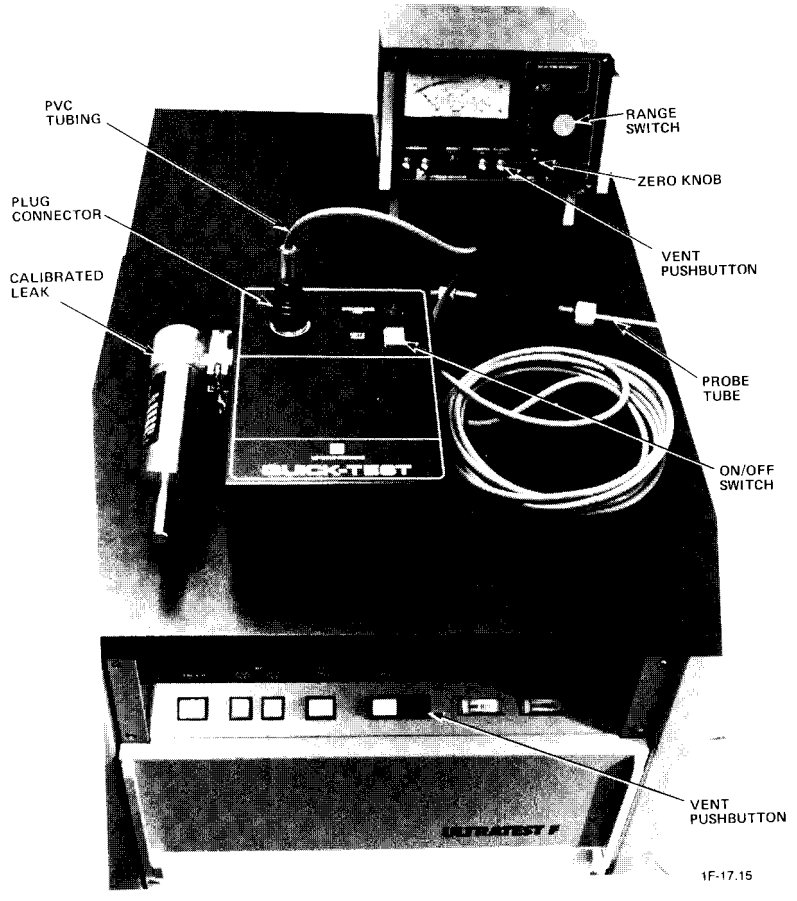

Figure A-2 - QUICK-TEST Installed on the ULTRATEST F

A-3 STARTUP AND CALIBRATION

The calibration may not be exact when the QUICK-TEST is installed because the PIII pressure will not be as good.

Switch the QUICK-TEST to the ON position; use Sections 4-2 and 4-3 to start and calibrate the ULTRATEST with the following exceptions:

- Sec. 4-2, Step 6a - LN_2 is not normally added to the ULTRATEST cold trap when the QUICK-TEST is being used because the separator in the QUICK-TEST prevents most contaminants from entering the leak detector.

- Sec. 4-2, Step 6e and Sec. 4-3, Step 2 - The PIII pressure needs to be less than 8×10^{-5} mbar to calibrate the ULTRATEST with the QUICK-TEST installed.

- After Step 7e and before Step 7f of Sec. 4-2 - Turn the range switch to the appropriate leak-rate position and note the background. This background is normally 1.5×10^{-8} due to the naturally occurring helium in air.

- Sec. 4-2, Step 7h and Sec. 4-3, Step 8 - With the QUICK-TEST installed, add the background that you previously noted to the leak rate stamped on the calibrated leak; then adjust the EMISSION potentiometer until the leak-rate indication on the meter matches this sum.

A-3-1 Determine the Correction Factor for the QUICK-TEST

Not all of the helium from a leak enters the ULTRATEST mass spectrometer. Some of the helium is not picked up by the probe tip. Part of the helium that enters the probe tip is pumped back to atmosphere by the QUICK-TEST diaphragm pump. Thus, the leak rate indicated on the ULTRATEST meter is lower than the actual leak rate by a factor of 100 to 1000. To get a rough approximate idea of the leak rate when using the QUICK-TEST, multiply the meter reading by a correction factor. This Section describes how to calculate the correction factor.

Determine the correction factor as follows:

1. Select a calibrated leak that has a flow rate equal to the smallest leak that you are trying to detect. A wide range of calibrated leaks are available (see Section 9 of the Leybold-Heraeus price list).

2. Close the 10^{-8} calibrated leak on the QUICK-TEST (see Figure A-2) and the built-in calibrated leak of the ULTRATEST, if installed (see Figure 2-2).

3. Insert a piece of sponge into the flange of the calibrated leak selected in Step 1 and open this calibrated leak.

4. NOTE: Ensure that the QUICK-TEST is switched ON (see Fig A-2).

   Insert the probe tube of the QUICK-TEST into the sponge in the calibrated leak and read the leak rate on the meter.

5. Divide the leak rate stamped on the calibrated leak by the leak rate indicated on the ULTRATEST meter to determine the correction factor.

6. When leak checking, multiply the meter reading by the correction factor to get an approximate leak rate (see Section 4-1-2).

A-3-2 Using the Helium Content in Air to Roughly Calibrate the ULTRATEST

Use this method for a rough approximate calibration only if you are using a QUICK-TEST and you do not have a calibrated leak.

This method gives a false calibration if the room has a higher than normal concentration of helium from leak checking.

Proceed as follows to check the calibration of the QUICK-TEST using the 4 to 5 ppm of naturally occurring helium in air.

1. Ensure that the QUICK-TEST is switched ON "1" (see Figure A-2).

2. Turn the range switch to PIII and wait until PIII reads less than 8×10^{-5} and the READY lamp lights with a steady glow.

3. Ensure that the mass switch is in the 4 position (see Table 8-3).

4. Turn the range switch fully clockwise to the "1" position.

5. Place your finger over the end of the probe tube of the optional QUICK-TEST and turn the "Zero" knob until the meter registers 0 (see Figure A-2).

6. Remove your finger and watch the needle deflection on the meter. If the ULTRATEST is roughly calibrated, the needle deflection will be 5% to 20% of full scale. The needle should drop close to 0 again when you replace your finger.

7. NOTE: This 5% to 20% range assumes that you are measuring normal atmospheric air. If you have been using helium in the room, it can cause the needle to deflect much more than 20% on a properly calibrated leak detector.

   Proceed as follows if the needle deflection in Step 6 was not within 5% to 20% of full scale with your finger removed.

   a. Turn the range switch to I_E and adjust the emission potentiometer until the needle points to 1 on the red 0 to 10 scale (see Figure 8-12).

   b. Return the range switch to the "1" position (see Figure A-2).

c. Do Steps 7 of Section 4-3 to adjust the U_1 and U_2 potentiometers for maximum deflection.

d. Adjust the emission potentiometer until the needle deflection is within 10 to 20% of full scale (see Figure 8-12). If you want to eliminate the background reading caused by the naturally occuring helium in air, use the ZERO knob to adjust the leak rate to 0 (see Figure A-2).

e. Turn the mass switch to the 4.5 and then to the 3.5 position; the meter reading should drop toward 0 when the switch is on 4.5 or 3.5. If the leak-rate indication does not drop toward 0, it is probably due to contamination (see Section 8-2-4).

f. Check the response of the QUICK-TEST by inserting its probe tube into a 10^{-5} atm.cc/sec or larger calibrated leak; the leak-rate reading should rise to the right.

g. Briefly place your finger over the probe tube. The meter reading should approach 0.

A-4 LEAK CHECKING TECHNIQUES FOR THE ULTRATEST WITH OPTIONAL QUICK-TEST.

The following are the techniques most commonly used to locate leaks using the QUICK-TEST.

A-4-1 Sniffing

Sniffing refers to using the helium sampling probe to find a leak in a container that has been filled with helium search gas (see Figure A-3).

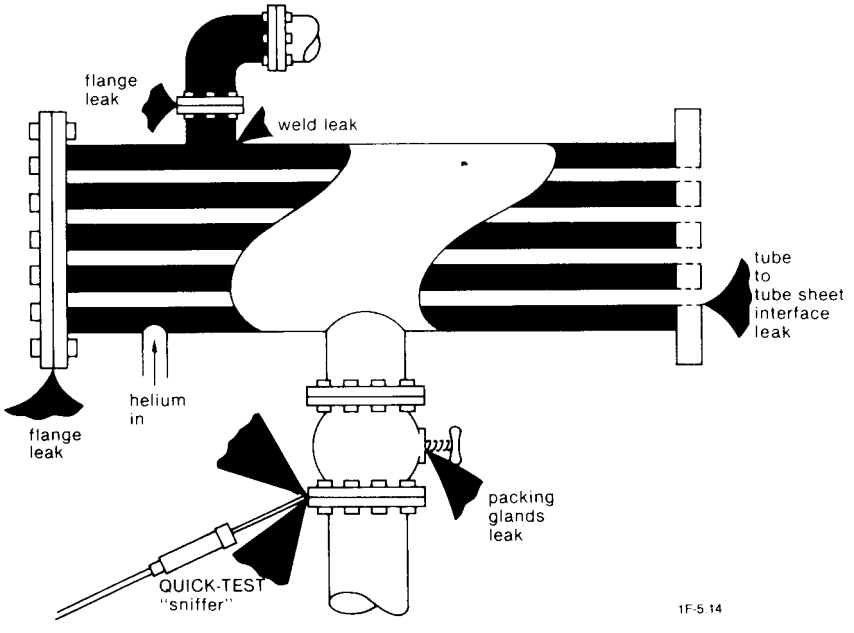

Fig A-3 - Using the QUICK-TEST to Leakcheck a Container Filled with Helium

Proceed as follows to use the sniffing technique:

1. Ensure that the vessel being checked is dry and clean to prevent dirt or moisture from clogging the QUICK-TEST probe.

2. NOTE: For the pressurizing gas you can either use 100% helium or a mixture of helium and another suitable gas. Using 100% helium will result in better leak detection sensitivity. If a gas mixture is used to pressurize, add the helium to the vessel first and then add the other gas to ensure a homogenous turbulent mixing.

   Fill the vessel with the gas until it has a few pounds positive pressure. Selection of the pressure must depend on the strength of the vessel and other test conditions.

3. NOTE: The concentration of helium decreases rapidly with increasing distance from the leak. Hold the tip of the probe tube 5 mm (3/16 inch) away from the vessel surface when scanning with the QUICK-TEST (see Figure A-4).

a = Ratio of the leak-rate reading on the meter to the actual leak rate.

D = Perpendicular distance between the tip of the QUICK-TEST probe tube and the leak.

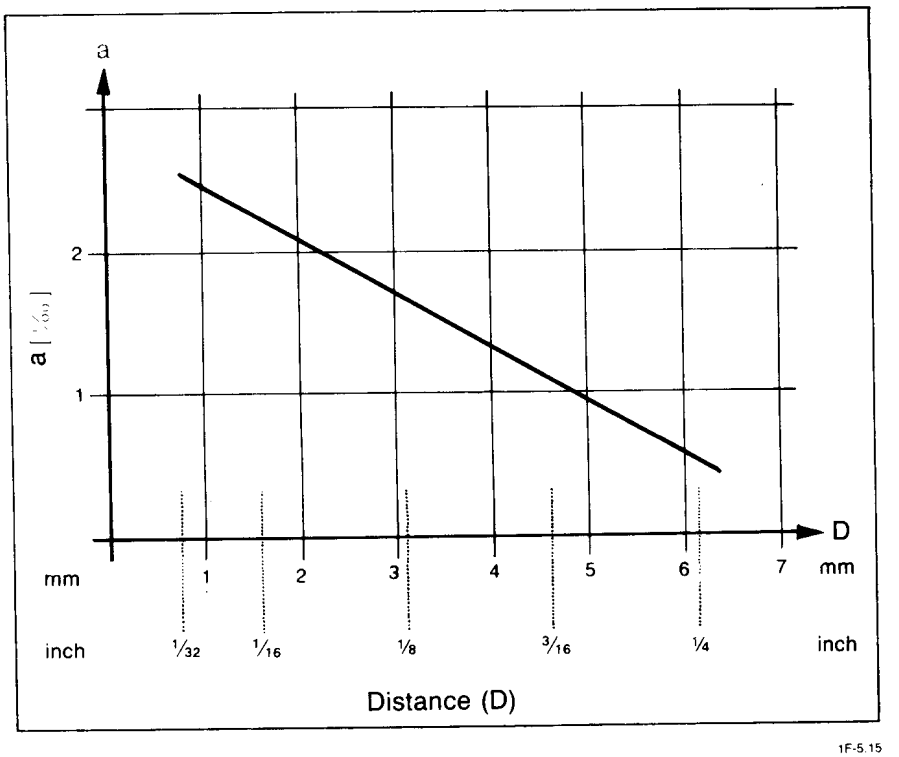

Figure A-4 - Distance Vs. Leak-Rate Reading When Sniffing with the QUICK-TEST

Slowly scan (less than 3/4-inch/second) the areas of the vessel suspected of leaking such as welds, flanges, tube/sheet-interface welds, thermocouple penetrations, etc. (see Figure A-5).

When the meter and/or audible signal indicates a leak, reverse the movement of the probe to find the precise location of the leak.

