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RATIOMATIC IONIZATION GAUGE CONTROL

operating instructions

varian / lexington vacuum division / 121 hartwell avenue / lexington / massachusetts 02173 / (617) 861-7200

varian

Dennis Tungoff
Walt Van Hemert } Technicians
1-800-9722
227

1 or behind

842/843

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Note

This manual should be read in its entirety before operation of the Ionization Gauge Control is attempted. A thorough description is given of the control and its operation to assist the user in proper turn on.

This control will read full scale when power is on and filament is off. Do not be alarmed! This is normal. Proceed with turn on.

0881-6999-08-075

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I. GENERAL INFORMATION

This manual contains operating instructions and maintenance information for the Ionization Gauge Control. This control is used for industrial or scientific vacuum applications where both thermocouple and hot filament ionization gauge tubes are employed to monitor pressure. For process control applications, models with set-points and auto filament turn-on are available.

RATIOMATIC GAUGE CONTROLS

Item	Part Number
842 Ratiomatic Ionization Gauge Control, complete with cables	0842-K3132-301
842 Ratiomatic Ionization Gauge Control with dual ion setpoints, complete with cables	0842-K3132-302
843 Ratiomatic Ionization Gauge Control with two independent thermocouple controls, complete with cables	0843-K3100-301
843 Ratiomatic Ionization Gauge Control with two independent thermocouple controls and three setpoint functions – two ion, and one thermocouple	0843-K3100-302
Auto filament turn-on	0891-K3128-301



SPECIFICATIONS:

Power Required	100 watts, 105–130V/210–250V; 50–60 Hz
Thermocouple Gauge Range	1 x 10^{-3} to 2 Torr (indicates to atmosphere)
Ionization Gauge Range	1 x 10^{-8} to 1 x 10^{-3} Torr
Accuracy	±2% of meter reading
Zero Drift	Negligible
Degas Power (resistance)	50 watts nominal
Process Control Contact Rating	5 (2.5) A (resistive) 115 (230) VAC or 24 VDC
Filament Status Relay Contact Rating	5 (2.5) A (resistive) 115 (230) VAC or 24 VDC
Recorder Output	1 V/Decade, 0–5V
Overpressure Protection Point	2 milliTorr (2 x 10^{-3} Torr)
Operating Temperature Range	10^{o} to 35^{o} C
Weight	approximately 9 pounds
Dimensions	3-1/2" H x 19" W x 9" D

OPERATIONAL PRINCIPLE (IONIZATION GAUGE)

The hot-filament ionization gauge tube consists of three basic elements:

- a heated filament,
- a grid for extracting electrons from the filament and,
- a collector.

Electrons emitted by the filament are accelerated to the grid which is at a positive potential with respect to the filament. These electrons collide with any gas molecules present and ultimately are collected by the grid. These collisions produce positive ions (electrons are removed from gas molecules to form ions) which are attracted by the collector and recorded as positive ion current. This ionization process is the basis for measurement of gas pressure within the tube.

Ion gauge pressure measurement is based on the following relationship:

$$P = \frac{i+}{i-} (1/S) \quad \text{Where} \quad P = \text{Pressure in Torr} \qquad (1)$$

$i+$ = Ion current (in amps)

$i-$ = Ionizing current (in amps; emission)

S = Gauge sensitivity ($Torr^{-1}$)

Conventional ionization gauge controls interpret and execute this relationship with a display that is a linear function of pressure. To date, this objective has been accomplished by regulating the ionizing current (i-) and indicating the ionized current (i+) as a function of pressure. Because voltage fluctuations, contamination by process gases, exposure to atmosphere, and changes of filament temperature at high pressures (10^{-5} Torr and above) cause large variations in i-, careful regulation is necessary to avoid errors.

The new gauge control which uses the Ratiomatic technique developed by Varian, differs from previous controls in the interpretation of the pressure indication, $P = \frac{i+}{i-} (1/S)$. Consequently, the need to regulate i- is eliminated along with its attendant problems.

In the ion gauge control circuit, this measurement is implemented by an analog microprocessor that continuously monitors i+ and i- and generates a signal voltage proportional to gas pressure independent of the absolute values of either i+ or i-. This voltage is used to display pressure on the meter and to provide the recorder output.

SENSITIVITY

It is readily apparent that the sensitivity (S) of an ionization gauge tube can be defined by Equation (2) which is based on the geometry of the gauge tube. The relationship is expressed as:

$$S = \frac{i+}{i-} \; 1/P \qquad (2)$$

It must be noted, however, that the sensitivity, as defined by Equation (2), depends on a number of factors. The factors are positive ion current (i+), the electron current (i-), the grid voltage, the collector voltage, and the actual pressure within the gauge tube. In addition, the *sensitivity will vary with different gas species*. For the relative gauge sensitivities of various gases, use the gas sensitivity table located on page 27.

MEASUREMENT RANGE

Early configurations of ionization gauges were designed to operate in the range of 10^{-7} to 10^{-3} Torr. Cathode (filament) life is greatly shortened at pressures above 10^{-3} Torr because of oxidation and bombardment by positive ions formed in the space between the cathode and grid. The lower pressure limit is the result of a residual collector current caused by the production of soft x-rays when the electrons strike the grid. This causes a photoelectron current that is measured along with the ion current (i+). This soft x-ray current limit is quite large in the triode type tube design because of a large ion collector surface.

A gauge tube, developed by Bayard & Alpert, reduces the x-ray current by using a fine wire inside the grid as the ion collector. This results in an x-ray current as low as 5×10^{-11} Torr, permitting accurate measurements into the 10^{-9} Torr range without extraordinary techniques.

DEGASSING

Operation of an ionization gauge during the pump down cycle of a vacuum system, particularly after a system has been exposed to atmospheric pressure, results in the outgassing of large quantities of absorbed gases from the gauge tube surfaces. Unless these gases are driven off, readings observed by the gauge will remain high for a long period of time when compared with the actual system pressure. This effect is negligible above 10^{-6} Torr, but degassing may be of some benefit to arrive at a final pressure reading sooner.

At pressures above 10^{-9} Torr, degassing of Bayard & Alpert type tubes is usually accomplished by passing a current through the grid, which can raise the grid temperature to as high as 1000^{o} C. The walls of the tube are indirectly heated by radiation from the grid which results in degassing of the surface.

It is recommended that a new gauge tube be degassed after installation on the vacuum system for a period of 30 to 60 minutes if pressures below 10^{-7} Torr are expected. This will ensure that all

contaminates are removed from the electrodes and wall surfaces. Periodic degassing may be required to keep the pressure readings caused by contaminants to a minimum. A brief (weekly) degassing period of 10 to 15 minutes is usually adequate to keep the tube clean, thereafter. More frequent degassing may be required if the tube is cycled to atmosphere or operated in a dirty vacuum environment.

GAUGE TUBE POSITIONING

Most hot filament ionization gauge tubes will operate in any position. However, it is recommended that the gauge tube be mounted in a vertical position or with the filament on the lower side of the tube, if at all possible. This will ensure that the filament will never short to the grid. In some gauge tubes because of age and long periods of operation, the filament may sag and touch the grid if mounted horizontally.

Gauge tube positioning on a vacuum system is very important if dependable readings are to be obtained. The tube port should be located as close to the region of interest as possible. If the port is near or looking at a cryogenic surface, the apparent pressure reading may be significantly lower. Locations near the inlets to the vacuum pump should also be avoided.

THERMOCOUPLE GAUGE OPERATION

Principles of Operation

A thermocouple gauge operates on the principle that at sufficiently low pressures, the thermal conductivity of the gas decreases with a decrease in pressure.

A thermocouple is attached to a heater wire in which the temperature is raised to about 350^{o} C by passing a current through the wire. When constant power is maintained through the heater wire, the temperature measured by the thermocouple will change with pressure. This change is directly related to the heat conducted away by the gas in the environment. The electromotive force (e.m.f.) measured from the thermocouple is read on a scale which has been calibrated for pressure.

The thermocouple response is also affected by factors other than pressure. Normally, the tube is calibrated for nitrogen or air. If the residual gas in the vacuum system is some other gas, the pressure reading may be affected. As an example, hydrogen and helium will conduct the heat away from the thermocouple more rapidly than air, leading to an erroneous reading which will be higher than the actual pressure. Contaminants such as oil, dust, and other chemicals can change the surface of the thermocouple and heater, which in turn will change the ability of the thermocouple to dissipate the heat and affect the pressure reading.

Because the thermocouple gauge tube is a thermal response device, the ability of the tube to respond to abrupt pressure changes is limited by the mass of the thermocouple and heater. If this combination is very small, the tube responds more rapidly than a tube with larger wire sizes.

In general, thermocouple gauge tubes are used to gain an indication of the vacuum in a system rather than an accurate measure. So many factors can affect the output of the tube that unless special care and precautions are taken, the pressure read on the control is usually accurate to within ±30 percent of indicated reading.

Thermocouple gauge tubes should be positioned on the vacuum system so that contaminants do not collect in the tube. Preferably the tube port should be looking down to prevent oil from mechanical pumps, etc. from building up in the tube base.

If further discussion on the theory and operation of ionization gauge and thermocouple gauge vacuum measurement is desired, the following references should be consulted.

References:

1. Dushman, S., J. M. Lafferty, **SCIENTIFIC FOUNDATIONS OF VACUUM TECHNIQUE**, John Wiley & Sons, Inc., Second Edition, New York, 1962.

2. Guthrie, A., **VACUUM TECHNOLOGY**, John Wiley & Sons, Inc., 1963.

3. Lewin, G., **VACUUM SCIENCE AND TECHNOLOGY**, McGraw-Hill, New York, 1965.

4. Redhead, P. A. et al., **ULTRAHIGH VACUUM**, Chapman and Hall, London, 1968.

5. Van Atta, C. M., **THE DESIGN OF HIGH VACUUM SYSTEMS**, Kinney Mfg. Div., N.Y. Brake Co., 1955.

6. Van Atta, C. M., **VACUUM SCIENCE AND ENGINEERING**, McGraw-Hill, 1965.

II. PREPARATION FOR USE

UNPACKING

Each gauge control is inspected and carefully packed prior to shipment. If the unit arrives damaged, save the packing materials and immediately notify the carrier. Because the packing materials are designed specifically for this instrument, they should always be used when transporting the unit. The instrument is packed with the following contents:

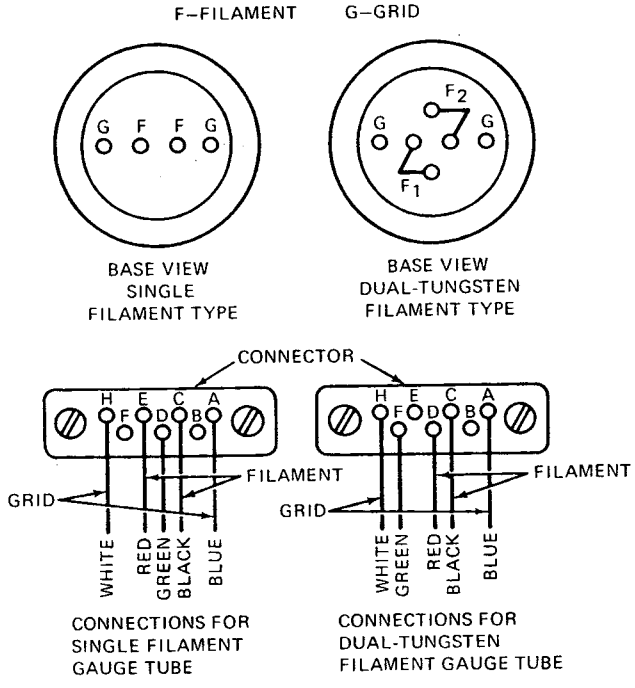
Quantity	Item
1	Ionization Gauge Control
1	AC Line Cord
2	Thermocouple Gauge Cords (thermocouple model only)
1	Ion Gauge Cord
1	Operating Instruction Manual
Note: (Gauge tubes must be ordered separately)	