4. See Section A-3-1 to determine the approximate leak rate when using the QUICK-TEST.

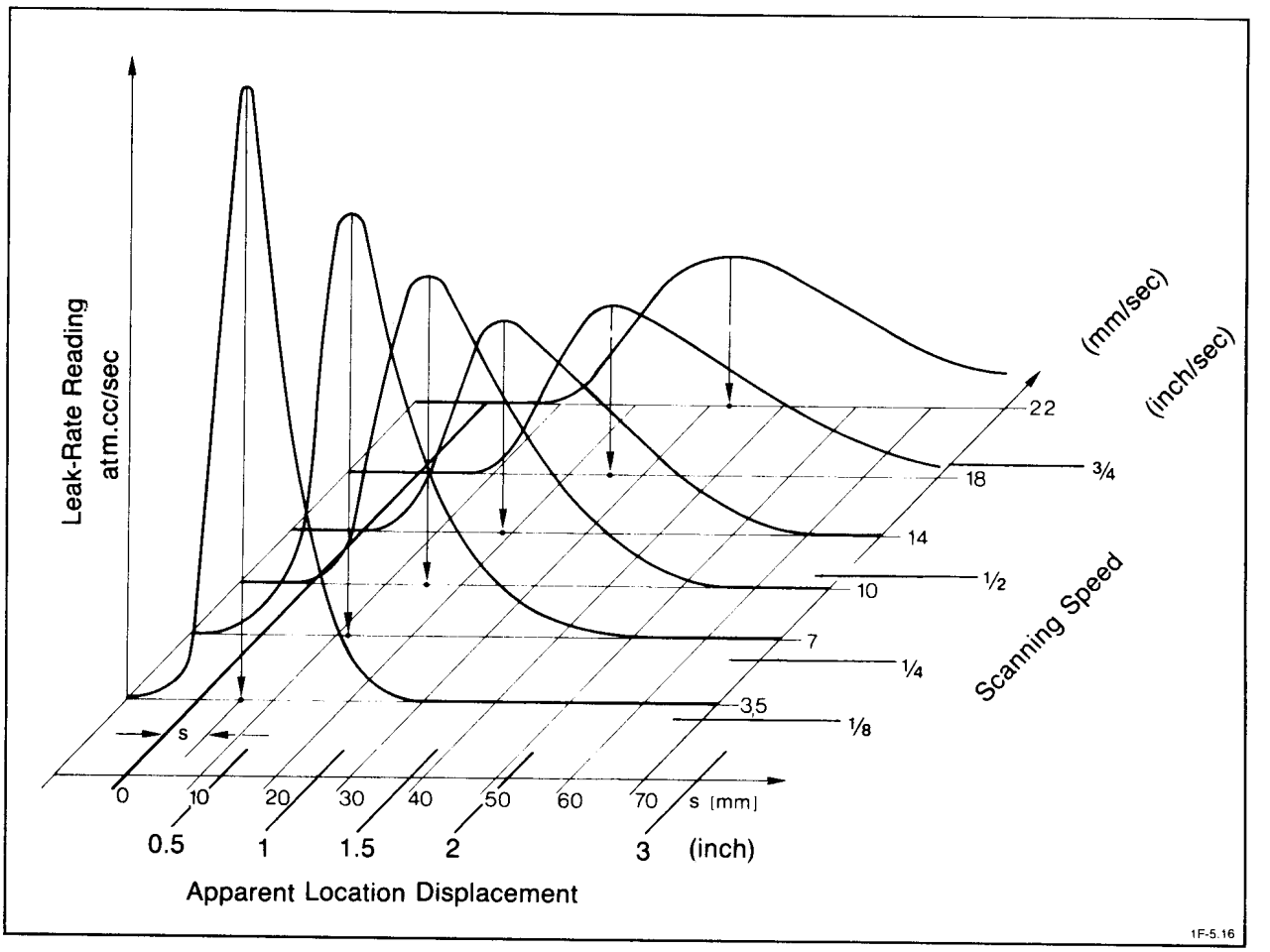

Figure A-5 - Location Displacement and Leak-Rate Reading as a Function of Scanning Speed when Sniffing with the QUICK-TEST

A-4-2 Vaccum Pump Exhaust

This technique can be used for most any process that has a vacuum pump. Proceed as follows to use the vacuum pump exhaust technique (see Figure A-6).

1. Insert the QUICK-TEST probe into the exhaust line of the system vacuum pump.

2. Spray helium on suspected leak areas.

   If there is a leak, the helium will penetrate the leak, be drawn through the system, and into the vacuum exhaust line where it will register on the ULTRATEST. The response time depends on the size and location of the leak, on the pressure of the system, and on the volume/pumping speed ratio of the system.

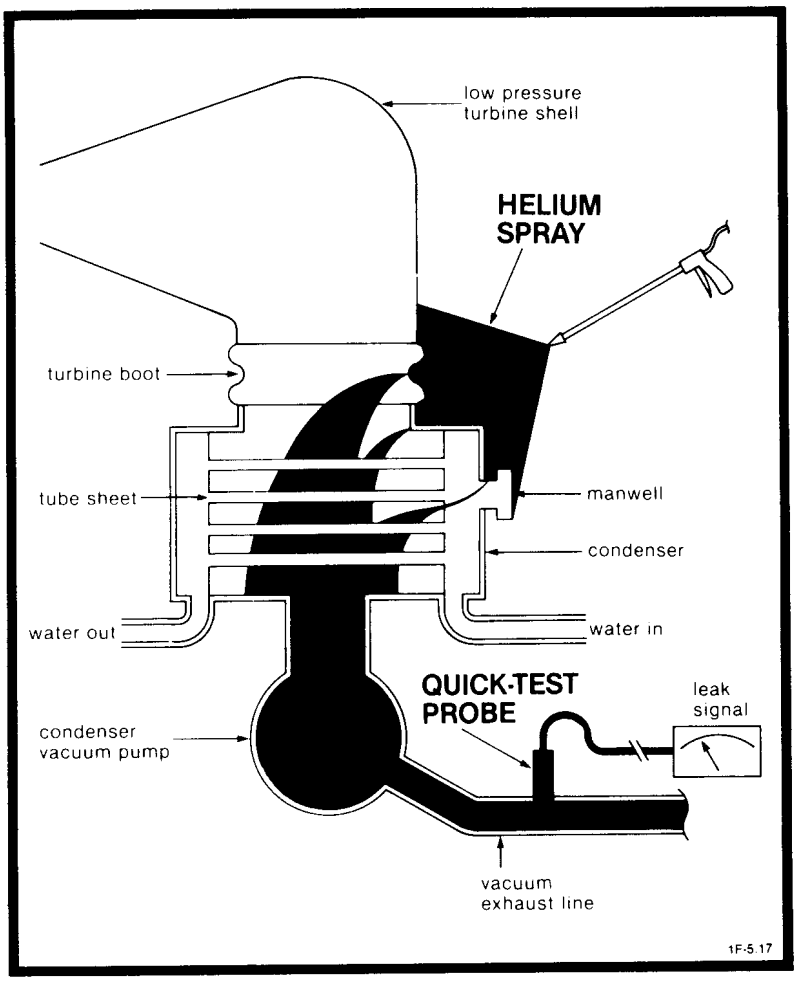

Figure A-6 - Using the QUICK-TEST to Leak Check Power Plant Condensers

A-5 MAINTENANCE AND CHECKOUT FOR OPTIONAL QUICK-TEST

NOTE: See Figure A-10 for the part numbers of spare parts for the QUICK-TEST.

If the pressure in the mass spectrometer is less than 3×10^{-5} mbar, the background leak rate is low, and the ULTRATEST does not sense helium, it indicates one of the following problems:

1) the dust filter in the probe tube is plugged (see Section A-5-1).
2) the mass separator is dirty (see Section A-5-2).
3) the PVC tubing is contaminated (see Section A-5-3).

A-5-1 Changing the Dust Filter

Change the dust filter as follows (see Figure A-7).

1. Unscrew the knurled nut and carefully remove the probe tube from the end of the probe (see Figure A-7).

2. Using the drift tool supplied with the QUICK-TEST, push the dust filter out of the probe tube.

3. Using the drift tool, push a new dust filter in place in the end of the probe tube.

4. Reassemble the probe.

A-5-2 Installing a New Mass Separator (Part No. 333-59-191)

The mass separator is located inside of the KF40 port which extends out of the back of the QUICK-TEST housing.

Install a new mass separator as follows:

1. Remove the QUICK-TEST from the leak detector.

2. Remove the four slotted screws that attach the separator to the inside of the KF40 port to remove the separator (see Figure A-10).

3. Remove the O-ring from the inside of the KF40 port and replace it with one of the spare O-rings that came with the QUICK-TEST. Make sure the O-ring and mating surfaces are clean.

4. Use the four slotted screws to install a new separator.

After a new mass spectrometer is installed, PIII is normally between 2×10^{-5} and 8×10^{-5} mbar with the ULTRATEST at operating temperature, the QUICK-TEST switched ON, and without LN_2 in the cold trap.

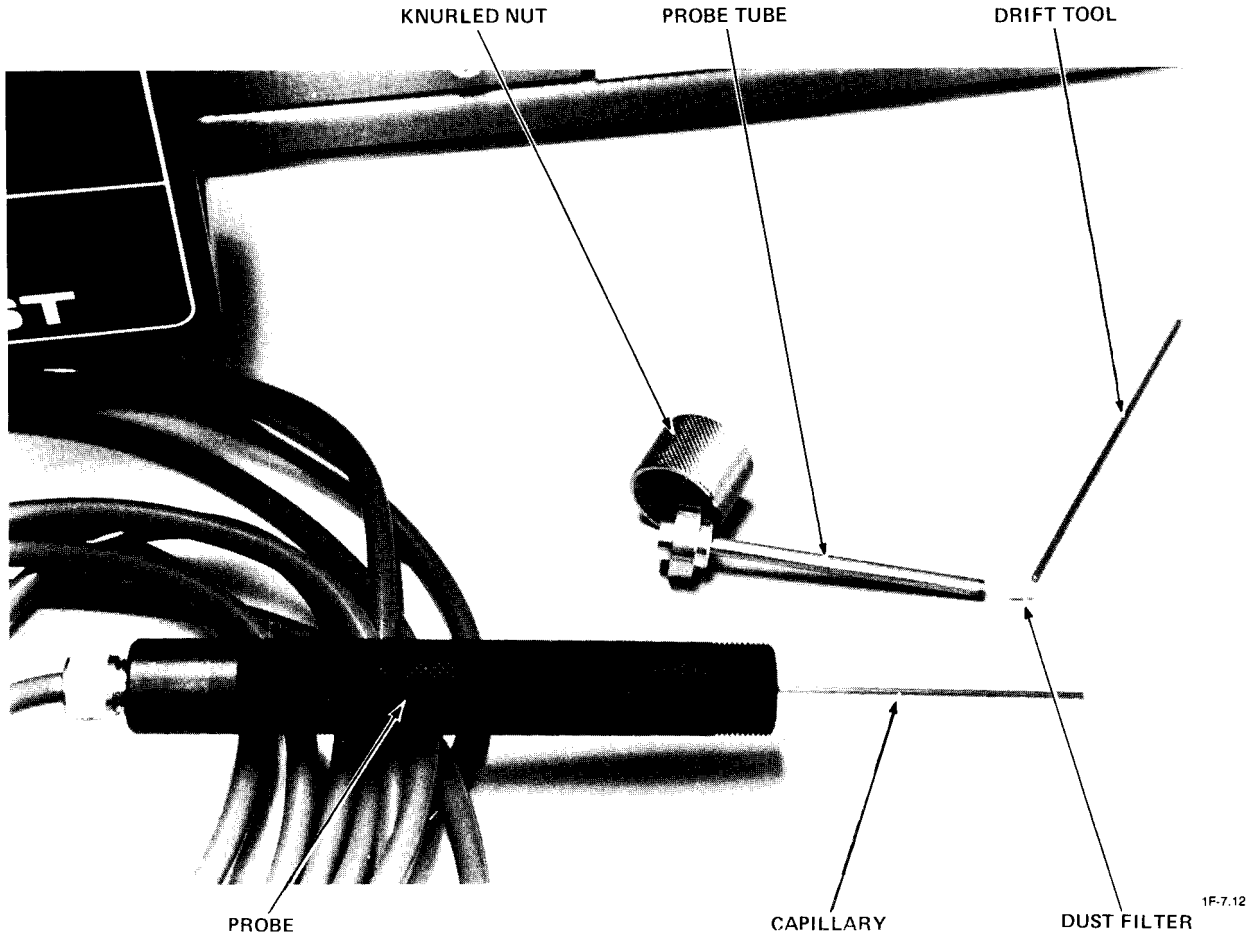

Figure A-7 - Changing the Dust Filter on the QUICK-TEST

A-5-3 Checking the Response and Clean-Up Time

The response to a 10^{-7} atm.cc/sec or greater leak should be less than two seconds with the standard 15-foot PVC tubing. The clean-up time should also be under 2 seconds.

Check the response and clean-up times as follows:

1. Insert the QUICK-TEST probe tube into a source of helium for 1 or 2 seconds. The meter should reach a maximum deflection in 1-1/2 to 2 seconds.

2. Rapidly move the probe tube away from the helium source and watch the leak-rate meter. The meter reading should drop off to near zero in 1-1/2 to 2 seconds.

3. If the response time (Step 1) or the clean-up time (Step 2) is greater than 2 seconds, either replace the PVC tubing (see Section A-7-1) or blow it clean with compressed air.

A-6 TROUBLESHOOTING

When troubleshooting an ULTRATEST that has the optional QUICK-TEST remove the QUICK-TEST from the test port and seal the test port (see Figure A-2). If the symptom remains, the problem is in the ULTRATEST. If the symptom clears when the QUICK-TEST is removed, the problem is in the QUICK-TEST.

Refer to Table A-1 to troubleshoot the QUICK-TEST. To use Table A-1, first observe the symptom, do the observation or check, and perform the recommended corrective action. The "Reference Section" column list Sections, Steps, or Figures in the manual that are helpful in correcting the problem.

See Figure A-10 for the part numbers of spare parts for the QUICK-TEST.

Refer to Section 8 if the problem is in the ULTRATEST.

TABLE A-1 - TROUBLESHOOTING CHART FOR THE OPTIONAL QUICK-TEST continued

Symptoms	Observation or Check	Probable Cause	Recommended Corrective Action	Reference Section
2. The ULTRATEST has little or no reaction to helium. Pressure PIII is greater than 10^{-4} mbar (continued).	Lack of noticeable suction at probe tip (continued).	Plug connector on the PVC tubing is not seated properly.	Ensure that plug connector is threaded properly into its socket in the QUICK-TEST housing.	Fig. A-2
		O-ring is missing from the plug connector.	Install a new O-ring into the PVC-tubing plug connector.	Fig. A-10
		Diaphragm pump malfunction.	Rebuild or install a new diaphragm pump.	Sec. A-7-2
3. Pressure PII is high resulting in decreased sensitivity to helium.	Background leak rate would likely be high (see Section 8-2).	Leaky mass separator.	Install a new separator and O-ring.	Sec. A-5-2
		Leak elsewhere in QUICK-TEST or diaphragm pump malfunction.	See Symptom 2.	
4. Pressure PIII is less than $1x10^{-4}$ mbar and the helium background is erratic or sensitivity is low.	Place your finger over the end of the probe tube. If the leak-rate reading does not change, the O-ring is missing.	Small O-ring is missing from base of probe tube.	Install new O-ring.	Fig. A-10
5. PIII is approximately 0 to $3x10^{-5}$ mbar and PVC tubing suction is good.	Slow response and cleanup or helium sensitivity is poor.	Mass separator is contaminated with dirt or oil.	Remove the plug connector from the QUICK-TEST. With the QUICK-TEST installed on the test port and the ULTRATEST ON, slowly introduce 1 to 2 tablespoons of methanol into the center of the socket in the QUICK-TEST housing. Allow the QUICK-TEST to run for 5 minutes.	Figs. A-2 & A-8. Sec. A-5-2 See Symptom 1b.

TABLE A-2 - TROUBLESHOOTING CHART FOR THE OPTIONAL QUICK-TEST

Symptoms	Observation or Check	Probable Cause	Recommended Corrective Action	Reference Section
1. The ULTRATEST has little or no reaction to helium. Pressure PIII is less than 1×10^{-4} mbar. The background leak rate is low (see Section 8-2).	a. Is probe held farther than 5 mm (3/16-inch) from surface or vessel being leak checked	Probe is too far from leak.	Hold probe tip 5 mm (3/16-inch) from vessel surface.	Figure A-4
	b. Remove knurled nut and probe tip from stainless steel capillary and observe the reaction to helium.	If the ULTRATEST now responds to helium, it means that the dust filter is clogged.	Install new dust filter.	Sec. A-5-1
		If the ULTRATEST still does not react to helium, remove the plug connector from the QUICK-TEST housing and watch PIII. If PIII rises, it means that the capillary or tubing is contaminated. If PIII does not rise, it means that the mass separator is clogged.	Remove and clean stainless steel capillary and tubing. If problem continues, install new tubing.	Sec. A-7-1
			Install a new mass separator and O-ring.	Sec. A-5-2; Symptom 5
2. The ULTRATEST has little or no reaction to helium. Pressure PIII is greater than 10^{-4} mbar.	Lack of noticeable suction at probe tip.	Leak in QUICK-TEST.	Ensure that all connections are tight including the mass separator, the clamp attaching the tubing to the plug connector, and the capillary/hose connection. Tighten the knurled nut. If necessary, replace the small O-ring in the plug connector, in the probe, or under the separator.	Sec. A-7-1 Fig. A-7
			Remove the cover from the QUICK-TEST housing and use helium to leak check the plug and tubing connections within the housing. Tighten the hose clamps on the nozzles.	Sec. A-7-1 Fig. A-8
		QUICK-TEST is not switched ON.	Switch ON the QUICK-TEST.	

A-7 REPAIR

Once you isolate the source of the problem (see Section A-6), refer to the applicable instructions in this section or in Section A-5 to repair the problem.

See Figure A-10 for replacement part numbers for the QUICK-TEST.

A-7-1 Disassembling the Probe, PVC Tubing, and Plug Connector

NOTE: A QUICK-TEST with clean PVC tubing has a cleanup and a response to a 10^{-6} atm.cc/sec. or greater leak of 1-1/2 to 3 seconds.

Proceed as follows to disassemble the probe/tubing assembly to clean or replace it.

1. Disassemble the probe as follows (see Figure A-7).

   a. Unscrew and remove the knurled nut from the probe tube end of the probe.

   b. Carefully remove the probe tube from the stainless steel capillary.

   c. Using the drift tool supplied with the QUICK-TEST, push the dust filter out of the probe tube (see Figure A-7).

   d. Remove the small O-ring from the base of the probe tube.

   e. Using a small screwdriver, remove the retainer ring from inside of the probe handle.

   f. Unscrew the knurled nut and pull back the plastic sleeve from the base of the probe handle.

   g. Pull the stainless steel capillary from the probe handle.

   h. Pull the PVC tubing off of the stainless steel capillary.

2. Disassemble the plug connector as follows:

   a. Unscrew and remove the plug connector from its socket in the QUICK-TEST housing (see Figure A-2).

   b. Remove the small O-ring from inside of the plug connector.

   c. Unscrew the black plastic nut from the PVC tubing end of the plug connector and slide the clear choke grommet up the tubing (see Figure A-2).

Section A-7-1, Step 2 continued

d. Unscrew the hose clamp securing the PVC tubing to the plug connector.

e. Remove the PVC tubing from the plug connector.

3. Clean the stainless steel capillary and PVC tubing with methanol and blow out with dry compressed air (see Figure A-10). If the problem continues, install new PVC tubing.

4. Clean or replace damaged parts and O-rings and reassemble ensuring all connections are vacuum tight.

A-7-2 Installing a New Diaphragm Pump in the QUICK-TEST

NOTE: Normally the diaphragm pump can be repaired by installing a new valve plate and diaphragm (see Section A-7-3).

If necessary, install a new diaphragm pump into the QUICK-TEST as follows:

1. If not already done, unplug the QUICK-TEST power cord from the outlet on the back of the leak detector (see Figure 8-18).

2. Remove the slotted screws from each of the four corners on the back of te QUICK-TEST housing and pull the black cover off of the housing (see Figure A-8).

3. Pull the two slip-on quick-disconnects off of the diaphragm pump motor (see Figure A-8).

4. Loosen the hose clamp and pull the hose off of the inlet of the diaphragm pump (see Figure A-8).

5. Remove the four large phillips screws attaching the bottom plate of the frame to the vibration absorbers (see Figure A-8).

6. Pull the bracket containing the diaphragm pump out of the QUICK-TEST housing (see Figure A-8).

7. Remove the four small phillips screws which hold the bottom of the bracket to the legs of the bracket (see Figure A-8).

8. Unscrew the four vibration absorbers from the bottom of the bracket and remove the diaphragm pump.

9. Reassemble the QUICK-TEST using a new diaphragm pump (see Figure A-8).

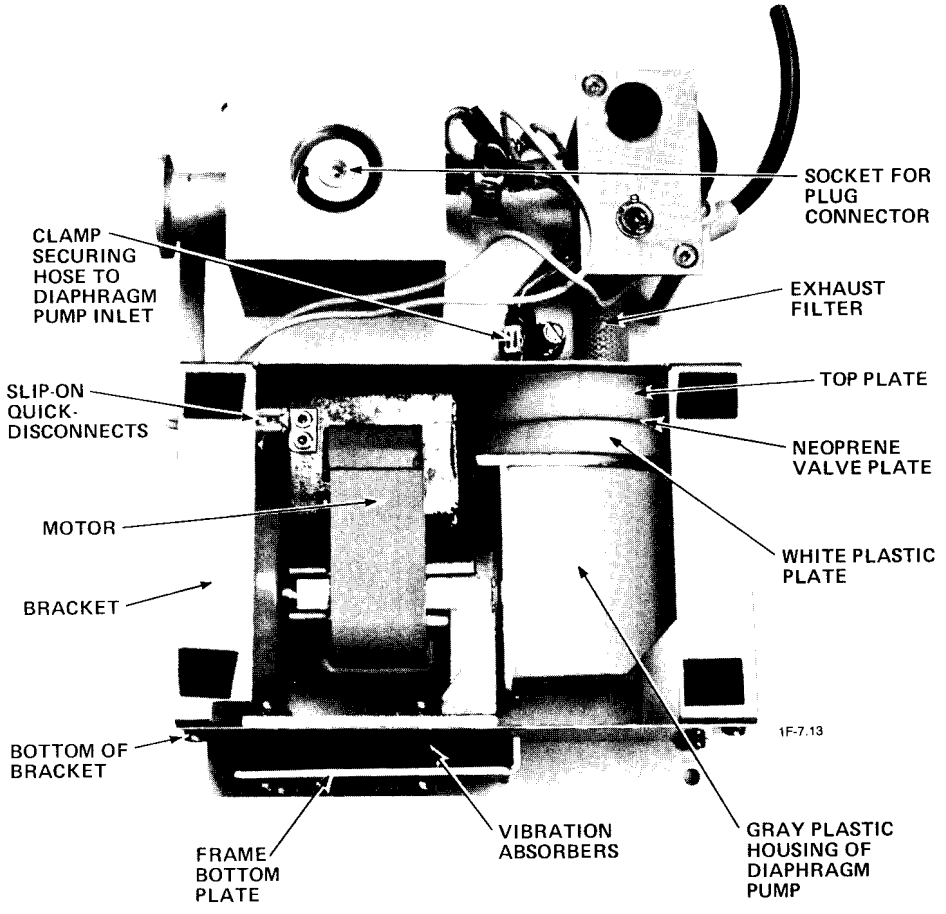

Figure A-8 - Diaphragm Pump Installed in Gas Transfer Unit of QUICK-TEST

A-7-3 Installing a Valve Plate and Diaphragm In the Diaphragm Pump

NOTE: A set consisting of a neoprene diaphragm and a valve plate is available under part number 99-236-3014.

1. Do Steps 1 through 5 of Section A-7-2 to remove the diaphragm pumps/bracket assembly from the QUICK-TEST.

2. Disassemble the diaphragm pump as follows (see Figure A-8).

   a. Remove the four slotted screws securing the white plastic top plate to the diaphragm pump and remove the top from the pump.

   b. Remove the black neoprene valve plate and the white plastic plate (see Figure A-9).

   c. Remove the gray plastic housing from the diaphragm pump by unscrewing the small slotted screw from the base of the gray plastic housing.

3. Unscrew the black neoprene diaphragm from the pump and replace it with the new diaphragm.

4. Reassemble the QUICK-TEST as follows:

   a. Reinstall the gray plastic housing ensuring that it snaps into its groove (see Figure A-8).

   b. Install the white plastic plate so that the concave surface faces down.

   c. Set the new black neoprene valve plate and the top plate onto the white plastic plate ensuring that the inlet and exhaust openings are aligned properly (see Figure A-9). Use the four slotted screws to secure the plates in place.

5. Reassemble the remainder of the QUICK-TEST (see Figure A-10 and A-8).

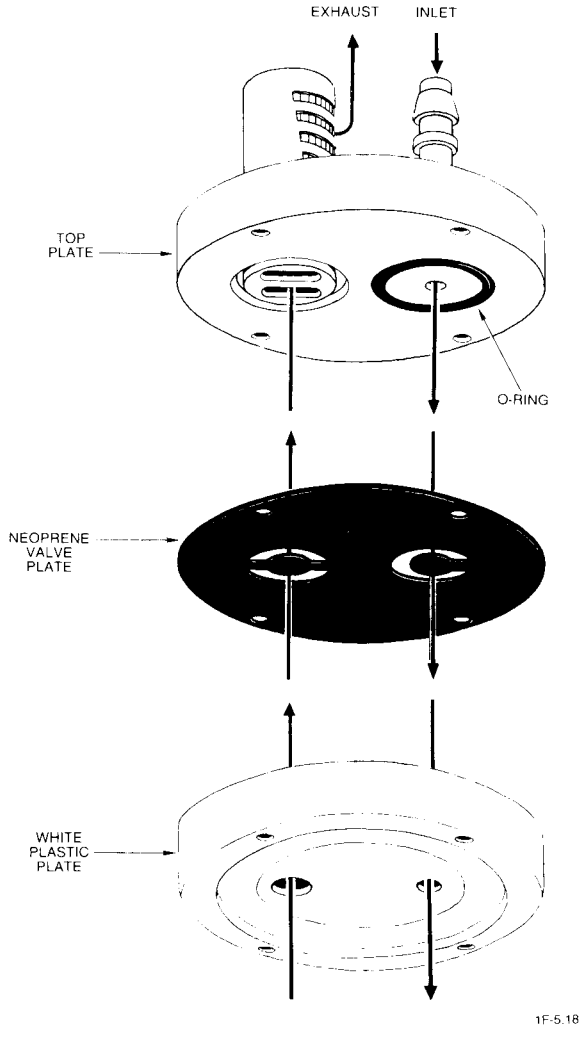

Figure A-9 - Inlet and Exhaust Openings for Plates of the QUICK-TEST Diaphragm Pump

A-8 PARTS LIST

See Figure A-10 for the complete list of parts for the QUICK-TEST.

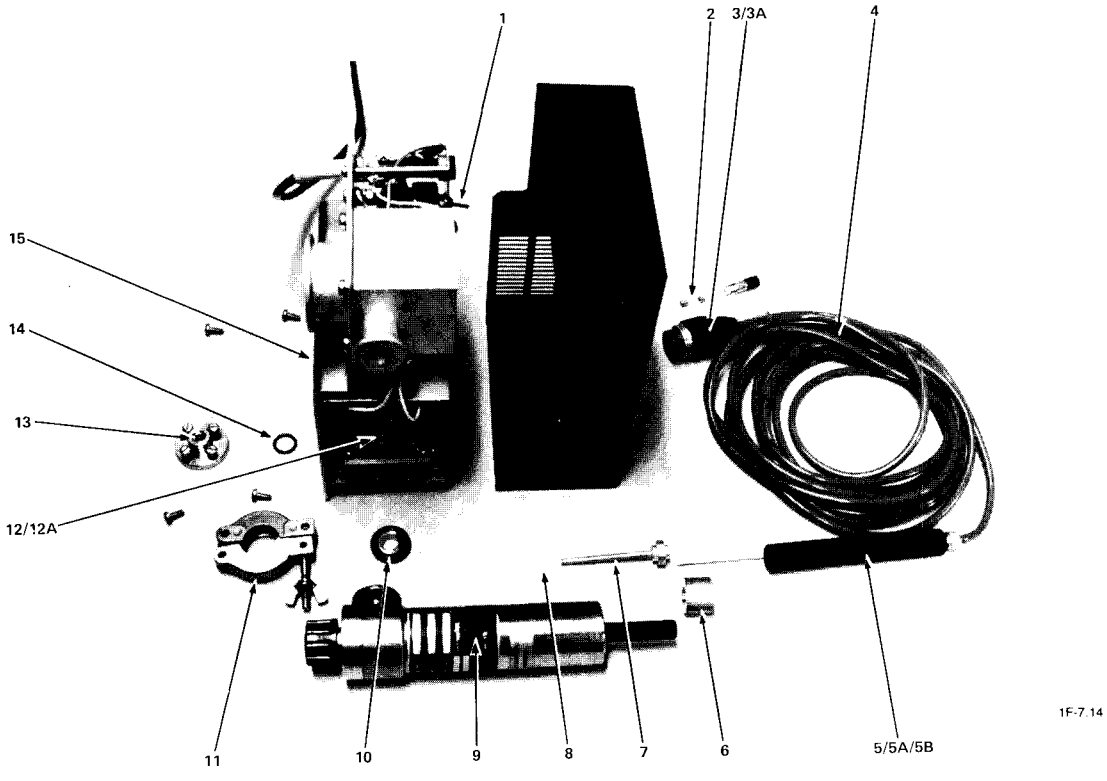

FIGURE A-10 - Disassembled QUICK-TEST (Catalog No. 89600-2)

Item No.	Description	Part Number	Remarks
1	ON/OFF Switch	500-36-024	
2	Fuse T 0.5	520-25-312*	
3	Plug Assembly	500-21-122*+	
3A	O-Ring	239-74-102*+	
4	PVC Tubing	99-262-2002*+	
5	Probe Handle	228-74-107+	
5A	O-Ring	239-74-102*+	
5B	Inlet Capillary	350-01-144+	
6	Knurled Nut	212-12-113+	
7	Probe Tube	401-57-226+	
8	Dust Filter (Package of 25)	390-26-149*+	See Section A-5
9	Calibrated Leak (10^{-8} mbar)	16557	For use with QUICK-TEST
10	KF10 Centering Ring with O-ring	88321	
11	KF10 Clamp Ring	18341	
12	Diaphragm Pump, Complete	99-236-3013	
12A	Neoprene Diaphragm with Valve Plate for Diaphragm Pump (Gasket Set)	99-236-3014*	
13	Mass Separator	333-59-191*	
14	O-Ring for Separator (Buna-N)	239-50-307	
15	Vibration Absorbers (4 required)	370-52-101	
*	Maintenance Kit	99-077-074	Kit includes all items with an "*" by its Part Number.
+	Probe Assembly	15577	Includes all items with a "+" by its Part Number.