INSTALLATION

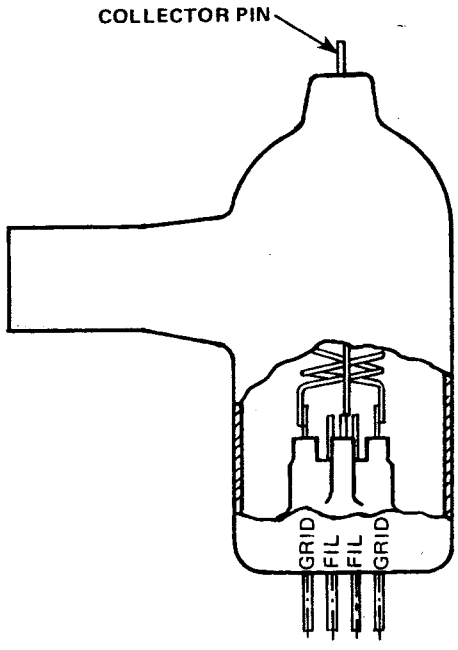
All cables should be kept away from hot surfaces and/or moving parts such as ionization gauge tubes and/or roughing pumps.

The line voltage selector switch must be set to the proper voltage before applying power. The setting can be observed (and changed, if necessary) from the rear panel of the unit.

Install the ionization gauge cable with the **AC LINE POWER OFF.** The gauge connector mates with standard Bayard & Alpert gauges. Pin connections are:



GAUGE TUBE CONNECTOR PIN WIRING



BAYARD-ALPERT TYPE GAUGE TUBE

The connector must be wired for the type of gauge tube to be used. If the user is in doubt, check to see that the connector supplied is wired correctly.

In order to use the second filament of the dual tungsten type tube, a simple 180^{o} rotation of the connector after disconnecting will apply the power to the second filament.

This control is designed to be used with various length cables. A filament tap "switch" is located on the main printed wiring board. (See Figure on Page 37 for location of tap "switch".) Table I gives tap "switch" position for extended ion gauge cable lengths.

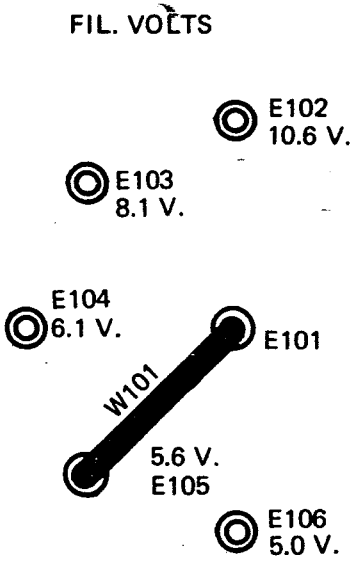
The filament tap switch changes the output voltage of the control to the filament to compensate for the voltage drop of longer wires. Therefore, the applied voltage at the gauge tube remains the same.

It is important to note that with increased cable lengths, the effective degas power is reduced because of losses in the cable. Degas times should be longer in this case to compensate for lower degas temperatures. Larger diameter wire on the grid leads will reduce the power lost for degas on longer cables.

TABLE I

ION GAUGE CABLE LENGTH

Tap Switch (Volts)	Cable Length (Std. Wire Size) (ft)
5	Under 10
5.6	10 (standard cable)
6.1	to 20
8.1	to 50
10.6	to 100



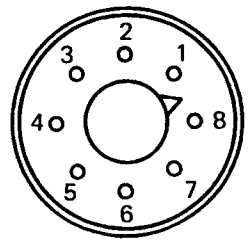
FILAMENT TAP SWITCH

For lengths of ion gauge cable above 100 ft. the following table of wire sizes should be used.

Length	Wire Size
101–125	#16
126–200	#14
201–325	#12
326–500	#10

The thermocouple gauge cables are furnished with a thermistor mounted inside the connector for temperature compensation. The gauge cable connections are:

Heater	=	Pin 1 (White Wire)
Heater	=	Pin 3 (Black Wire)
Tie Point	=	Pin 2 (Green Wire)
TC -	=	Pin 7 (Red Wire)
TC +	=	Pin 5 (Thermistor)



TC CONNECTOR

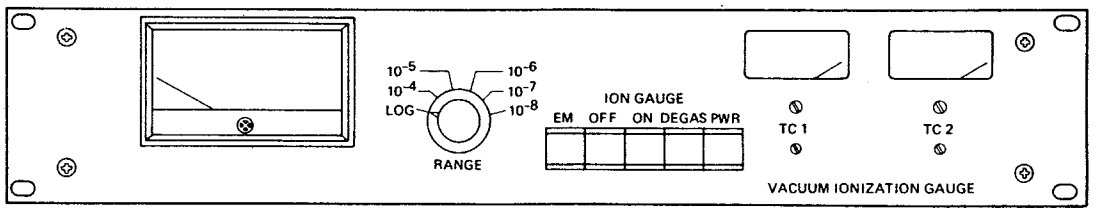
The accessory output connector (J102) located on the rear panel contains the output connections for the recorder, filament remote on and off, filament status relay, and the set-point outputs. Consult the particular section of this manual that pertains to the feature or option desired.

For T.G. gauge cable longer than 100 ft. the following table of wire sizes should be used.

Length	Wire Sizes
101–150	#18
151–200	#16
201–300	#14
301–800	#12

III. OPERATION

DESCRIPTION OF CONTROLS (Front Panel)



FRONT PANEL

- **PWR Switch:** Activates power for all circuits in the instrument. Push in to activate, push again to shut off power. Power lamp indicates on condition.

NOTE

> With the filament off and power on, the ion meter will read full scale to the right.

- **ON Switch:** A momentary push button that turns on the gauge tube filament. Push in and hold for approximately one second until the EM light comes on, then release. Gauge filament light will stay on if pressure being monitored is below two milliTorr. With the **FILAMENT ON** switch lighted, power is being applied to the filament.

- **OFF Switch:** A momentary push button that turns off the gauge tube filament. Push in and hold until **EM** light goes off to shut off the gauge tube. Illumination of the lamp indicates that the filament is off.

- **DEGAS Switch:** Controls degas power to gauge tube grid. Push in to activate, push again to shut off. Lamp illumination indicates on condition. Degas will function only when filament is on and **EM** light is on.

- **EM Indicator:** Lamp indicates that sufficient emission current (i-) is flowing.

NOTE

> The switch function at this button is not used.

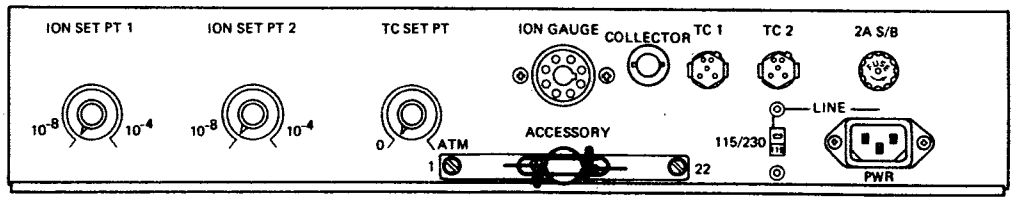
- **RANGE Switch:** Selects range of operation. Log position selects pressure indication from 1×10^{-3} to 1×10^{-8} torr. Other positions select each decade of pressure, i.e., in the 10^{-4} position, readings of 1×10^{-4} to 10×10^{-4} Torr (1×10^{-3}) are obtained.

- **TC 1, TC 2 Adjustments:** Zero's the thermocouple meter reading. Calibrate by adjusting zero at pressures below one milliTorr.

NOTE

> Before adjusting either of these TC units, refer to TC Calibration section.

DESCRIPTION OF CONTROLS (Rear Panel)



REAR PANEL

- **PWR:** Receptacle for AC power line.
- **2A S/B:** Main power fuse.
- **115/230:** Input voltage selector switch.
- **ION GAUGE:** Octal socket accepts gauge cord supplied with the unit.
- **COLLECTOR:** BNC connector for gauge tube collector cable.
- **ACCESSORY:** Printed circuit edge connector. Contains output connections for the recorder, filament status relay, filament remote on and off, and set-point relays (optional).
- **TC 1, TC 2:** Miniature type connectors for connecting the thermocouple gauge cords (thermocouple model only).
- **ION SET PT 1, ION SET PT 2:** Adjustment potentiometer for selecting the trip point of the set-point relays (set-point model only).
- **TC SET PT:** Adjustment potentiometer for selecting the trip point of the thermocouple set-point relay. Set-point works from TC 1 (set-point model only).

OPERATING THE IONIZATION GAUGE CONTROL

Before turning the power on, make sure that all cables and connections to the **ACCESSORY** output are installed properly.

NOTE

115/230 switch must be in proper position.

No preliminary calibration is necessary to operate the ionization gauge control. Pressure being monitored has to be below two milliTorr *before the gauge filament can be turned on.* Turn **RANGE** switch to desired pressure range. With the **RANGE** switch in the log position, observation of all five decades can be made without switching.

With power on, depress the **FILAMENT ON** button and hold for approximately one second or until emission is established as indicated by the **EM** light then release. Gauge filament should then remain on as indicated by the **FILAMENT ON** lamp. The **FILAMENT OFF** lamp will be off. If the gauge filament does not stay on, check for improper connections or that the pressure being monitored is above two milliTorr. When the filament is turned on, the **EM** lamp should also come on after a slight delay because of the filament warm up time. If the **EM** lamp does not light, check for faulty gauge, improper connections, or too high a pressure.

To degas the ionization gauge tube, push in the **DEGAS** button. The **DEGAS** lamp will light indicating that the gauge tube is being degassed. Degassing is only possible when the gauge tube has sufficient emission as indicated by the **EM** light. Pressure readings may be observed during this process.

Thermocouple Gauge (Thermocouple Model Only)

The thermocouple connectors are located on the rear panel and are labeled, **TC 1** and **TC 2**. Connect cables to the TC gauge tubes and thermocouple readings can immediately be observed with the control power on following the TC gauge tube calibration. The thermocouple control circuit is a constant current design which allows the use of cable lengths up to 100 feet using #20 Awg. wire. For cables of longer length, consult with the factory.