APPENDIX B

SETTING THE TRIGGERS FOR THE ZERO MONITOR AND LEAK-RATE MONITOR

CONTENTS

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B-2	Connecting and Setting the Triggers.....	208

LIST OF FIGURES

Figure	Title	Page
B-1	Rear View of FB Module	208

B-1 PURPOSE AND DESCRIPTION

The triggers automatically alert the operator when the zero setting or helium background has changed, or when the test object should be rejected. There are two triggers which are controlled by board LP7.

Trigger 1 is a "window" type design. The width of the trigger window is 10% of full scale defelction of the meter. If the meter needle is to the left of the window, it means the zero has drifted; if the needle is to the right of the window before you spray helium, it means either the zero has drifted or the background from helium or contamination has increased. Trigger 1 lights its red LED (see Figure B-1) and sends a signal to its relay outputs when the meter needle is to the left or to the right of the 10% window.

Trigger 2 is used during leak checking to alert the operator when to reject the test object. If the leak rate exceeds the preset value, trigger 2 lights its red LED (see Figure B-1) and sends a signal to its relay output.

Except for the US autoranging version (see Appendix E), the triggers are set off by the needle on the meter analog display regardless of the leak-rate position of the range switch.

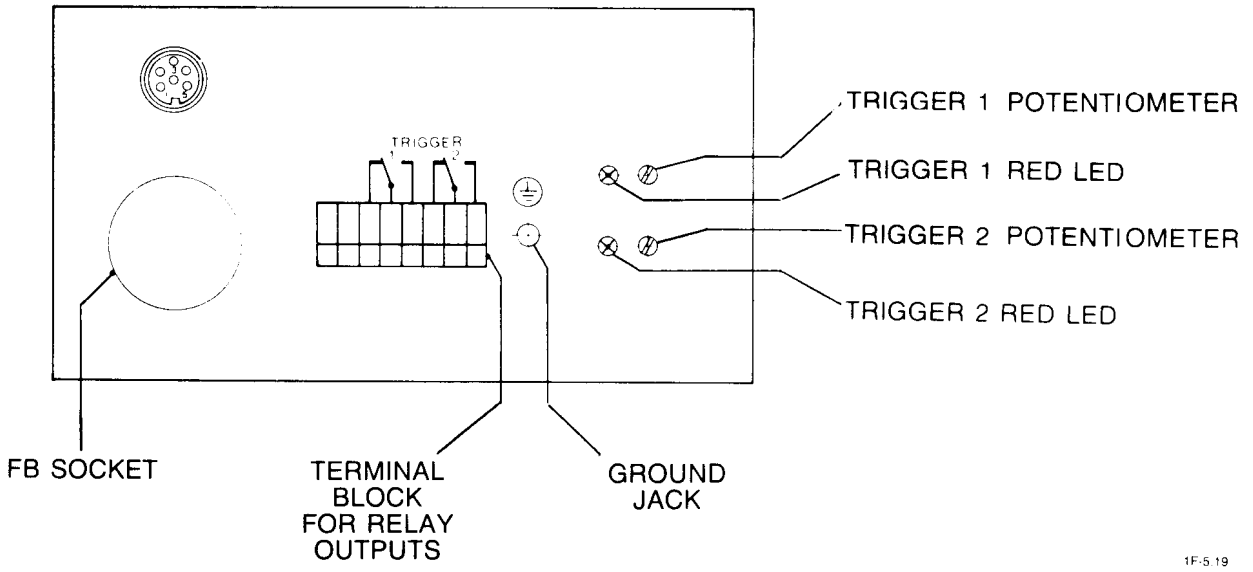

Figure B-1 - Rear View of FB Module

B-2 CONNECTING AND SETTING THE TRIGGERS

1. NOTE: See Table 3-1 for the trigger outputs.

   Wire your switching process to the trigger 1 and 2 terminal strip on the back of the FB module (see Figure B-1).

2. NOTE: The triggers are set at the factory at the following values:

   Trigger 1 - 10% of full scale deflection
   Trigger 2 - 50% of full scale deflection

   Proceed as follows if you want to change the trigger settings (see Figure B-1).

   a. Use Sections 4-2 and 4-3 to start and calibrate the ULTRATEST.

   b. Set the trigger 2 point as follows:

      1) With the test port sealed off, set the range switch and adjust the Zero knob on the front of the FB module so that the leak-rate reading is the maximum admissible leak for your test objects; i.e., if the leak-rate of a test object is higher than this reading, the test object will be rejected (see Section 4-1-2).

Section B-2, Step b continued

2) Adjust the trigger 2 potentiometer on the back of the FB module so that the red trigger 2 LED lights when the maximum admissible leak reading on the meter is exceeded.

3) Set trigger 1* to a leak rate value depending on the needs of your leak checking operation.

4) Use the ZERO knob to adjust the electrical zero of the meter.

* Trigger 1 is a window type design. The width of the trigger window is 10% of full scale deflection of the meter.

APPENDIX C

COLD TRAP VENT MODIFICATION (P/N 899411)

NOTE: Except as noted in this section, the information in this manual also applies to the ULTRATEST F with the cold trap vent modification.

C-1 DESCRIPTION

Some test procedures introduce an inordinant anount of contaminants into the leak detector vacuum system that freeze on the cold trap. These applications make it necessary to clean the cold trap frequently (see Sections 6-4 and 8-2-4). In these cases, many customers replace the cold trap metal gasket with an O-ring (P/N 239-70-404) because O-rings can be reused and because they are easier to use. However, there are two disadvantages to using O-rings: 1) O-rings are not as vacuum tight as metal gaskets resulting in increased background leak rate and decreased sensitivety, and 2) the cold trap does not vent when you remove its flange screws; thus the vacuum in the cold trap prevents you from pulling it out of the leak detector for cleaning.

When using an O-ring gasket the cold trap can be vented for cleaning by carefully inserting a wide flat blade scredriver under the edge of the flange and lifting it up slightly, or by use of the cold trap vent modification. The vent modification is the better alternative because it avoids the possibility of scratching the flange with the screwdriver and because it permits you to rough the cold trap after it is reinstalled in the leak detector. If the cold trap is not roughed before the leak detector is restarted, the diffusion pump will be exposed to atmospheric pressure which can result in loss or cracking of the diffusion pump fluid.

The vent modification consists of two service switches factory-mounted on the electrical bracket inside of the left side panel of the leak detector (see Figures 7-1A and C-1). The switches are only used when you want to remove and reinstall the cold trap for cleaning. Before removing the cold trap, operating the switches vents the cold trap by opening Valve V2 while venting valve V3 is open (see Figure 7-3 and Section C-2). After reinstalling the cold trap, operating the switches roughs the cold trap by opening Valve V2 while the roughing pump is ON with roughing valve V1 open and venting valve V3 is closed.

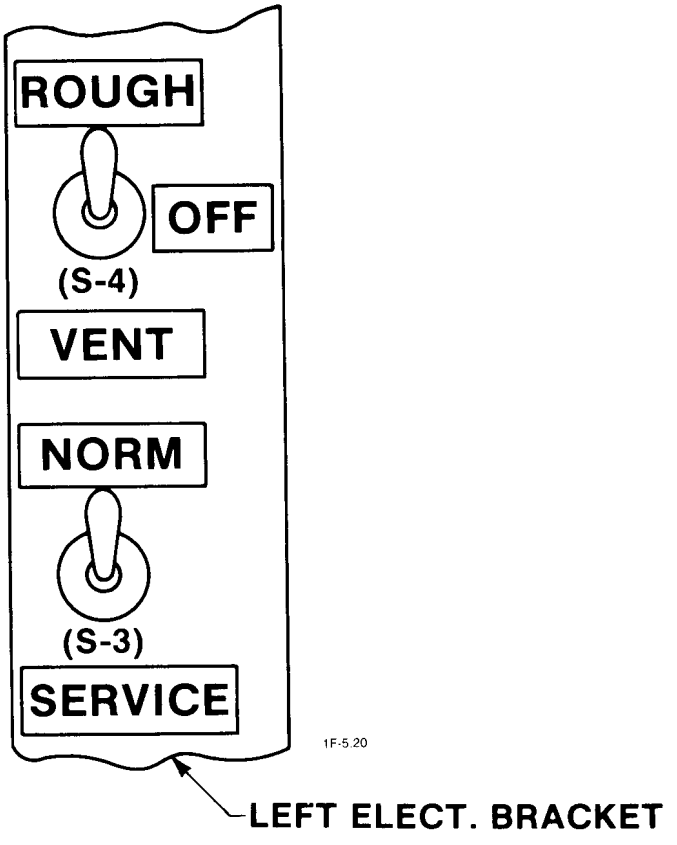

Figure C-1 - Service Switches Mounted on the Left Electrical Bracket

C-2 OPERATING THE COLD TRAP SERVICE SWITCHES

The cold trap service switches are used only when you want to remove and reinstall the cold trap.

1. Remove the cold trap from the leak detector as follows:

   a. Turn off the EMISSION (see Figure 4-3).

   b. Tap the VENT pushbutton on the front panel of the leak detector (see Figure 4-1B).

   c. Close handwheel valve V5, and then close handwheel valve V4 (see Figure 4-1A).

   d. Remove the gray left side panel from the leak detector.

   e. Push the lower service switch (S-3) down to the SERVICE position (see Figure C-1).

   f. Hold the upper service switch (S-4) down in the VENT position for 5 seconds; then release this switch (see Figure C-1).

Section C-2, Step 1 continued

g. Refer to Section 6-4 to remove, clean, and reinstall the cold trap.

2. After reinstalling the cold trap, rough the cold trap as follows:

a. Proceed as follows while holding the upper service switch (S-4) up to the ROUGH position,

1) Press the PUMP pushbutton on the front panel of the leak detector and observe pressure PI (see Figure 4-1B).

2) Once PI reaches 10^{-2} mbar, tap the VENT pushbutton on the front panel of the leak detector (see Figure 4-1B).

b. Release the upper service switch (S-4) (see Figure C-1).

c. Return the lower service switch to the NORMAL position (see Figure C-1).

d. Reinstall the gray side panel onto the left side of the leak detector.

e. Open handwheel valve V4, and then open handwheel valve V5 (see Figure 4-1A).

APPENDIX D

MANUAL GROSS LEAK BYPASS
(P/N 720-54-000)

NOTE: Except as noted in this section, the information in this manual also applies to the ULTRATEST F with manual gross leak bypass.

D-1 DESCRIPTION

The gross leak bypass permits leak testing when the test piece pressure is greater than 750 microns (0.75 Torr). It consists primarily of a bypass line, a solenoid valve, and a metering valve (see Figure D-1). A switch on the front panel of the leak detector controls the solenoid valve; a knob beside the switch controls the metering valve.

Most of the gas from the test piece is evacuated through the roughing pump; a small portion of the test-piece gas enters the bypass line if the bypass solenoid valve is open (see Figure D-1). The bypass line runs from the calibrated leak port in the valve block, through the solenoid and metering valves, and into the high vacuum line. The high vacuum line leads to the cold trap which is connected to the mass spectrometer. The operator uses the metering valve to control the amount of gas entering the mass spectrometer (see Section D-2).

D-2 INSTALLATION, START-UP, AND CALIBRATION

The manual gross leak bypass is factory installed.

NOTE: The calibrated leak port on the leak detector is used for the gross leak bypass; thus, this port can not be used to permanently install a calibrated leak as described in Step 4 of Section 2-2.

Use the installation, start-up, and calibration instructions in Sections 4-2 and 4-3 of this manual.