TC Calibration

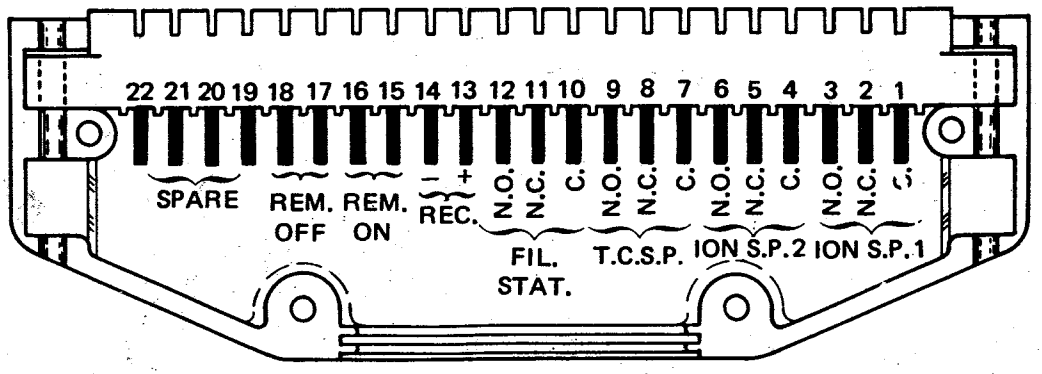
When a new thermocouple tube is installed on the vacuum system, this calibration procedure may be used to ensure proper reading. The circuit design minimizes drift, so that frequent recalibration is not required.

The calibration of the tube and circuit should be done as follows. With the power off to the control, the TC meters should read full scale to the right. The screwdriver adjustment directly under the meter allows the mechanical movement of the meter to be brought to the proper reading.

Turn the gauge control power on and connect the gauge cable to the tube. Evacuate the vacuum system to a pressure of 1 x 10^{-4} Torr. The thermocouple meters can now be adjusted to read zero (full scale left) by rotating the screwdriver adjustment in the holes directly under the holes marked TC 1 and TC 2. The thermocouple meter and tube are now calibrated for reading the pressure directly.

NOTE

> The mechanical adjustment must be made only with the power off.

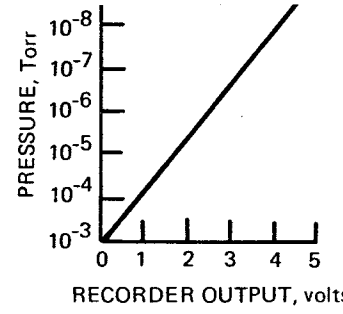


ACCESSORY CONNECTOR

Recorder Output

The recorder output terminals are located in the **ACCESSORY** output connector (J102) Pins 13 and 14. Pin 13 is positive with respect to Pin 14 which is tied to signal ground. The output signal is 0 to 5 volts or 1 volt/decade, corresponding to pressure readings of 1 x 10^{-3} to 1 x 10^{-8} Torr.

This is a logarithmic response and follows the movement of the pressure meter pointer in the LOG position exactly. The recorder output, however, is independent of the range switch position.



RECORDER OUTPUT VS. PRESSURE

Remote Filament Control

The remote filament control terminals are located in the **ACCESSORY** output connector (J102). An SPST **MOMENTARY** (1 sec) **SWITCH** is required to operate each output. Connect each switch as follows:

Remote-on terminals – Pins 15 and 16.

Remote-off terminals – Pins 17 and 18.

These terminals are extensions of the normal **FILAMENT ON/OFF** switches (See description of controls located in operation section of manual.) A switch closure across Pins 15 and 16 will start the filament. A switch closure across Pins 17 and 18 will turn the filament off.

Filament Status Relay

The output terminals for this feature are located in the **ACCESSORY** output connector (J102). Available contacts are SPDT, rated at 5 (2.5) A, 115 (230) VAC or 24 VDC Res. Connections are as follows:

C = J102 Pin 10

NC = J102 Pin 11

NO = J102 Pin 12

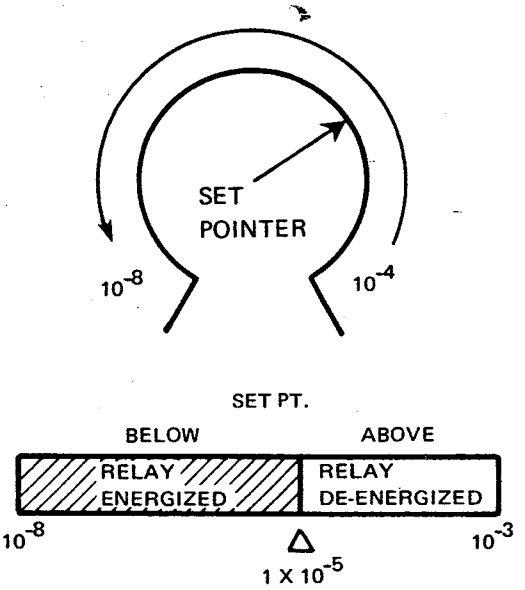
This relay is energized when the filament is on and de-energized with the filament off.

Ionization Gauge Set-Points (Set-point Model Only)

Two independent set points that operate between 1×10^{-3} to 1×10^{-8} Torr are provided. Adjustments are found on the rear panel and are labeled **ION SET PT 1, ION SET PT2.** The scale markings correspond to the log scale of the ion meter. When adjusting the set-points, it should be noted that a hysteresis of ±2% of reading is built-in to prevent oscillation at the trip point. Also when emission is lost, the meter will peg full scale, thus de-energizing the set-point relays.

Set-point Calibration (System Method)

With the ion gauge monitoring the vacuum system, adjust the system pressure to the reading at which the set point is to trip. Once the system has stabilized at that point, adjust the set-point potentiometer (located on the rear panel) until the relay trips. Relay tripping can be observed by connecting an ohmmeter across the normally open contacts of the set-point being adjusted and watching for a closure (meter will indicate a short circuit), or listening for the relay contact closure.



ION SET POINT

Note that either or both set-points can be used at different points or the same point on the scale. See adjacent figure for an example of set-point operation. The output terminals are located in the **ACCESSORY** output connector (J102) which is on the rear panel. Each set-point relay contact is rated at 5 (2.5) A, 115 (230) VAC or 24 VDC resistive. Connections are as follows:

ION SET PT. 1	ION SET PT. 2
C = J102 Pin 1	C = J102 Pin 4
NC = J102 Pin 2	NC = J102 Pin 5
NO = J102 Pin 3	NO = J102 Pin 6

Set-point Calibration (Electronic Method)

CAUTION

With the gauge control on, high voltage is present at the gauge tube connector. Make all connections with gauge control power off.

It was stated earlier in the ionization gauge operation section that gauge sensitivity is a function of the positive ion current, emission, and pressure. It follows that pressure can be determined by the equation

$$P = \frac{i+}{i-} \quad (1/S) \tag{1}$$

where

P = pressure

i+ = positive ion current

i- = emission current

S = sensitivity

Using Equation (1) as a basis, any pressure reading can be simulated electronically and the set-points adjusted to trip at a desired pressure. Assume that i- is 1 mA for all pressure settings. Let

$$i- = \frac{E_2}{R_2} \text{ and solve for } R_2 \text{ where } E_2 = 130 \text{ VDC} \tag{2}$$

E_2 = 160 VDC -30 VDC
(grid voltage -filament bias)

$$R_2 = \frac{E_2}{i-} = \frac{130}{0.001} = 130 \text{ Kohms} \tag{3}$$

$$\text{Let } i+ = \frac{E_1}{R_1} \text{ where } E_1 = 160 \text{ VDC} \tag{4}$$

R_1 = Resistor to simulate i+

From Equation (1)

$$i+ = (P)\ (S)\ (i-) \tag{5}$$

i- was chosen as 0.001A, therefore

$$i+ = (P)\ (S)\ 10^{-3}\ A \tag{6}$$

Now by using the preceding equations, any desired pressure can be simulated by selecting P, knowing S and solving for i+. The correct value of R_1 required to simulate this collector current may then be calculated from Equation (6). For example, if it is desired that a set-point trip at 1×10^{-5} Torr determine i+ (S = 11 $Torr^{-1}$ for Varian 571 gauge tube)

$$i+ = (1 \times 10^{-5}\ \text{Torr}) \left(\frac{11}{\text{Torr}}\right) (10^{-3}\ \text{A})$$

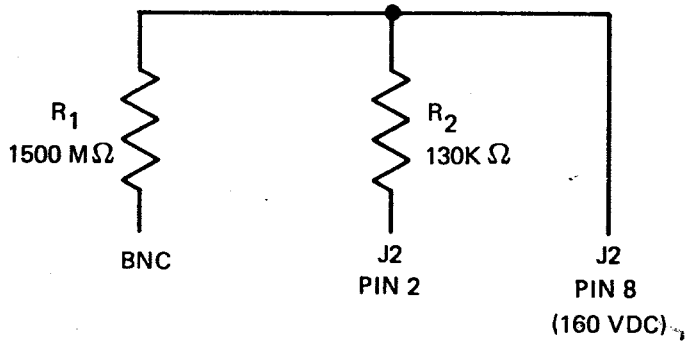
$$i+ = 1.1 \times 10^{-7}\ \text{A}$$

Then from Equation (4)

$$1.1 \times 10^{-7}\ \text{A} = \frac{160\ \text{VDC}}{R_1}$$

$$R_1 = 1.5 \times 10^{9}\ \text{ohms}$$

To simulate the pressure reading, connect R_1 and R_2 as follows



RESISTOR TO PIN CONNECTIONS

CAUTION

High Voltage

With this circuit plugged into the ion cable socket (J2) located on the rear panel, a pressure of 1×10^{-5} Torr is simulated on the pressure meter. To calibrate the set-point, turn on the power to the control. **FILAMENT ON** and **EM** light will come on automatically. This is normal because the emission is simulated through the external resistors. Note also that the **FILAMENT OFF** switch will have no effect while calibration resistors are connected. Adjust the set-point potentiometer until the relay trips (located on rear panel). The set-point selected is now calibrated.

To adjust for a new setting or to calibrate the other set-point, select the pressure at which relay tripping is desired and reuse Equations (4) and (6) to find new value for R_1. Note, R_2 remains at 130 Kohms and S should be the same for all calculations.

Table II presents typical values of R_1 and R_2 for different pressure settings. Note, i- = 0.001A for all settings.

TABLE II TYPICAL VALUES FOR SET-POINT OPERATION

Pressure (Torr)	S* ($Torr^{-1}$)	R_1 (ohms)	R_2 (ohms)
1×10^{-4}	11	150 meg	130K
1×10^{-5}	11	1.5×10^{9}	130K
1×10^{-6}	11	1.5×10^{10}	130K
1×10^{-7}	11	1.5×10^{11}	130K

*Varian Model 571

Thermocouple Set-point (Thermocouple Model Only)

The thermocouple set-point operates on the signal from TC 1. It provides relay contact closure on any set point adjustment within the range of 5 milliTorr and 2 Torr. The adjustment potentiometer is located on the rear panel and is labeled, **TC SET PT.**

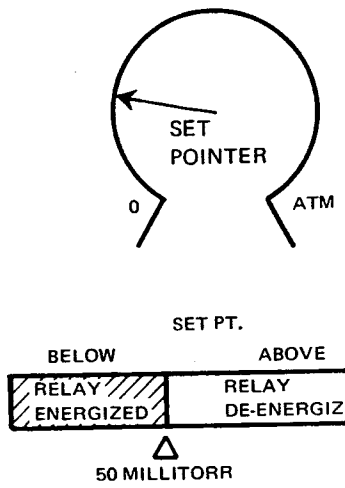
To calibrate the set-point, adjust the vacuum system pressure to the point where relay trip is desired. After the system has stabilized, rotate the set-point potentiometer until the relay trips. This can be observed by connecting an ohmmeter across the relay output contacts between the common and normally open contacts. When the relay trips zero resistance is read on the ohmmeter.

An alternate method to calibrate the set-point would be to make the TC meter read the desired pressure by deliberate misadjustment of the calibration potentiometer located on the front panel (screwdriver adjustment through bottom hole under TC 1 meter). Then rotate set-point potentiometer until relay trips. If this method is used, recalibration of the TC 1 thermocouple is necessary. See page 22 for instructions. Use Method 2 of the Automatic Filament Turn-on Adjustment Procedure.

NOTE

> This method can be used only if pressure on the TC tube is below 100 milliTorr.

See figure for typical example of set-point calibration.



TC SET POINT

The output terminals are located in the **ACCESSORY** output connector (J102). The relay contacts are rated at 5 (2.5) A, 115 (230) VAC or 24 VDC. Res. Connections are as follows:

C = J102 Pin 7

NC = J102 Pin 8

NO = J102 Pin 9

Automatic Filament Turn-on (Optional)

This option is purchased separately. When used, it will override the normal filament starting procedure (remote as well) and turn on the ion gauge filament at the pressure setting predetermined by the operator. This feature also overrides the over-pressure protection circuitry built in to the gauge control.

The option is connected to **TC 1**, therefore, it is mandatory to use the TC 1 gauge tube to monitor the pressure for the ionization gauge filament turn-on. It will not interfere with the set point provided for TC 1. A hysteresis of 3% of meter arc is built in to prevent oscillation at trip point.

CAUTION

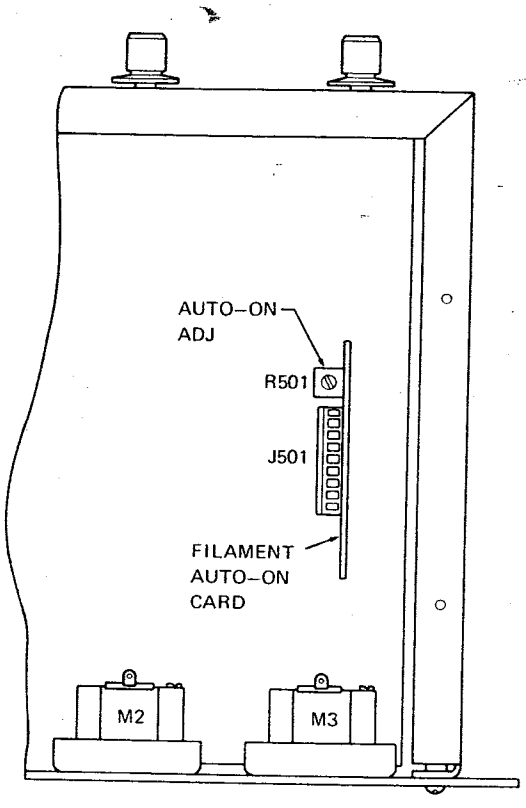
> *High voltage is present in this control. Use care when making adjustments.*

To operate, plug card into P501 (plug located on main printed circuit board). Adjust R501 (turn-on adjust potentiometer) located on the plug-in card so that the gauge filament turns on or off at the desired pressure. This procedure may be done by either of the following methods:

1. With TC 1 and the ion gauge monitoring the same pressure in the vacuum system, adjust the pressure of the vacuum system to the pressure point at which you desire to turn on the ion

gauge filament. The adjustable range is from 5 to 100 milliTorr (e.g., 20 milliTorr is a good point). Once vacuum is stable, adjust R501 (turn-on potentiometer) until filament turns on. See Figure 10 for the location of P501 and R501.

2. Ensure that the pressure which the ion gauge is monitoring is at a safe level for turning on the gauge filament. Plug in the auto-on card as previously described. Deliberately misadjust the TC 1 calibration control (screwdriver adjustment through front panel located under TC 1, bottom hole) until the desired turn-on pressure is indicated by the TC 1 meter, i.e., if 20 milliTorr is desired, adjust until meter pointer reaches 20 milliTorr on meter scale. Next, adjust R501 until the filament turns on. See the figure for the location of R501. *If this procedure is used, recalibration of TC 1 is required.* Once the auto-filament turn on point has been set, simply re-zero TC 1.



AUTO FILAMENT TURN-ON PC BOARD LOCATION

Calibration Procedure Ionization Gauge

This procedure should seldom, if ever, be necessary and is not recommended as a routine procedure. The instrument is fully tested and calibrated at the factory. The procedure is included only for the convenience of the user.

CAUTION

> *High voltage is present at gauge tube connector. Make all connections with power off.*

1. Disconnect the ion gauge from the control unit.
2. Connect a 15 meg 1/2 W ±1% resistor from J2 (ion gauge tube socket) Pin 8 to collector terminal (BNC).
3. Connect a 13K 1/2 W ±1% resistor from J2 Pin 8 to J2 Pin 7.
4. Set the RANGE switch (front panel) to the 10^{-4} position.

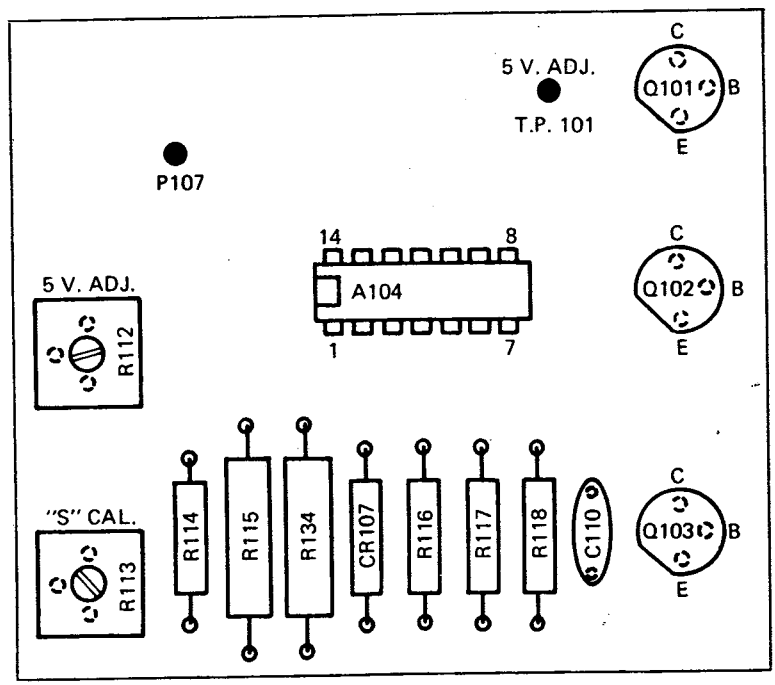
5. Connect a digital volt meter from TP101 (located on main printed wiring board) ground (J2 Pin 4).

6. Adjust the 5V ADJ (R112) for a 5 volt reading on the DVM.

7. Adjust the S CAL (R113) for a pressure reading of 1×10^{-4} Torr.

NOTE

> If a digital voltmeter is unavailable, a VTVM or other type may be used but the accuracy of the calibration will be reduced.



LOCATION OF S CAL, 5V ADJ & TP 101

IV. SERVICE

TROUBLESHOOTING

Fault Indication	Possible Causes/Checks/Remedy
With power switch on, all lights, functions inoperative.	1. Ensure that external power is operational. 2. Check fuse located on rear panel of gauge control. If fuse is defective, replace with proper type and value: 2 amp, slow blow.
Filament will not turn on when **FILAMENT ON** button is depressed; no pressure indication.	1. Burned out gauge tube. 2. System pressure too high. (Pressure must be below 2 milliTorr for control to operate). 3. 115/230 switch in wrong position (located on rear panel of control). 4. Filament tap switch in wrong position. (Refer to cable length chart on page 9). 5. Defective gauge tube cable or connection. 6. If automatic filament turn on option is used, read instructions on page 21.
EM light does not turn on when **FILAMENT ON** button is depressed.	1. Hold **FILAMENT ON** button in for several seconds since there is a slight delay for filament warm up. 2. Gauge tube is contaminated below a useful level. Replace gauge tube. 3. **EM** light is burned out. Replace with new bulb.

No degas power, **DEGAS** light does not turn on.	1. **FILAMENT** not turned on. **FILAMENT** and **EM** lights must be on before **DEGAS** will function.
Erratic pressure indication.	1. Gauge tube may be contaminated. 2. Check for leak in vacuum system.
Set points relays do not trip properly.	1. Check that the proper terminals have been used in **ACCESSORY** output connector. 2. Confirm that set point pressure is correctly seen. (See page 17 for proper procedure.)

If additional problems occur with the gauge control that are out of the range of the above trouble-shooting steps, consult with the service department of the manufacturer. He is prepared to assist you with any problem with the control.

Push-button Lamp Replacement

In the event that it becomes necessary to replace the indicator lamps in the push-button assembly the following steps should be followed:

1. Turn off power to the control.
2. The colored lens cap can be removed by simply depressing the top and bottom portion of the cap between the thumb and forefinger and pulling off.
3. With a long-nosed pliers the lamp may be carefully pulled from the base. The new lamp can similarly be installed.
4. Replace the colored lens cap by pushing back into place.

GAS SENSITIVITY TABLES

The following table lists relative gauge sensitivities for various gases. The values are derived by empirical methods substantiated by measurements reported in literature. The multiple values found in the table represent several different references. This table has been compiled and published by Robert L. Summers of Lewis Research Center, NASA Technical Note TN D-5285, National Aeronautics and Space Administration, Washington, D.C., June 1969.

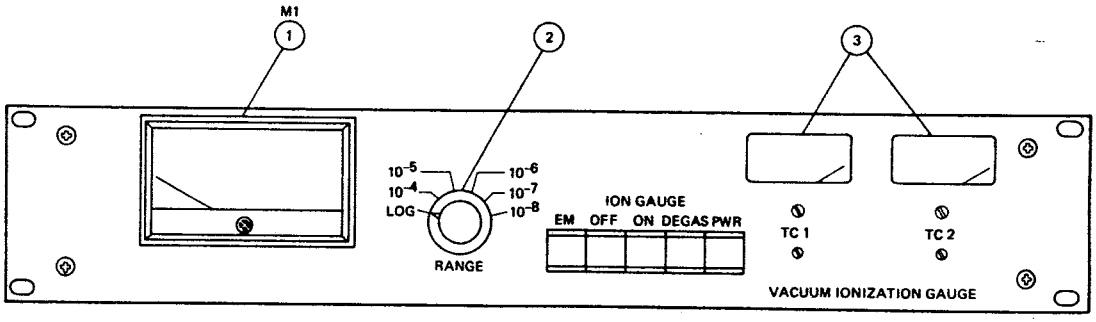
To convert readings from the ionization gauge control (normally calibrated for nitrogen) divide the indicated pressure by the number listed in the third column for the particular gas (S/S_{n_2}).