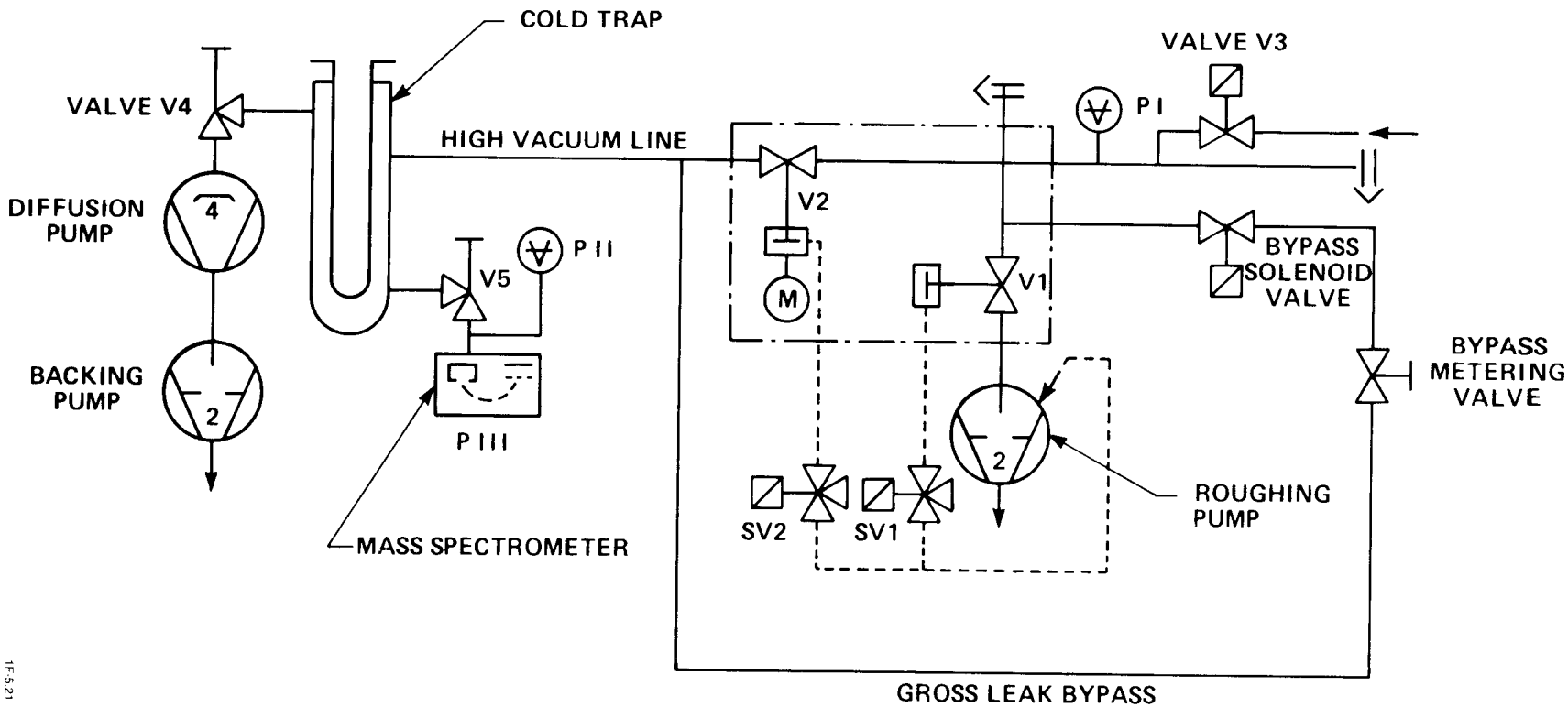

Figure D-1 - Vacuum Diagram of the ULTRATEST F with the Gross Leak Bypass

D-3 OPERATION

Proceed as follows to operate the leak detector in the gross leak mode.

1. Ensure that the BY-PASS/NORMAL switch on the front of the leak detector is in the NORMAL position.

2. Press the VENT pushbutton and hold it down for 10 seconds (see Figure 8-12).

3. Switch the BY-PASS/NORMAL switch to the BY-PASS position. Valve V2 can not open when this switch is in the BY-PASS position.

4. Close the bypass metering valve (do not force).

5. Press the PUMP pushbutton (see Figure 8-12).

6. CAUTION: DO NOT ALLOW PRESSURE PIII TO RISE ABOVE 2 X 10^{-4}; OPERATING ABOVE 2 X 10^{-4} RESULTS IN REDUCED SENSITIVITY AND PREMATURE FAILURE OF THE ION SOURCE.

   Slowly open the bypass metering valve until pressure PIII rises to 2 x 10^{-5} or until the metering valve is fully open (whichever comes first).

7. Set the range selector to the highest leak-rate range possible (see Figure 8-12) and check the test piece for gross leaks.

8. Close the metering valve and set the BY-PASS/NORMAL switch to NORMAL before proceeding with the normal operating or shutdown procedures.

APPENDIX E

AUTORANGE CHANGE/COMPUTER INTERFACE (P/N 98-077-068)

NOTE: There are two versions of the ULTRATEST F that come with autoranging:
1) The ULTRATEST F SOAG includes automatic range changing. It can be identified by the "AR + U" switch on the back of the FB module. This switch must be set to "AR" or to "AR + U" and the range switch on the front of the FB module must be set to 1 to allow automatic changing of the leak-rate range.
2) The US Autoranging version of the ULTRATEST does not have the "AR + U" switch. In this version the range switch must be set to the 1000 position to allow automatic changing of the leak-rate range. The information in this appendix applies only to the US autoranging version.

NOTE: Except as noted in this section, the information in this manual also applies to the ULTRATEST F with US autoranging.

E-1 DESCRIPTION

The US autoranging version of the ULTRATEST F has a factory-installed PC board in the FB module. This additional board allows for automatic range changing and computer interface.

The automatic range changing eliminates the need of changing the leak-rate range setting on the FB module. The direct leak reading capability is 2×10^{-11} to 1×10^{-6} atm.cc/sec, and 2×10^{-9} to 1×10^{-4} atm.cc/sec for each range. Which range your ULTRATEST displays depends on where the changeover switch on the preamplifier is set (see Section 7-6-1-2 and Figure 7-1A). This version of the ULTRATEAST also will interface to a computer with buffered BCD output for data acquisition (See Section E-2).

The adjustable high and low limit set points (Trigger 1 and Trigger 2) are accessable as on the standard ULTRATEST F through a terminal block at the rear of the FB module (see Appendix B). However, the US autorange unit has thumbwheel switches on the rear of the FB module instead of the slotted potentiometers to set the trigger points, and the trigger settings include the exponent.

E-2 INSTALLATION

The autoranging PC board is factory installed in the FB module of the US autorange version of the ULTRATEST.

See Figure E-1 for a pin-by-pin identification of signals of the BCD outputs. The BCD connector is located on the rear of the FB module.

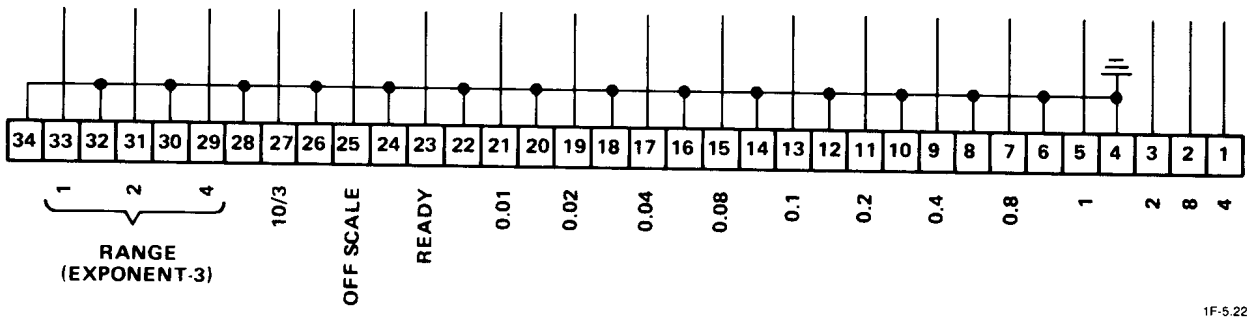

Figure E-1 - BCD Outputs

E-3 OPERATION

Operation of the USA autoranging version is the same as the operation of the standard ULTRATEST except that the range switch position does not need to be changed when leak checking (see Section 4-1-2). The range switch must be set to the "1000" position when leak checking; if the range switch is set to any other leak-rate position, you will have to change the ranges manually.

The leak-rate range will automatically change to the appropriate 10 scale (ie 1000, 100, 10 or 1). It does not range to the 3 scales (ie 300, 30 or 3), so be sure to read the leak rate from the 10 scale on the analog meter.

E-4 TROUBLESHOOTING AND PARTS LIST

The part number for the autoranging PC board in the FB module is 99-077-068. For part numbers of the autoranging board components contact the factory and ask for a copy of document ASK3070.

Contact the factory for help in troubleshooting the autoranging board. The electrical schematics and the board component location drawing for the autoranging board are available under drawing D99-077-068.

APPENDIX F

BOARD COMPONENT LOCATION DRAWINGS

AND

ELECTRICAL SCHEMATICS

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EL Schematic	Electrical Schematic for the EL Module and the Pump Controls	
FB Schematic	Electrical Schematic for the FB Module	

F-1 BOARD COMPONENT LOCATION DRAWINGS

The board component location drawings (Figures F-MSMB through F-EL) show the designation (such as R 103) and the rating (such as 4.7 K) for each component (see Figure F-LP1). The first digit of the component designations for boards LP1 through LP8 corresponds to the board number. For example, a resistor on LP3 is labeled R 329; a potentiometer on LP7 is labeled P 701. These drawings also show the pin numbering for the plugs and boards.

F-2 USING THE ELECTRICAL SCHEMATICS

Full size electrical schematics for the ULTRATEST F are in the back of this binder (see Schematics MS, EL, and FB).

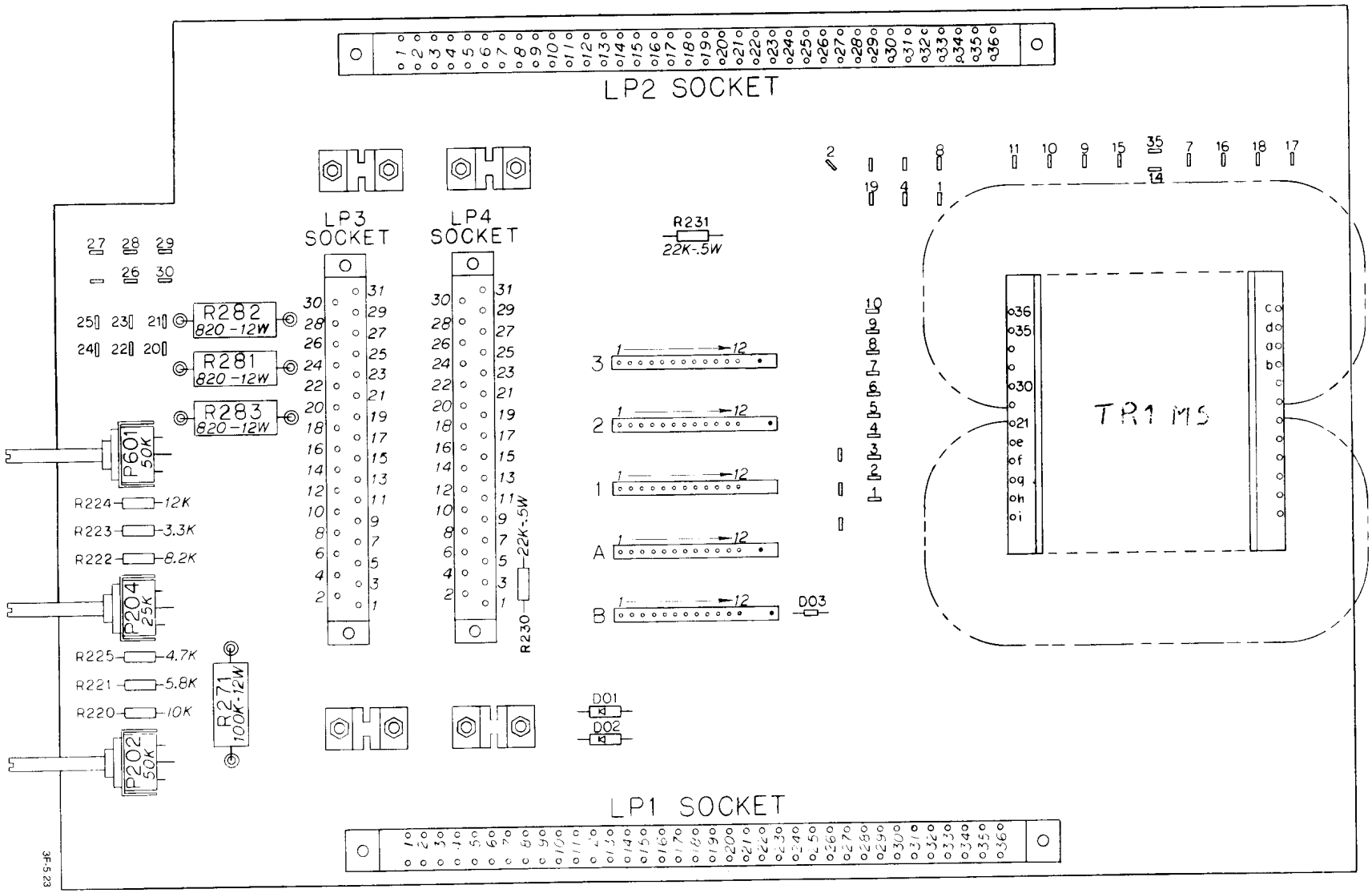
The foldout pages (Table F-1 and Figures F-12 and F-13) are needed to fully understand the schematics.

The circled numbers on the schematics correspond to the circled ID numbers on foldout Table F-1. For example, look at ID No. (1) on Table F-1. Going across the (1) row, the d1 contact is in the next column. The corresponding "Location" columns tell you to look at grid coordinate D10 on Schematic EL to find the d1 contact. The next column tells you that the d1 contact is connected to tab 28 and that tab 28 is found at grid coordinate C11 of Schematic EL. The other columns for ID No. (1) list the other connections in this circuit including the connections in the MS module.

Use Figure F-12 to physically locate the plugs and pc boards on your ULTRATEST. Use the board component location drawings to find the individual components and identify the pin numbers (see Section F-1).

Figure F-13 is a functional block diagram to aid in your understanding of the ULTRATEST.

Location: MS module (see Figure 8-17)
Electrical schematic: See Schematic MS
Part Number* for the complete MS module: 330-25-148
Function: Board interconnections and U_1, U_2, and emission control



*Do not use the part number printed on the board for ordering; the number on the board (400-76-548) is for the bare board without components.