Substance	Formula	Relative Ionization Gage Sensitivity, S/S_{N_2}
Acetaldehyde	C_2H_4O	2.6
Acetone	$(CH_3)_2CO$	3.6
		4.0
		3.6
Acetylene	C_2H_2	1.9
		2.0
Air		1.0
		0.98
Ammonia	NH_3	1.3
		1.2
		1.3
Amylene:		
iso-	iso-C_5H_{10}	5.9
cyclo-	cy-C_5H_{10}	5.8
Argon	Ar	1.3
		1.1
		1.2
		0.9
Benzene	C_6H_6	5.9
		5.8
		5.7
		5.9
		6.0
Benzoic acid	C_6H_5COOH	5.5
Bromine	Br	3.8
Bromomethane	CH_3Br	3.7
Butane:		
n-	n-C_4H_{10}	4.9
		4.7
iso-	iso-C_4H_{10}	4.6
		4.9
Cadmium	Cd	2.3
		3.4
Carbon dioxide	CO_2	1.4
		1.4
		1.5
		1.5
		1.4

Substance	Formula	Relative Ionization Gage Sensitivity, S/S_{N_2}
Carbon disulfide	CS_2	5.0
		4.7
		4.8
Carbon monoxide	CO	1.05
		1.05
		1.1
Carbon tetrachloride	CCl_4	6.0
		6.3
Cesium	Cs	4.3
		2.0
		4.8
Chlorine	Cl_2	0.68
		2.6
		1.6
Chlorobenzene	C_6H_5Cl	7.0
Chloroethane	C_2H_5Cl	4.0
Chloroform	$CHCl_3$	4.7
		4.8
		4.8
Chloromethane	CH_3Cl	2.6
		3.2
		3.1
Cyanogen	$(CN)_2$	2.8
		3.6
		2.7
Cyclohexylene	C_6H_{12}	7.9
		6.4
Deuterium	D_2	0.35
		0.38
Dichlorodifloromethane	CCl_2F_2	2.7
		4.1
Dichloromethane	CH_2Cl_2	3.7
Dinitrobenzene:	$C_6H_4(NO_2)_2$	
o-		7.8
m-		7.8
p-		7.6
Ethane	C_2H_6	2.6
		2.8
		2.5
Ethanol	C_2H_5OH	3.6
		2.9
Ethyl acetate	$CH_3COOC_2H_5$	5.0

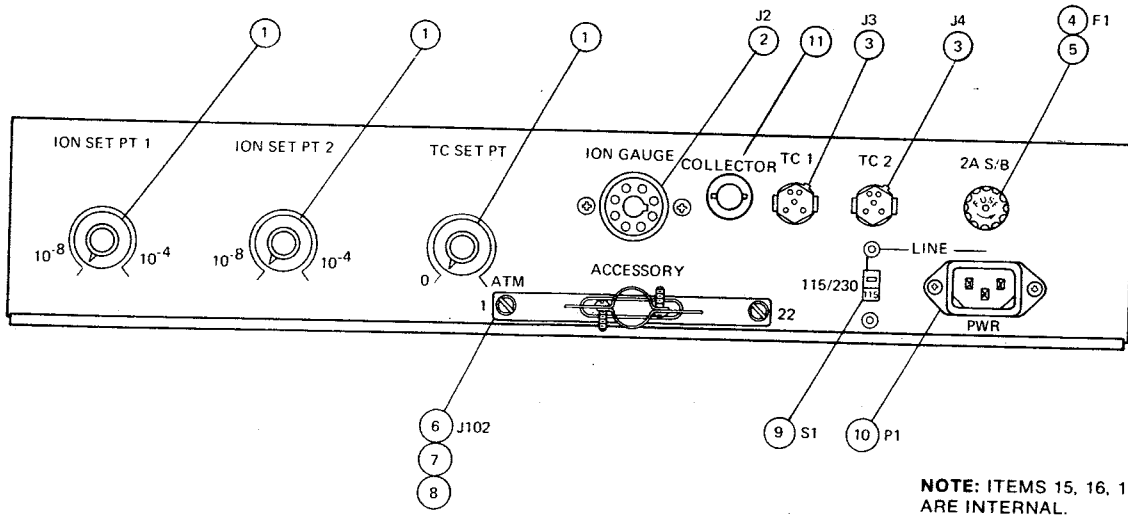
Substance	Formula	Relative Ionization Gage Sensitivity, S/S_{N_2}
Ethyl ether	$(C_2H_5)_2O$	5.1
		5.1
Ethylene	C_2H_4	2.3
		2.4
		2.2
		2.2 to 2.5
Ethylene oxide	$(CH_2)_2O$	2.5
Helium	He	0.18
		0.15
		0.13
		0.12
Heptane	C_7H_{16}	8.6
Hexadiene:		
1,5-	1,5-C_6H_{10}	6.4
cyclo-	cy-C_6H_{10}	6.0
Hexane	C_6H_{14}	6.6
Hexene:		
1-	1-C_6H_{12}	5.9
cyclo-	cy-C_6H_{10}	6.4
Hydrogen	H_2	0.46
		0.38
		0.41
		0.45
		0.44
Hydrogen bromide	HBr	2.0
Hydrogen chloride	HCl	1.5
		1.6
		2.0
		1.5
Hydrogen cyanide	HCN	1.5
		1.6
Hydrogen floride	HF	1.4
Hydrogen iodide	HI	3.1
Hydrogen sulfide	H_2S	2.2
		2.2
		2.3
		2.1
Iodine	I_2	5.4
Iodomethane	CH_3I	4.2
Isoamyl alcohol	$C_5H_{11}OH$	2.9
Isobutylene	C_4H_8	3.6
Krypton	Kr	1.9
		1.7
		1.7
Lithium	Li	1.9
Mercury	Hg	3.6
Methane	CH_4	1.4
		1.5
		1.6
		1.4 to 1.8
		1.5
		1.5
Methanol	CH_3OH	1.8
		1.9
Methyl acetate	CH_3COOCH_3	4.0
Methyl ether	$(CH_3)_2O$	3.0
		3.0

Substance	Formula	Relative Ionization Gage Sensitivity, S/S_{N_2}
Naphthalene	$C_{10}H_8$	9.7
Neon	Ne	0.30
		0.31
Nitrobenzene	$C_6H_5NO_2$	7.2
Nitrogen	N_2	1.0
Nitrotoluene (o-, m-, p-)	$C_6H_4CH_3NO_2$	8.5
Nitric oxide	NO	1.3
		1.2
		1.0
Nitrous oxide	N_2O	1.5
		1.7
		1.7
		1.3 to 2.1
Oxygen	O_2	1.0
		1.1
		.9
		.9
Pentane:		
n-	n-C_5H_{17}	6.2
		6.0
		5.7
iso-	iso-C_5H_{17}	6.0
neo-	$(CH_3)_4C$	5.7
Phenol	C_6H_5OH	6.2
Phosphine	PH_3	2.6
Potassium	K	3.6
Propane	C_3H_8	4.2
		3.7
		3.7 to 3.9
		3.6
Propene oxide	C_3H_6O	3.9
Propene:		
n-	n-C_3H_6	3.3
		3.2 to 3.7
cyclo-	cy-C_3H_6	3.6
Rubidium	Rb	4.3
Silver perchlorate	$AgClO_4$	3.6
Sodium	Na	3.0
Stannic iodide	SnI_4	6.7
Sulfur dioxide	SO_2	2.1
		2.3
Sulfur hexafloride	SF_6	2.3
		2.8
Toluene	$C_6H_5CH_3$	6.8
Trinitrobenzene	$C_6H_3(NO_2)_3$	9.0
Water	H_2O	1.1
		1.0
		0.8
Xenon	Xe	2.9
		2.2
		2.4
Xylene:		
o-	o-$C_6H_4(CH_3)_2$	7.8
p-	p-$C_6H_4(CH_3)_2$	7.9



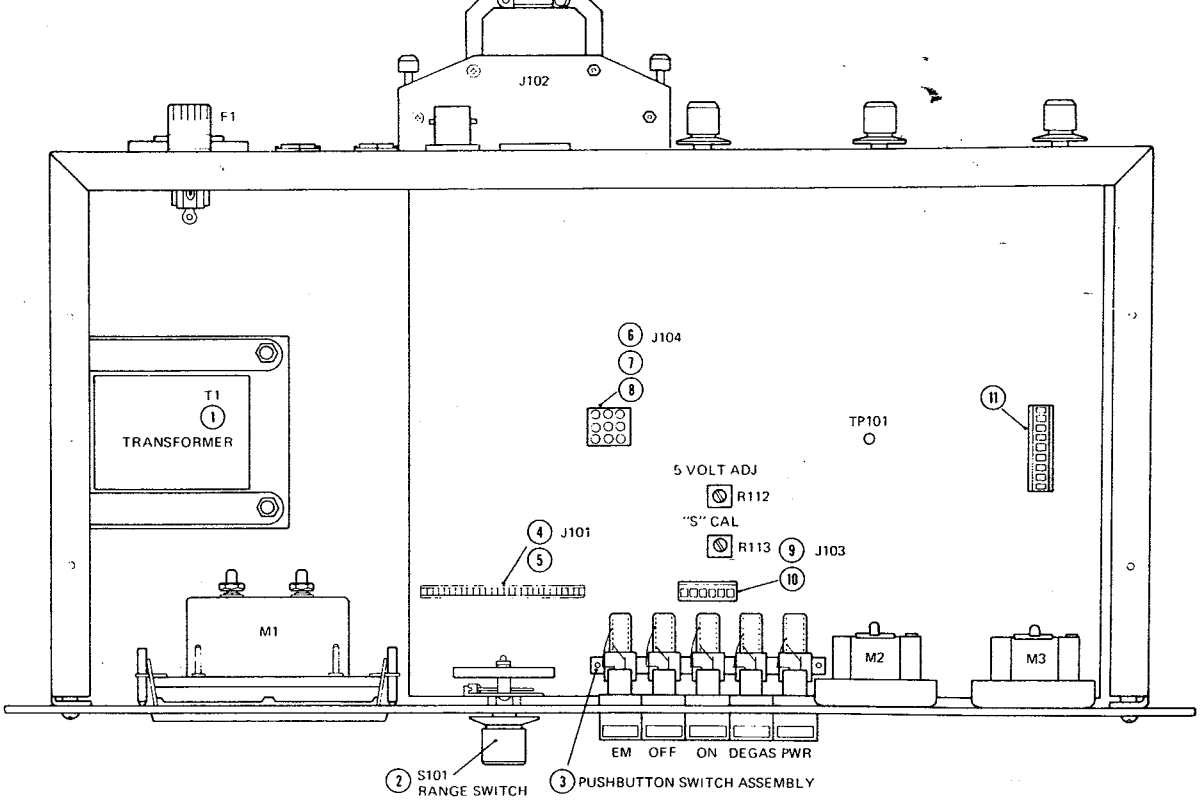
FRONT PANEL
PARTS LIST

Item	Description	Part No.
1	Ion Meter	0881-6522-08-142
2	Knob—Rogan: RB-67-1-SK-7M, Blk w/ 1/4" Dia. Shaft	0881-6602-51-315
3	TC Meter	0881-6522-08-125



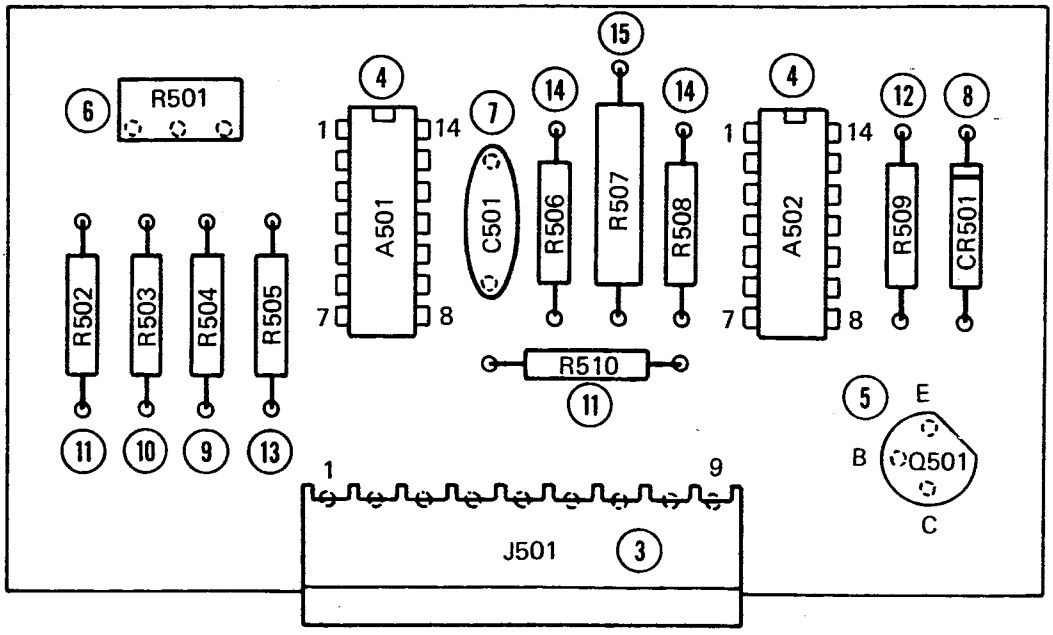
REAR PANEL
PARTS LIST

Item	Description	Part No.
1	Knob—Rogan: RB-67-0, SK-7m, Black with 1/4" dia. shaft hole	0881-6602-51-310
2	Socket—Amphenol: 77 MIP-8	
3	Connector—Amphenol: 126-218-1000	0881-6480-73-073
4	Fuse—3AG 2A SLO-BLO, Little Fuse: 313002	0881-6480-70-062
5	Fuseholder—Little Fuse: 342014	0881-6453-00-022
6	Connector—22, Pin, 0.156 Spacing, SAE: SAC-22S/1-2	0881-6456-00-005
7	Hood with cable clamp—SAE: 8031	0881-6480-72-422
8	Polarizing Key—SAE: 007900	0881-6480-72-308
9	Switch—DPDT 115/230, Switchcraft: 46206LF	0881-6700-72-179
10	Receptacle—Switchcraft: EAC-301	0881-6421-10-020
11	Connector—King: KC-79-106	0881-6480-76-031
12	T.C. gauge tube cable	0881-6480-70-579
13	Ion gauge tube cable	0881-K1649-301
14	Line cord—Belden: 17250, 18/3, SUT Blk.	0881-K3143-310
15	CR1+CR2—1N457A	0881-6564-58-203
16	C1+C2—Sprague #10TS-S10 Cap. .01μF/1000V	0881-6491-07-057
17	Resistor R1—100KΩ, 1/2W., 5% Dep. Carb.	0881-6441-02-008
		0881-6541-09-160



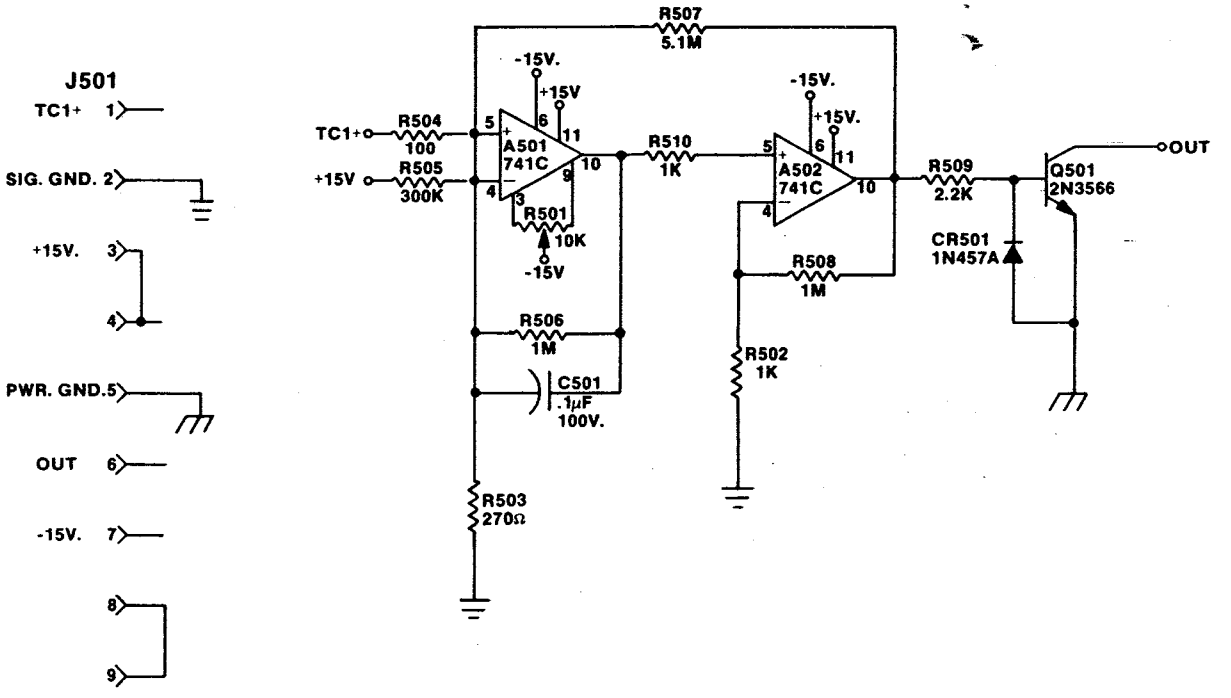
TOP CHASSIS
PARTS LIST

Item	Description	Part No.
1	Transformer C-K3114	0881-6581-00-254
2	S101 Range Switch Assembly	0881-6421-08-064
3	Pushbutton Switch Assembly	0881-K3115-001
4	Connector—28 Pin, Series 2695, Molex: 22-01-2281	0881-6480-72-218
5	Terminal—Molex: 08-56-0114	0881-6480-72-114
6	Connector—9 Pin, Molex: 03-09-1093	0881-6480-70-033
7	Terminal—Molex: 02-09-1118	0881-6480-94-130
8	Terminal—Molex: 02-09-2118	0881-6480-94-125
9	Connector—6 Pin, Molex: 09-50-7061	0881-6480-70-027
10	Terminal—Molex: 08-56-0106	0881-6480-73-208
11	Connector—Molex: Friction Lock Wafer 09-72-1091 (9 Pin)	0881-6480-70-039
12	Lamp—IEE/Schadow, Inc: 12522-12V, 30MA	0881-6511-64-022
13	Push button—IEE/Schadow, Inc: 17.5 FRV BLK/GRN (Green) 17.5 FRV BLK/ORN (Orange)	



AUTO TURN ON CARD
PARTS LIST

Item	Description	Part No.
1	Schematic – B-K3551	0881-K3551-001
3	Connector – P.C. Edge, 9 Pin, Molex: 09-62-3091	0881-6480-70-072
4	Op. Amp. – Lin. Type 741C, T.I.: SN72741N	0881-6490-71-035
5	Transistor – Fairchild: 2N3566	0881-6543-18-020
6	Potentiometer – 10KΩ, 1/2W, ±10% Cermet, Beckman: 72XW-10K	0881-6545-12-208
7	Capacitor – .1μf/100VDC, Sprague: TG-P10	0881-6449-10-020
8	Diode – ITT: 1N457A	0881-6491-07-057
9	Resistor – 100Ω, 1/2W, ±5% Dep. Carb., Dale: Type SBC	0881-6541-09-108
10	Resistor – 270Ω, 1/2W, ±5% Dep. Carb., Dale: Type SBC	0881-6541-09-113
11	Resistor – 1KΩ, 1/2W, ±5% Dep. Carb., Dale: Type SBC	0881-6541-09-175
12	Resistor – 2.2KΩ, 1/2W, ±5% Dep. Carb., Dale: Type SBC	0881-6541-09-153
13	Resistor – 300KΩ, 1/2W, ±5% Dep. Carb., Dale: Type SBC	0881-6541-09-130
14	Resistor – 1MΩ, 1/2W, ±5% Dep. Carb., Dale: Type SBC	0881-6541-09-123
15	Resistor – 5.1MΩ, 3/4W, ±5% Dep. Carb., Dale: Type SBE	0881-6541-11-329



AUTO ON
SCHEMATIC

PC ASSEMBLY PARTS LIST

Item	Description	Part No.	CONTROL MODEL (QUANTITY) BASIC	ST PT	TC	TC PLUS ST PT
2	Resistor – 22Ω, 1/2W, 5%, Dep. Carb.	0881-6543-17-050	0	0	4	4
3	Resistor – 33.2Ω, 1/2W, 1%, Type RN60D	0881-6542-78-239	5	5	5	5
4	Resistor – 33Ω, 1/2W, 5%, Dep. Carb.	0881-6541-09-100	1	1	1	1
5	Resistor – 100Ω, 1/2W, 5%, Dep. Carb.	0881-6541-09-108	0	0	4	6
6	Resistor – 620Ω, 1/2W, 5%, Dep. Carb.	0881-6541-10-620	1	1	1	1
7	Resistor – 750Ω, 1/2W, 5%, Dep. Carb.	0881-6541-10-750	1	1	1	1
8	Resistor – 2KΩ, 2W, 10%, TRW Type RGR42	0881-6541-11-101	2	2	2	2
9	Resistor – 2.2KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-153	4	4	4	5
10	Resistor – 470Ω, 3/4W, 5%, Dep. Carb.	0881-6541-11-255	1	1	1	1
11	Resistor – 9.2KΩ, 1/2W, 1%, Type RN60D	0881-6542-78-329	1	1	1	1
12	Resistor – 10KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-102	3	9	3	9
13	Resistor – 22KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-170	1	1	1	1
14	Resistor – 39KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-188	1	1	1	1
15	Resistor – 40.2KΩ, 1/2W, 1%, Type RN60D	0881-6542-78-342	1	1	1	1
16	Resistor – 68KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-190	2	2	2	2
17	Resistor – 100KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-160	3	3	3	3
18	Resistor – 120KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-159	0	0	0	1
19	Resistor – 470KΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-133	1	1	1	1
20	Resistor – 1MΩ, 1/2W, 5%, Dep. Carb.	0881-6541-09-123	2	2	2	2
21	Resistor – 2.2MΩ, 3/4W, 5%, Dep. Carb.	0881-6541-09-322	0	2	0	2
22	Resistor – 10MΩ, 3/4W, 5%, Dep. Carb.	0881-6541-09-120	1	3	1	4
23	Potentiometer – 100Ω, ±20% Lin. Taper, Shaft 1, 5/8" FMS. Plain Round, CTS: AR1533	0881-6545-09-083	0	0	0	1
24	Potentiometer – 200Ω, ±30%, 1/4W, CTS: X201	0881-6545-28-201	0	0	2	2
25	Potentiometer – 500Ω, Beckman: 72PR500	0881-6545-12-062	1	1	1	1
26	Potentiometer – 10K, Beckman: 72PR10K	0881-6545-12-070	0	0	0	1
27	Potentiometer – 10K, ±20%, Lin. Taper, Shaft 1 5/8" FMS, Plain Round, CTS: AR1534	0881-6545-09-084	0	2	0	2
28	Potentiometer – 100KΩ, Beckman: 72PR100K	0881-6545-12-069	1	1	1	1
29	Diode – ITT: 1N457A	0881-6491-07-057	7	9	7	10
30	Diode – Sarkes Tarzian: E6	0881-6491-02-025	3	6	3	7
31	Diode – Motorola: MZ-1000-24	0881-6491-02-038	1	1	1	1
32	F.W.B. – Mallory: FW-100	0881-6491-02-080	2	2	3	3
33	F.W.B. – Mallory: FW-300	0881-6491-02-085	1	1	1	1
34	Transistor – Fairchild: 2N3566	0881-6543-18-010	2	4	2	5