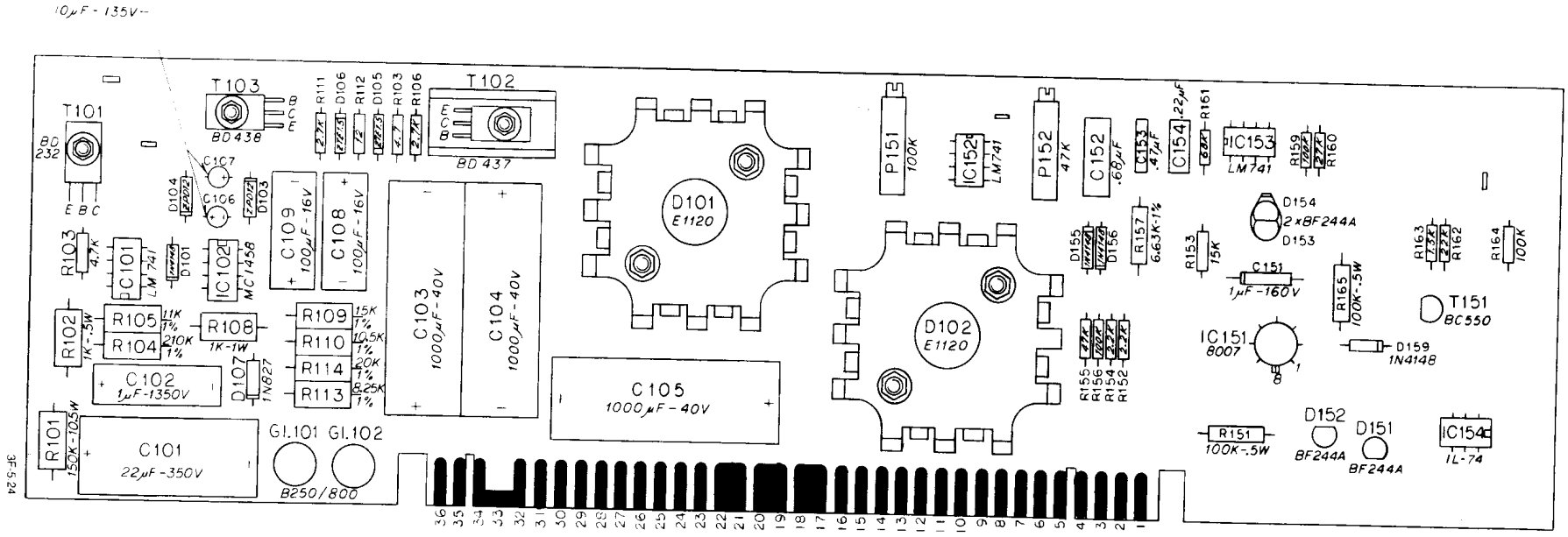
Figure F-MSMB - Component Location Drawing for the MS Module Motherboard

Location: MS module (see Figure 8-17)
Electrical Schematic: See Schematic MS
Part Number* for this board: 400-78-163
Function: DC power supply for +15V, -15V, +24V, and -120V; total pressure amplifier PIII; emission safety cut-out circuit; emission ON/OFF

Device Type	Part Number
BC 550	533-21-196
BD 437	533-21-184
BD 438	533-21-185

Device Type	Part Number
BF 244A	533-21-152
B 250/800	510-48-123
E1120	510-48-106
LM 741	533-21-164

Device Type	Part Number
IN 827	510-43-244
IN 4148	510-43-605



* Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

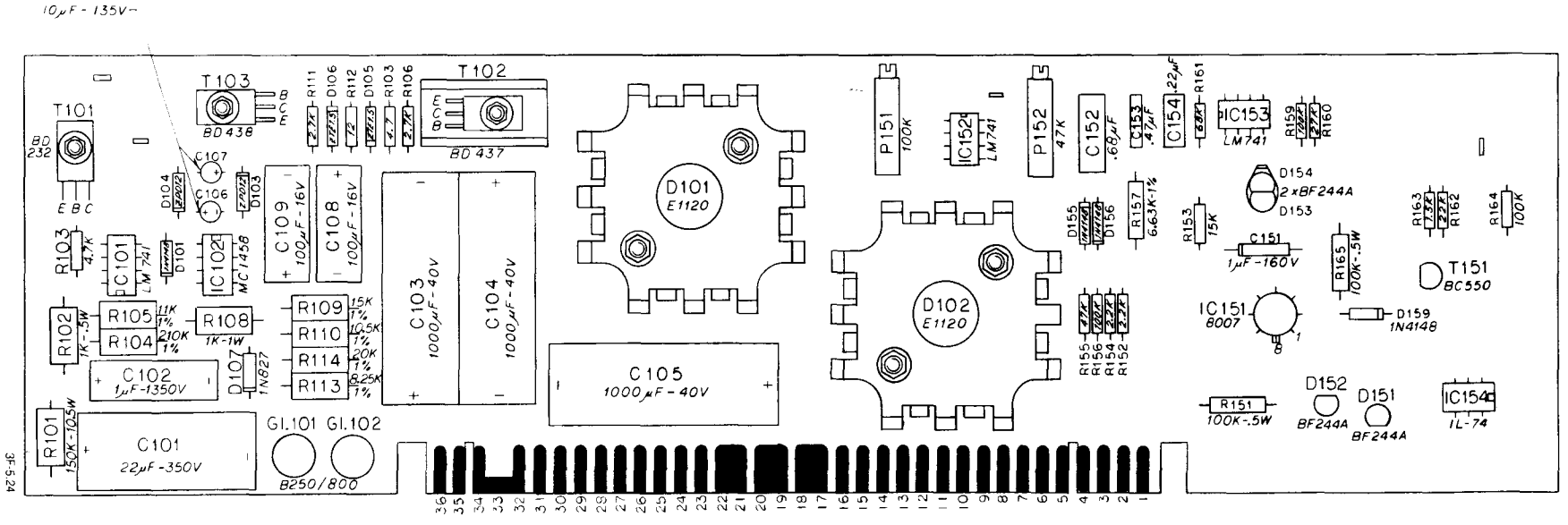
Figure F-LP1 - Component Location Drawing for Board LP1

Location: MS module (see Figure 8-17)
Electrical Schematic: See Schematic MS
Part Number* for this board: 400-78-163
Function: DC power supply for +15V, -15V, +24V, and -120V; total pressure amplifier PIII; emission safety cut-out circuit; emission ON/OFF

Device Type	Part Number
BC 550	533-21-196
BD 437	533-21-184
BD 438	533-21-185

Device Type	Part Number
BF 244A	533-21-152
B 250/800	510-48-123
E1120	510-48-106
LM 741	533-21-164

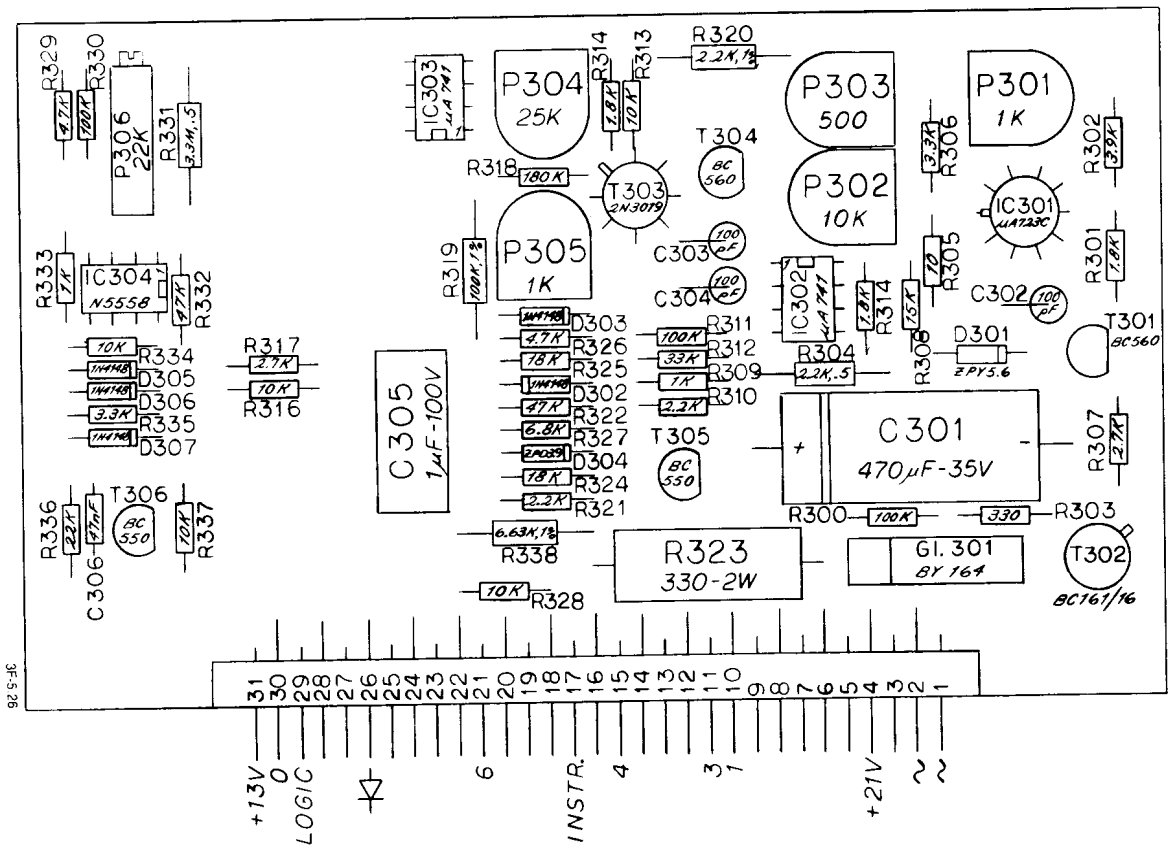
Device Type	Part Number
IN 827	510-43-244
IN 4148	510-43-605



* Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP1 - Component Location Drawing for Board LP1

Location: MS module (see Figure 8-17)
Electrical schematic: See Schematic MS
Part Number * for this board: 400-78-140
Function: Total pressure measurement "PII", gauge head supplies, signal amplifier and level trigger for emission current safety cut-out.



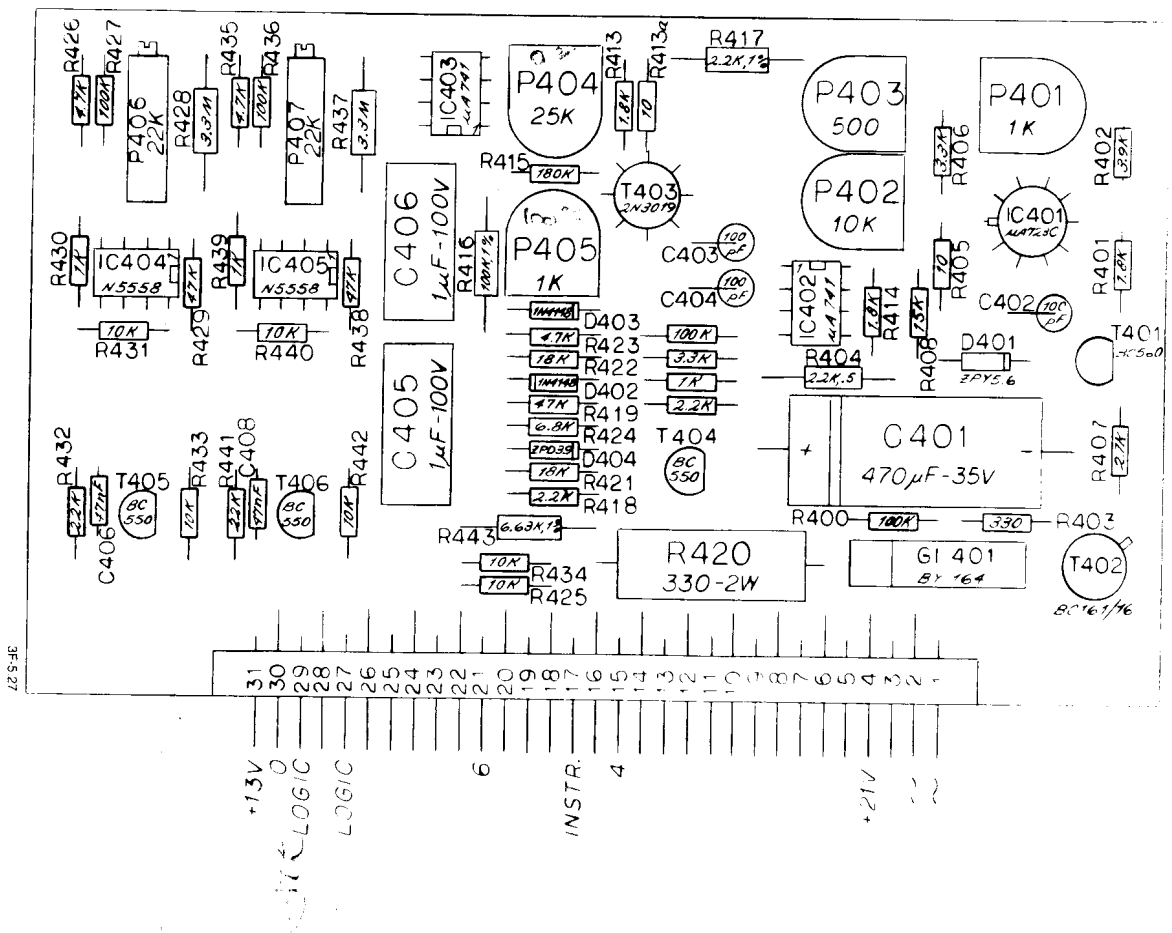
Device Type	Part Number
BC 550	533-21-196
BC 560	533-21-195
BY 164	510-42-329
MA 723C	533-21-168
N 5558	533-21-169
ZPY 5.6	510-43-111
1N 4148	510-43-605
2N 3019	533-21-197

* Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP3 - Component Location Drawing for Board LP3

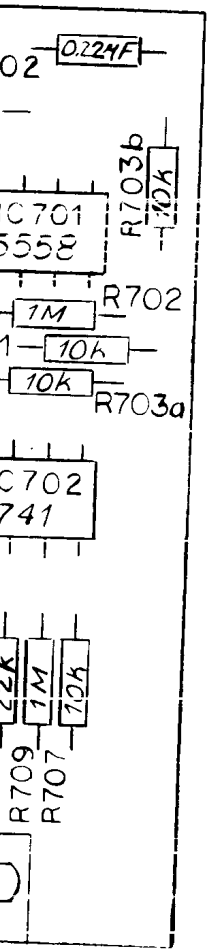
Location: MS module (Figure 8-17)
Electrical schematic: See Schematic MS
Part Number * for this board: 400-78-139
Function: PI pressure gauge

Device Type	Part Number
BC 550	533-21-196
BC 560	533-21-195
BY 164	510-42-329
MA 723C	533-21-168
N 5558	533-21-169
ZPY 56	510-53-111
1N 4148	510-43-605
2N 3019	533-21-197



* Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP4 - Component Location Drawing for Board LP4