PC ASSEMBLY
PARTS LIST (Cont'd)

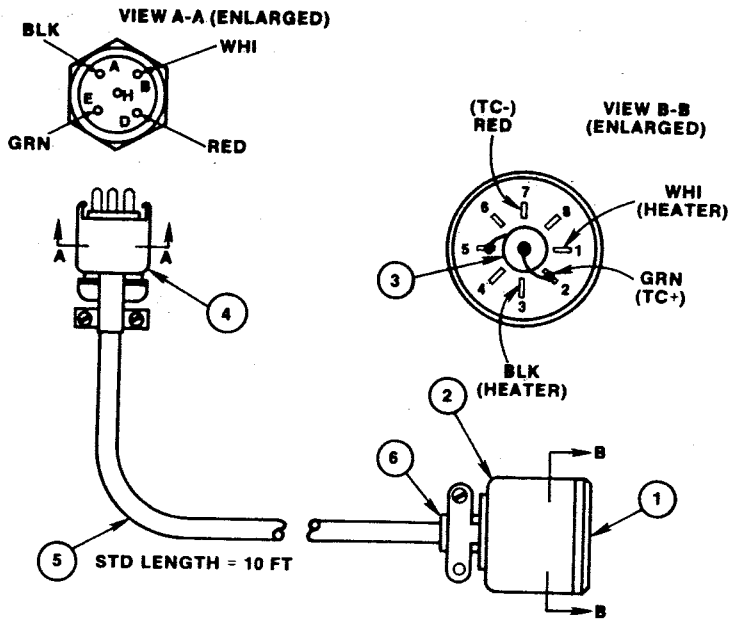
Item	Description	Part No.	CONTROL MODEL			
			BASIC	ST PT	TC	TC PLUS ST PT
			(QUANTITY)			
35	Transistor – T.I.: TIP-29	0881-6543-18-029	0	0	2	2
36	Voltage Regulator – 2-37V, Nat. Semicond: LM123N	0881-6429-71-123	1	1	1	1
37	Voltage Regulator – (Pos.), Fairchild: 78M05UC	0881-6429-72-041	0	0	2	2
38	Voltage Regulator (+15V) Fairchild: 7815UC	0881-6429-71-178	1	1	1	1
39	Voltage Regulator (-15V) Fairchild: 7915UC	0881-6429-71-179	1	1	1	1
40	Heat Sink – NIPL. Thermalloy: 6025D	0881-6492-00-012	2	2	6	6
41	Capacitor – 100 pF/1000VDC, Sprague: 5GA-T10	0881-6449-00-023	2	2	2	2
42	Capacitor – .001 μF/1000 VDC, Sprague: 5GA-D10	0881-6449-00-018	1	1	1	1
43	Capacitor – .01 μF/100VDC, Sprague: TG-S10	0881-6449-10-032	3	5	3	5
44	Capacitor – .1 μF/100VDC, Sprague: TG-P10	0881-6449-10-020	0	0	0	1
45	Capacitor – 10 μF/250VDC, Sprague: TVA-1504	0881-6449-10-025	1	1	1	1
46	Capacitor – 100 μF/25VDC, Sprague: TE-1211	0881-6449-09-065	4	4	4	4
47	Capacitor – 100 μF/50VDC, Sprague: TE-1309	0881-6449-09-102	1	1	1	1
48	Op. – Amp. – Lin. Type 741C, T.I.: SN72741N	0881-6490-71-035	2	4	2	5
49	Ratio Module	0881-6491-16-156	1	1	1	1
50	Relay – 24VDC, SPDT, Contacts 10A @ 115VAC, Magnecraft: W65RPCX-203 For Substitute Relay, See Note 1.	0881-6572-00-042	3	5	3	6
51	Terminal Pin – Claspcon Type, Molex: R-93-31	0881-6480-73-179	4	4	4	4
52	Connector – Molex "Konektcon": 09-61-1061 (6 Pin)	0881-6480-70-043	1	1	1	1
53	Connector – Molex: Friction Lock Wafer 09-72-1091 (9 Pin)	0881-6480-70-039	0	0	1	1
54	Connector – Molex: "Wafercon": 09-18-5094 (9 Pin)	0881-6480-70-049	1	1	1	1
55	Connector – Molex: Wafer 22-11-2281 (28 Pin)	0881-6480-72-221	1	1	1	1

PC ASSEMBLY
PARTS LIST (Concl'd)

Item	Description	Part No.	CONTROL MODEL			
			BASIC	ST PT	TC	TC PLUS ST PT
			(QUANTITY)			
56	Miniature Spring Socket – AMP: 50865-8	0881-6480-73-028	6	6	6	6
57	Switch – CTS: X5P7794 (This item does not have a substitute.)	0881-6421-08-064	1	1	1	1
58	Push Button Switch Assy.	0881-K3115-301	1	1	1	1
61	Resistor – 270Ω, 3/4W, 5%, Dep. Carb. Dale Type SBE	0881-6541-11-247	10	10	10	10
62	Buss Wire – 18 Awg. Tinned Copper, Solid	0881-6561-22-094	1	1	1	1
63	Resistor – 4.7KΩ, 1/2W, 5% Dep. Carb.	0881-6541-09-165	2	2	2	2
64	Buss Bar – B-K1083-310	0881-6569-00-320	1	1	1	1
66	Transistor – Fairchild: 2N3569	0881-6543-18-019	2	2	2	2
67	Cap. 1000μF/16 V.D.C. Sprague No. TVA-1163	0881-6449-10-017	0	0	1	1
68	Res. – 10Ω, 1/2W, 5%, Dep. Carb.	0881-6541-09-210	1	1	1	1
69	Diode – Schauer SZ-5.6	0881-6491-10-060	1	1	1	1

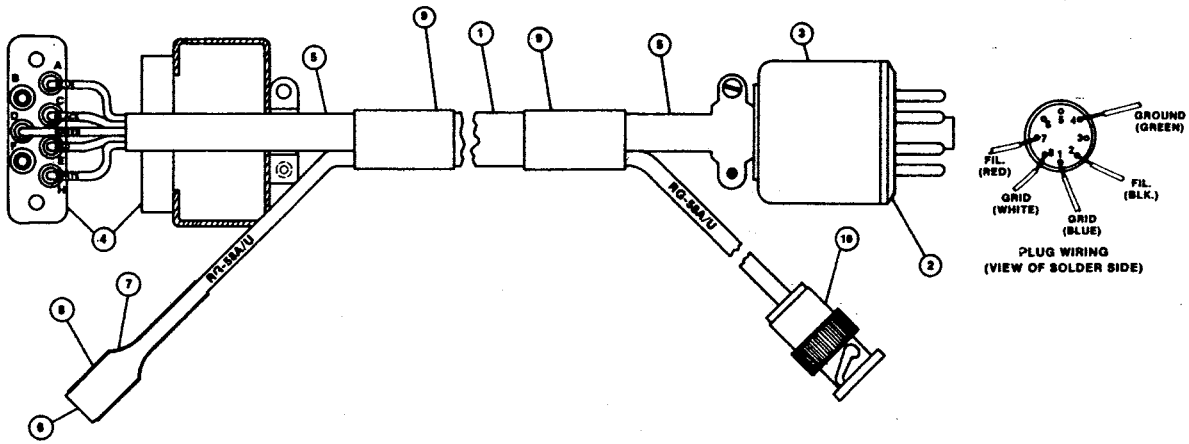
NOTES:

1. Substitute Relay (Item 50) Magnecraft: W65RPCX-203.
2. All 5%, 1/2W Resistors are Dale Type SBC.
3. All 5%, 3/4W Resistors are Dale Type SBE.



TC CABLE ASSEMBLY PARTS LIST

Item	Description	Part No.
1	Socket – 8 Pin, C-J # 8RI	6480-73-072
2	Cap ~ w/Clamp, Beau #200L-4B7	6480-73-036
3	Thermistor ~ 1Ω, 10% @ 25°C Fenwall #LD01K3	6542-08-005
4	Conn ~ 5 Pin Male w/Clamp & Hood, Amphenol #126-217	6480-70-059
5	Cable ~ 4 Cond #20 AWG 7/28 Strd, Unshielded Alpha #1896/4	6564-94-057
6	Strain Relief ~ Gen. Cement #H048	



ION GAUGE CABLE ASSEMBLY
PARTS LIST

Item	Description	Part No.
1	Cable — 18 AWG 19/32 RG-58, Madison Wire & Cable A/U Cable	6564-82-235
2	Plug — Amphenol #86-CP8T Blk Phenolic	6480-70-045
3	Cap — Beauchaine #2001-48-7	6480-73-036
4	Female Recepticle — Winchester #A7SH	6480-76-077
5	Heat Shrinkable Tubing Raychem Type 1 RNF-100 Blk	6568-00-250
6	Conn — Winchester #SM1S	6480-72-340
7	Hood — Winchester #SM1H.	6480-72-329
8	Heat Shrinkable Tubing — Raychem Type 1 RNF-100	6568-00-270
9	Heat Shrinkable Tubing — Raychem Type 1 RNF-100	6568-00-285
10	Plug (BNC Series) Kings No. KC-51-01	6480-70-571

varian
I E G
SERVICE OPERATION

SERVICE OPERATION

RETURNED AUTHORIZATION NO.

Prior to any product being returned to a Service Center a return authorization number must be obtained from the returned goods coordinator, and a copy of this report must accompany the products returned. Full information regarding reasons for return of the product will expedite repair or adjustment. Please fill in all blanks below and furnish any other information which will help identify the nature and cause of failure.

REASON FOR RETURN (Check appropriate boxes) ☐ Other _____

☐ Evaluation	☐ Rental Return	☐ Contract Exchange
☐ Corrective Shipment	☐ Rebuilt/Exchange Return	☐ Contract Repair
☐ Over Shipment	☐ Paid Repair	☐ Warranty Exchange
☐ Damaged Shipment	☐ Credit	☐ Warranty Repair

PRODUCT INFORMATION (use separate forms if more than one unit)

System Model No. _____ Serial No. _____ Inst. Date _____

Received Unit Model No. _____ Serial No. _____ Rec. Date _____

Shipped Unit Model No. _____ Serial No. _____ Ship. Date _____

PURCHASE INFORMATION (if product being returned for warranty reasons show original sales order and purchase order information; if product being returned for paid service show purchase order information; if product being returned for contract reasons show contract purchase order information.)

Sales Order No. _____ Sales Order Date _____

Purchase Order No. _____ Purchase Order Date _____

COMPANY NAME & ADDRESS _____

CITY/STATE/ZIP _____

CUSTOMER CONTACT: _____ TEL: _____

FAILURE REPORT (describe in detail suspected cause or nature of failure or malfunction)

_____

_____

_____

_____

_____

_____

RETURNED PRODUCTS

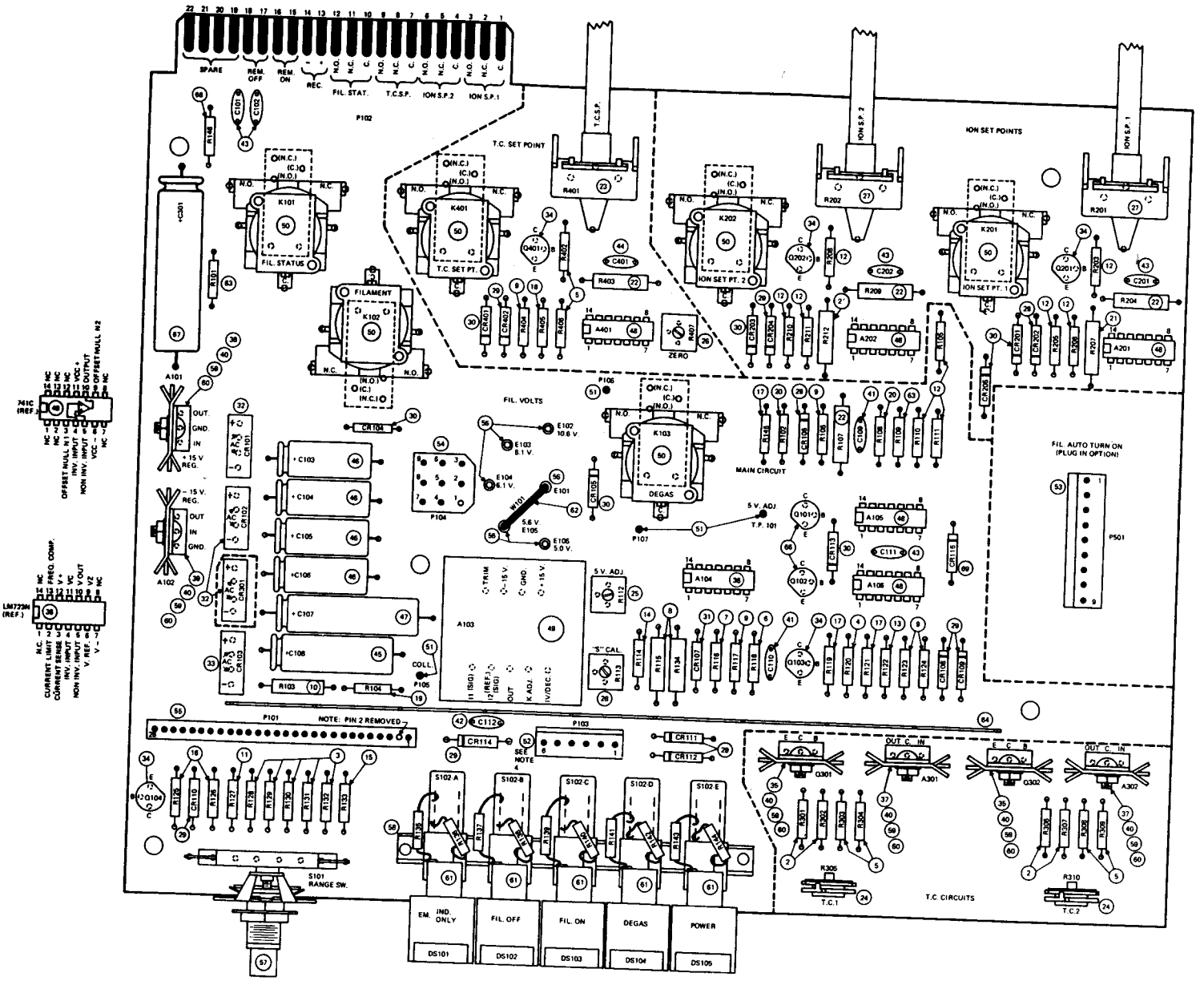
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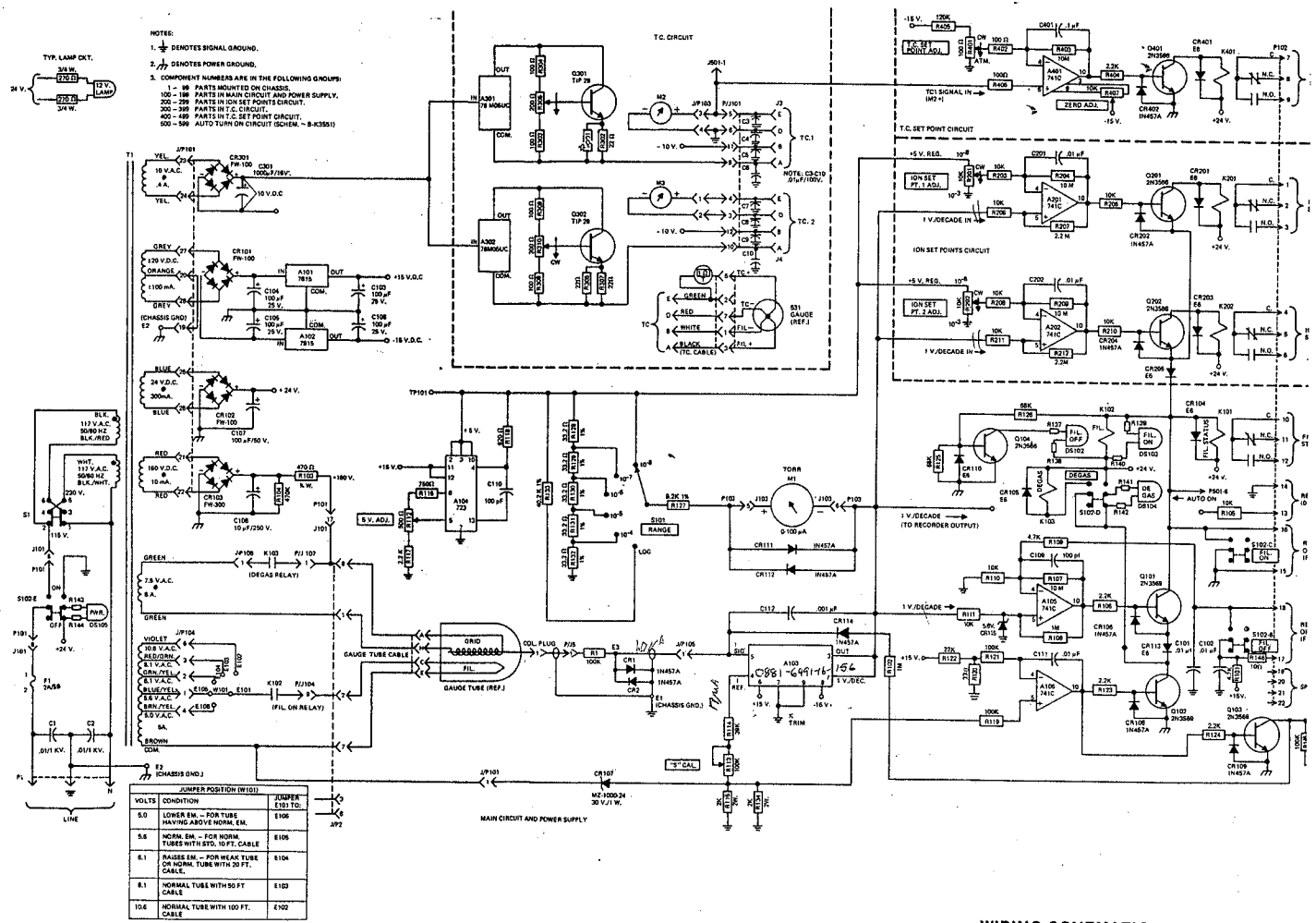
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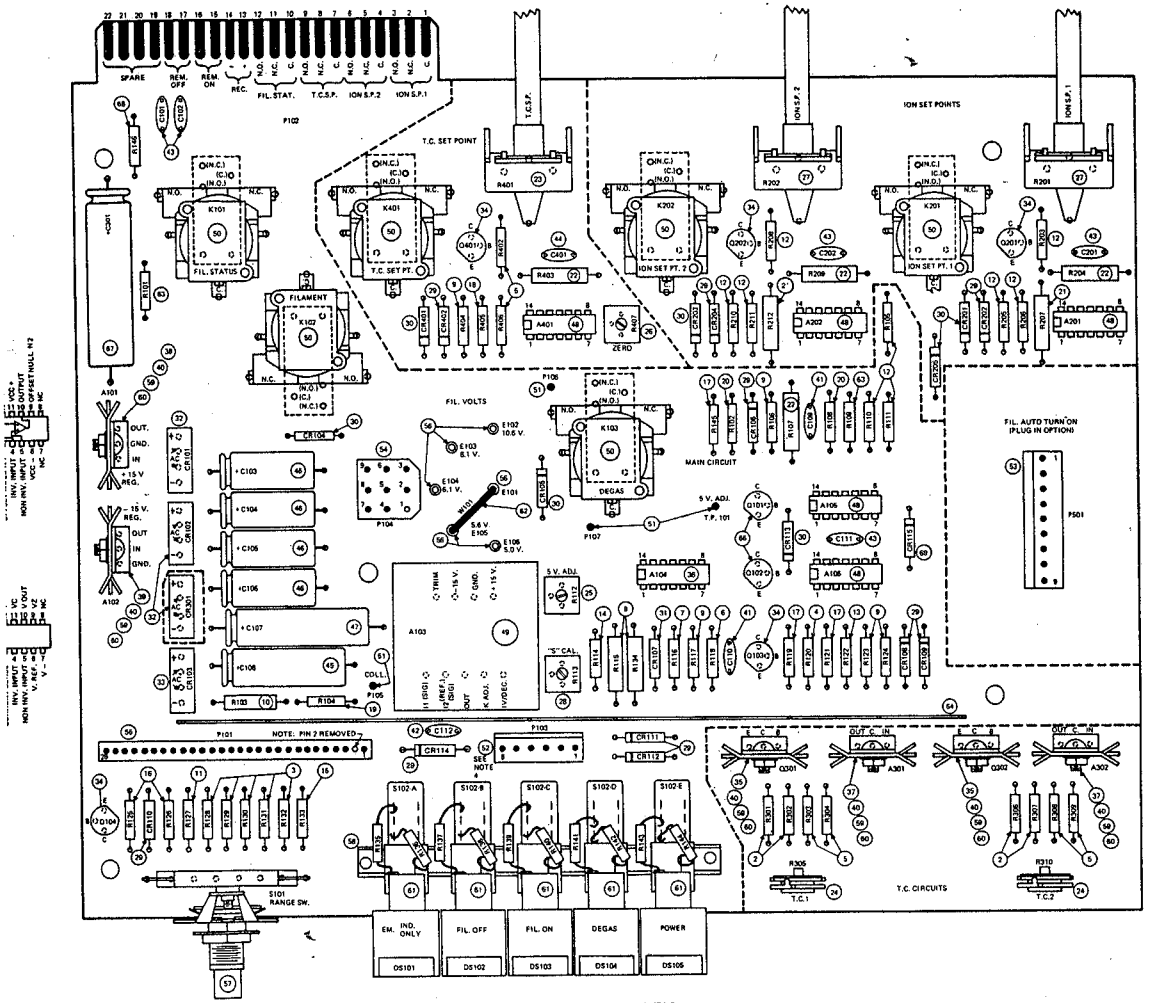
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