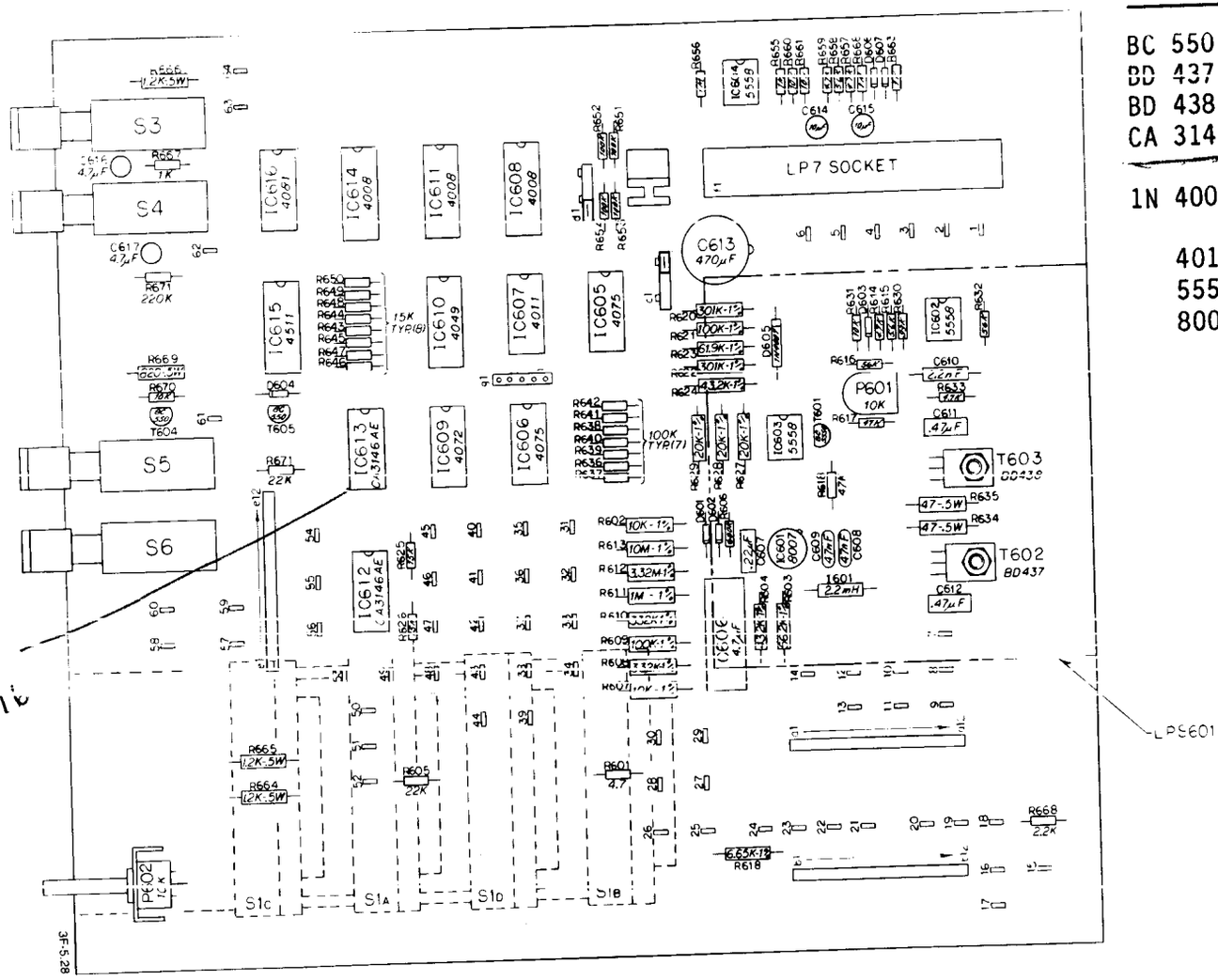


Device Type	Part Number
BAV 19	510-43-603
BC 550	533-21-196
4148	510-43-605
5558	533-21-169
Single-pole, Single-throw, Relay	590-22-235

he board for ordering; the number
t components.

Location: FB module (see Figure 6-19)
Electrical Schematic: See Schematic FB
Part Number* for this board: 400-78-172
Function: Main amplifier (leak-rate signal), voltage divider network for range switching, generation of the digital exponent display, generation of step voltage for range recognition, generation of the acoustic leak-rate signal.

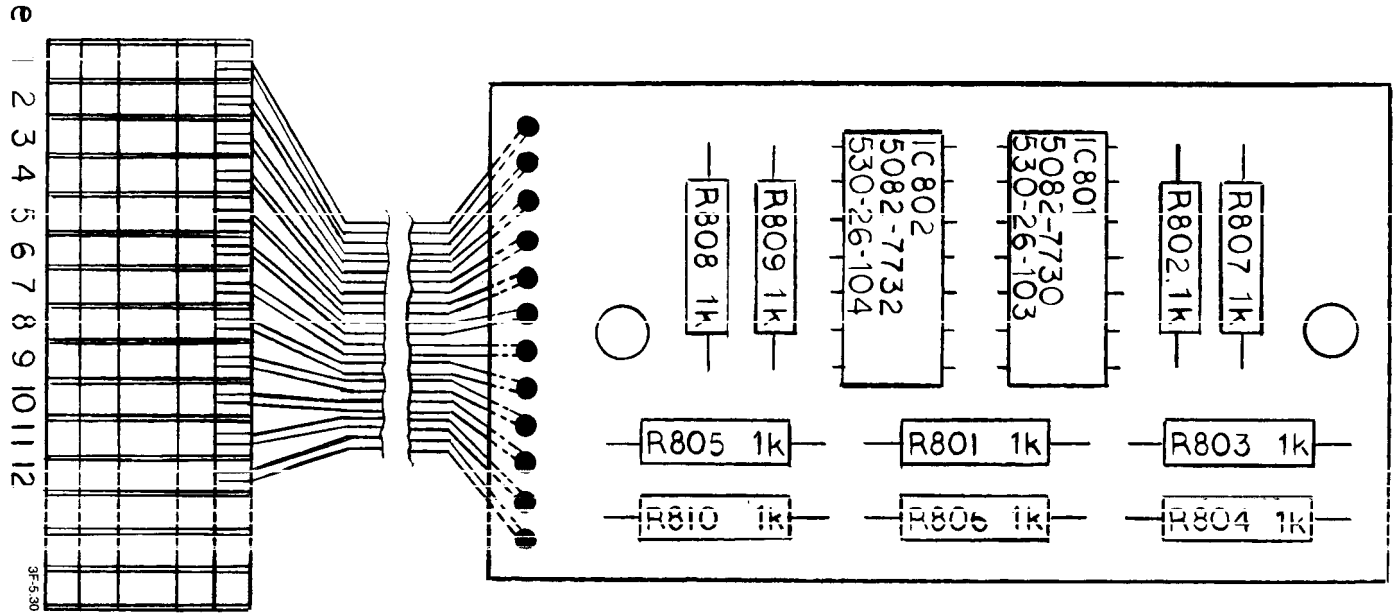
Device Type	Part Number
BC 550	533-21-196
BD 437	533-21-184
BD 438	533-21-185
CA 3146AE	533-21-210
1N 4007	510-43-324
4011	533-21-198
5558	533-21-169
8007	533-21-190



* Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP6 - Component Location Drawing for Board LP6

Location: FB module (see Figure 8-19)
Electrical Schematic: See Schematic FB
Part Number* for this board: 400-78-159
Function: Digital display of the leak-rate decade range



*Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

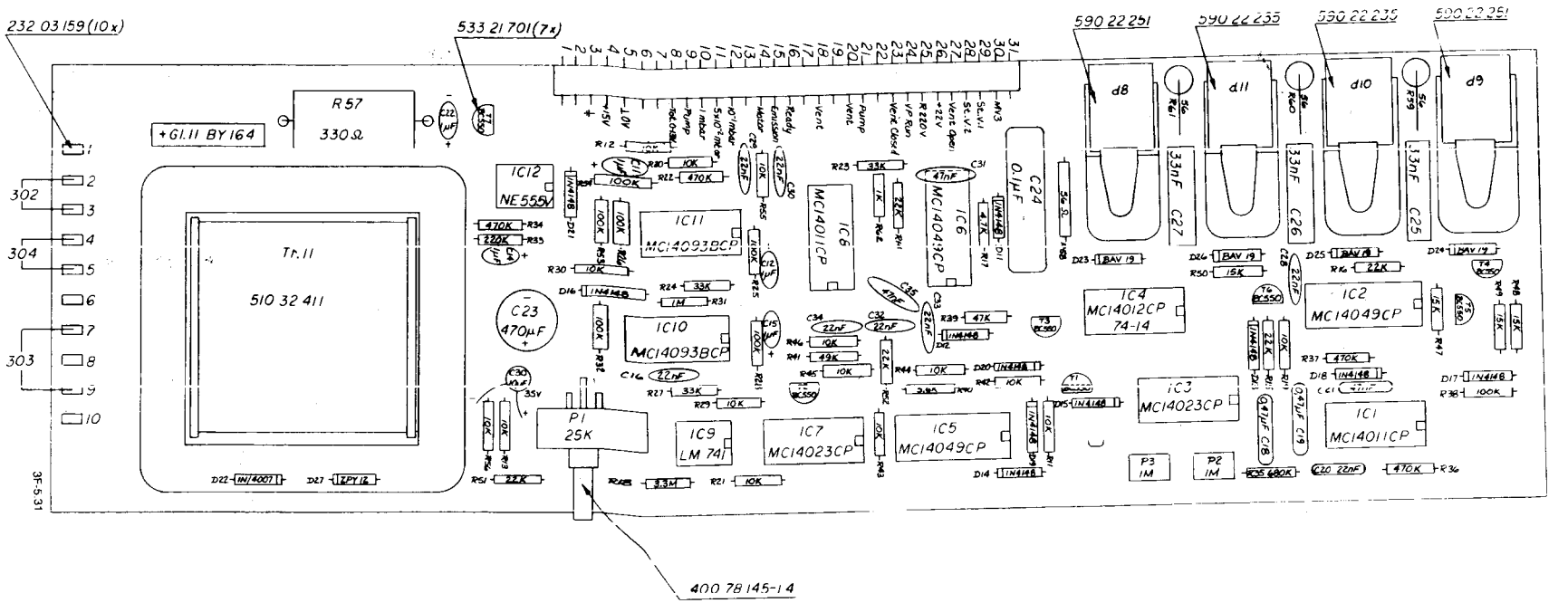
Figure F-LP8 - Component Location Drawing for Board LP8

Location: El module (see Figure 8-20)
Electrical schematic: See Schematic EL
Part Number* for this board: 400-78-145
Function: 15V and 220V power supply; control logic for automatic valve operation and automatic partial flow system using digital circuitry; gear motor control.

Device Type	Part Number
BY 164	510-42-329
BC 550	533-21-196
BAV 19	510-43-603

Device Type	Part Number
Transformer	510-32-411
Double-pole, double-throw, relay	590-22-251

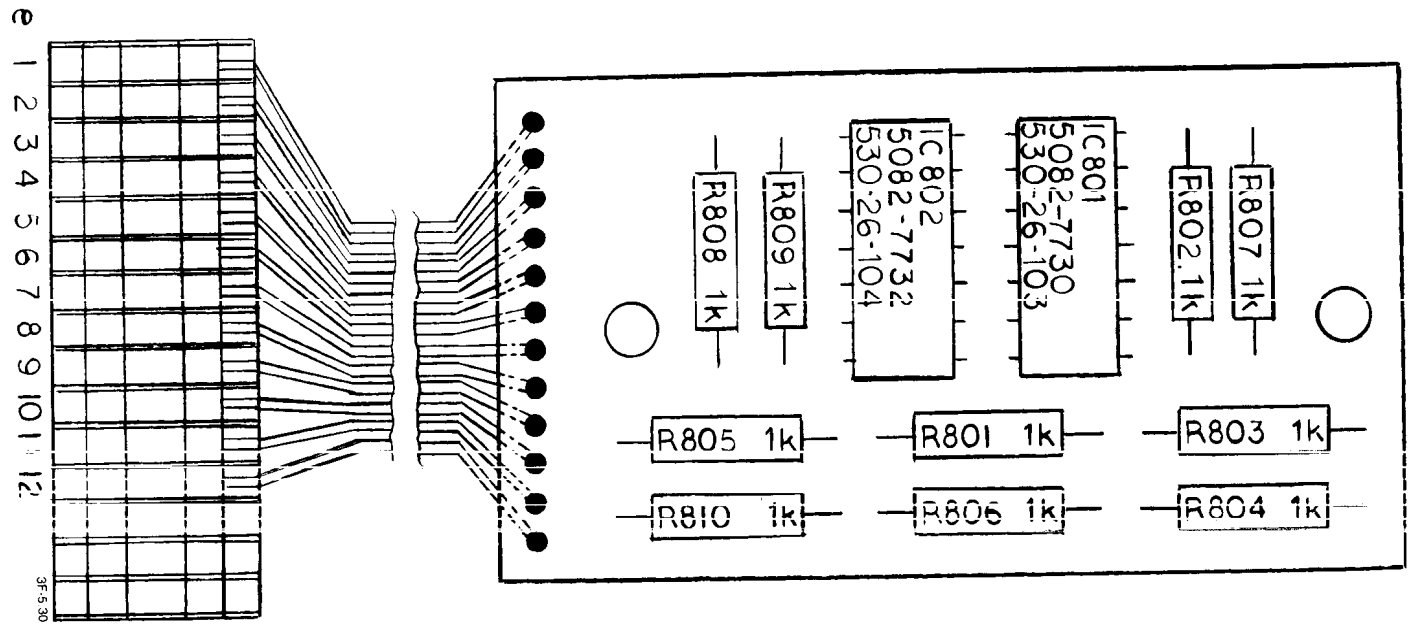
Device Type	Part Number
Single-pole, single-throw, relay	590-22-235



*Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP9 - Component Location Drawing for Board LP9

Location: FB module (see Figure 8-19)
Electrical Schematic: See Schematic FB
Part Number* for this board: 400-78-159
Function: Digital display of the leak-rate decade range



*Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

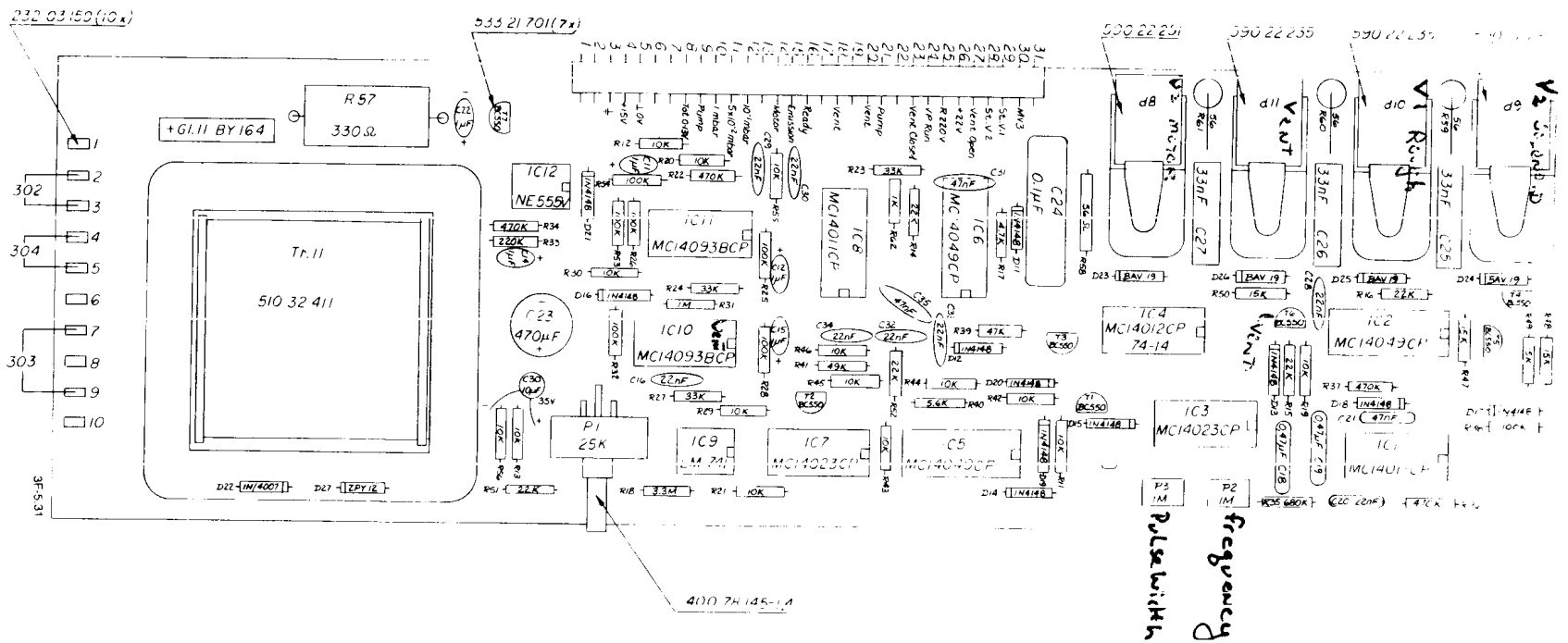
Figure F-LP8 - Component Location Drawing for Board LP8

Location: El module (see Figure 8-20)
Electrical schematic: See Schematic EL
Part Number* for this board: 400-78-145
Function: 15V and 220V power supply; control logic for automatic valve operation and automatic partial flow system using digital circuitry; gear motor control.

Device Type	Part Number
BY 164	510-42-329
BC 550	533-21-196
BAV 19	510-43-603

Device Type	Part Number
Transformer	510-32-411
Double-pole, double-throw, relay	590-22-251

Device Type	Part Number
Single-pole, single-throw, relay	590-22-235

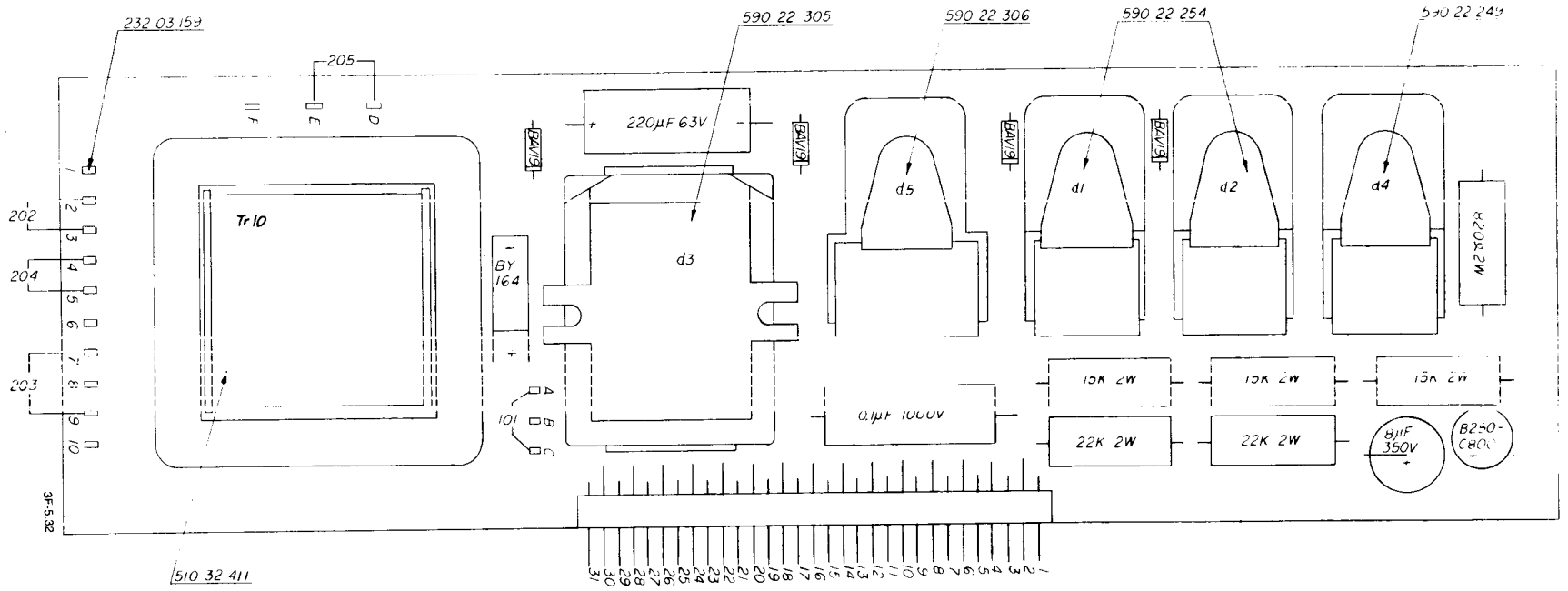


*Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP9 - Component Location Drawing for Board LP9

Location: EL module (see Figure 8-20)
Electrical schematic: See Schematic EL
Part Number* for this board: 400-78-144
Function: Relay circuit for pump power supply and mass spectrometer unit; power supply for relays; polarity safety circuit (3-phase supply).

Device Type	Part Number
BAV 19	510-43-603
BY 164	510-42-329
B250C800	510-48-123



*Do not use the part number printed on the board for ordering; the number on the board is for a bare board without components.

Figure F-LP10 - Component Location Drawing for Board LP10

Location: See Figures 8-3C and 8-18
Electrical schematic: See Schematic EL
Part Number* for this board: 400-78-158
Function: Power unit for the power supply to the gear motor, relay with transistor energizing circuit for the PUMP and VENT pushbuttons.

Device Type	Part Number
BAV 19	510-43-603
BY 164	510-42-429
BD 437	533-21-184
BC 560	533-21-195

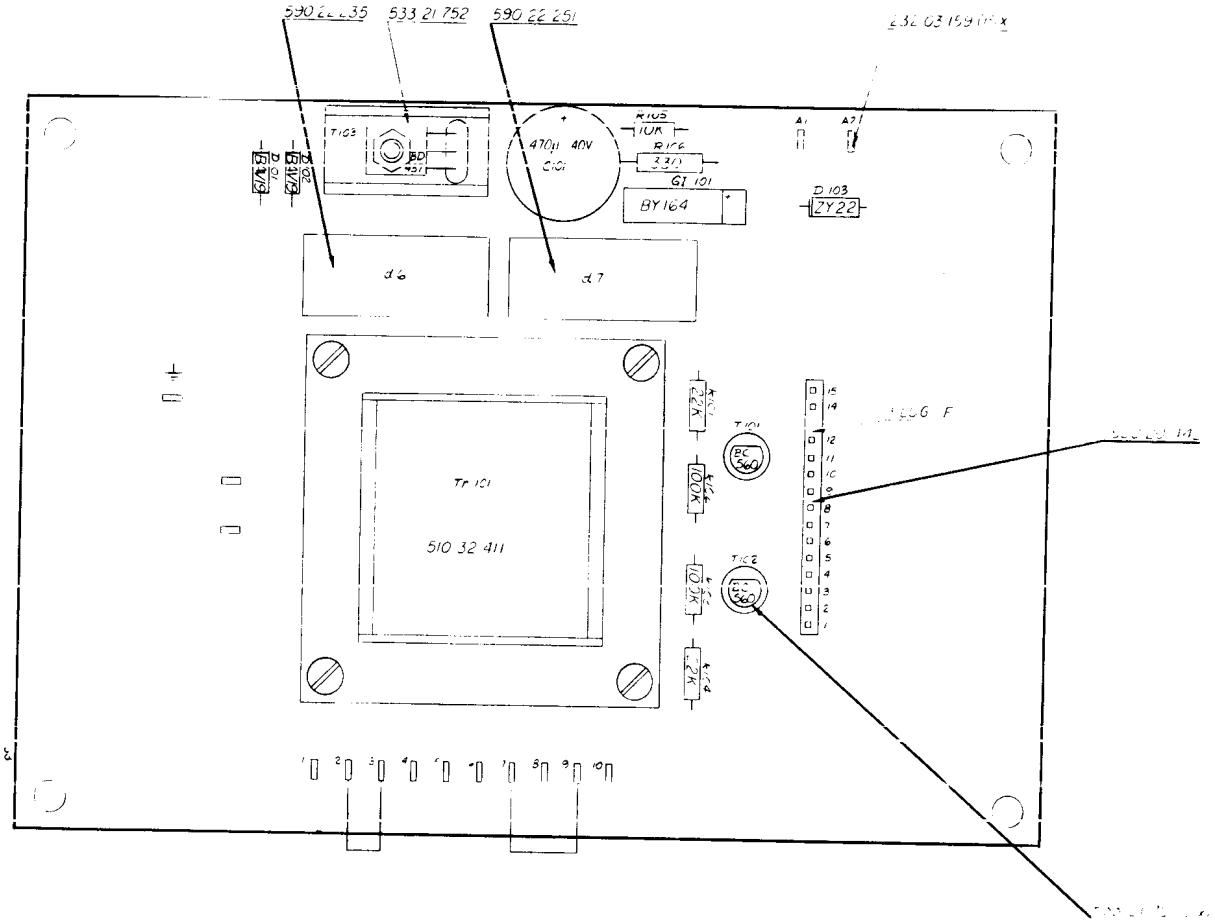


Figure F-LP11 - Component Location Drawing for Board LP11

Location: See Figure 8-20
Electrical schematic: See Schematic EL
Part Number of the bare EL motherboard without components : 400-76-555. See Fig. 9-1 for component part numbers.

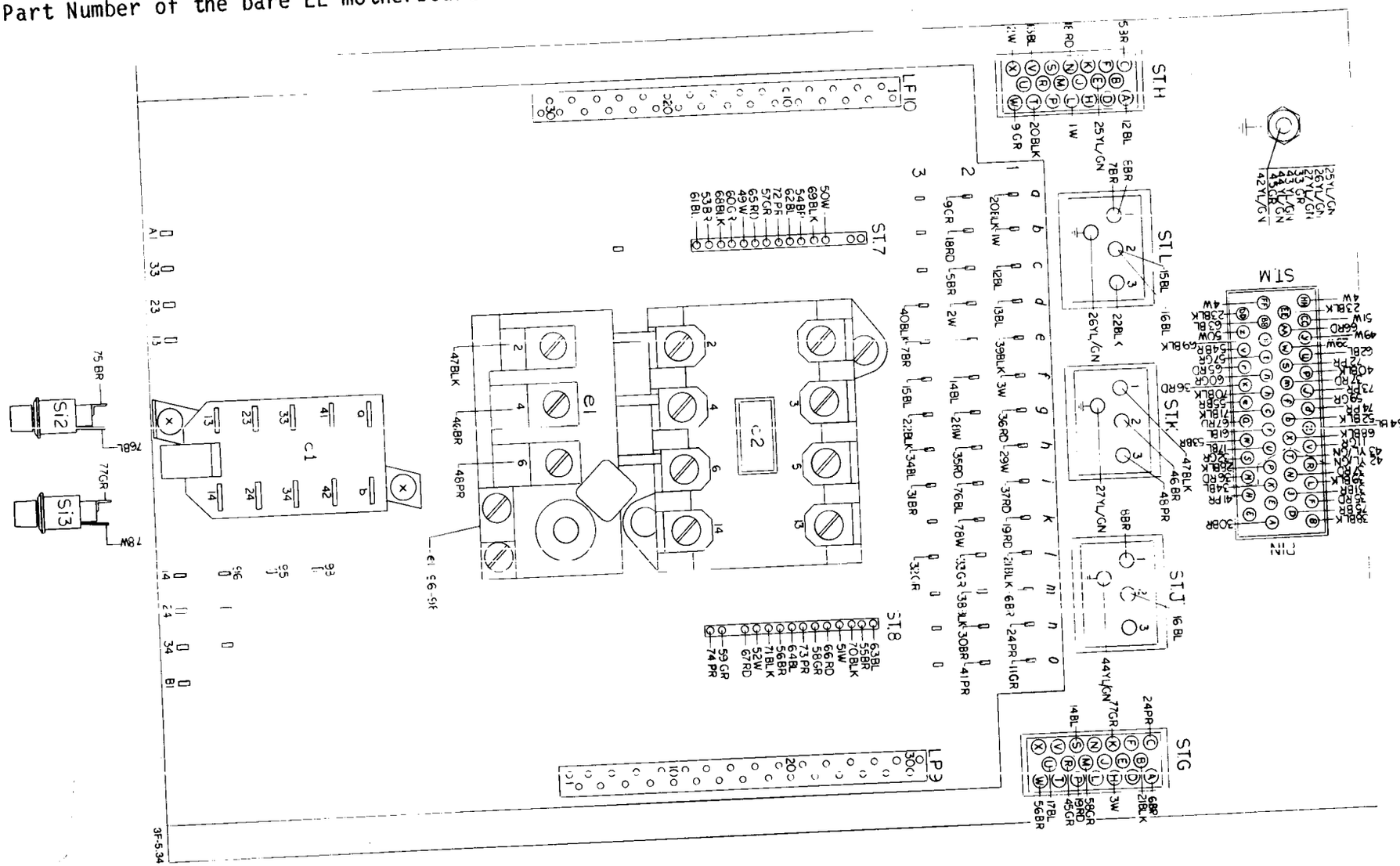


Figure F-EL - Component and Plug Location Drawing for the EL Module